Final Report of the Gamma-Gamma Logging Data Integrity Review (GamDat) Team

January 17, 2013

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This report presents the findings from an investigation of Caltrans' gamma-gamma logging (GGL) test data for the presence of irregularities within the data provided by field technicians that may indicate potential inaccurate or inconsistent reported test results. Over 23,000 data files representing unique tests on foundation piles were recovered from computers, network servers, and other file storage media, spanning an 18 year period from 1994 to 2011.

In total, eleven cases of significant findings were identified – eight new cases in addition to the three that were previously known. These cases represent irregularities in test data collected over a four year period from 2004 to 2008. Seven of these include certain observations of copy/paste/delete of blocks of recorded data, renaming of one test file to represent another test, and manual alterations to recorded data. Four involved implied irregular operational practices, the most important type being the use of GGL test data acquired by retesting of one tube to represent conditions in another tube.

The investigative team identified specific procedures and controls that, if applied consistently, will insure the integrity of GGL data in the future.

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Executive Summary

This report presents the findings from an investigation of Caltrans' gamma-gamma logging (GGL) test data for the presence of irregularities within the data provided by field technicians that may indicate potential inaccurate or inconsistent reported test results. Over 23,000 data files representing unique tests on foundation piles were recovered from computers, network servers, and other file storage media, spanning an 18 year period from 1994 to 2011.

In total, eleven cases of significant findings were identified – eight new cases in addition to the three that were previously known. These cases represent irregularities in test data collected over a four year period from 2004 to 2008. Seven of these include certain observations of copy/paste/delete of blocks of recorded data, renaming of one test file to represent another test, and manual alterations to recorded data. Four involved implied irregular operational practices, the most important type being the use of GGL test data acquired by retesting of one tube to represent conditions in another tube.

The investigative team identified specific procedures and controls that, if applied consistently, will insure the integrity of GGL data in the future.

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Preparation of This Report

This report was prepared by the GamDat Investigative Team.

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1 Background

1.1 Gamma-Gamma Logging (GGL)

Gamma-Gamma Logging (GGL) is conducted within Caltrans by the Foundation Testing Branch. It is the primary non-destructive testing technique used to verify that concrete placed by slurry displacement methods in Cast-In-Drilled-Hole (CIDH) piles is dense and homogeneous and meets contract specifications. Since the concrete in CIDH piles is deposited below a fluid surface that precludes visual inspection, Caltrans relies upon this post-placement testing to verify concrete integrity. CIDH piles are primarily used as foundations for bridges and other structures associated with the State highways.

The GGL testing equipment consists of a probe that is lowered into the pile, a winch that raises, lowers, and processes data received from the probe, and a laptop computer running software that records the testing data received from the winch. The GGL probe contains a low-level radioactive source at its tip, a gamma radiation detector located 15 inches above the tip that is internally shielded from the source, and electronics that create a data signal that is sent to the winch. The winch combines depth data with the data received from the probe and transmits it to the laptop computer. To facilitate GGL testing, two-inch diameter PVC inspection pipes are cast into the pile that provide access ports at ground surface so the GGL probe can be lowered and raised through the entire pile depth. The testing equipment with the probe positioned at the bottom of a pile is depicted in Figure 1-1.

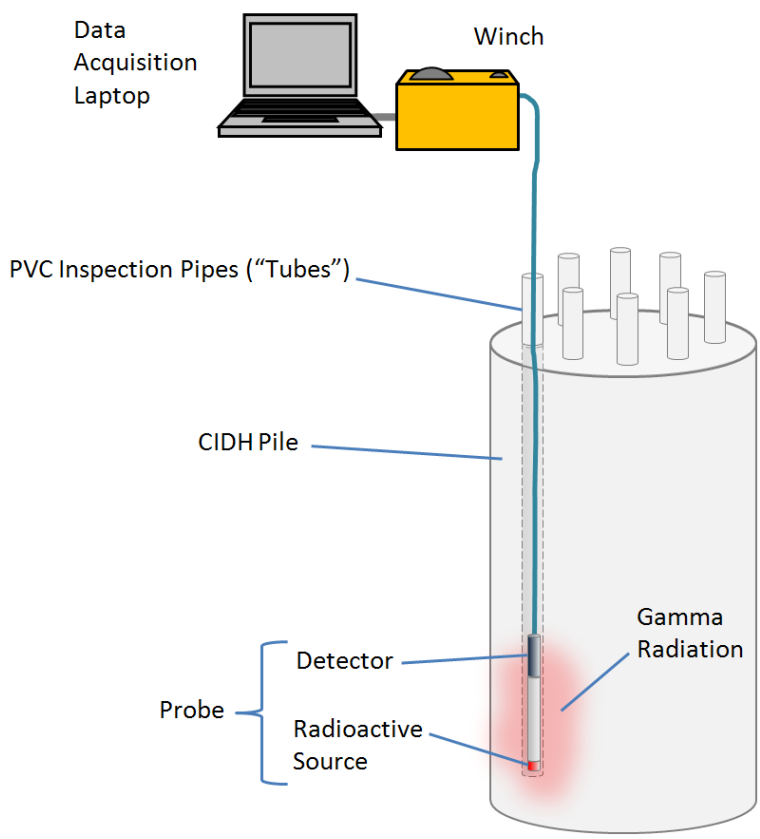

Figure 1-1 – Gamma-Gamma Logging

The radioactive source emits gamma particles (photons) that are back scattered by the pile concrete and received by the detector. The GGL method is based on measurements of the rate at which the photons emitted from the radioactive source are received by the detector. The rate of photons detected by the probe is referred to as *gamma counts* and measured in counts per second (cps). The relationship between concrete density and the amount of back scattered radiation received by the detector is established through calibration testing of the GGL equipment. The probes are calibrated to produce corresponding bulk densities reported in pounds per cubic feet (pcf). The testing process is described in further detail in Section 5 of this report and in California Test Method 233.

1.2 The GamDat Team

1.2.1 Investigative Team

In December of 2011, at the request of Caltrans' Structure Policy Board, a team of Caltrans engineers was assembled and tasked with reviewing the integrity of the Department's archives of GGL data. This group of engineers became the *Gamma-Gamma Logging Data Integrity Review (GamDat) Investigative Team*. As described in the *GamDat Team Charter* (included in Appendix B: GamDat Team Charter), the *Investigative Team* would be responsible for "day-to-day task management and technical work involving data compilation, analysis and documentation." The Investigative Team was given the following tasks:

- Conduct comprehensive fact finding and technical analyses needed to establish a level of confidence regarding the integrity of Gamma-Gamma Logging (GGL) data collected by the Caltrans Foundation Testing Branch (FTB) over time.
- Identify and document all evidence of irregular or manipulated GGL data.
- Conduct the review in a fully transparent manner with advice and review of external stakeholders.
- Identify opportunities to strengthen GGL data integrity.
- Develop a report of findings and recommendations for Caltrans' Structure Policy Board.

This comprehensive technical review process was initiated in response to concerns regarding the handling of evidence of data falsification which occurred in September 2008, and subsequent public disclosure and legislative oversight hearings which occurred in November 2011.

1.2.2 Advisory Team

Since the investigative work was to be carried out by Caltrans staff, including current and former foundation testing personnel, the need for an independent team of outside experts was identified. This team would advise on technical and procedural matters as well as provide independent review of the investigative work. An *Advisory Team* was proposed and described in the GamDat Team Charter as, "knowledgeable stakeholders, both internal and external to Caltrans, who will provide guidance, advice and review through both periodic and ad hoc meetings with the Investigative Team." Subsequently, an Advisory Team was formed that consisted of two independent members and a panel of technical experts.

The two separate members of the *Advisory Team* engaged independently with GamDat on an ad hoc basis. One of the advisors represented Caltrans Office of Audits and Investigations, and the other advisor represented the Federal Highway Administration (FHWA) California Division Office.

The panel of technical experts on the *Advisory Team* was referred to in the Team Charter as the *TPF Project Panel*. The panel was formally organized under a Transportation Pooled Fund Project (TPF) administered and led by the FHWA. Additional documentation about the TPF project can be found in Appendix O: Transportation Pooled Fund Study Solicitation. The *TPF Project Panel* ultimately became known as the *GGL Review Panel* and consisted of 3 technical experts.

The GamDat Team's interaction with the *GGL Review Panel* was limited to two webinar meetings and one full day in-person meeting. The meetings occurred in September and October 2012. In addition to the meetings, the GamDat Team transmitted a draft copy of this report to the *GGL Review Panel* in November 2012 and received written comments back from the panel members.

1.3 Initial Discovery of GGL Data Falsifications

The first GGL data falsification was discovered in September 2008 by an FTB Engineer performing routine pile acceptance analysis on La Sierra Avenue Bridge in Riverside County. The falsification was identified prior to test results being issued and the pile was subsequently retested. In May 2009 the same FTB Engineer independently discovered two additional instances of falsification and notified the FTB Branch Chief. These two additional instances were from GGL testing that preceded the September 2008 incident. Together, these three cases represent the only known GGL data falsifications prior to the work conducted by GamDat.

1.4 Prior Investigations into Caltrans' GGL Data Integrity

Investigative efforts prior to GamDat fell short of what could be considered comprehensive, as the lack of availability of data, the absence of advanced investigative and analysis tools, the partial sampling of data evaluated, or a combination of all three factors posed significant limitations. The GamDat Team is aware of two formal investigative efforts that addressed the falsification of Caltrans' GGL data following the initial discovery of the data falsification in September 2008. The first investigative effort was carried out in late 2008 within the FTB, and resulted in no additional cases being identified. An independent investigation was later carried out by the Federal Highway Administration in mid 2010, confirming three falsification cases.

1.4.1 Caltrans FTB Investigation

In November and December of 2008, a review of GGL records was conducted and the findings documented in an internal memorandum ("*Results of Investigation of Gamma-Gamma Logging Test Data for Duane Wiles Pursuant to Data Fabrication Incident of September 19, 2008"* January 20, 2009), included in Appendix M: January 2009 FTB Investigation Report. The investigation examined a limited set of test documents from eleven projects spanning a period from December 2005 to October 2008.

The investigative work consisted of:

- Comparison of dates on paper field logs to the file modified dates of the GGL data files associated with the test.
- Manual examination of lists of GGL data files looking for sequences containing irregular file save times.

The investigation was limited by the following factors:

- Approximately 20% of the work conducted during the period from December 2005 to October 2008 was reviewed (75 of 352 documented individual crew testing days).
- The review of documents was conducted for only 11 projects.
- The completeness of the review work and the available records was not established.
- Some irregularities were noted in the LAS file modified times and dates, but no further analysis was conducted.
- No analyses were performed to assess GGL data integrity for the reviewed files.
- The findings and methods were not subjected to peer review or review by those who conducted the investigative work.

1.4.2 FHWA Investigation

Following the Caltrans FTB investigation, the FHWA conducted an independent investigation in mid 2010 into the integrity of Caltrans GGL data. The FHWA's analysis tool focused on LAS files obtained from FTB's archive on their network file server. The primary analysis tool was built around pattern matching, where duplicated sequences of 10 or more consecutive density measurements in LAS files were identified.

The extent to which the investigation was comprehensive was limited by the following factors:

- LAS files were the only type examined.
- Systematic analysis of LAS files was limited to pattern matching.
- Non-project related data files were excluded from the investigation, such as calibrations and functionality tests.
- Approximately 62% of available LAS files (as found by GamDat) were determined to be in the collection of data obtained by the FHWA. The remaining LAS files were not available to the FHWA at the time due to a number of factors, including:
    - The FTB Archive did not store all available files, as many files were only available on staff computers.
    - A Novell-based 255 file path character limitation prevented copying of many LAS files during the data assimilation phase.
    - Many LAS files were stored in directories on the FTB Archive not named by bridge number, and therefore excluded during data copying.

The FHWA investigation confirmed the three falsification cases, as documented in an internal memorandum from the FHWA (*"ACTION: Gamma Gamma Testing, Review of Caltrans Records"* November 17, 2011. B. Forrester, Director Office of Infrastructure, to V. Mammano, Division Administrator). A copy of this document is included in Appendix N: November 2011 FHWA Investigation Report.

2 Overview and Scope of Work

The GamDat team's work was divided into seven tasks that were grouped in to four general stages as shown in Figure 2-1. For the most part these stages progressed sequentially, building off of prior work. However, some of the tasks were carried out in parallel. These tasks are described in more detail in the *GamDat Team Charter*, approved on December 21, 2011, and included in Appendix B: GamDat Team Charter.

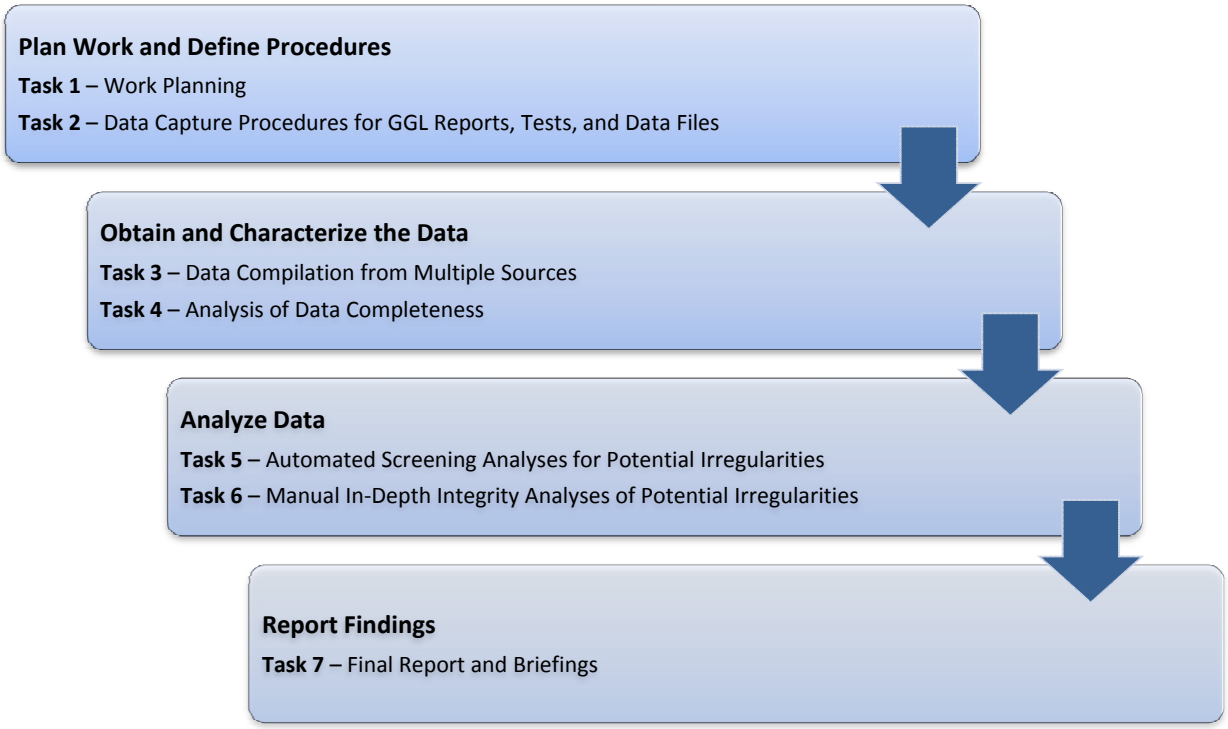

Figure 2-1 – Overview of Tasks

2.1 Task 1 - Work Planning

The GamDat effort was initiated by obtaining sponsor approval for work scope, identifying members of Investigative and Advisory Teams, and obtaining management approvals for time and resources to carry out the work. Task 1 resulted in the preparation and approval of the GamDat Team Charter.

2.2 Task 2 - Data Capture Procedures for GGL Reports, Tests, and Data Files

Under Task 2, all relevant data sources were identified and the tools and framework established to store and process the data. Task 2 included the following:

- Identifying the primary sources of relevant GGL data and reports.
- Constructing an initial data model/dictionary and designed a database to store and organize the collected data.
- Coordinating with HQ-IT to set up a secure virtual server instance on the Caltrans internal network for compilation and analysis of all relevant data sources.

- Instituting both organizational and technical protocols for team members and key personnel in HQ-IT for transfer of secure data over the Caltrans network.

2.3 Task 3 - Data Compilation from Multiple Sources

Task 3 consisted of the compilation of data needed for the GamDat work. There were two primary groups of data that needed to be compiled to carry out analyses:

- Metadata extracted from GGL Reports & Tests
- GGL Data Files.

The metadata (i.e. information about the data) from GGL Reports and GGL Tests were used to establish a baseline of what constitutes all tests conducted by Caltrans over time. The *GGL Data Files* contain the actual test data (i.e. depth, gamma count, density) that were the subject of integrity analyses. The integrity analyses were carried out for the most part with GGL data files alone, while the metadata from GGL Reports and Tests provided the necessary basis to carry out the completeness analysis, or *gap analysis*, under Task 4.

2.4 Task 4 - Analysis of Data Completeness

The purpose of Task 4 was to assess the overall availability of data files relative to documented occurrences of tests having been conducted. This assessment resulted in a characterization of the completeness of, or gap within the collection of data files relative to both records retention standards of the day and current standards. The establishment of data completeness allowed the team to report its findings in a context that more accurately characterized the population of GGL Data Files, GGL Test, and the gaps.

2.5 Task 5 - Automated Screening Analyses for Potential Irregularities

Task 5 was comprised of the development, testing, and execution of a suite of automated computer-based screening tools. The screening tools were applied to the collection of gamma-gamma logging (GGL) data files amassed by the team under Task 3. The types of analysis tools used are presented in Table 2-1 and detailed discussion is presented in later sections of this report.

Type of Analysis	Description	Section Presented
Pattern Matching	Identify occurrences of repeated density sequences both within a single data file and across all data files in the data collection. Identify instances of full data sequence replication from file renaming.	5.3, 5.4
Time Stamp	Identify inconsistencies in file dates and times or in testing chronology in a sequence of multiple tests within a pile.	5.5, 5.6
Calibration Constant	Identify inconsistencies in inferred density values relative to gamma count values within a single test file.	5.7
Depth Consistency	Identify inconsistencies between depth parameters embedded in a data file's header relative to depth data within the data set.	5.8
Fidelity	Verify the consistency of reported depth-density value pairs in data files.	5.9

Table 2-1 – Types of Analyses

2.6 Task 6 - Manual In-Depth Integrity Analyses of Potential Irregularities

The GamDat Team conducted manual in-depth integrity analysis (manual analysis) for each potentially irregular test file (or set of files). The objective of the manual analysis was to gain additional information for use in understanding and explaining observed irregularities. During the manual analysis evaluations, the Team considered all available information including, but not limited to, the data's path from technician in the field to engineer for analysis, its association with other related tests, and documents generated by technicians and engineers.

2.7 Task 7 - Final Report and Briefings

The final task was the preparation of this Final Report to the Sponsors.

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3 Compilation of Data

As first order of work, it was necessary to identify and compile two key collections of data that would be used by the team over the course of the investigation. First, *GGL Data Files* would be the subject of all subsequent analyses, and irregularities found in these files evaluated. Second, data obtained from *GGL Reports* and *GGL Tests* would be used to establish, to the extent feasible, a comprehensive list of all reported GGL tests carried out by Caltrans over time. Definitions are presented in Table 3-1 below.

Term	Definition
GGL Report	The reportable product of a gamma-gamma logging (GGL) investigation performed by the Foundation Testing Branch (FTB) and provided to the Office of Structure Construction (OSC). Typically, one or more GGL Reports were generated for each construction project involving a Cast-In-Drilled-Hole (CIDH) pile where drilling slurry was used. A single GGL Report may contain results for one or more GGL Tests. A GGL Report contains information which ties each GGL Test to a specific location (tube), testing date, and construction contract. Available GGL Reports were assembled from records maintained by OSC, FTB, and Geotechnical Services (GS).
GGL Test	The act of collecting a unique GGL data set at a specific location (foundation-pile-tube) on a specific date for a specific purpose, the results of which were ultimately reported in a GGL Report to OSC.
GGL Data File	Any electronic data file that was either auto-generated during a GGL Test or used for subsequent analysis, interpretation, or presentation. Typically, a GGL Data File contains general test information followed by rows of data measurements (e.g. depth, gamma count, speed, inferred density). Multiple GGL Data Files can be associated with a single GGL Test. Auto-generated files from current Mount Sopris test equipment can include a binary raw data (RD) file and/or an ASCII text file (LAS or LogShell) per test. ASCII text-based data are typically imported into software (e.g. Excel or Origin) for purposes of analysis and presentation in reports, thus resulting in the creation of additional analysis files (e.g. XLS, OPJ) containing results from one or more tests.

Table 3-1 – Definitions of GGL Report, Test, and Data File

3.1 GGL Data Files

3.1.1 File Types of Interest

Five types of GGL Data Files were identified, representing a combination of data files automatically generated by the GGL software as well as files generated for analysis and presentation by the engineer. The five types of files are described in Table 3-2.

GGL Data File Type	Windows File Extension	Software Used to Generate File	Approximate Years of Usage	Delivered By FTB Staff
LogShell (LS)	varies, user-specified	Mount Sopris *LogShell*	1994-2004	Technician
Raw Data (RD)	.RD	Mount Sopris *MSLog*	2002-present	Technician
Log ASCII Standard (LAS)	.LAS	Mount Sopris *MSLog LASwriter*	2002-present	Technician
Excel	.XLS, .XLSX	Microsoft *Excel*	1994-present	Engineer
Origin	.OPJ	OriginLab *Origin*	2000-present	Engineer

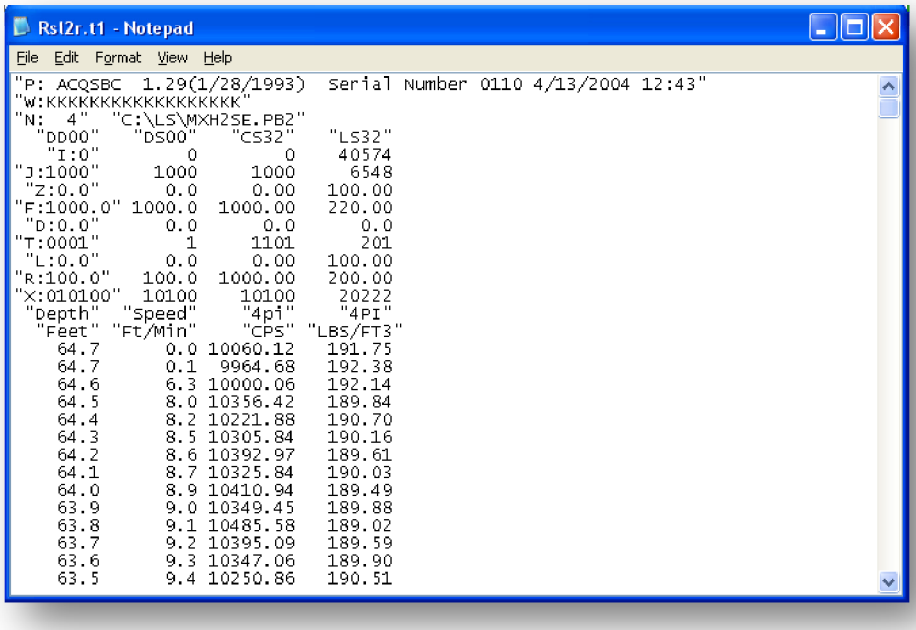
Table 3-2 – GGL Data File Types

RD, LAS, and LS files are generated by two versions of data acquisition software from Mount Sopris, the manufacturer of the GGL test equipment. The earliest file of this type discovered in Caltrans records dates back to a GGL Report from April 3, 1994, generated using *LogShell* software. A gradual transition to an updated version of software, *MSLog,* occurred between October 2002 and April 2004. During this time both versions of software were used, resulting in file types of one or the other depending on whether the equipment used had been upgraded at that time.

During the data file compilation process, the *Excel* and *Origin* files associated with GGL testing were also captured. General information about those files was gathered and stored, including the computer or server where the file was found, filepath, filename, and date/time. Excel files are used by Engineers for the analysis of GGL data; they are complex in nature and are not standardized. Origin files are used for the display of data inside the report after analysis is completed. Due to their complexity and non-standard nature, automated screening tools were not developed or applied to the Excel or Origin files. Additionally, systematic manual analysis of each Excel file was considered to be exceedingly difficult and outside of what could reasonably be accomplished by the GamDat effort. However, as part of the Manual Analysis follow-up of irregularities found with the automated screening tools, some Excel and Origin files were evaluated on a case by case basis.

3.1.2 LogShell (LS) Files

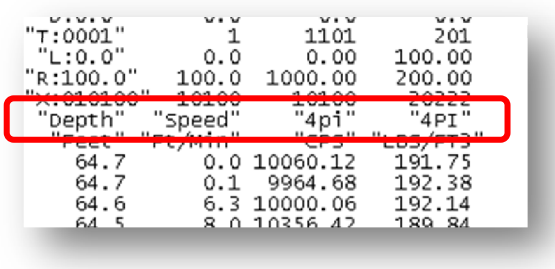
LogShell files are generated by the Mount Sopris *LogShell* software at the completion of the testing process. LogShell (LS) files are ASCII text files that can be opened and viewed using common word processing software (e.g. Notepad, Wordpad, Word, etc.) or spreadsheet software (e.g. Excel). Typical of all LogShell files are that the first 15 rows contain header info, and data are contained in rows 16 and below. An example of a typical LogShell data file is shown in Figure 3-1.



```
Rsl2r.t1 - Notepad
File  Edit  Format  View  Help
"P: ACQSBC  1.29(1/28/1993)  Serial Number 0110 4/13/2004 12:43"
"W:KKKKKKKKKKKKKKKKKK"
"N:  4"  "C:\LS\MXH2SE.PB2"
  "DD00"    "DS00"    "CS32"    "LS32"
   "I:0"        0         0     40574
"J:1000"     1000      1000      6548
 "Z:0.0"      0.0      0.00    100.00
"F:1000.0" 1000.0   1000.00    220.00
 "D:0.0"      0.0       0.0       0.0
"T:0001"        1      1101       201
 "L:0.0"      0.0      0.00    100.00
"R:100.0"   100.0   1000.00    200.00
"X:010100"  10100     10100     20222
 "Depth"  "Speed"     "4pi"     "4PI"
  "Feet" "Ft/Min"     "CPS" "LBS/FT3"
    64.7      0.0 10060.12    191.75
    64.7      0.1  9964.68    192.38
    64.6      6.3 10000.06    192.14
    64.5      8.0 10356.42    189.84
    64.4      8.2 10221.88    190.70
    64.3      8.5 10305.84    190.16
    64.2      8.6 10392.97    189.61
    64.1      8.7 10325.84    190.03
    64.0      8.9 10410.94    189.49
    63.9      9.0 10349.45    189.88
    63.8      9.1 10485.58    189.02
    63.7      9.2 10395.09    189.59
    63.6      9.3 10347.06    189.90
    63.5      9.4 10250.86    190.51
```

Figure 3-1 – Typical LogShell File Structure

LogShell files were challenging to identify amongst other files, since no consistent file extension was assigned nor enforced by the LogShell application. Typically, the technician would assign a filename using the tube ID as the extension, for example, "BENT2P4.T1," to designate tube 1 of pile 4 at bent 2. In other cases, the technician would allow the software to automatically assign the file extension, resulting in filenames such as "B2P4T1.SA0," "B2P4T2.SA1," and so forth. In order to more positively identify LogShell files, an open-source application, *Super Finder* by Freesoftland, was used. This application searched through all ASCII text files for the presence of a specific string of standard characters found on the 14th line in every LogShell file, as shown in Figure 3-2.



```
"T:0001"        1      1101       201
 "L:0.0"      0.0      0.00    100.00
"R:100.0"   100.0   1000.00    200.00
"X:010100"  10100     10100     20222
 "Depth"  "Speed"     "4pi"     "4PI"
  "Feet" "Ft/Min"     "CPS" "LBS/FT3"
    64.7      0.0 10060.12    191.75
    64.7      0.1  9964.68    192.38
    64.6      6.3 10000.06    192.14
    64.5      8.0 10356.42    189.84
```

Figure 3-2 – Standard String in LogShell File

The following data elements were extracted from all LogShell files and stored in a database for further evaluation and analysis (described in Appendix K: Codes and Database):

- File properties
  - Filename
  - Directory path where file was found

- Size
- Creation and modification dates

- All elements in the header block in the first 16 rows of the file
- All four columns of data, including:
  - Depth
  - Probe speed
  - Counts per sample
  - Density

3.1.3 Raw Data (RD) Files

RD files are generated by the Mount Sopris *MSLog* software at the completion of the testing process. RD files are encoded as hexadecimal in a proprietary data format. RD files were not systematically retained in early FTB practice, and, as such only a small sub-set of LAS files were found to have their corresponding RD files.
For the most part, the files cannot be easily read using common text editing tools (e.g. *Notepad, Word*). Although some of the hex translates directly to ASCII characters, a hexadecimal file editor (such as *HxD* shown in Figure 3-3) or other coding tools are needed to effectively extract key data.

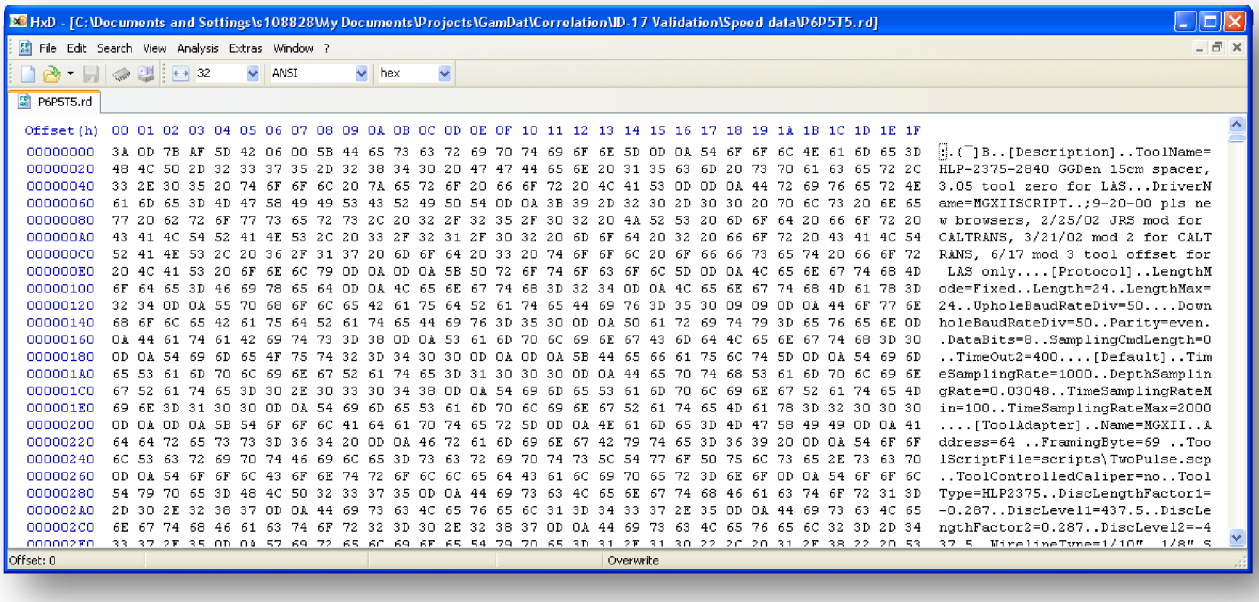


Figure 3-3 – Reading RD Files with a Hex Editor

RD files were identified based on having the filename extension .RD, for example "BENT2P4T1.RD."

The following data elements were extracted from all RD files and stored in a database for further evaluation and analysis (described in Appendix K: Codes and Database):

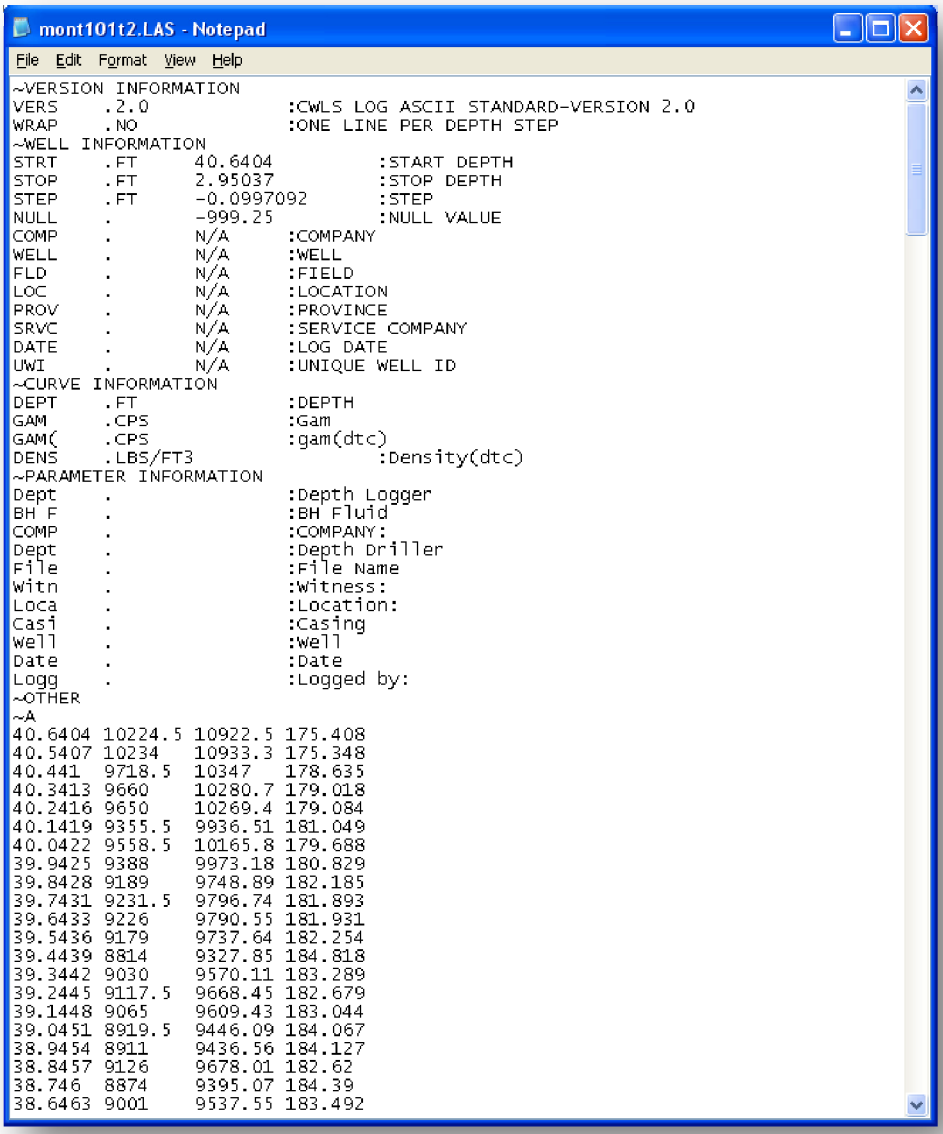
- File properties
  - Filename
  - Directory path where file was found

    - Size
    - Creation and modification dates
- Elements in the header, when present, including:
    - Calibration factors
    - Logger
    - Location
    - Tool type
    - Company
- Data, including:
    - Depth
    - Probe speed
    - Counts per sample

3.1.4 Log ASCII Standard (LAS) Files

LAS files are generated by the Mount Sopris *MSLog* software at the completion of the testing process by a module within the software called *LASwriter*. LAS files appear to be generated automatically by *LASwriter* only after the RD file is written. In most cases the files have the same time stamp. However, there were instances found where the writing of the LAS file had occurred tens of seconds later than the RD file. A combination of factors involving the interaction of *MSLog, LASwriter*, and the *Windows* operating system likely contributed to this observed latency. Although the specific cause is not well understood, this amount of time was considered as a factor in some of the more focused time-based analyses presented later in this report.

LAS files are ASCII text files that can be opened and viewed using common word processing software (e.g. *Notepad, Wordpad, Word*, etc.) or spreadsheet software (e.g. *Excel*). Typical of all LAS files are that the top rows contain header info, and data are contained below. The number of rows in the header can vary, depending upon the configuration selected by the operator. An example of a typical LAS data file is shown in Figure 3-4.



mont101t2.LAS - Notepad

File Edit Format View Help

```
~VERSION INFORMATION
VERS     .2.0              :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP     .NO               :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT     .FT      40.6404          :START DEPTH
STOP     .FT      2.95037          :STOP DEPTH
STEP     .FT      -0.0997092       :STEP
NULL     .        -999.25          :NULL VALUE
COMP     .        N/A      :COMPANY
WELL     .        N/A      :WELL
FLD      .        N/A      :FIELD
LOC      .        N/A      :LOCATION
PROV     .        N/A      :PROVINCE
SRVC     .        N/A      :SERVICE COMPANY
DATE     .        N/A      :LOG DATE
UWI      .        N/A      :UNIQUE WELL ID
~CURVE INFORMATION
DEPT     .FT               :DEPTH
GAM      .CPS              :Gam
GAM(     .CPS              :gam(dtc)
DENS     .LBS/FT3                  :Density(dtc)
~PARAMETER INFORMATION
Dept     .                 :Depth Logger
BH F     .                 :BH Fluid
COMP     .                 :COMPANY:
Dept     .                 :Depth Driller
File     .                 :File Name
Witn     .                 :Witness:
Loca     .                 :Location:
Casi     .                 :Casing
Well     .                 :Well
Date     .                 :Date
Logg     .                 :Logged by:
~OTHER
~A
40.6404 10224.5 10922.5 175.408
40.5407 10234   10933.3 175.348
40.441  9718.5  10347   178.635
40.3413 9660    10280.7 179.018
40.2416 9650    10269.4 179.084
40.1419 9355.5  9936.51 181.049
40.0422 9558.5  10165.8 179.688
39.9425 9388    9973.18 180.829
39.8428 9189    9748.89 182.185
39.7431 9231.5  9796.74 181.893
39.6433 9226    9790.55 181.931
39.5436 9179    9737.64 182.254
39.4439 8814    9327.85 184.818
39.3442 9030    9570.11 183.289
39.2445 9117.5  9668.45 182.679
39.1448 9065    9609.43 183.044
39.0451 8919.5  9446.09 184.067
38.9454 8911    9436.56 184.127
38.8457 9126    9678.01 182.62
38.746  8874    9395.07 184.39
38.6463 9001    9537.55 183.492
```

Figure 3-4 – Typical LAS File Structure

LAS files were identified based on having the filename extension .LAS, for example “BENT2P4T1.LAS.” Furthermore, the searching application also examined content of LAS files for the presence of a specific string of characters found in every LAS file ("~VERSION INFORMATION").

The following data elements were extracted from all LAS files and stored in a database for further evaluation and analysis (described in Appendix K: Codes and Database):

- File properties
  - Filename
  - Directory path where file was found
  - Size

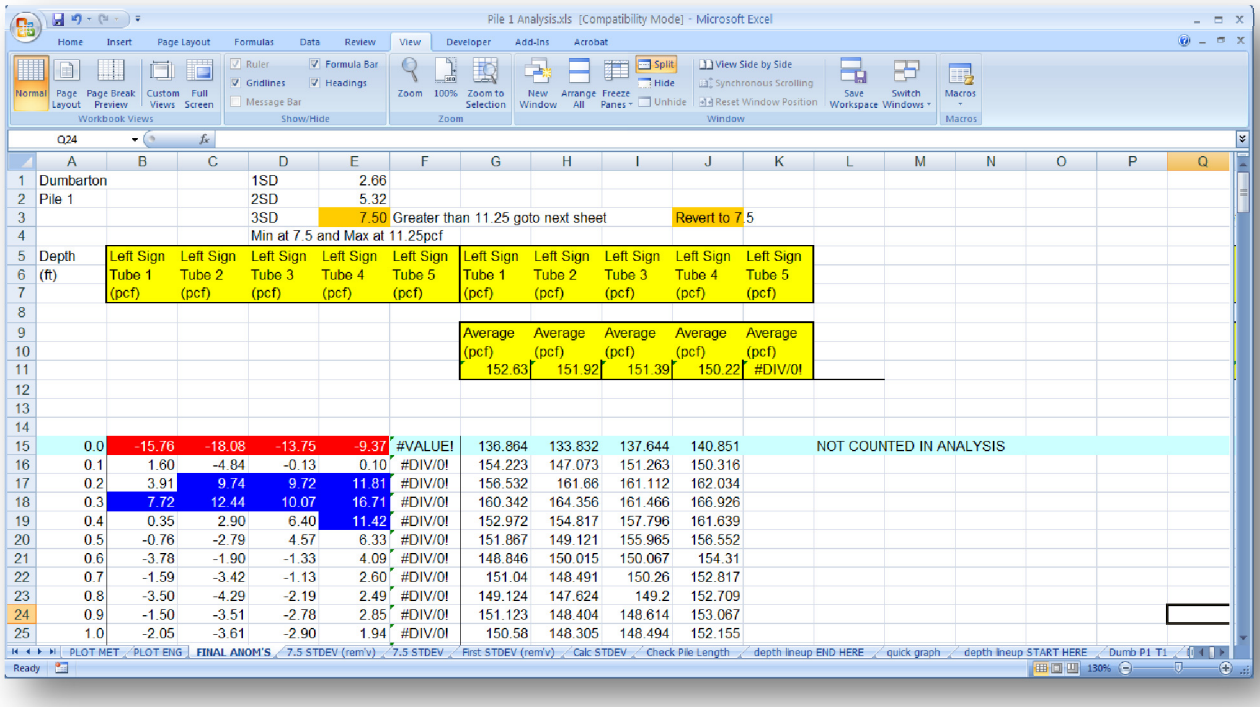
    - Creation and modification dates
- Depth data
    - Start depth
    - Stop depth
    - Depth increment
- Elements in the header found in some files, including:
    - Location
    - Date
    - Logged by
    - Recorded by
- All four columns of data, including:
    - Depth
    - Counts per sample
    - Counts per sample, dead time corrected (DTC)
    - Density

3.1.5 Excel Files

Excel spreadsheets are used by engineers to process and analyze GGL data. Typically the Excel files contain multiple worksheets (or tabs) that include the data for a pile or group of piles in various stages of processing. No standard worksheet format appears to exist, and many were found with various format and structure. However, most of the files included worksheets for:

- Original data from multiple tubes from LAS or LS file.
- Depth-shifted data to align for top of concrete.
- Calculation of mean and standard deviation.
- Correction of density data to account for water filled tubes.
- Identification of anomalies.
- Data used for export for plotting in Origin application.

An example of one engineer's spreadsheet is presented in Figure 3-5.



	A	B	C	D	E	F	G	H	I	J	K	L
1	Dumbarton			1SD	2.66							
2	Pile 1			2SD	5.32							
3				3SD	7.50	Greater than 11.25 goto next sheet				Revert to 7.5		
4				Min at 7.5 and Max at 11.25pcf								
5	Depth	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	Left Sign	
6	(ft)	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	Tube 1	Tube 2	Tube 3	Tube 4	Tube 5	
7		(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	
8												
9							Average	Average	Average	Average	Average	
10							(pcf)	(pcf)	(pcf)	(pcf)	(pcf)	
11							152.63	151.92	151.39	150.22	#DIV/0!	
12												
13												
14												
15	0.0	-15.76	-18.08	-13.75	-9.37	#VALUE!	136.864	133.832	137.644	140.851		NOT COUNTED IN ANALYSIS
16	0.1	1.60	-4.84	-0.13	0.10	#DIV/0!	154.223	147.073	151.263	150.316		
17	0.2	3.91	9.74	9.72	11.81	#DIV/0!	156.532	161.66	161.112	162.034		
18	0.3	7.72	12.44	10.07	16.71	#DIV/0!	160.342	164.356	161.466	166.926		
19	0.4	0.35	2.90	6.40	11.42	#DIV/0!	152.972	154.817	157.796	161.639		
20	0.5	-0.76	-2.79	4.57	6.33	#DIV/0!	151.867	149.121	155.965	156.552		
21	0.6	-3.78	-1.90	-1.33	4.09	#DIV/0!	148.846	150.015	150.067	154.31		
22	0.7	-1.59	-3.42	-1.13	2.60	#DIV/0!	151.04	148.491	150.26	152.817		
23	0.8	-3.50	-4.29	-2.19	2.49	#DIV/0!	149.124	147.624	149.2	152.709		
24	0.9	-1.50	-3.51	-2.78	2.85	#DIV/0!	151.123	148.404	148.614	153.067		
25	1.0	-2.05	-3.61	-2.90	1.94	#DIV/0!	150.58	148.305	148.494	152.155		

Figure 3-5 – Typical Excel File

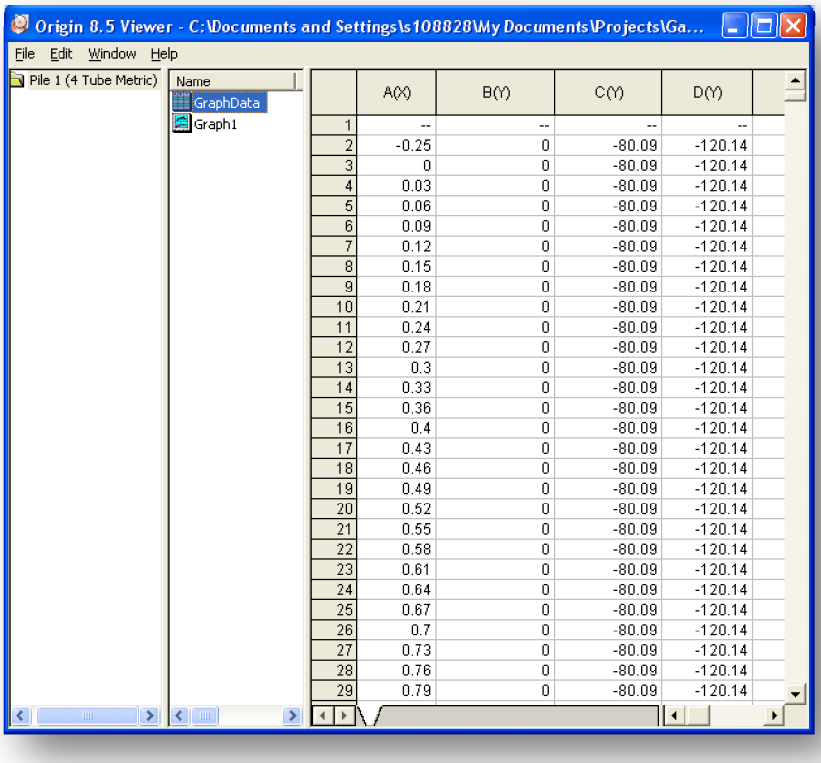
Excel files containing GGL data were identified based on the premise that the directory path in which the file was found contained keywords such as “gamma,” “gam,” or “GGL.” Excel files use the extension “.XLS” or “.XLSX.”

The following file property information was extracted for all Excel files and stored in a database for further evaluation (described in Appendix K: Codes and Database):

- Filename
- Directory path where file was found
- Size
- Creation and modification dates

3.1.6 Origin Files

Origin is an application used by FTB engineers to prepare plots of GGL data for presentation in reports. Typically, columns and rows of data are copied from Excel files and pasted into Origin worksheets. The data are then used to generate plots for inclusion in reports as shown in Figure 3-6. Although the reporting presentation is fairly consistent in overall visual organization, some variations in the files were observed. These include the order of columns of data, inclusion of single or multiple piles within a file, and order of depth measurements. This variability made it difficult to implement programmatic tools to carry out systematic analyses using the Origin files.



	A(X)	B(Y)	C(Y)	D(Y)
1	--	--	--	--
2	-0.25	0	-80.09	-120.14
3	0	0	-80.09	-120.14
4	0.03	0	-80.09	-120.14
5	0.06	0	-80.09	-120.14
6	0.09	0	-80.09	-120.14
7	0.12	0	-80.09	-120.14
8	0.15	0	-80.09	-120.14
9	0.18	0	-80.09	-120.14
10	0.21	0	-80.09	-120.14
11	0.24	0	-80.09	-120.14
12	0.27	0	-80.09	-120.14
13	0.3	0	-80.09	-120.14
14	0.33	0	-80.09	-120.14
15	0.36	0	-80.09	-120.14
16	0.4	0	-80.09	-120.14
17	0.43	0	-80.09	-120.14
18	0.46	0	-80.09	-120.14
19	0.49	0	-80.09	-120.14
20	0.52	0	-80.09	-120.14
21	0.55	0	-80.09	-120.14
22	0.58	0	-80.09	-120.14
23	0.61	0	-80.09	-120.14
24	0.64	0	-80.09	-120.14
25	0.67	0	-80.09	-120.14
26	0.7	0	-80.09	-120.14
27	0.73	0	-80.09	-120.14
28	0.76	0	-80.09	-120.14
29	0.79	0	-80.09	-120.14

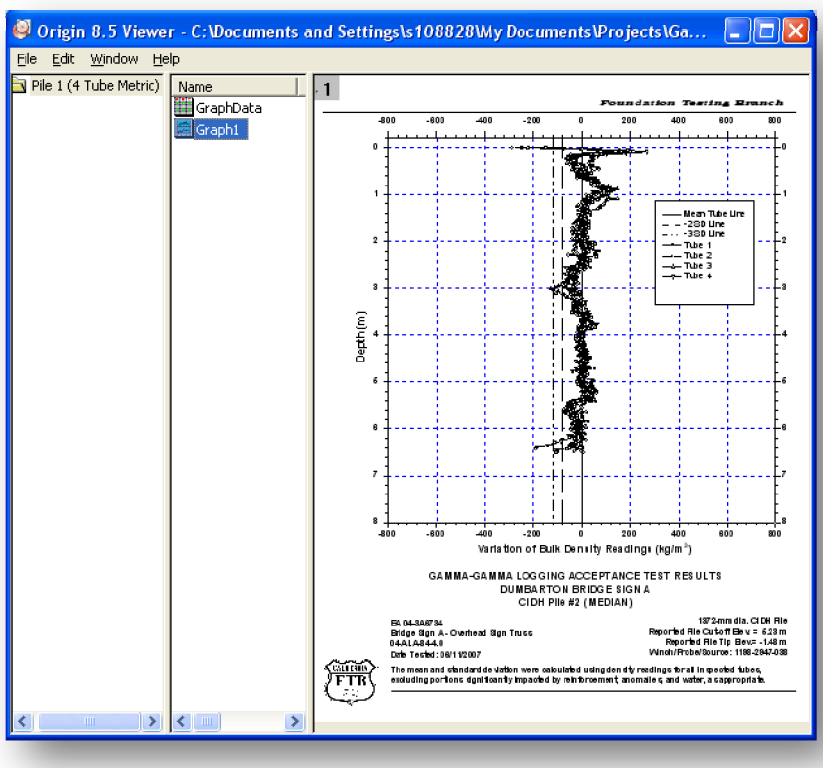


Figure 3-6 – Typical Origin File

Origin files containing GGL data were identified based on the premise that the directory path in which the file was found contained keywords such as “gamma,” “gam,” or “GGL.” Origin files use the file extension “.OPJ.”

The following file property information was extracted for all Origin files and stored in a database for further evaluation (described in Appendix K: Codes and Database):

- Filename
- Directory path where file was found
- Size
- Creation and modification dates

3.2 The Search for GGL Data Files

Locating and assembling the collection of all GGL data files required an extensive search and file gathering process. Although many of the data files of interest were generally archived on network servers, there appeared to be no consistent archiving practices within the FTB over the years that ensured that all data files were archived and were not subsequently modified or removed. As such, several different but redundant data storage sources were pursued, including:

- Network file server directories accessible to all FTB staff (commonly referred to by staff as the “Z:” drive, or the “FTB Archive”).
- Network file server directories established for individuals for backup (commonly referred to by staff as their “L:” drive).
- Field laptop computers used by technicians.
- Office desktop and laptop workstations used by engineers, technicians, and FTB managers.
- All physical data storage media that could have been used for data transfer or backup (e.g. floppy disks, CDs, DVDs, external hard drives, flash drives, SD cards, etc.).

3.2.1 Physical Search for Data File Storage Media

Shortly after the GamDat team was initiated, a physical search for all digital storage media was conducted. The objective of the search was to recover old computer server hard drives and any digital media used to store or convey data files in the past. All spaces occupied by FTB were searched and personnel were asked to turn in any digital storage media they may have had in their personal work areas. The search areas included unoccupied cubicles, vehicles, the FTB warehouse/shop, shipping containers, and the radiation building.

The physical search resulted in the recovery of floppy disks, USB flash drives, SD cards, CD’s, DVD’s, and two hard drives that had been removed in 2007 from a local server maintained by FTB. The server/computer had been located in the FTB offices until it began to fail and was shut down. The server contained two hard drives (identified as “WD600” and “WD1200” drives) and both were recovered from a shelf in the FTB warehouse. No data could be recovered from one of the hard drives (WD600). (A report from a data recovery company that worked on the drive is provided in Appendix L: FTB Server Hard Drive Recovery.) Data files were recovered from the second hard drive that turned out to be an important source of unique files not found in any other data collection. The significance of these files is discussed later in this section.

3.2.2 Caltrans Information Technology (IT) Forensics Efforts

The GamDat Team enlisted the help of Caltrans' Information Technology (IT) Forensics Unit to acquire all data from network storage and individual computers. When possible, specialized data forensic tools were used to recover previously deleted files.

Five sets of network file server data (i.e. "FTB Archives" and "L:" drive) were obtained, going back as far as 2007. These represent snapshots in time of project and data files archived by FTB staff. Additional details about the five file server data sets are summarized in Table 3-3.

Data Set	Source of Data	Recovered Data?	Recovered Deleted Files?
March 2007 FTB Archive	Hard drive from crashed FTB server (WD1200)	Yes	Yes
	Hard drive from crashed FTB server (WD600)	No	No
January 2009 FTB Archive	Backup of files made by FTB staff	Yes	No
August 2010 FTB Archive	Files provided by FTB at request of FHWA	Yes	No
January 2012 FTB Archive	Obtained from current operational network server	Yes	No
January 2012 "L:" Drive	Obtained from current operational network server	Yes	No

Table 3-3 – FTB Servers Examined

Between January and February 2012, the IT Forensics Unit gathered all available laptop and desktop computers used by current and former FTB staff. The list of computers was generated using current and past organizational charts of FTB staff and was extended to include other computers that may have been used for GGL data processing or storage. Although every effort was made to acquire these computers, no complete reference or inventory existed to verify that the computers gathered represent all computers used by FTB over the time period investigated. Furthermore, computers past their service life (typically 4 to 6 years and older) were no longer available to the team.

Recovery of previously deleted files was carried out for all computers. The final inventory of computers was comprised of 22 laptop and desktop workstations as shown in Table 3-4. For these individual computers, complete copies of the entire hard drive, including operating system and program files, were obtained.

Computer Make Model	Type	Serial Number	CT Inventory Tag Number	Recovered Data?	Recovered Deleted Files?
IBM Lenovo R61	Laptop	L3K2670	11146	Yes	Yes
IBM Lenovo R61	Laptop	L3K2719	11138	Yes	Yes
Panasonic Toughbook	Laptop	5DKYA09315	Tag Missing	Yes	Yes
Panasonic Toughbook	Laptop	5FKYA26805	94821	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA31895	94823	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA31903	94827	Yes	Yes
HP 4400	Desktop	2UA7281HZW	DHQ07535	Yes	Yes
HP 4300	Desktop	2UA54601HK	95855	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA27981	94822	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA31845	94824	Yes	Yes
IBM ThinkPad R52	Laptop	LVN3921	D59101102	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA31873	94825	Yes	Yes
HP 4300	Desktop	2UA606K6W5	DHQ000922	Yes	Yes
Dell 810	Laptop	J952T71	94929	Yes	Yes
IBM Lenovo R61	Laptop	L3K2669	DHQ11145	Yes	Yes
HP 4300	Desktop	2UA61818KL	DHQ004664	Yes	Yes
IBM Lenovo R61	Laptop	L3K2665	DHQ11147	Yes	Yes
HP 4400	Desktop	2UA7281HZF	DHQ07534	Yes	Yes
Panasonic Toughbook	Laptop	4EKSA35857	Tag Missing	Yes	Yes
Panasonic Toughbook	Laptop	5FKSA31875	94826	Yes	Yes
HP 4400	Desktop	2UA7281HZD	DHQ07524	Yes	Yes
Dell Latitude E6400	Laptop	CC63WN1	DHQ20145	Yes	Yes

Table 3-4 – FTB Workstations Examined

3.2.3 The GamDat Server

A dedicated and secure internal server was set up by Caltrans IT for use exclusively by the GamDat team. All files obtained through the media search and forensic file recovery process were stored on the GamDat server for

subsequent analysis. In aggregate, over 2.6 million files with a combined size of over 1 TB were collected, including both GGL data files relevant to the investigation as well as files not related to gamma testing (e.g. operating system files, program files, settings files, etc.). In order to minimize inadvertent modifications to the file collection, access to the server was restricted to one IT Forensics staff member, the GamDat team leader, and the software programmer on the GamDat team.

3.3 Identifying all Unique GGL Data Files

With the collection of files on the GamDat server, a process was carried out to identify the five types of files (i.e. LS, RD, LAS, XLS, and OPJ), their file names and file paths, and duplicate copies. A summary of total counts are presented below in Table 3-5 and described in subsequent sections.

	LAS	RD	LS	XLS	OPJ	GGL Tests (LAS+LS)
	Files Generated by Mt Sopris Equipment					
Total of All Files Found (Including Duplicates)	90,397	44,528	23,420	30,535	35,224	N/A
Unique Files (Duplicates Removed)	14,788	11,514	8,950	12,152	8,785	**23,738**
Unique Files Parsed (i.e. Gamma Data and Header Extracted)	14,451	8,944	8,919	N/A	N/A	**23,370**
Unique Files Cataloged (i.e. Corrupted, Blank, Non-Standard)	337	2,570	31	N/A	N/A	**368**

Table 3-5 – Totals for GGL Data Files

3.3.1 Identifying All Valid GGL Data Files, Assignment of File ID

The software application, *Super Finder,* was used to search through the millions of files (not all being relevant to the investigation) and generate lists of GGL data files. For each search of the five file types, the application produced a text file output which included filename, file path, date, and time. The five output files were then combined into a spreadsheet and total counts tabulated. A more thorough explanation of the codes and logic used to assess the validity of files is presented in Appendix K: Codes and Database.

A numeric identifier, called the *File ID*, was assigned to each file found for each type of file. As an example, Figure 3-7 illustrates a collection of 22 files of a single type (e.g. LAS files), where each file found is assigned a File ID.

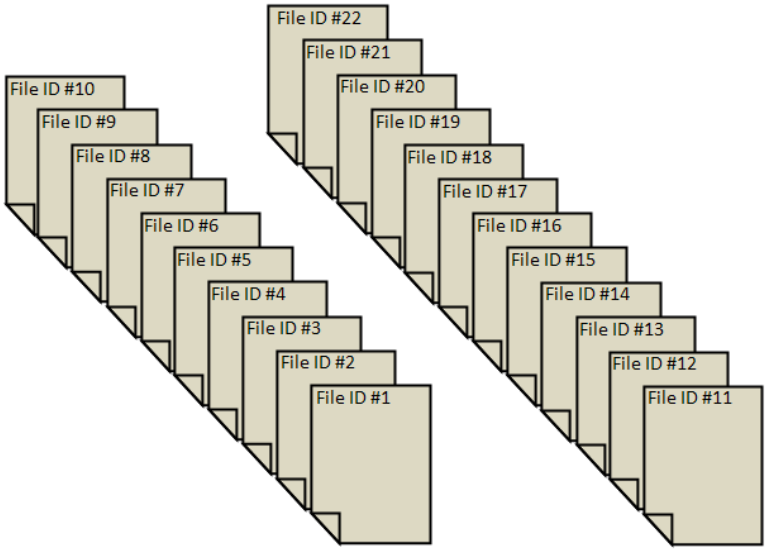


Figure 3-7 – File ID Assignment

As summarized in Table 3-5, a total of 224,104 files associated with GGL testing were found during this process of which 158,345 were determined to be of the type specifically generated by Mount Sopris GGL data acquisition equipment (i.e. RD, LAS, or LS). These totals include duplicate copies of most of the files.

3.3.2 Identifying Duplicate Files, Assignment of Unique ID

The occurrence of duplicate files was anticipated due to redundancies in the data sources. Files found on a laptop, for example, would likely be found within one or more versions of the FTB Archives from file servers. An automated method was coded that implemented two different functions – *MD5* (short for "message digest algorithm") and *SHA-1* (short for "secure hash algorithm"). Both functions are implemented widely in security and data transfer integrity applications. They are considered cryptographic hash functions and can be used similar to a checksum to compare file contents. Each function takes a slightly different approach to comparing file contents, and as a redundancy measure both methods were employed. A more detailed explanation of these methods is presented in Appendix K: Codes and Database.

Groups of files with identical content were assigned a numeric identifier, called the *Unique ID*. This identifier was assigned in addition to the File ID and served to associate multiple copies of the same file retrieved from different computers and other data storage media. During the analysis work, evaluation of multiple copies of the same file was an important consideration. In many instances, where the file was found (e.g. file path, computer, etc) provided relevant facts to support findings.

The example presented in the prior section is used here again in Figure 3-8 to illustrate the assignment of the Unique ID. In the example 22 files of a particular type were identified or which only 5 unique files exists. All other files are copies of the 5. Each file retains the File ID assigned in the prior process, and gets assigned a Unique ID that associates all files with identical file contents.

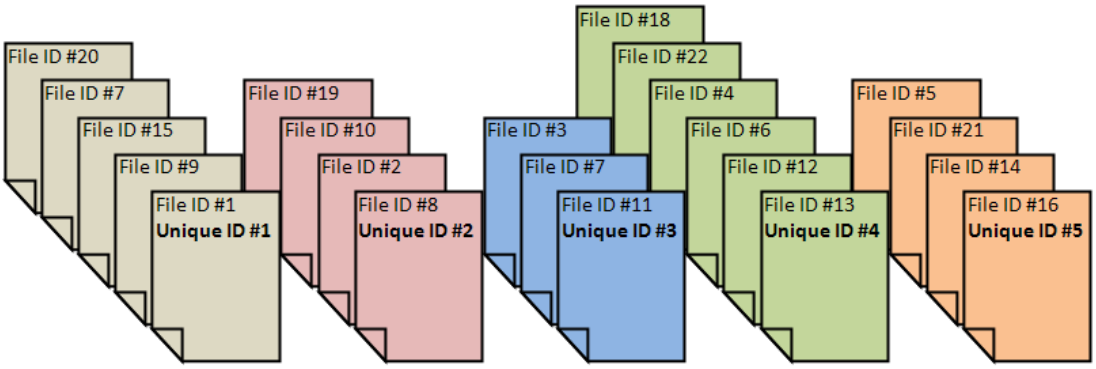


Figure 3-8 – Unique ID Assignment

A summary of total counts of unique files is shown in Table 3-5. 35,252 GGL data files of type generated by Mount Sopris GGL data acquisition equipment (i.e. RD, LAS, or LS) were determined to be unique. Using the total count of LAS and LS files as basis, 23,738 distinct GGL tests are represented by the data files found. This includes tests on CIDH piles as well as tests conducted for equipment testing, calibration, and other functional tests.

3.3.3 Parsing Data From Files

Data within LS, RD, and LAS files were extracted using programmatic parsing routines and stored in a database for analysis. The process of opening, reading, and deconstructing specific data elements from within a file is referred to as *parsing* throughout this report. Data from the header sections were stored as separate attributes in the database. For each row in the data block, and depending on file type, depth, gamma counts, density, and speed were stored. A more detailed explanation of data parsing methods and the GamDat database is described in Appendix K: Codes and Database.

During the parsing of LS, RD, and LAS files, some files were found to contain non-standard sections or partially corrupted sections of data, resulting in the code to stop parsing and skip to the next file in the cue. For files where only some of the data block could be read, that portion of the depth, gamma count, and density sequences were captured and stored to the GamDat database. For files where standard header data could not be read at all, these were skipped and marked in the database as a *cataloged* file. That is, the existence of the file was noted and information about the file captured, but no data was extracted for subsequent analyses. Totals for *parsed* versus *cataloged* files are presented in Table 3-5.

The sum of unique LAS and LS files represents a total number of unique test instances. Since the RD files are a paired sub-set of the LAS files, they don't represent unique tests by themselves. The total number of unique tests represented in the data file collection is 23,738 of which 23,370 could be parsed for further analysis.

Different file counts are presented in Table 3-5, as the various analysis tools examined the data file collection in different ways. In some analyses, the entire collection of files was relevant while in others on unique subsets of files were relevant. As an example, one of the tools examined all 90,397 LAS files for occurrences of files with identical content but having different filenames. This type of analysis necessitates the use of all files, including duplicates. By contrast, another tool that looked for pattern matches only examined the 14,451 unique LAS files where density data could be parsed and analyzed.

3.3.4 RD-LAS Pairs, Assignment of RD-LAS Pair ID

Since RD and LAS files are generated by the *MSLog* software in pairs, an attempt was made to positively identify associated file pairs and assign a numeric identifier to these, called the *RD-LAS Pair ID*. An automated method was developed and coded that examined the file names and paths of all LAS and RD files including duplicate files, then assigned a RD-LAS Pair ID where file names and paths were identical. This code was executed on file name and path information stored in a database. A more detailed explanation of the coding methods and interaction with the database is described in Appendix K: Codes and Database.

As an example, if the files *TCBB3P3CT1.LAS* and *TCBB3P3CT1.RD* shared the same root directory, as shown in Figure 3-9, those files would be assigned a single RD-LAS Pair ID.

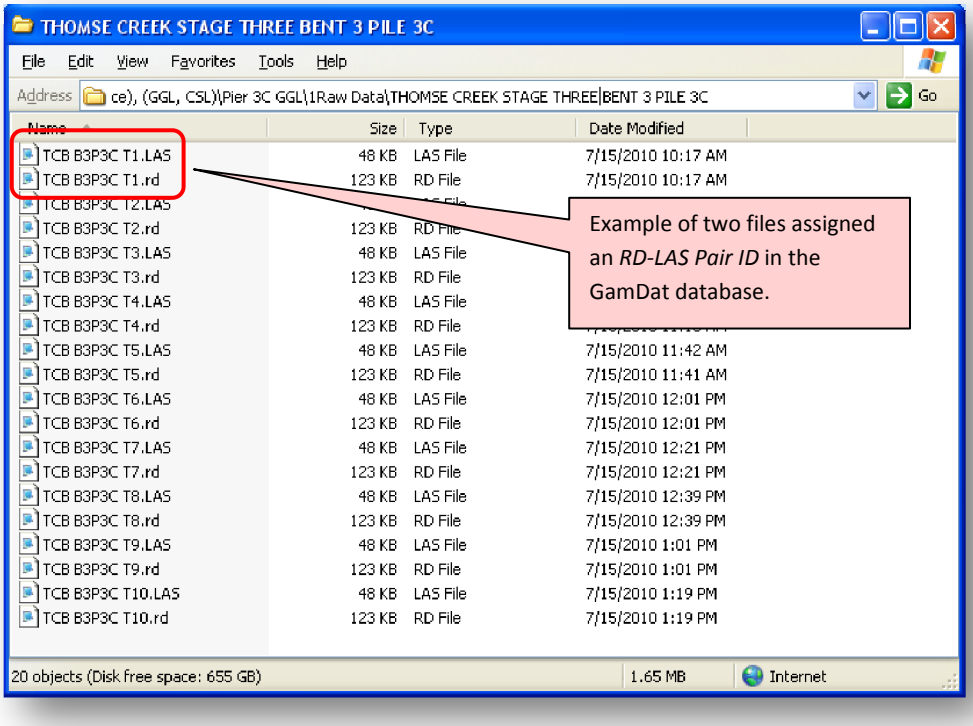


Figure 3-9 – Example of RD-LAS Pair ID Assignment

As a result of this process, 9,206 unique RD-LAS file pairs were identified. That is, 62% of all unique LAS files were paired with corresponding RD files (9,206 RD-LAS Pairs / 14,788 unique LAS files).

3.3.5 File Groups, Assignment of Group ID

Typically, RD, LAS, and/or LS files were found on computers or servers, organized in directories and sub-directories by pile or pile group and/or foundation location. For example, the RD and LAS files for 10 tubes from "Bent 3 Pile 3C" might be placed in a single directory named "…/BENT 3 PILE 3C/" as shown in Figure 3-10. This logical grouping of files into directories was used as the basis to assign files that share the same directory and file path to a *Group ID*. This assignment was carried out for all GGL data files (including duplicate files) of type RD, LAS, and LS. Additional details of the logic and coding can be found in Appendix K: Codes and Database.

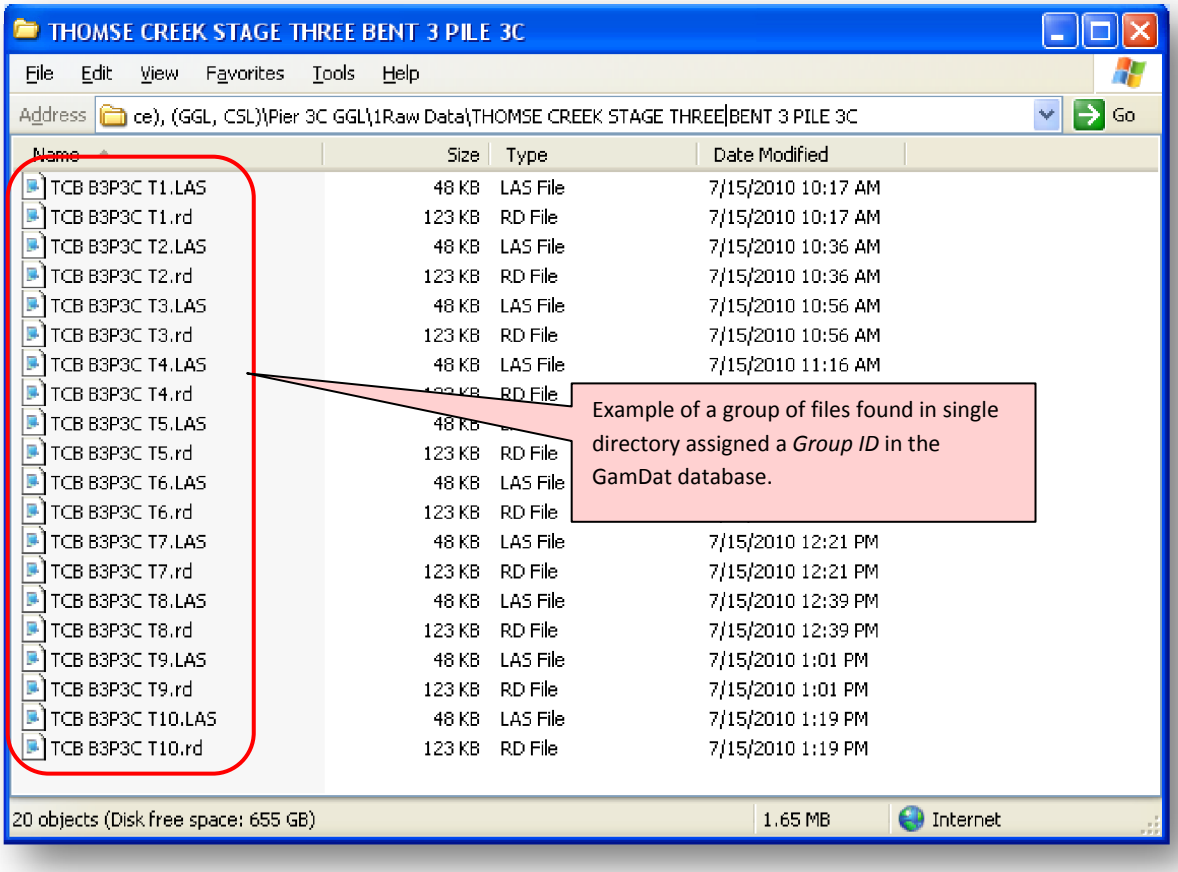
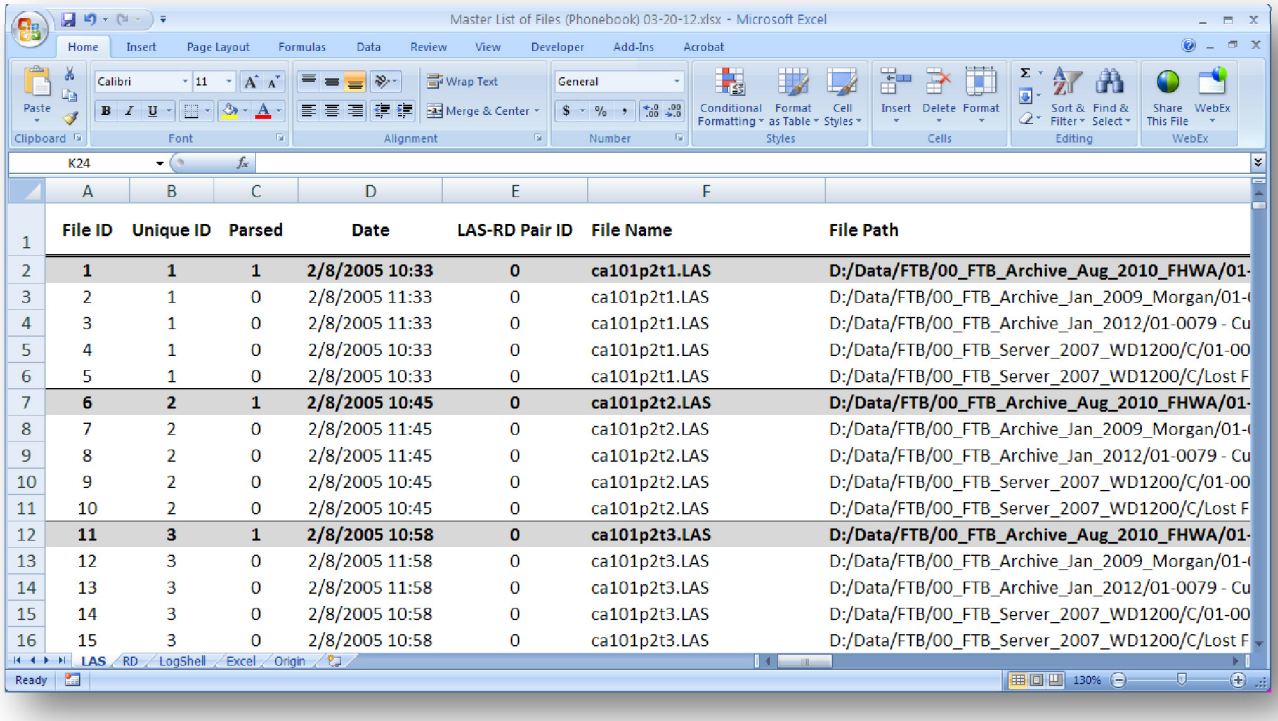


Figure 3-10 – Example of Group ID Assignment

3.3.6 Preparing the Master List of all GGL Data Files

Key information for all GGL data files found during the search process was captured in the GamDat database (described in Appendix K: Codes and Database). From this a *Master List* of all files was created as an Excel spreadsheet as shown in Figure 3-11. This was then used as a common reference for citing specific files (or groups of files) by the GamDat team in all subsequent documentation. Each file was assigned, at minimum, a File ID and Unique ID. These identifiers were unique to files of the same type. Table 3-6 lists all file attributes contained in the Master List.



File ID	Unique ID	Parsed	Date	LAS-RD Pair ID	File Name	File Path
1	1	1	2/8/2005 10:33	0	ca101p2t1.LAS	D:/Data/FTB/00_FTB_Archive_Aug_2010_FHWA/01-
2	1	0	2/8/2005 11:33	0	ca101p2t1.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2009_Morgan/01-
3	1	0	2/8/2005 11:33	0	ca101p2t1.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2012/01-0079 - Cu
4	1	0	2/8/2005 10:33	0	ca101p2t1.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/01-00
5	1	0	2/8/2005 10:33	0	ca101p2t1.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/Lost F
6	2	1	2/8/2005 10:45	0	ca101p2t2.LAS	D:/Data/FTB/00_FTB_Archive_Aug_2010_FHWA/01-
7	2	0	2/8/2005 11:45	0	ca101p2t2.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2009_Morgan/01-
8	2	0	2/8/2005 11:45	0	ca101p2t2.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2012/01-0079 - Cu
9	2	0	2/8/2005 10:45	0	ca101p2t2.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/01-00
10	2	0	2/8/2005 10:45	0	ca101p2t2.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/Lost F
11	3	1	2/8/2005 10:58	0	ca101p2t3.LAS	D:/Data/FTB/00_FTB_Archive_Aug_2010_FHWA/01-
12	3	0	2/8/2005 11:58	0	ca101p2t3.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2009_Morgan/01-
13	3	0	2/8/2005 11:58	0	ca101p2t3.LAS	D:/Data/FTB/00_FTB_Archive_Jan_2012/01-0079 - Cu
14	3	0	2/8/2005 10:58	0	ca101p2t3.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/01-00
15	3	0	2/8/2005 10:58	0	ca101p2t3.LAS	D:/Data/FTB/00_FTB_Server_2007_WD1200/C/Lost F

Figure 3-11 – Master List in an Excel Spreadsheet

Attribute	Description
File ID	A unique identification number assigned to every file found. This ID is unique within each group of files by type.
Unique ID	A unique identification number assigned to a one or more files that all have identical content, not necessarily the same filename or date/time. Identical content is established using MD5 and SHA-1 hashing methods. This ID is unique within each group of files by type.
RD-LAS Pair ID	A unique identification number assigned to the pairs of RD and LAS files sharing the same parent directory and filename.
Group ID	A unique identification number assigned to files that were found under a single parent directory.
Filename	As found on the original data source
Filepath	As found on the original data source
Date	The Windows "date modified" parameter.
Time	As found on the original data source
Type	LAS, RD, LS, OPJ, or XLS
Parsed	A flag of "0" or "1" is assigned to each file to indicate which file, within a group of files having the same Unique ID, was parsed for density/count/speed data sequences. Flag "1" indicates that the code attempted to parse the file, although, data may or may not have been successfully extracted from the file.
Cataloged	A flag of "0" or "1" is assigned to each file to indicate files that were found, but no data could be extracted from them. This occurs for LAS, RD, and LS files that were significantly corrupted and the standard file header could not be read.

Table 3-6 – Attributes in Master List

3.4 Observations About the GGL Data File Collection

During the process of identifying, compiling, sorting, and parsing of GGL data files, some significant observations were noted.

3.4.1 Recovery of Files from Crashed FTB Server Hard Drive

The recovered server hard drive from FTB Offices (described in Section 3.2) contained a significant number of data files that were not found on any other server, computer, or data storage media. This included 257 LAS files, 2142 RD files, and 528 LS files. Many of the files recovered from this hard drive were previously deleted files and did not carry any contextual information (typically available from the filepath) that could be used to associate files to specific projects or establish additional RD-LAS file pairs.

3.4.2 Files Missing from FHWA's August 2010 Investigation

A complete copy of the collection of files obtained by the FHWA that was used in a 2010 investigation was compared against the collection of files analyzed in the GamDat investigation. The FHWA's investigation only examined LAS files, representing 62% of all files as determined by the GamDat effort. The quantities are presented in Table 3-7.

File Type	Unique Files Available to FHWA Investigation	Unique Files Found in GamDat Investigation	FHWA/ GamDat (%)
LAS	9108	14788	62%
RD	2491	11514	22%
LS	2325	8950	26%

Table 3-7 – Unique GGL data files for FHWA's August 2010 investigation

A number of factors likely contributed to the reduced quantities of files in the FHWA's collection. However, one known limitation was discovered during the process of moving files from FTB Archives to the GamDat server. Early versions of the FTB Archives were hosted on Windows and/or Macintosh computers set up as common file servers. Over the years those servers had been migrated to other platforms, primarily Novell-based file servers. The Novell-based servers have different limitations on the number of characters permitted in total file path, including the filename, the various directory names in which the file resides, and the server name. The limits are lower than those of the Windows-based servers. Over the years, and through file server transitions, some of the longer file paths were retained on Novell servers and the names of the servers changed. As a result, some files became inaccessible, although remained visible when directory browsing. Many of the GGL data files resided in directories at the lowest levels of project directories. Consequently, many of these files in particular became inaccessible. A manual effort was carried out by the GamDat team, shortening file path character counts, to insure that all files on all Novell-based FTB file servers were accessible.

3.5 GGL Tests from GGL Reports

The GamDat Team, with the assistance of additional employees from the Division of Engineering Services (DES), carried out a process of extracting key metadata from previously published GGL Reports issued by the FTB. This metadata included project and test specific information that would be used to help match data files with reported tests. The work required manual review of individual report documents (typically as a PDF file) and transcription of key data elements to a spreadsheet. This work was followed by a compilation of the collected metadata in a database for analysis and association to GGL Data Files under a parallel effort.

The focus of this task was to assess the overall availability of data files relative to documented occurrences of tests having been conducted. This assessment would help in a characterizing the completeness of (or gap within) the collection of data files relative to both records retention standards of the day and current standards. Furthermore, this would allow the team to report its findings in a context that characterizes the population of found data files to the reported tests, and the gaps.

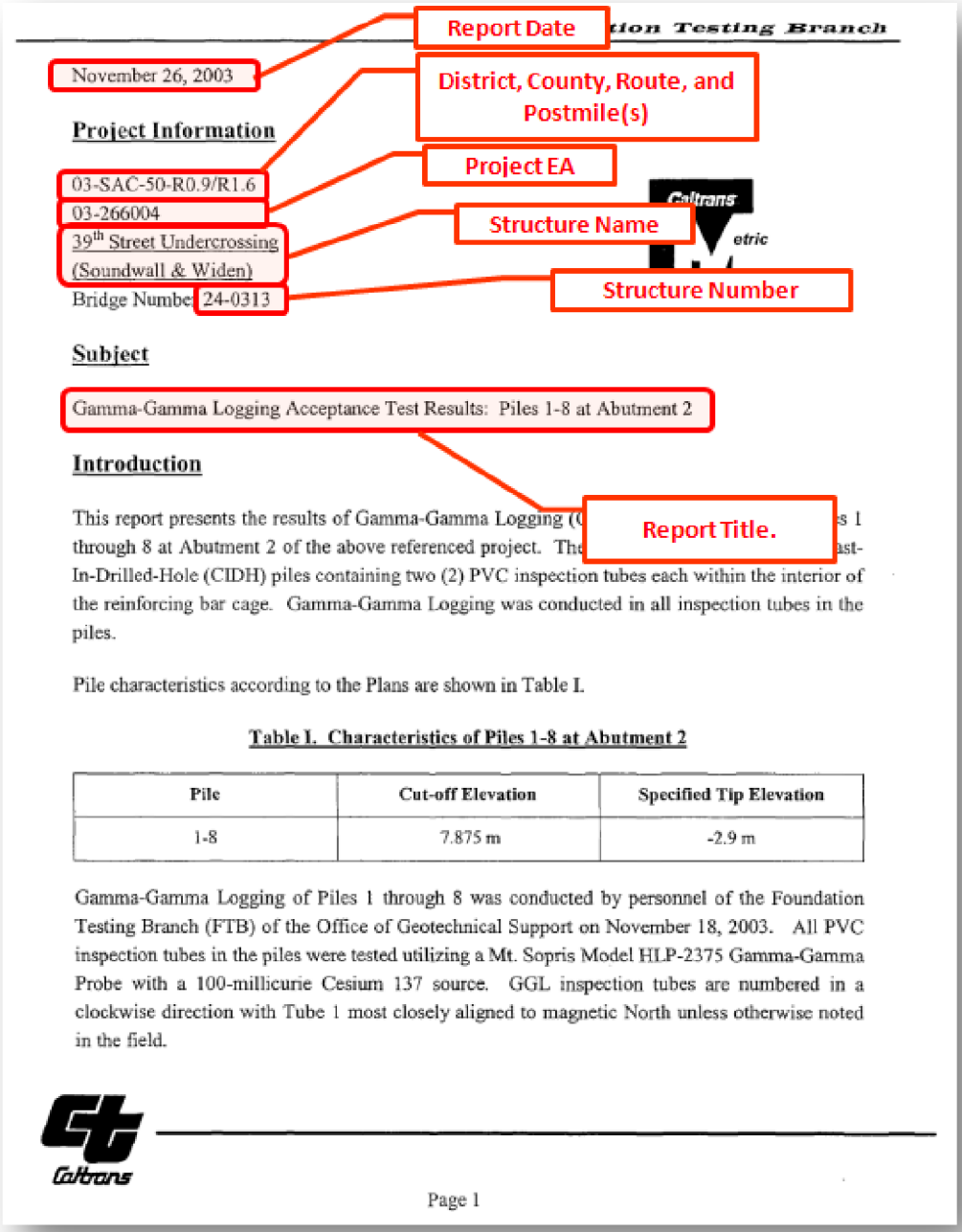
3.5.1 Metadata Extracted From GGL Reports

Metadata extracted from the GGL reports included both project information and test specific information, as summarized in Table 3-8 below.

Project Metadata	GGL Test Metadata
Data Source Report Date District County Route Post Mile Project EA Structure Name Structure Number Report Title Report Author	Pile Location Tube Numbers Test Date Test Equipment Serial Number

Table 3-8 – Metadata from GGL Reports

A protocol was defined to uniformly capture information from key pages from GGL reports, as shown in Figure 3-12 through Figure 3-14.



tion Testing Branch

November 26, 2003

Project Information

03-SAC-50-R0.9/R1.6
03-266004
39th Street Undercrossing
(Soundwall & Widen)
Bridge Number 24-0313

Subject

Gamma-Gamma Logging Acceptance Test Results: Piles 1-8 at Abutment 2

Introduction

This report presents the results of Gamma-Gamma Logging (G s 1 through 8 at Abutment 2 of the above referenced project. The ast-In-Drilled-Hole (CIDH) piles containing two (2) PVC inspection tubes each within the interior of the reinforcing bar cage. Gamma-Gamma Logging was conducted in all inspection tubes in the piles.

Pile characteristics according to the Plans are shown in Table I.

Table I. Characteristics of Piles 1-8 at Abutment 2

Pile	Cut-off Elevation	Specified Tip Elevation
1-8	7.875 m	-2.9 m

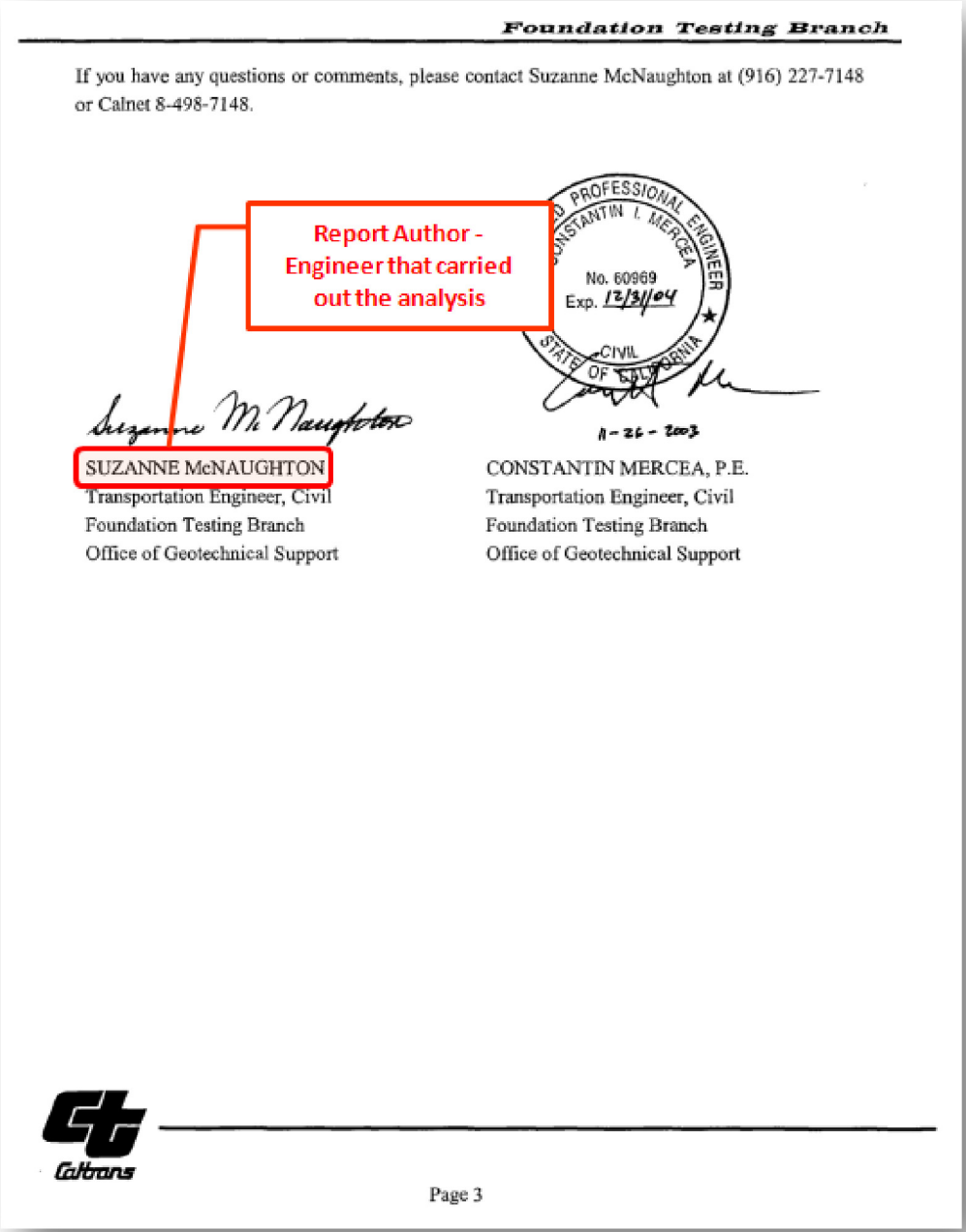
Gamma-Gamma Logging of Piles 1 through 8 was conducted by personnel of the Foundation Testing Branch (FTB) of the Office of Geotechnical Support on November 18, 2003. All PVC inspection tubes in the piles were tested utilizing a Mt. Sopris Model HLP-2375 Gamma-Gamma Probe with a 100-millicurie Cesium 137 source. GGL inspection tubes are numbered in a clockwise direction with Tube 1 most closely aligned to magnetic North unless otherwise noted in the field.

Caltrans

Page 1

Report Date
District, County, Route, and Postmile(s)
Project EA
Structure Name
Structure Number
Report Title.

Figure 3-12 – Metadata from First Page of GGL Report



Foundation Testing Branch

If you have any questions or comments, please contact Suzanne McNaughton at (916) 227-7148 or Calnet 8-498-7148.

Report Author - Engineer that carried out the analysis

REGISTERED PROFESSIONAL ENGINEER CONSTANTIN I. MERCEA No. 60969 Exp. 12/31/04 CIVIL STATE OF CALIFORNIA

11-26-2003

SUZANNE McNAUGHTON
Transportation Engineer, Civil
Foundation Testing Branch
Office of Geotechnical Support

CONSTANTIN MERCEA, P.E.
Transportation Engineer, Civil
Foundation Testing Branch
Office of Geotechnical Support

Caltrans

Page 3

Figure 3-13 – Metadata from Signature Page of GGL Report

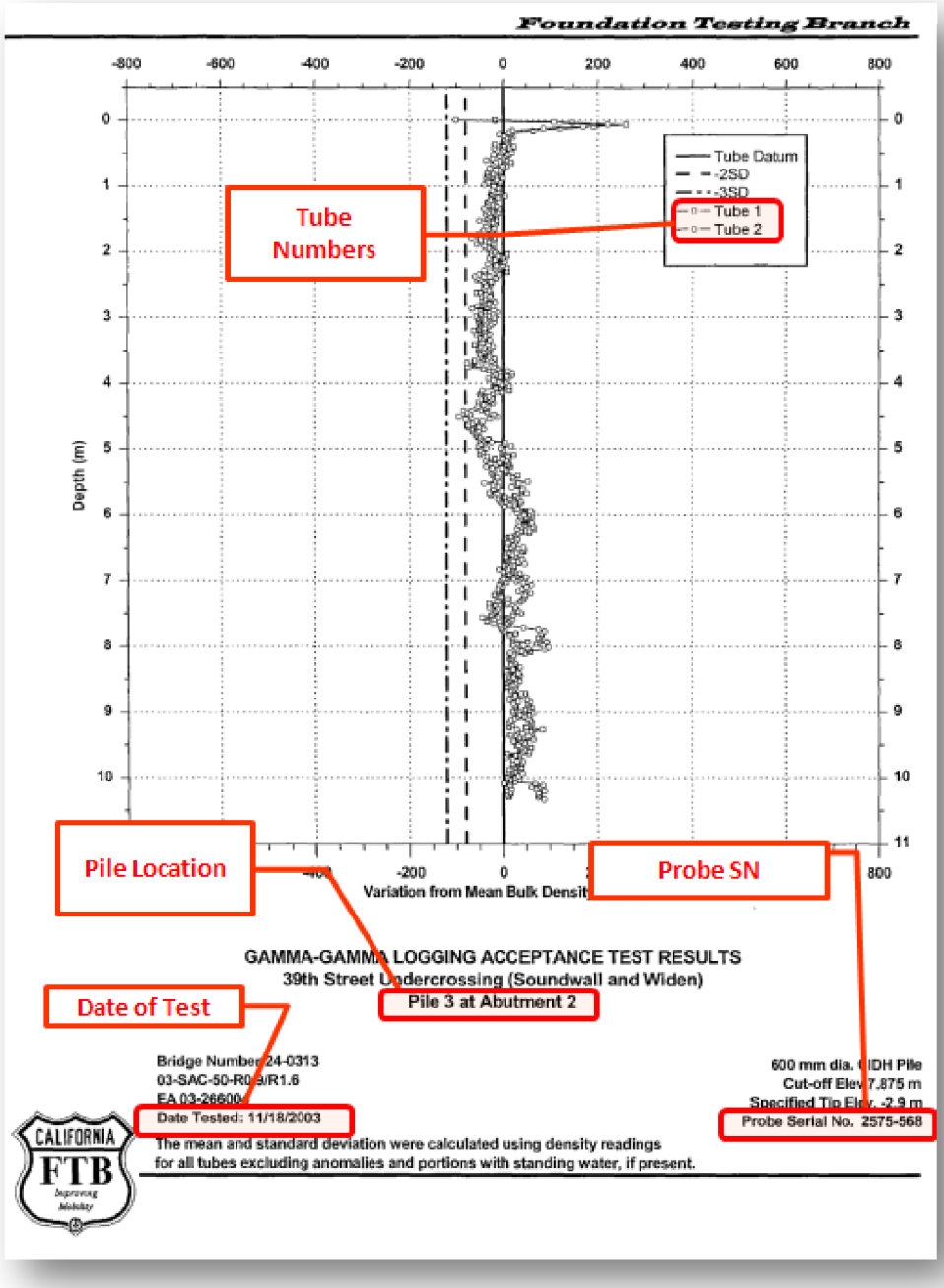


Figure 3-14 – Metadata from Data Plot Page of GGL Report

3.5.2 Sources of GGL Reports

The GamDat team searched three primary data sources for GGL reports in the following order:

- The Caltrans Digital Archive of Geotechnical Data (*GeoDOG*)
- The electronic *FTB Archive*
- *FTB Paper Files* (red folders)

3.5.2.1 Reports Found in GeoDOG

GeoDOG is an intranet tool that serves as the user interface for the Geotechnical Services (GS) Archive, a repository for geotechnical documents and data. GeoDOG is populated with scanned (PDF) documents from the old paper-based file room located at the Transportation Laboratory in Sacramento. In all, these documents represent over 30,000 individual projects and span over 85 years of geotechnical work by Caltrans. As the conversion to PDF is still work in progress, the GGL reports recovered from GeoDOG largely represent those GGL reports for projects in Districts 1-7, 9 and 10.

A search for reports that include either "Gamma" or "GGL" in the report titles yielded 1777 hyperlinked search results to reports in GeoDOG. Those hyperlinks were divided evenly into eight lists and each list assigned to a designated DES employee. The eight DES employees were trained to open the link and extract key information (metadata) from the reports and enter that information into a spreadsheet. In all the DES employees produced metadata from 1691 GGL reports. The GamDat team then performed a quality check on the metadata and compiled all the metadata into a single spreadsheet. The list of metadata extracted from each GGL report is presented in Section 3.5.1.

3.5.2.2 Reports Found in the FTB Archives on a File Server

The *FTB Archive*, located on a Caltrans intranet file server (also referred to as the *Z:/ drive*) was searched in order to retrieve GGL reports from Districts 8, 11 and 12 as well as to identify and retrieve those reports not in GeoDOG from Districts 1-7, 9 and 10. Based on conversations with FTB staff, project files are routinely written to the FTB Archive, however, there is no written requirement requiring staff to do so. GamDat staff performed the search of the FTB Archive and retrieved 110 reports from Districts 8, 11 and 12, and 48 reports from Districts 1-7, 9 and 10 not previously identified in the GeoDOG search. GamDat staff extracted metadata from each of the 158 reports from the FTB Archive and appended it to the spreadsheet generated through the GeoDOG search.

3.5.2.3 Reports Found in the FTB Paper Files (Red Folders)

The *FTB Paper Files* (also referred to as the *FTB Red Folders* due to the color of the folders), located at the FTB office at the Transportation Laboratory in Sacramento, was searched in order to retrieve any GGL reports from Districts 8, 11 and 12 not found in GeoDOG or the FTB Archive. The red folders have been used since the early 1990's by FTB to house project-related paper files including reports. GamDat staff performed a search of the red folders and retrieved 75 reports from Districts 8, 11 and 12 not previously identified in either GeoDOG or the FTB Archive. GamDat staff extracted metadata from each of the 75 reports from the red folders and appended it to the spreadsheet containing the GeoDOG and FTB Archive metadata.

3.5.2.4 Additional Reports Identified from SCEMS

The *Structure Construction Engineering Management System (SCEMS)* is an information system developed and maintained by the Caltrans Office of Structure Construction (OSC). The system's primary purpose is to compile and report information to assist in project management. GGL reports and some metadata on the piles and repairs to piles had been tracked in the system going back as far as June 1996 and up through October 2010.

An export of all GGL records from SCEMS was obtained from OSC in December 2011. A total of 1,637 GGL reports were identified. The GamDat Team compared the list of GGL reports found to date with those found in SCEMS to determine gaps in the list. 87 reports, representing an estimated 1,350 tests, were identified in SCEMS that were not previously identified by the GamDat Team. The team requested that these reports be furnished for inclusion in the analysis. However, these reports were not available at the time of this report preparation.

The data from SCEMS turned out to be an important validation resource, as it provided the only comprehensive inventory of GGL tests conducted statewide over the period investigated. The SCEMS database showed that the total number of GGL tests was very close to the total number of tests identified through reports obtained from GeoDOG, FTB Archives, and FTB red folders. As such, the total number of GGL tests identified by the team is likely close to the number of tests carried out.

3.5.3 Summary of GGL Tests from GGL Reports

The collection of GGL reports included documents found in GeoDOG, the FTB Archive, and the FTB Paper Files. After removal of duplicate reports (as well some early reports based on older generation gamma testing equipment) and performing a quality check on the inventory of reports, a total of 1,519 unique GGL reports remained, spanning the period from March 1994 through December 2011. Table 3-9 summarizes these findings.

Summary	
Time Period Represented by the Documents:	March 1994 through December 2011
GGL Reports Evaluated:	1,519 *(without 87 reports from SCEMS)*
CIDH Piles Reported as Tested:	7,183
GGL Tests Reported as Conducted:	22,944

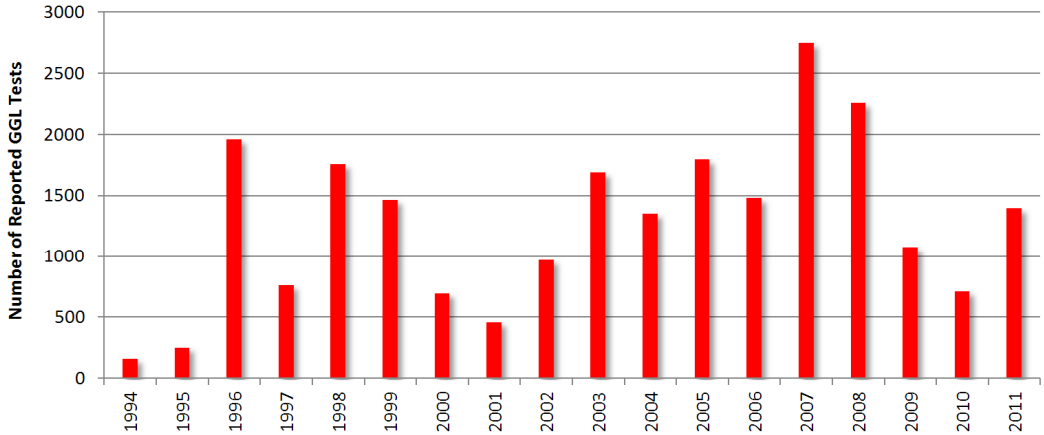
Table 3-9 – Summary of Data from GGL Reports

3.6 Characterization of the GGL Data Collection

Section 3.3 described the process and summarized total counts of GGL data files (i.e. LogShell, RD, and LAS files) found, as a result of an extensive search of FTB computers, servers, and other digital storage media. Section 3.5 described the process and summarized total counts of reported GGL tests, based on an extraction of metadata from GGL reports issued by the FTB. The combination of both sets of information provides a context for how comprehensive the GamDat analyses have been applied.

3.6.1 Reported GGL Tests by Year

The 22,944 reported GGL Tests (described in Section 3.5) are distributed over an 18 year period, as shown in Figure 3-15 below.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Reported Tests (from GGL Reports)	155	249	1959	758	1758	1463	693	457	968	1687	1351	1793	1478	2745	2256	1072	709	1393

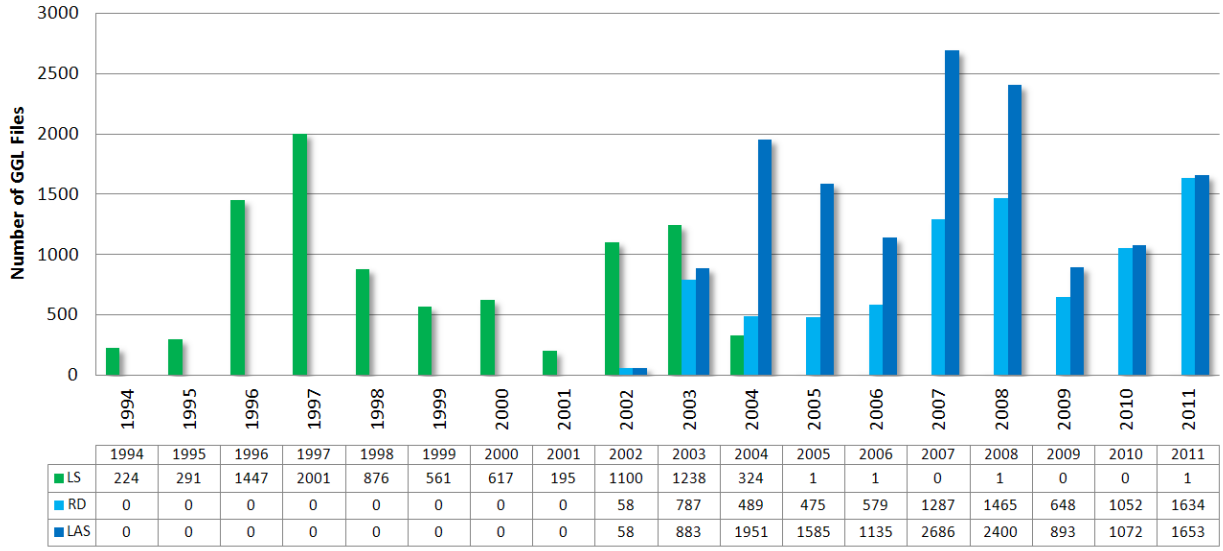
Figure 3-15 – Reported GGL Tests by Year

Notes about the data presented:

- The date of the actual test, not the report date, was used.
- Only tests conducted with Mount Sopris equipment (generating LogShell, LAS, or RD files) are included.
- An estimated 1,350 tests from SCEMS spanning 1994 through 2010 are not included.

3.6.2 GGL Data Files by Year

As described in Section 3.3, 23,738 distinct tests represented by the GGL data files were found to be distributed over a 19 year period up through 2012. In order to compare these data files to the tests reported in GGL reports, the same time period must be considered and only files used in testing CIDH piles included. Through the end of December 2011, 23,719 distinct tests represented by the GGL data files exist. Of these files, at least 525 were determined to be associated with calibration or other equipment testing activities and were not reported in a GGL report issued by the FTB. Excluding these, 23,194 remain that were from tests conducted on CIDH piles and were assumed to have been used in the preparation of a GGL Report. The distribution of these data files by type and by year is shown in Figure 3-16 below.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
LS	224	291	1447	2001	876	561	617	195	1100	1238	324	1	1	0	1	0	0	1
RD	0	0	0	0	0	0	0	0	58	787	489	475	579	1287	1465	648	1052	1634
LAS	0	0	0	0	0	0	0	0	58	883	1951	1585	1135	2686	2400	893	1072	1653

Figure 3-16 – GGL Data Files by Year

Notes about the data presented:

- For LAS and RD files, the file modified date is assumed to be the same as the date of the test.
- For LS files, a date extracted from a line within the file in the header, where available, was used to establish the date of the test.
- Only tests conducted with Mount Sopris equipment (generating LogShell, LAS, or RD files) are included.
- The annual sub-totals presented for each file type do not necessarily match the totals presented earlier in Section 3.3, as files associated with calibration and/or other equipment testing activity are excluded.
- Several single instances of LS files are counted in the years after the *LogShell* software was no longer in active use (2005-2011). Errors in the date found in the LS file header or the transfer of files from CD/DVD media during archiving activities appear to account for these isolated occurrences.

Significant observations:

- The 2002-2004 years mark a period where a staged transition from the older *LogShell* software to the newer *MSLog* software occurred. The presence of both LogShell and LAS-RD files during this period is consistent with the transition.
- A gradual improvement in the proportion of RD files relative to LAS files during 2009-2011 is consistent with improvements in FTB file archiving practices.

3.6.3 Comparing Reported GGL Tests to GGL Data Files

In order to assess the degree of completeness of the data set analyzed by the GamDat Team, processes for comparing reported GGL tests to GGL data files were evaluated. Since associations by file groups and/or file pairs are required for some of the analyses (e.g. fidelity), the team considered the process of matching reported GGL tests to GGL data files to be a key step. However, the process of exactly matching all reported tests to data files turned out to be more challenging than originally anticipated. As an alternative to file matching, a method of

associating data files to reported tests by dates was identified and used to assess data completeness in general. The date association process used is described below.

3.6.3.1 Challenges in Implementing Automated Matching Algorithms

After evaluating various approaches to matching up, one-to-one, GGL Data Files to GGL Tests, the team determined that an automated method providing a reasonably high degree of confidence in record matching was not feasible, and in many cases impossible. Matching files to tests in an automated way would require developing logic and codes that could anticipate all the possible combinations of abbreviations and concatenations used in file/directory naming conventions as well as all the variations of identifying information cited in reports.

In an ideal situation the GGL Report would provide clear foundation location information, for example:

Folsom Blvd OC, Bent 2, Pile 1, Tube 1

Likewise, the path from which the GGL Data File was discovered would use consistent directory and file naming conventions, for example:

…/GGL Projects/Folsom Blvd OC/Bent 2/Pile 1/Tube_1.LAS

In this situation there would be reasonably good odds at matching the file to the report. However, a more challenging problem was encountered with matching the report metadata to the file directory and file name snippets. In many instances, key identifying information was missing in file directory names and metadata taken from GGL Reports not always consistently captured to the level of detail required.

Some examples of the range of variation in pile and foundation identifying fields, extracted from GGL Reports, are as follows:

"East Pile of Footing B6E at Skid Bent B"
"Pile 8 at Abutment 5"
"Pile 6 of Footing 52AS at Bent 52A"
"RETAINING WALL 435B CIDH Pile WL-44 AT ABUTMENT 1 (LEFT) RW 435B"
"Right CIDH Pile at Pier 3R - STAGE II"
"OVERHEAD SIGN "L""
"Bent4R"
"Bent 4R, Column 3, Piles 4A, SA, & 6A"
"Bent 3R Shaft 2"

Some examples of the limitations in information available from file and directory names, include:

"…/Gamma/Rescue,Greenvalley Rd/A2P6T2.rd"
"…/Ret Wall F1, Piles 61 to 105, 107 JT/Raw Data/b/P102T1.rd"
"…/RECYCLER/S-1-5-21-1781078473-1503981198-212955658-1007/Bnt5 P52 T5.rd"
"…/49-0033L-R Estrella River Bridge (GGL)/GGL/Bent 5/Pile 52/Raw data/Bnt5 P52 T1.rd"
"…/Gamma/San Mateo 101A.L#2/SMAL#2P81T2.rd"

In some cases there is sufficient project and foundation location information, while in others the available information did not provide sufficient context to make any reasonable association. A file-by-file comparison of each of the 23,000+ unique data files in the collection would need to be manually matched to a GGL test identified in a GGL Report in order to adequately establish a comprehensive match. The time required to do this was not considered reasonable. Furthermore, the priority of carrying out a manual matching process was diminished after it was determined that tracing the fidelity of data from acquisition through report was impractical.

3.6.3.2 Method of Associating Reported GGL Tests to GGL Data Files by Test Date

An alternative approach of *date association* was identified, tested, and carried out on the collection of data. An approximate file association criterion was developed, comparing the dates of the GGL tests with dates of GGL data files. For a given date on which one or more tests were reported to have been conducted, the number of unique GGL data files (LAS and LS only) having that same date was counted. Then, as a way of generally assessing data file completeness, the number of data files found was compared to the number of reported tests.

This approach has significant limitations that introduce uncertainty and limit the extent to which well-founded conclusions can be made. These factors include the following:

- Multiple tests are frequently carried out on the same day.
- Multiple tests can occur on the same day on different projects with different probes. This was found to occur approximately 16% of the time based on available data.
- In some instances more files were found than reported tests, suggesting that a report may be missing.
- In some instances fewer files were found than reported tests, suggesting that data files may be missing.
- In some instances files are matched to reported tests by date, however, the files aren't actually associated to the report. This suggests that a report might be missing, data files might be missing, or both.
- In some instances where different dates were present for multiple duplicate files, the date associated with the file may not reflect the actual date of the test. No automated selection process was implemented to pick earlier or later dates of files during the file parsing process.

Dozens of groupings of file-to-report associations were randomly selected and examined more carefully to get a better sense of the degree to which the method correctly associated data files to reports.

3.6.4 Assessment of Completeness of the Data File Collection

The overarching goal of accounting for GGL data files and reported GGL tests was to characterize the completeness of the collection of data files relative to reported tests. This task proved particularly challenging to the team as both the collection of GGL data files and the list of reported GGL tests were incomplete – that is, the number of tests unaccounted for in either could not be readily quantified. Although the date association method provides some meaningful information about the data collection analyzed, the absence of a single authoritative list of all GGL tests conducted over this time period is a limitation of this study. The Venn diagram in Figure 3-17 shows how the date-associated tests relate to the collection of GGL data files and the list of reported GGL tests.

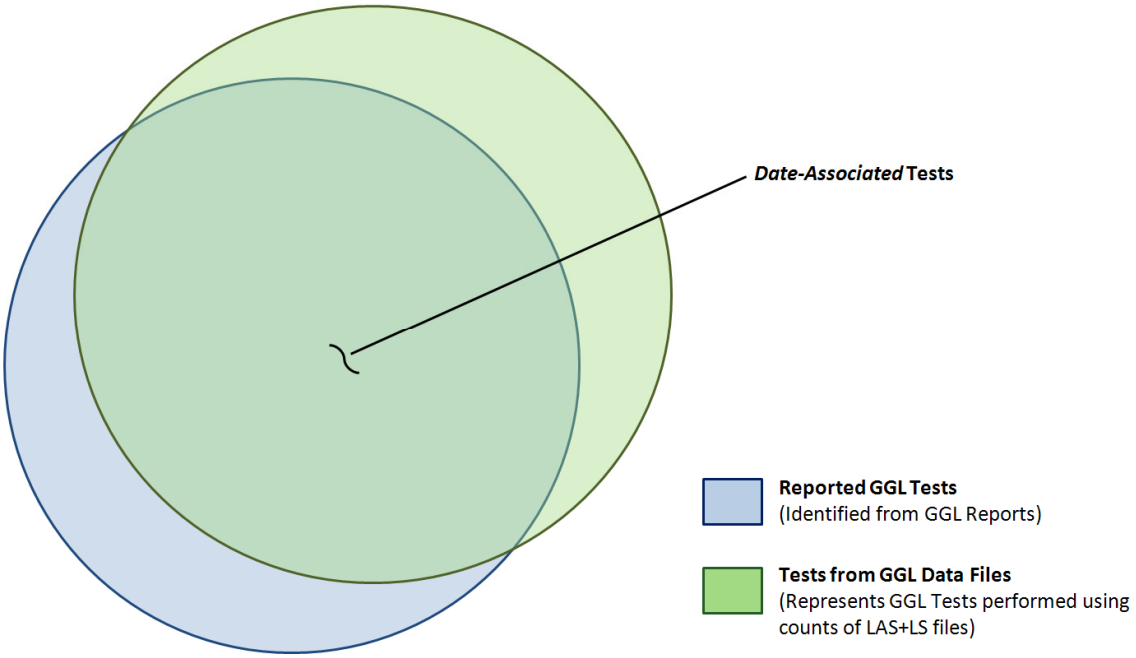
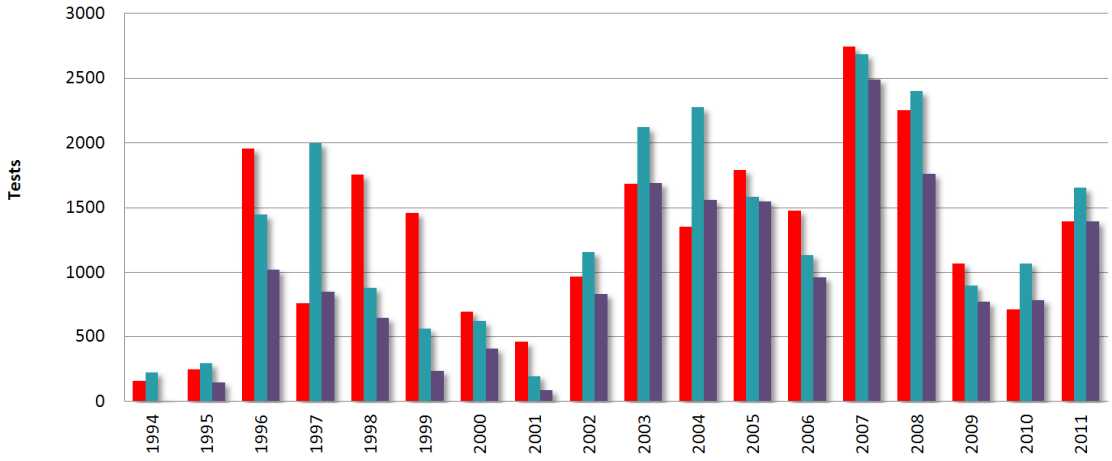


Figure 3-17 – Date-Associated Tests Relative to Data Files and Reported Tests

Date-associated tests were tabulated for each year between 1994 and 2011 and the totals presented in Figure 3-18. Totals for GGL data files and reported GGL Tests presented earlier are also shown in this figure.



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Reported Tests (from GGL Reports)	155	249	1959	758	1758	1463	693	457	968	1687	1351	1793	1478	2745	2256	1072	709	1393
Tests from Data Files (LAS,LS)	224	291	1447	2001	876	561	617	195	1158	2121	2275	1586	1136	2686	2401	893	1072	1654
Date-Associated Tests (LAS,LS)	17	145	1023	842	644	237	407	84	828	1692	1561	1552	962	2493	1763	767	782	1395

Figure 3-18 – Reported GGL Tests vs. Date-Associated Tests w/GGL Data Files

The following observations can be made about data files found between 1994 and 2011:

- 22,944 GGL Tests were identified based on published GGL Reports.
- 23,194 data files (LAS + LogShell) assumed to have been reported were found.

- 17,194 data files (LAS + LogShell) were date-associated to reported GGL Tests.
- Across this 18 year period, the percentage of date-associated data files to reported GGL tests is 75% (17,194/22,944).
- Note, the date-association method produced instances in 1997, 2004, 2010, and 2011 where more associations were made than tests reported, implying reports were missing. This was a limitation of the method and is cause for uncertainty in citing the 17,194 date-associated files.
- The reader is cautioned against drawing conclusions regarding the completeness of the data set acquired by the GamDat Team, as both the number of reported tests and data files are incomplete and the data association method applied has inherent limitations.

4 Characteristics of GGL Testing Operations and Equipment

This section of the report is intended to provide a primer for those not familiar with gamma-gamma logging operations and related terminology. Within this report, references are made to various testing operations, documents, files, and equipment, sometimes without explanation. This section offers an overview of the gamma-gamma logging process that provides context that may help in understanding other sections of the report.

In addition to a general overview, this section describes both typical and atypical testing operations. Typical testing operations are those procedures that were generally accepted as standard practice and include a reasonable amount of variation. Atypical test procedures are those procedures that are possible, but that would generally not be considered acceptable and would fall well outside of the norm. The reason for including possible atypical operations is so that there may be an explanation or understanding of possible causes for some of the irregular data files that are described in this report.

This section concludes with a brief summary and findings of the GamDat team's laboratory and field testing of the gamma-gamma logging equipment and operations. More detailed information from the testing can be found in Appendix C: Testing of Mt Sopris Equipment.

4.1 Overview of GGL Field Operations

The Foundation Testing Branch (FTB) within Caltrans Office of Geotechnical Support conducts Gamma-Gamma Logging (GGL) tests of bridge foundations and other highway structures under construction or retrofit in California. GGL is used to detect anomalous (low density) concrete in the most critical outermost portion of concrete surrounding the steel reinforcing cage within the foundation.

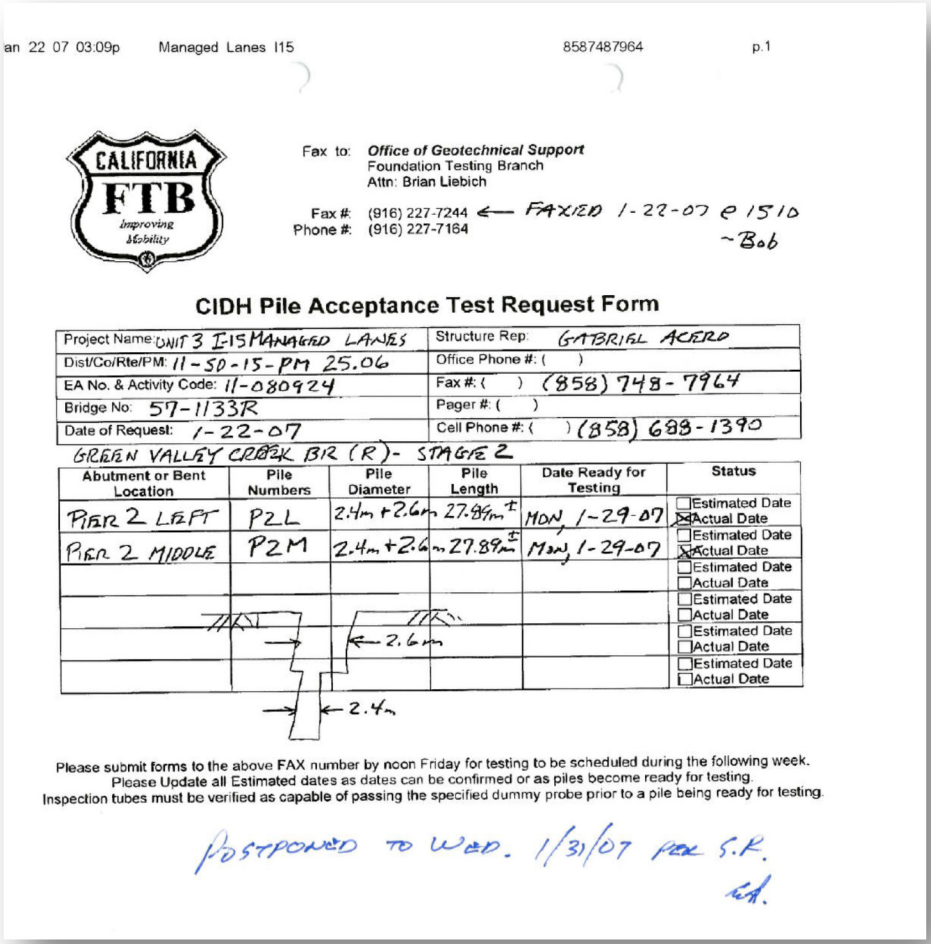
In FTB, *Transportation Engineering Technicians (TET)* operate the GGL equipment to collect test data in the field. Once the technician collects the data for a pile or collection of piles, he returns to the Transportation Laboratory (TransLab) in Sacramento, California, and gives the data to a testing engineer, typically a *Transportation (Civil) Engineer*, for analysis and reporting. Foundations that pass GGL testing are accepted by Caltrans and become part of the permanent structure. Foundations that fail GGL testing are not accepted by Caltrans and may be subject to other testing and remediation or replacement by the construction contractor. Testing is carried out in accordance with California Test Method 233 (CTM-233).

Until recently, the technicians conducting GGL testing did not follow a written standard operating procedure (SOP). New technicians typically were trained by an experienced technician and learned through on-the-job experience and training. Because there was no written standard, practices varied somewhat between technicians and over time.

4.1.1 GGL Testing Request by Construction

The process of GGL testing and reporting within FTB begins with receipt of a "CIDH Pile Acceptance Test Request Form," usually via fax from a Caltrans Engineer with the Office of Structure Construction who needs GGL tests performed on his/her structure construction project. The work is assigned to an engineer in FTB who will ultimately analyze the GGL data collected by the technician and write a report recommending acceptance or rejection of the tested foundation. The engineer in turn gives the request form along with any additional information to an available technician who usually proceeds on his own (sometimes with another technician or engineer) to travel to the construction site and conduct the testing. The Test Request form has general

information about the project and requestor, as well as some specific information about the foundation to be tested. An example of the form is shown in Figure 4-1.



an 22 07 03:09p Managed Lanes I15 8587487964 p.1

CALIFORNIA FTB Improving Mobility

Fax to: *Office of Geotechnical Support*
Foundation Testing Branch
Attn: Brian Liebich

Fax #: (916) 227-7244 ← FAXED 1-22-07 @ 1510
Phone #: (916) 227-7164
~Bob

CIDH Pile Acceptance Test Request Form

Project Name: UNIT 3 I15 MANAGED LANES	Structure Rep: GABRIEL ACERO
Dist/Co/Rte/PM: 11-SD-15-PM 25.06	Office Phone #: ( )
EA No. & Activity Code: 11-080924	Fax #: ( ) (858) 748-7964
Bridge No: 57-1133R	Pager #: ( )
Date of Request: 1-22-07	Cell Phone #: ( ) (858) 688-1390

GREEN VALLEY CREEK BR (R) - STAGE 2

Abutment or Bent Location	Pile Numbers	Pile Diameter	Pile Length	Date Ready for Testing	Status
PIER 2 LEFT	P2L	2.4m + 2.6m	27.89m ±	MON, 1-29-07	☐ Estimated Date ☒ Actual Date
PIER 2 MIDDLE	P2M	2.4m + 2.6m	27.89m ±	MON, 1-29-07	☐ Estimated Date ☒ Actual Date
					☐ Estimated Date ☐ Actual Date
					☐ Estimated Date ☐ Actual Date
					☐ Estimated Date ☐ Actual Date
					☐ Estimated Date ☐ Actual Date

← 2.6m
← 2.4m

Please submit forms to the above FAX number by noon Friday for testing to be scheduled during the following week.
Please Update all Estimated dates as dates can be confirmed or as piles become ready for testing.
Inspection tubes must be verified as capable of passing the specified dummy probe prior to a pile being ready for testing.

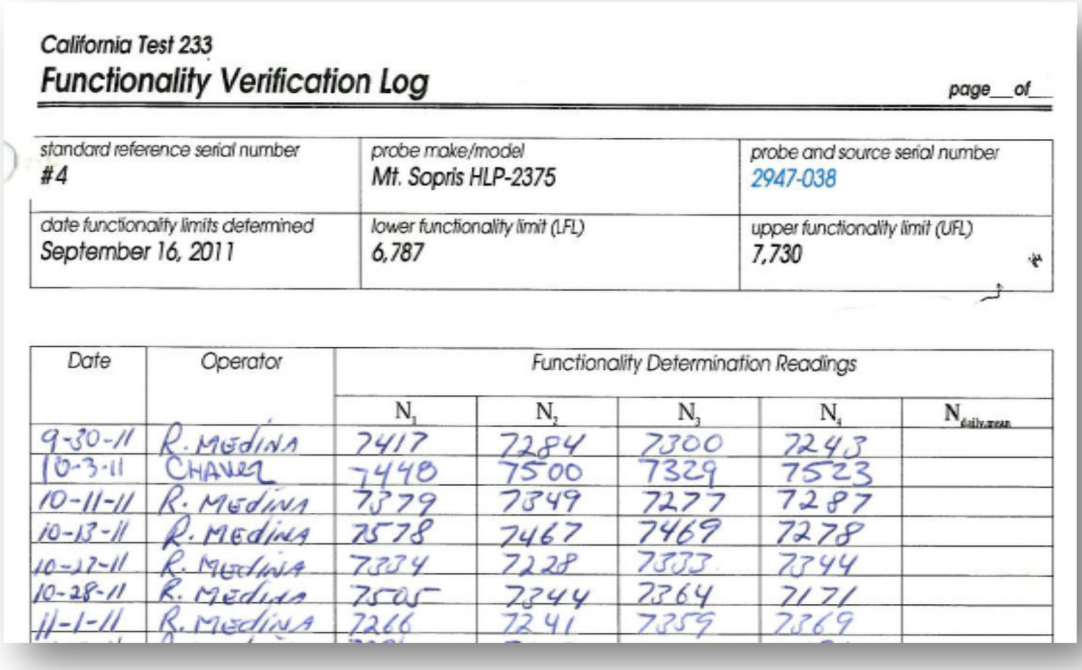
POSTPONED TO WED. 1/31/07 PER S.R.
BA.

Figure 4-1 – CIDH Pile Acceptance Test Request Form

4.1.2 Probe Check-Out Procedures and Functionality Verification

Once assigned to carry out the test, the technician signs out a FTB vehicle that is set up to accommodate the GGL test equipment and securely transport the radioactive source. The technician checks out a gamma-gamma probe and radioactive source from the radiation storage building at TransLab, and records the date and testing destination in the "Nuclear Gage Sign Out Log." He then removes the radioactive source from the radiation building and secures it in the FTB vehicle. Along with the radioactive source, the technician also takes the "Functionality Verification Log" binder associated with the source in order to perform and record the functionality evaluation according to CTM-233. The technician will normally conduct a functionality evaluation of the radioactive source and gamma-gamma logging probe combination before leaving the Translab. The functionality evaluation checks the raw gamma count readings from the probe/source combination against a concrete standard reference block of known density secured in the FTB vehicle. The functionality evaluation is required by CTM-233 to be conducted and recorded at the start of each workday for each gamma-gamma probe used. The test is done

before leaving the Translab as a matter of procedure to avoid the delays involved with traveling all the way to the work site without a working instrument. The functionality evaluation must follow the instructions in Part 4, "Field Testing Procedures," of CTM-233. Four independent, consecutive, and instantaneous readings along with the calculated mean of the four readings are recorded in the "Functionality Verification Log" for the source, probe and standard reference combination, as shown in the example in Figure 4-2.



California Test 233

Functionality Verification Log

page___of___

standard reference serial number	probe make/model	probe and source serial number
#4	Mt. Sopris HLP-2375	2947-038
date functionality limits determined	**lower functionality limit (LFL)**	**upper functionality limit (UFL)**
September 16, 2011	6,787	7,730

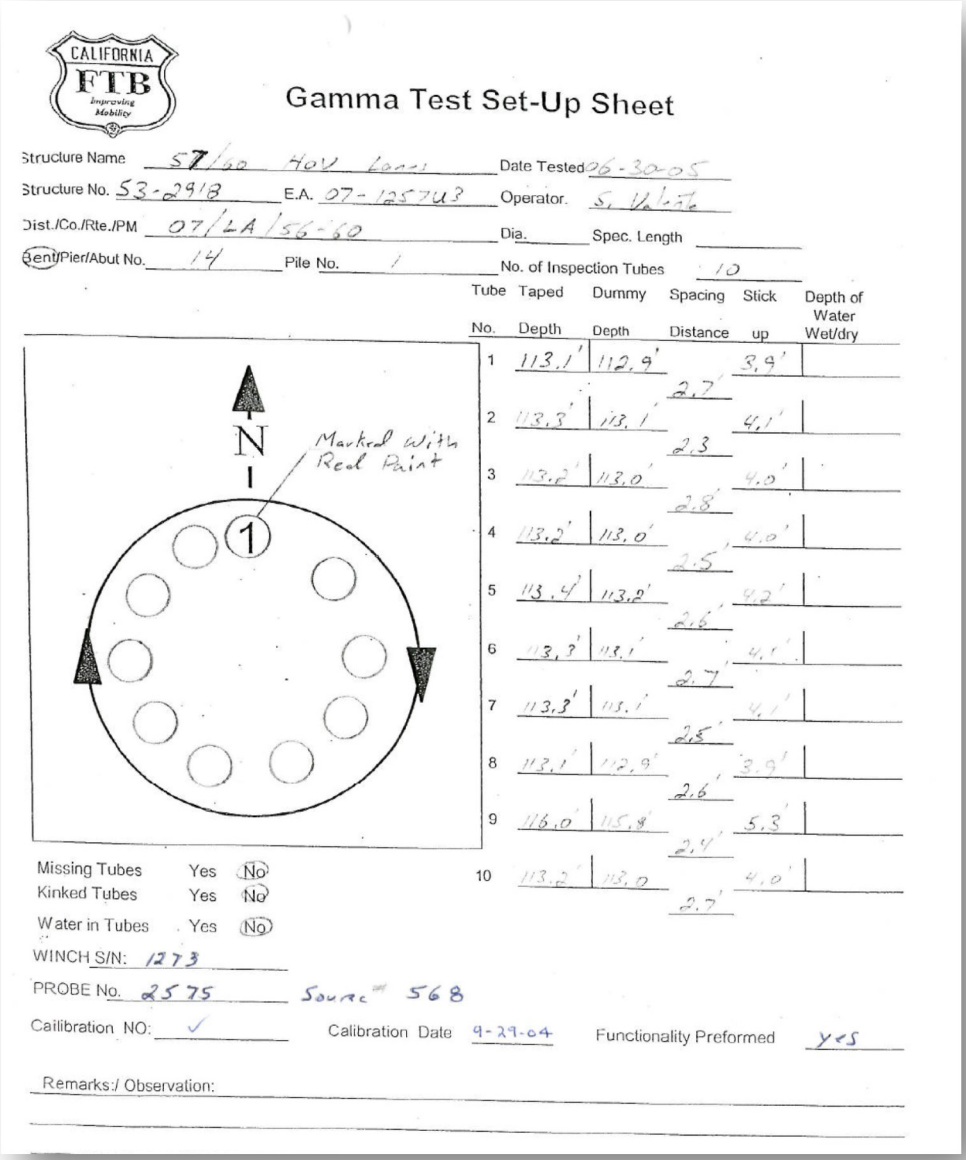
Date	Operator	Functionality Determination Readings				
		N_1	N_2	N_3	N_4	$N_{daily\ mean}$
9-30-11	R. Medina	7417	7284	7300	7243	
10-3-11	Chavez	7448	7500	7329	7523	
10-11-11	R. Medina	7379	7349	7277	7287	
10-13-11	R. Medina	7578	7467	7469	7278	
10-27-11	R. Medina	7334	7228	7333	7344	
10-28-11	R. Medina	7505	7344	7364	7171	
11-1-11	R. Medina	7266	7241	7359	7369	

Figure 4-2 – Functionality Verification Log

If a valid functionality evaluation is not completed and recorded for the probe/source before the GGL test on the same day, then per CTM-233 the GGL tests conducted that day would not be considered valid. Additionally, the calculated mean from the evaluation must be checked against the "Lower" and "Upper Functionality Limits" (LFL and UFL) that are determined through a separate procedure and listed at the top of the Functionality Verification Log. The technician must verify that the daily mean falls between the LFL and the UFL or the gamma-gamma probe and source may not be used to perform tests.

4.1.3 On-Site Testing Documentation

The technician travels to the job site and conducts GGL tests. Before starting the GGL test, the technician first fills out the "Gamma Test Set-Up Sheet." This form is used to record information about the project, the test operator, date of testing, physical dimensions of the foundation to be tested, including gamma tube length and stick-up above top of concrete, and other information about the test equipment and observations. When a Functionality Evaluation is done on site, the technician will often record the results as well as the mean on this form. An example "Gamma Test Set-Up Sheet" is shown in Figure 4-3.



CALIFORNIA FTB Improving Mobility

Gamma Test Set-Up Sheet

Structure Name 57/60 HOV Lanes Date Tested 06-30-05

Structure No. 53-2918 E.A. 07-125743 Operator. S. Valdez

Dist./Co./Rte./PM 07/LA/56-60 Dia. Spec. Length

Bent/Pier/Abut No. 14 Pile No. 1 No. of Inspection Tubes 10

Tube No.	Taped Depth	Dummy Depth	Spacing Distance	Stick up	Depth of Water Wet/dry
1	113.1'	112.9'	2.7'	3.9'	
2	113.3'	113.1'	2.3	4.1'	
3	113.2'	113.0'	2.8'	4.0'	
4	113.2'	113.0'	2.5'	4.0'	
5	113.4'	113.2'	2.6'	4.2'	
6	113.3'	113.1'	2.7'	4.1'	
7	113.3'	113.1'	2.5'	4.1'	
8	113.1'	112.9'	2.6'	3.9'	
9	116.0'	115.8'	2.4'	5.3'	
10	113.2'	113.0	2.7'	4.0'	

Missing Tubes Yes (No)

Kinked Tubes Yes (No)

Water in Tubes Yes (No)

WINCH S/N: 1273

PROBE No. 2575 Source 568

Calibration NO: ✓ Calibration Date 9-29-04 Functionality Preformed yes

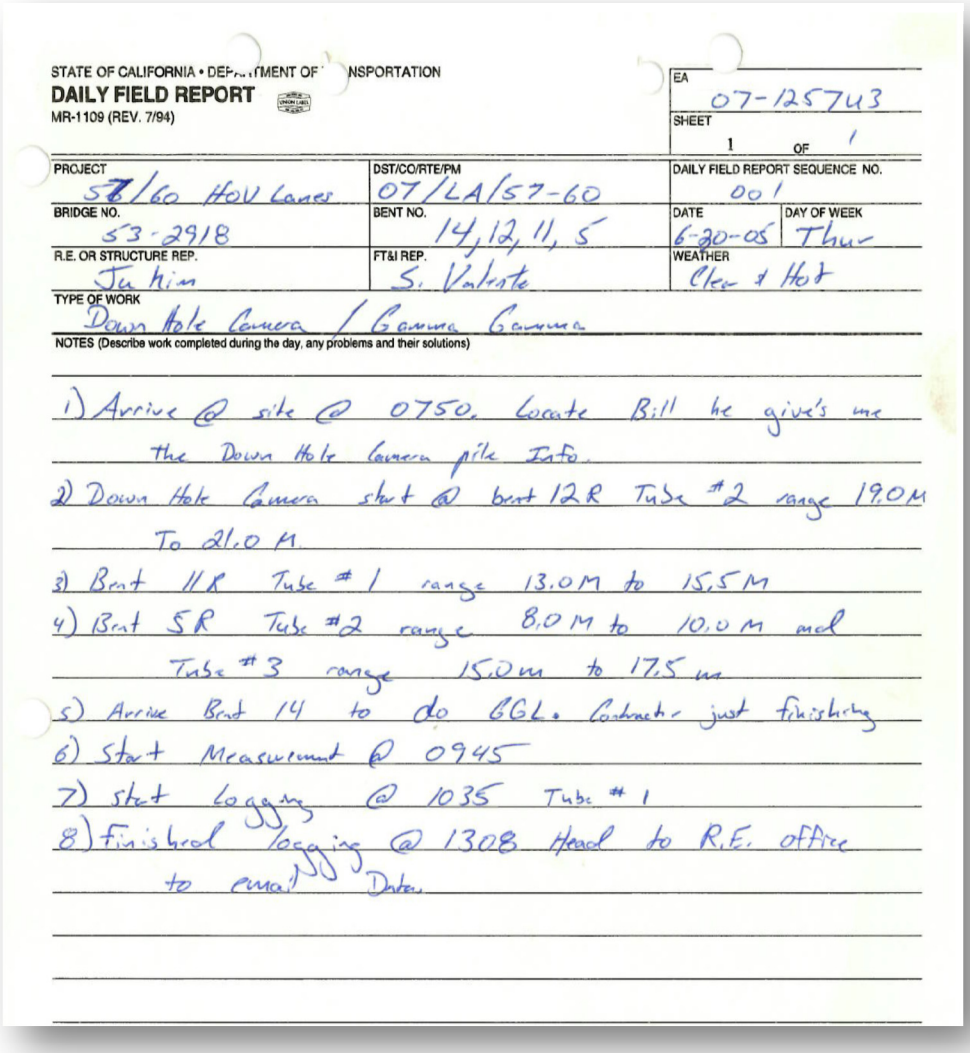
Remarks:/ Observation:

Figure 4-3 – Gamma Test Set-up Sheet

As part of the GGL tests, software is used by the Technician that records a set of GGL Data Files. Each foundation to be tested has PVC tubes cast into the concrete that allow for the radioactive source and probe to pass through. Each tube results in a pair of files generated by the software. The file that contains the data typically used by the Engineer for analysis has a three letter file name extension of ".LAS". The second file has a two letter file name extension of ".RD". Unless modified later, the LAS data file will have an associated "Date Modified" that reflects the date and time that the test for that tube was completed. The technician gives the data files to the engineer upon return to the Translab or transmitted as attachments to email.

While at the job site where the GGL tests are performed, the Technician is required to fill out a "Daily Field Report" form, as shown in Figure 4-4, that reflects his day's activities regarding the conduct of GGL tests. In the past, when

a Functionality Evaluation was done on site, the Technician would often record the fact that the evaluation was conducted as well as the results, and the mean of the results, on the Daily Field Report.



STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

DAILY FIELD REPORT

MR-1109 (REV. 7/94)

EA: 07-125743

SHEET 1 OF 1

PROJECT	DST/CO/RTE/PM	DAILY FIELD REPORT SEQUENCE NO.
57/60 HOV Lanes	07/LA/57-60	001
BRIDGE NO.	BENT NO.	DATE / DAY OF WEEK
53-2918	14, 12, 11, 5	6-30-05 / Thur
R.E. OR STRUCTURE REP.	FT&I REP.	WEATHER
Ju Kim	S. Valente	Clear & Hot

TYPE OF WORK: Down Hole Camera / Gamma Gamma

NOTES (Describe work completed during the day, any problems and their solutions)

1) Arrive @ site @ 0750. Locate Bill he give's me the Down Hole Camera pile Info.
2) Down Hole Camera start @ bent 12R Tube #2 range 19.0M To 21.0 M.
3) Bent 11R Tube #1 range 13.0M to 15.5M
4) Bent 5R Tube #2 range 8.0 M to 10.0 M and Tube #3 range 15.0m to 17.5 m
5) Arrive Bent 14 to do GGL. Contractor just finishing
6) Start Measurement @ 0945
7) start logging @ 1035 Tube #1
8) Finished logging @ 1308 Head to R.E. office to email Data

Figure 4-4 – Daily Field Report Form

4.1.4 GGL Test Equipment

FTB technicians use a Mount Sopris Model HLP-2375 Gamma-Gamma Probe that contains a 100-millicurie Cesium 137 nuclear source. The probe is connected by a data cable with a wire wound flexible steel cover to a winch with an electrical motor for raising and lowering in the pile foundation. In addition to raising and lowering the probe, the winch processes the data signal it receives from the probe and in turn sends the processed probe signal along with depth data to the data logging software that runs on a laptop computer connected to the winch through a serial data cable. The winch contains a depth encoder that provides the depth information. *MSLog* is the software used to log the data signal coming from the winch. Prior to around 2004, a DOS-based software application called *LogShell* had been used. (Subsequent discussions in this section of the report pertain only to

MSLog software.) Testing equipment and examples of test site conditions are shown in Figure 4-5 through Figure 4-8

Figure 4-5 – Mount Sopris Testing Equipment: Winch and Computer

Figure 4-6 – Mount Sopris Testing Equipment: Probe

Figure 4-7 – Example of GGL Testing Site

Figure 4-8 – Example of GGL Testing Site

4.2 Typical Testing Procedures

Typical testing operations, as described here, are those procedures that were generally accepted as standard practice and include a reasonable amount of variation. An overview is shown in Figure 4-9.

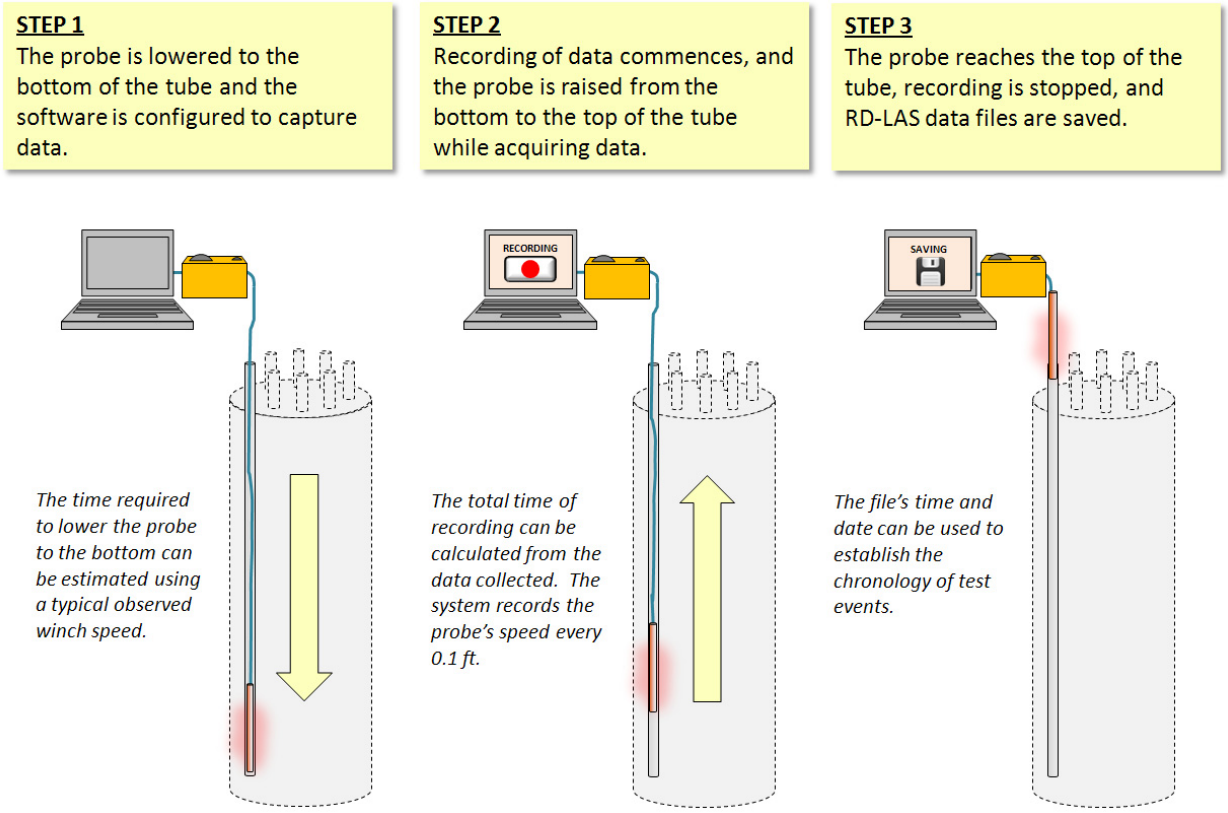


Figure 4-9 – Typical Testing Sequence

4.2.1 "Zeroing" the Depth Encoder

When the gamma-gamma probe is suspended at the top of the tube, and before lowering it into the pile, the depth encoder on the winch is "zeroed." The "zero" setting is typically 3.05 feet. The gamma-gamma tubes should stick up 3 feet above the top of pile concrete. When the depth encoder is zeroed, the top of the probe is near the top of the tube. When the probe is lowered into the pile, the depth reading will be approximately zero when the top of the probe passes the top of the pile concrete.

4.2.2 Lowering the Probe

Following typical testing procedures, data are collected as the probe is raised up from the bottom of the gamma-gamma tube located near the bottom of the pile. In order to get the probe to the bottom of the tube, the technician first suspends the probe by placing it inside the gamma-gamma tube with the probe data cable over a pulley connected to the top of the tube. The data cable is connected to the engaged winch spool which will not turn when the control switch is in the stop position.

The technician then toggles the winch control switch to the down direction to begin lowering the probe. In addition to the control switch, the winch has a speed control knob that allows the operator to set the tool raising/lowering speed from zero to about 50 feet per minute. Since data is typically not being collected on the way down, the technician usually sets the speed control knob to the fastest setting for the trip to the bottom of the tube.

4.2.3 Data File Initiation

Once the probe has been lowered to the bottom of the tube, the technician initiates a data file on a laptop computer that is connected to the winch through a serial data cable. The software program, *MS Log,* is used to process the data from the winch and create a raw data (RD) file and a log ASCII standard (LAS) file that are written to a specified location on the laptop. The RD file is written first and the LAS file is usually written within a few seconds of the RD file. Following typical procedures, the file would normally be initiated in depth-up mode (modes of operation are discussed below). Various aspects of initiating data acquisition in the MSLog software interface are shown in Figure 4-10.

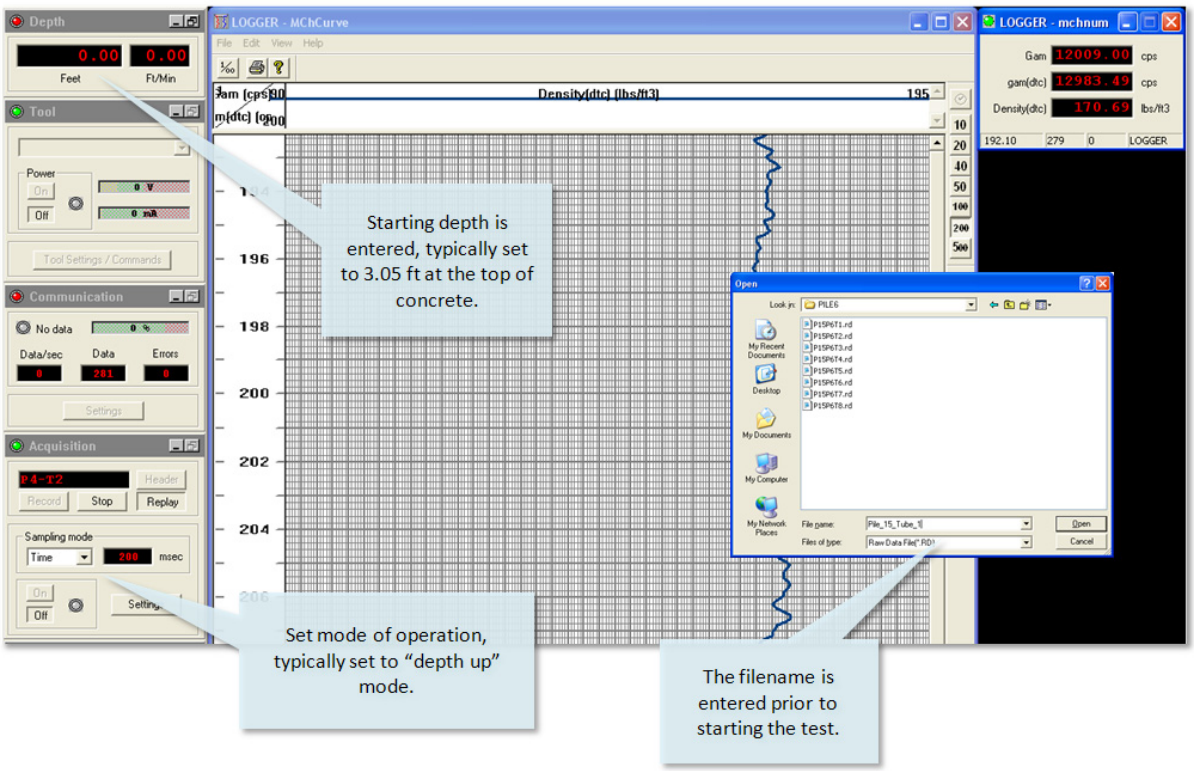


Figure 4-10 – Initiating Data Acquisition in MSLog

4.2.4 Probe Speed During Acquisition

After initiating the software data file, the winch motor is switched on in the up direction. The winch motor is usually initiated at a slow speed setting and then adjusted to the normal operating speed using the speed control knob. There was no well defined restriction on probe speed setting in the past. When asked about logging speeds commonly used in the past, FTB technician have responded anecdotally that 12 to 15 feet per minute was

generally the norm. At 12 feet per minute, the software records an average bulk density measurement every 0.5 seconds.

The RD files automatically generated by *MSLog* contain speed information. The GamDat Team went through and compiled average logging speeds from all gamma-gamma data logs for all recovered RD files in the GamDat collection. The compiled logging speeds are presented in Figure 4-11 and at a zoomed vertical scale in Figure 4-12. Examination of the recorded data shows that probe speed settings during data acquisition were generally in the range of 10 to 16 feet per minute, considered to be within the manufacturer's recommendations.

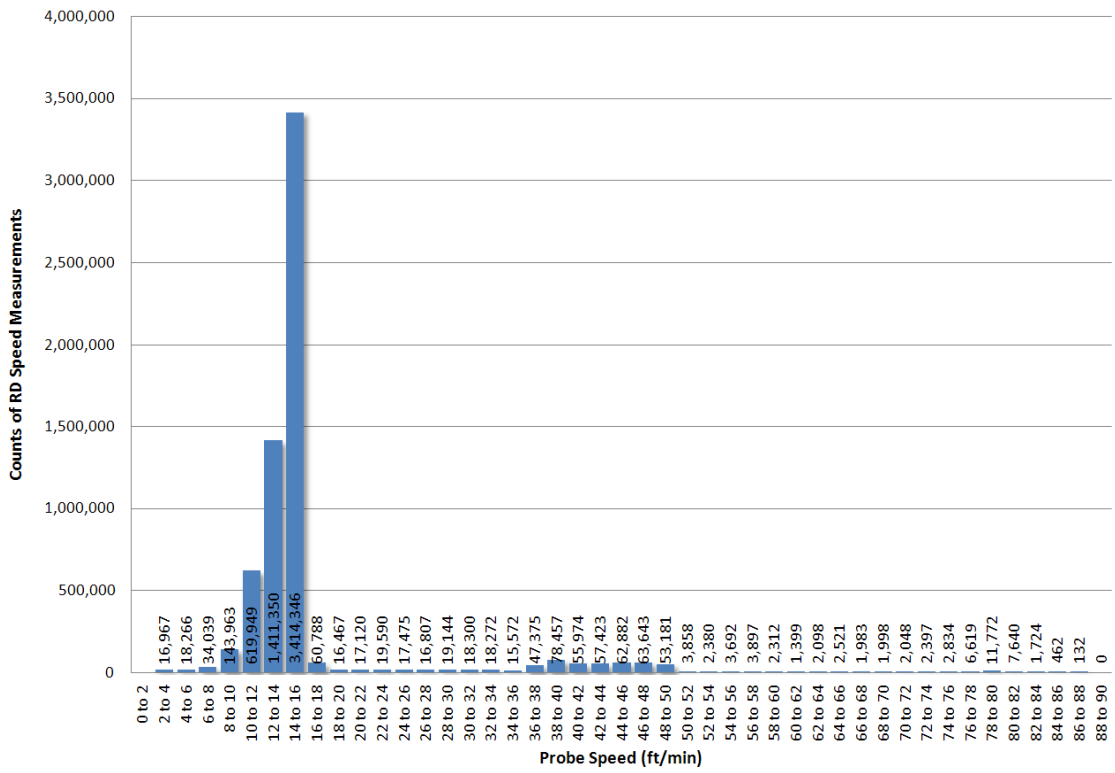


Figure 4-11 – Distribution of All Speed Measurement From All RD Files

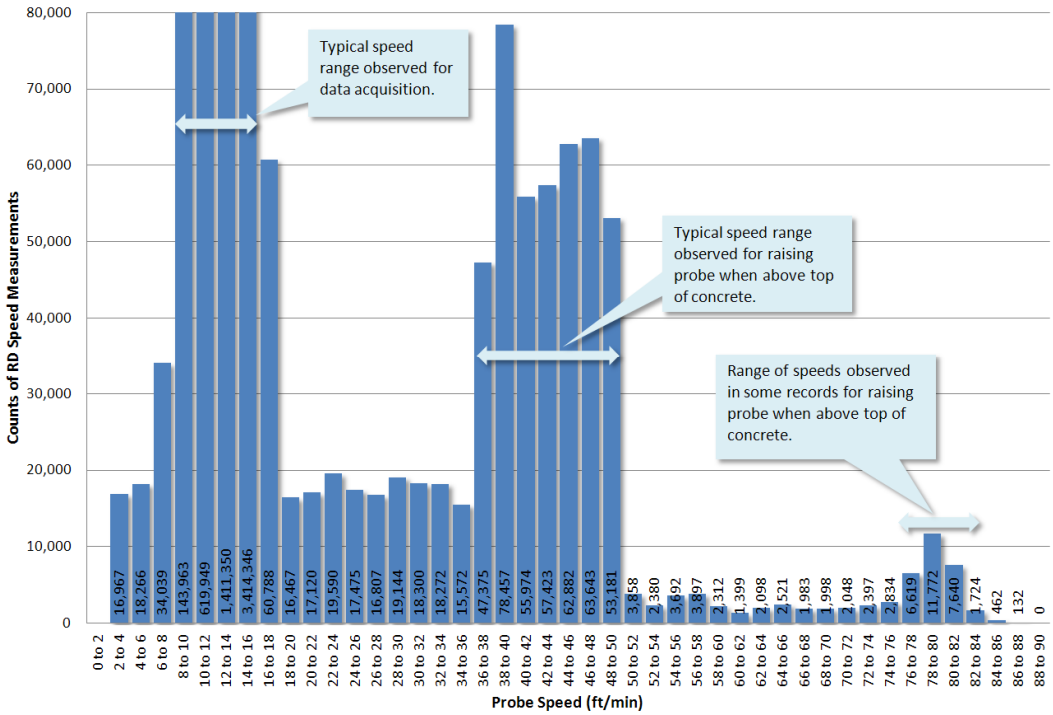


Figure 4-12 – Distribution of All Speed Measurement From All RD Files (Zoomed Scale)

In addition to having probe speeds at specific depths, the total duration of when the probe is moving and collecting data can be estimated from the integration of the speed data recorded every 0.1 ft.

4.2.5 Mode of Operation

Three different modes can be selected for data logging with the *MS Log* software, depth-up, depth-down, and time mode. Depth-up mode is normally used for gamma-gamma logging of foundations, depth-down mode is rarely used in normal operations, and time mode is generally used for verification, calibration, and testing the probe. Probe depth information is controlled by a depth encoder wheel located in front of the winch cable spool. The probe data cable passes through the depth encoder as it is either wound onto the spool or wound off of the spool.

4.2.5.1 Depth-Up Mode

In typical gamma-gamma logging operations, the data log begins at the bottom of the pile and continues in the up direction to the top of the pile. Nearly all gamma-gamma logs have been recorded in depth-up mode operation. In depth-up mode operation, a bulk density reading and depth reading is recorded at every 0.1 feet of probe travel in the up direction only. When the probe is stopped, or if the probe is reversed to the down direction, no readings are recorded. Also, the recording of depths and density readings resumes only after the probe passes back through the highest recorded depth. Probe reversals and stops do not appear in the logging record for depth-up operation.

4.2.5.2 Depth-Down Mode

In depth-down mode operation, a bulk density reading and depth reading is recorded at every 0.1 feet of probe travel in the down direction only. When the probe is stopped, or if the probe is reversed to the up direction, no

readings are recorded. Also, the recording of depths and density readings resumes only after the probe passes back through the lowest recorded depth. Probe reversals and stops do not appear in the logging record for depth-down operation. Depth down mode has rarely been used.

4.2.5.3 Time Mode

In time mode data logging, when the probe is stationary, a bulk density reading is recorded at a time interval setting, typically set to 1 second. However, when the probe is moving and the data cable is being drawn through the depth encoder at greater than 6 feet per minute, a density reading and depth reading will be recorded for every 0.1 feet of movement regardless of direction. Time mode data recording is typically used when density data are required with no probe movement, such as when conducting verification testing, block certification, radius of detection, and probe calibration.

4.2.6 Data File Recording

During typical operations, the probe is lowered to the bottom of the tube and the *MSLog* software is configured for data acquisition. Configuration of the software is carried out in several steps (as was shown earlier in Figure 4-10 in Section 4.2.3):

- The mode of data acquisition is selected (i.e. depth-up, depth-down, or time) in the *Acquisition* panel.
- The *LASWriter* module is configured to create a LAS file upon completion of logging.
- File header information is entered using the header feature in the *Acquisition* panel.
- Starting depth is set in the *Depth* panel.
- Recording is initiated in the Acquisition panel by clicking *Record* button, which prompts the user to enter the filename to be used.

Following these software configuration steps, the probe is raised and data is acquired. Once the probe reaches the top of the tube, the winch is stopped, and in the MSLog software the *Stop* button is clicked. RD and LAS files are written to the computer and the operating system assigns to “file modified” time to the files. This is the last step in logging the pile. Once completed, the probe is moved to the next tube and the process is repeated.

4.3 Atypical Testing Procedures

Atypical test procedures are those procedures that are possible, both from a physical and operational standpoint, but generally would be considered unacceptable and would fall well outside of the norm. The GamDat Team considered and described atypical operations in the presentation of findings, as they provide an explanation in some instances, or further the understanding of possible causes for some of the irregular data files.

4.3.1 Free-Wheeling the Probe

Typically, the probe is lowered within the pile with the winch motor engaged to the data cable spool. This allows the technician to lower the probe at a controlled rate using a variable speed control knob on the winch. This limits the lowering speed to about 52 feet per minute. At 52 feet per minute it takes approximately 4 minutes to get the probe to the bottom of a 200 foot pile.

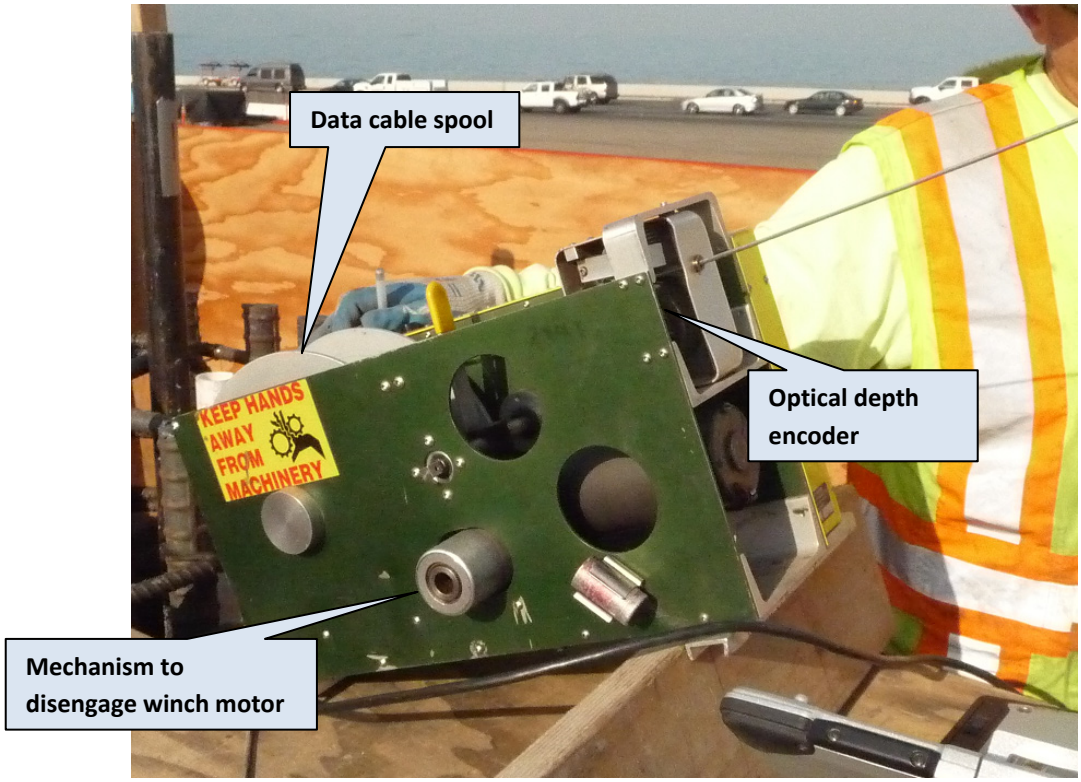


Figure 4-13 – Mount Sopris Winch Components

Free-wheeling is an atypical method of lowering the probe to the bottom of the pile at a much faster rate. To free-wheel the probe, the technician would disengage the data cable spool on the winch and allow gravity to lower the probe down the pile. These winch components are shown in Figure 4-13. GamDat experiments demonstrated that the probe could be lowered at speeds of up to 550 feet per minute by disengaging the spool and controlling descent with a gloved hand providing friction directly to the spool.

When asked about the possibility that free-wheeling has been used to lower the probe, FTB technicians have responded anecdotally that although uncommon, they had either seen or heard of this atypical operation used by others in the past. This atypical operation would result in a shorter total time required to log a given tube. The time difference is an important factor in the chronology analysis described in Section 5.6 later in this report.

4.3.2 Moving to the Next Tube and Lowering Prior to Saving

As described above under typical operations, the probe would be raised to the top of the pile and the data file would be closed and saved before moving the probe to the next tube. One possible atypical procedure would be to close out and save the data file at the bottom of the next tube to be logged. Note that while this procedure is theoretically possible, there is no anecdotal evidence that this process has been employed by Caltrans staff.

In this atypical operation, the first tube would be logged from the bottom up in depth-up mode data collection. Once at the top of the tube and without stopping the data log or saving the file, the probe is moved to the next tube and lowered to the bottom of the pile. Once at the bottom of the next tube to be logged, the data log from the previous tube is stopped and the file is saved.

The atypical operation described here would not be detectable by reviewing the data written to the file. Since data is only recorded when the probe is traveling in the up direction during depth-up mode, no data would be recorded during the trip down the second tube. The difference between this atypical method and the typical method would be a difference in the file save time and the resulting file modified time recorded by the computer operating system. The time difference is an important factor in the chronology analysis described in Section 5.6 later in this report.

4.3.3 Double-Transit Logging

The typical testing procedure used on nearly all GGL tests involves lowering the probe to the bottom of tube (referred to as *down-transit*) without recording data, then initializing the *MSLog* software to depth-up mode and recording data with the probe moving upwards to the top of the tube (referred to as *up-transit*). The data file is typically, but not necessarily, saved with the probe at the top of the tube where data was recorded. The atypical double-transit procedure involves initializing the *MSLog* software to time mode after the probe is lowered to the bottom of the tube, then recording for both an up-transit and a subsequent down-transit. The data file is necessarily saved at the end of the second down-transit while the probe is at the bottom of the tube for a second time. Double-transits were critical for establishing chronology evidence in the three cases involving double-transit. Double-transit logging is shown in Figure 4-14.

It is important to note that the use of the time mode setting and double-transit recording does not introduce data integrity issues alone. However, it is precisely because of the use of this atypical testing sequence that a compelling chronological case could be established in three cases as presented in Section 7 later in this report.

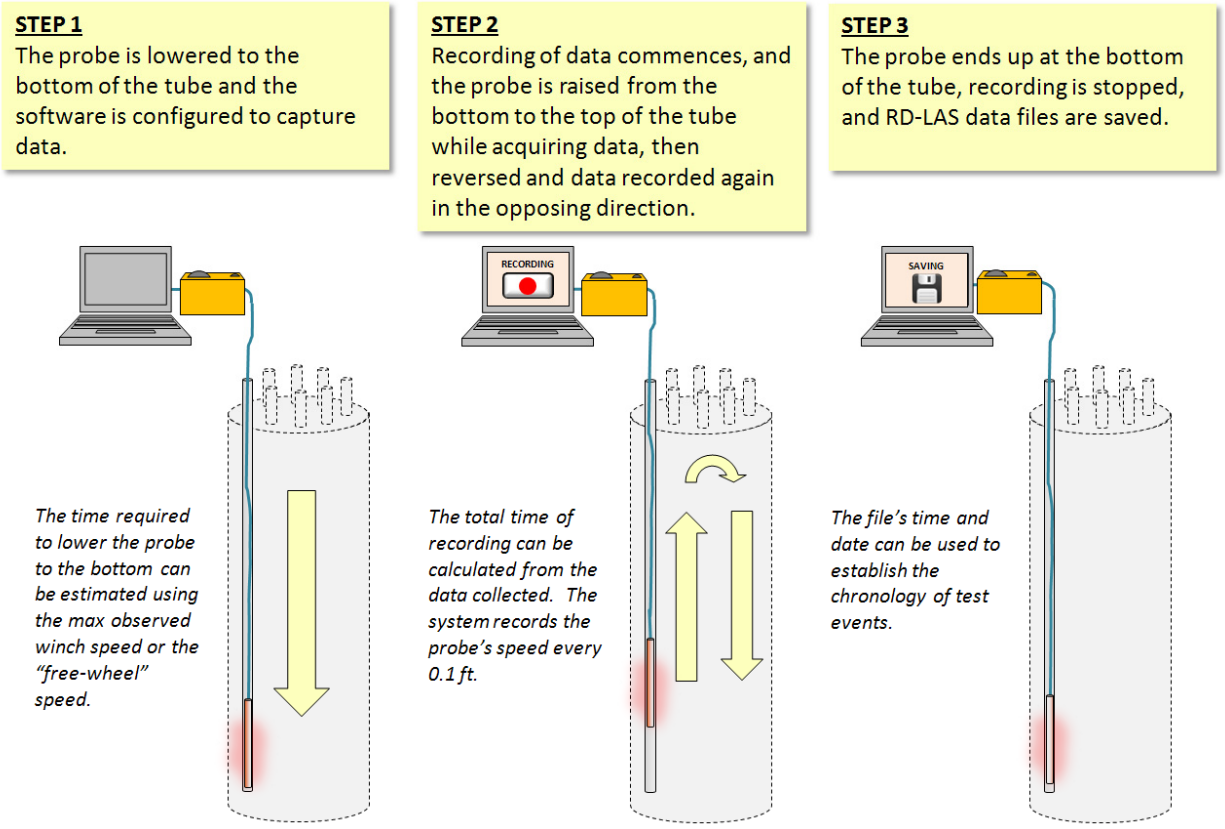


Figure 4-14 – Atypical Double-Transit Testing Sequence

4.4 Observations from Testing of GGL Equipment and Software

In order to gain a better understanding of the GGL equipment and operations, the GamDat Team conducted comprehensive laboratory and field testing. The initial goal of the testing was to challenge the assumptions used in our analyses of data irregularities and to learn more about the effects from irregular operations. Testing was also used to answer questions that emerged from ongoing analysis and problem solving. As a result, the GamDat Team gained knowledge of how GGL testing works as an integrated system that includes the probe, winch, computer data logger, and technician. Detailed information from the testing can be found in Appendix C: Testing of Mt Sopris Equipment.

4.4.1 Field and Lab Testing Conducted

A series of tests were conducted under laboratory conditions at the TransLab in Sacramento and under field conditions on CIDH piles at the High Street Bridge project in Oakland. The testing included varying operational conditions, mechanical equipment parameters, and software settings. In some instances, attempts were made to reproduce a specific type of data irregularity through trial and error. Goals of the testing include the following:

- Reproduce irregular spikes and offsets in count readings as observed in data from qualification of functionality blocks from 2007. Testing included repositioning the probe (i.e. rotational and linear) in the block during testing.

- With the probe stationary in a concrete block, operate the winch motor and record data files while moving cable through the depth encoder to emulate actual logging.
- Test the operational limits of the optical depth encoder by manually passing cable through the encoder as fast as possible and abruptly alternating direction.
- Attempt to introduce null values into the data files by operating the winch at fastest possible speed. Identify conditions where null values are introduced.
- Create time mode logs including double-transits and stationary data.
- Create multiple data logs of the same tube.
- Determine if and when data collection can be paused during data file creation. Identify specific operational modes where possible.
- Attempt to re-create some of the irregular time mode files found by GamDat.
- Attempt to induce errors of any type in the data files.
- Establish the minimum testing time.
- Create standard operation logging mode reference files.
- Challenge the communication between the winch and data logger and attempt to introduce null values.
- Validate and understand the speed data that is recorded in RD files through capture and interpretation of raw data stream from the winch to the computer data acquisition system. (Additional details of this testing is provided in Appendix C: Testing of Mt Sopris Equipment).

4.4.2 Observations

Observations from the equipment testing include the following:

- In general, operational consistency, lower winch speeds, and controlled environmental conditions appear to produce more consistent, reliable, and repeatable data. That is, the occurrences of null values or zero counts are minimized and the depth encoder more accurately reflects true probe position in the hole.
- The direction of probe travel has a significant impact on the depth encoding of individual measurements. Differences in cable tension/slack and use of compliant ancillary cable supports may be contributing factors, although, this aspect was not specifically studied.
- Null data values can be introduced into data files through irregular operations. (e.g. cable is quickly pulled past the depth encoder).
- Although the speed data recorded in RD files is generally very consistent with independent measurements, an averaging filter applied by the data acquisition software can introduce some amount of error in speed data when the probe is accelerating from a stationary position. These erroneous speed values can be identified easily, as extremely small values that typically occur at the beginning of the file. (Additional details about this finding are provided in Appendix C: Testing of Mt Sopris Equipment).
- The optical depth encoder was generally found to track cable position very reliably and consistently. However, the configuration and compliance of ancillary cable supports at the job site could introduce discrepancies between the encoded depth and the true depth of the probe in some instances. For example, in a test site configuration as shown in Figure 4-15, the combination of long cable runs, the two pulley configuration, and differing cable slack depending on direction of probe travel could lead to differences in recorded probe position. Significant differences in data were observed for collection in opposing directions.

Figure 4-15 – Double pulley configuration at test site

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5 Development and Execution of Screening Tools

A suite of screening tools was developed that subjected the collection of GGL data files generated by Mount Sopris equipment (i.e. LogShell, RD, LAS) to focused analyses, as summarized in Table 5-1.

Analysis Type	File Types Analyzed	% of File Types Analyzed	% of All Tests Analyzed (LAS+LS)	Files Flagged	Number of Manual Analysis IDs Established	IDs Turned into Cases
Pattern Matching	LAS, LS	100%	100%	190 LAS 12 LS	10	ID-2, ID-12, ID-13
Pattern Matching (File Renaming)	LAS, LS	100%	100%	184 LAS 62 LS	15	ID-18, ID-52
Time Stamp (RD-LAS Pairs)	RD, LAS	62%	39%	189 RD-LAS	14	ID-2
Time Stamp (Chronology)	RD, LS	100%	76%	130 LAS 79 LS	31	ID-17, ID-76
Calibration Constant	LAS, LS	100%	100%	39 LAS 72 LS	10	ID-4, ID-13
Depth Consistency	LAS	100%	62%	56 LAS	10	ID-2, ID-10, ID-11, ID-13, ID-17, ID-33
Fidelity (RD-LAS Pairs)	RD, LAS	62%	39%	89 RD-LAS	7	ID-2, ID-4

Table 5-1 – Screening Tools

Two percentages are cited in the table that show to what percent of the files the specific analysis tool was applied. Some of the analysis tools were applied comprehensively to all unique data files found, while others could only be applied to specific file types, or instances where file pairs or file groups could be identified. The "% of file types analyzed" presents the percentage of the files of a specific type that could be analyzed. For instance, the fidelity analysis could only be carried out on LAS-RD file pairs, and only 62% of the LAS file had a corresponding RD file. The "% of All Tests Analyzed" is based on a similar calculation; however, the percent is relative to all tests represented by the data files (i.e. the LAS plus the LS files).

Tools were implemented as a web-based application, an Excel spreadsheet, or both. The automated screening tools produced 1102 flags for potential irregularities, representing 876 unique GGL Tests. Depending upon the type of analysis, the flag can represent a single file (e.g. depth consistency analysis) or a pair of files (e.g. fidelity analysis). For a number of these flags, the same files or file pairs were flagged by one or more analyses. As such, the total number of unique GGL Tests represented by the flags is less than the total number of flags. All flags were assigned to one of the 100 Manual Analysis IDs for further evaluation. (Note that in Table 5-1, the number of Manual Analysis IDs do not total to 100, as some IDs were established that did not result from a automated analysis tool.)

5.1 Technology Platform

The suite of automated analysis tools were developed and deployed on a secured Caltrans intranet web server. A virtual instance of Windows 2008 server was set up for this purpose. An open-source web-based stack of technologies was configured, consisting of *Apache*, *MySQL*, and *PHP*, collectively referred to as a *WAMP stack*. Analysis codes were developed using the PHP scripting language. A copy of the complete collection of GGL data files was hosted on the server. The MySQL data housed file metadata and gamma and density measurements parsed from all files. This framework allowed execution of PHP codes against the entire collection of data, and provided a secure storage for files and results. A more detailed description of the technology framework and the codes developed is described in Appendix K: Codes and Database.

5.2 Analysis Procedures

The team adopted a multi-stage procedure to manage the analysis process and handling of the hundreds of results generated by the screening tools.

1st Stage – Execute screening tools and generate lists of flagged files.

- The screening tools are applied to the data file collection.
- Lists of files flagged for potential irregularities are generated.
- Flagged files are not necessarily tests with irregularities, and further examination of each flagged file is needed.
- Tens of thousands of files are filtered down to hundreds of files being flagged during this step.

2nd Stage – Assign flagged files to *Manual Analysis IDs*.

- Conduct a cursory review of each flagged file and assign to a *Manual Analysis ID*, representing a single file or a group of files, depending on nature of the irregularity.
- Identify bugs or other limitations in the analysis methods and software codes.
- The original list of hundreds of flagged files is reduced down to dozens of more manageable *Manual Analysis IDs*.

3rd Stage – Conduct in-depth analyses and establish cases.

- For each *Manual Analysis ID*, conduct in-depth analyses and evaluation of relevant files.
- Enlist other analysis tools as warranted (e.g. correlation).
- Conduct lab/field testing, if needed, to substantiate assertions and findings.
- Document each *Manual Analysis ID* with details of in-depth investigative work (e.g. review of project records, calculations, etc.), relevant files examined, findings, and conclusions.
- Establish a case when the Manual Analysis has established that an irregularity is at least plausible and is consequential.
- Communicate cases to Sponsors when identified.

These stages are illustrated in the diagram in Figure 5-1.

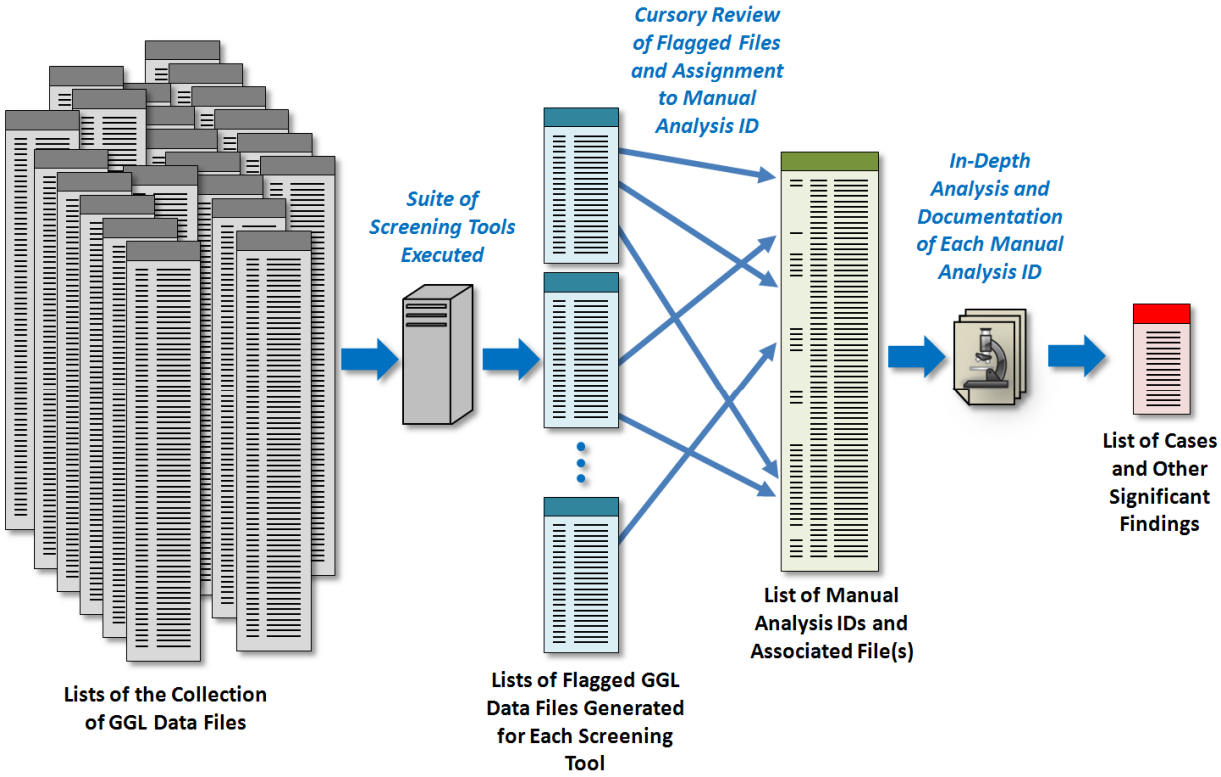


Figure 5-1 – Overview of Analysis Procedures

The remainder of this section of the report presents details of each of the screening tools applied. Within each sub-section for an analysis tool, a table is presented that summarizes the number of flagged files, the Manual Analysis IDs established, and resulting cases. In-depth discussion of cases is presented in Section 7.

5.3 Pattern Matching

The *Pattern Matching Analysis* tool was executed on LAS and LogShell files to identify occurrences of repeated patterns of density measurements. These repeating patterns could be within a single file or across multiple files. The purpose of the tool is to detect evidence of possible copy/paste from files within the GamDat data collection. The tool flagged all files with repeating patterns of four or more consecutive densities values. The example in Figure 5-2 demonstrates pattern matching across two files. In this example, a sequence of density measurements from file "A" is also found in file "B." This would indicate a significant data irregularity.

GGL Data File "A"		
Date		1/1/01
Start Depth		1
Stop Depth		10
Depth	Counts	Density
1	17216.1	160.1
2	17449.2	161.2
3	17027.4	151.4
4	17304.9	160.9
5	16683.3	153.4
6	17582.4	155.9
7	17471.4	150.3
8	17771.1	158.4
9	16772.1	157.4
10	17404.8	160.1

GGL Data File "B"		
Date		1/1/01
Start Depth		1
Stop Depth		10
Depth	Counts	Density
1	17216.1	155.1
2	17449.2	157.2
3	17027.4	153.4
4	17304.9	155.9
5	[illegible]	150.3
[illegible]	17582.4	158.4
7	17471.4	157.4
8	17771.1	160.1
9	16772.1	151.1
10	17404.8	156.8

Figure 5-2 – Pattern Matching

5.3.1 Files Analyzed

This analysis was carried out on all unique LAS and LS files obtained by the team. However, pattern matching between LAS and LS files was not carried out, as significant differences in data file formats and density precision prevented the comparison. Note that the scenario of alteration of data files by copying and pasting between two different data formats is highly unlikely due these differences.

5.3.2 Scenarios Generating Irregularities

Repeating patterns can occur in collections of LAS or LS files for a number of reasons, some legitimate while others suggesting that an intentional alteration occurred that may have compromised the integrity of the data. These include:

- Data is copied and pasted from one file into another.
- A file is renamed and metadata within the file (e.g. logger, location, date, etc.) modified such that the two files appear to be different even though the full data sequences are identical.
- Despite the random nature of gamma radiation counts and nuclear statistics, there's a finite probability that a sequence of three or more measurements can recur naturally, though infrequently.
- A partial sequence of densities from a corrupted file is matched to the original uncorrupted version of the same file.
- LogShell files containing repeating values (equivalent to the "-999.25" null values in LAS files)

5.3.3 Implementation of the Tool

The analysis was implemented in two stages. The first stage was carried out in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code examined all LAS files for occurrences of patterns of three or more (four or more for LS files), determined the length of pattern match, and the files where the patterns were found. The code generated an output file containing the following attributes:

- File ID
- Unique File ID

- File path and Filename
- Pattern ID
- Pattern of Density Values (comma-delimited string)
- Number of Density Values in the Pattern
- Number of Occurrences of the Pattern Within the Same File

A second stage filtering analysis was carried out in an Excel spreadsheet, using the code's output as a starting point. Three groups of pattern matching results were filtered out in this process, including:

- Repeating patterns of the same high density value (e.g. "…, *63218.100, 63218.100, 63218.100, …*") occurring in multiple files, typically found in calibration data files where multiple readings of the probe outside of the concrete barrel resulted in minimum gamma count (maximum density) values.
- Patterns associated with a group of altered files used in a gamma data integrity review that predates the GamDat work.
- Files identified with pattern matches of only three consecutive densities values.

Although patterns of three or more were identified for LAS files, the significant number of occurrences of patterns of three suggest that sequences of up to three occur naturally to some degree, or may be a result of the digitization and round-off of values within the data acquisition system. These patterns of three were found in 662 out of the 14,451 LAS files examined, approximately 5%. A sharp drop off in frequency of patterns of four or more was observed, as presented in Table 5-2 – Count of Patterns of Three to Ten Observed in All Unique LAS Files. All patterns of four or more were evaluated and assigned to a Manual Analysis ID.

Length of Sequence of Density Values in LAS Files	Count
3	662
4	1
5	1
6	1
7	0
8	1
9	0
10	3

Table 5-2 – Count of Patterns of Three to Ten Observed in All Unique LAS Files

A similar observation was made with the LS file results for patterns of four or more. The significant number of patterns of four suggest that sequences of up to four occur naturally to some degree, or may be a result of the digitization and round-off of values within the data acquisition system. (Density values in LS files are reported to 2 decimal places, whereas LAS files are reported to 3 decimal places.) These patterns of four were found in 360 out of the 8,919 LS files examined, approximately 4%. A sharp drop off in frequency of patterns of five or more was observed, as presented in Table 5-3.

Length of Sequence of Density Values in LS Files	Count
4	360
5	0
6	0
7	0
8	0
9	0
10	0

Table 5-3 – Count of Patterns of Four to Ten Observed in All Unique LS Files

5.3.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 190 LAS and 12 LS files were flagged by this analysis. All flagged files were assigned to one of 10 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 5-4. Three cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. More detailed documentation for each Manual Analysis ID can be found in Appendix P: Manual Analysis Documentation. The complete list of all results from this analysis is presented in Appendix E: Lists of All Flagged Files.

File Type	Total Number of Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
LAS	190	ID-1		LAS header modified
		ID-2	**Yes**	**Qualification Testing of FTB Standard Reference Blocks**
		ID-12	**Yes**	**Previously identified falsification case**
		ID-13	**Yes**	**Previously identified falsification case**
		ID-14		Files opened & saved in Excel but no data integrity compromises
		ID-21		Corrupted or truncated LAS and LS files are flagged
		ID-26		Pattern Match in file pairs
		ID-27		Files opened, annotated, & saved in Excel but no data integrity compromises
		ID-29		Single data point removed from LAS file
		ID-31		LAS files with extra row of data at end
LS	12	ID-21		Corrupted or truncated LAS and LS files are flagged

Table 5-4 – Pattern Matching: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.4 Pattern Matching – File Rename

The *File Rename Analysis* extends the pattern matching analysis to identify files where the entire sequence of density values occurs in more than one file. In the files flagged, all data within the file, including the header data, was identical to another file with a different file name. For example, a group of four files with duplicate content were found in different file folders. However, one of the files has a different filename, as shown in Figure 5-3. The purpose of this analysis is to identify instances where a file may have been renamed and used to improperly represent another test.

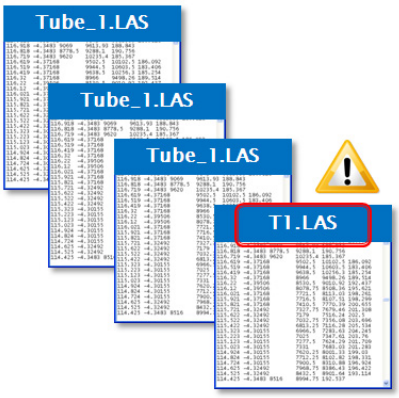


Figure 5-3 – Example Group of Duplicate Files With One Renamed

5.4.1 Files Analyzed

The File Rename analysis was carried out on all LAS and LS files obtained by the team, and was not limited to the subset of unique LAS and LS files. Duplicate versions of files identified through checksum and hashing functions (described in Section 3.3.2) were examined for changes to filename. The filepaths of all duplicates of each unique data file were examined to assure the duplicates were not used to represent two different GGL tests and/or locations.

5.4.2 Scenarios Generating Irregularities

Renaming of LAS, RD, and LS files may have been done for a number of reasons, some legitimate while others indicating that an intentional alteration occurred that may have compromised the integrity of what was reported. Scenarios include:

- Revising the filename to include more clearly identifying foundation information (e.g. renaming "*T1.LAS*" to "*Bent2_Pile4_T1.LAS*" shown in Figure 5-4).
- Correcting a mistake in the identifier for an inspection pipe after the file was generated.

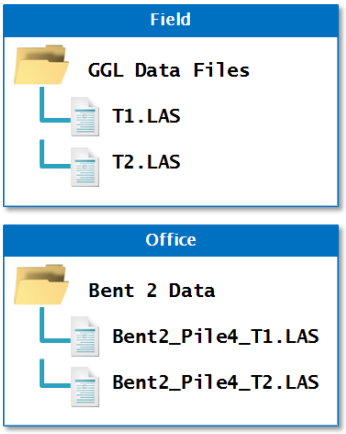


Figure 5-4 – Example File Renaming to Include Location Information

5.4.3 Implementation of the Tool

The analysis was carried out using the Master List of all files as the basis (described earlier in Section 3.3.6). A flagging function was implemented in an *Excel* spreadsheet to examine the groups of files with identical content (i.e. files that share the same Unique ID), as shown in an example in Table 5-5. If, within the group of duplicate files, a different filename was encountered, the entire group was flagged for further evaluation.

The example presented in Table 5-5 illustrates what was typically encountered in this analysis, whereby several copies of a file were found on different data sources. Each file has its own File ID, and all share the same Unique ID, as the data contents are identical. These are flagged because more than one filename (i.e. "P4T1.LAS" and "A1T2.LAS") was assigned to the Unique ID.

File ID	Unique ID	Date	File Path	File Name
10	22	12/20/2012	...laptop/33-1234 Folsom Blvd/B2/P4/	P4T1.LAS
11	22	12/20/2012	...desktop/33-1234 Folsom Blvd/B2/P4/	P4T1.LAS
12	22	12/20/2012	...dvd/33-1234 Folsom Blvd/B2/P4/	P4T1.LAS
13	22	12/20/2012	...archive/33-1234 Folsom Blvd/B2/P4/	P4T1.LAS
14	22	12/20/2012	...server/33-1234 Folsom Blvd/B2/P4/	P4T1.LAS
15	22	12/20/2012	...backup drive/33-1234 Stockton Blvd/Abut/	***A1T2.LAS***
16	22	12/20/2012	...laptop/33-1234 Stockton Blvd/Abut/	***A1T2.LAS***

Table 5-5 – Example of Files Flagged for Different Filename

A variation of this scenario exists where a file is copied and used to represent a test at a different foundation location or different structure altogether. However, if the copied file is not renamed, neither the file rename nor the pattern matching tools would flag the irregularity, as the file is considered to be the same as the others under the Unique ID designation. This is illustrated in a variation of the prior example and is presented in Table 5-6.

File ID	Unique ID	Date	File Path	File Name
10	22	12/20/2012	...laptop/33-1234 Folsom Blvd/B2/P4/	T1.LAS
11	22	12/20/2012	...desktop/33-1234 Folsom Blvd/B2/P4/	T1.LAS
12	22	12/20/2012	...dvd/33-1234 Folsom Blvd/B2/P4/	T1.LAS
13	22	12/20/2012	...archive/33-1234 Folsom Blvd/B2/P4/	T1.LAS
14	22	12/20/2012	...server/33-1234 Folsom Blvd/B2/P4/	T1.LAS
15	22	12/20/2012	...backup drive/33-1234 Stockton Blvd/Abut/	***T1.LAS***
16	22	12/20/2012	...laptop/33-1234 Stockton Blvd/Abut/	***T1.LAS***

Table 5-6 – Example of Files Not Flagged by File Rename Analysis

Note here that the filename is the same for all files. The data contents for all files under this Unique ID are also identical. The only indicator of a potential irregularity is that the file path in two instances appears to reference a different bridge. This variation of the file rename analysis was not carried out due to challenges with matching data files to reported tests and specific projects/locations based on information extrapolated from file paths alone. Additional discussion of this issue is presented in Section 3.6.3.1.

5.4.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 184 LAS and 62 LS file pairs were flagged by this analysis. All flagged files were assigned to one of 15 Manual Analysis IDs. A summary of flagged files and a brief description of the ID to which these were assigned are presented in Table 5-7. Two cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Total Number of Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
LAS	184	**ID-18**	**Yes**	**File Rename; Sawtelle Blvd**
		ID-43		Files renamed to include the location information
		ID-44		File opened/closed and new file extension added; Oakland Sep
		ID-45		Filename changed to identify issue with file or retest
		ID-52	**Yes**	**Previously identified falsification case, file rename; Braddock**
		ID-63		File renamed to correct location information
		ID-64		File renamed to include Tube number
		ID-65		Files renamed to indicate subsequent iteration of testing
		ID-66		No data below header - associated as Renamed
		ID-68		File name changed to include date information
		ID-69		File rename as result of null value problem
		ID-70		Renamed files requiring red folder follow up
LS	62	ID-43		Files renamed to include the location information
		ID-46		Windows to DOS 8.3 filename conversion files flagged
		ID-47		Windows backup or restore files flagged
		ID-73		File renamed upon receipt by Engineer

Table 5-7 – File Rename: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.5 Time Stamp – RD-LAS File Analysis

The *Time Stamp RD-LAS File Analysis* examines matched pairs of RD and LAS files to identify instances where the dates are significantly different between the RD and LAS file creation, suggesting that the LAS file may have been modified after the test. The analysis approach is illustrated in an example in Figure 5-5 where timestamps of paired files are compared.

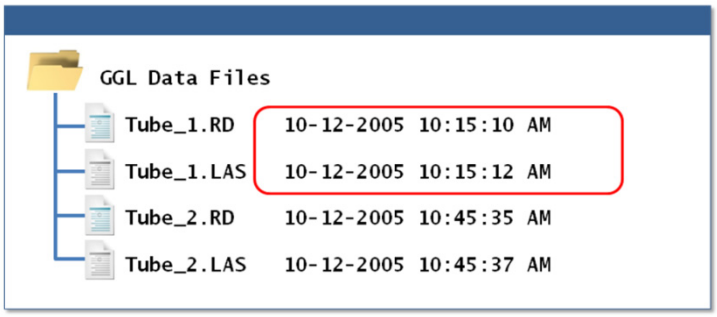


Figure 5-5 – Example of RD-LAS Timestamp Comparison

The basis for this analysis is the "modified" date and time property of the file, assigned by the Windows operating system, as shown in a file properties panel in an example in Figure 5-6. In Windows the "modified" date and time is changed when a file's contents or properties change. The "created" date and time property changes when a file is moved or copied from its original location in a file system.

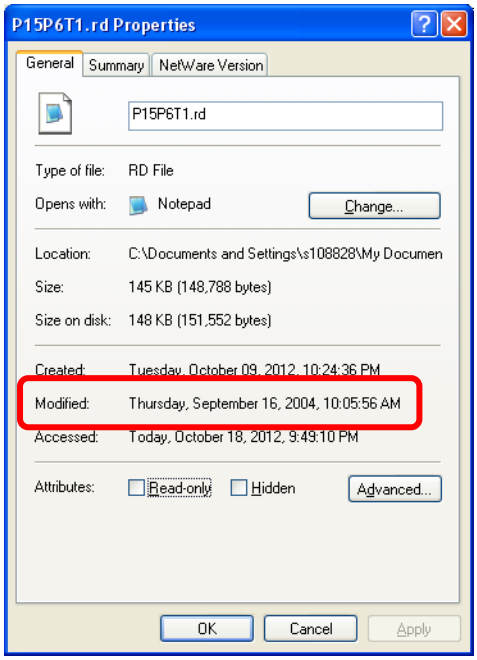


Figure 5-6 – Modification Date Assigned by the Windows OS

Large time gaps suggest that the LAS file was modified some time after the original file was created, and warrant a more careful evaluation. In many instances an assessment by one of the other analysis tools is needed to identify the nature of the file alteration that changed the file timestamp and resulted in the time discrepancy.

The Mount Sopris *MSLog* software automatically saves a pair of RD and LAS files upon completion of a GGL test. The RD file is written initially, as it is the native file format of the software. A separate and optionally configured module within MSLog, called *LASwriter*, generates and saves a LAS file after the RD file is saved. In the vast majority of RD and LAS files manually examined, the date and time stamps for the file pair are identical. However, a number of file pairs were identified with time differences up to a one minute, with no evidence to suggest the LAS file was opened, modified, or data compromised in any way.

A time lapse between RD-LAS file pairs of greater than one minute was adopted as the initial screening criterion to apply to the thousands of data file pairs in the collection. This time limit was set based on observations of typical times observed throughout the data file collection. This criterion appeared to be a reasonable limit, producing a manageable list of the RD-LAS file pairs with timing discrepancies warranting more in-depth analysis.

5.5.1 Files Analyzed

This analysis could only be carried out on matched pairs of RD and LAS files (described in Section 3.3.4).

5.5.2 Scenarios Generating Irregularities

Differences in timestamps between RD and LAS files can be attributed to two predominant reasons:

- An observed latency within the *MSLog* software and the *LASwriter* module introduces a time lapse between the closing timestamps of the RD and LAS files. The LAS files in these instances typically exhibit no evidence of alteration of any kind.
- The LAS file is opened in *Excel* at a later time and saved upon closing. The LAS files in these instances typically have evidence of having been opened and saved.

5.5.3 Implementation of the Tool

The analysis was implemented in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code calculated the differences in the timestamps of all RD-LAS file pairs and flagged file pairs where the time difference was in excess of one minute. The code generated an output file containing the following attributes:

- RD-LAS Pair ID
- Unique File ID
- File path and Filename
- Timestamp flag
- Time difference (days, hours, minutes, seconds)

5.5.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 189 RD-LAS file pairs were flagged by this analysis. All flagged files were assigned to one of 14 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 2-1. One case was established based on the results of this analysis. Descriptions

of cases are presented later in this report in Section 7. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Total Number of Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
RD-LAS Pairs	189	ID-1		LAS header modified, Benicia-Martinez
		ID-2	**Yes**	**Qualification Testing of FTB Standard Reference Blocks**
		ID-23		RD-LAS Timestamp, SFOBB
		ID-41		RD-LAS Time Discrepancy, SE Connector
		ID-42		RD-LAS Date Discrepancy, Lake Hodges
		ID-53		Files from initial investigation flagged
		ID-54		Analysis of RD-LAS Timestamp Discrepancies Under 2 minutes
		ID-55		RD-LAS Timestamp Discrepancies, SFOBB
		ID-59		RD-LAS Time Discrepancy, Lake Hodges
		ID-60		RD-LAS Timestamp Discrepancy
		ID-61		RD-LAS Timestamp Comparison Replayed RD Files, No Data Editing
		ID-62		RD-LAS Timestamp Discrepancy; Tube Retested, Marysville Maint Sta
		ID-71		Data In LAS-RD Pair Does Not Match, Sawtelle Blvd
		ID-72		RD-LAS Timestamp Diff less than 4 min

Table 5-8 – Time Stamp: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.6 Time Stamp – Chronology Analysis

The original purpose for developing *Chronology Analysis* was to screen for possible retests, that is, where two tests conducted in a single tube are reported as independent tests conducted in two different tubes. However, as the investigation ensued, it became apparent that identification of retest by this means was ineffective since other operational factors could also reasonably account for irregular chronology data. Ultimately, this analysis was used by GamDat for the detection of operational irregularities.

The chronology analysis uses the time stamps from a group of RD files obtained within a single pile to establish a sequence of testing events. The time intervals between tests can be compared against estimates of times required to carry out testing activities. An example of a typical testing sequence is presented in Figure 5-7. The interval between any two consecutive tests in the test sequence must account for the standard set of testing activity steps summarized in Table 5-9. The chronology analysis involves estimating time increments required to complete each step, where the estimates are based on a combination of calculations and assumptions. If the cumulative elapsed time exceeds the time available between consecutive time stamps, the file is flagged for a potential irregularity and assigned to a Manual Analysis ID for further examination.

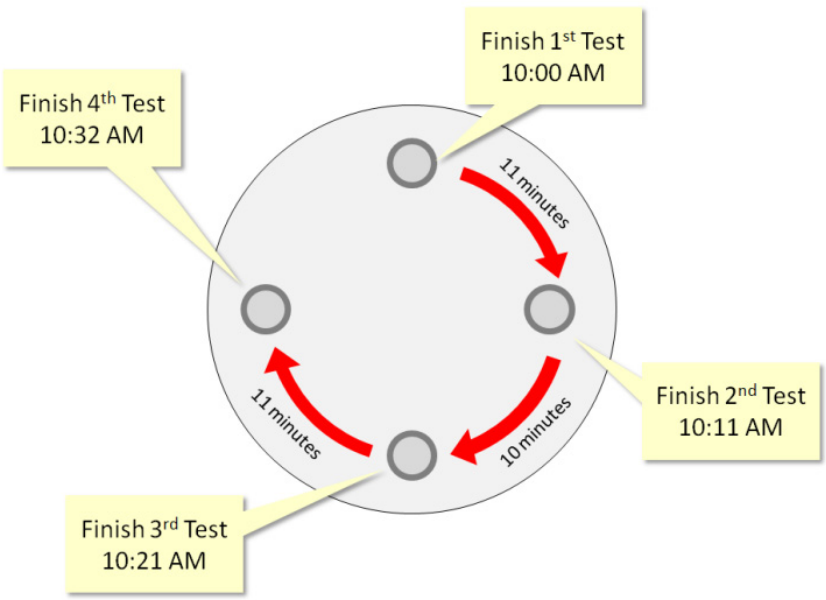


Figure 5-7 – Typical Sequence of Testing of a Pile

Step	Test Activity	Determination of Time Increment	Example of Typical Time Increment (min:sec)	Cumulative Elapsed Time (min:sec)
0	File is saved from prior test.	Assumed to be instantaneous for RD and LS file creation.	***00:00***	***00:00***
1	Set up ancillary equipment and position the gamma probe at the top of the inspection pipe.	Estimates of time required for this activity is based largely on the experience and observations of GamDat team members. While unbounded on the high end, typical values are often in the 2 to 5 minute range, and 15 seconds is considered a practical minimum. Factors influencing the time estimate for any particular set of tests include the physical proximity of the testing equipment relative to the tested tubes and the presence of a helper on site.	***02:30***	***02:30***
2	Lower the probe to bottom of the inspection pipe (i.e. non-recording down-transit).	Calculated based on assumed value for probe speed since lowering speeds are not recorded. A uniform speed of 52 fpm is assumed based on typical maximum winch speed. There is anecdotal evidence of the use of an atypical procedure involving free-wheeling the probe at speeds estimated to be as high as 550 fpm.	***01:55***	***04:25***
3	Set up the software for the new test.	Estimates of time required for this activity is based largely on the experience and observations of GamDat team members. 15 seconds is considered a practical minimum.	***00:30***	***04:55***
4	Raise the probe while acquiring data (i.e. recording up-transit).	Calculated using speed data recorded in RD and LS files at 0.1 ft increments. (Limitations of the speed data is presented in Appendix C: Testing of Mt Sopris Equipment.)	***06:40***	***11:35***
5	Stop recording, and data files are automatically saved.	Assumed to be instantaneous for RD and LS file creation.	***00:00***	***11:35***

Table 5-9 – Sequence of Testing Activities Between Time Stamps and Example Chronology Calculation

Understanding the assumptions and calculations used to estimate the required time increment for each step is critical to the application of this analysis method and interpretation of its results. An explanation of these time interval estimates and calculations are presented in Table 5-9.

The intended purpose of chronology analysis was to screen files for potential operational irregularities by looking for unusually short time intervals in a testing sequence. The two operational irregularities considered here have the same effect on testing chronology, that is, both reduce testing time relative to normal procedures. The more important of these irregularities is the retest scenario which is considered to have consequential impact since the test results analyzed and reported by the engineer are inaccurate and incomplete. The other irregularity involves use of the atypical free-wheel procedure for probe lowering which, although considered unacceptable from an equipment operation and safety perspective, is considered to be inconsequential for purposes of this investigation since it has no impact on the reported data.

Application of chronology analysis for purposes of screening for operational irregularities requires making assumptions for steps 1 through 3 in Table 5-9. A limitation of the analysis is that the time reductions caused by either of the two operational irregularities described above are comparable to the typical range of times needed to complete step 1. For example, either a rapid repositioning of the probe from tube-to-tube or a retest irregularity could yield time reductions in step 1 on the order of a couple of minutes. A comparable time reduction could also be achieved by use of free-wheeling in step 2. As a result, there are tradeoffs in making different assumptions in

the application of chronology analysis. To eliminate incorrect flagging of acceptable tests performed with rapid procedures, a small time interval (e.g. 15 sec) must be assumed for the equipment-repositioning step (1). However, adoption of this assumption also masks detection of potential retests where more typical equipment-repositioning time (2 to 5 min) was involved. Meaningful application of the analysis using the typical repositioning times would require either a manual verification that rapid procedures at a particular site were infeasible, or a reliable correlation analysis to delineate between independent tests and retests.

Table 5-10 presents a summary of assumed parameters implemented for GamDat's analysis. Lower-bound values of 15 seconds each were assumed for steps 1 and 3. These short time intervals are not considered a realistic or typical time interval, but rather represent bounding values for physically-feasible testing. Note that this selection eliminates most potential time reductions that would be associated with retest. A probe-lowering speed of 52 fpm was used for step 2 which is consistent with observations of typical operations. Together, these assumptions yield the *minimum* time required to complete a test using normal test procedures. This minimum standard was adopted by GamDat due to the absence of an efficient and definitive correlation tool to eliminate false positives that would be incorrectly flagged had more typical time intervals been assumed for steps 1 and 3. Unless explained by extenuating conditions, files flagged using the parameters assumed by GamDat identify the use of the irregular freewheel procedure. This could have occurred during either a fast independent test or an irregular retest as the analysis is incapable of discerning between these scenarios.

Step	Test Activity	Parameters and Calculations Implemented in Chronology Analysis Screening Tool
0	File is saved from prior test.	0 seconds
1	Set up ancillary equipment and position the gamma probe at the top of the inspection pipe.	15 seconds
2	Lower the probe to bottom of the inspection pipe.	Calculation: (___ ft) / (52 ft/min)
3	Set up the software for the new test.	15 seconds
4	Raise the probe while acquiring data	Calculation: Σ (0.1 ft) / (___ ft/min)
5	Stop recording, and data files are automatically saved.	0 seconds

Table 5-10 – Assumed Parameters Implemented for Chronology Analysis Screening Tool

5.6.1 Files Analyzed

This analysis was carried out on all groups of RD and LS files obtained by the team, including duplicate files. The analysis could only be carried out on file groups that were assigned a Group ID. As described in Section 3.3.5, Group IDs could only be assigned to files when found in the same directory and assumes that all files in the directory are in some way associated. This dependency on file directory association introduced a limitation in the extent to which this analysis could be comprehensively applied.

5.6.2 Scenarios Generating Potential Irregularities

Chronology analysis can flag files as being potentially irregular either for the intended purposes or because of an error in assumptions and calculations. As discussed above, the original intended purpose of the analysis was to detect instances of retest, however it was found in application to be most effective as a means to detect the use of other atypical procedures (i.e. most notably free-wheel) that are not considered to have consequential impacts.

Limitations of chronology analysis can be framed in terms of scenarios leading to false negatives, where files acquired by irregular means are not flagged, and false positives where acceptable files are incorrectly flagged as irregular. There are many more scenarios leading to a false negative, and in no way should it be construed that chronology analysis can detect all instances of atypical operations (i.e. either retest or free-wheel). Since the analysis (using any criterion) only flags unusually short testing times, any irregular testing conducted at an unhurried pace would not be detected.

Several other analysis considerations or scenarios were identified which could introduce errors in timing calculations, and thus lead to incorrect assignments. These include:

- If the winch was stopped or reversed at some point during an otherwise typical test with the *MSLog* software set to depth-up mode, there is a pause in the data acquisition even though time is elapsing. This would cause an underestimate in the calculation of the recording time, thus leading to an overestimate of time available for other steps. The additional time could mask an irregularity that may have been otherwise detected, thus resulting in a false negative.
- The typical procedure assumed in chronology analysis is that data recording is stopped and the file is saved at the top of the tube just tested. However, if the *MSLog* software is set to depth-up mode, it is possible to spool out the winch cable without recording data. Therefore, it is feasible that the probe could be moved to and lowered into the next tube prior to saving the file. The resulting time stamps would not correspond to standard assumptions used in the analysis, and could lead to either a false positive or a false negative depending upon where this procedure was used in the testing sequence. Note that while theoretically feasible, GamDat has no knowledge that this procedure was used in practice.
- In some instances, chronology irregularities can be introduced through data file handling methods. For example, file timestamps are modified when sent as attachments in an email. Also, when files are transmitted using FTP over the internet, the timestamps are modified. Chronology analysis cannot be performed on these types of files.

When files are flagged, supplemental information needs to be manually reviewed to see to what extent these factors might apply. This can include review of the technician's daily field reports, notes, correspondence, and other relevant records.

5.6.3 Implementation of the Tool

The analysis was implemented in two stages. The first stage was carried out in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code analyzed all groups of RD or LS files and generated an output file containing the following attributes:

- File ID
- Unique File ID

- Group ID
- File Save Time
- Time between File Saves (min)
- Data Acquisition Time (min)
- Total Depth (ft)
- Probe Max Speed (ft/min)
- Probe Average Speed (ft/min)
- Probe Median Speed (ft/min)

A second stage analysis was carried out in an Excel spreadsheet, using the code's output as a starting point. A "parameters" worksheet within the file was used to specify key assumptions for probe lowering rate, as well as the times for moving the probe and setting up the software. This is shown in Figure 5-8. This feature allowed the team to assess the sensitivity of these parameters and determine a set of limits that would result in the flagging of a reasonable number of files for further evaluation.

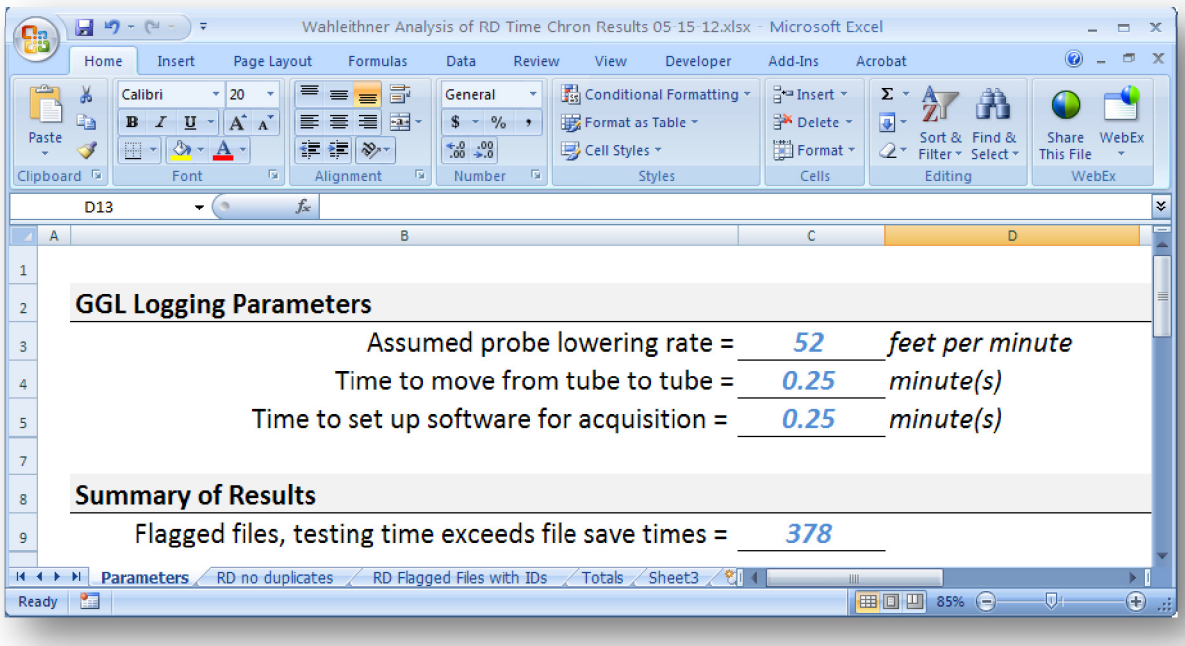
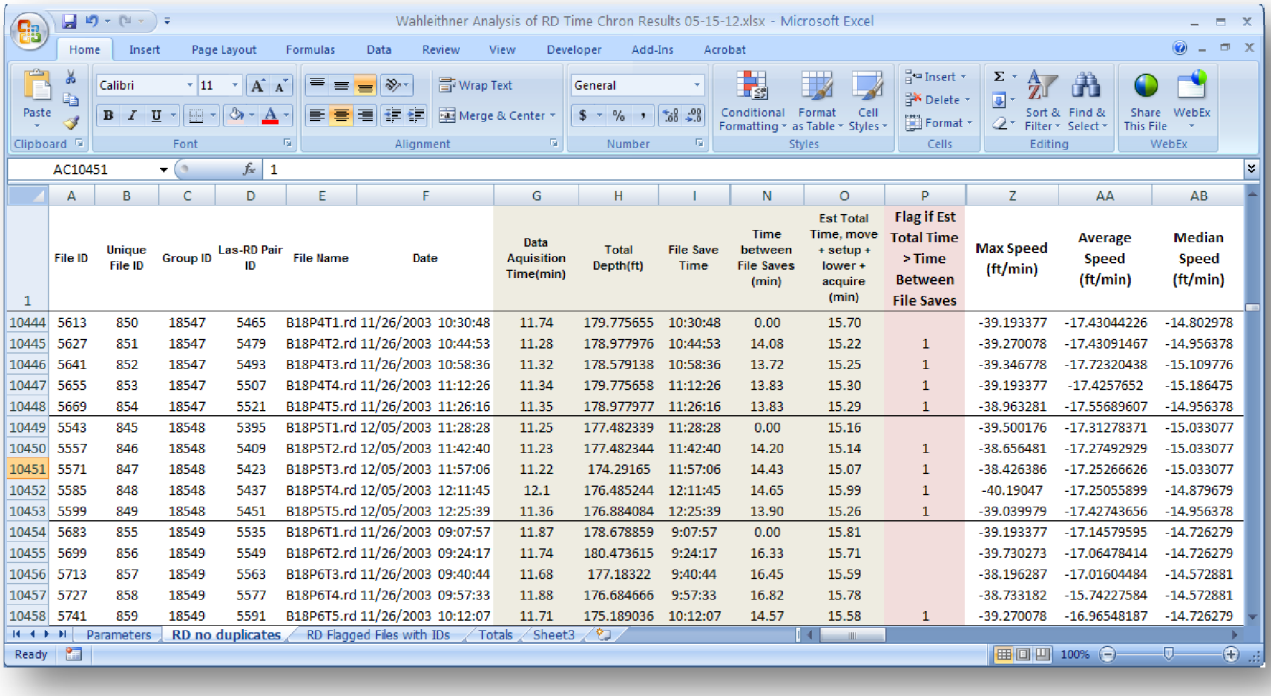


Figure 5-8 – Setting Analysis Parameters in the Excel Spreadsheet

With the parameters defined, the spreadsheet sets flags for files where the calculated total time exceeds the time between sequential file saves. The presentation of results of the analysis is shown in Figure 5-9.



	File ID	Unique File ID	Group ID	Las-RD Pair ID	File Name	Date	Data Aquisition Time(min)	Total Depth(ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Max Speed (ft/min)	Average Speed (ft/min)	Median Speed (ft/min)
10444	5613	850	18547	5465	B18P4T1.rd	11/26/2003 10:30:48	11.74	179.775655	10:30:48	0.00	15.70		-39.193377	-17.43044226	-14.802978
10445	5627	851	18547	5479	B18P4T2.rd	11/26/2003 10:44:53	11.28	178.977976	10:44:53	14.08	15.22	1	-39.270078	-17.43091467	-14.956378
10446	5641	852	18547	5493	B18P4T3.rd	11/26/2003 10:58:36	11.32	178.579138	10:58:36	13.72	15.25	1	-39.346778	-17.72320438	-15.109776
10447	5655	853	18547	5507	B18P4T4.rd	11/26/2003 11:12:26	11.34	179.775658	11:12:26	13.83	15.30	1	-39.193377	-17.4257652	-15.186475
10448	5669	854	18547	5521	B18P4T5.rd	11/26/2003 11:26:16	11.35	178.977977	11:26:16	13.83	15.29	1	-38.963281	-17.55689607	-14.956378
10449	5543	845	18548	5395	B18P5T1.rd	12/05/2003 11:28:28	11.25	177.482339	11:28:28	0.00	15.16		-39.500176	-17.31278371	-15.033077
10450	5557	846	18548	5409	B18P5T2.rd	12/05/2003 11:42:40	11.23	177.482344	11:42:40	14.20	15.14	1	-38.656481	-17.27492929	-15.033077
10451	5571	847	18548	5423	B18P5T3.rd	12/05/2003 11:57:06	11.22	174.29165	11:57:06	14.43	15.07	1	-38.426386	-17.25266626	-15.033077
10452	5585	848	18548	5437	B18P5T4.rd	12/05/2003 12:11:45	12.1	176.485244	12:11:45	14.65	15.99	1	-40.19047	-17.25055899	-14.879679
10453	5599	849	18548	5451	B18P5T5.rd	12/05/2003 12:25:39	11.36	176.884084	12:25:39	13.90	15.26	1	-39.039979	-17.42743656	-14.956378
10454	5683	855	18549	5535	B18P6T1.rd	11/26/2003 09:07:57	11.87	178.678859	9:07:57	0.00	15.81		-39.193377	-17.14579595	-14.726279
10455	5699	856	18549	5549	B18P6T2.rd	11/26/2003 09:24:17	11.74	180.473615	9:24:17	16.33	15.71		-39.730273	-17.06478414	-14.726279
10456	5713	857	18549	5563	B18P6T3.rd	11/26/2003 09:40:44	11.68	177.18322	9:40:44	16.45	15.59		-38.196287	-17.01604484	-14.572881
10457	5727	858	18549	5577	B18P6T4.rd	11/26/2003 09:57:33	11.88	176.684666	9:57:33	16.82	15.78		-38.733182	-15.74227584	-14.572881
10458	5741	859	18549	5591	B18P6T5.rd	11/26/2003 10:12:07	11.71	175.189036	10:12:07	14.57	15.58	1	-39.270078	-16.96548187	-14.726279

Figure 5-9 – Chronology Analysis in the Excel Spreadsheet

5.6.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 130 LAS and 79 LS files were flagged by this analysis. All flagged files were assigned to one of 31 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 5-11. Two cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. Additionally, fifteen ID's were associated with operational irregularities that are either attributable to freewheeling or were inconclusive. These are discussed in Section 8. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Total Number of Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
RD	130	**ID-17**	**Yes**	**Irregular testing chronology , Benicia-Martinez**
		ID-74		Irregular testing chronology (RD files), Benicia-Martinez
		ID-75		Irregular testing chronology (RD files), Green Vlly
		ID-76	**Yes**	**Altered Excel file, Benicia-Martinez**
		ID-77		Irregular testing chronology (RD files), Benicia-Martinez
		ID-78		Irregular testing chronology (RD files), SFOBB
		ID-79		Irregular testing chronology (RD files), Benicia-Martinez
		ID-80		Irregular testing chronology (RD files), N680-W780 Conn
		ID-81		Irregular testing chronology (RD files), Lake Hodges
		ID-82		Irregular testing chronology (RD files), N680-W780 Conn
		ID-83		Irregular testing chronology (RD files), Benicia-Martinez
		ID-84		Irregular testing chronology (RD files), Benicia-Martinez
		ID-85		Irregular testing chronology (RD files), Benicia-Martinez
		ID-86		Irregular testing chronology (RD files), Benicia-Martinez
		ID-87		Irregular testing chronology (RD files), Benicia-Martinez
		ID-88		Irregular testing chronology (RD files), SFOBB
		ID-89		Irregular testing chronology (RD files), SFOBB
		ID-90		Irregular testing chronology (RD files), Benicia-Martinez
		ID-91		Irregular testing chronology (RD files), Benicia-Martinez
		ID-92		Irregular testing chronology (RD files), N680-W780 Conn
		ID-93		Irregular testing chronology (RD files), N680-W780 Conn
		ID-94		Irregular testing chronology (RD files), Benicia-Martinez
		ID-96		Irregular testing chronology (RD files)
		ID-97		RD and LS acquisition times overestimated
		ID-99		Irregular testing chronology (LS files), Benicia-Martinez
LS	79	ID-95		Irregular testing chronology (LS files), Sound Wall Piles
		ID-96		Irregular testing chronology (RD files)
		ID-97		RD and LS acquisition times overestimated
		ID-98		LS Chronology
		ID-99		Irregular testing chronology (LS files), Benicia-Martinez
		ID-100		Irregular testing chronology (LS files)

Table 5-11 – Chronology: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.7 Calibration Constant

The *Calibration Constant Analysis* method is an analysis technique used by the GamDat Team to examine all available LAS and LS files for potential digital alterations to a GGL data file regardless of whether a RD file is available. It is capable of detecting essentially all manual revisions of density data, unless such revisions are carefully crafted. It will also detect selected copy-paste alterations where the source data comes from a GGL data file obtained either with different equipment or with the same equipment having different calibration constants, and where the altered data does not constitute the entirety of the data set. The method is a complementary extension to the Pattern Matching analysis technique which is incapable of detecting either manual data alterations or copy-paste alterations where the source data does not exist within the Caltrans' data set.

The Calibration Constant Method is based on the principle that each density should relate to the count data using the calibration function having calibration constants 'A' and 'B'. The relationship adopted by Caltrans in CTM-233 is:

$$Density = [Ln\ (Count) - B] / A \qquad (Eq.\ 1)$$

Manual revisions to one value in the count-density pair (e.g. density), even by small amounts, will result in a different relationship between the count and density values that is readily detectable. Similarly, if both count and density values are altered, but not in proportions precisely the same as indicated by the calibration constants, that alteration will also be readily detectable. However, the method can be defeated if precisely crafted manual alterations to both count and density are used, or if data is imported from another file obtained using the same calibration constants. The latter scenario is detected by Pattern Match analysis provided the source data exists within the Caltrans data set.

The algorithm employed for the Calibration Constant Method involves four steps as illustrated in Figure 5-10.

<u>Step 1:</u> Use the least-squares technique to regress calibration constants A and B in equation 1 from all count-density pairs within a GGL data file.

<u>Step 2:</u> Determine a calculated density by evaluating equation 1 for each count value using the regressed calibration constants.

<u>Step 3:</u> Calculate the residual for each data row as the difference between the density value in the GGL data file and the calculated density.

<u>Step 4:</u> Check that the residual for each data row is less than a specified threshold value associated with rounding error in the computations.

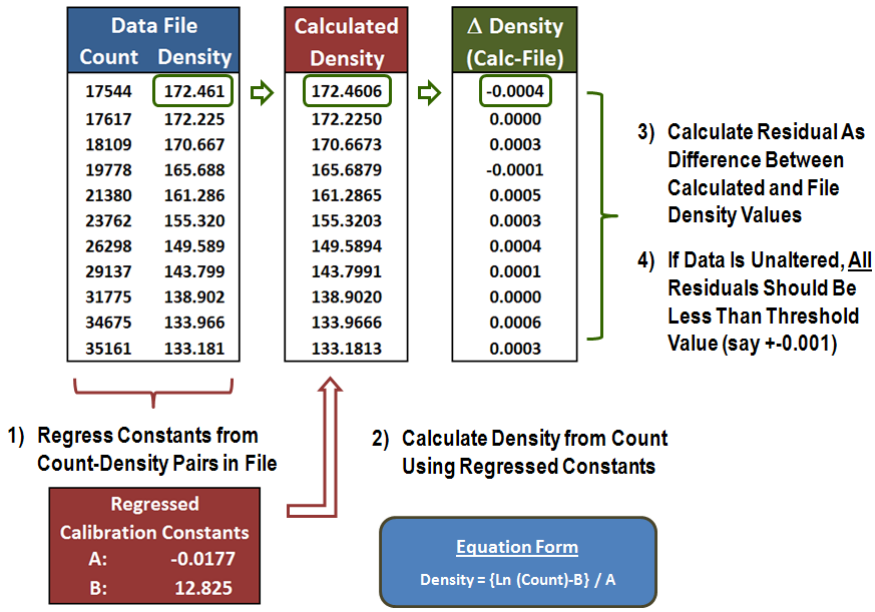


Figure 5-10 – Calibration Constant Analysis

For all GGL data files evaluated by GamDat, the threshold value for LAS files was 0.001 pcf, and for LS files was 0.01 pcf, both of which are orders of magnitude below typical random scatter in GGL data. The method detects all data revisions above these thresholds for as little as a single data point in a file, but cannot detect replacement of all data within a file where that data is all related by the same calibration constants. If blocks of data are revised, they are readily detected, and with some manual processing, can be isolated to specific depth ranges. Further, calibration constants A* and B* can be determined from the altered data block to a precisions of better than 0.01%, which is smaller than typical changes between annual calibrations of the equipment. This opens the possibility of tracing copied data blocks to a specific piece of equipment and calibration period if an archive of calibration constants were maintained.

5.7.1 Files Analyzed

This analysis was carried out on all unique LAS and LS files obtained by the team.

5.7.2 Scenarios Generating Irregularities

This analysis flagged files where:

- Count or density data are manually entered or revised, where the relationship between the count and density data are not precisely aligned with calibration factors used in the unaltered data.
- Data was copied from one file to another, where a different probe having different calibration factors were applied.
- Density measurements were not calculated from gamma counts using the natural logarithm formula presented earlier in Equation 1.

5.7.3 Implementation of the Tool

The analysis was implemented in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code examined all LAS and LS files, reported the regressed calibration coefficients, calculated densities, and compared the residuals against predefined limits. The code generated an output file containing the following attributes:

- File ID
- Unique File ID
- Description of Flag

5.7.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 39 LAS and 72 LS files were flagged by this analysis. All flagged files were assigned to one of 10 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 5-12. Two cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
LAS	39	ID-3		GGL Consultant LAS & LS calibration and output format
		ID-4	**Yes**	**Manual alteration of data in calibration file**
		ID-13	**Yes**	**Previously identified falsification case, La Sierra OH**
		ID-21		Corrupted or truncated LAS and LS files are flagged
		ID-22		Calibration Constant irregularity, low counts, Richmond San Rafael
		ID-30		File contains only one row of data
LS	72	ID-3		GGL Consultant LAS & LS calibration and output format
		ID-21		Corrupted or truncated LAS and LS files are flagged
		ID-30		File contains only one row of data
		ID-56		LogShell files with low count data flagged

Table 5-12 – Calibration Constant: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.8 Depth Consistency

The *Depth Consistency Analysis* is used to check the depth data in LAS files, which is encoded in the file in multiple places. When generating LAS files, the *LASWriter* module within the *MSLog* software automatically encodes the start, stop, and incremental depth parameters unique to each file. These parameters can be checked against the rows of data in the body of the file for internal consistency. An irregularity in the consistency of the depth data could suggest that data may have been altered, appended, or removed.

GGL Data File		
Date		1/1/01
Start Depth		1
Stop Depth		10
Step		1
Depth	Counts	Density
1	17216.1	155.1
2	17449.2	157.2
3	17027.4	153.4
4	17304.9	155.9
5	16683.3	150.3
6	17582.4	158.4
8	17471.4	157.4
9	17771.1	160.1
10	16772.1	151.1
11	17404.8	156.8
12	17896.2	161.1
13	17147.3	155.8

Figure 5-11 – Check That the Start/Stop Depths Match the Data Block

GGL Data File		
Date		1/1/01
Start Depth		1
Stop Depth		10
Step		1
Depth	Counts	Density
1	17216.1	155.1
2	17449.2	157.2
3	17027.4	153.4
4	17304.9	155.9
5	16683.3	150.3
6	17582.4	158.4
8	17471.4	157.4
9	17771.1	160.1
10	16772.1	151.1
11	17404.8	156.8
12	17896.2	161.1
13	17147.3	155.8

Depth	Increment
1	
2	1
3	1
4	1
5	1
6	1
8	2
9	1
10	1
11	1
12	1
13	1

Figure 5-12 – Check That the Depth Increment Matches the Step Value

Two checks are performed in this analysis:

- The start and stop depths reported in the header section of the file are checked against the depths reported in the first and last rows in the data block, as shown in the example in Figure 5-11.
- The depth increment, or "step," reported in the header is checked against the differences in depths between each subsequent row of data, as shown in the example in Figure 5-12.

5.8.1 Files Analyzed

This analysis was carried out on all LAS files obtained by the team.

5.8.2 Scenarios Generating Irregularities

Files flagged for depth consistency irregularities can be attributed to the following:

- Rows of data were removed or added to the file, and the start/stop depths no longer match the first and/or last row depth values.
- The file was corrupted and/or truncated due to a computer-related file transfer or storage problem, and rows of data could not be recovered.
- The data was collected in time mode, resulting in the depth increment reported as zero. Although encoded as a zero increment, these files may contain depth incremented data if the probe is raised or lowered during data acquisition. This is typically the mode used during calibrations; however, has been observed to have been used in several instances for pile testing.

5.8.3 Implementation of the Tool

The analysis was implemented in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code examined all LAS files to identify depth related discrepancies. The code generated an output file containing the following attributes:

- File ID
- Unique File ID
- Description of Flag

5.8.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 56 LAS files were flagged by this analysis. All flagged files were assigned to one of 10 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 5-13. Six cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
LAS	13	**ID-2**	**Yes**	**Qualification Testing of FTB Standard Reference Blocks**
		ID-10	**Yes**	**Irregular testing chronology, SE Connector**
		ID-11	**Yes**	**Irregular testing chronology, Lake Hodges**
		ID-13	**Yes**	**Previously identified falsification case, La Sierra OH**
		ID-17	**Yes**	**Irregular testing chronology , Benicia-Martinez**
		ID-21		Corrupted or truncated LAS and LS files are flagged
		ID-32		Depths Not Constantly Incremented-RD Files Exist
		ID-33	**Yes**	**Depths Not Constantly Incremented; Possible tube retest, Benicia-Martinez**
		ID-34		Header Start /Stop Depths do not match data block, Dry Creek
		ID-37		Calibration / Qualification Files Flagged For depth irregularity, Calibration

Table 5-13 – Depth Consistency: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

5.9 Fidelity

The *Fidelity Analysis* was used to confirm that all gamma count data found in the LAS file could be traced back to gamma count data in the RD file. GGL data should be traceable throughout its lifecycle, from original data collection in the field through to final reported results. However, the RD-LAS fidelity analysis conducted by the GamDat effort considered only the fidelity of the raw gamma count measurements between the two field-collected files. That is, the analysis checked that the sequence of raw gamma counts in the RD file were the same as the raw gamma counts written to the LAS file, as illustrated in Figure 5-13.

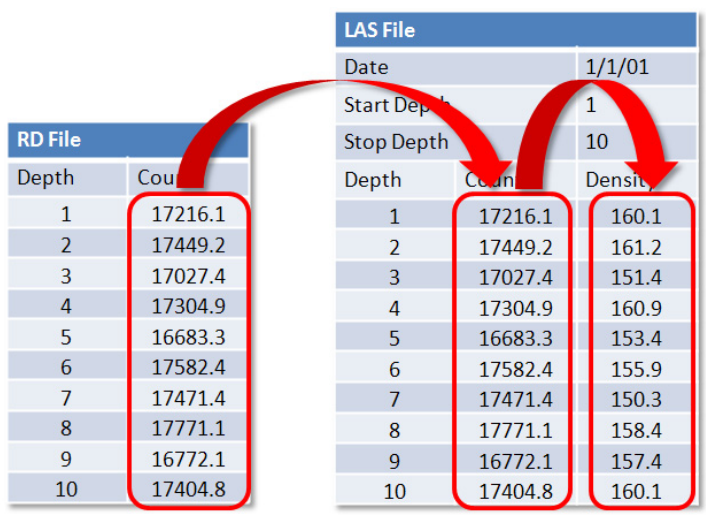


Figure 5-13 – Check That the Sequence of Counts are Consistent Between RD and LAS Files

The fidelity analysis was limited to GGL Data Files generated by the GGL testing equipment operated by Caltrans Technicians. No substantive analyses were conducted to assess the fidelity of the files generated by Caltrans Engineers in the preparation of GGL Reports (i.e. Excel and Origin files).

An additional check of fidelity within the LAS files was conducted to confirm that the raw gamma counts and "Dead-Time Corrected (DTC)" gamma counts, both included as separate measurements in LAS files, were consistently related. The Gamma (DTC) Count is an adjusted count automatically applied by the MSLog software, using the formula:

*Gamma (DTC) Count = [Raw Gamma Count] / (1 - [Raw Gamma Count] * 0.00000625)*

5.9.1 Files Analyzed

This analysis could only be carried out on matched pairs of RD and LAS files (described in Section 3.3.4).

5.9.2 Scenarios Generating Irregularities

Due to the hexadecimal encoding of RD files, modification of RD files using conventional text editing tools is particularly challenging. By contrast, modification of LAS files can be done easily using text editing tools. When both RD and LAS files are available for comparison, changes to the LAS file relative to the RD can be clearly identified. Causes of fidelity irregularities can be attributed to a couple of factors:

- Rows of data were altered, removed, or added to the LAS file, resulting in the RD data no longer matching the LAS data.
- The file was corrupted and/or truncated due to a computer-related file transfer or storage problem, resulting in the RD data no longer matching the LAS data.

5.9.3 Implementation of the Tool

The analysis was implemented in PHP code and executed within the web-application framework set up on the GamDat virtual server. Technical details of the code and the server configuration are described in Appendix K: Codes and Database. The code examined all RD-LAS file pairs and generated an output file containing the following attributes:

- File ID
- Unique File ID
- RD-LAS Pair ID
- Number of gamma count measurements found in the RD file
- Number of gamma count measurements found in the LAS file
- Description of Flag

5.9.4 Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

In total, 89 RD-LAS file pairs were flagged by this analysis. All flagged files were assigned to one of 7 Manual Analysis IDs. A summary of flagged files and a brief description of the Manual Analysis ID to which these were assigned are presented in Table 5-14. Three cases were established based on the results of this analysis. Descriptions of cases are presented later in this report in Section 7. More detailed documentation for each ID can be found in Appendix P: Manual Analysis Documentation.

File Type	Files Flagged	Assigned to Manual Analysis ID	Assigned to a Case?	Description
RD-LAS Pairs	89	**ID-2**	**Yes**	**Qualification Testing of FTB Standard Reference Blocks**
		ID-4	**Yes**	**Manual alteration of data in calibration file**
		ID-21		Corrupted or truncated LAS and LS files are flagged
		ID-26		Pattern Match in file pairs, SFOBB
		ID-31		LAS files with extra row of data at end
		ID-50		Null values in data files causing analysis flags
		ID-51		Rows of data above top of concrete deleted, Lake Hodges

Table 5-14 – Fidelity: Flagged Files, Assignment to Manual Analysis IDs, and Resulting Cases

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6 Consideration of Correlation Methods

6.1 Overview

During the course of the investigation, the team identified a need for a new analysis tool to assess if two GGL tests had been carried out in the same tube. A scenario of a field technician repeating a test in the same tube and calling it another tube (referred as a "rerun" or "retest") was one brought to the team's attention during early Senate Transportation Committee Hearing meetings and echoed in questions posed by Caltrans management.

The need for such a tool became increasingly important while evaluating groups of files flagged for chronology irregularities. That is, within these file groups there were one or more instances where there appeared to be insufficient time between subsequent tests to reposition the testing equipment. These types of chronology irregularities suggested that a rerun had possibly been carried out. Correlation analysis to support or refute the possibility in these instances motivated the development of the methods presented in this section.

Although, significant progress was made toward the development of tools, further development would be needed prior to confidently applying results to corroborate findings in specific cases.

6.2 Methods Examined

The GamDat Team evaluated the applicability of several statistical and signal processing correlation methods. These methods ranged from qualitative visual evaluation of pairs of plotted data, to a textbook cross-correlation approach, to single-valued statistical metric calculations.

6.2.1 Visual

The visual technique consists of a qualitative evaluation of two GGL tests plotted together. The goal is to identify clear evidence that each test is in fact unique. This evidence typically manifests as the presence of a unique signal appearing in one record but not in the other. For example, if one test reflects water at the bottom of the tube (i.e. shift in density) while the other record does not, this would suggest that the two data sets were not collected from the same tube, as illustrated by example in Figure 6-1.

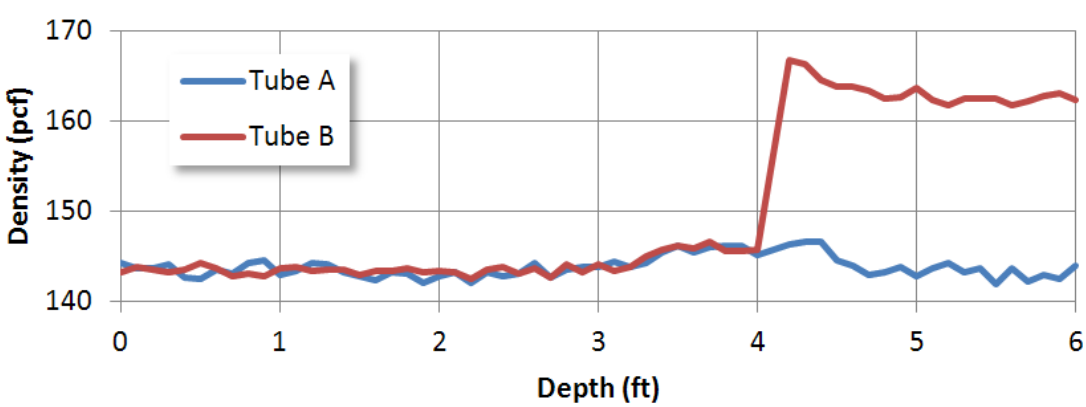

Figure 6-1 – Visual Evaluation to Refute Rerun

6.2.2 Cross-Correlation

Cross-correlation was briefly evaluated by the team, but found to be ineffective for intended purposes without extensive signal processing. GGL test data for individual tubes often involve a component that is common to all tubes in a pile. For example, reinforcing steel, tied to inspection tubes at regularly spaced intervals, manifests in the plotted data as discreet spikes across all tests in the pile, as shown in Figure 6-2. Other features of the data common to all tubes include a gradient in concrete density with depth. The results of cross-correlation were found to be largely governed by the match of these common pile features rather than discerning the smaller tube-specific features that are indicative of a rerun. This shortcoming prevented the effective use of standard cross-correlation statistics. The team also briefly explored the potential of applying cross-correlation after pre-processing the GGL data to remove common pile features. This strategy did not appear to provide more insight into the potential for rerun than the sigma delta methods (discussed below), and was abandoned as it required substantially more time and effort.

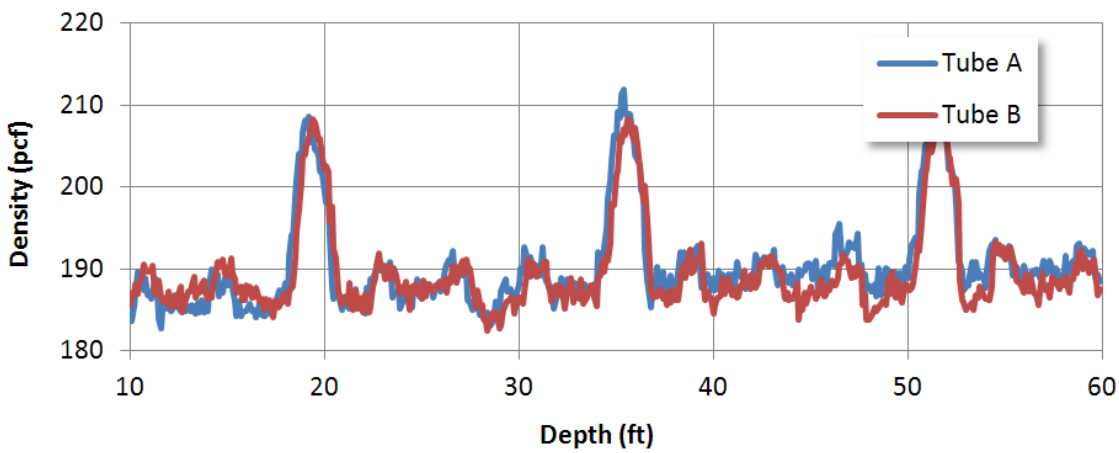

Figure 6-2 – Cross-Correlation Ineffective at Discerning Rerun

6.2.3 Single-Valued Statistical Metrics Using Signal Differencing

Of all the correlation methods evaluated by the team, the calculation of single-valued statistical metrics appeared to be the most reliable indicator for identifying rerun test pairs. Various statistical metrics were considered, all based on calculating the differences between density measurements at each depth interval between two test records, as shown in the example in Figure 6-3.

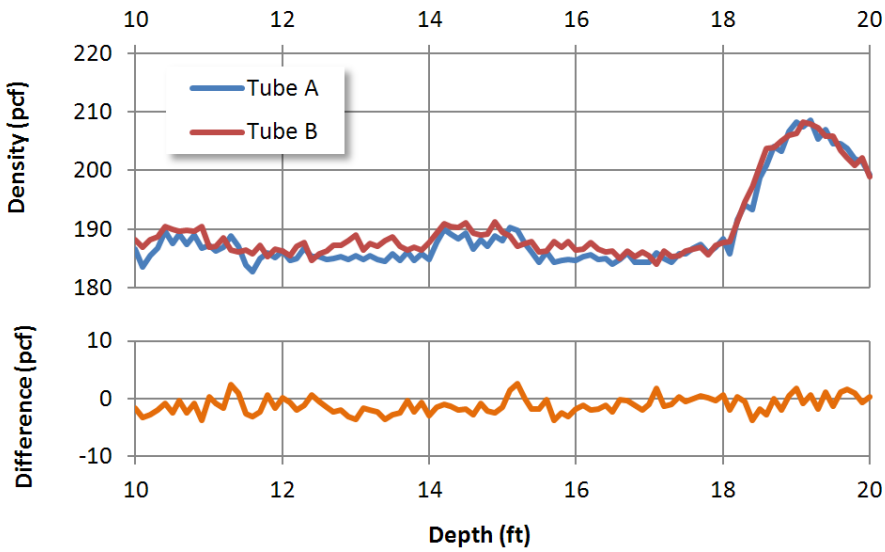

Figure 6-3 – Signal Differencing

Using the resulting differences, various statistical indices can then be calculated (e.g. standard deviation, average, median, maximum, minimum, etc.), as shown in the example data set in Table 6-1.

Depth (ft)	Tube A (pcf)	Tube B (pcf)	Difference (pcf)
10.0	186.55	188.16	-1.61
10.1	183.62	186.88	-3.26
10.2	185.47	188.23	-2.76
10.3	186.76	188.67	-1.92
…	…	…	…
19.9	201.51	202.10	-0.59
20.0	199.30	198.90	0.40
		Mean	**-1.11**
		Standard Deviation of Signal Difference	**1.46**
		Maximum Difference	**2.64**
		Minimum Difference	**-3.73**

Table 6-1 – Statistical Values from Signal Differencing

The standard deviation of signal differences (referred from this point forward as the *sigma-delta*) was found to be the most useful statistical measure. This metric quantifies the variability of the differences between two sets of data. In general, a lower sigma-delta is expected for data sets that are substantially similar (i.e. rerun), whereas a higher sigma-delta is anticipated for signal pairs where significant differences exist (i.e. independent tests in different tubes). Furthermore, it was observed from test data that a number of operational factors can affect the sigma-delta value obtained from a particular tube-pair, and all operational inconsistencies appear to produce higher sigma-delta values. Therefore, detection of a retest could be readily masked by operational inconsistencies between runs.

6.3 Prototype Sigma-Delta Based Methods

Two prototype methods for characterizing the existence of a retest were developed, both built upon the sigma-delta metric. They are:

- The *Empirical Sigma-Delta Analysis Method*
- The *Retest Discrimination Analysis Method*

These methods (documented in Appendix H: Correlation by the Empirical Sigma-Delta Analysis Method; and Appendix I: Retest Discrimination Analysis (RDA) Method) are considered prototype, as significant uncertainty remains in confidently applying and interpreting results for the following reasons:

- Use of the standard deviation of signal differences, *sigma-delta*, as the reliable indicator was tested but not adequately reviewed by experts. The prototype designation was used for these sigma-delta-based methods, as additional vetting by experts in both statistical and signal processing methods could lead to significant improvements in both the calculation and interpretation of this or an alternative metric of waveform similarity.

- Sigma-delta values are known to be influenced by a number of data-processing, field-operational, equipment, environmental, and site-specific factors. These factors are as follows.

    - <u>Data Processing</u>: Key factors include smoothing-filter design, depth alignment of the data, and the depth-range considered for the evaluation of the sigma-delta value. GamDat used a 9-point moving average filter for all analyses. Alternative filter designs or signal processing techniques may provide improvements, but the adoption of a single filter design in these prototype applications minimized variability introduced by this factor. Similarly, a standard method for optimizing depth alignment based on minimization of sigma-delta value was adopted. However, a standard method for selection of depth-range considered was not developed. For the prototype applications included in this report, independent calculations were performed using alternative assumptions for depth-range considered and resulting sigma-delta values were found to be reasonably consistent.

    - <u>Field Operations</u>: Key factors considered include an operator's test setup, equipment used, direction of probe travel, and probe speed. The limited data set available showed the largest effect on sigma-delta reproducibility to be related to a combination of operator test setup and equipment used. Test setup considerations largely affect the reproducibility of the position of the probe which is influenced by the consistency of cable tension and random movements of the cable introduced by cable guides (swaying of intermediate hung pulleys and long pipe extensions above the top of concrete). These factors manifest as differences in results attributed to both operator and testing direction. Although probe speed is thought to be a key factor, the limited data acquired under auspices of the GamDat investigation seems to indicate this effect to have less influence than some of the other factors considered.

    - <u>Equipment and Environment</u>: A number of other factors may contribute to variability in data collection, such as the condition of the radioactive source, operational characteristics unique to individual probes, and environmental factors (weather, moisture, temperature, water in tubes, etc.). No systematic study was performed to quantify these effects.

- Site Specific: Sigma-delta value averages from different sites and/or projects were observed to show a degree of variability that is comparable to variability introduced by the other factors discussed above. No systematic study was performed to isolate the source of this variability, but potential causes include overall pile length, pile reinforcing details, tube-submergence during testing, and consistency of construction at the site.

- Differentiation of a retest in one tube from independent tests conducted in a pair of adjacent clean tubes (without distinct anomalies) is inherently challenging since the pairs of concrete-density profiles for both situations are normally very similar. The distinction between these situations is based on detection of subtle differences in sigma-delta value caused by tube-to-tube variability, but these differences can be readily masked by a variety of other factors. As a result, there is significant overlap in sigma-delta values associated with retests and independent tests which often makes interpretation less than definitive.

- A very limited set of data were available for the development of a reference basis – that is, instances where known retests and independent tests could be clearly identified and validated, and the conditions of the tests were well documented. Although the available reference set data is thought to reasonably represent gross overall trends sufficient for prototype application, it was insufficient to develop detailed models needed to isolate the effects of each factor influencing results.

6.4 Application of Prototype Correlation Analysis

The prototype sigma-delta based correlation methods described in this section were only applied to a very limited set of GGL data files using manual procedures and are documented in the Manual Analysis IDs in Appendix P: Manual Analysis Documentation. For these Manual Analysis IDs, including those that were assigned to cases, the findings and conclusions did not rely on the prototype correlation results as sole basis.

No automated software tools were developed to apply correlation analysis as a screening tool to the broader data collection in a comprehensive manner.

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7 Cases

Eleven cases were identified as a result of irregularities in 21 files flagged by the suite of analysis tools and/or identified in subsequent in-depth analyses. In the context of the GamDat investigation, these irregularities are designated as *cases* as the manual analysis establishes that the existence of the irregularity is at least plausible and the test data affects subsequent engineering analyses or a published GGL Report, or establishes an important fact for the GamDat investigation.

The eleven cases are presented in this section of the report in logical order and are grouped based on the type of the irregularity, as presented in Table 7-1.

Type		Description	Number/ Type of Irregular Files	Manual Analysis ID(s)	Report Section
Data Irregularities	File Rename	File Rename at Sawtelle Blvd UC, Abutment 1L, Piles 69 and 72	1 LAS	ID-18	7.1
		File Rename at Braddock Drive UC, Piles 50 and 51	1 LAS	ID-52	7.2
	Data Alteration	Duplicated, Replaced, and Deleted Data for Qualification Testing of FTB Standard Reference Blocks	9 LAS	ID-2/15	7.3
		Altered Density and Gamma Count Data in Calibration File	1 LAS	ID-4	7.4
		Duplicated, Replaced, and Deleted Data at Overhead Sign #19, Route 580	2 LAS	ID-12	7.5
		Duplicated and Replaced Data at La Sierra Ave. OH, Bent 2, Pile W2	2 LAS	ID-13	7.6
		Irregular Testing Chronology and Duplicated Data in Excel File at Benicia-Martinez Bridge, Pier 14, Pile 8	1 XLS	ID-76	7.7
Operational Irregularities	Double-Transit; Retest	Irregular Testing Chronology Indicating Likely Retest at Benicia-Martinez, Pier 6, Pile 5	1 LAS	ID-17	7.8
		Irregular Testing Chronology Indicating Plausible Retest at SE Connector SB 215/EB 215, Pile at Bent 15	1 LAS	ID-10	7.9
		Irregular Testing Chronology Indicating Plausible Retest at Lake Hodges Bridge, Abut 6, Pile 1	1 LAS	ID-11	7.10
	Retest	Plausible Retest at Benicia-Martinez Bridge, Pier 12, Pile 6	1 LAS	ID-33	7.11

Table 7-1 – Summary of Cases

A summary of each of the eleven cases is presented in the following subsections. Additional supporting details for cases can be found in the Manual Analysis ID documentation in Appendix P: Manual Analysis Documentation.

In Table 7-1 the number of "Irregular Data File(s)" represents the number of files that were found to have a significant irregularity. In many of these cases multiple files of different type were evaluated to provide context for

findings, or groups of files were flagged (e.g. for chronology related irregularities). These additional files were not included in the counts.

7.1 File Rename at Sawtelle Blvd UC, Abutment 1L, Piles 69 and 72 (Manual Analysis ID-18)

The file rename analysis flagged two files for having identical content but different filenames. The files were associated with GGL tests on two piles within the same foundation conducted on the same day. The occurrence of this irregularity appears closely related to the other file rename case at Braddock Drive UC, as both occurred on the same project within several weeks of each other.

7.1.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-2.

Attribute	Description
Structure Name:	Sawtelle Blvd. UC (Widen)
Structure Number:	53-1403
District, County, Route, PM	07-LA-405-25.9/29.5
Foundation Location:	Abutment 1 (Left) Retaining Wall 435B
Pile(s) Investigated:	Piles 69 and 72
Pile Diameter:	600 mm (24 in)
Tested Pile Length:	8.8 m (28.9 ft)
Number of Tubes in Pile:	4
Tube(s)/Test(s) Investigated:	Pile 69 Tube 4, Pile 72 Tube 4
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: Piles RW-29, RW-35 through RW-40 and RW-55 through RW-74 at Abutment I (Left) Retaining Wall 435B" (May 21, 2007)

Table 7-2 – Test Details from Manual Analysis ID-18

7.1.2 Description of Irregularities

Two files were flagged, P69T4.LAS and P72T4.LAS, having identical content as well as identical file save times and dates. The data from the file, P69T4.LAS, was confirmed to have been reported as the results from Pile 69, Tube 4. Likewise, the data from file, P72T4.LAS, was confirmed to have been reported as the results from Pile 72, Tube 4.

Based on an examination of the file timestamps for tests at both piles, it was observed that the sequence of testing on Pile 72 Tube 4 (P69T4.LAS) was inconsistent with the other tubes, whereas the time is consistent with the sequence of testing for Pile 69 Tube 4. This supports the assertion that P72T4.LAS is a copy of P69T4.LAS. Timing information is presented in Table 7-3 and Table 7-4 for both piles.

Filename	File Date/Time Stamp
P69T1.LAS	5/17/07 1:36 PM
P69T2.LAS	5/17/07 1:39 PM
P69T3.LAS	5/17/07 1:42 PM
P69T4.LAS	***5/17/07 1:46 PM***

Table 7-3 – Testing Chronology at Pile 69

Filename	File Date/Time Stamp
P72T1.LAS	5/17/07 2:04 PM
P72T2.LAS	5/17/07 2:07 PM
P72T3.LAS	5/17/07 2:10 PM
P72T4.LAS	***5/17/07 1:46 PM***

Table 7-4 – Testing Chronology at Pile 72

7.1.3 Conclusions

The body of evidence supports the assertion that P72T4.LAS is a copy of P69T4.LAS.

7.1.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for Tube 4 of Pile 72.

7.2 File Rename at Braddock Drive UC, Piles 50 and 51 (Manual Analysis ID-52)

The file rename analysis flagged two files for having identical content but different filenames. The files were associated with GGL tests on two piles within the same foundation conducted on the same day. The occurrence of this irregularity was identified in 2009 by FTB. The information presented in this case further validates the prior findings.

7.2.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-5.

Attribute	Description
Structure Name:	Braddock Drive UC
Structure Number:	53-1258
District, County, Route, PM	07-LA-405-25.9/29.5
Foundation Location:	Abutment 1 Right
Pile(s) Investigated:	Piles 50 and 51
Pile Diameter:	600 mm (24 in)
Tested Pile Length:	8.8 m (28.9 ft)
Number of Tubes in Pile:	4
Tube(s)/Test(s) Investigated:	Pile 50 Tube 2, Pile 51 Tube 2
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: Piles 35A, 48 through 55 and 62 through 75 at Abutment I (Right)" (April 10, 2007)

Table 7-5 – Test Details from Manual Analysis ID-52

7.2.2 Description of Irregularities

Two files were flagged, P50T2.LAS and P51T2.LAS, having identical content as well as identical file save times and dates. The data from the file, P50T2.LAS, was confirmed to have been reported as the results from Pile 50, Tube 2. Likewise, the data from file, P51T2.LAS, was confirmed to have been reported as the results from Pile 50, Tube 2.

Based on an examination of the file timestamps for tests at both piles, it was observed that the test on Pile 51 Tube 2 (P51T2.LAS) was conducted 4 hours earlier than the other tests at that pile. This supports the assertion that P51T2.LAS is a copy of P50T2.LAS. Timing information is presented in Table 7-6 and Table 7-7 for both piles.

Filename	File Date/Time Stamp
P50T1.LAS	Wednesday, April 04, 2007, 9:38:30 AM
P50T2.LAS	***Wednesday, April 04, 2007, 9:44:24 AM***
P50T3.LAS	Wednesday, April 04, 2007, 9:50:34 AM
P50T4.LAS	Wednesday, April 04, 2007, 9:55:46 AM

Table 7-6 – Testing Chronology at Pile 50

Filename	File Date/Time Stamp
P51T1.LAS	Wednesday, April 04, 2007, 1:32:00 PM
P51T2.LAS	***Wednesday, April 04, 2007, 9:44:24 AM***
P51T3.LAS	Wednesday, April 04, 2007, 1:42:02 PM
P51T4.LAS	Wednesday, April 04, 2007, 1:47:26 PM

Table 7-7 – Testing Chronology at Pile 51

An additional finding further supports that P51T2.LAS is a copy of P50T2.LAS. A single unique file named P51T2.LAS was located on a technician's field laptop computer (and not found on any other data storage source), having a date and time stamp of Wednesday, April 04, 2007, 1:36 PM. The time of this file is consistent with the sequence of testing for the other GGL tests at Pile 51. This file appears to contain the data originally collected for Tube 2 at Pile 51. Upon further examination it was found that this LAS file had incomplete data, which may have been due to a problem encountered during the testing process. The evidence suggests that a new file was generated by simply renaming a copy of P50T2.LAS as P51T2.LAS. No RD file corresponding to the original LAS file P51T2.LAS (April 04, 2007, 1:36 PM) was located.

7.2.3 Conclusions

The body of evidence supports the assertion that P51T2.LAS is a copy of P50T2.LAS.

7.2.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for Tube 2 of Pile 51.

7.3 Duplicated, Replaced, and Deleted Data for Qualification Testing of FTB Standard Reference Blocks (Manual Analysis ID-2 & ID-15)

Pattern matching, time stamp, depth consistency, and fidelity analysis tools flagged six data files acquired during the qualification testing of probe/blocks from January 2007. The same analysis tools flagged three data files in subsequent qualification tests carried out a month later in February 2007. There is clear evidence of data having been duplicated, replaced, and deleted as a means to eliminate irregular spikes and offsets found in the recorded data that would have led to rejection of the qualification test results for nine combinations of probe and standard reference blocks.

7.3.1 GGL Test Details

The standard reference blocks are concrete blocks of known density that are permanently mounted and transported in equipment vans for purposes of conducting daily functionality evaluations of GGL probes per CTM-233, Part 4-A, "Functionality Evaluation Using the Standard Reference," and described earlier in Section 4.1.2. A one-time qualification testing procedure for each combination of probe/source and block is required to insure the combination is within required standards. The qualification testing procedure involves taking two sets of measurements, one each while the block is in a horizontal and vertical position as shown in Figure 7-1.

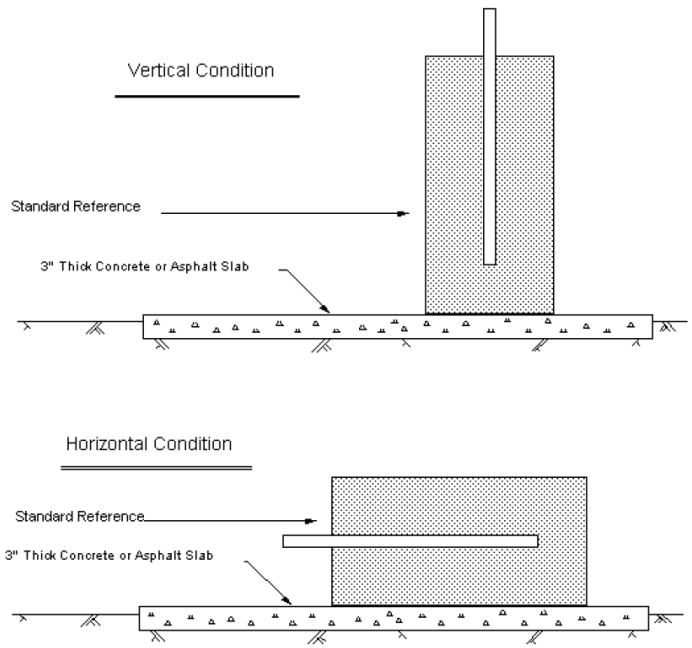


Figure 7-1 – Qualification of Standard Reference Blocks in Two Positions

While the qualification testing programs in January and February 2007 involved multiple source/probe-block combinations, all of the detected data irregularities in the January 2007 tests involved the single source/probe serial number 3551-041 (designated as probe "D" in testing documents). Irregularities in the February 2007 tests, that appear to have been carried out to redo some of the prior January tests, involved two sources/probes, serial numbers 2947-038 (probe "C") and 3551-041 (probe "D).

A summary of the number of data files flagged is presented in Table 7-8.

Attribute	Description
Testing Location:	TransLab, Sacramento, California
Tube(s)/Test(s) Investigated:	Probes "C" and "D"; Blocks 1, 2, 3, 5, 6, 7, 8, and 9
Reference GGL Report:	N/A

Table 7-8 – Test Details from Manual Analysis ID-2 and ID-15

7.3.2 Description of Irregularities

For the January 2007 tests, a clear and varied sequence of data manipulations occurred on 1/24/2007 between the acquisition and transmittal of six LAS data files. The manipulations had the effect of eliminating spurious data in those files that would have lead to rejection of test results. The cause of the spurious data is uncertain, but is believed by the GamDat team to be related to having a second gamma source within the range of detection of the GGL equipment that was recording at the time, a practice verified to have occurred during these tests.

Irregularities are confirmed in transmitted data files for 6 of the 18 tests conducted (D1V.LAS, D3H.LAS, D5V.LAS, D6V.LAS, D8V.LAS, and D9V.LAS) with source/probe D. Re-creation of the data manipulations was possible due to the availability of RD files to regenerate LAS files. This allowed complete re-creation and fully accounts for all transmitted data as illustrated in Figure 7-2 through Figure 7-10.

The extent of alterations varied considerably between files. Two instances (D5V.LAS and D3H.LAS) involved simple deletion of a small number of data points (8 and 2, respectively).

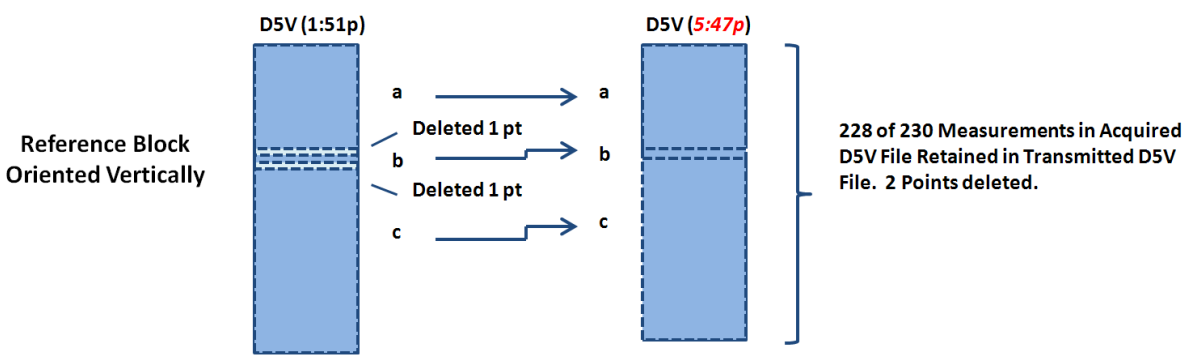


Figure 7-2 – Data Alterations Found in D5V.LAS

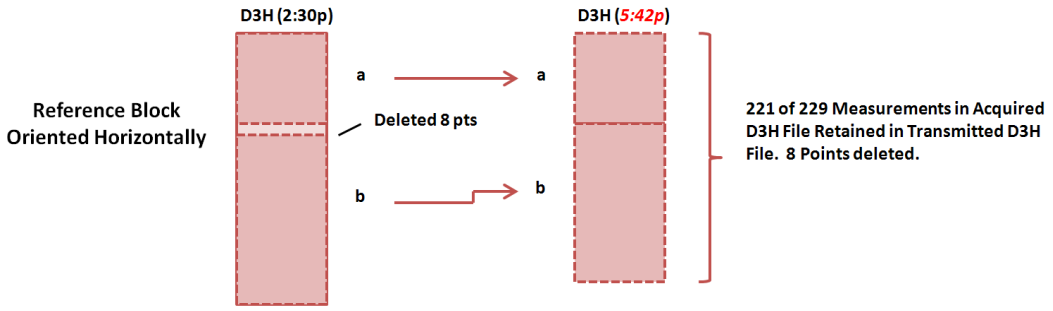


Figure 7-3 – Data Alterations Found in D3H.LAS

The remaining four instances (D1V.LAS, D6V.LAS, D8V.LAS, and D9V.LAS) involved substantial deletion of originally recorded data (approximately 40% to 80% of sequence) and replacement with data copied from testing within the same block in the other orientation. One of these instances (D6V.LAS) also included padding of the end of the data file with a single repeated value.

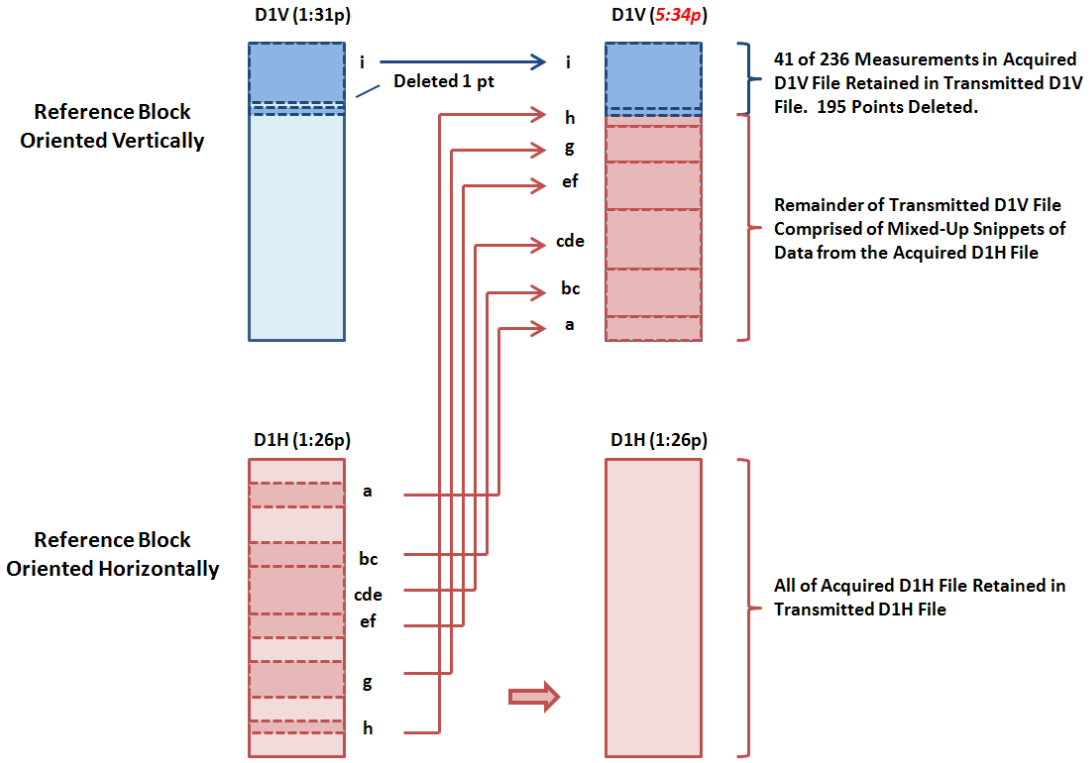


Figure 7-4 – Data Alterations Found in D1V.LAS

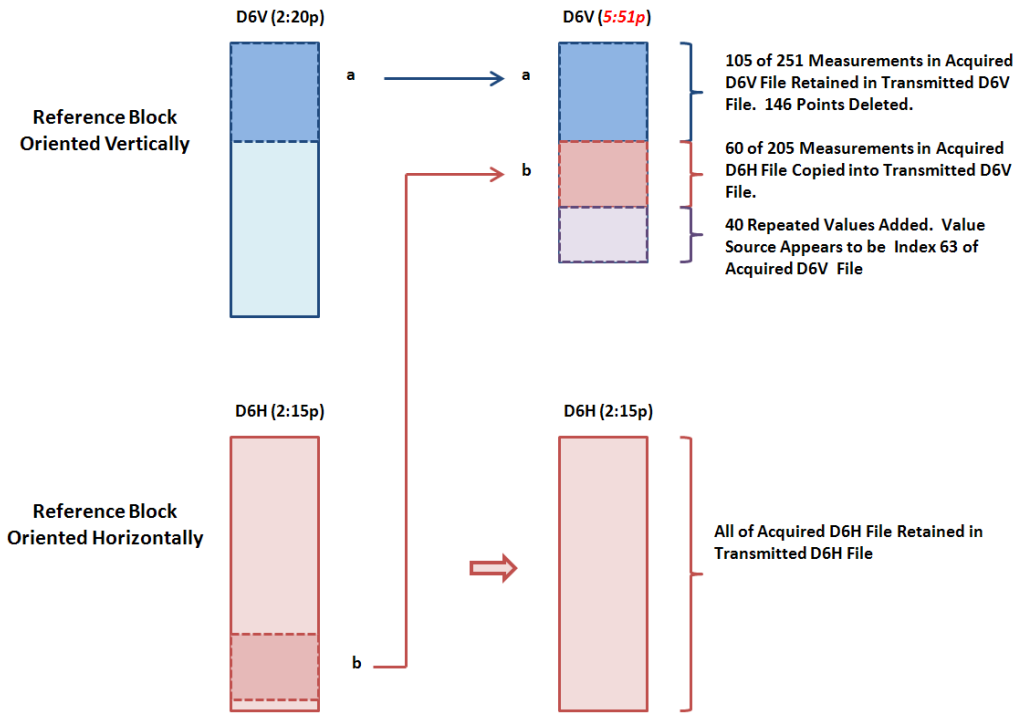


Figure 7-5 – Data Alterations Found in D6V.LAS

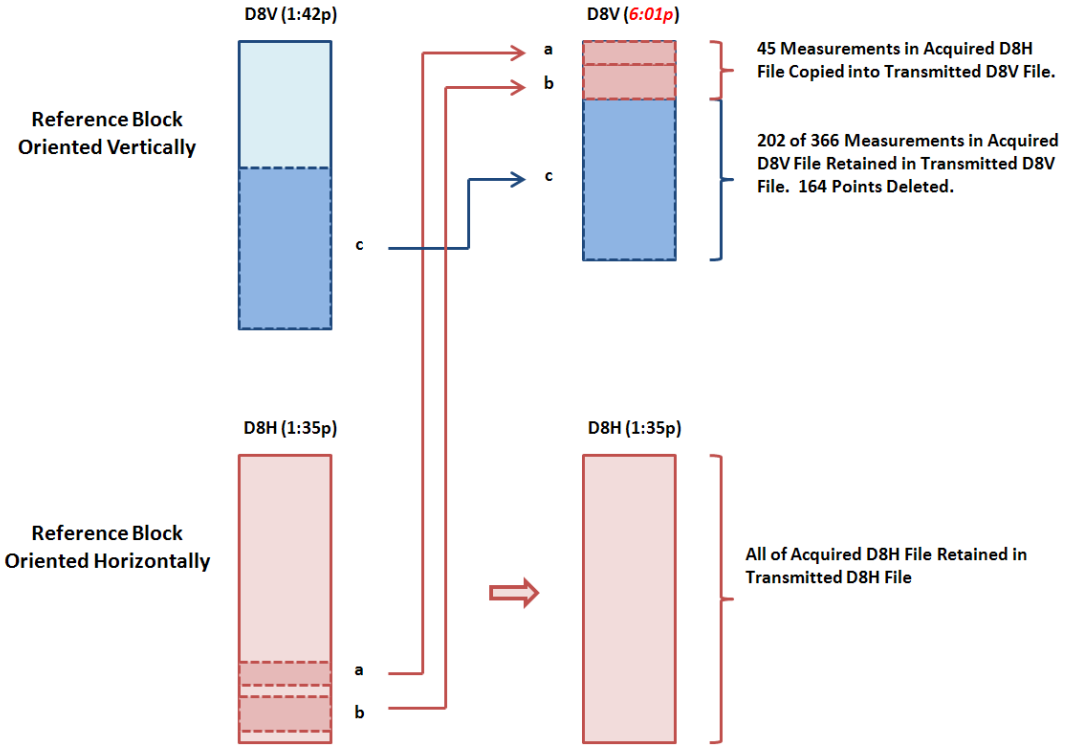


Figure 7-6 – Data Alterations Found in D8V.LAS

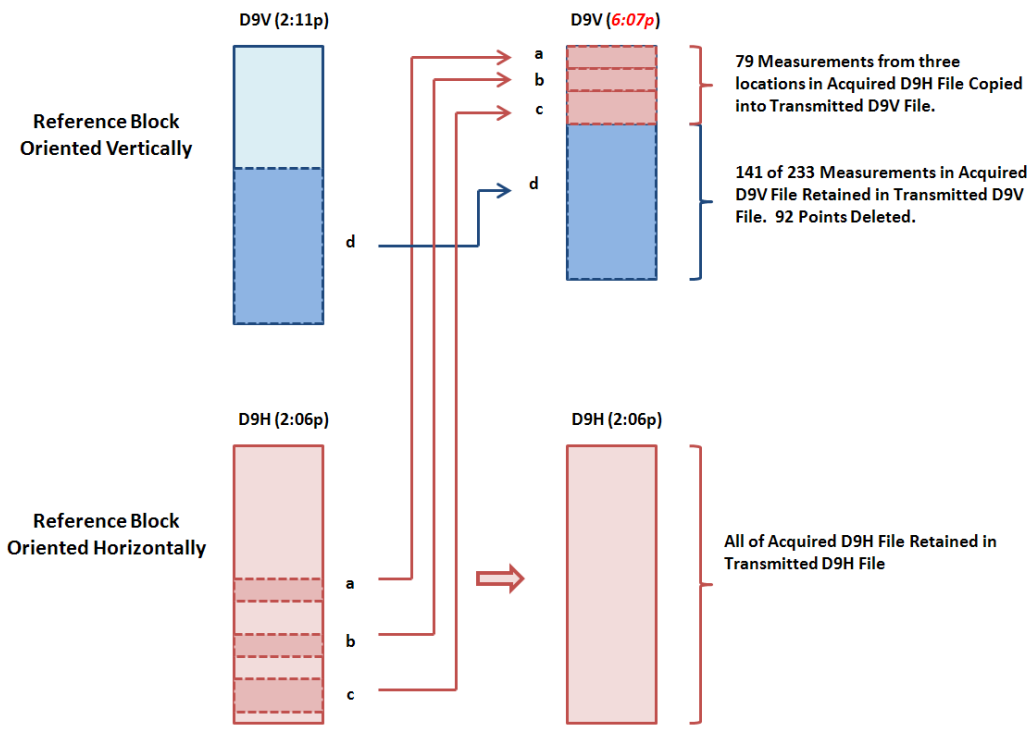


Figure 7-7 – Data Alterations Found in D9V.LAS

D1V.LAS was the most complex instance as it involved copy/paste of six different data snippets as a means to replace about 80% of the original data.

The file modification chronology also fully supports the data manipulation scenario. Time stamps for unaltered LAS files were identical between the 'acquired' and 'transmitted' files, and these matched the RD file time stamp. However, for the altered files, the transmitted LAS file had a time stamp approximately 4 hours later than both the original LAS and RD files.

For the February 2007 tests, similar observations were made for three files generated on 2/23/2007. In one instance (3551-2v.LAS) a sequence of 31 values were duplicated from another section of the file and appended to the end of the file. This appears to have been done in order to have a file with 200 data points as required by CTM-233.

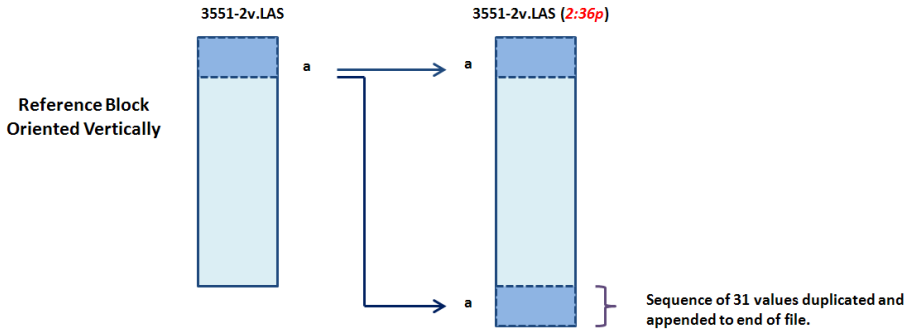


Figure 7-8 – Data Alterations Found in 3551-2v.LAS

In two other instances (1V and 7H), data was deleted in two places each to remove spurious data that were present in the original files.

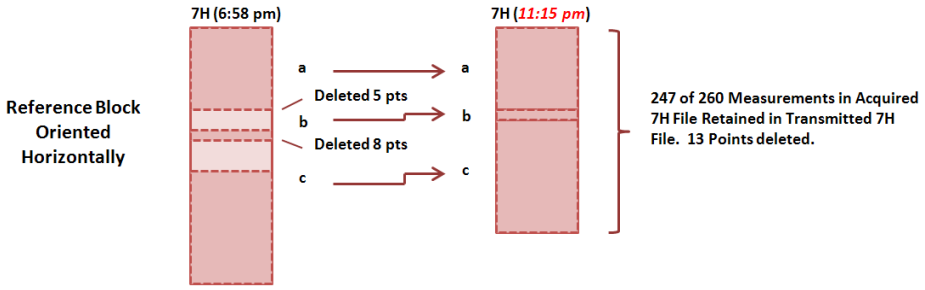


Figure 7-9 – Data Alterations Found in 7H.LAS

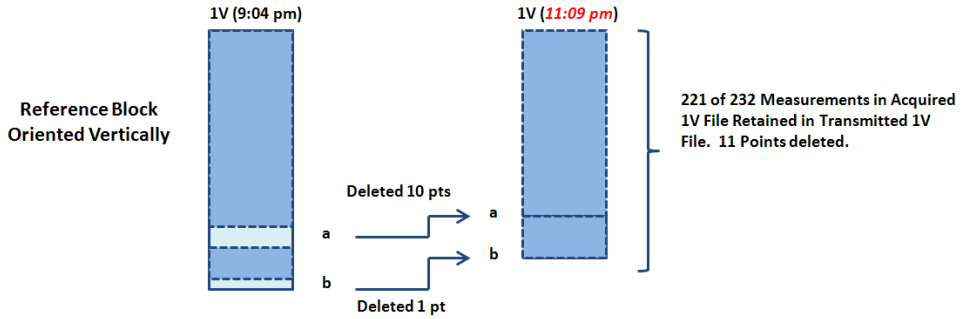


Figure 7-10 – Data Alterations Found in 1V.LAS

7.3.3 Discussion of Findings

All indications are that the technician intentionally removed and/or replaced recorded data in six files from January 2007 and three files from February 2007 prior to transmittal to the engineer.

The purpose of most of the alterations appears to be to eliminate inconsistent readings in the original data files where both spikes and offsets in gamma count were recorded, as shown for two instances in Figure 7-11 and Figure 7-12. Spikes consistently trended toward higher count values (inferring lower density) with spike amplitudes ranging from approximately 120% to 180% of normal readings. Original recordings show shifts/offsets in data moving both from lower-to-higher and from higher-to-lower gamma count. The maximum shift is approximately 125%. Deleted data was invariably the larger count values.

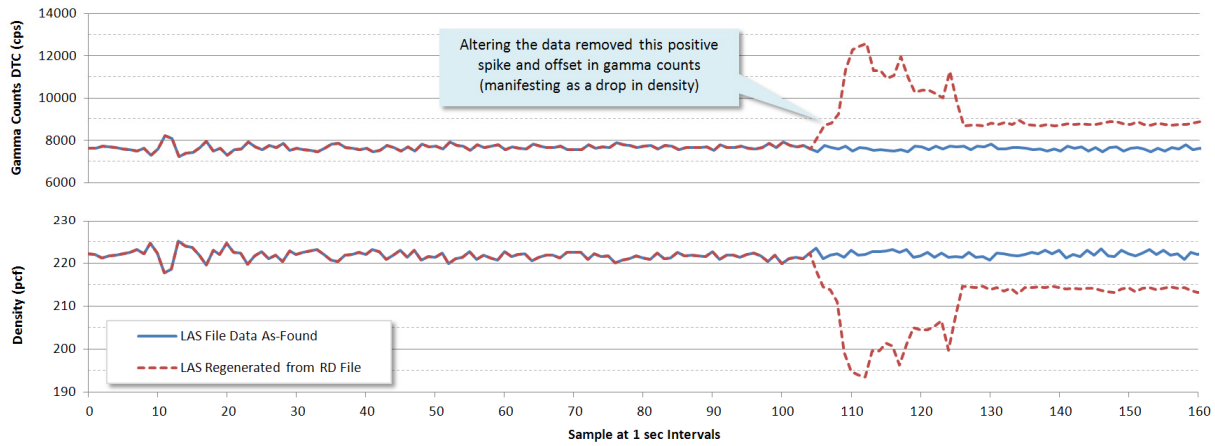


Figure 7-11 – Deleted Spikes and Offsets in D6V.LAS from January 2007 Tests

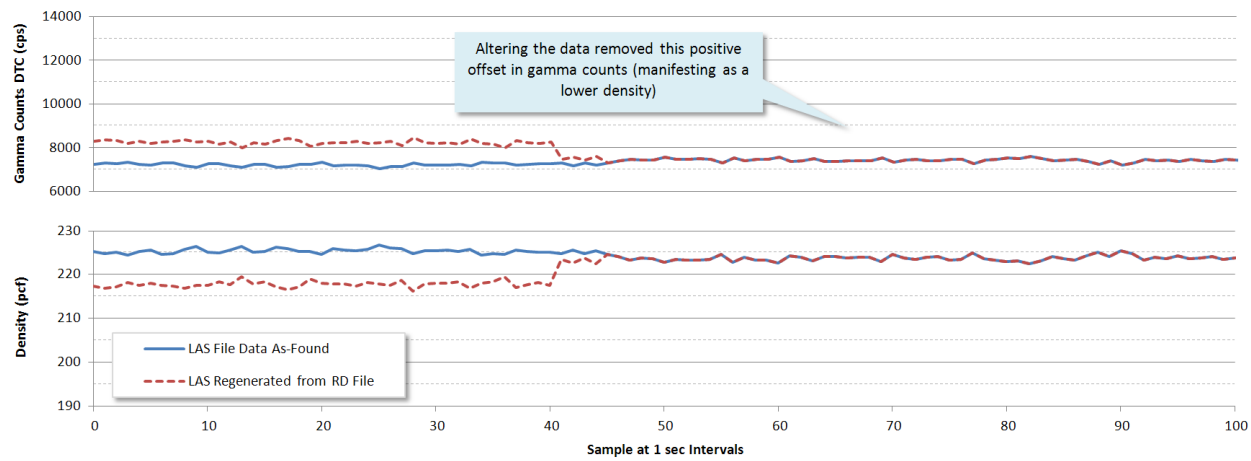


Figure 7-12 – Deleted Offset in D8V.LAS from January 2007 Tests

Due to time constraints, the GamDat team did not pursue further investigation into the cause of the spurious spikes and offsets appearing in the original data, though three viable hypotheses were considered:

- *Adjacent Source*: A second gamma source may have been within the range of detection of the GGL equipment that was recording at the time of the qualification testing.
- *Probe Repositioning*: The recording GGL probe may have been repositioned within the functionality block during the qualification testing.
- *Intermittent Equipment Malfunction*: The GGL equipment may have not been operating properly during the qualification testing.

The GamDat team considers the adjacent source hypothesis to be most likely for the January 2007 tests, as data spikes and offsets similar to those observed in the 2007 testing were observed again during 2012 testing for re-qualification of the functionality blocks under comparable testing conditions. This hypothesis accounts for shifts toward higher counts and provides the most rational explanation for the observations, as the records confirm the presence of other probes undergoing testing during the same time period and operating in the same vicinity.

Additional details are presented about the qualification testing from both 2007 and 2012 in Appendix D: Influence on Test Results from Proximity of Probes.

The probe repositioning hypothesis was tested by members of the GamDat team who were able to reproduce comparable data spikes and offsets by physically moving the probe within the functionality blocks during testing. While this can account for the 2007 observations, it is considered unlikely by the GamDat team because it would have required sustained and deliberate effort to gradually move and hold the probe to various positions within the vertically-oriented functionality block.

The intermittent equipment malfunction scenario, while viable, has not been demonstrated. GGL experts on the GamDat Advisory Team have identified several scenarios (e.g. cracked detector crystal, detector crystal fogging, and minor cable degradation short of breakage) for intermittent malfunction or poor function short of clear malfunction (e.g. complete signal loss). However, these malfunction scenarios identified would yield a reduced gamma count, not an increase as observed, and they do not account for the spikes of high gamma count appearing in the 2007 data. Further investigation would be needed to thoroughly evaluate these and other potential equipment malfunction scenarios.

7.3.4 Conclusion

The series of GGL test results conducted for the 2007 qualification of the functionality blocks presents a clear and unambiguous case of intentional data falsification in nine instances.

7.3.5 Impacts of Findings

The GamDat Team found that the adjacent source hypothesis best accounts for the 2007 observations. Under this scenario, the downstream consequences to tests conducted using these probes are minimal. This is because the properties (i.e. density) of the concrete functionality blocks change little over time, and the recent 2012 requalification implies the blocks were in good functioning order throughout their use. However, the possibility of intermittent equipment malfunction cannot be ruled out with certainty.

7.4 Altered Density and Gamma Count Data in Calibration File (Manual Analysis ID-4)

Calibration constant, timestamp, and fidelity analysis tools flagged a LAS file where there was clear evidence of alteration of density and gamma count data. The file appeared to contain data intended for use in establishing gamma probe calibration parameters.

7.4.1 GGL Test Details

The LAS and corresponding RD files in question (568-147.LAS and 568-147.RD) were only found on once source, a hard drive recovered from a crashed FTB server. The filenames and parent directory name in which the file was found suggest that this test had been conducted as part of a calibration procedure for probe-source "568" in the 147 pcf concrete barrel. The date of the file suggests that this data would have been used in a calibration of this probe on or around October 19, 2004.

A summary of the data files flagged is presented in Table 7-9.

Attribute	Description
Testing Location:	TransLab, Sacramento, California
Tube(s)/Test(s) Investigated:	Probe 568, 147 pcf calibration barrel
Reference GGL Report:	N/A

Table 7-9 – Test Details from Manual Analysis ID-4

7.4.2 Description of Irregularities

The fidelity analysis flagged the pair of files due to differences between the data in the RD and LAS files. The timestamp analysis flagged the file pair due to an 11 minute time difference between the file save times. The calibration constant analysis flagged the LAS file due to an inconsistency in the calibration relationship between the gamma count and density values. The combination of findings from all three indicates the LAS file had been altered after data collection.

As the RD file was available, an unaltered LAS file could be regenerated and compared against the LAS file found in order to isolate the exact locations of alterations. The comparison revealed that a sequence of 8 consecutive density values was altered. The data appears to have been manually edited rather than changed through a copy/paste approach, as a duplicate of this sequence was not found elsewhere. Density values were increased by integer values (e.g. 1, 2, and so forth). Likewise, some of the corresponding gamma counts, both raw and dead-time-corrected, were also changed by integer values in the hundreds or thousands (e.g. 100, 200, 1000, 2000, and so forth). A comparison of the original LAS file as found and the regenerated LAS file is shown in Figure 7-13.

LAS File As-Found

```
~VERSION INFORMATION
VERS      .2.0                    :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP      .NO                     :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT      .FT            -21495.4 :START DEPTH
STOP      .FT            -21495.4 :STOP DEPTH
STEP      .FT                   0 :STEP
NULL      .               -999.25 :NULL VALUE
        ...
~CURVE INFORMATION
DEPT      .FT                     :DEPTH
GAM       .CPS                    :Gam
GAM(      .CPS                    :gam(dtc)
DENS      .LBS/FT3                :Density(dtc)
~PARAMETER INFORMATION
~OTHER
~A
 -21495.4    21033    24216.4    147.873
 -21495.4    21224    24469.9    147.271
 -21495.4    20951    24107.8    148.133
      ...       ...       ...        ...
 -21495.4    21290    24557.7    147.064
 -21495.4    21202    24440.7     147.34
 -21495.4    21157    24380.9    147.482
 -21495.4    21320    24597.6     147.97
 -21495.4    21400    24704.2     147.72
 -21495.4    21601    24472.4    147.096
 -21495.4    21923    24403.8    147.106
 -21495.4    21999    24259.9    147.884
 -21495.4    21123    24129.2    148.521
 -21495.4    21910    24110.8    147.253
 -21495.4    22426    24181.7    147.584
 -21495.4    21021    24200.5    147.911
 -21495.4    21061    24253.5    147.785
 -21495.4    20988    24156.8    148.016
      ...       ...       ...        ...
```

LAS File Regenerated From RD File Found

```
~VERSION INFORMATION
VERS      .2.0                    :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP      .NO                     :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT      .FT            -21495.4 :START DEPTH
STOP      .FT            -21495.4 :STOP DEPTH
STEP      .FT                   0 :STEP
NULL      .               -999.25 :NULL VALUE
        ...
~CURVE INFORMATION
DEPT      .FT                     :DEPTH
GAM       .CPS                    :Gam
GAM(      .CPS                    :gam(dtc)
DENS      .LBS/FT3                :Density(dtc)
~PARAMETER INFORMATION
~OTHER
~A
 -21495.4    21033    24216.4    147.873
 -21495.4    21224    24469.9    147.271
 -21495.4    20951    24107.8    148.133
      ...       ...       ...        ...
 -21495.4    21290    24557.7    147.064
 -21495.4    21202    24440.7     147.34
 -21495.4    21157    24380.9    147.482
 -21495.4    21320    24597.6     146.97
 -21495.4    21400    24704.2     146.72
 -21495.4    21601    24972.4    146.096
 -21495.4    21923    25403.8    145.106
 -21495.4    22999    26859.9    141.884
 -21495.4    23123    27029.2    141.521
 -21495.4    23910    28110.8    139.253
 -21495.4    22426    26081.7    143.584
 -21495.4    21021    24200.5    147.911
 -21495.4    21061    24253.5    147.785
 -21495.4    20988    24156.8    148.016
      ...       ...       ...        ...
```

Differences in Values

```
     0       0       0       0
     0       0       0       0
     0       0       0       0
   ...     ...     ...     ...
     0       0       0       0
     0       0       0       0
     0       0       0       0
     0       0       0       1
     0       0       0       1
     0       0    -500       1
     0       0   -1000       2
     0   -1000   -2600       6
     0   -2000   -2900       7
     0   -2000   -4000       8
     0       0   -1900       4
     0       0       0       0
     0       0       0       0
     0       0       0       0
   ...     ...     ...     ...
```

Figure 7-13 – Alterations to LAS File

The alteration to the data appeared to have been carried out to remove a low density spike, which possibly could have disqualified the test from being used in the calibration process. The spike that was altered is shown in Figure 7-14.

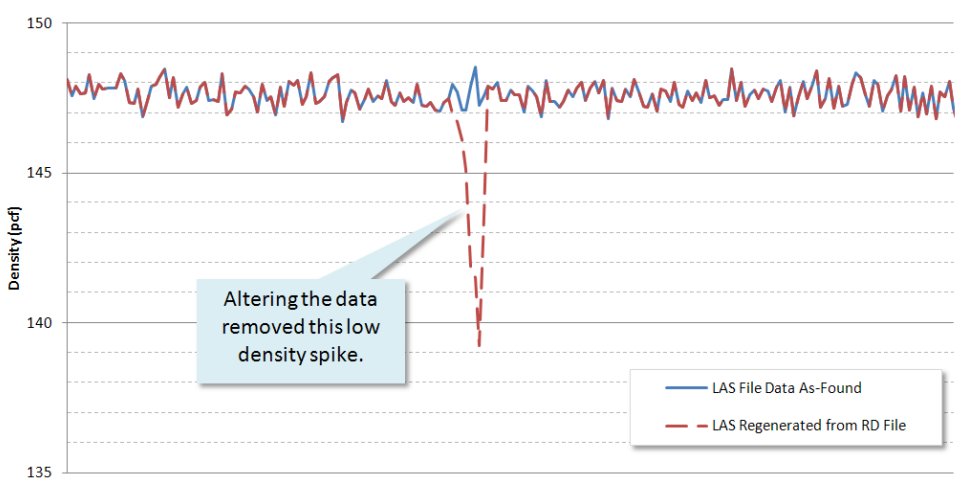


Figure 7-14 – Alteration of LAS File to Remove Low Density Spike

7.4.3 Conclusions

The preponderance of evidence supports the assertion that the LAS file was altered from its original state. Although no evidence was found to support that this data had been used in practice, this irregularity was designated a case, as it is the earliest identified example of data having been edited manually one value at a time.

7.4.4 Impacts of Findings

A comprehensive search of all recovered calibration related spreadsheets and documents was carried out to determine where this data may have been used. The annual calibration for this specific probe had been carried out on September 29, 2004, three weeks prior to the date of the LAS file in question. The data used in that calibration process did not contain the data in question, nor was a calibration carried out in the month or two following. No other calibration related spreadsheets or files in the entire GamDat collection for any probe were found to have even isolated measurements of the data from the LAS file in question, and there is no formal record of calibration for this probe for October/November. As such, it was concluded that the altered data file was not used for establishing calibration parameters and there are no impacts to projects where this probe had been used as a result of this irregularity.

7.5 Duplicated, Replaced, and Deleted Data at Overhead Sign #19, Route 580 (Manual Analysis ID-12)

The pattern matching analysis flagged two data files representing two tubes from a single pile, each showing evidence of data having been duplicated, replaced, and deleted. The occurrence of this irregularity was identified in 2009 by FTB. The information presented in this case further validates the prior findings.

7.5.1 Structure, Foundation, Pile, and GGL Test Details

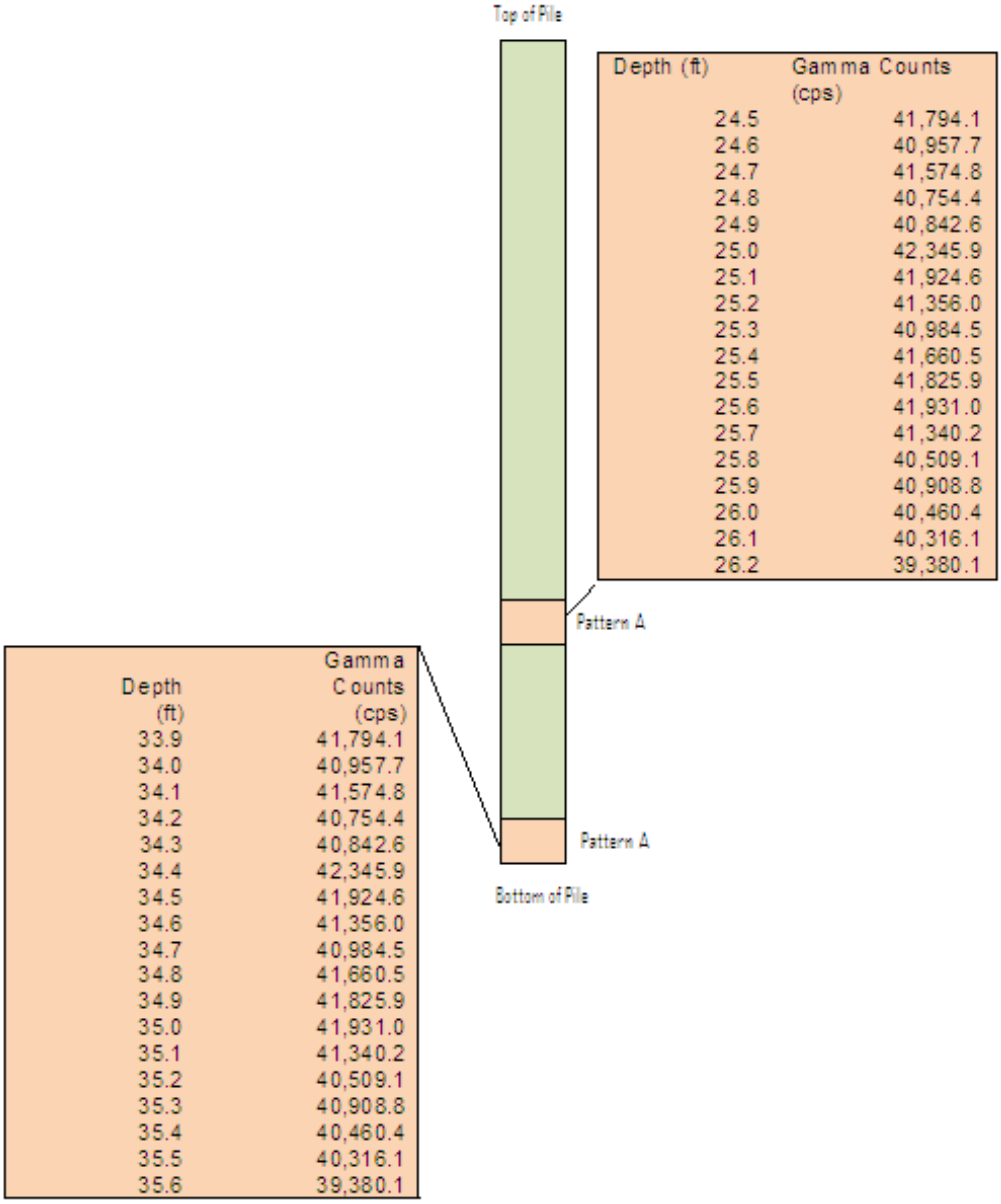
Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-10.

Attribute	Description
Structure Name:	Overhead Sign #19, Route 580
Structure Number:	N/A
District, County, Route, PM	04-ALA-580-Sta F 166+75 (FWBT)
Foundation Location:	Sign #19
Pile(s) Investigated:	Sign #19
Pile Diameter:	1524 mm (60 in)
Tested Pile Length:	9.7 m (31.8 ft)
Number of Tubes in Pile:	5
Tube(s)/Test(s) Investigated:	Tubes 3 and 4
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: CIDH Pile at Overhead Sign 19, Route 580" (March 21, 2008)

Table 7-10 – Test Details from Manual Analysis ID-12

7.5.2 Description of Irregularities

Two LAS files representing two of five inspection pipes at this pile contained duplicated sequences of data. In both cases this data was copied from one part of the data set and pasted to another. In Tube 3 a single pattern of 18 consecutive count and density values (labeled "Pattern A" in Figure 7-15) was found in two places within the file. In Tube 4 three patterns of 11, 17, and 3 consecutive count and density values (labeled "Pattern A," "Pattern B," and "Pattern C" in Figure 7-16) were each found in two places within the file.



Depth (ft)	Gamma Counts (cps)
24.5	41,794.1
24.6	40,957.7
24.7	41,574.8
24.8	40,754.4
24.9	40,842.6
25.0	42,345.9
25.1	41,924.6
25.2	41,356.0
25.3	40,984.5
25.4	41,660.5
25.5	41,825.9
25.6	41,931.0
25.7	41,340.2
25.8	40,509.1
25.9	40,908.8
26.0	40,460.4
26.1	40,316.1
26.2	39,380.1

Depth (ft)	Gamma Counts (cps)
33.9	41,794.1
34.0	40,957.7
34.1	41,574.8
34.2	40,754.4
34.3	40,842.6
34.4	42,345.9
34.5	41,924.6
34.6	41,356.0
34.7	40,984.5
34.8	41,660.5
34.9	41,825.9
35.0	41,931.0
35.1	41,340.2
35.2	40,509.1
35.3	40,908.8
35.4	40,460.4
35.5	40,316.1
35.6	39,380.1

Figure 7-15 – Pattern Matching in Tube 3 LAS File

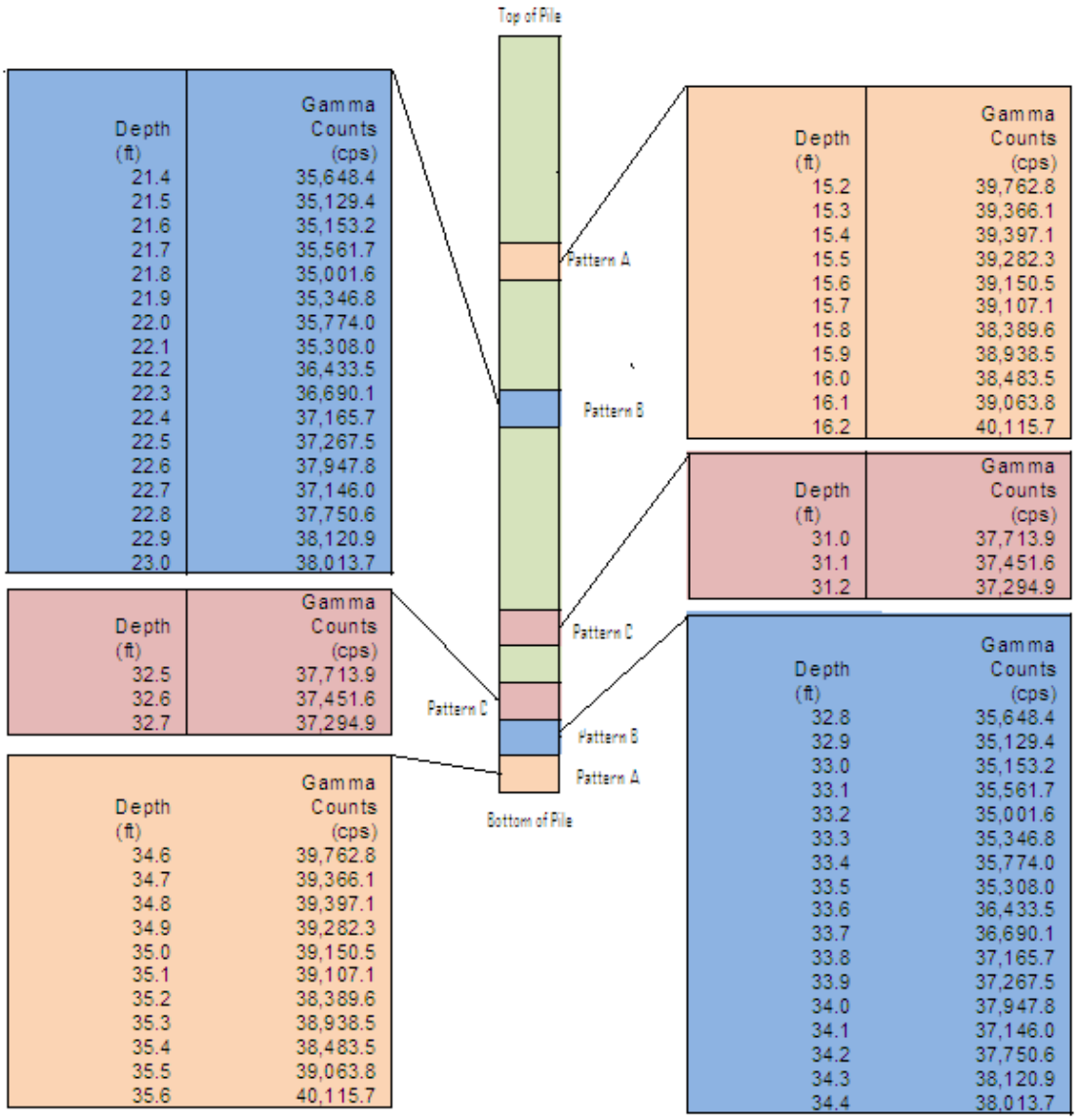


Figure 7-16 – Pattern Matching in Tube 4 LAS File

It is notable that duplicated sequences of data in both tubes were found at the bottom of the pile. As the RD files were not recovered, unaltered LAS file could not be regenerated and compared against the LAS files found in order to determine which sequences were the original and which were the copies. In the case of Tube 4, all three sequences of duplicated data were found grouped together at the very bottom of the pile. The three duplicated sequences of data originated from three non-contiguous locations within the file. This suggests that the original sequence of data at the bottom of the pile was likely replaced by randomly grabbing the three sequences from other parts of the same data set. In the case of Tube 3, a similar observation could be made.

It is also notable that one of the three duplicated sequences of data for Tube 4 was a sequence of three values and was not presented in the final pattern matching results. Patterns of three were generally ignored in the analysis results as their occurrence in most instances was random, as described in Section 5.4. The sequence of three was

included in this particular case, because of the proximity to the other two sequences suggesting an extension of the deliberate editing of this data set.

7.5.3 Conclusions

The body of evidence supports the assertion that in two tubes on this pile data was copied from one part of the file and pasted to another.

7.5.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for both Tubes 3 and 4.

7.6 Duplicated and Replaced Data at La Sierra Ave. OH, Bent 2, Pile W2 (Manual Analysis ID-13)

Pattern matching and depth consistency analyses flagged data files representing two tubes from a single pile, showing evidence of data having been duplicated and replaced. The occurrence of this irregularity was identified in 2008 by FTB. The information presented in this case further validates the prior findings.

7.6.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-11.

Attribute	Description
Structure Name:	La Sierra Avenue OH
Structure Number:	56C0571
District, County, Route, PM	08–RIV–91–17.7/20.3
Foundation Location:	Bent 2
Pile(s) Investigated:	Pile W2
Pile Diameter:	1.8 m (71 in)
Tested Pile Length:	27.7 m (90.9 ft)
Number of Tubes in Pile:	6
Tube(s)/Test(s) Investigated:	Tubes 1 and 5
Reference GGL Report:	"Gamma–Gamma Logging Acceptance Test Results: Pile W2 at Bent 2" (September 24, 2008)

Table 7-11 – Test Details from Manual Analysis ID-13

7.6.2 Description of Irregularities

The analysis showed that editing of GGL test data occurred for Tubes 1 and 5 of Pile W2 at Bent 2. The pattern matching analysis found two LAS files, representing two of six inspection tubes at this pile, contained duplicated sequences of data. The source of the duplicated data in both instances was data copied from another tube within Pile W2 or from a tube from adjacent Pile W3.

The duplicated patterns are shown in Figure 7-17 and Figure 7-18, where each distinct pattern is designated (e.g. "A", "B", etc.), and the location where each pattern was copied from and pasted into the files for Tubes 1 and 5.

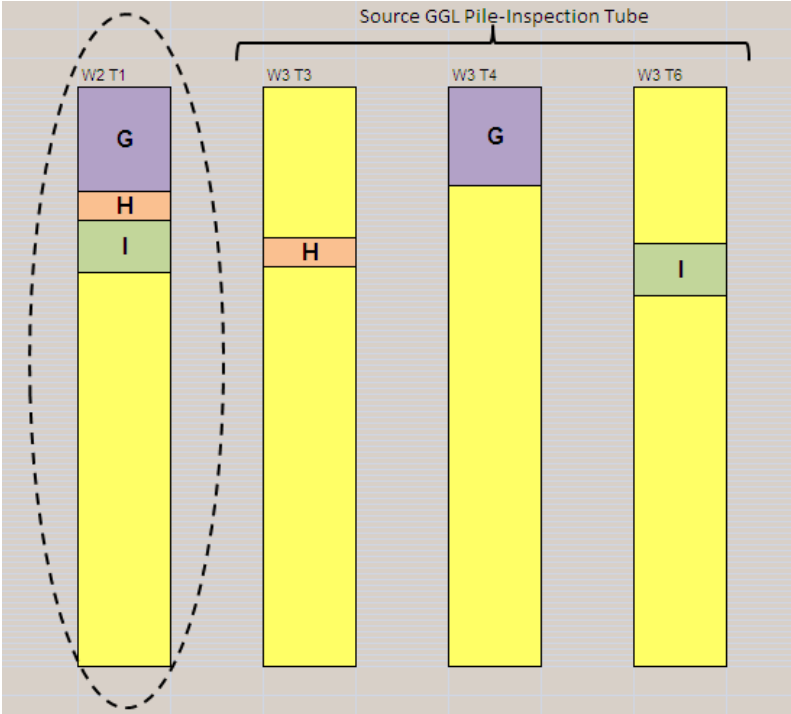


Figure 7-17 – Duplicated Patterns Identified in Tube 1

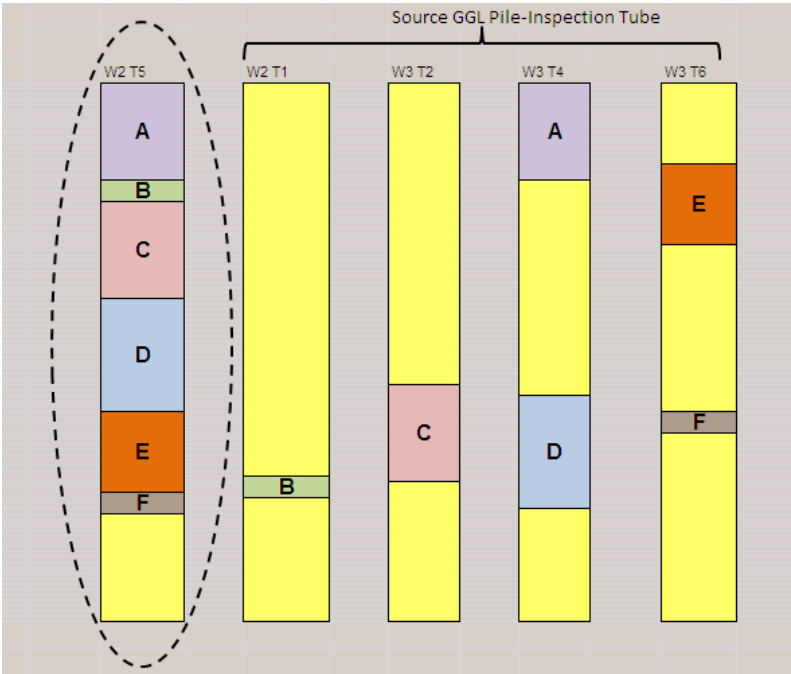


Figure 7-18 – Duplicated Patterns Identified in Tube 5

The evidence provided by the depth consistency analysis suggests that approximately 29 ft of data in Tube 1 and approximately 73 ft of data in Tube 5 had not been recorded originally. The reason for stopping recording short of

completion is not evident from examination of the data files. However, the replacement of duplicated data to fill in the gaps is consistent with the depth-related irregularities.

Examination of the file time and date stamps shows that the two files in question were opened and saved two days after the testing was conducted. This further supports the assertion of these two files having been altered.

As the RD files were not recovered, unaltered LAS files could not be regenerated and compared against the LAS files found.

7.6.3 Conclusions

The body of evidence supports the assertion that in two tubes on this pile, data was copied from tests from other tubes both within the same pile and from an adjacent pile.

7.6.4 Impacts of Findings

The data falsification addressed in this case was discovered by an FTB Engineer in 2008 during analysis of the test data, prior to a report being issued. The falsified data was not used in the pile acceptance report and the pile was re-tested shortly after the falsification was discovered.

7.7 Irregular Testing Chronology and Duplicated Data in Excel File at Benicia-Martinez Bridge, Pier 14, Pile 8 (Manual Analysis ID-76)

The time stamp chronology analysis initially flagged several files from Pile 8 due to irregularities in the testing chronology. During the evaluation of the data, an unusual sequence of zero gamma count samples over a 0.8 ft interval within the concrete region was found in one of the files. Further examination of an *Excel* spreadsheet, used for engineering analysis of the data, revealed that the zero count values had been replaced with data copied from an adjacent tube and was used in the GGL Report issued by the FTB.

7.7.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-12.

Attribute	Description
Structure Name:	Benicia-Martinez Bridge
Structure Number:	28-0153 R
District, County, Route, PM	04–CC, SOL–680–40.1/41.4
Foundation Location:	Pier 14
Pile(s) Investigated:	Pile 8
Pile Diameter:	2.5 m (98 in)
Tested Pile Length:	39.6 m (129.9 ft)
Number of Tubes in Pile:	8
Tube(s)/Test(s) Investigated:	Tubes 3, 4, 5, 6, and 7
Reference GGL Report:	"Gamma–Gamma Logging Acceptance Test Results: Pile 8 at Pier 14" (August 12, 2004)

Table 7-12 – Test Details from Manual Analysis ID-76

7.7.2 Description of Irregularities

Two types of irregularities were identified for this group of files. The group of test files associated with the pile was flagged primarily due to a series of irregularities with the time intervals between several of the tests. However, upon further evaluation an irregularity in an *Excel* spreadsheet was found to be a more significant issue.

7.7.2.1 Chronology Irregularity

The GGL tests performed on Tubes 3, 4, 5, 6, and 7 of Pier 14 Pile 8 were flagged by the chronology analysis, as the time intervals between each of these tests were approximately 1 to 3 minutes shorter than the estimated total test time needed to feasibly carry out the tests using typical procedures (i.e. lowering probe at 52 fpm, 15 sec to

move probe, 15 sec to configure software). The specific time intervals and tubes that were flagged are shown in Figure 7-19. The "___ *minutes remaining*" indicates the additional time available beyond what is considered physically feasible using typical procedures. The "___ *minutes deficient*" indicates the time short of what is considered physically feasible using typical procedures. A more detailed presentation of the chronology analysis approach and the timing calculations are presented in Section 5.6.

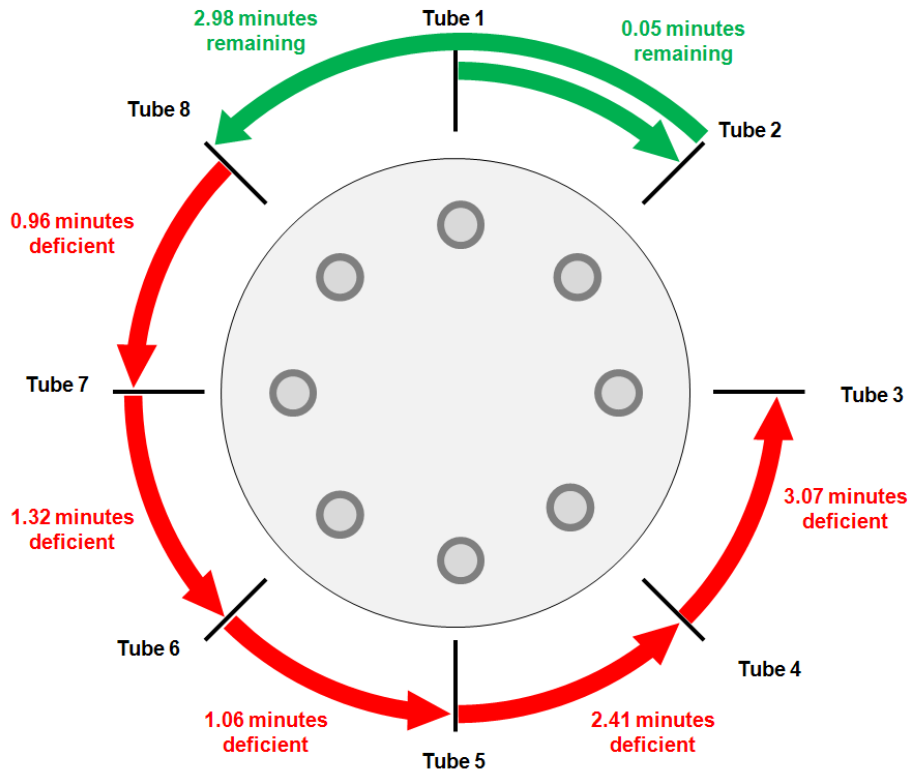


Figure 7-19 – Calculated Time Deficiencies in Testing Sequence Using Typical Procedures

The following observations were made from the available test data:

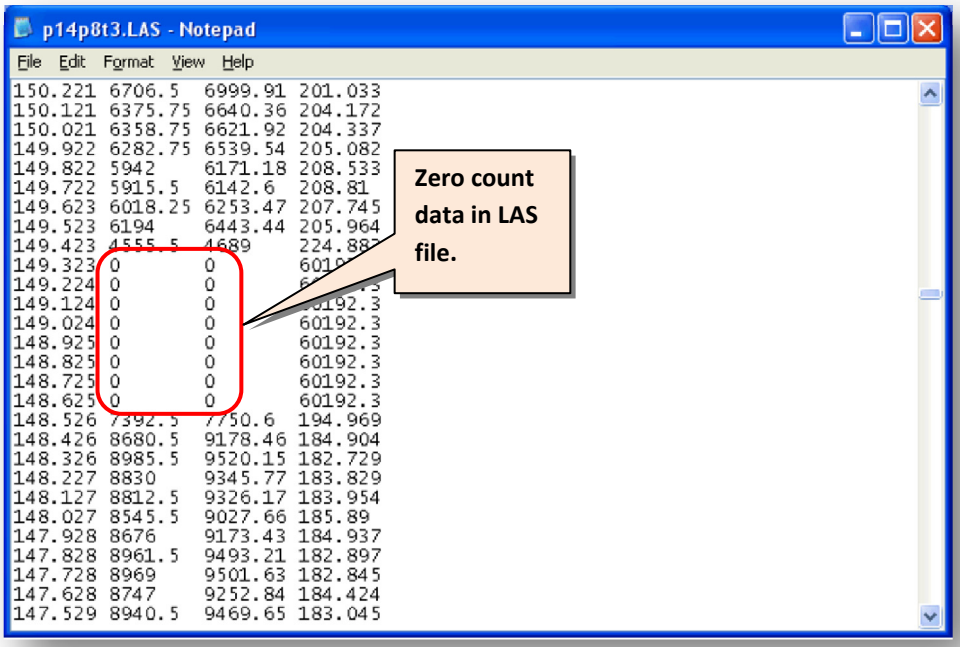
- All tests on this pile was collected with the *MSLog* software configured to depth-up mode. This is the typical operational mode for data collection.
- Both RD and LAS files were available for all tests on this pile.
- The duration during data acquisition is well established, as speed data every 0.1 ft from the RD files were available.
- The calculated time deficiency ranges from 1 to 3 minutes for the flagged tubes, using a key assumption that the probe had been lowered to the bottom of the tubes at a speed of 52 fpm.
- The order in which the testing was carried out did not follow typical practice where the Tube 1 is the first test and subsequent tests carried out in a clockwise direction around the pile. This is an atypical test sequence, and no explanation for this could be determined from the available records.

The only reasonable explanation that accounts for the observed timing deficiencies is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically

considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

7.7.2.2 Irregularity in the Spreadsheet

During the examination of the data files associated with this ID, the team discovered that the LAS data file for Tube 3 contained a sequence of 8 consecutive zero count measurements, embedded in the middle of the test. The data, as it appears in the LAS file, is shown in Figure 7-20.




```
150.221 6706.5  6999.91 201.033
150.121 6375.75 6640.36 204.172
150.021 6358.75 6621.92 204.337
149.922 6282.75 6539.54 205.082
149.822 5942    6171.18 208.533
149.722 5915.5  6142.6  208.81
149.623 6018.25 6253.47 207.745
149.523 6194    6443.44 205.964
149.423 4555.5  4689    224.883
149.323 0       0       601[illegible]
149.224 0       0       [illegible]
149.124 0       0       [illegible]192.3
149.024 0       0       60192.3
148.925 0       0       60192.3
148.825 0       0       60192.3
148.725 0       0       60192.3
148.625 0       0       60192.3
148.526 7392.5  7750.6  194.969
148.426 8680.5  9178.46 184.904
148.326 8985.5  9520.15 182.729
148.227 8830    9345.77 183.829
148.127 8812.5  9326.17 183.954
148.027 8545.5  9027.66 185.89
147.928 8676    9173.43 184.937
147.828 8961.5  9493.21 182.897
147.728 8969    9501.63 182.845
147.628 8747    9252.84 184.424
147.529 8940.5  9469.65 183.045
```

Figure 7-20 – Sequence of Zero Gamma Count Samples in LAS File

The sequence of zero counts, however, was not found in the data plots (based on *Origin* and *Excel* files) presented in the GGL Report. An examination of the *Excel* spreadsheet revealed that data from Tube 5 had been copied to replace the cells with the zero count data in Tube 3. The duplicated cells of data are identified in Figure 7-21. The resulting densities were carried over to the plots, generated in *Origin,* and presented in the GGL Report.

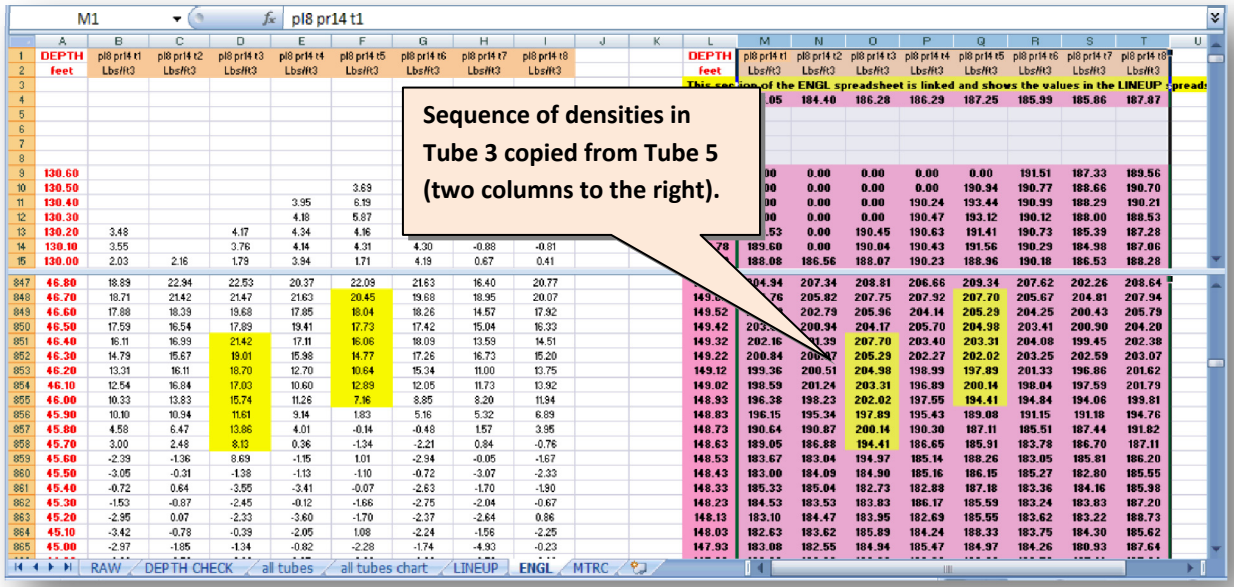


Figure 7-21 – Duplicated Data in Excel Spreadsheet

It is clear that this sequence of 8 data points (over a depth of 0.8 ft) was duplicated within the *Excel* file as a means of mitigating the occurrence of the zero count samples. The copied data over this 0.8 ft interval was reported in the plots in the GGL Report.

7.7.3 Conclusions

The timing irregularities were the primary cause for these files being flagged, and the evidence supports the assertion that the probe was lowered using the free-wheeling method. It was the observation of the duplicated data in the *Excel* spreadsheet which carried through to the reported test results that warranted this to become a case.

7.7.4 Impacts of Findings

The extent to which GGL test results are missing and/or misrepresented by the GGL Report is limited to Tube 5 over a 0.8 ft depth interval, spanning 148.5 to 149.4 ft.

7.8 Irregular Testing Chronology Indicating Likely Retest at Benicia-Martinez, Pier 6, Pile 5 (Manual Analysis ID-17)

This case presents a near-certain instance of an improper retest, where it is suspected that data acquired during a retest of one tube was reported as independent data for another tube. The near-certain level of confidence is based on strong chronological evidence whereby the only physically-feasible explanation which could be identified by the GamDat team to account for documented chronological facts is the stated retest.

7.8.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-13.

Attribute	Description
Structure Name:	Benicia-Martinez Bridge
Structure Number:	28-0153 R
District, County, Route, PM	04–CC, SOL–680–40.1/41.4
Foundation Location:	Pier 6
Pile(s) Investigated:	Pile 5
Pile Diameter:	2.5 m (98 in)
Tested Pile Length:	39.2 m (128.6 ft)
Number of Tubes in Pile:	8
Tube(s)/Test(s) Investigated:	Tubes 4 and 5
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: Pile 5 at Pier 6" (April 7, 2004)

Table 7-13 – Test Details from Manual Analysis ID-17

7.8.2 Description of Irregularities

The circumstances enabling detection of the retest irregularity in this case are unique and provide compelling indirect evidence of retest. This case is one of three cases of retest irregularity that involves the isolated use of an atypical testing procedure of double-transit described earlier in Section 4.3.3.

This case is particularly unique and compelling among the three double-transit cases because the RD file for this test was recovered, containing probe speed data and readings at least every second. This allowed for the determination of the time interval over which data was recorded to within several seconds. The existence of the RD file, and firm estimate of testing time, is what makes this case the most compelling of the three double-transit cases.

7.8.2.1 Chronology of Testing

GGL tests were reported to have occurred at Pier 6 Pile 5 in seven of eight tubes in that pile as shown in Figure 7-22. No results were reported for Tube 6, and that is not a consideration in this analysis. Testing in Tubes 1, 2, 3, 7, and 8 employed typical testing procedures. For unknown reasons, an atypical procedure was employed for testing of Tube 4.

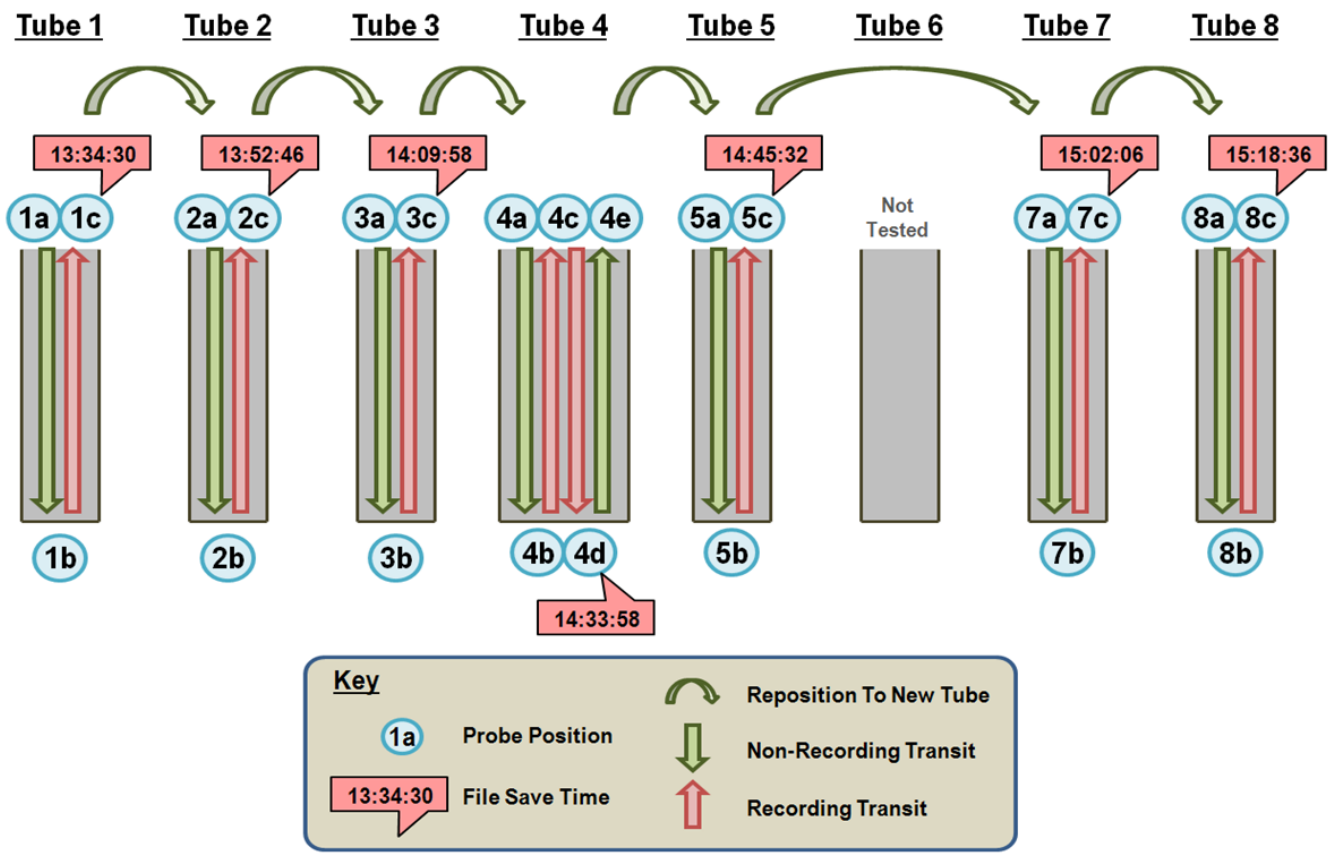


Figure 7-22 – Chronology of Testing for Pile 5 at Pier 6

Two alternative chronological scenarios were considered for where and how data reported for Tube 5 may have actually been recorded. The first scenario assumes the data reported for Tube 5 indeed came from Tube 5, whereas a second scenario assumes the data reported for Tube 5 actually came from Tube 4. Timelines are presented for each scenario. In both scenarios, the entire test sequence for Pile 5 is shown to illustrate that the analysis yields reasonable results for all but the suspect test reported for Tube 5 as well as to demonstrate the effects of alternative procedural assumptions.

7.8.2.2 Scenario Assuming Testing as Reported

Figure 7-23presents the timeline if testing occurred as reported. Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as Tube 5 is located at position 5c. Based on time stamps, the time interval between positions 4d and 5c is known to be 11 minutes and 34 seconds. Analysis of the probe speed data appearing in the

RD file showed that the time required to record data from position 5b to 5c is 10 minutes and 56 seconds. This leaves only 38 seconds for the probe to be moved from position 4d to 5b.

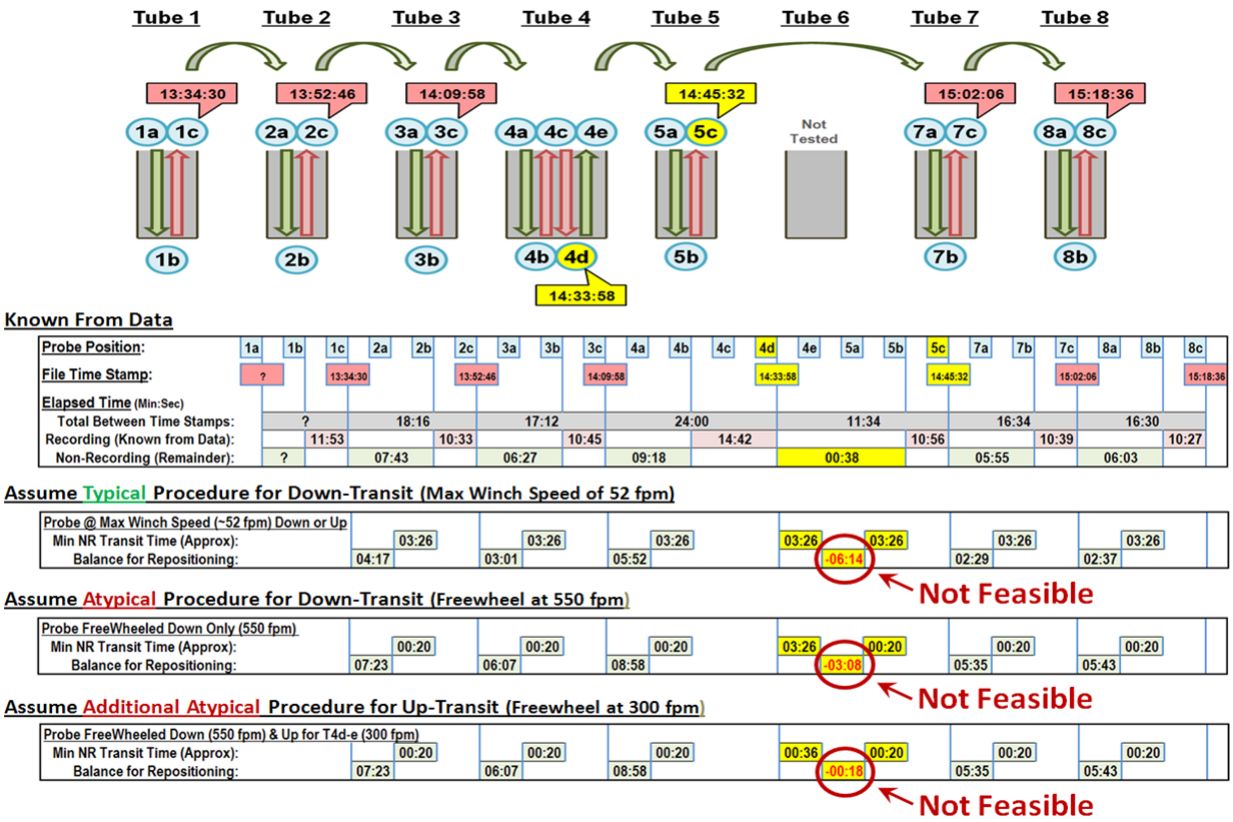


Figure 7-23 – Testing as Reported for Pile 5 at Pier 6

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 4d-to-4e and 5a-to-5b) as discussed below:

- Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 178 feet, approximately 3 minutes and 26 seconds are required for each non-recording transit. Therefore, a total of 6 minutes and 52 seconds would be required just for the transits. This exceeds the 38 seconds available by approximately 6 minutes and 14 seconds, without considering the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). This scenario is physically infeasible.

- The first of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch and allowed to free-wheel on the downward non-recording transit (i.e. positions 5a to 5b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 20 seconds. Assuming the winch is used to raise the probe, a total of 3 minutes and 46 seconds is required for the transits. However, this exceeds the 38 seconds available by approximately 3 minutes and 8 seconds, again without considering

the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). This scenario is also physically infeasible.

- The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on both the upward and downward non-recording transits (i.e. positions 4d-to-4e and 5a-to-5b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 36 seconds, and total time for both non-recording transits could be reduced to 56 seconds. However, this exceeds the 38 seconds available by approximately 18 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). Therefore, this scenario is also physically infeasible.

7.8.2.3 Retest Scenario

Figure 7-24 presents similar information for the suspected scenario where data reported for Tube 5 actually came from Tube 4 (recorded from positions 4d to 4e).

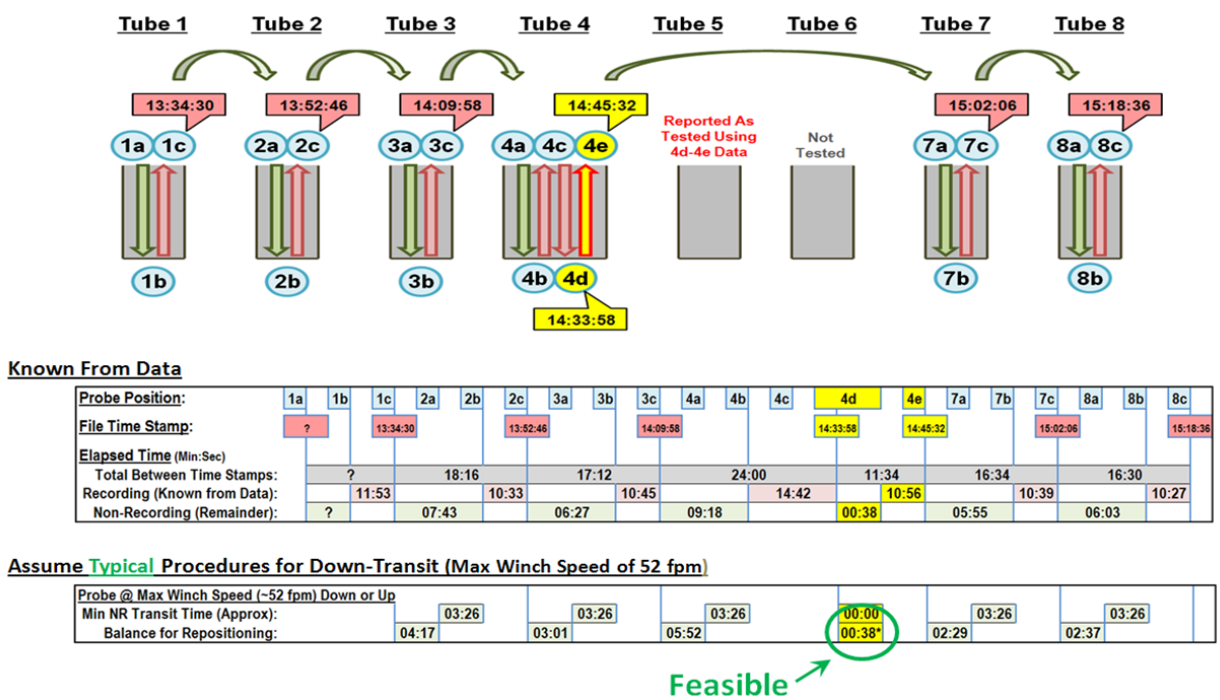


Figure 7-24 – Retest Scenario for Pile 5 at Pier 6

Physically, this scenario eliminates the need for repositioning the equipment to the bottom of Tube 5, and the only tasks required to be completed within 38 seconds in non-recording time available is to initialize the *MSLog* software for recording. Experienced GamDat team members estimate that this task could be completed within a timeframe on the order of 15 seconds. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

Prototype correlation analyses carried out for this scenario are presented in the Manual Analysis documents in Appendix P: Manual Analysis Documentation.

7.8.3 Conclusions

The GamDat team was unable to envision any other operational procedure besides retest that could account for the observed chronological facts, and based on chronological evidence alone, concluded that it is likely that results reported for Tube 5 were actually retest data obtained in Tube 4.

7.8.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for Tube 5 of Pile 5.

7.9 Irregular Testing Chronology Indicating Plausible Retest at SE Connector SB 215/EB 215, Pile at Bent 15 (Manual Analysis ID-10)

This case presents a plausible instance of an improper retest, where it is suspected that data acquired during a retest of one tube was reported as independent data for another tube. The existence of the irregularity is based primarily on chronological evidence whereby it was physically infeasible to complete testing as reported using typical procedures within the constraints of documented chronological facts, while the suspected retest is fully consistent with these same facts. Consideration was given to alternative testing scenarios involving use of three atypical procedures (i.e. free-wheel down-transit, free-wheel up-transit, and faster recording speed), but all of these were found to be physically infeasible when considered separately. Additional scenarios were considered involving various combinations of the atypical procedures. Only the combined use of all three atypical procedures yielded equipment-repositioning time intervals approaching those observed at this site for other tests using typical procedures. The GamDat team considered the potential for sudden change in all three operational procedures for this single test to be unrealistic. Therefore, the most reasonable explanation which could be identified by the GamDat team to account for documented chronological facts is the suspected retest.

7.9.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-14.

Attribute	Description
Structure Name:	SE Connector (SB 215/EB 215)
Structure Number:	56-0802F
District, County, Route, PM	08-RN-215,60,91-60.7/70.6,22.0/18.5,32.7/34.7
Foundation Location:	Bent 15
Pile(s) Investigated:	Pile at Bent 15
Pile Diameter:	3650 mm (144 in)
Tested Pile Length:	20.5 m (67.3 ft)
Number of Tubes in Pile:	14
Tube(s)/Test(s) Investigated:	Tubes 13 and 14
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: Pile at Bent 15" (May 5, 2005)

Table 7-14 – Test Details from Manual Analysis ID-10

7.9.2 Description of Irregularities

This case is one of three cases of retest irregularity that involves the isolated use of an atypical testing procedure of double-transit as is described in Section 4.3.3. As the data file is known to have been saved with the probe at the bottom of the tube upon completion of all logging, this establishes a critical chronology fact for this case.

Since no corresponding RD files could be located for these tests (and, thus, no speed data), the chronological analysis required that certain testing procedures be assumed regarding the probe speed during both the non-recording down-transit and recording up-transit. Both typical and atypical procedures were considered in the analysis as detailed below. Chronological data is presented for testing of adjacent tubes to demonstrate the reasonableness of the assumptions employed.

7.9.2.1 Chronology of Testing

GGL tests were reported to have occurred in fourteen tubes in the pile at Bent 15 before noon on 5/3/2005. Chronological evidence for a representative selection of these tests (tubes 6 through 14) is summarized in Figure 7-25. The sequence of testing, file save times, and direction of recording are noted.

Figure 7-25 – Chronology of Testing for Pile at Bent 15

Testing in Tubes 1 through 12 and 14 employed typical testing procedures, as described in Section 4.2. However, for unknown reasons an atypical double-transit procedure was employed for testing of Tube 13. If typical testing procedures were used, the probe would need to be raised to the top of Tube 13 (positions 13d to 13e), repositioned onto Tube 14 (positions 13e to 14a), then lowered to the bottom of Tube 14 (positions 14a to 14b) before data could have been acquired in Tube 14 during the up-transit (position 14b to 14c). However, the chronology data indicate this was highly unlikely, and instead, data reported for Tube 14 is suspected to have been recorded on the final up-transit in Tube 13 (positions 13d to 13e).

Three alternative chronological scenarios were considered for where and how data reported for Tube 14 may have actually been recorded. Two consider alternative procedural scenarios assuming no retesting had occurred. The third considers the suspected retest scenario where the data reported for Tube 14 actually came from Tube 13. Timelines are presented for each scenario.

7.9.2.2 Scenario of Recording at the Typical Rate of 15 fpm

Figure 7-26 presents the timeline assuming testing occurred as reported and the typical probe rate of 15 fpm was used for the recording transits (red arrows). Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as tube 14 is located at position 14c. Based on time stamps, the time interval between positions 13d and 14c is known to be 6 minutes and 34 seconds. The fastest time required to record data from position 14b to 14c using typical procedures is 5 minutes and 01 seconds assuming the probe speed was 15 fpm while in concrete (67 ft) and 52 fpm while above concrete (28.5 ft). This leaves 1 minute and 33 seconds for the probe to be moved from position 13d to 14b.

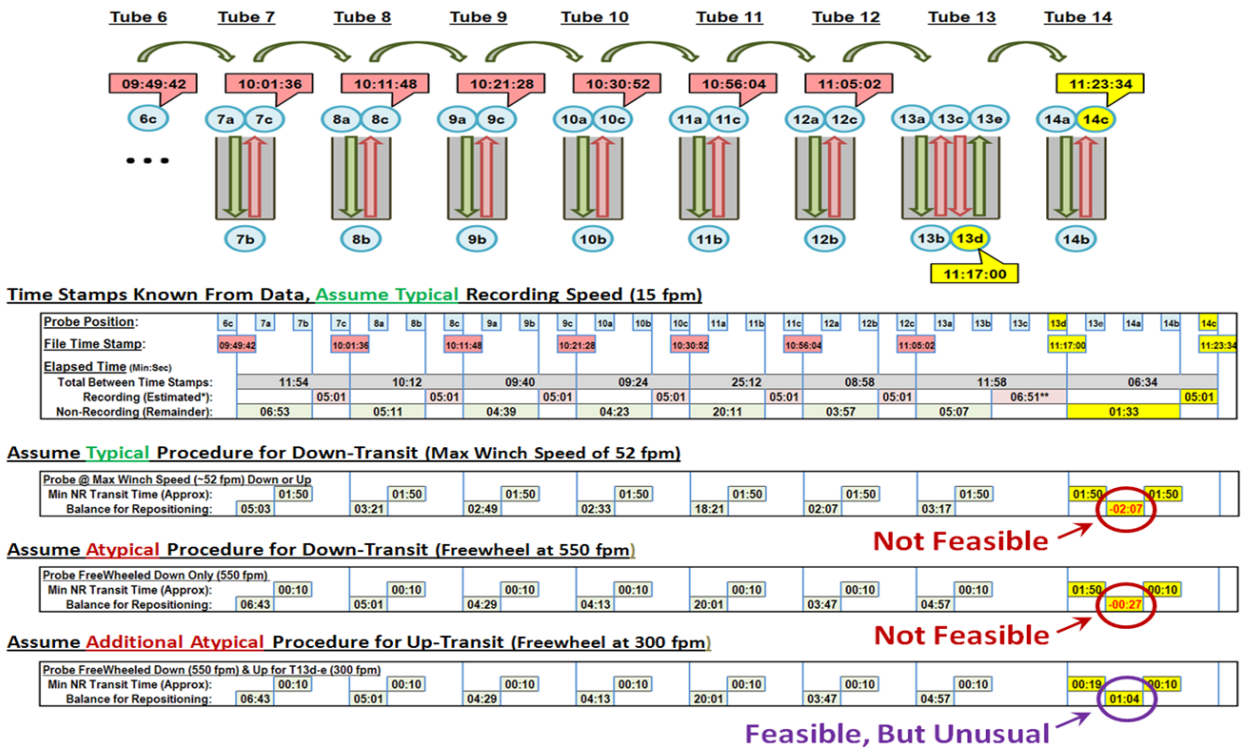


Figure 7-26 – Recording at Typical Rate of 15 fpm for Pile at Bent 15

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 13d-to-13e and 14a-to-14b) as discussed below:

- Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 98.5 feet, approximately 1 minute and 50 seconds is required for each non-recording transit. Therefore, a total of 3 minutes and 40 seconds would be required just for the transits. This exceeds the 1 minute and 33 seconds available by approximately 2 minutes and 7 seconds, without

considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). This scenario is physically infeasible.

- The first of two scenarios involving atypical procedures assumes the probe was disengaged from the winch and allowed to free-wheel on the downward non-recording transit (i.e. positions 14a to 14b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 10 seconds. Assuming the winch is used to raise the probe, a total of 2 minutes is required for the transits. However, this exceeds the 1 minute and 33 seconds available by approximately 27 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). Thus, this scenario is also physically infeasible.

- The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on both the upward and downward non-recording transits (i.e. positions 13d-to-13e and 14a-to-14b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 19 seconds, and total time for both non-recording transits could be reduced to 29 seconds. Under these assumptions, a positive 1 minute and 4 seconds is available for repositioning the probe to the new tube (i.e. positions 13e to 14a). While this is physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

7.9.2.3 Scenario of Recording at an Atypical Rate of 20 fpm

Figure 7-27 considers the same three operational scenarios as those discussed above except, in addition, that an atypical probe speed of 20 fpm, rather than 15 fpm, is assumed while the probe was in concrete for the recording transits (red arrows). In this scenario, a total of 3 minutes and 54 seconds is required to complete the up-transit in tube 14 (i.e. position 14b to 14c), thus leaving 2 minutes and 40 seconds available for the probe to be moved from position 13d to 14b.

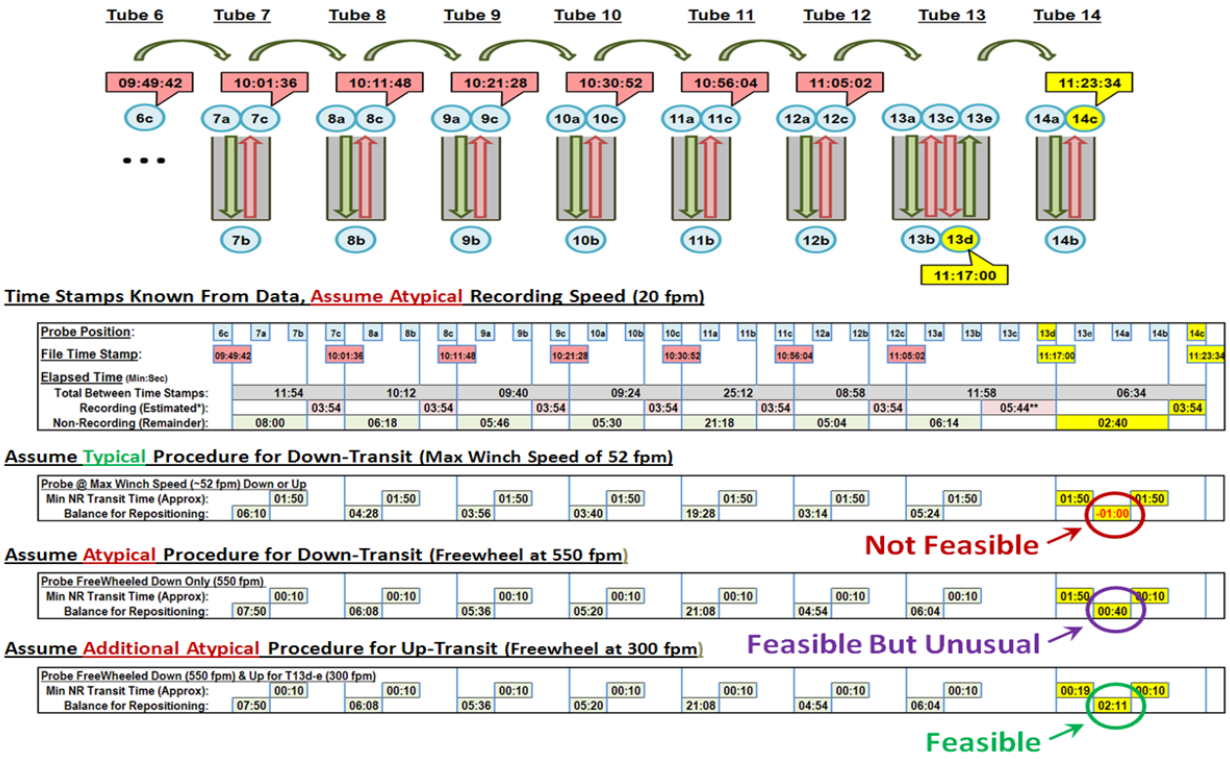


Figure 7-27 – Recording at Atypical Rate of 20 fpm for Pile at Bent 15

The three operational scenarios for the non-recording transits are discussed below:

- The first scenario assumes the winch is engaged for both non-recording transits. Again assuming a typical maximum winch speed of 52 fpm, approximately 1 minute and 50 seconds is still required for each non-recording transit (i.e. positions 13d to 13e, and 14a to 14b). The total of 3 minutes and 40 seconds required for just the transits exceeds the 2 minutes and 40 seconds available by approximately 1 minute, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). Thus, this scenario is also physically infeasible.

- The next scenario considered combined use of two atypical procedures where both a recording speed of 20 fpm is assumed and the probe is allowed to fall the full length of tube 14 under free-wheel conditions. Under these assumptions, a positive 40 seconds is available for repositioning the probe to the new tube (i.e. positions 13e to 14a). While this is physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

- The final scenario to account for the reported test location considered combined use of all three atypical procedures: the recording speed is 20 fpm, the probe is free-wheeled on the down-transit at 550 fpm and also free-wheeled (i.e. manually pulled) on the up-transit at 300 fpm. Under these assumptions, a positive 2 minutes and 11 seconds is available for repositioning the probe to the new tube (i.e. positions 13e to 14a). This time interval is clearly feasible and approaches those observed at this site for other tests

using typical procedures. However, the GamDat team considered the potential for sudden and isolated change in all three operational procedures for this single test to be unrealistic.

7.9.2.4 Retest Scenario

Figure 7-28 presents a timeline for the suspected scenario where data reported for Tube 14 actually came from Tube 13 (recorded from positions 13d to 13e) and normal testing procedures are used.

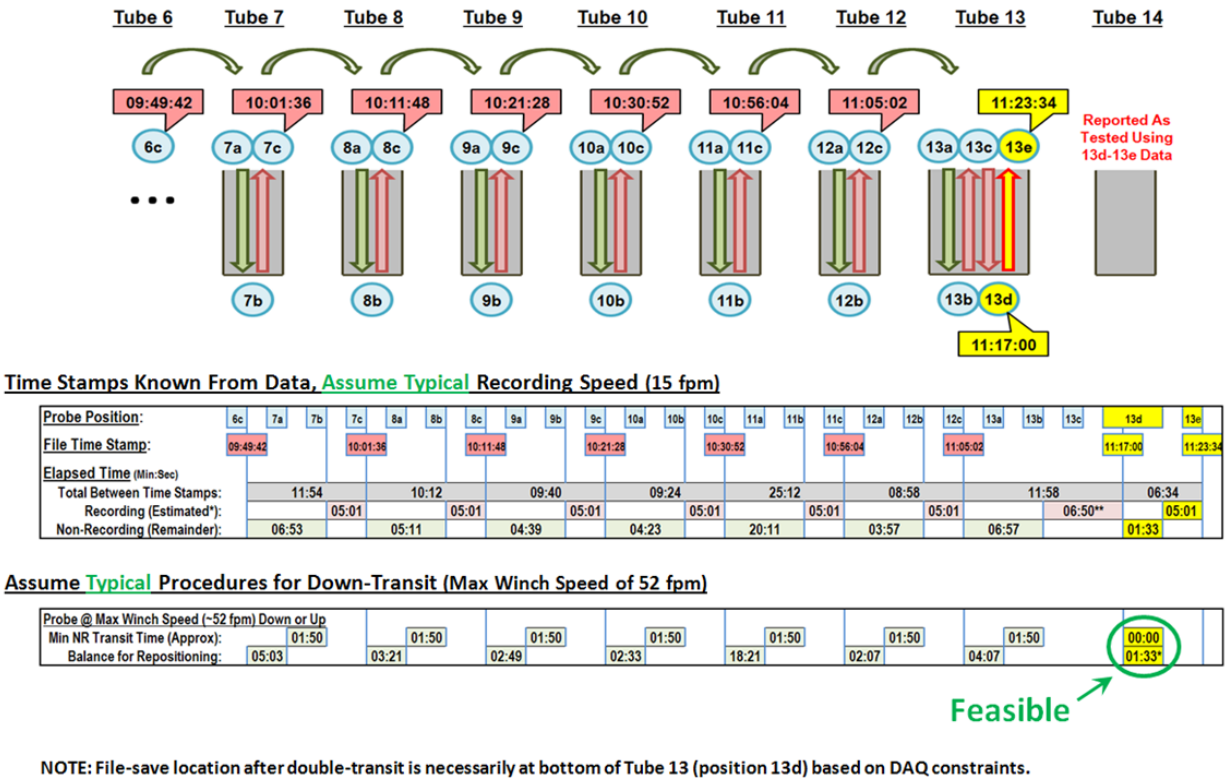


Figure 7-28 – Retest Scenario for Pile at Bent 15

Physically, this scenario eliminates the need for repositioning the equipment to the bottom of Tube 14, and the only tasks required to be completed within 1 minute and 33 seconds in non-recording time available is to initialize the *MSLog* software for recording. Experienced GamDat team members estimate that on the order of 15 seconds is required to complete this task. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

Prototype correlation analyses carried out for this scenario are presented in the Manual Analysis documents in Appendix P: Manual Analysis Documentation.

7.9.3 Conclusions

The GamDat team considered the retest scenario to most reasonably account for the observed chronological facts, and based on chronological evidence alone, concluded that it is plausible that results reported for Tube 14 were actually retest data obtained in Tube 13.

7.9.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for Tube 14 at Bent 15.

7.10 Irregular Testing Chronology Indicating Plausible Retest at Lake Hodges Bridge, Abut 6, Pile 1 (Manual Analysis ID-11)

This case presents a plausible instance of an improper retest, where it is suspected that data acquired during a retest of one tube was reported as independent data for another tube. The existence of the irregularity is based primarily on chronological evidence whereby it was physically infeasible to complete testing as reported using typical procedures within the constraints of documented chronological facts, while the suspected retest is fully consistent with these same facts. Consideration was given to alternative testing scenarios involving use of three atypical procedures (i.e. free-wheel down-transit, free-wheel up-transit, and faster recording speed), but all of these were found to be physically infeasible when considered separately. Additional scenarios were considered involving various combinations of the atypical procedures. Only the combined use of all three atypical procedures yielded equipment-repositioning time intervals approaching those observed at this site for other tests using typical procedures. The GamDat team considered the potential for sudden change in all three operational procedures for this single test to be unrealistic. Therefore, the most reasonable explanation which could be identified by the GamDat team to account for documented chronological facts is the suspected retest.

7.10.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-15.

Attribute	Description
Structure Name:	Lake Hodges Bridge
Structure Number:	57-1134 R
District, County, Route, PM	11- SD -15-M38.7JM42.7
Foundation Location:	Abutment 6
Pile(s) Investigated:	Pile 1
Pile Diameter:	1400 mm (55 in)
Tested Pile Length:	24.9 m (81.7 ft)
Number of Tubes in Pile:	4
Tube(s)/Test(s) Investigated:	Tubes 1 and 2
Reference GGL Report:	"Gamma-Gamma Logging Acceptance Test Results: Piles 1-5 at Abutment 6" (January 27, 2005)

Table 7-15 – Test Details from Manual Analysis ID-11

7.10.2 Description of Irregularities

This case is one of three cases of retest irregularity that involves the isolated use of an atypical testing procedure of double-transit described earlier in Section 4.3.3. As the data file is known to have been saved with the probe at the bottom of the tube upon completion of all logging, this establishes a critical chronology fact for this case.

Since no corresponding RD files could be located for these tests, the chronological analysis required that certain testing procedures be assumed regarding the probe speed during both the non-recording down-transit and recording up-transit. Both typical and atypical procedures were considered in the analysis as detailed below. Chronological data is presented for testing of adjacent tubes to demonstrate the reasonableness of the assumptions employed.

7.10.2.1 Chronology of Testing

GGL tests were reported to have occurred in four tubes of each of four piles at Abutment 6 before noon on 1/20/2005. The testing sequence progressed from high-numbered piles to low-numbered piles. Chronological evidence for a representative selection of these tests in Pile 2 (Tubes 1-4) and Pile 1 (Tubes 1-4) is summarized in Figure 7-29. Sequence of testing, file save times, and direction of recording are noted.

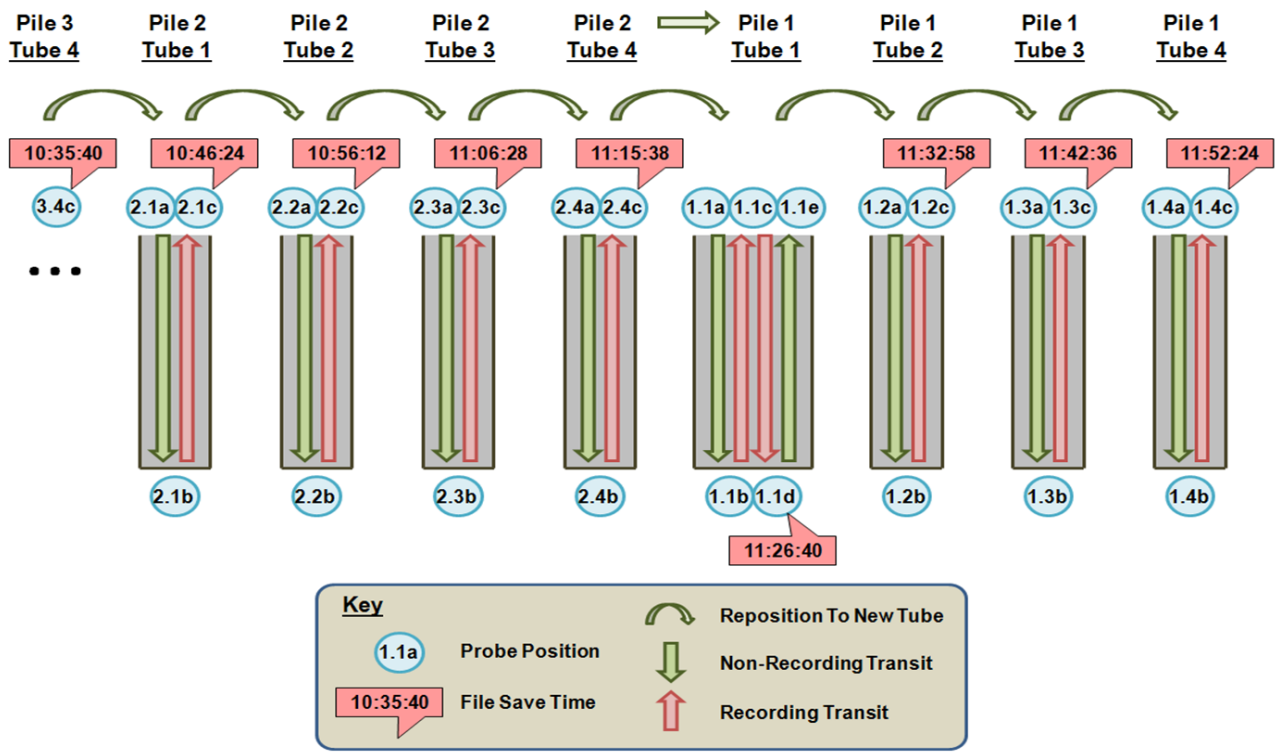


Figure 7-29 – Chronology of Testing for Piles at Abutment 6

Testing in all tubes at this site except Pile 1, Tube 1 employed typical testing procedures, as described in Section 4.2. However, for unknown reasons an atypical procedure was employed for testing of Tube 1 in Pile 1. If the typical testing procedures were used, the probe would need to be raised to the top of Tube 1 (positions 1.1d to 1.1e), repositioned onto Tube 2 (positions 1.1e to 1.2a), then lowered to the bottom of Tube 2 (positions 1.2a to 1.2b) before data could have been acquired in Tube 2 during the up-transit (position 1.2b to 1.2c). However, the

chronology data indicate this was highly unlikely, and instead, data reported for Tube 2 is suspected to have been recorded on the final up-transit in Tube 1 (positions 1.1d to 1.1e).

Three alternative chronological scenarios were considered for where and how data reported for Pile 1 Tube 2 may have actually been recorded. Two of these consider alternative procedural scenarios assuming no retesting had occurred. The third considers the suspected retest scenario where the data reported for Tube 2 actually came from Tube 1. Timelines are presented for each scenario.

7.10.2.2 Scenario of Recording at the Typical Rate of 15 fpm

Figure 7-30 presents the timeline assuming testing occurred as reported and the typical probe rate of 15 fpm was used for the recording transits (red arrows). Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as tube 2 is located at position 1.2c. Based on time stamps, the time interval between positions 1.1d and 1.2c is known to be 6 minutes and 18 seconds. The fastest time required to record data from position 1.2b to 1.2c using typical procedures is 5 minutes and 24 seconds assuming the probe speed was 15 fpm while in concrete (80 ft) and 52 fpm while above concrete (3 ft). This leaves 54 seconds for the probe to be moved from position 1.1d to 1.2b.

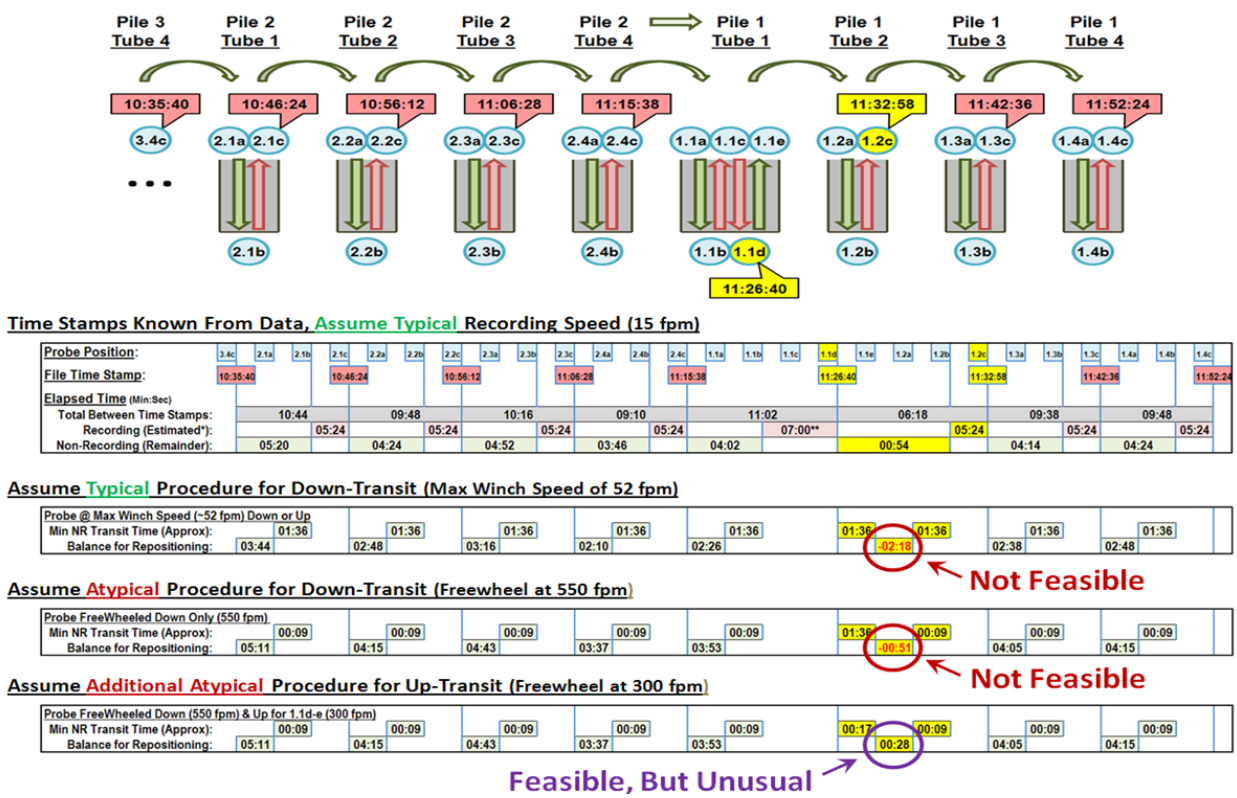


Figure 7-30 – Recording at Typical Rate of 15 fpm for Piles at Abutment 6

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 1.1d-to-1.1e and 1.2a-to-1.2b) as discussed below.

- Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 83 feet, approximately 1 minute and 36 seconds is required for each non-recording transit. Therefore, a total of 3 minutes and 12 seconds would be required just for the transits. This exceeds the 54 seconds available by approximately 2 minutes and 18 seconds, without considering the additional time required for repositioning the probe to a new tube (1.1e to 1.2a). This scenario is physically infeasible.

- The first of two scenarios involving atypical procedures assumes the probe was disengaged from the winch and allowed to free-wheel on the downward non-recording transit (i.e. positions 1.2a to 1.2b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 9 seconds. Assuming the winch is used to raise the probe, a total of 1 minute and 45 seconds is required for the transits. However, this exceeds the 54 seconds available by approximately 51 seconds, again without considering the additional time required for repositioning the probe to a new tube (1.1e to 1.2a). Thus, this scenario is also physically infeasible.

- The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on both the upward and downward non-recording transits (i.e. positions 1.1d-to-1.1e and 1.2a-to-1.2b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 17 seconds, and total time for both non-recording transits could be reduced to 26 seconds. Under these assumptions, a positive 28 seconds is available for repositioning the probe to the new tube (i.e. positions 1.1d-to-1.1e). While this is marginally feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

7.10.2.3 Scenario of Recording at an Atypical Rate of 20 fpm

Figure 7-31 considers the same three scenarios as those discussed above except, in addition, that an atypical probe speed of 20 fpm, rather than 15 fpm, is assumed while the probe was in concrete for the recording transits. In this scenario, a total of 4 minutes and 04 seconds is required to complete the up-transit in tube 2 of pile 1 (i.e. position 1.2b to 1.2c), thus leaving 2 minutes and 14 seconds available for the probe to be moved from position 1.1d to 1.2b.

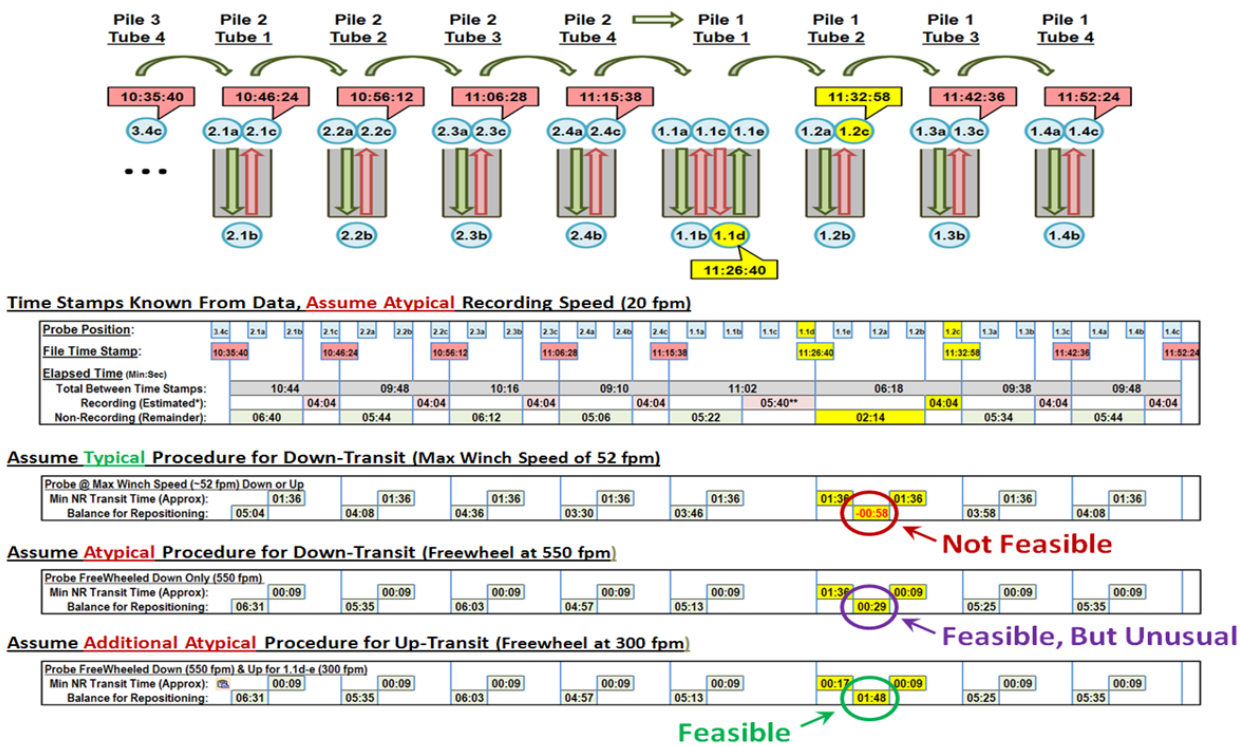


Figure 7-31 – Recording at Atypical Rate of 20 fpm for Piles at Abutment 6

The three operational scenarios for the non-recording transits are discussed below.

- The first scenario assumes the winch is engaged for both non-recording transits. Again assuming a typical maximum winch speed of 52 fpm, approximately 1 minute and 36 seconds is still required for each non-recording transit (i.e. positions 1.1d to 1.1e, and 1.2a to 1.2b). The total of 3 minutes and 12 seconds exceeds the 2 minutes and 14 seconds available by approximately 58 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 1.1e to 1.2a). Thus, this scenario is also physically infeasible.

- The next scenario considered combined use of two atypical procedures where both a recording speed of 20 fpm is assumed and the probe is allowed to fall the full length of tube 1.2 under free-wheel conditions. Under these assumptions, a positive 29 seconds is available for repositioning the probe to the new tube (i.e. positions 1.1e to 1.2a). While this is on the borderline of being physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

- The final scenario to account for the reported test location considered combined use of all three atypical procedures: the recording speed is 20 fpm, the probe is free-wheeled on the down-transit at 550 fpm and also free-wheeled (i.e. manually pulled) on the up-transit at 300 fpm. Under these assumptions, a positive 1 minute and 48 seconds is available for repositioning the probe to the new tube (i.e. positions 1.1e to 1.2a). This time interval is clearly feasible and approaches those observed at this site for other tests using typical procedures. However, the GamDat team considered the potential for sudden and isolated change in all three operational procedures for this single test to be unrealistic.

7.10.2.4 Retest Scenario

Figure 7-32 presents a chronology for the suspected scenario where data reported for Tube 2 actually came from Tube 1 (recorded from positions 1.1d to 1.1e) and normal testing procedures were used.

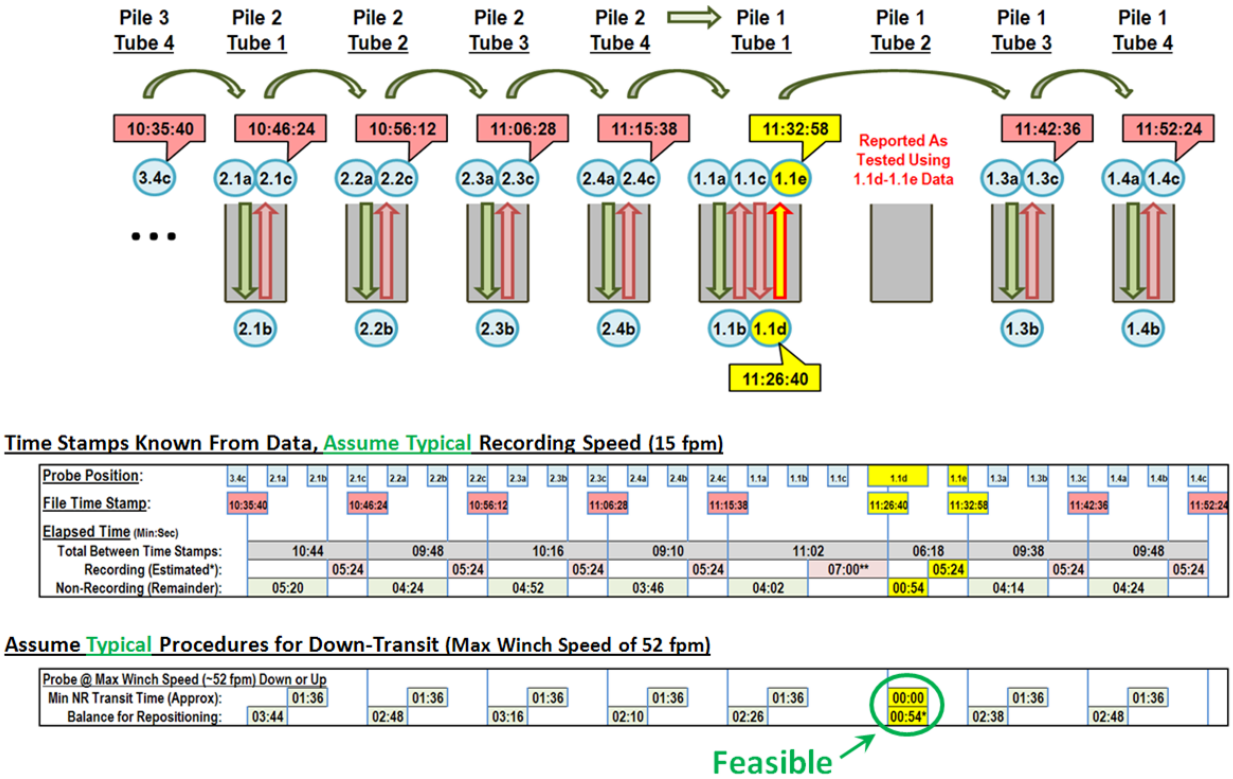


Figure 7-32 – Retest Scenario for Piles at Abutment 6

Physically, this scenario eliminates the need for repositioning the equipment to the bottom of Tube 2, and the only tasks required to be completed within 54 seconds in non-recording time available is to initialize the *MSLog* software for recording. Experienced GamDat team members estimate that on the order of 15 seconds is required to complete this task. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

Prototype correlation analyses carried out for this scenario are presented in the Manual Analysis documents in Appendix P: Manual Analysis Documentation.

7.10.3 Conclusions

The GamDat team considered the retest scenario to most reasonably account for the observed chronological facts, and based on chronological evidence alone, concluded that it is plausible that results reported for Tube 2 were actually retest data obtained in Tube 1.

7.10.4 Impacts of Findings

This irregularity results in missing and/or misrepresented data in the GGL Report for Tube 2 of Pile 1.

7.11 Plausible Retest at Benicia-Martinez Bridge, Pier 12, Pile 6 (Manual Analysis ID-33)

The depth consistency analysis flagged a group of six unrelated LAS files that had been collected in time mode in the *MSLog* software. Time mode data collection results in a recorded discrepancy between the depth information presented in the file's header and the depth information encoded with each reported measurement. Although time mode operation does not introduce data integrity issues, further evaluation is warranted due to its atypical nature and rare occurrence. During the evaluation of test files from Pier 12 Pile 6, a plausible case of a retest was identified.

7.11.1 Structure, Foundation, Pile, and GGL Test Details

Key details of the GGL test, the foundation and pile locations, and reference to the document where the test results had been originally reported are presented in Table 7-16.

Attribute	Description
Structure Name:	Benicia-Martinez Bridge
Structure Number:	28-0153 R
District, County, Route, PM	04–CC, SOL–680–40.1/41.4
Foundation Location:	Pier 12
Pile(s) Investigated:	Pile 6
Pile Diameter:	2.5 m (98 in)
Tested Pile Length:	36.7 m (120.4 ft)
Number of Tubes in Pile:	8
Tube(s)/Test(s) Investigated:	Tubes 6 and 7
Field Testing Personnel:	
Reference GGL Report:	"Gamma–Gamma Logging Acceptance Test Results: Pile 6 at Pier 12" (August 18, 2004)

Table 7-16 – Test Details from Manual Analysis ID-33

7.11.2 Description of Irregularities

In comparing data from consecutive files at Pier 12 Pile 6, a potential re-test was identified. Based on visual observation alone, the data for Tube 6 appeared to be very similar to Tube 7. The degree of similarity suggests that both data sets were collected from the same inspection pipe.

Figure 7-33 shows a 30 ft section of the pile with test results from all tubes displayed. The data presented has a 9-point moving average filter applied in order to more clearly discern trends in the data. The degree of similarity between Tubes 6 and 7 becomes evident when the differences in densities between these tests are examined and compared against the differences between other pairs of adjacent tube pairs, as shown in Figure 7-34. Correlation

analyses carried out for this scenario are presented in the Manual Analysis documents in Appendix P: Manual Analysis Documentation.

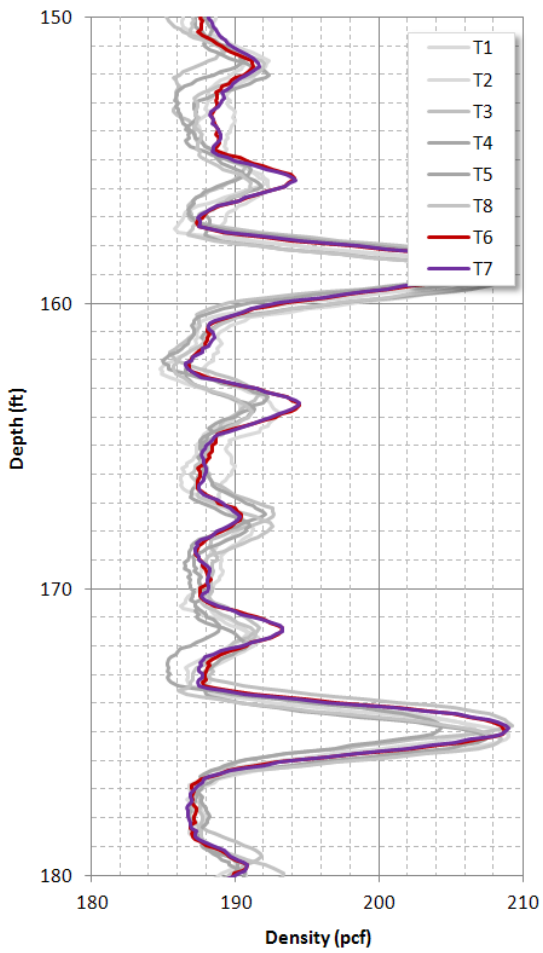


Figure 7-33 – Data From All Tubes with 9-Point Moving Average Filter Applied

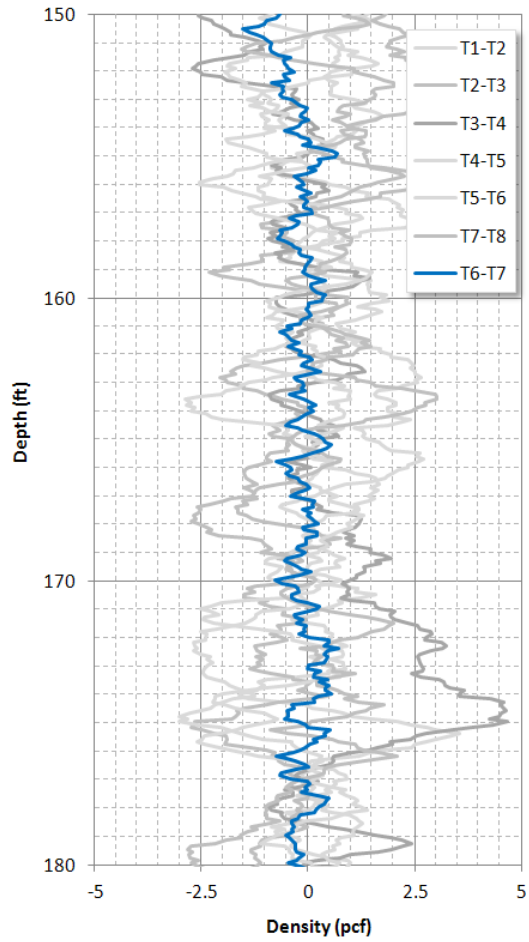


Figure 7-34 – Differences in Density Between Adjacent Tube Pairs

7.11.3 Conclusions

The comparison of data from Tubes 6 and 7 suggests that a retest of a single tube is plausible and the results used to represent two different tubes.

7.11.4 Impacts of Findings

The extent to which GGL test results are missing and/or misrepresented in the GGL Report appears to be limited to a single tube within Pile 6. The tube in question could, in theory, be any of the tubes in the pile as there is no way to determine otherwise. However, based on the practice of testing in a clockwise direction, it is likely that the tube in question is either Tube 6, 7, or 8.

8 Irregularities Unique to Chronology Analysis

The chronology analysis flagged multiple groups of files where there appeared to be insufficient time between one of more tests within a pile to acquire data using typical testing procedures. As described in Section 5.6, this analysis required that a few key assumptions be made to account for a sequence of typical testing activities. One of key assumptions in the chronology analysis is that the probe is lowered to the bottom of the inspection tube at 52 ft/min using the winch motor. As described in earlier sections, the practice of lowering the probe with the winch disengaged, sometimes referred to as free-wheeling, at 550 ft/min is anecdotally known to have been used, although the prevalence of this practice not well established. In instances where the inspection tubes are on the order of 200 to 300 ft long, the time saved by lowering at 550 ft/min versus 52 ft/min can be significant, on the order of a few minutes or more.

The time between file save timestamps in a sequence of tests is considered to be comprised of the time to move and reposition the probe, the time to lower the probe, the time to set up the data acquisition software and begin testing, and the actual time of data acquisition. For purposes of flagging file sets, a total of 30 seconds was used as the minimum time to repositioning the probe and set up the software. The 30 seconds was not considered a realistic or typical time, rather it represented a lower threshold below which it is virtually infeasible to complete testing using typical procedures, and which warranted further examination. A *time deficiency* exists when the sum of the times for the testing activities (a mix of calculated and assumed parameters) exceeds the time between file saves between two subsequent tests.

8.1 Chronology Irregularities Attributable to Probe Lowering Method

Several piles were found to have significant time deficiencies based on the chronology analysis, suggesting that the probe was lowered at a rate faster than the typical speed of 52 fpm using the winch. The GamDat team was unable to offer any other explanation for the observed timing. A summary of these observations is presented in Table 2-1.

The table presents the number of tubes in the pile, the IDs of the tubes where the time deficiencies were identified, the median depth (or length) of all of the tubes in the pile, and the median time deficiency. Additional details for each of these piles can be found in the Manual Analysis ID documentation in Appendix P: Manual Analysis Documentation.

Bridge	Foundation Location	ID	Total Number of Tubes in Pile	Tube IDs With Time Deficiency	Median Tube Length (ft)	Maximum Time Deficiency (min)
23-0212G, N680-W780 Connector OH	Bent 18, Pile 5	ID-80	5	T2,3,4,5	177	1.4
	Bent 18, Pile 4	ID-82	5	T2,3,4,5	179	1.5
	Bent 18, Pile 6	ID-92	5	T5	175	1.0
28-0153, Benicia-Martinez	Pier 14, Pile 8	ID-76	8	T3,4,5,6,7	230	3.1
	Pier 8, Pile 5	ID-87	8	T2,4,5,6,7,8	256	2.5
	Pier 8, Pile 1, Tube 4	ID-79	8	T4	289	2.0
	Pier 12, Pile 1	ID-85	8	T6	208	1.7
	Pier 16, Pile 6	ID-86	8	T3, T8	206	1.3
	Pier 10, Pile 6	ID-91	8	T7	260	2.0
	Various	ID-94	Varies	Varies	Varies	2.3
34-0006, SFOBB	T1, Pile 5	ID-88	6	T3,4,5,6	215	2.5
	T1, Pile 3	ID-89	6	T2,3,4,5	215	2.8
	T1, Pile 2A	ID-78	6	T6	214	1.1

Table 8-1 – Piles Where Faster Probe Lowering Methods (Free-Wheel) Accounts for Time Deficiencies

Characteristics common to these groups of tests:

- All piles are large diameter and considered long piles, greater than 175 ft in length, where lowering by free-wheeling would save a significant amount of time.
- Data was acquired in the depth-up mode.
- RD files were available with speed data captured every 0.1 ft.
- Two FTB staff (including technicians and engineers) were reported as present in the DFRs in at least seven of these instances. Having multiple staff working on a test further supports the notion that shorter probe moving and repositioning times may have been more feasible.
- For the piles with multiple tubes, relatively constant time deficiency of 1 to 2 minutes across most or all of the tests in the pile suggests that a specific testing practice had been used consistently for all tubes.
- Assuming a free-wheel rate of 550 ft/min, the calculated lowering time is reduced, by 2 to 3 minutes depending upon tube length. In these instances this additional time between file saves accounts for the entire calculated time discrepancy and provides a reasonable time interval to reposition the probe and setup software.

Although the GamDat Team had no independent means to confirm the probe lowering method actually used by the technician, the use of the irregular free-wheel procedure reasonably accounts for the observed time deficiencies in the chronology analysis in each of these instances. Note, as discussed in Section 5.6, the assumptions employed within the chronology analysis already discounts potential time-reductions that might be provided by retest, so the retest scenario alone cannot account for the observed time deficiencies.

The use of freewheel procedures, while considered unacceptable from an equipment operation and safety perspective, is considered to be inconsequential for purposes of this investigation since it has no impact on the reported data. Therefore, these instances were not assigned to a case because, while an irregularity exists, the impact is considered to be inconsequential.

8.2 Chronology Irregularities – Inconclusive Findings

For two piles identified through the chronology analysis, the calculated time deficiencies could not be accounted for with free-wheeling alone. A remaining deficiency on the order of 15 seconds exists in both instances. This difference can be explained by a retest in addition to free-wheeling, or the use of other atypical procedures (e.g. the probe was moved to the next tube, and the data recording stopped at the bottom). Alternatively, it is possible that the small remaining deficiency is the result of errors in the assumptions or calculations used in the chronology analysis. As the retest scenario has consequential impacts, the prototype correlation methods were applied, but results were not definitive. Overall, a definitive conclusion simply cannot be made. Complete details for each are documented in the Manual Analysis ID write-ups in Appendix P: Manual Analysis Documentation.

ID	Bridge and/or Location
ID-77	28-0153, Benicia-Martinez, Pier 15, Pile 6
ID-83	28-0153, Benicia-Martinez, Pier 14, Pile 6

Table 8-2 – Inconclusive Manual Analysis IDs

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9 Other Observed Irregularities

Over the course of the investigation, the GamDat Team identified a few instances of other unusual data or procedures that have not already been discussed. These included occurrences of null values, zero gamma counts, and time mode acquisition which were found in small groups of files in the collection.

9.1 Null Values in LAS Files

A number of LAS files were flagged by fidelity and calibration constant analysis tools due to occurrence of null values in the data. In these LAS files, null values appear in density and gamma count readings as "-999.25" as shown in the example in Figure 9-1. This value is user-defined, assigned by the Mount Sopris software, and does not represent an actual gamma count or calculated density value. As a result, no measurements of concrete density are available at the depths where null values are recorded.

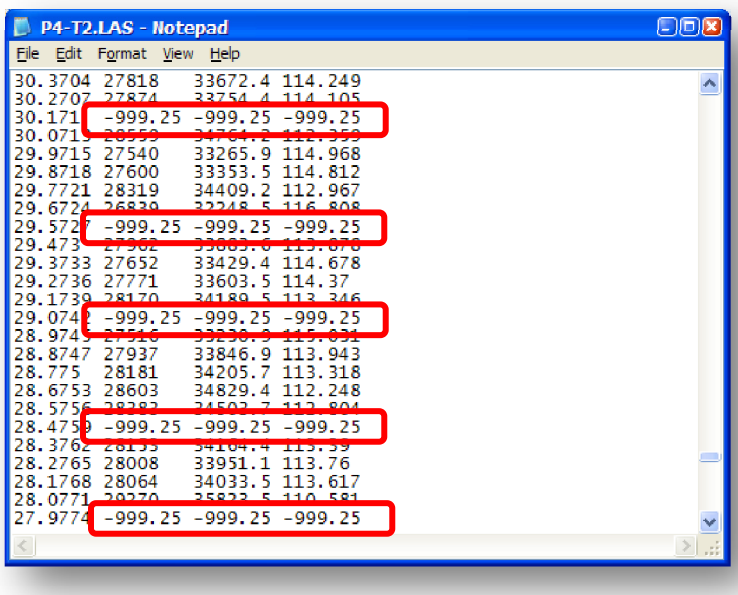

Figure 9-1 – Example of Null Values in LAS File

9.1.1 Number of Files Where Null Values Were Found

Of the 14,450 unique LAS files with data that were evaluated:

- 531 files were found to contain one or more null values.
- 52 of these files had sequences of two or more consecutive null values.
- 20 of the 52 files had sequences of 10 or more consecutive null values. Of these files, 17 were predominantly null values – that is, greater than 90% of the density values in the file were null values.

A full list of all files with null values can be found in Appendix F: Files Containing Null Values.

9.1.2 Cause of Null Values

Based on discussions with Mount Sopris technical support staff, it is the GamDat Team's understanding that null values occur and are written to the file when data buffers for the data acquisition hardware and/or computer are filled faster than the software can process. The team was able to generate null value measurements in data files by rapidly moving the data cable past the depth encoder. However, generating null values under more typical operating conditions could not be replicated.

Although the team identified one mechanism for generating null values, other technical, environmental, or operational mechanisms for introducing null values may exist, thereby limiting the scope of this aspect of the investigation. For example, equipment malfunctions or operator error may be a factor. Furthermore, we did not evaluate whether the occurrence of null values was associated with a particular time period, a particular set of testing equipment and laptop, or a particular technician. With further work, these associations could lead to a better understanding of the occurrence of null values.

9.1.3 Examination of Files with Null Values

A spreadsheet analysis tool was developed to more carefully examine the density data in the 531 files found. Using conditional formatting functions in *Excel*, density measurements within the pile's concrete could be easily discerned from measurements above the pile's top of concrete. Furthermore, the extent and frequency of null values could be assessed visually to isolate files of interest. Figure 9-2 shows the spreadsheet and analysis approach.

In the spreadsheet, 531 columns of data representing all of the files containing null values that required analysis were conditionally formatted. Density values corresponding to pile concrete were highlighted with a different color than the density values corresponding to the environment above the pile concrete. Additionally, null values were highlighted in bright red so they would visually stand out against the other highlighted density values. All of the columns of data were reviewed visually in order to determine if the null values were located within the pile, and if so, were there enough to warrant further review.

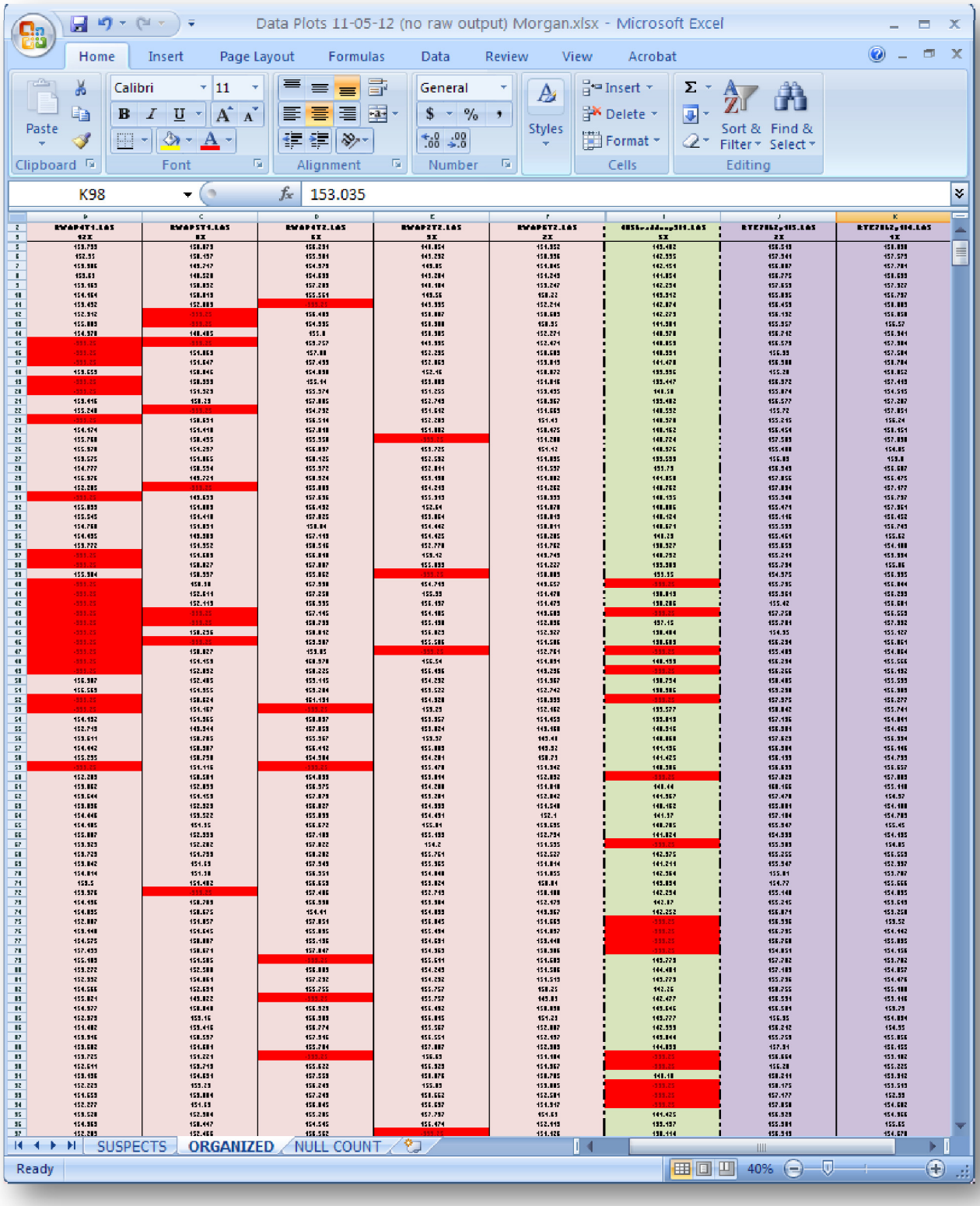

Figure 9-2 – Spreadsheet Tool to Examine Null Values in LAS Files

In most instances, null values appeared in the data above the top of the pile's concrete during high speed retrieval of the gamma probe. The occurrence of null values above the top of concrete is not considered to be consequential in the interpretation and analysis of pile integrity, and therefore was not scrutinized further by the GamDat Team. Furthermore, many of the files found had only one or a few non-consecutive scattered null values within the tested pile concrete. These files were not scrutinized further by the GamDat Team as their occurrences did not significantly impact the interpretations presented in the GGL Report.

9.1.4 Files with a Significant Number of Null Values

In total, ten data files from five projects were found to have a significant number of null values occurring within the tested section of concrete in the pile. The occurrence of a significant number of null values within the tested section is considered to be consequential in the interpretation and analysis of pile integrity. Therefore, additional investigative work was carried out on these ten files to determine how the null value data was subsequently processed.

In one of the ten files, the tube associated with the data file was retested, and the file containing null values does not appear to have been used in any subsequent analysis (SR76P9LT7DN.LAS). In another file, the null values were associated with time mode data collection on the return trip (i.e. double-transit, high speed, winch down mode) and were not used in the subsequent analysis (T1.LAS, ID-11). The occurrence of null values in these two files is considered to be inconsequential.

For the eight remaining files from three projects, the files were used in the subsequent analysis and report. A summary of these eight files is presented in Table 9-1.

Project	Foundation Location	Filename	Number of Null Values Within Concrete	Date of Test
53-RW-405-62.3, Gap Closure Wall A	Pile 2, Tube 2	RWAP2T2.LAS	17	12/20/2006 13:40
	Pile 4, Tube 1	RWAP4T1.LAS	52	12/20/2006 12:06
	Pile 4, Tube 2	RWAP4T2.LAS	25	12/20/2006 12:15
	Pile 5, Tube 1	RWAP5T1.LAS	33	12/20/2006 12:25
	Pile 6, Tube 2	RWAP6T2.LAS	15	12/20/2006 13:02
12-0199, S149-E70, Rte 149 Conn. Sep.	Bent 2, Pile 1, Tube 5	RTE70b2p1t5.LAS	17	1/25/2007 11:34
	Bent 2, Pile 1, Tube 4	RTE70b2p1t4.LAS	5	1/25/2007 11:22
53-1258, Braddock Drive UC	Pile 3, Tube 1	405braddocp3t1.LAS	21	2/27/2007 12:11

Table 9-1 – Files Found With Significant Number of Null Values in Tested Concrete

Based on a review of project records, it appears that the null values within the files were either omitted from the analysis or replaced with the mean concrete density values calculated for the pile. Although one of the eight files

contained relatively few null values (RTE70b2p1t4.LAS), it was included here because the null values were found within the same pile as another test having null values. The omission or replacement of null values in these eight files is considered consequential and may have significantly impacted the engineering interpretations presented in the GGL Report.

Although considered consequential these eight occurrences were not assigned to a case, as there were no integrity issues introduced into the GGL data file as a result of field operator actions. Rather, the issue raised through the discovery of these null values is the subsequent treatment of the null values in the GGL Report relative to testing requirements set forth in CTM-233. Further consideration of this issue was beyond the scope of the GamDat investigation.

9.2 Zero Gamma Count Samples

Zero gamma count samples were found in 26 files out of the entire collection of LAS files. These appear in LAS files for the "gam" and "gam(dtc)" reported measures, representing gamma counts in units of counts per second. An example of zero count samples in a LAS file is shown in Figure 9-3.

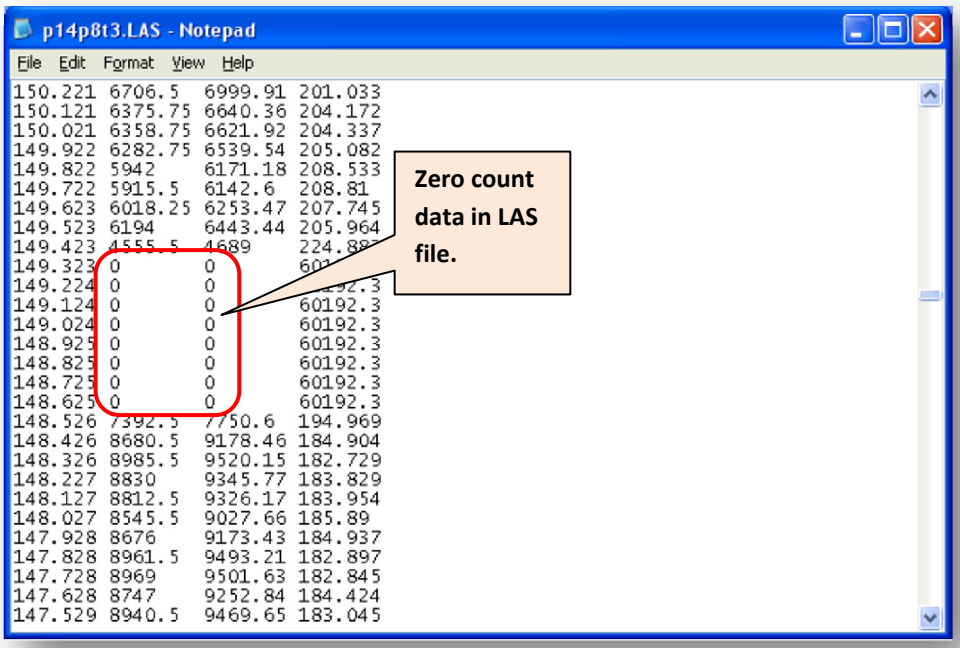

Figure 9-3 – Sequence of Zero Gamma Count Samples in LAS File

It is the GamDat Team's understanding that the cause of zero count samples is typically the result of a break in the connection between the detector in the probe and the winch with the data acquisition electronics. This can occur as a result of a failure at some point in the cable or by physically disconnecting the probe from the source/detector assembly. Cable failures at the probe head connection is common, and "reheading" the probe is part of a routine preventative maintenance practice.

9.2.1 Number of Files Where Zero Counts Were Observed

The 26 files found with zero count samples had the following characteristics:

- 6 files were comprised entirely of multiple zero gamma count samples. (e.g. "0,0,0,0,0,0,…,0,0,0")
- 11 files were comprised entirely of null values, with a single zero count sample at the beginning and end of the data and a few within the data sequence. (e.g. "0,-999.25,-999.25,…,-999.25,-999.25,0")
- 1 file was comprised of mostly null values, with a single zero gamma count sample within the data. (e.g. "…-999.25,-999.25,0,13952,-999.25,14045.5,-999.25,…")
- 7 files contained a sequence of multiple consecutive zero gamma count samples at the end of a data sequence of typical gamma count values. (e.g. "…,19581.1,17919.9,21801.4,0,0,0,0,0,0,0…")
- 1 file contained a sequence of 8 consecutive zero count samples in the middle of a larger sequence of more typical gamma count values. (e.g. "…,6443.44,4689,0,0,0,0,0,0,0,0,7750.6,9178.46,…")

A listing of the 26 files can be found in Appendix G: Files Containing Zero Gamma Count Samples.

9.2.2 Cause of Zero Counts

Files comprised entirely of zero count samples were likely collected with the probe/detector assembly physically disconnected from the cable head and winch unit. In the instances where a mixture of null values and zero count samples were observed, it appears that a partial cable failure could have resulted in the mixture of zero and null values. Files where zero counts were observed at the end of the data collection sequence could be attributed to the technician disconnecting the probe/detector from the winch unit prior to stopping the recording process. In one instance, a sequence of 8 zero count samples were observed. The details of this instance were presented as a case (and documented in Manual Analysis ID-76) in Section 7.7.

9.3 Double-Transit and Time Mode Files

LAS files collected with the MSLog software configured for time mode were found in 334 of the 14,788 unique LAS files in the collection. As previously explained in Section 4.3.3, collection of data in time mode does not by itself introduce a data integrity issue. In fact, the Mt. Sopris operating manual recommends the use of time mode when carrying out any testing where the probe is stationary (e.g. calibration, functionality, etc.). Of the files identified with time mode:

- 314 files were associated with calibration, functionality, radius of detection, and other tests not directly associated with testing CIDH piles.
- 20 files appear to be associated with production tests on CIDH piles.

Of the 20 tests identified, three became retest-irregularity cases as presented earlier in Section 7. The high percentage of retest cases associated with time-mode production tests is notable. These particular tests in time mode were also logged in double-transit (where recording of data is done in both upward and downward directions during in a single test). The capture of full timing information introduced by this operational constraint facilitated the discovery of these chronological irregularities.

10 Limitations of the GamDat Investigation

The GamDat team pursued a comprehensive analysis approach under a scope and schedule commensurate with the investigative goals. However, for some aspects of the investigative work, the team identified changes and/or improvements in analysis techniques only after months of analysis work had been carried out, and there was insufficient time to go back to try other approaches. In other instances scope and schedule constraints precluded more in-depth analysis of some investigative aspects, thereby limiting the extent to which findings and irregularities could be explained. A discussion of these limitations is presented here.

10.1 Causes of GGL Equipment Malfunction

The GamDat investigation did not pursue development of a comprehensive understanding of GGL equipment malfunction scenarios for purposes of establishing practices that minimize or eliminate use of suboptimal equipment. While clear malfunction (e.g. broken cable connection causing signal loss) is easily detected, a much more difficult problem involves equipment having an intermittent malfunction or poor function. GGL experts on the GamDat Advisory Panel offered several such scenarios including cracked detector crystal, detector crystal fogging, and minor cable degradation short of breakage. It is understood that these scenarios typically lead to a reduced gamma count, and thus a higher reported density.

The GamDat investigation encountered two instances where equipment malfunction was considered further.

- At least two records collected during GamDat testing at High Street Bridge showed small, but sustained localized drifts in reported density relative to multiple retests in the same two tubes. The drifts were on the order of a 2 pcf increase over depth ranges of 15 to 20 ft. These records were collected under routine testing conditions (i.e. depth-up mode, 12 fpm probe speed). Although not the first records of the day, they were among the earliest, and discussion with the GamDat advisory team suggests this might be attributable to crystal fogging. Probe temperature changes related to the transition from ambient air temperature to possibly much warmer conditions inside the pile may also affect reported density values. Data acquired through the remainder of the day appeared normal.

- As described in the discussion of ID-2 in Appendix P: Manual Analysis Documentation, the anomalous data (i.e. spikes and offsets) originally collected during the qualification testing of the functionality blocks is believed to be associated with having a second gamma source within the range of detection of the GGL equipment that was recording at the time. However, spikes and offsets similar to those observed could have been introduced as a result of intermittent equipment malfunction, having broader impacts. The GamDat team did not pursue an in-depth investigation into how various types of equipment malfunction manifests in the data as anomalous patterns.

Additional work in this area would have been needed in order to include an in-depth examination of equipment malfunction scenarios, identification of the early signs and symptoms of problems in equipment function and data irregularities, and examination whether current standard operating procedures and maintenance protocols provide sufficient safeguard against the potential for capture of inaccurate data. Collecting data twice for each test may facilitate early detection and mitigation of intermittent equipment malfunction issues.

10.2 Prevalence of Operational Irregularities

The GamDat investigation identified several instances of operational irregularities in past Caltrans GGL testing practices, including inappropriate retest and use of atypical testing procedures. These findings are not exhaustive, but rather only serve to provide examples of types of operational irregularities that can occur. Additional work in this area could have led to a better understanding of the prevalence of these practices and enabled more careful examination of possible impacts.

The GamDat investigation discovered example instances of operational irregularities indirectly using a combination of manual and prototype data screening and analysis techniques based largely on chronological and correlation strategies. As presented earlier in this report, these techniques had significant limitations, and a number of changes and/or improvements would be considered if the analyses were to be carried out again. These include:

- Adapt and extend the chronology analysis to more fully characterize the extent of operational irregularities. Although atypical procedures, including retest, can readily occur without triggering a chronological irregularity, test sequences having unusually short and unexplained timelines relative to other tests at the same site are candidates for further evaluation. The GamDat analysis only considered a minimum feasible time interval of 30 seconds to reposition testing equipment and initiate software, but depending upon testing conditions, this interval is more likely to be on the order of several minutes. A revised analysis that more accurately characterizes these time intervals would likely lead to more meaningful findings.

- Validate, refine, and automate the prototype correlation tools and apply them to a broader range of tests. The sigma-delta metric and alternative data interpretation schemes (i.e. Empirical, RDA) developed by GamDat were demonstrated to show significant promise for identifying many instances of inappropriate retest. However, the prototype methods were manually intensive and thereby applied to an extremely limited set of data where retest was suspected based on chronology analysis. Automation offers the potential to examine much broader portions of the data archives to better establish the prevalence of the practice of conducting inappropriate retests.

- The GamDat investigation relied solely on analysis of archival data, and detection of operational irregularities by these means is both indirect and incapable of detecting many irregularities. While additional analysis as described above has merit, a more complete strategy would include broad-based efforts to capture available information from staff familiar with practices over the time interval of concern, including surveys or interviews with staff.

10.3 Fidelity of GGL Data Through to Reported Results

The GamDat analysis tools examined the fidelity of GGL data from the point of field acquisition by a technician to delivery of data files to the engineer, but did not examine the fidelity of the same data through subsequent analysis and interpretation by the engineer and reported to the project sponsor. Nearly all mechanisms leading to a data irregularity by a technician could also occur during the engineering analysis and reporting stage. The GamDat investigation did not develop the software tools necessary to systematically evaluate GGL data as it transforms from RD to LAS files in *MSLog*, to spreadsheets in *Excel,* and finally to plotting files in *Origin*.

10.4 Unbiased Investigative Approach

All GamDat analyses were carried out as possible on all available data files obtained by the team without bias toward any particular bridge, person, or time period. This unbiased strategy was intentional as it provided the best opportunity to broadly assess GGL data integrity within the Department. Further, the GamDat team did not attempt to characterize personnel involvement, responsibility, or motive in any of the cases as these were considered beyond the data integrity fact-finding mission of the investigation. Narrower focus on any combination of these variables may have led to additional findings.

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11 Summary and Recommendations

11.1 Summary of Findings

The GamDat team completed a comprehensive and objective investigation of Caltrans' GGL test data for the presence of irregularities within the data that may indicate potential inaccurate or inconsistent reported GGL Test results. Over 23,000 data files representing distinct GGL tests were recovered from computers, network servers, and other file storage media, spanning an 18 year period from 1994 to 2011.

In total, eleven cases of significant data irregularities were identified – eight new cases in addition to the three that were previously known. These cases represent irregularities in test data collected over a four year period from 2004 to 2008. The eleven cases can be viewed as consisting of two general types:

- *Data Irregularity Cases* – Associated with alterations of originally-recorded digital data.
- *Operational Irregularity Cases* – Associated with how and where a GGL test was conducted and analyzed

The analysis methods applied by GamDat for the discovery of *data irregularities* evaluated all available GGL data from the point of field acquisition by a technician to delivery of data files to the engineer, but did not address the potential for irregularities associated with subsequent analysis and interpretation of the data performed by the engineer and reported to the Structure Representative. Four of the eight new cases are considered data irregularities. In each case, the existence of the irregularity is certain, though both the impacts and cause of the irregularity vary by case. The data alterations resulting in the cases are copy/paste/delete of blocks of recorded data, renaming of one test file to represent another test, and manual alterations to recorded data.

The analysis methods applied by GamDat for the discovery of *operational irregularities* were inherently less definitive due to the indirect nature of the detection methods. These methods could only be applied to subsets of available data. Nevertheless, the GamDat team discovered four plausible or likely cases based on operational irregularities, the most important type being the use of GGL test data acquired by retesting of one tube to represent conditions in another tube. Other potential operational irregularities include testing at an incorrect location (not the reported location) and the use of atypical testing procedures. The analysis techniques used by GamDat were incapable of detecting the incorrect location scenario, but did show evidence of atypical procedures including testing with fast probe speeds and lowering of the probe to the bottom of a tube while disengaged from the winch.

The investigative team identified specific procedures and controls that, if applied consistently, will insure the integrity of GGL data in the future.

11.2 Recommendations

Based on the experience and observations of the GamDat team, recommendations have been developed under the following three categories:

- Process improvement strategies to minimize observed data file irregularities.
- Process improvement strategies to minimize observed operational irregularities.
- Additional process improvement opportunities.

11.2.1 Process Improvement Strategies to Minimize Observed GGL Data File Irregularities

The overarching goal of all strategies aimed at minimizing data file irregularities is to assure the fidelity and traceability of GGL data throughout its life cycle from original acquisition by a technician in the field to engineer-stamped findings reported to the client. Any alterations to the data within the life cycle should be documented and justified. The following strategy is recommended:

1) **Establish procedures and implement tools to rapidly upload and deliver GGL data files (both RD and LAS) from technicians to engineers through a secure and robust web-based system.** Data communications hardware and related tools to facilitate rapid upload and secure archive of data files from remote field locations should be explored and adopted to the extent feasible.

2) **Establish procedures and implement tools for electronic archive and convenient discovery/retrieval of all GGL reports, GGL data files, and associated engineering analysis spreadsheets.** As an immediate measure, the *GeoDog* system, currently used by Geotechnical Services for archiving design phase documents and files, should be implemented as the authoritative repository of GGL Reports and related files. Further consideration of specific standards and protocols related to this implementation (e.g. file naming conventions, minimum required files, metadata, QA/QC, etc.) may be needed to assure consistency in GGL data archiving practices. A long-term strategy should consider the integration of archiving systems (e.g. GeoDOG) with data delivery systems, such as the one recommended in the above strategy with clear traceability between both.

3) **Establish data handling procedures and implement tools to minimize opportunities for data alterations that verify data integrity at each stage, and provide clear documentation of, and justification for, any alterations to the data.** As an immediate measure, the *GamDat Data Check Tool*, which applies the suite of the GamDat analyses to new data sets, should be used to check all GGL data sets collected. Standards for documenting and justifying all data alterations through the life cycle should be developed. The capabilities of the tool could be expanded to allow checking of data at later stages in the engineering analysis procedures.

11.2.2 Process Improvement Strategies to Minimize Potential Operational Irregularities

The overarching goal of all strategies aimed at minimizing operational irregularities is to assure that reproducible and excellent-quality data is acquired, and that recorded data is unambiguously tied to a specific and reproducible tube location.

A key issue considered by the GamDat team was whether the reported testing location was accurate and reproducible. Scenarios considered include either the intentional or inadvertent misrepresentation of the location where GGL Test data was acquired. This could involve using test data taken from an adjacent tube, an adjacent pile or, in the extreme, from another location altogether (Caltrans project or not). While the data analysis techniques adopted by GamDat (and also implemented in the *GamDat Data Check Tool*) can unambiguously detect copied digital data, detection of retest data is much more challenging and conclusions are less definitive. Therefore, a vitally important recommendation of the GamDat team is that the Department develop and implement improved procedures that assure the reported test location is accurate. Additionally, test procedures

and training should be strengthened to assure test data is both of excellent quality and reproducible. The following recommendations are provided for consideration:

1) **Investigate "tube tagging" to assure GGL data files can be traced to a specific test at a tube location.** Alternatives to consider include:

    a. Electronic Tagging Technology. Adopt an electronic tagging technology (e.g. RFID, barcode, QR, etc.) where tube identification is automatically captured in the GGL data file during collection. An ID tag would be placed in each gamma tube that would be read by the data logger, creating a unique and reproducible identification of each tube. Integration with existing Mount Sopris test equipment would be needed.

    b. Physical Marker. Attach GGL-detectable physical markers to the tubes (e.g. short length of insulating foam pipe wrap, short section of oversized steel pipe, etc) at unique specified locations (e.g. pre-determined, staggered depths) in all tubes in a pile that would produce artificially low or high-density spikes in the data.

    The effectiveness of any tube tagging approach may be improved by enhanced field monitoring procedures including independent witness and photographic documentation of each GGL Test location and testing time.

2) **Implement standard procedures requiring that field staff enter identifying information about the test (e.g. test location, operator, project, pile, tube, etc) prior to data acquisition using existing metadata capture features in the *MSLog* software.** The entry of a minimum set of information should be established by standard operating procedure, defined by a FTB-specific TOL file in *MSLog*, and checked by the engineer during the review of data. In current practice there has not been a requirement to enter test related information using *MSLog's* built-in features. Typically, test location and other identifying information have only been captured in filename and directory names, and these can be readily changed without leaving a trace that alteration occurred. Inclusion of location data within RD and LAS files assures that any subsequent change could be readily identified with data integrity checking tools, such as the *GamDat Data Check Tool*.

3) **Evaluate the use of time mode instead of depth-up mode as the standard data logging mode.** The time mode setting provides the capability to document a complete testing timeline when delays, direction reversals, or extremely slow probe speeds are occurring. Efficient use of time mode logged files would require development of additional processing tools. Other factors associated with time mode logging that may influence test data would also need further consideration.

4) **Establish standard allowable probe speeds within concrete during testing and prohibit free-wheeling.** Current Caltrans practice for probe speed while testing in concrete is typically 10-15 fpm, however higher speeds may be equally effective. Maximum allowable probe speeds should be established for safe operation of equipment. GamDat recommends that standard procedures be established that preclude free-wheeling the probe within the tube.

5) **Evaluate the feasibility of a new practice of collecting data twice in each tube.** Key benefits of testing each tube twice include:

a. Anomalies can be verified, thus minimizing the need to revisit a site for confirmation.

b. Intermittent equipment malfunctions can be more readily detected. Data variations caused by intermittent causes are unlikely to occur in the same location twice, thus notable differences between traces observed during data analysis would be cause to check equipment and retest the site.

c. Having retest information available for all tubes will improve capabilities to detect improper retests.

Data collection in different directions (downward and upward transits of probe) could be implemented without introducing additional steps and time in the testing process. However, the GamDat has observed poorer correlation between data sets obtained using opposing transit directions than with common transit directions. The specific implementation of this recommendation would require further consideration.

11.2.3 Additional Process Improvement Opportunities

The process improvement strategies discussed in the prior sections were focused on mitigating the potential for repeating the variety of data irregularities discovered during the GamDat investigation. This section outlines additional process improvement opportunities not directly related to observed irregularities that the GamDat team believes would also strengthen current practices. The overarching goals of these recommendations are to improve the reliability, efficiency and interpretability of GGL data analyses. Specific recommendations are:

1) **Develop a complete understanding of GGL equipment malfunction scenarios and adopt appropriate mitigation measures**. The GamDat investigation encountered instances of intermittent GGL equipment malfunction and were informed by experts on the Advisory Team of additional such scenarios. The Department should develop guidance materials which support identification of the early signs and symptoms of problems with equipment function, and add/revise operating procedures and maintenance protocols to provide sufficient safeguard against the potential for capture of inaccurate data.

2) **Standardize the processing of GGL data through the engineering analysis stage.** Current practices allow for use of many differing Excel spreadsheet formats and analysis protocols for routine data processing and analysis, where multiple tests in a pile are analyzed as a group. There appear to be opportunities to immediately improve both analysis efficiency and data traceability through the adoption of standard spreadsheet formats and automation of routine processing steps (e.g. depth alignment, data smoothing, plotting, anomaly detection, statistical calculations, etc.). For example, a spreadsheet developed by GamDat to carry out many of the basic data pre-processing steps could be adapted and extended for production use. Standardizing spreadsheets may allow for the development of a software tool that could verify data fidelity beyond what's currently possible.

   It is important to note here that automation and standardization does not eliminate the need to apply engineering judgment in the interpretation of the analysis results, but does offer opportunities to free up engineering time for interpretation rather than conducting routine data pre-processing.

3) **Consider changes to the existing data plotting formats required in CTM-233 to provide more interpretable, informative, and traceable plots of GGL data for use in engineering analysis and in final report documentation.** Current practice for data display involves plotting the raw collected GGL data as relatively large symbols. While effective at conveying broad averages for the pile and revealing anomalies, much of the information about data trends for individual tubes are indistinct. Several new ideas are provided to improve presentation of GGL data in reports:

   a. Use a single software tool. Currently, GGL data plots are prepared using *Origin* software separate from the software used to pre-process the data, *Excel*, hindering convenient traceability of plotted values appearing in a report back to an engineer's analysis spreadsheets. Adopt a single software platform that allows convenient traceability between plot and analysis. This could be readily accomplished using plotting capabilities within Excel.

   b. Apply data filtering. Smooth data to remove high-wavenumber noise prior to both analysis and charting. GamDat found use of a 9-point moving average (boxcar) filter to be effective, but examination of alternative filter designs is encouraged. Changes to CTM-233 would need to be made to support this.

   c. Remove data symbols in the plots. GamDat found that use of fine lines connecting smoothed data points, rather than symbols, aided in effective display while clearly differentiating data trends for each individual tube within a pile. Consideration should be given to use of line styles or other visual mechanisms to differentiate multiple tests in a single plot.

4) **Evaluate the role of calibration in GGL testing.** Cursory review of Caltrans' historic calibration data by GamDat suggests that systematic variations over time for a single piece of equipment were difficult to detect. It is recommended that this historic data be organized, archived, and closely examined to determine whether meaningful trends can be established with equipment age and calibration testing conditions (e.g. temperature). Findings should be compared with those that may exist in the literature as well as with the experience of the equipment manufacturer. Discrepancies should be isolated and addressed with improved calibration procedures if the current strategy of annual calibrations is to be retained. Changes to CTM-233 would need to be made as appropriate.

   Note that the fundamental need for performing calibrations might be reconsidered altogether. The calibration constants allow the fundamental GGL measurement of gamma count to be converted into a density value that has more significance to a civil engineer. While there is merit to retaining a density basis for engineering analysis and reporting, the more relevant information carried by GGL data is the uniformity of density (or counts per second) values over depth within a pile, thus indicating uniform concrete density. As this primary purpose does not require accurate density values (which can be established by other means), the fundamental need for calibrations is questionable as merely representative count-to-density conversion parameters could simply be assigned.

5) **Explore the potential of correlation analysis tools for use in establishing quality control of GGL testing procedures and operators.** The prototype sigma-delta analysis procedures developed by GamDat have established target ranges that should be achievable for controlled retests of a pile. These standards could be used as operator training targets, for periodic certification of an operator, and to evaluate the acceptability of production data where retests are routinely performed.

6) **Eliminate Field-Generated LAS Files.** Consider revising practice to have only the RD files delivered to the engineer, as it is practically impossible to alter the contents of an RD file. The engineer would be responsible for converting RD files to LAS files.

7) **Evaluate standardizing the practice of GGL testing in water-filled tubes.** Experts on the Advisory Team who conduct gamma-gamma logging reported that they do so in tubes filled with water. The current FTB requirement to dewater the gamma-gamma tubes often requires a significant effort on the construction site. Additionally, dewatering the tubes contributes to de-lamination of the tubes from the pile concrete. Once de-laminated the PVC gamma tubes can't be used for cross-hole sonic logging. The effect of water on the radius of detection, density precision and calibration would need to be evaluated.

Appendix A: Glossary of Terms

GGL Report	Reportable product of a gamma-gamma logging (GGL) investigation performed by the Foundation Testing Branch (FTB) provided to the Office of Structure Construction (OSC). Typically, one or more GGL Reports were generated for each construction project involving 'wet' CIDH piles. A single GGL Report may contain results for one or more GGL Tests (see below). A GGL Report contains information which ties each GGL Test to a specific location (tube), testing date, and construction contract. Available GGL Reports will be assembled from records maintained by OSC, FTB, and Geotechnical Services.
GGL Test	The act of collecting a unique GGL data set at a specific location (i.e. pile and tube) on a specific date for a specific purpose, the results of which were ultimately reported in a GGL Report to OSC.
GGL Data File	Any electronic data file that was either auto-generated during a GGL Test or used for subsequent analysis, interpretation, or display. Typically, a GGL Data File contains header information followed by rows of data measurements (e.g. depth, gamma count, speed, inferred density). Multiple GGL Data Files can be associated with a single GGL Test. Auto-generated files from current Mount Sopris GGL test equipment include a binary raw data (.RD) file and one or more ASCII text files (e.g. .LAS, .Txx, etc.) per test. ASCII text-based data are typically imported into software such as MS Excel for purposes of analysis and presentation in reports, thus resulting in the creation of additional analysis files (e.g. .XLS) containing results from one or more tests.
Automated Screening Tools	The software codes that were developed, tested, and executed on the collection of unique GGL data files: (1) Time Stamp, (2) Calibration Constant, (3) Depth Consistency, (4) Fidelity (RD-LAS), and (5) Pattern Matching.
Flagged Files	Files that have been identified by the suite of automated screening tools.
Irregularity	Feature or property associated with a data file (or group of data files) indicating the potential for inaccurate or inconsistent test results. This may be due to a number of factors, such as atypical operations, or inadvertent or intentional modifications to the data file(s).
Potential Irregularity	An irregularity that may or may not exist and requires review.
Certain	Level of confidence applied to "Existence of Irregularity," "Impact of Irregularity," and "Cause of Irregularity" conclusions. All data and analysis results examined clearly and unambiguously points to the conclusion. The

	assignment of this level of confidence requires unanimous concurrence of the GamDat Team.
Likely	Level of confidence applied to "Existence of Irregularity," "Impact of Irregularity," and "Cause of Irregularity" conclusions. Preponderance of data and analysis results examined points to the conclusion. The assignment of this level of confidence requires consensus of GamDat Team.
Plausible	Level of confidence applied to "Existence of Irregularity," "Impact of Irregularity," and "Cause of Irregularity" conclusions. Some data or analysis results suggest conclusion. The assignment of this level of confidence requires consensus of GamDat Team.
Consequential	The GGL Test data affects subsequent engineering analyses or a published GGL Report, or establishes an important fact for the GamDat investigation.
Inconsequential	Not consequential.
Intentional Action	The irregularity associated with the data file (or group of data files) is deliberately introduced by the knowledgeable act of a person.
Inadvertent Action	The irregularity associated with the data file (or group of data files) is not deliberately introduced by the knowledgeable act of a person. For example, the irregularity may have been introduced into the file by the data acquisition equipment, or as a result of file management or transfer actions.
Manual Analysis	An in-depth analysis of one or more flagged files for the existence, impact, and cause of an irregularity.
Case	One or more flagged files where the Manual Analysis has established that an irregularity is at least plausible and is consequential.
Time Stamp Analysis	One of the automated screening tools that uses file time stamp info and file data acquisition times as basis. This analysis is comprised of two components. In the first, *RD-LAS Time Stamp*, pairs of electronic data files are automatically generated by the data acquisition equipment during the test. File time stamps for these pairs of files are expected to be within a very short time interval. A significant time lapse between pairs could suggest that a file had been edited at a later time. In a second test, *Chronology*, the time intervals between consecutive tests within a pile are expected to be within a "normal" time interval that accounts for the physical test condition (e.g. time to setup, lower, and raise the probe). A time interval that falls short of what's physically feasible could suggest an irregularity warranting further investigation.

Irregular Testing Chronology

A group of data files within a pile that are flagged by the Time Stamp Chronology Analysis are considered to have an "irregular testing chronology" if the time interval between tests is less than a minimum time interval considered physically feasible. A feasible test chronology assumes: (1) the probe is lowered to bottom of tube at 52 ft/min (and up to 87 ft/min in some cases where substantiated); (2) the time to configure the software, enter filename, and initiate data recording is 15 seconds; and (3) the time for technician to move the probe and related equipment from a completed test on a tube to the next tube is 15 seconds. The time of data acquisition is calculated from data recorded in the file.

Calibration Constant Analysis

This is one of the automated screening tools. Data files generated by the data acquisition equipment contain both raw (gamma count) data and calculated density data. The relationship between these data is governed by a pair of calibration constants, unique to a specific gamma probe and calibration era. For each file these calibration constants can be back-calculated with regression methods using only the data found in the file and are used to recalculate the density data from raw gamma count. Discrepancies between the reported and calculated density values indicate that the data had been altered or replaced with data generated by a different probe or era.

Depth Consistency Analysis

This is one of the automated screening tools. The data acquisition equipment automatically encodes start, stop, and incremental depth parameters unique to each file. These parameters can be checked against the collected data within the same file for internal consistency. An irregularity in the consistency of the depth data could suggest that data had be altered, appended, or removed.

Fidelity Analysis

This is one of the automated screening tools. GGL data can be traced throughout its lifecycle, from original data collection in the field through to final reported results. The RD-LAS fidelity analysis conducted under auspices of GamDat considered only the fidelity of the raw gamma count measurements between the two field-collected files. That is, the analysis checked that the sequence of raw gamma counts in the RD file were the same as the raw gamma counts written to the LAS file.

Pattern Matching Analysis

This is one of the automated screening tools. Repeated sequences of density measurements, both within a single GGL Data File and/or across the collection of all GGL Data Files (of the same type), indicates a significant irregularity. This is because the recorded data precision includes a certain level of random noise that would be difficult to reproduce over significant depth intervals. The analysis considered pattern matching across all available LAS and LS files. As an extension to the pattern matching approach, instances of full pattern matches (i.e. file was renamed) were also identified.

Appendix B: GamDat Team Charter

Caltrans California Department of Transportation

"GAMDAT" TEAM CHARTER
GAMMA-GAMMA LOGGING DATA INTEGRITY REVIEW TEAM

CHARTER ITEM	ITEM DESCRIPTION
REVIEW FOCUS	• Conduct comprehensive fact finding and technical analyses needed to establish a level of confidence regarding the integrity of Gamma-Gamma Logging (GGL) data collected by the Caltrans Foundation Testing Branch (FTB) over time. • Identify and document all evidence of irregular or manipulated GGL data. • Conduct the review in a fully transparent manner with advice and review of external stakeholders. • Identify opportunities to strengthen goals for Caltrans' management of GGL data integrity. • Develop a report of findings and recommendations for Caltrans' Structure Policy Board.
BACKGROUND	On December 6, 2011, at the request of Caltrans' Structure Policy Board, a team of Caltrans engineers was assembled and tasked with reviewing the integrity of the Department's archives of GGL data. This comprehensive technical review process was initiated in response to concerns regarding the handling of evidence of data falsification which occurred in September 2008, and subsequent public disclosure and legislative oversight hearings which occurred in November 2011.
PROPOSED TASKS	The proposed work plan is broadly summarized at the task title level here. Key terms appear in Appendix A, and an expanded work plan appears in Appendix B. • Task 1 – Work Planning • Task 2 – Data Capture Procedures for GGL Reports, GGL Tests, and GGL Data Files • Task 3 – Data Compilation from Multiple Sources • Task 4 – Analysis of Data Completeness • Task 5 – Automated Screening Analyses of All Available GGL Tests for Potential Irregularities • Task 6 – Manual In-Depth Integrity Analyses of Data Sets Showing Potential Irregularities (As Needed) • Task 7 – Final Report and Briefings
DESIRED OUTPUTS/ DELIVERABLES	Final report, written at a level understandable by the informed public, which is accepted by both the Advisory Team and Sponsors. The report will address the following topics: • Technical and procedural background needed to understand report findings; • Description of automated and manual methods used to discover and characterize potential irregularities in GGL data; • Findings regarding the completeness of available data; • Findings regarding both the occurrence and characterization of all potentially irregular data; • Recommendations regarding goals for future management of GGL data integrity.
TIMES FRAMES	This investigation will proceed at a focused pace as consistent with maintaining full diligence regarding the quality and integrity of results. The time frame will be constrained by several organizational dependencies and the input of the Advisory Team.
COSTS	A draft cost estimate is detailed in Appendix E.
TEAM MEMBERS	The overall project team will consist of two entities. The *Investigative Team* will be involved in day-to-day task management and technical work involving data compilation, analysis and documentation. The *Advisory Team* will be knowledgeable stakeholders, both internal and external to Caltrans, who will provide guidance, advice and review through both periodic and ad hoc meetings with the Investigative Team.

December 21, 2011

	Investigative Team Members: **Loren Turner** (Chair), Division of Research & Innovation **Craig Hannenian**, Geotechnical Services **Michael Morgan**, Structure Construction **Cliff Roblee**, Division of Research & Innovation **Jason Wahleithner**, Geotechnical Services **Yang Zhu**, Federal Highway Administration Advisory Team Members: **Emilio Flores,** Caltrans Office of Audits and Investigations **Sarah Skeen**, Federal Highway Administration **TPF Project Panel,** Approximately 8 Technical Experts from Industry, Government & Academia
COORDINATION WITH RELATED EFFORTS	The GamDat Team will work in parallel with other review and investigative efforts underway, sharing data and findings as relevant to common interests. Delegation of work is described in Appendix F. • **Toll Bridge Program Peer Review Examination of Impacts,** Liaison: Brian Maroney, Deputy Toll Bridge Program Manager • **FHWA-Led TPF Review of Foundation Testing Practices**, Liaison: Bill Forrester, Director of Infrastructures • **Caltrans Audits and Investigations FTB Review**, Liaison: Emilio Flores, Staff Management Auditor • **Case-Specific GGL Test Review Team**, Liaison: Shira Rajendra, Chief, Office of Geotechnical Support (see Appendix F)
ADDITIONAL RESOURCES/ DEPENDENCIES	• **FHWA:** Continuation of MOU for services of Yang Zhu to assist with IT aspects of data analysis. • **Caltrans HQ-IT:** Provide secure server for storage database and data files. Provide copies of all available GGL Data Files currently maintained, archived, or imaged as part of investigations. • **Caltrans Office of Structures Construction or other appropriate DES Office:** Inventory, metadata, and scans of all available GGL Reports. • **Caltrans Office of Audits and Investigations:** Inventory, metadata, and scans of all available GGL Reports, copies of all available GGL Data Files, and data obtained for all Nuclear source sign-out logs. • **Geotechnical Services & Foundation Testing Branch:** Inventory of all relevant hard drives containing GGL Data Files. Inventory, metadata, and scans of all available GGL Reports not yet contained in GeoDOG. • **Forensic-Level Data Recovery:** For recovery of current and erased data as possible. • **Advisory Team Support:** Support for required travel and nominal stipends to offset the cost of participation for non-governmental members of advisory team.
SPONSORS	**Barton Newton,** State Bridge Engineer, Deputy Division Chief, Structure Policy & Innovation **Philip J. Stolarski**, State Materials Engineer, Deputy Division Chief, Material Engineering Testing Services and Geotechnical Services

This charter is approved by the Investigative Team members and the Sponsors:

12-21-11

Barton Newton, State Bridge Engineer, Deputy Division Chief, Structure Policy & Innovation — Date

12-21-11

Philip J. Stolarski, Deputy Division Chief of Material Engineering Testing Services and Geotechnical Services — Date

Appendix A: Key Terms

GGL Report Reportable product of a gamma-gamma logging (GGL) investigation performed by the Foundation Testing Branch (FTB) provided to the Office of Structure Construction (OSC). Typically, one or more GGL Reports were generated for each construction project involving 'wet' CIDH piles. A single GGL Report may contain results for one or more GGL Tests (see below). A GGL Report contains information which ties each GGL Test to a specific location (tube), testing date, and construction contract. Available GGL Reports will be assembled from records maintained by OSC, FTB, and Geotechnical Services.

GGL Test The act of collecting a unique GGL data set at a specific location (pile and tube) on a specific date for a specific purpose, the *results of which were ultimately reported* in a GGL Report to OSC.

GGL Data File Any electronic data file that was either auto-generated during a GGL Test or used for subsequent analysis, interpretation, or display. Typically, a GGL Data File contains header information followed by rows of data measurements (e.g. depth, gamma count, speed, inferred density). Multiple GGL Data Files can be associated with a single GGL Test. Auto-generated files from current Mount Sopris GGL test equipment include a binary raw data (.RD) file and one or more ASCII text files (e.g. .LAS, .Txx, etc.) per test. ASCII text-based data are typically imported into software such as MS Excel for purposes of analysis and presentation in reports, thus resulting in the creation of additional analysis files (e.g. .XLS) containing results from one or more tests.

Appendix B: Expanded Work Plan

- **Task 1 – Work Planning**
  - Obtain sponsor approval for work scope (via this charter).
  - Establish members of Investigative and Advisory Teams.

    MILESTONE: Agreement with Sponsors on basis to proceed with investigation.

- **Task 2 – Data Capture Procedures for GGL Reports, GGL Tests, and GGL Data Files**
  - Identify sources of relevant data (draft list presented in Appendix C).
  - Establish data model/dictionary for database (draft entity-relationship diagram presented in Appendix D).
  - Establish secure server on Caltrans network for compilation and analysis of all relevant data sources, and for file sharing amongst the project team.
  - Establish both organizational and technical protocols for transfer of needed data from each data source.

    MILESTONE: Agreement with Data Sources on basis to proceed with secure data compilation.

- **Task 3 – Data Compilation from Multiple Sources**
  - Collect all available data from all sources using defined protocols. It is recognized that duplicate copies of most data is likely to be captured through this process.
  - Establish a comprehensive master list in the database of all available *unique* GGL Tests. This will involve extraction of metadata from all collected GGL Reports and reconciliation of any duplicate records of tests.
  - Populate database with records of all available GGL Data Files.
  - Develop file assignment criteria to relate each GGL Data File record to a specific GGL Test record. Note that this is anticipated to be a challenging task and may require numerous iterations of criteria development and testing.
  - Establish the set of *unique* GGL Data File records associated with each specific GGL Test through identification of duplicate instances of GGL Data Files. Instances of duplicate GGL Data Files will be determined using a variety of file comparison methods, including ASCII character comparison, file check-sum matching, file size comparison, and other methods to be identified.

    MILESTONE: Populated database of all available 'GGL Tests', all available 'GGL Data Files', and associations between each unique File and Test.

- **Task 4 – Analysis of Data Completeness**
  - Establish the presence and type (i.e. RD, LAS, Txx, XLS, etc.) of all unique GGL Data Files associated with each specific GGL Test. The existence of multiple unique files of any single type is criteria to flag the GGL Test as having "potential irregularities" (see task 5).
  - Assess the overall availability of GGL Data Files of each type relative to the GGL Tests.
  - Characterize the completeness of GGL Data Files for all available GGL Tests relative to both records retention standards of the day and current standards. For example, current standards require archive of both auto-generated files (i.e. RD and LAS or Txx) and analysis files (i.e. XLS), but early standards did not.
  - Prepare an interim report summarizing data completeness in the context of relevant policies, procedures and technologies that existed over various time periods.

    MILESTONE: Interim report on findings from data completeness analysis.

- **Task 5 – Automated Screening Analyses of All Available GGL Tests for Potential Irregularities**
  - Develop, test, and execute a suite of automated screening scripts to evaluate each electronic GGL Data File for data integrity. These scripts may include, but are not limited to:

Type of Analysis	Description
Time Stamp	Identify inconsistencies in file dates associated with each GGL Test.
Calibration-Constant	Identify inconsistencies in inferred density values relative to gamma count values within a single GGL Test.
Depth-Consistency	Identify inconsistencies between depth ranges identified in the file header relative to data rows for a single GGL Data File.
Fidelity	Verify the fidelity of reported depth-density value pairs throughout all unique GGL Data files associated with each individual GGL Test. Identify inconsistencies not associated with normal data processing procedures.
Pattern-Matching	Look for occurrences of repeated data patterns both within a single GGL Data File and across GGL Data Files associated with all unique GGL Tests.

  - Prepare an interim report that identifies and characterizes the subset of all available data that shows any indication of potential irregularities using the data completeness or automated screening criteria.
    MILESTONE: Interim report on findings from automated screening analyses.

- **Task 6 – Manual In-Depth Integrity Analyses of GGL Tests Showing Potential Irregularities (As Needed)**
  - To the extent reasonable, *as defined by the Advisory Team and Sponsors*, the Investigative Team will manually analyze each potentially irregular GGL Test for additional information that may, or may not, explain reasons for observed irregularities. This analysis may include:

Type of Analysis	Description
Data Lifecycle	Construct, to the degree possible, the timeline of data collection and transfer, along with the associated data integrity, over the full GGL measurement lifecycle from request to reported results.
Data Cross-Check	Compare of potentially irregular data with adjacent data (GGL and/or crosshole sonic) for the presence of distinct differences.
Categorization	Categorize the irregularity based on characterization and possible range of explanations.

  - Prepare an interim report summarizing findings from in-depth analyses performed on any GGL Test.
    MILESTONE: Interim report on findings from manual in-depth integrity analyses.

- **Task 7 – Final Report and Briefings**
  MILESTONE: Acceptance and distribution of final report.

Appendix C: Preliminary List of Data Sources

To establish master list of GGL Tests from comprehensive inventory of GGL Reports:

- *Office of Structures Construction* – Potentially complete set of GGL Reports for CIDH Pile construction and mitigation (paper files) maintained with construction contract records.
- *Division of Audits and Investigations* – GGL Reports (paper files in "red folders") maintained by the Foundation Testing Branch.
- *Geotechnical Services, "Bridge Files"* – GGL reports (paper files) pending scanning into GeoDOG.
- *GeoDOG* – Scanned subset of GGL Reports (electronic image files) maintained in Geotechnical Services' archives.
- *Foundation Testing Branch* – GGL reports (paper files).
- *Office Engineer's Bid Item List* - Investigate the availability of lists of projects that included CIDH piles as a bid item.
- *Electronic Sources* – see below.

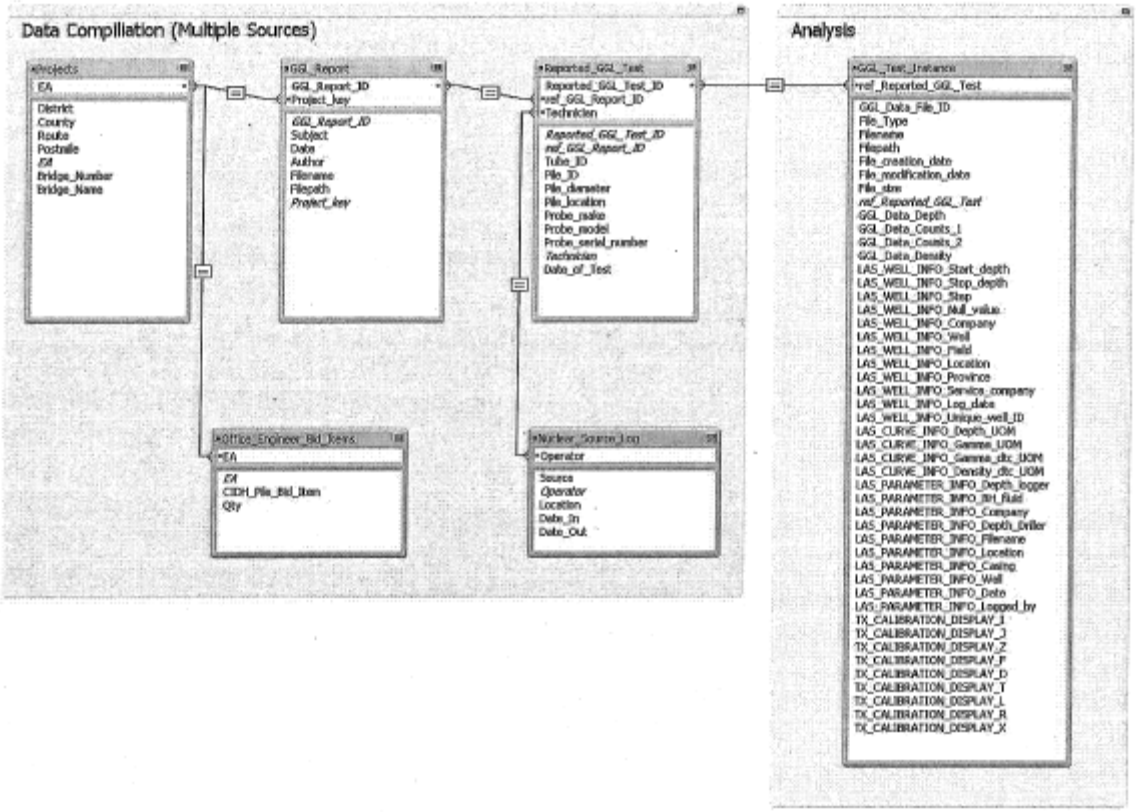
To capture all available GGL Test Files (.RD, .LAS, .Txx, .XLS, etc) for each GGL Test:

- *FTB server (managed by HQ-IT)* – Obtain current and backup server images from HQ-IT.
- *FTB Staff workstations* – Obtain hard drive images from HQ-IT for FTB technician and engineer computers.
- *FTB Field Computers (Toughbooks)* – Obtain hard drive image of each.
- *FTB Functional Backup Hard Drives (both Current and Decommissioned)* – Obtain image of each.
- *FTB Non-Functional Hard Drives* – Have commercial data recovery service conduct forensic-level image recovery of current and erased data as possible on corrupted hard drive.
- *Other Sources* – Conduct outreach to FTB stakeholders to identify other possible sources of data.

To capture information that may be needed to construct data lifecycle timelines for in-depth analysis (Task 6):

- *FTB Workload Assignment Database* – Obtain databases used by FTB staff in daily assignment and tracking of projects, if available.
- *Nuclear Source Sign-Out Logs* – Obtain spreadsheets and other relevant data recently compiled by Audits & Investigations. Provides names, dates, times, and locations for check in/out of gamma radiation source.

Appendix D: Preliminary Entity-Relationship Diagram of Project Database



Appendix E: Cost Estimate

A preliminary estimate of costs, per month over the duration of the effort, are presented below for the project team members. The PY costs, stipends, and travel costs represent very crude estimates.

	Monthly FTE	Stipend/Services	Travel
Investigative Team Members:			
Loren Turner (Chair), Division of Research & Innovation	70%		
Craig Hannenian, Geotechnical Services	50%		
Michael Morgan, Structure Construction	70%		
Cliff Roblee, Division of Research & Innovation	70%		
Jason Wahleithner, Geotechnical Services	50%		
Yang Zhu, Federal Highway Administration			
Advisory Team Members:			
Sarah Skeen, Federal Highway Administration			
TBD (8 members, 1 in-person meeting, 1 phone call per month)		~$4000	~$1,500
Emilio Flores, Caltrans Office of Audits and Investigations	10%		
Estimated TOTAL Monthly Costs	3.2 FTE/mo	$4,000	$1,500
	~$32,000/month	~$5,500/month	

Notes:

- FHWA participation comes at no direct cost to Caltrans.
- Advisory Team members not internal to Caltrans may require payment of stipends or travel reimbursement.
- The Advisory Team will likely be required to participate in two meetings per month, one in-person and the other via teleconference or WebEx.

Additional one-time expenses are anticipated as shown here:

	Annual FTE	Stipend/Services
Other Resources Needed:		
TBD, OSC Staff – catalogue all GGL Reports, extract metadata, populate database with project/pile/test info (est. 10 staff, 1 to 2 months, full-time)	2.0	
TBD, Caltrans HQ-IT support to set up server space, recover hard drives, etc.	0.3	
TBD, Consultant(s) or IT Service Providers to assist in analysis, data recovery, or other activity where in-house expertise is not available		$15,000
Estimated TOTAL of One-Time Expenses	2.3 FTE/yr	$15,000
	~$23,000	

Summary:

- The duration of the effort cannot be determined at this time.
- Costs include internal Caltrans PY costs, service contracts, and stipends and travel for external team members.
- Initial cost of effort is on the order of **$75k**, and every month thereafter will cost approximately **$37K**.
- Total funding needed through the planned FHWA-Caltrans Transportation Pooled Fund (TPF) project, assuming 6 months of work, to support external Advisory Team and service contracts, is approximately **$48k.**

Appendix F: Delegation of Work for Case-Specific Requests

The GamDat Team is focused on a *comprehensive* fact finding and technical analysis of all available GGL data. This effort involves compilation and organization of large amounts of data not currently available through any single source, and the development of new analytical tools to systematically evaluate data integrity for all tests conducted to date. This study is proceeding at a focused pace consistent with maintaining the full integrity of the comprehensive review process.

The high-profile nature of the GGL test integrity issue may lead to inquiries by clients, management and the public for review of existing GGL data for specific structures. These case-specific inquiries may include requests for information regarding:

- Technical aspects of GGL equipment, operation, calibration, and accuracy;
- FTB operational procedures and practices;
- Availability and/or integrity of GGL data sets for a specific bridge or group of bridges;
- Availability and/or integrity of GGL data collected and/or processed by a specific technician or engineer;
- Availability of a specific GGL Report;
- Comparison of GGL with other methods, such as Crosshole Sonic Logging for a specific case.

The GamDat team understands the urgency of requests for case-specific GGL data integrity reviews. When the GamDat Team's study is complete, the results can be used to characterize the completeness and integrity of any case-specific GGL test. However, while many of the goals of immediate case-specific reviews are consistent with the GamDat Team's focus, the methodology and approach differs substantially and is counterproductive to achieving the GamDat Team's goal of establishing a level of confidence in the integrity of *all* Caltrans' GGL data. Therefore, all case-specific review requests will be addressed separately by a separate team (referred herein as the *Case-Specific GGL Test Review Team*) organized under the auspices of the Office of Geotechnical Support, coordinated through the Division of Engineering Services (DES) management.

The GamDat Team will assist, as possible, the *Case-Specific GGL Test Review Team* and other investigative teams by sharing both data and methods that are mature at the time of the specific review. Key technical staff from the GamDat Investigative Team is participating in multiple investigative efforts and coordination is ongoing. However, it should be recognized that these case-specific reviews are limited in scope, and the comprehensive GamDat Team's analyses may ultimately reveal integrity issues that simply cannot be identified by a case-specific review. Furthermore, findings of a case-specific review, even those developed by individuals serving on the GamDat Team, *are not to be misconstrued* to represent findings of the GamDat Team for the specific case. Given these limitations, clients are strongly encouraged to identify any cases needing case-specific review, but to wait for completion of the GamDat Team's work, at which point a comprehensive case-specific response can be provided with much greater confidence.

Appendix C: Testing of Mt Sopris Equipment

An overview of the GGL equipment and operations testing conducted by GamDat was presented in the main body of this report. More detailed information is included here along with a list of the test data files created and the associated notes taken during testing. Table C-1 presents a summary.

Test Data Files Created	Testing Date	Location	Description
01-11	13 March 2012	Translab	Re-create data spikes
12-20	15 March 2012	Translab	Check operations, functionality block, no notes
21-33	2 April 2012	Translab	Winch speed vs data regularity, operational conditions
41-68	3 April 2012	High Street, Pile 11R	CIDH Pile test logging
71-79	2 April 2012	High Street, Pile 11R	CIDH Pile production logging
81-84	4 April 2012	High Street, Pile 12R	CIDH Pile free-wheeling logs
91-97	12 April 2012	Translab	File saving vs position & direction, no notes
101-110	14 May 2012	Translab	Rate testing, challenge serial bus
111-120	18 May 2012	Translab	Rate testing, Serial Raw Data Log, Snooper Cable

Table C-1 – Summary of Testing Conducted

C.1 Lab Testing at the TransLab

A series of laboratory tests were carried out at the TransLab in Sacramento, California. The testing program included the following:

- Re-create data spikes
- Check operations, functionality block, no notes
- Winch speed vs data regularity, operational conditions
- File saving vs position & direction, no notes
- Rate testing, challenge serial bus
- Rate testing, Serial Raw Data Log, Snooper Cable

C.2 Field Testing at High Street Bridge

In an effort to better understand the operation of the gamma-gamma data logging equipment, logging process, and output, GamDat conducted field testing at CIDH Pile 11R on the High Street Bridge construction project in Oakland, California. The field testing consisted of conducting gamma-gamma testing and creating a set of data files. Gamma data logs were created under a variety of different conditions with a focus on understanding data irregularities and the effects of atypical operations.

The GamDat testing at High Street was conducted on Tuesday, April 3, 2012. During the testing, FTB personnel were also at the site conducting production gamma-gamma logging for pile acceptance. The data files from the production logging were included in the GamDat testing records for comparison and additional data.

High Street Bridge Testing Program:

- **Standard logging mode:** Standard gamma data logs of all tubes in the tested pile were created using standard logging practices. All tubes logged during this testing program were also logged by another probe/source/technician for the pile acceptance report and are available for reference. The standard logging mode file set also establishes a reference for the amount of non-logging time required between runs.
- **Winch speed vs data regularity:** A series of data logs were created while running the winch at different average speeds. As a baseline, a set of logs were created at a winch speed of 12 feet per minute (manufacturer recommends ~12.5 fpm data logging speed). Subsequent logging speeds were increased.
- **Round trip logging in time mode:** Data files were created with the data logger set to time mode data collection (instead of the standard winch mode) and tubes were logged from bottom to top and back down to the bottom in a continuous operation.
- **Standard data log of a single tube run multiple times:** All tubes were run multiple times under both typical and atypical operations.
- **Time mode data logs of stationary probe in pile:** Use data to check signal noise and drift. Use to establish independent standard deviation of signal.
- **Attempt to induce errors in the data log:** Various atypical operations were used (see testing notes).

C.3 Probe Speed Data from "Snooper Cable" Testing

Testing was conducted on May 18, 2012 to examine the raw data stream between Mt. Sopris Logger and laptop running the MSLog software. Photos from this work are shown in Figure C-2.

Figure C-2 – Snooper Cable Testing in Progress

Physical lab testing:

- Data output from Mt. Sopris MGX logger is in a format similar to RD files – mix of ASCII and binary.
- In "depth mode" the data output is in increments of 0.1 ft when the winch is in motion. When not in motion, the MGX outputs a reading at approximately once every 3 seconds.

- In “time mode” the data is output in increments of 1 sec while the winch is not in motion. If the winch is set in motion, the data increment switches to 0.1 ft. If the winch is subsequently stopped, the increment reverts back to 1 sec intervals.

Examination of speed data in RD file:

- In time mode the acceleration and deceleration speed records suggest that some type of filtering of the data is being applied to the data stream at the data acquisition hardware level. The specific method of filtering applied is not clear. However, it seems likely that a moving average using last 5 readings is a possibility. For example:

Depth	Speed	Moving Avg.	Notes
0	**0**	0.0	
0.1	**1**	0.5	
0.2	**2**	1.0	
0.3	**3**	1.5	
0.4	**4**	**2.0**	**Speed at this point is average of last 5 readings**
0.5	5	3.0	
0.6	6	4.0	
0.7	7	5.0	
0.8	8	6.0	
0.9	9	7.0	
1	10	8.0	
1.1	11	9.0	
1.2	12	10.0	
1.3	13	11.0	
1.4	14	12.0	
1.5	15	13.0	
1.6	16	14.0	
1.7	17	15.0	
1.8	18	16.0	
1.9	19	17.0	
2	20	18.0	The average speed lags the true speed here.
2.1	20	18.8	
2.2	20	19.4	
2.3	20	19.8	
2.4	20	20.0	The average now matches.
2.5	20	20.0	
2.6	20	20.0	
2.7	20	20.0	
2.8	20	20.0	
2.9	20	20.0	
3	20	20.0	
3.1	20	20.0	
3.2	20	20.0	

- The deceleration records illustrate the filtering effort more dramatically, since the operator typically dials down the speed quickly (< 1 sec) or near instantaneously if switching off the winch.

Notes	Depth(FT)	Speed (FT/MIN)	Count	"Speculated" Speed	5-pt Average Speed	time from reported speed	time from "speculated" speed
Probe not moving	3.1	0.000	44388	0.000	0.000		
	3.1	0.000	44328	0.000	0.000		
	3.1	0.000	44586	0.000	0.000		
	3.1	0.000	44434	0.000	0.000		
	3.1	0.000	44466	0.000	0.000		

	3.1	0.000	44342	0.000	0.000			
	3.1	0.000	44564	0.000	0.000			
Probe moving	3.1	0.000	44540	0.001	0.000			
	3.2	0.000	44614	0.001	0.000			
	3.3	3.375	45570	8.000	1.600	0.0296	0.0125	
	3.4	3.375	45036	8.000	3.200	0.0296	0.0125	
	3.5	3.375	45770	8.000	4.800	0.0296	0.0125	
	3.6	6.980	45162	10.000	6.800	0.0143	0.0100	
	3.7	6.980	42646	10.000	8.800	0.0143	0.0100	
	3.8	6.980	43172	10.000	9.200	0.0143	0.0100	
	3.9	10.661	43724	12.000	10.000	0.0094	0.0083	
	4.0	10.661	43630	12.000	10.800	0.0094	0.0083	
	4.1	10.661	42904	12.000	11.200	0.0094	0.0083	
	4.2	10.661	42616	12.000	11.600	0.0094	0.0083	
	4.3	15.493	42218	16.000	12.800	0.0065	0.0063	
	4.4	15.493	42282	16.000	13.600	0.0065	0.0063	
	4.5	15.493	42096	16.000	14.400	0.0065	0.0063	
	4.6	15.493	40914	16.000	15.200	0.0065	0.0063	
	4.7	20.172	38958	21.000	17.000	0.0050	0.0048	
	4.8	20.172	39082	21.000	18.000	0.0050	0.0048	
	4.9	20.172	41850	21.000	19.000	0.0050	0.0048	
	5.0	20.172	43022	21.000	20.000	0.0050	0.0048	
	5.1	21.553	43884	22.000	21.200	0.0046	0.0045	
	5.2	21.553	43640	23.777	21.755	0.0046	0.0042	
	5.3	21.553	44428	23.777	22.311	0.0046	0.0042	
	5.4	21.553	43856	23.777	22.866	0.0046	0.0042	
	5.5	22.703	44176	23.777	23.421	0.0044	0.0042	
	5.6	22.703	44780	23.777	23.777	0.0044	0.0042	
	5.7	22.703	44658	23.777	23.777	0.0044	0.0042	
	3.4	-22.013	45832	-21.936	-21.936	0.0045	0.0046	
	3.3	-22.013	45674	-21.936	-21.936	0.0045	0.0046	
	3.2	-22.013	45454	-21.936	-21.936	0.0045	0.0046	
	3.1	-21.169	45336	-21.936	-21.936	0.0047	0.0046	
Probe not moving	3.1	-21.169	44668	-21.936	-21.936	0.0047		
	3.1	-16.490	44418	0.000	-17.549	0.0061		
	3.1	-12.579	44630	0.000	-13.162	0.0079		
	3.1	-8.207	44438	0.000	-8.774	0.0122		
	3.1	-4.602	44500	0.000	-4.387	0.0217		
	3.1	-2.531	44288	0.000	0.000	0.0395		
	3.1	-0.460	44486	0.000	0.000	0.2173		
	3.1	0.000	44504	0.000	0.000			
	3.1	0.000	44642	0.000	0.000			
						0.575	**0.193**	**minutes**
						34	**12**	**seconds**

- At depth of 3.1 the winch is stopped. However, note that the speed readings trail off for several readings afterwards.
- From the point at which the probe starts moving, note that the speed readings are initially very low for the first couple of depth intervals. This is much slower than observed during the test.
- A "speculated" speed column was added here to show what the actual instantaneous speed might be. Using this synthesized data and applying a 5-point averaging filter, the resulting data are very close to what is reported in RD files and also directly output from the MGX logger.
- The deceleration sequence is likely a good reflection of the actual test condition. The acceleration sequence is more difficult to estimate, since the operator is ramping up the speed and attempting to dial in a target velocity. In the example above, Morgan was attempting to dial in 20 ft/min for the test.
- Morgan observed that there is a latency in the LED readout on the MGX logger when adjusting the speed dial. This would be consistent with moving average type filter applied.

- Time intervals associated with acceleration and deceleration sequences from the filtering can introduce significant times to the records. These times are an artifact from the filtering and do not reflect actual times. In the example above, the acceleration/deceleration times alone account for as much as 34 seconds. An estimated time based on the speculated speed yields on the order of 12 seconds.
- Based on these observations, it appears that it will not be possible to calculate the actual time associated with acceleration/deceleration of the probe. During case-specific analyses, we will need to examine the speed data for records in question and apply a reasonable range of time and error for the acceleration/deceleration of the probe.

C.4 Details of Test Files Created

GENERAL DESCRIPTION: Re-create data spikes.	
TEST FILES CREATED	CONDITIONS
01-11	*The following notes were taken during the creation of gamma logging data files utilizing probe 3551, source 041, and standard reference block #4 on Tuesday, 13 March, 2012. Notes by Michael Morgan. All work by Dave Sawko and Michael Morgan. Gamma data logs created with conditions noted in an effort to create data anomalies. In particular, attempt to re-create data spikes found in standard reference block certification files.*
01	Probe in shield (pic 01). Timed counts. At end of log began to pull cable out of winch. Seemed to have minor effect on log.
02	Probe in standard block #4. Timed counts. Started counts with cable pulled out as in gamma log. About 260 counts with probe seated in block in static condition. Then reeled in winch at about 12 feet per minute. After winch stopped, manipulated kink in cable just before shutting down log.
03	Probe in standard block #4. Timed counts. About 200 counts with probe seated in block in static condition. Continued log while manipulating winch, pull out short lengths, alternate spool by hand. "LOGGER mchnum" screen periodically blanked out. Seemed to blank out on startup and changing directions. Don't know if it affected log. At counts 360-600 pulled cable manually and rapidly at end 46.8 feet (read off winch)
04	Probe in standard block #4. Winch counts. Started with cable out to 46.8 feet from log "03." Reeled in cable from 46.8. At 44.93 ft reversed winch direction and reeled out to 46.02 then reversed again and back through 44.93 and continued. Count restarted automatically at 44.93. Reeled in to 16.6 then stop.
05	Probe in standard block #4. Timed count. About 200 counts with probe seated in block in static condition. Then pulled probe out of block incrementally. At counts ~195 pulled probe 4 inches out of seated position in block. At counts ~250 pulled probe another 4 inches out of block for total 8 inches. At ~300 counts moved probe back in to seated position in block.
06	Probe in standard block #4. Timed count. About 100 counts with probe seated in block in static condition. Then:
	Probe out 2" & back in, probe out 4" & back in, probe out 6" & back in, probe out 8" & back in.
	Probe out 6" then back in to 2", probe out 8" then back in to 2"
	Probe out 6" then back in to seated, out 6" then back in to 1", then seated
07	Probe in standard block #4. Timed count. About 100 counts with probe seated in block in static condition:
	At counts 125 set source shield on top of block above tip of probe.
	At counts 200 set source shield on top of middle of block (see pic 05)
	Removed shield and placed steel plates on top and side of block (see pic 06)
08	Probe in standard block #4. Steel plates on top and side of block (see pic 06). About 100 counts seated in block in static condition then removed steel plates.
09	Probe in standard block #4. Started log with probe seated in block then rotated probe and moved in and out of block (see video)
10	Probe in standard block #4. Probe static and seated in block. Manipulated cord and head connection.
11	Logged in Time Mode. Approx 4,000 counts with depth encoder set at "zeroed out" value of 3.05008 feet. No movement of cable through encoder. Started log with probe fully inserted in standard block #4. At approximately every 100 counts I withdrew the probe from the block 0.5 inches.

GENERAL DESCRIPTION: Testing winch speed vs data regularity.	
TEST FILES CREATED	CONDITIONS
021-033	*The following are notes taken during the creation of gamma logging data files utilizing probe 3551, source 041, winch 1194, and standard reference block #1 on Monday, 02 April 2012 at the Translab. Notes by Michael Morgan. All work by Dave Sawko and Michael Morgan. Gamma data logs created with conditions noted in an effort to understand normal operations and possible data irregularities. Depth mode set to measure every 0.0997022 feet. Time mode set to measure every 1,000 milliseconds.*
021	Depth mode up. Winch speed **6 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
022	Depth mode up. Winch speed **12 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file. A few times during retrieve, cable slipped momentarily due to irregular cable build-up on spool - may not be noticeable on log.
023	Depth mode up. Winch speed **15 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
024	Depth mode up. Winch speed **20 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
025	Depth mode up. Winch speed **25 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
026	Depth mode up. Winch speed **30 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
027	Depth mode up. Winch speed **35 feet per minute**. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
028	Depth mode up. Winch speed **38-40 feet per minute**. Maximum winch speed. Piled up cable on one side of spool to increase spool radius and increase speed. Probe stationary in standard reference block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
029	Depth mode up. Winch speed **35 feet per minute**. Probe stationary **in lead shield**. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
030	Depth mode up. Winch speed **35 feet per minute**. Probe stationary **in probe case lying on floor of gamma van**. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file.
	After file 030, changed depth mode rate from 0.0997022 feet to 0.1997022 feet. Depth mode setting then reverted to 0.0984309 feet. Tried to change setting back to original setting of 0.0997022 feet but the setting again reverted to 0.0984309 feet. **Left setting at 0.0984309 feet**.
	After file 030, changed time mode rate from 1000 msec to 9000 msec. Time mode setting reverted to 2000 msec. 2000 msec appears to be the longest setting. **Then reset time mode rate to 1000 msec.**
031	Time mode. Source stationary in lead shield. Starting at about 135 counts, pulled cable rapidly through depth encoder. Also tried to pause data collection. All software buttons except "Stop" recording button are inactive during file recording. Found no way to pause data collection.
032	Time mode. Probe stationary in standard block #1. At about 130 counts, pulled cable backward through depth encoder (toward spool). At about 250 counts, pulled cable forward (away from spool) rapidly through encoder.
033	Time mode. Probe stationary in standard block #1. Pulled out length of probe cable before starting data file. Maintained tension on probe cable while motoring winch and retrieving cable. Zeroed counter to 3.05 feet before starting data file. Motored winch in "up" direction for about 35 feet then stopped winch and disengaged cable spool from winch motor allowing free wheeling. While continuing to record file, rapidly ran cable out. Max speed of about 150 fpm observed on display.

GENERAL DESCRIPTION: Test logging of CIDH pile by GamDat team	
TEST FILES CREATED	CONDITIONS
041-068	*The following are notes taken during the creation of gamma logging data files utilizing probe 3551, source 041, winch 1194, and standard reference block #1 on Tuesday, 03 April 2012 at Pile 11R of the High Street Bridge Project in Oakland, CA. For project and pile information see scanned Gamma-Gamma Logging Set-Up Record. Notes by Michael Morgan. All work by Dave Sawko and Michael Morgan. Gamma data logs created with conditions noted in an effort to understand normal operations and possible data irregularities. Depth mode set to measure every 0.0984309 feet. Time mode set to measure every 1,000 milliseconds. Pile was located about 15 feet behind the van on level ground.* *CIDH Pile Diameter = 8 feet. Pile contains 9 inspection tubes.*
041	**Tube No. 1.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
042	**Tube No. 2.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. During the creation of 043, the RD file from 042 was deleted. Tube No. 2 was re-logged in this same mode in file 050 (see below).
043	**Tube No. 3.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
044	**Tube No. 4.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
045	**Tube No. 5.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
046	**Tube No. 6.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
047	**Tube No. 7.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
048	**Tube No. 8.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
049	**Tube No. 9.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
050	**Tube No. 2.** Depth mode up. Winch speed **12 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. This is a re-log of 042 after loss of RD file during re-naming.
051	**Tube No. 3.** Depth mode up. Winch speed **up as fast as possible (maximum winch speed)**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. Before initiating file, probe was disconnected from computer and re-connected. Although a data file was recorded, most densities were 999 null values. Had to reboot computer and re-try data file acquisition with file 052.
052	**Tube No. 3.** Depth mode up. See 051 notes. Winch speed **up as fast as possible (maximum winch speed ~38 fpm)**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. Probe reached a maximum speed of about 38 feet per minute.
053	**Tube No. 3.** Depth mode up. Winch speed **30 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
054	**Tube No. 3.** Depth mode up. Winch speed **20 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
055	**Tube No. 3.** Time mode recording. Winch speed **up as fast as possible (maximum winch speed ~38 fpm)**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. While continuing to record data file, winch was reversed at the top and lowered back down to the bottom. Data file was closed out at bottom of tube. Speed **going up tube was about 38 feet per minute**. Speed **going down tube was about 41 feet per minute**.
056	**Tube No. 3.** Time mode recording. Winch speed **20 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch. While continuing to record data file, winch was reversed at the top and lowered back down to the bottom. Data file was closed out at bottom of tube.
057	**Tube No. 3.** depth-up mode recording. Winch speed about **15 feet per minute**. Continuation of 056 logging. File initiated with probe at bottom following close-out of 056, then retrieved by winch. Data file was closed out at top of tube.

058	**Tube No. 4.** Time mode recording. Winch speed **up at 15 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch at 15 fpm. While continuing to record data file, winch was reversed at the top and lowered back down to the bottom as fast as possible with winch engaged. Data file was closed out at bottom of tube. Speed going **down tube about 40 feet per minute**.
059	**Tube No. 4.** Depth up mode recording. Winch speed about **15 feet per minute**. Continuation of 058 logging. File initiated with probe at bottom following close-out of 058, then retrieved by winch. Data file was closed out at top of tube.
060	**Tube No. 4.** Time mode recording. **Probe stationary** in pile about 20 feet from top of concrete. Depth zeroed to 3.05 feet at top then lowered to stationary position. About 650 counts recorded.
061	**Tube No. 5.** Time mode recording. Winch speed **up at 15 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch at 15 fpm. While continuing to record data file, winch was reversed at the top and lowered back down to the bottom as fast as possible with winch engaged. Data file was closed out at bottom of tube. Speed going **down tube about 40 feet per minute**.
062	**Tube No. 5.** Depth up mode recording. Winch speed about **15 feet per minute**. Continuation of 061 logging. File initiated with probe at bottom following close-out of 061, then retrieved by winch. Data file was closed out at top of tube.
063	**Tube No. 5.** Time mode recording. **Probe stationary** in pile about 20 feet from top of concrete. Depth zeroed to 3.05 feet at top then lowered to stationary position. About 700 counts recorded.
064	**Tube No. 6.** Time mode recording. Winch speed about **20 feet per minute**. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered with winch to bottom of tube. While continuing to record data file, winch was reversed at the bottom and probe raised with winch at about 20 fpm back up to the top. Data file was closed out at top of tube.
065	**Tube No. 7.** Time mode recording. Winch speed about **20 feet per minute**. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered with winch to bottom of tube. While continuing to record data file, winch was reversed at the bottom and probe raised with winch at about 20 fpm back up to the top. Data file was closed out at top of tube.
066	**Tube No. 8.** Time mode recording. Winch speed about **20 feet per minute**. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered with winch to bottom of tube. While continuing to record data file, winch was reversed at the bottom and probe raised with winch at about 20 fpm back up to the top. Data file was closed out at top of tube.
067	**Tube No. 9.** Time mode recording. Winch speed about **20 feet per minute**. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered with winch to bottom of tube. While continuing to record data file, winch was reversed at the bottom and probe raised with winch at about 20 fpm back up to the top. Data file was closed out at top of tube.
068	**Tube No. 1.** Time mode recording. Winch speed about **20 feet per minute**. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered with winch to bottom of tube. While continuing to record data file, winch was reversed at the bottom and probe raised with winch at about 20 fpm back up to the top. Data file was closed out at top of tube.

GENERAL DESCRIPTION: Production CIDH pile logging files produced for reporting and pile acceptance. These files are from the same CIDH pile and same tubes as files 041-068 but logged with a different probe/source/winch and by a different technician.	
TEST FILES CREATED	CONDITIONS
071-079	*The following is information about gamma logging data files created utilizing probe 2947, source 038, winch 1192, and standard reference block #4 on Tuesday, 02 April 2012 at Pile 11R of the High Street Bridge Project in Oakland, CA. For project and pile information see scanned Gamma-Gamma Logging Set-Up Record. All work by Robert Medina. Winch was operated at about 10 feet per minute for all files.* *CIDH Pile Diameter = 8 feet. Pile contains 9 inspection tubes.*
071	**Tube No. 1.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
072	**Tube No. 2.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
073	**Tube No. 3.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
074	**Tube No. 4.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
075	**Tube No. 5.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
076	**Tube No. 6.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
077	**Tube No. 7.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
078	**Tube No. 8.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.
079	**Tube No. 9.** Depth mode up. Winch speed **10 feet per minute**. Depth zeroed to 3.05 feet at top then lowered to bottom of tube. File initiated with probe at bottom then retrieved by winch.

GENERAL DESCRIPTION: CIDH pile logging in time mode to assess winch free-wheeling operations. These files are from the same High Street Bridge project, equipment, and technician as files 071-079, but are from a different pile.	
TEST FILES CREATED	CONDITIONS
081-084	*The following is information about gamma logging data files created utilizing probe 2947, source 038, winch 1192, and standard reference block #4 on Wednesday, 04 April 2012 at Pile 12R of the High Street Bridge Project in Oakland, CA. For project and pile information see scanned Gamma-Gamma Logging Set-Up Record. All work by Robert Medina.* *CIDH Pile Diameter = 8 feet. Pile contains 9 inspection tubes.*
081	**Tube No. 9.** Time mode recording. Winch disengaged from spool for lowering probe to bottom of hole rapidly. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered to bottom of tube with speed controlled by hand pressure on wheel. Continued to record data, engaged winch and raised probe to top using winch. File closed out at top of hole.
082	**Tube No. 9.** Time mode recording. Winch disengaged from spool for lowering probe to bottom of hole rapidly. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered to bottom of tube with speed controlled by hand pressure on wheel. Continued to record data, engaged winch and raised probe to top using winch. File closed out at top of hole.
083	**Tube No. 9.** Time mode recording. Winch disengaged from spool for lowering probe to bottom of hole rapidly. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered to bottom of tube with speed controlled by hand pressure on wheel. Continued to record data, engaged winch and raised probe to top using winch. File closed out at top of hole.
084	**Tube No. 9.** Time mode recording. Winch disengaged from spool for lowering probe to bottom of hole rapidly. Depth zeroed to 3.05 feet at top, file initiated, then probe lowered to bottom of tube with speed controlled by hand pressure on wheel. Continued to record data, engaged winch and raised probe to top using winch. File closed out at top of hole.

GENERAL DESCRIPTION: Objective to gain information about the accuracy and the way the rate of probe movement is encoded in the rd & las files. Conducted gamma-gamma data logging in the FTB shop with the gamma probe static in standard reference block. Simulated probe movement by operating the winch and maintaining tension on the probe cable as it was drawn through the encoder. Used an external timer to track the amount of time that it took to collect the data contained within the files (time from start of file initiation to closing and saving the file).

TEST FILES CREATED	READING NUMBERS	CONDITIONS	External Timer Min.(tenths)	Time Calculated from Data
101-110		*The following is information about gamma logging data files created utilizing probe 3551, source 041, winch 1194, and standard reference block #3 on Monday, 14 May 2012 at the Translab. MS log depth sample set at 0.0984 feet. Time sample set at 1,000 milliseconds. Testing conducted by Mike Morgan, Rick Chavez, and Mark Pearson.* External timer operation: The timer was initiated simultaneously with data file initiation. The timer was stopped when the data collection was stopped. If the data file was initiated in depth mode with the winch static, the external timer will reflect a longer time than the total time as calculated from the data file rate information. The difference will reflect the amount of time the winch was static. In normal operation in an actual pile log the difference between actual time and calculated time in depth mode would also include any time during direction reversals until the probe advances beyond the reversal point and increments one tenth.		
101		Time mode data collection. For baseline information, recorded ~200 counts with probe stationary in block and winch off.	None	
102	334	Winch down mode data collection. Started file with winch on in down mode and speed knob turned full counter-clockwise (CCW). There is no cable spool movement with the speed knob turned full counter-clockwise. Did not monitor data collection with external timer. File contains zero rate recorded at count #2 and count #10. Both occurred during very slow operation.	None	10.53
	0-90	Adjusted winch speed variously from zero to ~3 fpm (feet per minute). Speed readout on winch housing seems to correspond accurately to recorded winch speed.		
	90	Increase winch speed to 3.3 fpm		
	135	Begin winch speed increase to 5.6 fpm		
	200	Begin winch speed increase to 7.0 fpm		
	270	Begin winch speed increase to 10 fpm		
103	293	Winch up mode data collection. Started file with winch on in up mode ~3 fpm. Established ~0.75 fpm rate until about 20 counts.	5.42	5.24
	20	Increase winch speed to 2.9 fpm	1.76	
	50	Increase winch speed to 6.3 fpm	2.88	
	102	Increase winch speed to 10.9 fpm	3.76	
	176	Increase winch speed to 15.9 fpm	4.5	
104	300	Time mode data collection. Start data collection with winch stopped until 20th count then began to increase winch speed in the up direction. Calculated time of 5.93 minutes was done by adding the accumulated time based on the rate information to the accumulated time based on 1 second time counts. It appears that the rate is not calculated if the count is recorded based on the 1 second interval even though the cable is moving (see count numbers 22 and 23).	5.84	5.93
	20	Increase winch speed from zero to 8.6 fpm		
	100		1.32	

	120	Decrease winch speed from 8.6 to 3.0 fpm		
	150	Decrease winch speed to 0.61 fpm	2.55	
	165	Increase winch speed to 14 fpm	4.71	
105	274	Winch up mode data collection. Start data collection and start winch at about 6 fpm. Increase winch speed to 12 fpm. Run winch at constant 12 fpm until near simultaneous stop winch and stop file/data collection.	2.5	2.48
106	463	Winch down mode data collection. Zero probe before start. Started winch at about 1.3 fpm.	5.15	4.99
	25	Increase winch speed to 12.5 fpm.	1.81	
	165	Increase winch speed to 15.2 fpm. At end stop winch, close file.		
107	33	Winch up mode data collection. Zero probe before start. Very slow operation. Start a little fast then slowed to 0.3 fpm.	9.01	9.28
108	79	Winch up mode data collection. Zero probe before start. Slow operation. Steady rate about 1.3 fpm.	6.28	5.99
109	422	Winch up mode data collection. Start slow. At about 200 counts start 1 GB data file transfer from USB flash drive. Then play video file. Turned up logging speed toward end of data collection. No null values.	7.74	7.74
110	1250	Winch down mode data collection. Start slow then increase speed. Started at local clock time of 1335. Immediately started 1 GB data transfer on USB. Then started to play video file and repeatedly ran the file while data logging. At ~100 counts went to maximum winch speed. Sometime after 1,000 counts witnessed rate display on winch go to zero momentarily. Appears to be reflected in data at count # 1102, rate recorded as zero for one increment while operating at about 20 fpm. This file shows largest discrepancy between external time and calculated time.	6.29	5.64

GENERAL DESCRIPTION: Objective to record the serial raw data being sent from the winch to the laptop while simultaneously generating a raw data (rd) file from the MS Log software based on the same data. By doing so we hope to gain insight into the way the data files are created and the impact of both normal and irregular operation of the winch. Conducted gamma-gamma data logging in the FTB shop with the gamma probe static in standard reference block. Simulated probe movement by operating the winch and maintaining tension on the probe cable as it was drawn through the encoder. Used an external timer to track the amount of time that it took to collect the data contained within the files (time from start of file initiation to closing and saving the file). With this set of data files (111-120), the external timer times may be poorly correlated to calculated file times due to irregular winch starts, reversals, etc.				
TEST FILES CREATED	READING NUMBERS	CONDITIONS	External Timer Min.(tenths)	Time Calculated from Data
111-120		*The following is information about gamma logging data files created utilizing probe 3551, source 041, winch 1194, and standard reference block #3 on Friday, 18 May 2012 at the Translab. MS log depth sample set at 0.0984 feet. Time sample set at 1,000 milliseconds. Testing conducted by Mike Morgan, Rick Chavez, Mark Pearson, Yang Zhu, and Loren Turner.* Serial Raw Data Log: Serial raw data was captured on a second laptop connected to the winch via a signal splitter cable. Windows HyperTerminal software was used to monitor the serial port and record a text file documenting the data transmission. The HyperTerminal recording was initiated before the gamma log data file was initiated on MS Log. The HyperTerminal recording was ended after the gamma log data file was ended on MS Log and the RD file recorded. HyperTerminal settings were 9,600 Bits per second, 8 Data bits, Even Parity, Stop bits 1, Flow control None. Serial Raw Data Log text files are named/numbered the same as the corresponding LAS/RD files. External timer operation: The timer was initiated simultaneously with data file initiation, or where noted, the timer was initiated with the start of the winch movement. The timer was stopped when the data collection was stopped. If the data file was initiated in depth mode with the winch static, the external timer will reflect a longer time than the total time as calculated from the data file rate information. The difference will reflect the amount of time the winch was static. In normal operation in an actual pile log the difference between actual time and calculated time in depth mode would also include any time during direction reversals until the probe advances beyond the reversal point and increments one tenth.		
111		Time mode data collection. For baseline information, recorded ~100 counts with probe stationary in block and winch off. External timer not used/recorded.	None	
112	383	Winch down mode data collection. Started file with winch on in down mode and speed knob turned full counter-clockwise (CCW). There is no cable spool movement with the speed knob turned full counter-clockwise. Did not monitor data collection with external timer. File contains zero rate recorded at count #1. Zero rate occurred during very slow initial operation.	None	3.64
	0-50	Adjusted winch speed variously from zero to ~4 fpm (feet per minute).		
	50	Establish steady winch speed of approx. 3.4 fpm		
	383	End data collection, close & save file.		
113	313	Winch down mode data collection. Started file with winch off.	2.17	2.49

		Started external timer with winch start - not file start. Established ~0.75 fpm rate until about 20 counts.		
	15	Established steady winch speed ~ 14 fpm		
	313	End data collection, close & save file with winch running.	2.17	
114	312	Winch down mode data collection. Started external timer after starting winch.	3.25	2.34
	15	Established winch speed ~13.5 fpm		
	130	Reversed winch, time approx. Continue external timer.	1.55	
	130	Reversed winch, passed reversal point in down direction. Time approx. Speed ~14.8 fpm. External timer reverse duration = 0.42 minutes.	1.97	
	312	Stopped winch, then stopped external timer. End time approx.	3.25	
115	556	Winch up mode data collection. Start winch ~7 fpm, then start external timer.	3.72	3.49
	25	Begin winch rate increase to ~13 fpm.		
	185	Begin winch rate increase to ~23 fpm.	1.72	
	400	Stop winch, continue external timer, 400 is estimated count, time is approx.	2.72	
	423	String of three zero rate points (422 is likely the actual stop winch point)		
	423	Restart winch, continuation of winch up mode. External timer stop duration = 0.41 minutes.	3.13	
	556	Stop winch, stop external timer, end data collection / save file.	3.72	
116	230	Winch up mode data collection. Start file, start external timer with winch stopped. Run ~1 min with no winch movement. Then increase speed from stop to very slow.		
	0-1	Engage winch motor (switch off to up), speed adjustment ccw(counter-clockwise) to no movement.	1	
	0-1	Start turning speed adjustment up cw (clockwise). Still no visible movement.	1.25	
	~2	First spool movement recognized.	1.75	
		Several speed adjustments made.		
	8	Adjustment to 0.12 meters/minute on winch display	3.17	
	10	Adjusted speed to slower, spool movement barely visible, winch display alternated between 1st reading of ~.05 and 2nd reading of 0.0.	3.75	
	11-13	Two zero rate points followed by a rate of 0.02 meters/minute		
	13	Begin increase winch speed to ~4 meters/minute	7.03	
	230	Close out and save file winch running, stop external timer, stop winch.	8.8	
117	420	Winch down mode data collection. Start file, start external timer, start winch. Experimenting with pulling cable through encoder.	5.25	N/A
		Establish winch speed ~5 meters/minute		
		Stop winch to manually pull cable through encoder.	0.57	
	92-183	Operation generated many null values		
		Several iterations of manually pulling probe cable through the encoder in down direction		
		Re-start winch	2.67	
		Several iterations of manually pulling probe cable through the encoder in up and down direction.		
	420	Close out and save file winch running, stop external timer, stop winch.	5.25	
118	597	Time mode data collection. Start file, start external time, then start winch operation in down direction.	4.1	N/A
	171	Reverse winch to up direction		
	265	Stop winch	2.09	

		Manually pull cable through encoder alternating direction. First set slower and longer pulls. Second set rapid short pulls.		
		Notable in data: No null values generated. Compare to file 117 above.		
	597	Close out and save file, stop external timer.	4.1	
119	575	Time mode data collection. Start file, start external time, then start winch operation in down direction. Run winch in down direction at max winch speed.	1.83	1.82
		Slow winch, close out and save file, stop external timer.		

Appendix D: Influence on Test Results from Proximity of Probes

Following adoption of CTM-233 in November 2005, Caltrans contracts began referencing the test method as the standard for GGL tests. In January 2007 the Foundation Testing Branch reviewed all GGL systems used by the unit for conformance with standards established by CTM-233. Based on the review, it was found that the unit was missing documentation for the qualification of standard reference blocks.

Standard reference blocks are used for the purpose of daily verification of probe functionality. The standard reference blocks are mounted into Caltrans Foundation Testing Branch vehicles. At the start of each day of testing, a probe is placed into the standard reference block and the average of four consecutive readings is compared to upper and lower limits, determined on an annual basis, or following probe maintenance or repair. CTM-233 requires that each standard reference block pass a qualification process, verifying the block is not subject to boundary effects that would affect daily functionality tests. The qualification is achieved by recording data with the block in both a horizontal and vertical position as shown below in Figures D-1 and D-2 below. The two data sets are compared through statistical calculations.

Figure D-1 – Standard Reference (Vertical)

Figure D-2 – Standard Reference (Horizontal)

CTM 233 requires a unique qualification for each combination of standard reference block and probe-source system. In 2007 the Foundation Testing Branch utilized nine standard reference blocks and five GGL systems. The combination of standard reference blocks and GGL systems resulted in the need for forty-five unique qualifications. The unit undertook this extensive qualification process between January 24 and 25, 2007. Additional qualification work was performed on February 23, 2007.

One of the findings of the GamDat team in 2012 was that nine LAS files from the 2007 qualification process were deliberately edited by the same technician. The raw data files (RD files) for the 2007 qualification work were recovered by GamDat and replayed to generate new LAS files, which were then compared to the edited LAS files from 2007. It was determined that the technician's editing consisted of removing unusual increases, or spikes, in the gamma counts of some of the 2007 qualification test data. An example is shown below in Figure D-3 for data collected during the qualification of Block No. 6 with Probe-Source 3551-041. A normal test would find the counts collected in the vertical position to follow approximately the same line as the counts collected in the horizontal position. For the example shown below, the original data from the test in the vertical position shows a distinct spike in the counts and then a leveling off at an elevated count. The falsified data file for the vertical position shows no spike and the data following approximately the same line as the horizontal test.

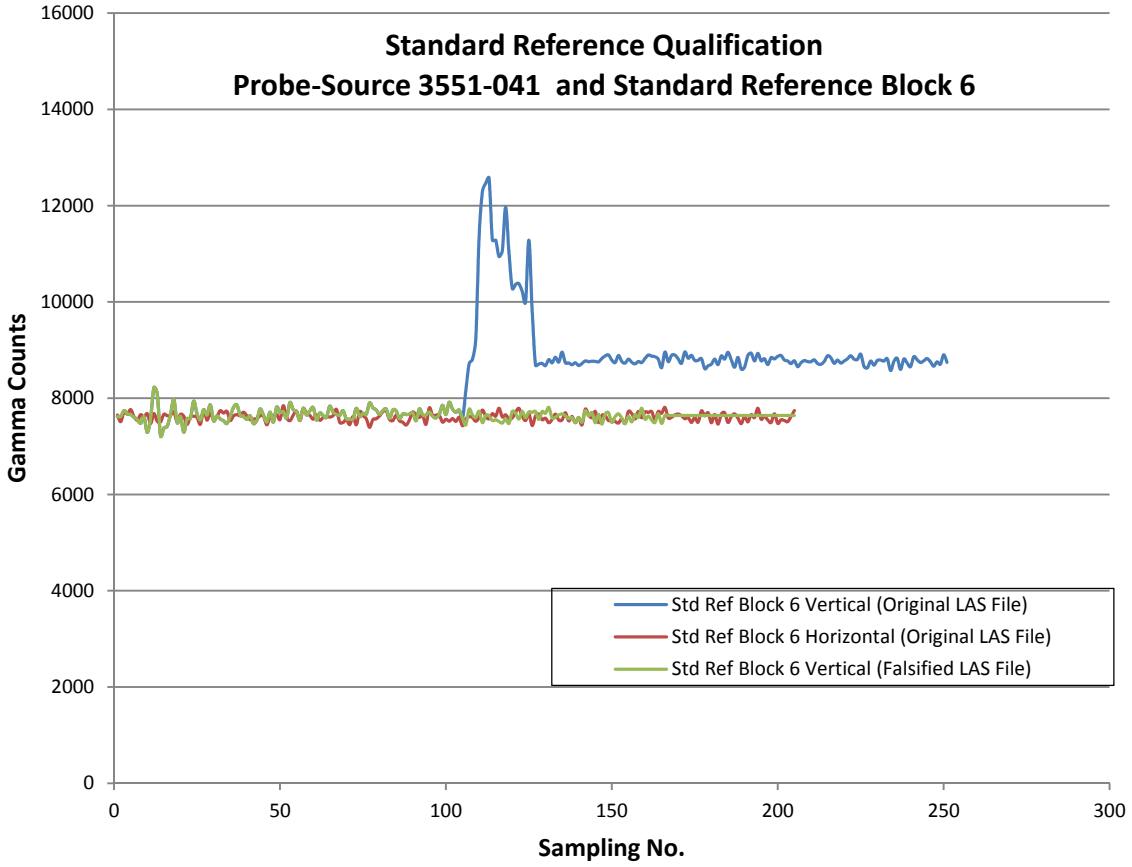


Figure D-3 – 2007 Qualification Data (Probe-Source 3551-041 and Standard Reference Block #6)

In the example shown above, the technician replaced the spike in gamma counts by copying data from the horizontal test and pasting over the rows of data from the vertical test that contained the spikes in gamma counts. The falsification of the standard reference qualification data is explained in further detail in the presentation of the case in Section 7 as well as in documentation for Manual Analysis ID-2 and ID-15.

The technician's deliberate falsification of the 2007 test data concealed the data spike problem from the testing engineer. One concern identified by the GamDat team was that the spikes in gamma counts may have been the result of a problem with the probe since the data spikes occurred in six of nine qualifications for a single probe-

source system (probe 3551-source 041). This probe was being actively used in December 2006 and January 2007 including testing at the San Francisco-Oakland Bay Bridge project.

The GamDat team made several attempts to recreate the spikes in gamma counts that occurred in 2007 in order to determine the cause. It was found that spikes could be introduced in the data set if the probe's position within the qualification block was changed during data collection. However, the combination of a spike and the data leveling off at an elevated count could not be reproduced by moving the probe in the block without holding the probe at a new position for the remainder of the test.

The most likely explanation was discovered during data collection associated when the qualification process was repeated in April 2012. During that process it was noted that several probes experienced data spikes similar to those removed by the technician in 2007. These spikes were associated with source to source influence resulting from the movement of adjacent probes between blocks. An example showing a data spike and leveling at an elevated count is shown in Figure D-4.

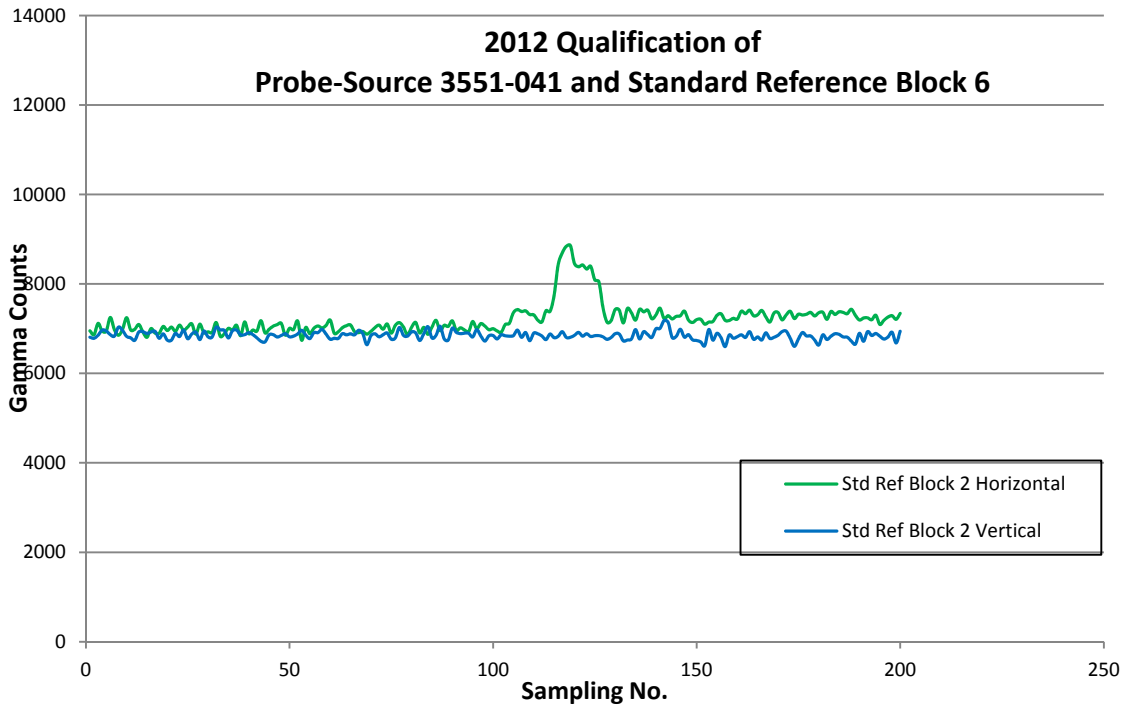


Figure D-4 – 2012 Qualification Data (Probe-Source 3551-041 and Standard Reference Block #6)

Because of the large number of qualification tests undertaken, the technicians were performing simultaneous qualifications using two or more probes, as shown in Figures D-5 and D-6 below. It was observed that one probe system would experience a data spike when a second probe was moved near the first, or in some cases simply removed from the shield and transferred to a qualification block in the vicinity of the first probe.

Figure D-5 – 2012 Qualification

Figure D-6 – 2012 Qualification

The data spikes were similar to the data spikes found in the original 2007 data. A review of the qualification data in 2007 showed that multiple probe-source systems were collecting qualification data at the same time making the source to source influence the most likely explanation for the data spikes concealed by the technician.

Appendix E: Lists of All Flagged Files

E.1 Pattern Matching

LAS Files Flagged for Pattern Matching

LAS File ID	Unique LAS File ID	Pattern ID	Pattern	Pattern Length	Occurrence	Assigned to Manual Analysis ID
69581	9788	481	189.939,188.764,188.280,187.765,186.573,...	2117	1	1
87843	13703	481	189.939,188.764,188.280,187.765,186.573,...	2117	1	1
69588	9789	482	189.326,187.915,188.598,187.159,186.680,...	2113	1	1
87845	13704	482	189.326,187.915,188.598,187.159,186.680,...	2113	1	1
69595	9790	483	187.683,186.349,186.039,185.756,189.057,...	2108	1	1
87847	13705	483	187.683,186.349,186.039,185.756,189.057,...	2108	1	1
69602	9791	484	187.258,186.859,186.075,185.354,186.462,...	2033	1	1
87849	13706	484	187.258,186.859,186.075,185.354,186.462,...	2033	1	1
69609	9792	485	185.091,184.813,184.258,184.491,183.765,...	1827	1	1
87851	13707	485	185.091,184.813,184.258,184.491,183.765,...	1827	1	1
69616	9793	486	182.022,182.953,183.225,182.918,184.077,...	1823	1	1
87853	13708	486	182.022,182.953,183.225,182.918,184.077,...	1823	1	1
69623	9794	487	184.045,183.708,183.769,184.869,185.101,...	2116	1	1
87855	13709	487	184.045,183.708,183.769,184.869,185.101,...	2116	1	1
69630	9795	488	192.338,192.659,192.774,191.692,189.932,...	2110	1	1
87857	13710	488	192.338,192.659,192.774,191.692,189.932,...	2110	1	1
85077	13111	573	220.825,220.819,221.295,220.745,221.403,...	87	1	2
90232	14720	573	220.825,220.819,221.295,220.745,221.403,...	87	1	2
85077	13111	574	221.744,222.342,223.237,222.243,223.193,...	134	1	2
90232	14720	574	221.744,222.342,223.237,222.243,223.193,...	134	1	2
86039	13192	577	222.742,224.276,221.715,223.243,223.746,...	30	1	2
86061	13193	577	222.742,224.276,221.715,223.243,223.746,...	30	1	2
86039	13192	578	223.224,222.929,222.986,223.991,223.140,...	45	1	2
86061	13193	578	223.224,222.929,222.986,223.991,223.140,...	45	1	2
86039	13192	579	223.293,221.175,223.759,222.462,222.495,...	15	1	2
86061	13193	579	223.293,221.175,223.759,222.462,222.495,...	15	2	2
86039	13192	580	223.293,221.175,223.759,222.462,222.495,...	40	1	2
86061	13193	580	223.293,221.175,223.759,222.462,222.495,...	40	1	2
86039	13192	581	223.541,223.262,222.572,221.037,222.690,...	17	1	2
86061	13193	581	223.541,223.262,222.572,221.037,222.690,...	17	2	2
86039	13192	582	223.541,223.262,222.572,221.037,222.690,...	21	1	2
86061	13193	582	223.541,223.262,222.572,221.037,222.690,...	21	1	2
86039	13192	583	224.206,223.955,221.791,224.008,222.439,...	33	1	2
86061	13193	583	224.206,223.955,221.791,224.008,222.439,...	33	1	2
86039	13192	584	222.202,222.536,223.619,222.779,222.619,...	20	1	2
86061	13193	584	222.202,222.536,223.619,222.779,222.619,...	20	1	2
86061	13193	585	222.748,222.338,221.199,221.088,221.435,...	40	1	2
90226	14719	585	222.748,222.338,221.199,221.088,221.435,...	40	1	2
86178	13199	586	219.232,219.354,218.785,218.852,218.709,...	38	1	2
90176	14710	586	219.232,219.354,218.785,218.852,218.709,...	38	1	2
86178	13199	587	219.271,220.578,219.676,219.295,220.570,...	188	1	2
90176	14710	587	219.271,220.578,219.676,219.295,220.570,...	188	1	2
86192	13200	588	223.405,220.946,221.866,222.247,221.283,...	60	1	2
86214	13201	588	223.405,220.946,221.866,222.247,221.283,...	60	1	2
86214	13201	589	222.090,222.076,221.187,221.647,221.782,...	105	1	2
90238	14721	589	222.090,222.076,221.187,221.647,221.782,...	105	1	2
86214	13201	591	221.926,221.926,221.926,221.926...	4	10	2
86214	13201	592	221.926,221.926,221.926,221.926,221.926...	5	8	2

LAS File ID	Unique LAS File ID	Pattern ID	Pattern	Pattern Length	Occurrence	Assigned to Manual Analysis ID
86214	13201	593	221.926,221.926,221.926,221.926,221.926,...	6	6	2
86214	13201	594	221.926,221.926,221.926,221.926,221.926,...	8	5	2
86214	13201	595	221.926,221.926,221.926,221.926,221.926,...	10	4	2
86214	13201	596	221.926,221.926,221.926,221.926,221.926,...	13	3	2
86214	13201	597	221.926,221.926,221.926,221.926,221.926,...	20	2	2
86267	13204	598	225.165,224.580,224.938,224.308,225.044,...	20	1	2
86286	13205	598	225.165,224.580,224.938,224.308,225.044,...	20	1	2
86267	13204	599	224.404,225.738,225.440,225.238,225.642,...	25	1	2
86286	13205	599	224.404,225.738,225.440,225.238,225.642,...	25	1	2
86286	13205	600	224.528,223.913,223.168,223.600,223.543,...	202	1	2
90183	14711	600	224.528,223.913,223.168,223.600,223.543,...	202	1	2
86301	13206	601	224.859,224.867,226.116,224.646,225.325,...	24	1	2
86321	13207	601	224.859,224.867,226.116,224.646,225.325,...	24	1	2
86301	13206	602	225.917,223.577,226.108,224.674,224.310,...	25	1	2
86321	13207	602	225.917,223.577,226.108,224.674,224.310,...	25	1	2
86301	13206	603	225.334,223.790,225.338,224.614,224.736,...	30	1	2
86321	13207	603	225.334,223.790,225.338,224.614,224.736,...	30	1	2
86321	13207	604	224.458,225.362,225.325,223.613,224.104,...	141	1	2
90216	14715	604	224.458,225.362,225.325,223.613,224.104,...	141	1	2
20630	2743	141	152.281,150.907,150.698,150.053,150.627,...	18	2	12
20638	2744	142	151.198,152.752,153.627,152.940,153.770,...	11	2	12
20638	2744	143	154.346,154.181,154.752,155.696,154.447,...	17	2	12
54588	7609	337	143.977,143.956,143.338,144.629,144.283,...	718	1	13
54652	7615	337	143.977,143.956,143.338,144.629,144.283,...	718	1	13
54588	7609	338	145.173,145.005,145.319,144.804,145.353,...	33	1	13
54632	7613	338	145.173,145.005,145.319,144.804,145.353,...	33	1	13
54652	7615	338	145.173,145.005,145.319,144.804,145.353,...	33	1	13
54588	7609	340	143.156,142.841,143.553,143.867,143.473,...	85	1	13
54704	7628	340	143.156,142.841,143.553,143.867,143.473,...	85	1	13
54588	7609	341	145.241,145.508,144.911,146.304,146.252,...	52	1	13
54692	7625	341	145.241,145.508,144.911,146.304,146.252,...	52	1	13
54588	7609	342	144.714,139.206,127.892,115.179,104.109,...	150	1	13
54632	7613	342	144.714,139.206,127.892,115.179,104.109,...	150	1	13
54696	7626	342	144.714,139.206,127.892,115.179,104.109,...	150	1	13
54632	7613	343	154.409,147.334,141.692,142.050,144.915,...	284	1	13
54656	7616	343	154.409,147.334,141.692,142.050,144.915,...	284	1	13
54632	7613	344	142.685,143.215,144.851,144.240,143.333,...	39	1	13
54704	7628	344	142.685,143.215,144.851,144.240,143.333,...	39	1	13
54632	7613	345	144.070,144.028,143.956,144.436,146.122,...	94	1	13
54704	7628	345	144.070,144.028,143.956,144.436,146.122,...	94	1	13
54632	7613	346	147.774,149.140,149.525,149.096,148.176,...	215	1	13
54696	7626	346	147.774,149.140,149.525,149.096,148.176,...	215	1	13
54632	7613	347	145.616,145.465,145.551,146.282,144.007,...	187	1	13
54688	7624	347	145.616,145.465,145.551,146.282,144.007,...	187	1	13
21226	2867	145	188.459,187.742,187.697,189.650,191.259,...	287	1	14
89161	14273	145	188.459,187.742,187.697,189.650,191.259,...	287	1	14
21502	2936	146	186.157,186.133,187.308,186.718,186.533,...	226	1	14
88102	13778	146	186.157,186.133,187.308,186.718,186.533,...	226	1	14
71964	10292	497	151.715,151.036,149.341,149.186,150.150,...	1019	1	14
84273	12888	497	151.715,151.036,149.341,149.186,150.150,...	1019	1	14
83472	12678	552	152.279,151.120,150.624,148.592,148.419,...	915	1	14
89517	14365	552	152.279,151.120,150.624,148.592,148.419,...	915	1	14
83583	12705	553	155.377,155.496,154.062,154.284,155.173,...	352	1	14
90391	14782	553	155.377,155.496,154.062,154.284,155.173,...	352	1	14
84630	13006	554	149.249,150.050,148.514,149.768,151.788,...	254	1	14
88763	14043	554	149.249,150.050,148.514,149.768,151.788,...	254	1	14
84638	13009	555	146.573,145.972,147.332,147.527,148.048,...	255	1	14

LAS File ID	Unique LAS File ID	Pattern ID	Pattern	Pattern Length	Occurrence	Assigned to Manual Analysis ID
88764	14044	555	146.573,145.972,147.332,147.527,148.048,...	255	1	14
84766	13052	556	181.248,181.337,182.774,182.434,181.821,...	289	1	14
88765	14045	556	181.248,181.337,182.774,182.434,181.821,...	289	1	14
85165	13118	575	218.895,219.067,218.931,219.482,219.198,...	438	1	14
88621	13971	575	218.895,219.067,218.931,219.482,219.198,...	438	1	14
86882	13369	608	116.499,117.025,116.474,117.076,116.302,...	818	1	14
86894	13372	608	116.499,117.025,116.474,117.076,116.302,...	818	1	14
86886	13370	609	220.770,221.991,221.220,219.644,220.406,...	286	1	14
86900	13375	609	220.770,221.991,221.220,219.644,220.406,...	286	1	14
88121	13787	612	143.021,143.298,143.009,144.569,144.351,...	258	1	14
89578	14396	612	143.021,143.298,143.009,144.569,144.351,...	258	1	14
88122	13788	613	143.865,144.348,145.704,146.502,147.508,...	257	1	14
89579	14397	613	143.865,144.348,145.704,146.502,147.508,...	257	1	14
88123	13789	614	150.245,149.933,150.202,150.199,150.743,...	246	1	14
89580	14398	614	150.245,149.933,150.202,150.199,150.743,...	246	1	14
88331	13855	615	217.773,216.601,216.349,217.050,218.011,...	252	1	14
89725	14511	615	217.773,216.601,216.349,217.050,218.011,...	252	1	14
88332	13856	616	116.269,116.704,116.804,116.926,116.300,...	1044	1	14
89726	14512	616	116.269,116.704,116.804,116.926,116.300,...	1044	1	14
90331	14745	685	199.034,199.512,199.998,198.571,199.824,...	31	2	15
12669	1820	106	159.798,160.170,162.873,162.290,160.616,...	882	1	21
89723	14509	106	159.798,160.170,162.873,162.290,160.616,...	882	1	21
19164	2499	125	185.410,183.780,184.872,185.106,185.889,...	171	1	21
19224	2508	125	185.410,183.780,184.872,185.106,185.889,...	171	1	21
19172	2500	126	187.261,186.644,186.459,187.412,188.453,...	441	1	21
19236	2510	126	187.261,186.644,186.459,187.412,188.453,...	441	1	21
19180	2501	127	176.190,178.165,177.847,178.002,179.938,...	40	1	21
19242	2511	127	176.190,178.165,177.847,178.002,179.938,...	40	1	21
19200	2504	128	188.603,188.151,187.816,187.569,188.017,...	179	1	21
19248	2512	128	188.603,188.151,187.816,187.569,188.017,...	179	1	21
19206	2505	129	189.805,189.894,191.442,191.139,191.780,...	439	1	21
19254	2513	129	189.805,189.894,191.442,191.139,191.780,...	439	1	21
19212	2506	130	188.556,188.582,187.766,187.065,186.508,...	441	1	21
19260	2514	130	188.556,188.582,187.766,187.065,186.508,...	441	1	21
19218	2507	131	185.499,184.665,183.571,184.163,184.515,...	443	1	21
19266	2515	131	185.499,184.665,183.571,184.163,184.515,...	443	1	21
19230	2509	132	188.632,189.296,188.360,186.553,189.878,...	444	1	21
19278	2517	132	188.632,189.296,188.360,186.553,189.878,...	444	1	21
26888	3740	165	196.415,197.424,197.894,199.969,197.453,...	1043	1	21
90079	14683	165	196.415,197.424,197.894,199.969,197.453,...	1043	1	21
26910	3742	166	182.158,178.801,172.697,168.470,159.975,...	1042	1	21
90081	14685	166	182.158,178.801,172.697,168.470,159.975,...	1042	1	21
26921	3743	167	177.907,174.538,168.298,160.848,158.778,...	105	1	21
90084	14688	167	177.907,174.538,168.298,160.848,158.778,...	105	1	21
26932	3744	168	159.186,160.234,161.731,162.908,161.874,...	507	1	21
90086	14690	168	159.186,160.234,161.731,162.908,161.874,...	507	1	21
27092	3755	169	180.892,176.564,166.898,159.484,155.277,...	105	1	21
90082	14686	169	180.892,176.564,166.898,159.484,155.277,...	105	1	21
27438	3785	170	203.610,201.599,193.305,188.140,176.881,...	507	1	21
90080	14684	170	203.610,201.599,193.305,188.140,176.881,...	507	1	21
27453	3786	171	169.233,170.478,167.649,167.182,168.082,...	105	1	21
90083	14687	171	169.233,170.478,167.649,167.182,168.082,...	105	1	21
27468	3787	172	166.187,169.308,170.607,170.715,171.226,...	105	1	21
90085	14689	172	166.187,169.308,170.607,170.715,171.226,...	105	1	21
27720	3810	175	202.172,203.485,205.014,203.270,196.921,...	220	1	21
90090	14692	175	202.172,203.485,205.014,203.270,196.921,...	220	1	21
52905	7358	325	148.630,150.810,150.830,150.162,148.165,...	1172	1	21

LAS File ID	Unique LAS File ID	Pattern ID	Pattern	Pattern Length	Occurrence	Assigned to Manual Analysis ID
90379	14770	325	148.630,150.810,150.830,150.162,148.165,...	1172	1	21
62664	8712	386	155.179,154.885,154.393,153.366,153.923,...	326	1	21
90224	14717	386	155.179,154.885,154.393,153.366,153.923,...	326	1	21
68466	9620	479	181.376,182.228,182.297,180.606,179.895,...	2247	1	21
90223	14716	479	181.376,182.228,182.297,180.606,179.895,...	2247	1	21
72680	10436	506	152.256,151.866,151.820,152.475,153.711,...	640	1	21
89724	14510	506	152.256,151.866,151.820,152.475,153.711,...	640	1	21
30760	4212	182	158.073,158.089,156.673,157.384,157.495,...	585	1	26
89632	14429	182	158.073,158.089,156.673,157.384,157.495,...	585	1	26
31023	4252	183	159.947,160.497,160.984,160.546,158.085,...	625	1	26
89646	14436	183	159.947,160.497,160.984,160.546,158.085,...	625	1	26
31032	4253	184	157.788,157.707,158.829,158.323,157.005,...	434	1	26
89648	14437	184	157.788,157.707,158.829,158.323,157.005,...	434	1	26
31166	4267	185	161.088,163.330,159.716,159.757,159.192,...	216	1	26
89650	14438	185	161.088,163.330,159.716,159.757,159.192,...	216	1	26
84842	13069	570	227.241,227.445,228.193,226.796,227.650,...	318	1	27
90388	14779	570	227.241,227.445,228.193,226.796,227.650,...	318	1	27
85020	13097	571	218.134,218.278,217.380,218.670,218.176,...	222	1	27
88761	14041	571	218.134,218.278,217.380,218.670,218.176,...	222	1	27
89745	14519	571	218.134,218.278,217.380,218.670,218.176,...	222	1	27
85167	13119	576	217.590,218.624,218.873,217.982,218.790,...	302	1	27
89501	14355	576	217.590,218.624,218.873,217.982,218.790,...	302	1	27
88120	13786	611	142.691,142.282,144.082,143.743,144.830,...	259	1	28
89576	14395	611	142.691,142.282,144.082,143.743,144.830,...	259	1	28
86890	13371	610	223.198,225.374,226.032,224.721,226.319,...	10	1	29
86902	13376	610	223.198,225.374,226.032,224.721,226.319,...	10	1	29
85073	13110	572	216.864,215.610,217.936,219.440,219.777,...	356	1	31
88311	13843	572	216.864,215.610,217.936,219.440,219.777,...	356	1	31

LS Files Flagged for Pattern Matching

LS File ID	Unique LS File ID	Pattern ID	Pattern	Pattern Length	Occurrence	Assigned to Manual Analysis ID
19592	5333	227	167.140,167.730,167.770,167.080,167.270,...	14	1	21
20634	6216	227	167.140,167.730,167.770,167.080,167.270,...	14	1	21
18262	4212	176	152.290,153.150,153.560,154.420,153.910,...	281	1	21
21330	6882	176	152.290,153.150,153.560,154.420,153.910,...	281	1	21
18497	4445	199	149.680,149.330,149.610,150.990,150.470,...	173	1	21
21332	6884	199	149.680,149.330,149.610,150.990,150.470,...	173	1	21
20982	6557	240	145.970,146.060,145.790,146.100,145.830,...	254	1	21
21382	6933	240	145.970,146.060,145.790,146.100,145.830,...	254	1	21
19917	5656	230	145.870,147.090,146.670,146.520,145.710,...	524	1	21
21352	6903	230	145.870,147.090,146.670,146.520,145.710,...	524	1	21
15885	3468	168	145.030,145.940,144.960,145.270,145.210,...	413	1	21
15946	3479	168	145.030,145.940,144.960,145.270,145.210,...	413	1	21

E.2 Pattern Matching – File Rename

LAS Files Flagged for File Rename

LAS File ID	LAS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
86830	13345	P72T4.LAS, P69T4.LAS	18
3580	549	psmrw2t1.LAS, psmrw2p126t1.LAS	43
3588	550	psmrw2t2.LAS, psmrw2p126t2.LAS	43
16937	2164	A1-T1.LAS, A1, P1-T1.LAS	43
16944	2165	A1-T2.LAS, A1, P1-T2.LAS	43
16951	2166	A2-T1.LAS, A1, P2-T1.LAS	43
16958	2167	A2-T2.LAS, A1, P2-T2.LAS	43
60263	8484	T1.LAS, Pile 1T1.LAS	43
60279	8485	T2.LAS, Pile 1T2.LAS	43
60294	8486	T3.LAS, Pile 1T3.LAS	43
60311	8487	T4.LAS, Pile 1T4.LAS	43
60326	8488	T1.LAS, Pile 2T1.LAS	43
60342	8489	T2.LAS, Pile 2T2.LAS	43
60358	8490	T3.LAS, Pile 2T3.LAS	43
60374	8491	T4.LAS, Pile 2T4.LAS	43
60390	8492	T1.LAS, Pile 3T1.LAS	43
60406	8493	T2.LAS, Pile 3T2.LAS	43
60421	8494	T3.LAS, Pile 3T3.LAS	43
60437	8495	T4.LAS, Pile 3T4.LAS	43
60453	8496	T1.LAS, Pile 4T1.LAS	43
60469	8497	T2.LAS, Pile 4T2.LAS	43
60485	8498	T3.LAS, Pile 4T3.LAS	43
60500	8499	T4.LAS, Pile 4T4.LAS	43
60516	8500	T1.LAS, Pile 5T1.LAS	43
60532	8501	T2.LAS, Pile 5T2.LAS	43
60547	8502	T3.LAS, Pile 5T3.LAS	43
60563	8503	T4.LAS, Pile 5T4.LAS	43
60579	8504	T2.LAS, P1 T2.LAS	43
60594	8505	T3.LAS, P1 T3.LAS	43
60609	8506	T4.LAS, P1 T4.LAS	43
60624	8507	TI.LAS, P1 TI.LAS	43
60639	8508	T1.LAS, P2 T1.LAS	43
60654	8509	T2.LAS, P2 T2.LAS	43
60669	8510	T3.LAS, P2 T3.LAS	43
60684	8511	T4.LAS, P2 T4.LAS	43
60700	8512	T1.LAS, P3 T1.LAS	43
60716	8513	T2.LAS, P3 T2.LAS	43
60731	8514	t3.LAS, P3 t3.LAS	43
60747	8515	T4.LAS, p3T4.LAS	43
60763	8516	T1.LAS, P4 T1.LAS	43
60778	8517	T2.LAS, P4 T2.LAS	43
60793	8518	T3.LAS, P4 T3.LAS	43
60808	8519	T4.LAS, P4 T4.LAS	43
60823	8520	T2.LAS, P5 T2.LAS	43
60839	8521	T3.LAS, P5 T3.LAS	43
60854	8522	T4.LAS, P5 T4.LAS	43
60869	8523	ta1.LAS, p5 ta1.LAS	43
61079	8548	T1.LAS, Pile 1 T1.LAS	43
61097	8549	T2.LAS, Pile 1 T2.LAS	43
61115	8550	T3.LAS, Pile 1 T3.LAS	43
61134	8551	T4.LAS, Pile 1 T4.LAS	43
61153	8552	T1.LAS, Pile 2 T1.LAS	43

LAS File ID	LAS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
61171	8553	T2.LAS, Pile 2 T2.LAS	43
61189	8554	T3.LAS, Pile 2 T3.LAS	43
61209	8555	T4.LAS, Pile 2 T4.LAS	43
61227	8556	T1.LAS, Pile 3 T1.LAS	43
61245	8557	T2.LAS, Pile 3 T2.LAS	43
61263	8558	T3.LAS, Pile 3 T3.LAS	43
61281	8559	T4.LAS, Pile 3 T4.LAS	43
61299	8560	T1.LAS, Pile 4 T1.LAS	43
61317	8561	T2.LAS, Pile 4 T2.LAS	43
61335	8562	T3.LAS, Pile 4 T3.LAS	43
61353	8563	T4.LAS, Pile 4 T4.LAS	43
61373	8564	T1.LAS, Pile 5 T1.LAS	43
61392	8565	T2.LAS, Pile 5 T2.LAS	43
61411	8566	T3.LAS, Pile 5 T3.LAS	43
61430	8567	T4.LAS, Pile 5 T4.LAS	43
65042	9023	T2A.LAS, T2.LAS	43
19417	2533	OSB20P3T2.LAS.LAS, OSB20P3T2.LAS	44
27118	3757	P4-T1.LAS, P4-T1 Bad Data.LAS	45
53966	7543	rivbent8t4 after removal of stuck dummy probe.LAS, B8T4.LAS	45
70047	9859	T1.LAS, T1(water in tube).LAS	45
75338	11107	BNT5RTP1T1.LAS, BNT5RTP1T1 (short data need retest).LAS	45
75428	11116	CAUCB5P1T1.LAS, CAUCB5P1T1 (retest data).LAS	45
76861	11433	A1P1T4retested.LAS, A1P1T4.LAS	45
76862	11433	A1P1T4.LAS, A1P1T4 retested.LAS	45
84926	13086	DO NOT USE block#5.LAS, block#5.LAS	45
40279	5662	P51T2.LAS, P50T2.LAS	52
87801	13689	P51T2.LAS, P2STG2RT.LAS	52
2793	407	sw2p136t1.LAS, sw2p135t1.LAS	63
16962	2168	B2-T1.LAS, B1-T1.LAS	63
16969	2169	B2-T2.LAS, B1-T2.LAS	63
16976	2170	B2-T3.LAS, B1-T3.LAS	63
16983	2171	B2-T4.LAS, B1-T4.LAS	63
16990	2172	B3-T1.LAS, B2-T1.LAS	63
16997	2173	B3-T2.LAS, B2-T2.LAS	63
17004	2174	B3-T3.LAS, B2-T3.LAS	63
17011	2175	B3-T4.LAS, B2-T4.LAS	63
30973	4247	B6LP4T1.LAS, B6LP 3T1.LAS	63
30984	4248	B6LP4T2.LAS, B6LP 3T2.LAS	63
30995	4249	B6LP4T3.LAS, B6LP 3T3.LAS	63
31006	4250	B6LP4T4.LAS, B6LP 3T4.LAS	63
31017	4251	B6LP4T5.LAS, B6LP 3T5.LAS	63
31046	4254	B6LP3T1.LAS, B6LP 4T1.LAS	63
31057	4255	B6LP3T2.LAS, B6LP 4T2.LAS	63
31068	4256	B6LP3T3.LAS, B6LP 4T3.LAS	63
31079	4257	B6LP3T4.LAS, B6LP 4T4.LAS	63
31090	4258	B6LP3T5.LAS, B6LP 4T5.LAS	63
31101	4259	B6LP3T6.LAS, B6LP 4T6.LAS	63
31112	4260	B6LP3T7.LAS, B6LP 4T7.LAS	63
33870	4690	PV4L T7.LAS, PV4L T6.LAS	63
33877	4691	PV4L T7.LAS, PV4L T7 A.LAS	63
38497	5420	HUEROB3P26T1.LAS, HUEROB2P26T1.LAS	63
38506	5421	HUEROB3P26T2.LAS, HUEROB2P26T2.LAS	63
38515	5422	HUEROB3P27T1.LAS, HUEROB2P27T1.LAS	63
38524	5423	HUEROB3P27T2.LAS, HUEROB2P27T2.LAS	63
46145	6428	la101bd5p2t1.LAS, la101bd4p1t01.LAS	63
46151	6429	la101bd5p2t2.LAS, la101bd4p1t02.LAS	63
46157	6430	la101bd5p2t3.LAS, la101bd4p1t03.LAS	63

LAS File ID	LAS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
46163	6431	la101bd5p2t4.LAS, la101bd4p1t04.LAS	63
46169	6432	la101bd5p2t5.LAS, la101bd4p1t05.LAS	63
46175	6433	la101bd5p2t6.LAS, la101bd4p1t06.LAS	63
46181	6434	la101bd5p2t7.LAS, la101bd4p1t07.LAS	63
46187	6435	la101bd5p2t8.LAS, la101bd4p1t08.LAS	63
46193	6436	la101bd5p2t9.LAS, la101bd4p1t09.LAS	63
46199	6437	la101bd5p2t10.LAS, la101bd4p1t10.LAS	63
46205	6438	la101bd5p2t11.LAS, la101bd4p1t11.LAS	63
64077	8905	I15P3RT4.LAS, I15P3RT1.LAS	63
66532	9321	BMP10P3T1.LAS, BMP10P2T1.LAS	63
66540	9322	BMP10P3T2.LAS, BMP10P2T2.LAS	63
66548	9323	BMP10P3T3.LAS, BMP10P2T3.LAS	63
66556	9324	BMP10P3T4.LAS, BMP10P2T4.LAS	63
66564	9325	BMP10P3T5.LAS, BMP10P2T5.LAS	63
66572	9326	BMP10P3T6.LAS, BMP10P2T6.LAS	63
66580	9327	BMP10P3T7.LAS, BMP10P2T7.LAS	63
66588	9328	BMP10P3T8.LAS, BMP10P2T8.LAS	63
71631	10179	B3W P1.LAS, B2W P1 T1.LAS	63
71634	10180	B3W P2.LAS, B2W P1 T2.LAS	63
71637	10181	B3W P2 T1.LAS, B2W P2 T1.LAS	63
71640	10182	B3W P2 T2.LAS, B2W P2 T2.LAS	63
71643	10183	B3W P3 T1.LAS, B2W P3 T1.LAS	63
71646	10184	B3W P3 T2.LAS, B2W P3 T2.LAS	63
71649	10185	B3W P4 T1.LAS, B2W P4 T1.LAS	63
71652	10186	B3W P4 T2.LAS, B2W P4 T2.LAS	63
71655	10187	B3W P5 T1.LAS, B2W P5 T1.LAS	63
71658	10188	B3W P5 T2.LAS, B2W P5 T2.LAS	63
71661	10189	B3W P6 T1.LAS, B2W P6 T1.LAS	63
71664	10190	B3W P6 T2.LAS, B2W P6 T2.LAS	63
73631	10637	14MILEB6P1T1.LAS, 14MILEB5P1T1.LAS	63
73637	10638	14MILEB6P1T2.LAS, 14MILEB5P1T2.LAS	63
73643	10639	14MILEB6P2T1.LAS, 14MILEB5P2T1.LAS	63
73649	10640	14MILEB6P2T2.LAS, 14MILEB5P2T2.LAS	63
73655	10641	14MILEB6P3T1.LAS, 14MILEB5P3T1.LAS	63
73661	10642	14MILEB6P3T2.LAS, 14MILEB5P3T2.LAS	63
73987	10737	HS B4L P1 T2.LAS, HS B4L P1 T1.LAS	63
73989	10738	HS B4L P1 T1A.LAS, HS B4L P1 T1.LAS	63
80209	11995	sawp14t3.LAS, saw14t3.LAS	63
84692	13027	MCA5P5T1.LAS, MCA4P5T1.LAS	63
84728	13039	MCB4T4.LAS, MCB3P4T4.LAS	63
87893	13727	p11t1.LAS, p10t1.LAS	63
87897	13728	p11t2.LAS, p10t2.LAS	63
87899	13729	p11t1.LAS, p10t1.LAS	63
87903	13730	p11t2.LAS, p10t2.LAS	63
87907	13731	p11t2a.LAS, p10t2a.LAS	63
89832	14570	CRB5AP4T1.LAS, CBB5AP4T1.LAS	63
5496	829	ThomasCrkA1P3T1.LAS, ThomasCrkA1P3.LAS	64
16419	2100	BMB19P11T1-04.LAS, BMB19P11T1.LAS	65
16451	2101	BMB19P11T2-04.LAS, BMB19P11T2.LAS	65
16483	2102	BMB19P12T1-04.LAS, BMB19P12T1.LAS	65
16515	2103	BMB19P12T2-04.LAS, BMB19P12T2.LAS	65
16545	2104	BMB19P4T1-04.LAS, BMB19P4T1.LAS	65
16565	2105	BMB19P4T2-04.LAS, BMB19P4T2.LAS	65
16585	2106	BMB19P4T3-04.LAS, BMB19P4T3.LAS	65
16605	2107	BMB19P4T4-04.LAS, BMB19P4T4.LAS	65
25403	3510	92880RWF1P217T1Old.LAS, 92880RWF1P217T1.LAS	65
25410	3511	92880RWF1P217T2Old.LAS, 92880RWF1P217T2.LAS	65

LAS File ID	LAS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
25736	3553	P67T2.LAS, P67T1.LAS	65
25750	3555	P78T1R.LAS, P78T1.LAS	65
68281	9609	P14P3T6R.LAS, P14P3T6.LAS	65
65201	9057	SR76A10P1T2b.LAS, BENT4.LAS	66
65207	9057	BENT4.LAS, BENT1K.LAS	66
65208	9057	BENT1K.LAS, 147.5.LAS	66
87591	13653	PILE3.LAS, BENT34L.LAS	66
87592	13653	BENT34L.LAS, 1234.LAS	66
88098	13777	p167.LAS, lhba6p.LAS	66
88099	13777	P174T@.LAS, p167.LAS	66
88467	13925	hb1p1t1.LAS, 4.LAS	66
88468	13925	hb1p1t2.LAS, hb1p1t1.LAS	66
70769	9970	RRCBA2P1T2.LAS, Dc536.LAS	67
89609	14418	block 7 cert 1273-3552-568 H.LAS, block 7 cert 1273-3552-568 H 1Feb08.LAS	68
89613	14419	block 7 cert 1273-3552-568 V.LAS, block 7 cert 1273-3552-568 V 1Feb08.LAS	68
25601	3538	92880RWF1P231T2.LAS, 92880RWF1P231T1.LAS	69
25617	3539	92880RWF1P233T2.LAS, 92880RWF1P232T1.LAS	69
65051	9025	T4.LAS, T2.LAS	70

LS Files Flagged for File Rename

LS File ID	LS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
20837	6416	33ws92r.t3, 33b92r.t3	43
21014	6588	33ws92r.t4, 33b92r.t4	43
21099	6669	33ws92r.t5, 33b92r.t5	43
7746	2059	NYP3P11.SA1, NYP3P1~1.SA1	46
7751	2060	NYP3P11.SA3, NYP3P1~1.SA3	46
7756	2061	NYP3P1-1.SA5, NYP3P1~1.SA5	46
7761	2062	NYP3P1-1.SA7, NYP3P1~1.SA7	46
7770	2063	NYP3P2~11.SA1, NYP3P2~1.SA1	46
7766	2063	NYP3P2-1.SA1, NYP3P2~11.SA1	46
7768	2063	Nyp3p24t1.sa1, NYP3P2-1.SA1	46
7775	2064	NYP3P2~21.SA1, NYP3P2~2.SA1	46
7771	2064	NYP3P2-2.SA1, NYP3P2~21.SA1	46
7776	2065	NYP3P3-1.SA1, NYP3P3~1.SA1	46
7781	2066	NYP3P3-2.SA1, NYP3P3~2.SA1	46
7790	2067	NYP3P2~11.SA3, NYP3P2~1.SA3	46
7786	2067	NYP3P2-1.SA3, NYP3P2~11.SA3	46
7788	2067	Nyp3p24t2.sa3, NYP3P2-1.SA3	46
7795	2068	NYP3P2~21.SA3, NYP3P2~2.SA3	46
7791	2068	NYP3P2-2.SA3, NYP3P2~21.SA3	46
7796	2069	NYP3P3-2.SA3, NYP3P3~2.SA3	46
7805	2070	NYP3P2~11.SA5, NYP3P2~1.SA5	46
7801	2070	NYP3P2-1.SA5, NYP3P2~11.SA5	46
7803	2070	Nyp3p24t3.sa5, NYP3P2-1.SA5	46
7810	2071	NYP3P2~21.SA5, NYP3P2~2.SA5	46
7806	2071	NYP3P2-2.SA5, NYP3P2~21.SA5	46
7811	2072	NYP3P3-1.SA5, NYP3P3~1.SA5	46
7816	2073	NYP3P2-1.SA7, NYP3P2~1.SA7	46
7821	2074	NYP3P2-2.SA7, NYP3P2~2.SA7	46
7826	2075	NYP3P3-1.SA7, NYP3P3~1.SA7	46
11951	2836	A0045596.TB, A0045594.TB	47
11952	2836	A0045620.TB, A0045596.TB	47

LS File ID	LS Unique ID	Details of Filename Change	Assigned to Manual Analysis ID
11941	2836	NBB19P3.TB, A0045620.TB	47
11967	2837	A0045597.TB, A0045595.TB	47
11968	2837	A0045621.TB, A0045597.TB	47
11957	2837	NBB19P6.TB, A0045621.TB	47
12161	2848	A0045599.TB, A0045598.TB	47
12162	2848	A0045622.TB, A0045599.TB	47
12146	2848	BMB19P1.TB, A0045622.TB	47
13613	3186	SW250P2.TB, A0037610.TB	47
21446	6995	WL20-62.SA1, WL20-62.BAK	47
3052	1213	SMC1A.SA1, B2lp1at1.sa1	73
3059	1214	SMB2LP1AT1.SA1, B2lP3aT1.sa1	73
3066	1215	SMC1A.SA3, B2lP1aT2.sa3	73
3069	1216	B2lP3at2.sa3, B2LP1AT2.SA3	73
3080	1217	SMC1A.SA5, B2lP1aT3.sa5	73
3083	1218	B2lP3aT3.sa5, B2LP1AT3.SA5	73
3238	1242	B2rP4aT3, B2R2.SA5	73
3245	1243	B2rP5aT3, B2R2.SAD	73
3252	1244	B2rP4aT1.sa1, B2R2.SA1	73
3266	1246	B2rP4aT2.sa3, B2R2.SA3	73
3295	1251	B2rP5aT1.sa8, B2R2.SA8	73
3309	1253	B2rP5aT2.saa, B2R2.SAA	73
3554	1290	B3LP6BT3.SA5, B3LA.SA5	73
3994	1357	B4lP4bT2.sad, B2lP4bT2.sad	73
4001	1358	B4lP6bT1.saf, B2lP6bT1.saf	73
4008	1359	B4lP6bT2.sah, B2lP6bT2.sah	73
4015	1360	B4lP6bT3.saj, B2lP6bT3.saj	73
4050	1365	B3rP4aT2q1.sa3, B3rP4aT2.sa3	73

E.3 Time Stamp RD-LAS

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
18104	2757	Time Difference: 3 21:44:16 LAST MODIFIED: 2004-01-17 10:25:12	1
18110	2758	Time Difference: 3 21:25:1 LAST MODIFIED: 2004-01-17 10:46:12	1
18116	2759	Time Difference: 3 21:6:56 LAST MODIFIED: 2004-01-17 11:05:12	1
18122	2760	Time Difference: 3 20:45:45 LAST MODIFIED: 2004-01-17 11:27:08	1
18128	2761	Time Difference: 3 20:29:59 LAST MODIFIED: 2004-01-17 11:43:42	1
18134	2762	Time Difference: 3 20:8:45 LAST MODIFIED: 2004-01-17 12:05:36	1
18140	2763	Time Difference: 3 19:50:39 LAST MODIFIED: 2004-01-17 12:24:28	1
18146	2764	Time Difference: 3 19:32:26 LAST MODIFIED: 2004-01-17 12:43:20	1
18104	9788	Time Difference: 3 21:44:16 LAST MODIFIED: 2004-01-21 08:09:28	1
18110	9789	Time Difference: 3 21:25:1 LAST MODIFIED: 2004-01-21 08:11:14	1
18116	9790	Time Difference: 3 21:6:56 LAST MODIFIED: 2004-01-21 08:12:08	1
18122	9791	Time Difference: 3 20:45:45 LAST MODIFIED: 2004-01-21 08:12:54	1
18128	9792	Time Difference: 3 20:29:59 LAST MODIFIED: 2004-01-21 08:13:42	1
18134	9793	Time Difference: 3 20:8:45 LAST MODIFIED: 2004-01-21 08:14:22	1
18140	9794	Time Difference: 3 19:50:39 LAST MODIFIED: 2004-01-21 08:15:08	1
18146	9795	Time Difference: 3 19:32:26 LAST MODIFIED: 2004-01-21 08:15:46	1
39020	10862	Time Difference: 0 3:55:33 LAST MODIFIED: 2007-01-24 21:11:26	2
39130	10889	Time Difference: 0 2:5:31 LAST MODIFIED: 2007-02-23 21:04:04	2
39558	11000	Time Difference: 0 3:11:41 LAST MODIFIED: 2007-01-24 21:30:32	2
39618	11005	Time Difference: 0 3:55:40 LAST MODIFIED: 2007-01-24 20:51:32	2
39642	11007	Time Difference: 0 3:30:43 LAST MODIFIED: 2007-01-24 21:20:42	2
39901	11430	Time Difference: 0 4:2:57 LAST MODIFIED: 2007-01-24 20:31:30	2
39937	11433	Time Difference: 0 4:18:30 LAST MODIFIED: 2007-01-24 20:42:32	2
39998	11443	Time Difference: 0 4:17:30 LAST MODIFIED: 2007-02-23 18:58:28	2
39558	13111	Time Difference: 0 3:11:41 LAST MODIFIED: 2007-01-25 00:42:14	2
39130	13175	Time Difference: 0 2:5:31 LAST MODIFIED: 2007-02-23 23:09:36	2
39998	13186	Time Difference: 0 4:17:30 LAST MODIFIED: 2007-02-23 23:15:58	2
39901	13193	Time Difference: 0 4:2:57 LAST MODIFIED: 2007-01-25 00:34:28	2
39618	13199	Time Difference: 0 3:55:40 LAST MODIFIED: 2007-01-25 00:47:12	2
39642	13201	Time Difference: 0 3:30:43 LAST MODIFIED: 2007-01-25 00:51:26	2
39937	13205	Time Difference: 0 4:18:30 LAST MODIFIED: 2007-01-25 01:01:02	2
39020	13207	Time Difference: 0 3:55:33 LAST MODIFIED: 2007-01-25 01:07:00	2
34325	4233	Time Difference: 0 0:32:34 LAST MODIFIED: 2007-06-13 10:51:33	23
34325	7574	Time Difference: 0 0:32:34 LAST MODIFIED: 2007-06-13 10:18:59	23
26254	4952	Time Difference: 2 3:36:27 LAST MODIFIED: 2005-05-11 21:29:54	41
26267	4953	Time Difference: 2 3:35:42 LAST MODIFIED: 2005-05-11 21:41:16	41
26280	4954	Time Difference: 2 3:35:11 LAST MODIFIED: 2005-05-11 21:53:34	41
26293	4955	Time Difference: 4 18:25:50 LAST MODIFIED: 2005-05-11 22:05:42	41
26307	4956	Time Difference: 2 2:8:5 LAST MODIFIED: 2005-05-11 22:16:34	41
26320	4957	Time Difference: 2 2:6:11 LAST MODIFIED: 2005-05-11 22:28:52	41
26333	4958	Time Difference: 2 1:38:15 LAST MODIFIED: 2005-05-11 22:39:52	41
26346	4959	Time Difference: 4 16:56:28 LAST MODIFIED: 2005-05-11 22:53:48	41
26372	4961	Time Difference: 4 19:59:48 LAST MODIFIED: 2005-05-11 19:56:30	41
26386	4962	Time Difference: 2 3:45:46 LAST MODIFIED: 2005-05-11 20:16:38	41
26399	4963	Time Difference: 2 4:16:14 LAST MODIFIED: 2005-05-11 20:26:36	41
26412	4964	Time Difference: 2 4:13:32 LAST MODIFIED: 2005-05-11 20:36:28	41
26425	4965	Time Difference: 4 18:59:9 LAST MODIFIED: 2005-05-11 20:44:34	41
26438	4966	Time Difference: 4 18:36:4 LAST MODIFIED: 2005-05-11 20:58:22	41
26452	4967	Time Difference: 2 4:31:41 LAST MODIFIED: 2005-05-11 21:09:24	41
26254	7350	Time Difference: 2 3:36:27 LAST MODIFIED: 2005-05-14 01:06:22	41
26267	7351	Time Difference: 2 3:35:42 LAST MODIFIED: 2005-05-14 01:16:58	41
26280	7352	Time Difference: 2 3:35:11 LAST MODIFIED: 2005-05-14 01:28:46	41
26293	7353	Time Difference: 4 18:25:50 LAST MODIFIED: 2005-05-16 16:31:32	41

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
26307	7354	Time Difference: 2 2:8:5 LAST MODIFIED: 2005-05-14 00:24:40	41
26320	7355	Time Difference: 2 2:6:11 LAST MODIFIED: 2005-05-14 00:35:04	41
26333	7356	Time Difference: 2 1:38:15 LAST MODIFIED: 2005-05-14 00:18:08	41
26346	7357	Time Difference: 4 16:56:28 LAST MODIFIED: 2005-05-16 15:50:16	41
26372	7359	Time Difference: 4 19:59:48 LAST MODIFIED: 2005-05-16 15:56:18	41
26386	7360	Time Difference: 2 3:45:46 LAST MODIFIED: 2005-05-14 00:02:24	41
26399	7361	Time Difference: 2 4:16:14 LAST MODIFIED: 2005-05-14 00:42:50	41
26412	7362	Time Difference: 2 4:13:32 LAST MODIFIED: 2005-05-14 00:50:00	41
26425	7363	Time Difference: 4 18:59:9 LAST MODIFIED: 2005-05-16 15:43:44	41
26438	7364	Time Difference: 4 18:36:4 LAST MODIFIED: 2005-05-16 15:34:26	41
26452	7365	Time Difference: 2 4:31:41 LAST MODIFIED: 2005-05-14 01:41:06	41
32731	6886	Time Difference: 2 5:4:16 LAST MODIFIED: 2005-11-01 09:00:27	42
32733	6887	Time Difference: 2 4:58:51 LAST MODIFIED: 2005-11-01 09:12:51	42
32735	6888	Time Difference: 2 4:49:59 LAST MODIFIED: 2005-11-01 09:25:38	42
32737	6889	Time Difference: 2 4:42:51 LAST MODIFIED: 2005-11-01 09:36:47	42
32739	6890	Time Difference: 2 3:47:4 LAST MODIFIED: 2005-11-01 10:36:44	42
32741	6891	Time Difference: 2 4:2:48 LAST MODIFIED: 2005-11-01 10:24:54	42
32743	6892	Time Difference: 2 4:28:37 LAST MODIFIED: 2005-11-01 10:04:00	42
32745	6893	Time Difference: 2 4:47:43 LAST MODIFIED: 2005-11-01 09:51:12	42
32731	8615	Time Difference: 2 5:4:16 LAST MODIFIED: 2005-11-03 14:04:43	42
32733	8616	Time Difference: 2 4:58:51 LAST MODIFIED: 2005-11-03 14:11:43	42
32735	8617	Time Difference: 2 4:49:59 LAST MODIFIED: 2005-11-03 14:15:38	42
32737	8618	Time Difference: 2 4:42:51 LAST MODIFIED: 2005-11-03 14:19:38	42
32739	8619	Time Difference: 2 3:47:4 LAST MODIFIED: 2005-11-03 14:23:49	42
32741	8620	Time Difference: 2 4:2:48 LAST MODIFIED: 2005-11-03 14:27:43	42
32743	8621	Time Difference: 2 4:28:37 LAST MODIFIED: 2005-11-03 14:32:37	42
32745	8622	Time Difference: 2 4:47:43 LAST MODIFIED: 2005-11-03 14:38:56	42
30788	3767	Time Difference: 761 17:16:19 LAST MODIFIED: 2007-01-17 11:32:20	53
30788	5681	Time Difference: 761 17:16:19 LAST MODIFIED: 2004-12-16 18:16:00	53
33804	7267	Time Difference: 4 23:9:24 LAST MODIFIED: 2007-01-17 11:46:46	53
33808	7268	Time Difference: 62 23:24:18 LAST MODIFIED: 2007-01-17 12:01:58	53
33804	14686	Time Difference: 4 23:9:24 LAST MODIFIED: 2007-01-12 12:37:21	53
33808	14689	Time Difference: 62 23:24:18 LAST MODIFIED: 2006-11-15 12:37:40	53
131	23	Time Difference: 0 0:1:1 LAST MODIFIED: 2009-10-30 08:47:32	54
131	36	Time Difference: 0 0:1:1 LAST MODIFIED: 2009-10-30 08:48:34	54
393	66	Time Difference: 0 0:1:20 LAST MODIFIED: 2006-05-25 18:21:48	54
434	74	Time Difference: 0 0:1:58 LAST MODIFIED: 2010-01-26 10:50:24	54
393	206	Time Difference: 0 0:1:20 LAST MODIFIED: 2006-05-25 18:23:08	54
434	312	Time Difference: 0 0:1:58 LAST MODIFIED: 2010-01-26 10:52:22	54
4091	662	Time Difference: 0 0:1:52 LAST MODIFIED: 2004-12-01 08:04:02	54
4307	679	Time Difference: 0 0:1:6 LAST MODIFIED: 2008-10-02 12:14:18	54
4467	700	Time Difference: 0 0:1:58 LAST MODIFIED: 2009-11-19 11:07:02	54
4882	767	Time Difference: 0 0:1:23 LAST MODIFIED: 2010-07-01 15:46:26	54
5008	794	Time Difference: 0 0:1:0 LAST MODIFIED: 2009-11-17 13:01:58	54
5083	812	Time Difference: 0 0:1:15 LAST MODIFIED: 2009-07-08 11:49:40	54
5922	883	Time Difference: 0 0:1:18 LAST MODIFIED: 2003-11-14 11:10:14	54
6982	936	Time Difference: 0 0:1:32 LAST MODIFIED: 2003-08-01 14:28:54	54
8051	1054	Time Difference: 0 0:1:32 LAST MODIFIED: 2003-05-22 11:08:56	54
8779	1152	Time Difference: 0 0:1:26 LAST MODIFIED: 2010-03-29 15:12:00	54
37665	1200	Time Difference: 0 0:1:11 LAST MODIFIED: 2007-09-05 14:30:04	54
10067	1362	Time Difference: 0 0:1:56 LAST MODIFIED: 2008-03-07 10:41:22	54
10403	1407	Time Difference: 0 0:1:14 LAST MODIFIED: 2008-07-24 10:36:00	54
4091	1540	Time Difference: 0 0:1:52 LAST MODIFIED: 2004-12-01 08:05:54	54
35530	1550	Time Difference: 0 0:1:32 LAST MODIFIED: 2008-09-03 19:03:42	54
4307	1587	Time Difference: 0 0:1:6 LAST MODIFIED: 2008-10-02 12:15:24	54
12184	1689	Time Difference: 0 0:1:0 LAST MODIFIED: 2009-07-28 14:30:04	54

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
4467	1690	Time Difference: 0 0:1:58 LAST MODIFIED: 2009-11-19 11:09:00	54
12240	1701	Time Difference: 0 0:1:35 LAST MODIFIED: 2009-07-30 12:07:28	54
12366	1724	Time Difference: 0 0:1:38 LAST MODIFIED: 2009-07-31 10:40:18	54
4882	1826	Time Difference: 0 0:1:23 LAST MODIFIED: 2010-07-01 15:47:50	54
5008	1853	Time Difference: 0 0:1:0 LAST MODIFIED: 2009-11-17 13:02:58	54
5083	1871	Time Difference: 0 0:1:15 LAST MODIFIED: 2009-07-08 11:50:56	54
5922	1953	Time Difference: 0 0:1:18 LAST MODIFIED: 2003-11-14 11:11:32	54
13639	1964	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-01-12 08:43:52	54
6982	2057	Time Difference: 0 0:1:32 LAST MODIFIED: 2003-08-01 14:30:26	54
14660	2136	Time Difference: 0 0:1:11 LAST MODIFIED: 2008-10-21 12:21:44	54
35434	2375	Time Difference: 0 0:1:1 LAST MODIFIED: 2008-09-11 16:06:49	54
35502	2392	Time Difference: 0 0:1:16 LAST MODIFIED: 2008-09-11 14:50:59	54
35522	2397	Time Difference: 0 0:1:6 LAST MODIFIED: 2008-09-11 15:44:53	54
16393	2404	Time Difference: 0 0:1:38 LAST MODIFIED: 2007-09-11 15:46:50	54
8051	2434	Time Difference: 0 0:1:32 LAST MODIFIED: 2003-05-22 11:10:28	54
16803	2469	Time Difference: 0 0:1:1 LAST MODIFIED: 2010-05-28 14:33:20	54
39378	2649	Time Difference: 0 0:1:1 LAST MODIFIED: 2007-06-19 20:08:26	54
17628	2652	Time Difference: 0 0:1:1 LAST MODIFIED: 2004-04-11 10:42:46	54
17667	2665	Time Difference: 0 0:1:30 LAST MODIFIED: 2004-04-02 07:37:28	54
17688	2672	Time Difference: 0 0:1:34 LAST MODIFIED: 2004-04-02 07:37:20	54
17691	2673	Time Difference: 0 0:1:39 LAST MODIFIED: 2004-03-10 16:14:10	54
8779	2678	Time Difference: 0 0:1:26 LAST MODIFIED: 2010-03-29 15:13:26	54
17868	2707	Time Difference: 0 0:1:20 LAST MODIFIED: 2003-10-22 12:50:22	54
17904	2713	Time Difference: 0 0:1:54 LAST MODIFIED: 2003-10-22 15:42:40	54
18202	2790	Time Difference: 0 0:1:23 LAST MODIFIED: 2004-01-26 14:51:44	54
10067	3121	Time Difference: 0 0:1:56 LAST MODIFIED: 2008-03-07 10:43:18	54
10403	3259	Time Difference: 0 0:1:14 LAST MODIFIED: 2008-07-24 10:37:14	54
20618	3377	Time Difference: 0 0:1:7 LAST MODIFIED: 2011-10-13 14:11:02	54
21291	3536	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-10-12 17:20:02	54
38079	3547	Time Difference: 0 0:1:24 LAST MODIFIED: 2008-08-21 11:11:17	54
21830	3715	Time Difference: 0 0:1:22 LAST MODIFIED: 2011-07-18 12:10:06	54
21939	3743	Time Difference: 0 0:1:47 LAST MODIFIED: 2011-03-22 12:01:16	54
22200	3830	Time Difference: 0 0:1:27 LAST MODIFIED: 2011-06-21 15:57:54	54
38376	3854	Time Difference: 0 0:1:49 LAST MODIFIED: 2007-10-10 14:10:06	54
22447	3909	Time Difference: 0 0:1:20 LAST MODIFIED: 2010-09-30 09:13:36	54
22492	3918	Time Difference: 0 0:1:7 LAST MODIFIED: 2010-09-30 10:52:26	54
22588	3933	Time Difference: 0 0:1:14 LAST MODIFIED: 2010-09-30 14:42:02	54
22718	3961	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-10-05 17:33:32	54
23723	4229	Time Difference: 0 0:1:11 LAST MODIFIED: 2011-07-14 12:51:36	54
34330	4238	Time Difference: 0 0:1:15 LAST MODIFIED: 2007-06-13 11:23:35	54
23909	4274	Time Difference: 0 0:1:15 LAST MODIFIED: 2011-06-22 13:21:02	54
24115	4331	Time Difference: 0 0:1:52 LAST MODIFIED: 2010-10-13 14:03:52	54
24474	4418	Time Difference: 0 0:1:14 LAST MODIFIED: 2011-03-10 09:20:48	54
24486	4422	Time Difference: 0 0:1:30 LAST MODIFIED: 2011-03-09 12:58:12	54
24498	4426	Time Difference: 0 0:1:15 LAST MODIFIED: 2011-03-09 13:33:12	54
24588	4456	Time Difference: 0 0:1:22 LAST MODIFIED: 2011-03-09 11:08:54	54
24664	4476	Time Difference: 0 0:1:1 LAST MODIFIED: 2011-02-02 10:54:32	54
34441	4767	Time Difference: 0 0:1:38 LAST MODIFIED: 2007-05-22 14:00:04	54
36862	4780	Time Difference: 0 0:1:20 LAST MODIFIED: 2007-08-30 10:55:37	54
36870	4784	Time Difference: 0 0:1:34 LAST MODIFIED: 2007-08-30 12:22:30	54
36872	4785	Time Difference: 0 0:1:50 LAST MODIFIED: 2007-08-30 12:40:45	54
12184	4912	Time Difference: 0 0:1:0 LAST MODIFIED: 2009-07-28 14:31:04	54
12240	4924	Time Difference: 0 0:1:35 LAST MODIFIED: 2009-07-30 12:09:04	54
12366	4947	Time Difference: 0 0:1:38 LAST MODIFIED: 2009-07-31 10:41:56	54
13639	5486	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-01-12 08:44:56	54
29035	5537	Time Difference: 0 0:1:3 LAST MODIFIED: 2005-02-08 10:16:02	54

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
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31444	5734	Time Difference: 0 0:1:42 LAST MODIFIED: 2005-08-04 10:34:12	54
31655	5753	Time Difference: 0 0:1:47 LAST MODIFIED: 2005-08-09 09:06:20	54
29035	6695	Time Difference: 0 0:1:3 LAST MODIFIED: 2005-02-08 10:17:06	54
32678	6834	Time Difference: 0 0:1:30 LAST MODIFIED: 2006-03-14 09:34:58	54
32782	6930	Time Difference: 0 0:1:19 LAST MODIFIED: 2006-12-12 11:11:54	54
32827	6975	Time Difference: 0 0:1:38 LAST MODIFIED: 2006-04-18 10:31:26	54
33855	7287	Time Difference: 0 0:1:30 LAST MODIFIED: 2003-12-23 12:01:02	54
34104	7372	Time Difference: 0 0:1:14 LAST MODIFIED: 2009-08-06 11:23:24	54
34116	7374	Time Difference: 0 0:1:26 LAST MODIFIED: 2009-08-06 10:10:32	54
14660	7573	Time Difference: 0 0:1:11 LAST MODIFIED: 2008-10-21 12:22:56	54
34330	7579	Time Difference: 0 0:1:15 LAST MODIFIED: 2007-06-13 11:22:19	54
29414	7645	Time Difference: 0 0:1:46 LAST MODIFIED: 2005-02-09 09:18:56	54
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35368	7991	Time Difference: 0 0:1:6 LAST MODIFIED: 2011-12-20 14:31:28	54
35434	8026	Time Difference: 0 0:1:1 LAST MODIFIED: 2008-09-11 16:05:47	54
35502	8043	Time Difference: 0 0:1:16 LAST MODIFIED: 2008-09-11 14:49:42	54
35522	8048	Time Difference: 0 0:1:6 LAST MODIFIED: 2008-09-11 15:43:47	54
35530	8050	Time Difference: 0 0:1:32 LAST MODIFIED: 2008-09-03 19:02:10	54
37902	8289	Time Difference: 0 0:1:51 LAST MODIFIED: 2009-03-31 12:02:33	54
32678	8457	Time Difference: 0 0:1:30 LAST MODIFIED: 2006-03-14 09:36:28	54
36477	8495	Time Difference: 0 0:1:37 LAST MODIFIED: 2008-04-08 12:16:51	54
31444	8505	Time Difference: 0 0:1:42 LAST MODIFIED: 2005-08-04 10:35:54	54
31655	8523	Time Difference: 0 0:1:47 LAST MODIFIED: 2005-08-09 09:08:08	54
16393	8543	Time Difference: 0 0:1:38 LAST MODIFIED: 2007-09-11 15:48:28	54
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36870	8692	Time Difference: 0 0:1:34 LAST MODIFIED: 2007-08-30 12:20:56	54
36872	8693	Time Difference: 0 0:1:50 LAST MODIFIED: 2007-08-30 12:38:55	54
32827	8998	Time Difference: 0 0:1:38 LAST MODIFIED: 2006-04-18 10:33:04	54
37665	9039	Time Difference: 0 0:1:11 LAST MODIFIED: 2007-09-05 14:28:52	54
40408	9057	Time Difference: 0 0:1:11 LAST MODIFIED: 2011-12-06 19:40:29	54
16803	9074	Time Difference: 0 0:1:1 LAST MODIFIED: 2010-05-28 14:34:22	54
37902	9144	Time Difference: 0 0:1:51 LAST MODIFIED: 2009-03-31 12:00:42	54
38079	9298	Time Difference: 0 0:1:24 LAST MODIFIED: 2008-08-21 11:09:52	54
38193	9345	Time Difference: 0 0:1:6 LAST MODIFIED: 2007-01-24 10:00:11	54
38376	9459	Time Difference: 0 0:1:49 LAST MODIFIED: 2007-10-10 14:08:17	54
17628	9544	Time Difference: 0 0:1:1 LAST MODIFIED: 2004-04-11 10:43:48	54
17667	9565	Time Difference: 0 0:1:30 LAST MODIFIED: 2004-04-02 07:38:58	54
17688	9572	Time Difference: 0 0:1:34 LAST MODIFIED: 2004-04-02 07:38:54	54
17691	9573	Time Difference: 0 0:1:39 LAST MODIFIED: 2004-03-10 16:15:50	54
17868	9738	Time Difference: 0 0:1:20 LAST MODIFIED: 2003-10-22 12:51:42	54
17904	9744	Time Difference: 0 0:1:54 LAST MODIFIED: 2003-10-22 15:44:34	54
38535	9764	Time Difference: 0 0:1:20 LAST MODIFIED: 2010-04-12 09:48:18	54
18202	9829	Time Difference: 0 0:1:23 LAST MODIFIED: 2004-01-26 14:53:08	54
20618	10545	Time Difference: 0 0:1:7 LAST MODIFIED: 2011-10-13 14:12:10	54
21291	10704	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-10-12 17:21:06	54
21830	10883	Time Difference: 0 0:1:22 LAST MODIFIED: 2011-07-18 12:11:28	54
21939	10911	Time Difference: 0 0:1:47 LAST MODIFIED: 2011-03-22 12:03:04	54
39378	10964	Time Difference: 0 0:1:1 LAST MODIFIED: 2007-06-19 20:07:24	54
22200	10998	Time Difference: 0 0:1:27 LAST MODIFIED: 2011-06-21 15:59:22	54
22447	11077	Time Difference: 0 0:1:20 LAST MODIFIED: 2010-09-30 09:14:56	54
22492	11086	Time Difference: 0 0:1:7 LAST MODIFIED: 2010-09-30 10:53:34	54
22588	11101	Time Difference: 0 0:1:14 LAST MODIFIED: 2010-09-30 14:43:16	54
22718	11129	Time Difference: 0 0:1:3 LAST MODIFIED: 2010-10-05 17:34:36	54
23723	11397	Time Difference: 0 0:1:11 LAST MODIFIED: 2011-07-14 12:52:48	54

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
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40396	11498	Time Difference: 0 0:1:14 LAST MODIFIED: 2009-08-12 11:33:52	54
24115	11499	Time Difference: 0 0:1:52 LAST MODIFIED: 2010-10-13 14:05:44	54
40408	11510	Time Difference: 0 0:1:11 LAST MODIFIED: 2011-12-06 19:39:18	54
24474	11585	Time Difference: 0 0:1:14 LAST MODIFIED: 2011-03-10 09:22:02	54
24486	11589	Time Difference: 0 0:1:30 LAST MODIFIED: 2011-03-09 12:59:42	54
24498	11593	Time Difference: 0 0:1:15 LAST MODIFIED: 2011-03-09 13:34:28	54
24588	11623	Time Difference: 0 0:1:22 LAST MODIFIED: 2011-03-09 11:10:16	54
24664	11643	Time Difference: 0 0:1:1 LAST MODIFIED: 2011-02-02 10:55:34	54
38193	13150	Time Difference: 0 0:1:6 LAST MODIFIED: 2007-01-24 10:01:17	54
33855	13714	Time Difference: 0 0:1:30 LAST MODIFIED: 2003-12-23 12:02:32	54
34104	13770	Time Difference: 0 0:1:14 LAST MODIFIED: 2009-08-06 11:24:38	54
34116	13772	Time Difference: 0 0:1:26 LAST MODIFIED: 2009-08-06 10:11:58	54
35368	13865	Time Difference: 0 0:1:6 LAST MODIFIED: 2011-12-20 14:32:35	54
36477	14081	Time Difference: 0 0:1:37 LAST MODIFIED: 2008-04-08 12:18:28	54
38535	14498	Time Difference: 0 0:1:20 LAST MODIFIED: 2010-04-12 09:49:38	54
40396	14735	Time Difference: 0 0:1:14 LAST MODIFIED: 2009-08-12 11:35:06	54
38442	4249	Time Difference: 0 20:58:8 LAST MODIFIED: 2007-06-20 12:40:08	55
38424	4254	Time Difference: 0 1:54:8 LAST MODIFIED: 2007-06-19 14:34:35	55
38426	4255	Time Difference: 0 1:53:43 LAST MODIFIED: 2007-06-19 14:41:30	55
38428	4256	Time Difference: 0 1:33:3 LAST MODIFIED: 2007-06-19 14:28:10	55
38430	4257	Time Difference: 0 1:42:3 LAST MODIFIED: 2007-06-19 14:46:08	55
38432	4258	Time Difference: 0 1:6:44 LAST MODIFIED: 2007-06-19 14:20:23	55
38434	4259	Time Difference: 0 0:41:21 LAST MODIFIED: 2007-06-19 14:11:01	55
38396	9475	Time Difference: 15 1:29:24 LAST MODIFIED: 2007-06-05 11:05:35	55
38424	9489	Time Difference: 0 1:54:8 LAST MODIFIED: 2007-06-19 12:40:27	55
38426	9490	Time Difference: 0 1:53:43 LAST MODIFIED: 2007-06-19 12:47:47	55
38428	9491	Time Difference: 0 1:33:3 LAST MODIFIED: 2007-06-19 12:55:06	55
38430	9492	Time Difference: 0 1:42:3 LAST MODIFIED: 2007-06-19 13:04:05	55
38432	9493	Time Difference: 0 1:6:44 LAST MODIFIED: 2007-06-19 13:13:39	55
38434	9494	Time Difference: 0 0:41:21 LAST MODIFIED: 2007-06-19 13:29:40	55
38442	9498	Time Difference: 0 20:58:8 LAST MODIFIED: 2007-06-19 15:41:59	55
38448	9501	Time Difference: 0 20:26:47 LAST MODIFIED: 2007-06-19 16:10:31	55
38450	9502	Time Difference: 0 20:27:47 LAST MODIFIED: 2007-06-19 16:21:21	55
38464	9509	Time Difference: 78 2:28:32 LAST MODIFIED: 2007-06-25 12:13:34	55
38396	14429	Time Difference: 15 1:29:24 LAST MODIFIED: 2007-06-20 12:34:59	55
38448	14436	Time Difference: 0 20:26:47 LAST MODIFIED: 2007-06-20 12:37:18	55
38450	14437	Time Difference: 0 20:27:47 LAST MODIFIED: 2007-06-20 12:49:08	55
38464	14438	Time Difference: 78 2:28:32 LAST MODIFIED: 2007-09-11 14:42:07	55
32657	6813	Time Difference: 0 2:30:1 LAST MODIFIED: 2005-10-26 10:46:25	59
32657	8631	Time Difference: 0 2:30:1 LAST MODIFIED: 2005-10-26 13:16:26	59
19421	3124	Time Difference: 13 18:17:10 LAST MODIFIED: 2011-09-30 16:47:40	60
38336	3826	Time Difference: 13 4:24:39 LAST MODIFIED: 2007-10-23 15:45:29	60
38336	9439	Time Difference: 13 4:24:39 LAST MODIFIED: 2007-10-10 11:20:50	60
19421	12888	Time Difference: 13 18:17:10 LAST MODIFIED: 2011-10-14 11:04:50	60
2171	349	Time Difference: 0 0:4:7 LAST MODIFIED: 2008-10-22 16:11:48	61
2171	835	Time Difference: 0 0:4:7 LAST MODIFIED: 2008-10-22 16:15:56	61
34399	1455	Time Difference: 0 0:17:0 LAST MODIFIED: 2007-05-21 12:23:42	61
34407	1463	Time Difference: 0 0:5:7 LAST MODIFIED: 2007-05-21 09:52:39	61
17152	2556	Time Difference: 0 0:5:35 LAST MODIFIED: 2003-11-05 13:49:58	61
21382	3561	Time Difference: 0 0:6:6 LAST MODIFIED: 2010-10-28 09:50:42	61
24880	4548	Time Difference: 0 0:10:26 LAST MODIFIED: 2011-12-09 15:12:42	61
24988	4577	Time Difference: 3 4:58:10 LAST MODIFIED: 2011-10-11 13:28:30	61
25101	4604	Time Difference: 2 21:30:33 LAST MODIFIED: 2011-11-29 11:34:52	61
25973	4870	Time Difference: 2 3:37:22 LAST MODIFIED: 2010-12-01 12:06:14	61
25982	4873	Time Difference: 2 3:20:56 LAST MODIFIED: 2010-12-01 12:21:24	61

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
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26237	4950	Time Difference: 0 0:50:37 LAST MODIFIED: 2010-04-15 10:58:50	61
29205	5551	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 09:49:36	61
31545	5743	Time Difference: 0 0:5:54 LAST MODIFIED: 2005-08-09 08:44:34	61
32322	5803	Time Difference: 0 0:54:32 LAST MODIFIED: 2006-01-23 13:54:55	61
32819	6967	Time Difference: 0 0:7:4 LAST MODIFIED: 2006-10-26 09:40:49	61
34172	7407	Time Difference: 2 22:4:33 LAST MODIFIED: 2007-03-30 12:43:46	61
34174	7408	Time Difference: 2 22:1:58 LAST MODIFIED: 2007-03-30 12:50:02	61
34399	7651	Time Difference: 0 0:17:0 LAST MODIFIED: 2007-05-21 12:06:41	61
34407	7659	Time Difference: 0 0:5:7 LAST MODIFIED: 2007-05-21 09:47:31	61
34480	7733	Time Difference: 0 0:3:1 LAST MODIFIED: 2007-05-29 12:55:22	61
34501	7754	Time Difference: 0 0:8:39 LAST MODIFIED: 2007-05-30 09:44:46	61
35347	7981	Time Difference: 0 0:22:7 LAST MODIFIED: 2011-10-26 15:53:20	61
35349	7982	Time Difference: 0 1:22:16 LAST MODIFIED: 2011-10-26 14:06:14	61
31545	8514	Time Difference: 0 0:5:54 LAST MODIFIED: 2005-08-09 08:50:28	61
32819	8706	Time Difference: 0 0:7:4 LAST MODIFIED: 2006-10-26 09:47:54	61
17152	9267	Time Difference: 0 0:5:35 LAST MODIFIED: 2003-11-05 13:55:34	61
38074	9293	Time Difference: 0 0:4:55 LAST MODIFIED: 2008-08-21 11:39:42	61
21382	10729	Time Difference: 0 0:6:6 LAST MODIFIED: 2010-10-28 09:56:48	61
34480	12303	Time Difference: 0 0:3:1 LAST MODIFIED: 2007-05-29 12:58:24	61
34501	12351	Time Difference: 0 0:8:39 LAST MODIFIED: 2007-05-30 09:53:26	61
24880	12545	Time Difference: 0 0:10:26 LAST MODIFIED: 2011-12-09 15:23:08	61
24988	12678	Time Difference: 3 4:58:10 LAST MODIFIED: 2011-10-14 18:26:40	61
25101	12705	Time Difference: 2 21:30:33 LAST MODIFIED: 2011-12-02 09:05:26	61
25973	13006	Time Difference: 2 3:37:22 LAST MODIFIED: 2010-12-03 15:43:36	61
25982	13009	Time Difference: 2 3:20:56 LAST MODIFIED: 2010-12-03 15:42:20	61
26107	13052	Time Difference: 3 2:45:52 LAST MODIFIED: 2011-04-22 15:55:42	61
26237	13119	Time Difference: 0 0:50:37 LAST MODIFIED: 2010-04-15 11:49:28	61
29205	13652	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 10:00:58	61
32322	13657	Time Difference: 0 0:54:32 LAST MODIFIED: 2006-01-23 14:49:27	61
34172	13780	Time Difference: 2 22:4:33 LAST MODIFIED: 2007-04-02 10:48:20	61
34174	13781	Time Difference: 2 22:1:58 LAST MODIFIED: 2007-04-02 10:52:01	61
38074	14413	Time Difference: 0 0:4:55 LAST MODIFIED: 2008-08-21 11:34:47	61
35347	14511	Time Difference: 0 0:22:7 LAST MODIFIED: 2011-10-26 16:15:27	61
35349	14512	Time Difference: 0 1:22:16 LAST MODIFIED: 2011-10-26 15:28:31	61
321	52	Time Difference: 0 0:4:3 LAST MODIFIED: 2009-10-22 09:23:18	62
321	66	Time Difference: 0 0:4:3 LAST MODIFIED: 2009-10-22 09:27:22	62
34378	7629	Time Difference: 0 18:35:58 LAST MODIFIED: 2007-04-03 14:23:15	71
34378	13808	Time Difference: 0 18:35:58 LAST MODIFIED: 2007-04-04 08:59:14	71
1919	326	Time Difference: 0 0:3:11 LAST MODIFIED: 2010-06-28 15:07:46	72
1919	802	Time Difference: 0 0:3:11 LAST MODIFIED: 2010-06-28 15:10:58	72
8003	1048	Time Difference: 0 0:3:40 LAST MODIFIED: 2003-05-22 12:47:46	72
9156	1235	Time Difference: 0 0:2:41 LAST MODIFIED: 2008-06-18 13:56:24	72
11342	1547	Time Difference: 0 0:3:57 LAST MODIFIED: 2010-05-27 11:40:40	72
14254	2075	Time Difference: 0 0:2:13 LAST MODIFIED: 2005-12-29 09:41:04	72
29881	2220	Time Difference: 0 0:2:23 LAST MODIFIED: 2005-07-18 10:31:40	72
16522	2420	Time Difference: 0 0:2:47 LAST MODIFIED: 2007-12-27 08:59:54	72
8003	2428	Time Difference: 0 0:3:40 LAST MODIFIED: 2003-05-22 12:51:26	72
17379	2591	Time Difference: 0 0:2:12 LAST MODIFIED: 2003-11-18 11:23:14	72
17733	2680	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-03-10 16:13:36	72
9156	2954	Time Difference: 0 0:2:41 LAST MODIFIED: 2008-06-18 13:59:06	72
19310	3102	Time Difference: 0 0:4:1 LAST MODIFIED: 2011-09-13 15:41:48	72
21282	3533	Time Difference: 0 0:2:12 LAST MODIFIED: 2010-10-12 16:32:00	72
21401	3570	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-10-29 11:41:24	72
22525	3923	Time Difference: 0 0:2:18 LAST MODIFIED: 2010-09-30 13:27:58	72
23386	4131	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-08-19 11:26:36	72

RD-LAS Pair ID	RD Unique File ID	Flag Description	Assigned to Manual Analysis ID
23713	4227	Time Difference: 0 0:2:47 LAST MODIFIED: 2011-07-14 11:50:26	72
24462	4414	Time Difference: 0 0:3:24 LAST MODIFIED: 2011-03-10 10:23:48	72
24570	4450	Time Difference: 0 0:2:23 LAST MODIFIED: 2011-02-01 12:51:10	72
24745	4503	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-12-08 13:13:28	72
11342	4670	Time Difference: 0 0:3:57 LAST MODIFIED: 2010-05-27 11:44:38	72
26501	4980	Time Difference: 0 0:2:58 LAST MODIFIED: 2007-03-05 15:37:46	72
28272	5480	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-07-30 12:31:08	72
29881	5607	Time Difference: 0 0:2:23 LAST MODIFIED: 2005-07-18 10:29:16	72
14254	6495	Time Difference: 0 0:2:13 LAST MODIFIED: 2005-12-29 09:43:18	72
32858	7006	Time Difference: 0 0:2:46 LAST MODIFIED: 2006-04-18 15:50:18	72
34138	7378	Time Difference: 0 0:3:57 LAST MODIFIED: 2009-08-06 10:15:32	72
34271	7505	Time Difference: 0 0:2:15 LAST MODIFIED: 2007-05-10 12:04:49	72
34538	7791	Time Difference: 0 0:2:23 LAST MODIFIED: 2007-05-30 13:06:42	72
16522	8885	Time Difference: 0 0:2:47 LAST MODIFIED: 2007-12-27 09:02:42	72
32858	8993	Time Difference: 0 0:2:46 LAST MODIFIED: 2006-04-18 15:53:04	72
37997	9216	Time Difference: 0 0:2:15 LAST MODIFIED: 2008-09-29 10:16:58	72
37998	9217	Time Difference: 0 0:2:18 LAST MODIFIED: 2008-09-29 10:19:41	72
17379	9310	Time Difference: 0 0:2:12 LAST MODIFIED: 2003-11-18 11:25:26	72
17733	9580	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-03-10 16:15:44	72
28272	9622	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-07-30 12:33:16	72
38536	9769	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-04-13 14:11:30	72
19310	10270	Time Difference: 0 0:4:1 LAST MODIFIED: 2011-09-13 15:45:50	72
21282	10701	Time Difference: 0 0:2:12 LAST MODIFIED: 2010-10-12 16:34:12	72
21401	10738	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-10-29 11:43:46	72
22525	11091	Time Difference: 0 0:2:18 LAST MODIFIED: 2010-09-30 13:30:16	72
23386	11299	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-08-19 11:28:46	72
23713	11395	Time Difference: 0 0:2:47 LAST MODIFIED: 2011-07-14 11:53:14	72
40409	11511	Time Difference: 0 0:2:18 LAST MODIFIED: 2011-12-06 19:41:43	72
40410	11512	Time Difference: 0 0:2:38 LAST MODIFIED: 2011-12-06 19:46:19	72
40412	11514	Time Difference: 0 0:3:21 LAST MODIFIED: 2011-12-08 16:18:06	72
24462	11581	Time Difference: 0 0:3:24 LAST MODIFIED: 2011-03-10 10:27:12	72
24570	11617	Time Difference: 0 0:2:23 LAST MODIFIED: 2011-02-01 12:53:34	72
26501	11854	Time Difference: 0 0:2:58 LAST MODIFIED: 2007-03-05 15:40:44	72
34271	12049	Time Difference: 0 0:2:15 LAST MODIFIED: 2007-05-10 12:07:04	72
34538	12388	Time Difference: 0 0:2:23 LAST MODIFIED: 2007-05-30 13:09:06	72
24745	12500	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-12-08 13:15:38	72
34138	13776	Time Difference: 0 0:3:57 LAST MODIFIED: 2009-08-06 10:19:30	72
37997	14410	Time Difference: 0 0:2:15 LAST MODIFIED: 2008-09-29 10:19:14	72
37998	14411	Time Difference: 0 0:2:18 LAST MODIFIED: 2008-09-29 10:22:00	72
38536	14500	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-04-13 14:13:52	72
40409	14785	Time Difference: 0 0:2:18 LAST MODIFIED: 2011-12-06 19:44:02	72
40410	14786	Time Difference: 0 0:2:38 LAST MODIFIED: 2011-12-06 19:48:58	72
40412	14788	Time Difference: 0 0:3:21 LAST MODIFIED: 2011-12-08 16:21:27	72

E.4 Time Stamp – Chronology

RD Files Flagged for Chronology

File ID	Unique File ID	Group ID	Date	Data Acquisition Time(min)	Total Depth(ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
17562	2509	4280	04/04/2004 15:45:32	10.94	178.6	11.57	14.87	1	17
16165	2278	2992	01/09/2003 10:21:50	4.70	44.7	5.07	6.06	1	74
22666	3761	19314	04/26/2011 10:13:22	7.07	97.6	7.97	9.45	1	74
36851	7452	19016	05/09/2007 09:57:51	2.02	29.0	2.48	3.08	1	74
17258	2453	3345	06/02/2010 14:30:40	6.34	74.1	7.63	8.26	1	74
17520	2491	3367	06/22/2010 18:25:12	5.32	70.9	5.97	7.18	1	74
5097	781	623	07/01/2010 10:09:36	7.99	103.7	9.17	10.48	1	74
38523	8169	19220	07/10/2008 11:19:53	4.49	65.3	5.35	6.25	1	74
33001	5774	18178	08/20/2004 16:46:15	2.05	26.3	2.40	3.06	1	74
1793	301	18586	11/03/2003 11:32:23	4.21	54.5	4.85	5.76	1	74
32602	5744	26467	08/04/2005 13:06:56	7.56	90.8	9.67	9.81	1	75
32642	5748	24967	08/04/2005 21:17:58	7.10	91.5	9.07	9.36	1	75
29466	5498	18117	08/07/2004 10:59:21	11.56	230.2	15.43	16.49	1	76
29504	5500	26435	08/07/2004 11:28:26	11.76	230.1	15.73	16.69	1	76
29483	5499	25496	08/07/2004 18:43:56	11.89	230.5	15.50	16.82	1	76
29455	5497	25496	08/07/2004 19:13:36	11.73	229.4	14.23	16.64	1	76
29441	5496	25496	08/07/2004 19:26:52	11.41	230.1	13.27	16.34	1	76
29554	5504	25497	09/16/2004 18:34:02	11.59	220.1	09+	16.32	1	77
29610	5508	25497	09/16/2004 20:06:06	5.94	126.1	6.87	8.87	1	77
36349	7250	25254	11/08/2006 14:32:04	13.11	214.1	15.40	17.73	1	78
36471	7287	18456	12/23/2003 13:01:02	16.52	291.9	20.68	22.63	1	79
5545	846	646	12/05/2003 12:42:42	11.23	177.5	14.20	15.14	1	80
5559	847	646	12/05/2003 12:57:08	11.22	174.3	14.43	15.07	1	80
5573	848	646	12/05/2003 13:11:46	12.10	176.5	14.63	15.99	1	80
5587	849	646	12/05/2003 13:25:40	11.36	176.9	13.90	15.26	1	80
35380	6932	18352	12/12/2006 10:35:34	6.66	100.1	8.83	9.09	1	81
5771	862	648	11/21/2003 13:33:04	11.33	178.7	13.90	15.27	1	82
5785	863	648	11/21/2003 13:48:44	11.73	179.5	15.67	15.68	1	82
5615	851	647	11/26/2003 11:44:54	11.28	179.0	14.07	15.22	1	82
5629	852	647	11/26/2003 11:58:38	11.32	178.6	13.73	15.25	1	82
5643	853	647	11/26/2003 12:12:28	11.34	179.8	13.83	15.30	1	82
5657	854	647	11/26/2003 12:26:18	11.35	179.0	13.83	15.29	1	82
29310	5487	18026	08/23/2004 11:35:42	12.08	232.0	16.87	17.04	1	83
29324	5488	18026	08/23/2004 11:51:34	11.29	231.6	15.87	16.24	1	83
29338	5489	18026	08/23/2004 12:07:10	11.13	231.8	15.60	16.09	1	83
29366	5491	18026	08/23/2004 12:42:28	10.98	231.3	14.33	15.93	1	83
29370	5491	25495	08/23/2004 20:42:28	10.98	231.3	14.33	15.93	1	83
29384	5492	25495	08/23/2004 20:56:30	10.76	230.3	14.03	15.69	1	83
29398	5493	25495	08/23/2004 21:08:16	10.97	228.0	11.77	15.86	1	83
29077	5471	18024	07/16/2004 09:03:28	12.19	230.4	13.10	17.12	1	84
28755	5450	18020	07/16/2004 14:10:18	11.36	207.8	14.17	15.86	1	85
18581	2733	18559	12/08/2003 10:34:06	11.82	205.4	14.93	16.27	1	86
18601	2738	18559	12/08/2003 11:55:12	11.61	206.4	15.17	16.08	1	86
17802	2568	4331	12/01/2003 12:52:32	13.81	256.2	19.07	19.24	1	87
17824	2570	4331	12/01/2003 13:31:42	13.49	255.0	18.43	18.89	1	87
17835	2571	4331	12/01/2003 13:48:54	13.71	254.3	17.20	19.10	1	87

File ID	Unique File ID	Group ID	Date	Data Acquisition Time(min)	Total Depth(ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
17846	2572	4331	12/01/2003 14:06:50	13.96	256.2	17.93	19.39	1	87
17857	2573	4331	12/01/2003 14:23:36	13.83	256.7	16.77	19.27	1	87
17868	2574	4331	12/01/2003 14:40:46	13.53	253.8	17.17	18.91	1	87
36355	7252	25255	01/12/2007 11:52:32	12.07	215.4	15.87	16.71	1	88
36358	7253	25255	01/12/2007 12:07:08	12.74	215.5	14.60	17.38	1	88
36362	7255	18398	01/12/2007 12:36:57	12.16	215.6	15.05	16.81	1	88
36405	7265	18400	01/17/2007 11:17:52	11.98	215.4	15.22	16.62	1	89
36410	7266	18400	01/17/2007 11:32:15	12.24	215.1	14.38	16.88	1	89
36415	7267	18400	01/17/2007 11:46:45	12.08	215.2	14.50	16.72	1	89
36419	7268	18400	01/17/2007 12:01:58	11.98	214.7	15.22	16.61	1	89
27531	5065	14110	10/16/2004 13:21:12	11.28	230.3	16.17	16.21	1	90
27534	5066	14110	10/16/2004 13:36:42	10.98	230.4	15.50	15.91	1	90
27537	5067	14110	10/16/2004 13:52:28	11.15	230.3	15.77	16.08	1	90
28648	5443	18019	09/16/2004 13:57:42	12.94	257.0	16.43	18.38	1	91
28618	5441	18019	09/16/2004 15:39:04	14.09	258.2	19.37	19.56	1	91
5729	859	647	11/26/2003 11:12:08	11.71	175.2	14.57	15.58	1	92
5503	843	646	12/05/2003 11:49:42	12.29	179.2	16.13	16.24	1	93
17761	2562	4329	01/15/2004 13:18:24	15.38	282.3	20.40	21.31	1	94
17767	2563	4329	01/15/2004 13:38:32	15.31	282.4	20.13	21.24	1	94
17773	2564	4329	01/15/2004 13:57:58	15.14	279.4	19.43	21.01	1	94
17779	2565	4329	01/15/2004 14:17:30	15.85	282.3	19.53	21.78	1	94
17785	2566	4329	01/15/2004 14:38:30	15.11	282.5	21.00	21.04	1	94
29677	5513	18125	06/04/2004 11:45:57	11.14	240.2	15.73	16.26	1	94
29695	5514	24909	06/04/2004 20:02:38	12.08	241.5	16.67	17.22	1	94
29724	5516	25498	06/04/2004 20:39:12	11.59	236.5	16.03	16.64	1	94
18075	2621	4382	07/02/2004 12:52:18	13.94	264.3	19.33	19.52	1	94
18080	2622	4382	07/02/2004 13:14:10	16.36	265.0	21.87	21.96	1	94
28878	5458	18021	07/30/2004 09:20:34	14.73	209.9	19.17	19.27	1	94
29254	5483	18025	07/30/2004 13:22:34	10.65	230.6	15.47	15.59	1	94
28985	5465	18022	08/01/2004 09:46:26	10.97	230.7	15.23	15.91	1	94
29000	5466	18022	08/01/2004 10:02:16	11.00	230.9	15.83	15.94	1	94
29031	5468	18022	08/01/2004 10:34:12	10.37	231.0	15.23	15.31	1	94
17913	2586	4341	11/11/2003 10:18:04	14.85	248.3	19.87	20.12	1	94
17959	2595	4346	11/18/2003 12:39:30	13.35	251.8	18.00	18.69	1	94
17963	2596	4346	11/18/2003 12:56:26	13.46	251.3	16.93	18.79	1	94
17967	2597	4346	11/18/2003 13:13:02	13.73	247.8	16.60	18.99	1	94
17971	2598	4346	11/18/2003 13:30:18	13.21	250.7	17.27	18.53	1	94
11348	1485	1473	01/31/2007 12:03:58	12.41	215.1	16.87	17.05	1	96
11353	1486	1473	01/31/2007 12:21:18	13.35	215.1	17.33	17.99	1	96
11358	1487	1473	01/31/2007 12:37:34	12.26	215.0	16.27	16.89	1	96
11363	1488	1473	01/31/2007 12:53:22	12.13	215.1	15.80	16.77	1	96
27879	5181	14120	04/06/2005 12:08:30	8.28	117.9	11.00	11.05	1	96
41140	9506	22282	06/25/2007 11:50:06	5.52	74.1	7.42	7.44	1	96
11219	1465	1357	07/25/2008 10:40:04	2.18	24.0	3.13	3.14	1	96
36074	7213	25652	07/28/2006 19:19:20	5.80	84.6	7.87	7.93	1	96
43077	10955	26500	10/03/2007 11:29:32	5.77	90.1	7.53	8.00	1	96
43083	10956	26500	10/03/2007 11:37:28	5.89	91.2	7.93	8.14	1	96
43101	10959	26500	10/03/2007 12:03:52	5.91	92.8	7.80	8.20	1	96
43044	10950	25846	10/03/2007 12:32:47	6.38	96.8	8.55	8.74	1	96
44476	11492	25644	10/03/2007 20:16:24	6.00	94.5	7.57	8.32	1	96
44481	11493	25644	10/03/2007 20:24:14	6.34	94.6	7.83	8.66	1	96

File ID	Unique File ID	Group ID	Date	Data Acquisition Time(min)	Total Depth(ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
35602	7154	18374	10/14/2005 08:43:49	5.61	59.3	7.15	7.25	1	96
6049	879	682	11/14/2003 10:13:58	13.78	198.4	17.90	18.10	1	96
6073	883	682	11/14/2003 11:10:14	13.04	200.0	16.13	17.39	1	96
36447	7277	18402	11/15/2006 11:43:56	11.92	215.0	16.47	16.55	1	96
36453	7279	18402	11/15/2006 12:21:10	11.91	214.6	15.52	16.54	1	96
36456	7280	18402	11/15/2006 12:37:37	11.93	215.2	16.45	16.57	1	96
11591	1518	18574	12/10/2003 12:09:09	7.14	101.1	9.20	9.58	1	96
11571	1516	1545	12/10/2003 12:50:20	7.83	100.5	9.80	10.26	1	96
11594	1519	1545	12/10/2003 13:18:28	7.13	101.1	9.30	9.57	1	96
33417	5806	18460	12/18/2003 10:13:49	10.89	171.2	13.98	14.68	1	96
35361	6913	18350	12/19/2006 08:54:55	6.87	97.2	8.45	9.24	1	96
35364	6916	18350	12/19/2006 09:23:22	6.86	99.8	8.98	9.28	1	96
35365	6917	18350	12/19/2006 09:32:14	6.58	99.3	8.87	8.99	1	96
35366	6918	18350	12/19/2006 09:40:52	6.53	99.6	8.63	8.95	1	96
33895	6024	18095	01/16/2007 14:26:33	3.71	25.0	4.08	4.69	1	97
30072	5544	18133	02/08/2005 10:52:45	3.82	34.3	4.63	4.98	1	97
30134	5549	24911	02/08/2005 19:17:44	4.19	35.0	4.73	5.36	1	97
39795	8893	21758	02/20/2008 15:42:06	3.37	30.3	4.30	4.45	1	97
39794	8893	21703	02/20/2008 15:42:07	3.37	30.3	4.30	4.45	1	97
3986	616	422	04/06/2007 12:14:22	4.25	42.7	5.43	5.57	1	97
4001	619	422	04/06/2007 12:30:24	4.23	43.2	5.50	5.56	1	97
4026	624	422	04/06/2007 13:01:08	3.89	43.3	4.93	5.22	1	97
27552	5072	14111	04/19/2005 09:40:12	3.86	36.4	4.70	5.06	1	97
28548	5436	18018	05/04/2005 12:37:24	7.45	84.2	9.50	9.57	1	97
37128	7728	19018	05/29/2007 14:02:43	3.30	28.9	4.23	4.36	1	97
11205	1463	1357	07/25/2008 10:33:08	3.03	24.7	3.23	4.01	1	97
36073	7213	18381	07/28/2006 11:19:20	5.80	84.6	7.88	7.93	1	97
38845	8326	21255	08/12/2008 09:55:58	3.28	25.3	4.27	4.27	1	97
38861	8342	21256	08/13/2008 08:51:34	3.24	23.3	3.97	4.19	1	97
38867	8348	21256	08/13/2008 09:19:16	3.33	26.3	3.57	4.34	1	97
11504	1507	1543	12/11/2003 11:26:40	6.28	65.2	7.97	8.03	1	97
33171	5785	26477	08/20/2004 17:11:50	5.94	71.7	7.80	7.82	1	99
42274	10578	24555	12/14/2011 11:52:40	2.55	11.9	3.23	3.28	1	99

LS Files Flagged for Chronology

File ID	Unique File ID	Group ID	Date-Time	Data Aquisition Time (min)	Total Depth (ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
14608	3310	204	12/17/2003 09:16:28	4.42	52.6	3.67	5.93	1	95
14621	3311	204	12/17/2003 09:52:46	4.52	52.8	3.23	6.04	1	95
15446	3406	218	12/19/2003 10:21:08	4.82	55.4	5.17	6.39	1	95
15338	3394	218	12/19/2003 09:50:18	4.95	56.3	4.67	6.53	1	95
15455	3407	218	12/19/2003 10:00:18	4.7	56.6	4.30	6.29	1	95
15347	3395	218	12/19/2003 09:16:26	4.68	55.2	3.47	6.24	1	95

File ID	Unique File ID	Group ID	Date-Time	Data Aquisition Time (min)	Total Depth (ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
15482	3410	218	12/19/2003 11:51:34	4.81	55.4	4.67	6.38	1	95
15550	3418	221	12/22/2003 10:35:42	5.35	56.6	4.30	6.94	1	95
15722	3444	221	12/22/2003 10:44:48	5.26	56.5	1.27	6.85	1	95
15728	3445	221	12/22/2003 11:05:28	5.32	56.7	4.47	6.91	1	95
15734	3446	221	12/22/2003 11:26:02	5.3	56.6	2.77	6.89	1	95
15568	3421	221	12/22/2003 11:37:34	5.17	56.6	1.33	6.76	1	95
15580	3423	221	12/22/2003 12:21:22	5.25	56.8	5.07	6.84	1	95
15843	3462	224	12/22/2003 15:48:16	5.03	56.7	5.97	6.62	1	95
15857	3464	224	12/22/2003 14:50:54	5.02	56.7	4.00	6.61	1	95
15928	3476	2326	12/23/2003 10:58:34	7.51	79.7	2.13	9.54	1	95
15976	3484	2326	12/23/2003 11:46:06	7.29	79.3	8.53	9.32	1	95
15934	3477	2326	12/23/2003 10:38:36	6.03	67	4.20	7.82	1	95
5649	1637	17194	04/15/2002 12:01:10	9.08	97.9	9.60	11.46	1	95
5651	1639	17194	04/15/2002 12:15:00	9.27	100	4.37	11.69	1	95
5657	1645	17194	04/15/2002 12:57:04	9.32	99	10.13	11.72	1	95
5646	1634	17194	04/15/2002 11:51:34	9.36	128.8	5.87	12.34	1	95
5648	1636	17194	04/15/2002 12:10:38	9.22	125.3	9.47	12.13	1	95
5652	1640	17194	04/15/2002 12:46:56	9.05	124.8	2.97	11.95	1	95
5654	1642	17194	04/15/2002 13:03:46	9.07	128.1	6.70	12.03	1	95
7422	1974	17201	08/22/2002 12:45:00	32.25	202.2	28.83	36.64	1	95
13738	3204	201	12/11/2003 10:35:38	4.72	53.3	3.30	6.25	1	95
13754	3206	201	12/11/2003 11:41:40	4.24	53.2	4.03	5.76	1	95
13914	3226	201	12/11/2003 12:04:16	5.2	53.7	1.63	6.73	1	95
14056	3244	201	12/11/2003 10:32:20	6.14	53.8	7.27	7.67	1	95
13818	3214	201	12/11/2003 10:58:02	5.63	53.4	2.47	7.16	1	95
13978	3234	201	12/11/2003 11:10:36	5.29	53.2	3.23	6.81	1	95
13826	3215	201	12/11/2003 11:47:32	4.63	53.6	5.87	6.16	1	95
13842	3217	201	12/11/2003 12:34:14	4.61	54.1	1.97	6.15	1	95
14002	3237	201	12/11/2003 12:58:56	4.59	53.5	3.10	6.12	1	95
14018	3239	201	12/11/2003 14:04:40	4.76	53.7	2.77	6.29	1	95
13547	3176	201	12/10/2003 16:17:06	4.69	53.6	4.13	6.22	1	95
14520	3298	204	12/17/2003 09:02:44	4.52	52.9	1.90	6.04	1	95
15243	3383	215	12/18/2003 13:31:24	5.12	53.9	4.60	6.66	1	95
15383	3399	218	12/19/2003 10:15:58	5.38	55.3	4.60	6.94	1	95
15491	3411	218	12/19/2003 10:26:26	5.35	55.5	5.30	6.92	1	95
15500	3412	218	12/19/2003 09:56:00	7.89	55.4	5.70	9.46	1	95
15527	3415	218	12/19/2003 11:57:38	5.01	55.3	6.07	6.57	1	95
15629	3430	221	12/22/2003 11:01:00	5.2	56.7	3.47	6.79	1	95
15815	3458	221	12/22/2003 12:16:18	5.12	56.9	5.17	6.71	1	95
15864	3465	224	12/22/2003 14:46:54	5.16	56.8	3.23	6.75	1	95
15871	3466	224	12/22/2003 15:31:18	5.22	56.7	1.37	6.81	1	95
15713	3442	224	12/22/2003 15:42:18	5.12	56.6	1.33	6.71	1	95
15878	3467	224	12/22/2003 15:53:06	5.36	56.8	4.83	6.95	1	95
4513	1440	14685	02/28/2002 13:11:28	2.68	29.7	3.60	3.75	1	96
6253	1777	2908	06/21/2002 15:03:58	2885.15	578.6	14.20	2896.78	1	97
6896	1892	641	07/24/2002 20:19:48	43.03	60.8	12.37	44.70	1	97
3231	1241	2829	01/22/2002 14:53:16	7902.2	606.5	14.07	7914.36	1	97
6630	1846	17204	07/03/2002 14:36:16	3674.05	469.2	16.40	3683.57	1	97
9084	2319	17167	12/30/2002 12:38:42	4642.79	860	11.43	4659.83	1	97
7733	2052	17197	09/19/2002 15:03:26	5877.77	837.8	22.00	5894.38	1	97
4875	1502	2131	03/19/2002 15:20:52	21.65	70.7	15.87	23.51	1	97
11832	2828	651	07/08/2003 11:27:04	13198.5	1453.3	15.57	13226.95	1	97

File ID	Unique File ID	Group ID	Date-Time	Data Aquisition Time (min)	Total Depth (ft)	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)	Flag if Est Total Time > Time Between File Saves	Manual ID
10361	2545	15318	03/20/2003 15:35:56	45.27	191.3	28.53	49.45	1	97
10367	2548	15318	03/20/2003 17:18:16	41.31	191.7	29.30	45.50	1	97
12728	2959	952	09/17/2003 02:39:56	870.52	209.1	15.67	875.04	1	97
8	4	14423	12/23/1998 07:39:42	14.24	222.3	1.63	19.02	1	98
9	5	14423	12/23/1998 07:41:20	12.02	218.9	1.63	16.73	1	98
10	6	14423	12/23/1998 07:43:00	13.53	219.5	1.67	18.25	1	98
3962	1352	2817	02/08/2002 13:14:50	5.68	64.7	1.17	7.42	1	98
3127	1225	2820	01/23/2002 06:40:22	5.93	62.4	3.57	7.63	1	98
3134	1226	2820	01/23/2002 06:42:06	5.66	65.3	1.73	7.42	1	98
3934	1348	2868	02/07/2002 12:30:28	5.8	56.3	1.80	7.38	1	98
3927	1347	2877	02/07/2002 12:31:54	5.04	55.7	1.43	6.61	1	98
2517	1047	1074	02/21/2001 12:07:48	16.52	205.4	20.53	20.97	1	98
9094	2324	17163	12/30/2002 10:30:06	18.51	190.4	22.53	22.67	1	99
8990	2283	337	12/06/2002 12:37:36	12.53	127.3	15.43	15.48	1	100
5315	1578	1208	03/25/2002 12:04:56	8.14	79.6	10.10	10.17	1	100
6103	1747	1219	05/15/2002 13:55:54	8.74	84.1	10.73	10.86	1	100
17011	3679	1590	02/11/2004 13:05:04	8.28	76	9.80	10.24	1	100
17232	3729	1706	02/23/2004 14:34:06	13.49	141	16.27	16.70	1	100
11035	2693	493	05/09/2003 11:07:18	5.74	58	7.33	7.36	1	100

E.5 Calibration Constant

LAS Files

File ID	Unique File ID	Reason	Manual Analysis ID
62626	8707	Constant A: -0.058751659983506. Constant B: 18.262072560735 Minimum in Density Delta: -3.9264703254064. Maximum in Density Delta: 7.6653956182145.	3
62634	8708	Constant A: -0.05839757872883. Constant B: 18.20775250542 Minimum in Density Delta: -4.0528557836569. Maximum in Density Delta: 6.8593534246968.	3
62642	8709	Constant A: -0.057593628926068. Constant B: 18.079414488411 Minimum in Density Delta: -4.3243212546854. Maximum in Density Delta: 6.6097225986801.	3
62650	8710	Constant A: -0.059453846778779. Constant B: 18.366937434495 Minimum in Density Delta: -3.8660862423613. Maximum in Density Delta: 6.6830538139165.	3
62658	8711	Constant A: -0.064444940025901. Constant B: 19.114223950734 Minimum in Density Delta: -3.2429594975332. Maximum in Density Delta: 5.520084771207.	3
62664	8712	Constant A: -0.06348187551848. Constant B: 18.970254412543 Minimum in Density Delta: -3.3438574598091. Maximum in Density Delta: 5.6593544790404.	3
62671	8713	Constant A: -0.059106713897271. Constant B: 18.290938853394 Minimum in Density Delta: -4.2273398182346. Maximum in Density Delta: 5.5537493080769.	3
62677	8714	Constant A: -0.06129520279964. Constant B: 18.628579157236 Minimum in Density Delta: -3.8200767163654. Maximum in Density Delta: 6.6520120201082.	3
62683	8715	Constant A: -0.071036700546612. Constant B: 20.121541302021 Minimum in Density Delta: -2.3184904479498. Maximum in Density Delta: 2.8847419334488.	3
62690	8716	Constant A: -0.065578522733334. Constant B: 19.296291383891 Minimum in Density Delta: -2.9136977346788. Maximum in Density Delta: 3.7192638248314.	3
62697	8717	Constant A: -0.065454036198811. Constant B: 19.281091728684 Minimum in Density Delta: -2.8745299956067. Maximum in Density Delta: 3.7768051321618.	3

File ID	Unique File ID	Reason	Manual Analysis ID
62705	8718	Constant A: -0.065206279864832. Constant B: 19.246794221444 Minimum in Density Delta: -2.8749160368208. Maximum in Density Delta: 3.9086734710229.	3
62713	8719	Constant A: -0.063173845186006. Constant B: 18.92759285704 Minimum in Density Delta: -3.2774536697384. Maximum in Density Delta: 4.879492633165.	3
62721	8720	Constant A: -0.059320458337271. Constant B: 18.316948068646 Minimum in Density Delta: -4.3827633001066. Maximum in Density Delta: 1.7029094113597.	3
62729	8721	Constant A: -0.072319667365672. Constant B: 20.320092153657 Minimum in Density Delta: -2.2135192486331. Maximum in Density Delta: 1.0811733838464.	3
62736	8722	Constant A: -0.063019775803461. Constant B: 18.899385906816 Minimum in Density Delta: -3.42425242761. Maximum in Density Delta: 4.5932141211159.	3
62744	8723	Constant A: -0.062474424528789. Constant B: 18.811877679342 Minimum in Density Delta: -3.526164667919. Maximum in Density Delta: 5.3879617487705.	3
62752	8724	Constant A: -0.05897393758628. Constant B: 18.276257422827 Minimum in Density Delta: -4.2330583309819. Maximum in Density Delta: 4.6923791276698.	3
62760	8725	Constant A: -0.067129299142411. Constant B: 19.515173865423 Minimum in Density Delta: -2.925984187995. Maximum in Density Delta: 3.888196122832.	3
62768	8726	Constant A: -0.06399495750871. Constant B: 19.044442959717 Minimum in Density Delta: -3.2914815509214. Maximum in Density Delta: 5.1683363535645.	3
62776	8727	Constant A: -0.065835017142875. Constant B: 19.337421643171 Minimum in Density Delta: -2.8203830680395. Maximum in Density Delta: 4.6116408874357.	3
62783	8728	Constant A: -0.066079619327656. Constant B: 19.368104201033 Minimum in Density Delta: -2.8370478866498. Maximum in Density Delta: 4.1719920357387.	3
62791	8729	Constant A: -0.065248592941703. Constant B: 19.238792569781 Minimum in Density Delta: -3.0565331440036. Maximum in Density Delta: 4.8662975513587.	3
62799	8730	Constant A: -0.065302781715835. Constant B: 19.24738376588 Minimum in Density Delta: -3.0791543413675. Maximum in Density Delta: 4.9555512331588.	3
62806	8731	Constant A: -0.054934535114487. Constant B: 17.65865028636 Minimum in Density Delta: -5.2252818916015. Maximum in Density Delta: 8.8423547172443.	3
62813	8732	Constant A: -0.05489079642743. Constant B: 17.649846725492 Minimum in Density Delta: -5.2640707970329. Maximum in Density Delta: 7.4655339244594.	3
62819	8733	Constant A: -0.062212518859784. Constant B: 18.77347782403 Minimum in Density Delta: -3.5800258423563. Maximum in Density Delta: 4.3374643122268.	3
62826	8734	Constant A: -0.056926168578754. Constant B: 17.97353162868 Minimum in Density Delta: -4.5433688934103. Maximum in Density Delta: 8.7775346760032.	3
90224	14717	Constant A: -0.13557852233933. Constant B: 30.074204068436 Minimum in Density Delta: -0.0033663504248409. Maximum in Density Delta: 0.064987870727578.	3
87577	13652	Constant A: -0.017220407107414. Constant B: 12.641245075628 Minimum in Density Delta: -1.003577372946. Maximum in Density Delta: 0.8753170507847.	4
54632	7613	Constant A: -0.017099824688777. Constant B: 13.18499292191 Minimum in Density Delta: -0.031175514290311. Maximum in Density Delta: 0.00091814293787706.	13
19200	2504	Constant A: -0.00019866632844419. Constant B: 9.3066169258918 Minimum in Density Delta: -342.59967729412. Maximum in Density Delta: 286.85281946422.	21
90090	14692	Constant A: -0.0058344202471128. Constant B: 10.837805595621 Minimum in Density Delta: -22.926248024705. Maximum in Density Delta: 144.88871234927.	21
87360	13608	Constant A: NAN. Constant B: NAN Minimum in Density Delta: NAN. Maximum in Density Delta: NAN.	22
87362	13609	Constant A: NAN. Constant B: NAN Minimum in Density Delta: NAN. Maximum in Density Delta: NAN.	22
87364	13610	Constant A: NAN. Constant B: NAN Minimum in Density Delta: NAN. Maximum in Density Delta: NAN.	22
87366	13611	Constant A: NAN. Constant B: NAN Minimum in Density Delta: NAN. Maximum in Density Delta: NAN.	22
88144	13809	Constant A: . Constant B: 10.250825542468 Minimum in Density Delta: -146.878. Maximum in Density Delta: -146.878.	30
88472	13928	Constant A: . Constant B: 10.183691735132 Minimum in Density Delta: -150.922. Maximum in Density Delta: -150.922.	30

LS Files

Unique ID	File ID	Reason	Manual Analysis ID
2628	10728	Constant A: -0.011640263786126. Constant B: 11.158220639331 Minimum in Density Delta: -10.945501941124. Maximum in Density Delta: 17.692076148446.	3
2625	10713	Constant A: -0.014220291186015. Constant B: 11.604323155943 Minimum in Density Delta: -4.1672487761993. Maximum in Density Delta: 20.446149893459.	3
2626	10718	Constant A: -0.013014480085094. Constant B: 11.393797605828 Minimum in Density Delta: -6.771059759171. Maximum in Density Delta: 25.965931004705.	3
2627	10723	Constant A: -0.013540517192148. Constant B: 11.48307802514 Minimum in Density Delta: -5.6965304504024. Maximum in Density Delta: 21.572328021398.	3
1166	2865	Constant A: -0.0089584188312393. Constant B: 11.302787752628 Minimum in Density Delta: -4.5764753662048. Maximum in Density Delta: 12.835663858756.	3
1167	2871	Constant A: -0.008787617825992. Constant B: 11.278626209651 Minimum in Density Delta: -5.1678145698903. Maximum in Density Delta: 14.555763592023.	3
1168	2877	Constant A: -0.0077869323607855. Constant B: 11.134609387572 Minimum in Density Delta: -10.401900503312. Maximum in Density Delta: 24.309060854563.	3
1169	2883	Constant A: -0.0069196579563854. Constant B: 11.009675704639 Minimum in Density Delta: -18.12610713878. Maximum in Density Delta: 20.852535320379.	3
1170	2889	Constant A: -0.0067432931101501. Constant B: 10.985180962995 Minimum in Density Delta: -20.041977295387. Maximum in Density Delta: 16.753247606198.	3
1171	2895	Constant A: -0.0064416141033489. Constant B: 10.950954082392 Minimum in Density Delta: -22.604060030368. Maximum in Density Delta: 14.656645968936.	3
1172	2901	Constant A: -0.0079856574166078. Constant B: 11.162278334696 Minimum in Density Delta: -8.9058417261716. Maximum in Density Delta: 6.6267124621577.	3
1173	2907	Constant A: -0.0083367778639298. Constant B: 11.219760070334 Minimum in Density Delta: -6.0906659428035. Maximum in Density Delta: 9.3552468881838.	3
1174	2913	Constant A: -0.0094428294735324. Constant B: 11.376769479247 Minimum in Density Delta: -2.3386736522422. Maximum in Density Delta: 8.988842571358.	3
3899	17828	Constant A: -0.013760322964669. Constant B: 11.231044555853 Minimum in Density Delta: -16.015323062029. Maximum in Density Delta: 26.372245493509.	3
3900	17833	Constant A: -0.013098211480364. Constant B: 11.10019766068 Minimum in Density Delta: -19.436241786312. Maximum in Density Delta: 30.272708786486.	3
3901	17838	Constant A: -0.013937482800236. Constant B: 11.262778888415 Minimum in Density Delta: -15.872617220573. Maximum in Density Delta: 26.225723019406.	3
3902	17843	Constant A: -0.016164455372534. Constant B: 11.691262490981 Minimum in Density Delta: -8.9053279953894. Maximum in Density Delta: 25.661620586708.	3
3903	17848	Constant A: -0.013923580616268. Constant B: 11.264082914807 Minimum in Density Delta: -15.439336563522. Maximum in Density Delta: 27.76697923214.	3
3904	17853	Constant A: -0.011384544452463. Constant B: 10.789571904335 Minimum in Density Delta: -27.970742445057. Maximum in Density Delta: 31.494421253683.	3
3905	17858	Constant A: -0.01226504884421. Constant B: 10.949332128298 Minimum in Density Delta: -23.341767255528. Maximum in Density Delta: 32.403188947813.	3
3906	17863	Constant A: -0.012932681512365. Constant B: 11.082811929319 Minimum in Density Delta: -19.325727734687. Maximum in Density Delta: 26.685598796839.	3
3907	17868	Constant A: -0.0097975503681454. Constant B: 10.484720590434 Minimum in Density Delta: -42.908438989027. Maximum in Density Delta: 30.438633575592.	3
3908	17873	Constant A: -0.011771428796045. Constant B: 10.856815957584 Minimum in Density Delta: -26.24636364655. Maximum in Density Delta: 33.335330864978.	3
3909	17878	Constant A: -0.010866271391956. Constant B: 10.687143033412 Minimum in Density Delta: -32.621796334842. Maximum in Density Delta: 27.921702069741.	3
3910	17883	Constant A: -0.014994749536939. Constant B: 11.504452451954 Minimum in Density Delta: -9.6343203704764. Maximum in Density Delta: 84.057283037092.	3
3911	17888	Constant A: -0.012363580366082. Constant B: 10.982018414757 Minimum in Density Delta: -21.255936016175. Maximum in Density Delta: 29.378195978051.	3
3916	17913	Constant A: -0.017380173604758. Constant B: 11.93291868409 Minimum in Density Delta: -6.0120459417656. Maximum in Density Delta: 15.069169156212.	3
3912	17893	Constant A: -0.012999836883745. Constant B: 11.108520429209 Minimum in Density Delta: -17.810719159947. Maximum in Density Delta: 23.78019238684.	3
3913	17898	Constant A: -0.014724686151153. Constant B: 11.430709738395	3

Unique ID	File ID	Reason	Manual Analysis ID
		Minimum in Density Delta: -11.934749363234. Maximum in Density Delta: 25.235853014868.	
3914	17903	Constant A: -0.014271021783208. Constant B: 11.345039032384 Minimum in Density Delta: -13.360863869721. Maximum in Density Delta: 24.259915048009.	3
3915	17908	Constant A: -0.0095921250598968. Constant B: 10.472495709341 Minimum in Density Delta: -42.485323315681. Maximum in Density Delta: 13.66300775043.	3
2535	10343	Constant A: -0.009896647251256. Constant B: 10.848937638532 Minimum in Density Delta: -20.841865681245. Maximum in Density Delta: 8.4658192555265.	3
2536	10345	Constant A: -0.010353314786766. Constant B: 10.920527729353 Minimum in Density Delta: -18.620367360461. Maximum in Density Delta: 25.149111230905.	3
2537	10347	Constant A: -0.0093991319522415. Constant B: 10.754931538328 Minimum in Density Delta: -25.258065042764. Maximum in Density Delta: 27.488858325847.	3
2549	10369	Constant A: -0.0095162077502777. Constant B: 10.773235125673 Minimum in Density Delta: -24.992709928231. Maximum in Density Delta: 14.99523900817.	3
2657	10907	Constant A: -0.015686253842367. Constant B: 11.852206852339 Minimum in Density Delta: -2.6618523159901. Maximum in Density Delta: 25.532504772749.	3
2658	10909	Constant A: -0.011629766208943. Constant B: 11.137531588171 Minimum in Density Delta: -12.491696548921. Maximum in Density Delta: 31.767412858138.	3
2659	10911	Constant A: -0.01307414940142. Constant B: 11.396019061935 Minimum in Density Delta: -7.0024157396844. Maximum in Density Delta: 20.555747241904.	3
2660	10913	Constant A: -0.010112227611813. Constant B: 10.866282045659 Minimum in Density Delta: -21.221997621061. Maximum in Density Delta: 38.457205498325.	3
2661	10915	Constant A: -0.01116528247702. Constant B: 11.067698410176 Minimum in Density Delta: -13.682352729193. Maximum in Density Delta: 24.184966527226.	3
2662	10917	Constant A: -0.010947000187547. Constant B: 11.026539884421 Minimum in Density Delta: -15.067921872532. Maximum in Density Delta: 27.126181618947.	3
2805	11681	Constant A: -0.010969529640138. Constant B: 11.029208571507 Minimum in Density Delta: -15.069806108486. Maximum in Density Delta: 15.637198232165.	3
2806	11683	Constant A: -0.012719066911828. Constant B: 11.332917816144 Minimum in Density Delta: -8.2838017653946. Maximum in Density Delta: 14.314826338777.	3
2807	11685	Constant A: -0.013716536090207. Constant B: 11.512262120569 Minimum in Density Delta: -5.4121946943088. Maximum in Density Delta: 17.182386852169.	3
2808	11687	Constant A: -0.012592204426483. Constant B: 11.313125873474 Minimum in Density Delta: -8.3794794378159. Maximum in Density Delta: 11.368963016783.	3
6216	20634	Constant A: -0.014625016858208. Constant B: 11.956275744181 Minimum in Density Delta: -0.022760303786782. Maximum in Density Delta: 1.6335324220685.	21
6882	21330	Constant A: -0.00057424459434962. Constant B: 10.042577183854 Minimum in Density Delta: -94.809199856661. Maximum in Density Delta: 140.99662392262.	21
2504	10133	Constant A: . Constant B: 9.7551499440232 Minimum in Density Delta: -157.69. Maximum in Density Delta: -157.69.	30
7828	22286	Constant A: . Constant B: 10.170272799275 Minimum in Density Delta: -132.73. Maximum in Density Delta: -132.73.	30
1892	6896	Constant A: -0.013799980542663. Constant B: 12.027474468233 Minimum in Density Delta: -0.14242203235153. Maximum in Density Delta: 0.061957665234331.	56
2959	12728	Constant A: -0.014699467536849. Constant B: 12.085549430195 Minimum in Density Delta: -0.011986740263069. Maximum in Density Delta: 0.0050539467700332.	56
1048	2524	Constant A: -0.014208400426916. Constant B: 12.090043354429 Minimum in Density Delta: -0.015891342127475. Maximum in Density Delta: 0.0051446837628646.	56
4657	18724	Constant A: -0.015124195687097. Constant B: 12.237027212568 Minimum in Density Delta: -0.0066032439650741. Maximum in Density Delta: 0.01988930340508.	56
2545	10361	Constant A: -0.014880578868382. Constant B: 12.101644685531 Minimum in Density Delta: -0.040339575140251. Maximum in Density Delta: 0.0051530859660147.	56
2548	10367	Constant A: -0.01488055967867. Constant B: 12.101642709494 Minimum in Density Delta: -0.03531352104369. Maximum in Density Delta: 0.0051702941448752.	56
2828	11832	Constant A: -0.014700089425694. Constant B: 12.085649673465 Minimum in Density Delta: -0.32462401228702. Maximum in Density Delta: 0.61600346312173.	57
1241	3231	Constant A: -0.01380146829728. Constant B: 12.027713855566 Minimum in Density Delta: -1.1808711348202. Maximum in Density Delta: 1.4678000707167.	57
1777	6253	Constant A: -0.013230954640146. Constant B: 11.930001990323 Minimum in Density Delta: -0.092369490573674. Maximum in Density Delta: 0.041289166862043.	57

Unique ID	File ID	Reason	Manual Analysis ID
2500	10109	Constant A: -0.014881290887296. Constant B: 12.101763761479 Minimum in Density Delta: -0.011721990978572. Maximum in Density Delta: 0.01157466914583.	57
4041	18042	Constant A: -0.01368731469279. Constant B: 12.045997402901 Minimum in Density Delta: -0.060396371378033. Maximum in Density Delta: 0.046507674909321.	57
4246	18296	Constant A: -0.013565592651059. Constant B: 11.390038695647 Minimum in Density Delta: -0.013867028329855. Maximum in Density Delta: 0.007757227641946.	57
6933	21382	Constant A: -0.013664227224867. Constant B: 12.042648070779 Minimum in Density Delta: -0.014912561383966. Maximum in Density Delta: 0.5844484009771.	57
2319	9084	Constant A: -0.014876420474762. Constant B: 12.100872980748 Minimum in Density Delta: -4.8192605273268. Maximum in Density Delta: 1.0268864996153.	57
2052	7733	Constant A: -0.014886194709571. Constant B: 12.102488225606 Minimum in Density Delta: -2.7568845682272. Maximum in Density Delta: 3.4901438070048.	57
1846	6630	Constant A: -0.01300077664177. Constant B: 11.885501952452 Minimum in Density Delta: -0.055588511165752. Maximum in Density Delta: 0.096070175526961.	57
6448	20872	Constant A: -0.01356630331963. Constant B: 11.390154686782 Minimum in Density Delta: -0.016975393949792. Maximum in Density Delta: 0.034870324294161.	58
4356	18406	Constant A: -0.013567218234309. Constant B: 11.390292857404 Minimum in Density Delta: -0.03493874205833. Maximum in Density Delta: 0.029597675941091.	58
472	764	Constant A: -0.014279336621695. Constant B: 12.076851842585 Minimum in Density Delta: -0.065733865818288. Maximum in Density Delta: 0.0065724119953074.	58
1212	3047	Constant A: . Constant B: 0 Minimum in Density Delta: . Maximum in Density Delta: .	58
2082	7850	Constant A: -0.014880700887839. Constant B: 12.101660249978 Minimum in Density Delta: -0.0058371588446562. Maximum in Density Delta: 0.010429146213369.	58
2040	7721	Constant A: -0.014880677363653. Constant B: 12.101657572918 Minimum in Density Delta: -0.058186309206121. Maximum in Density Delta: 0.0064742920434355.	58
2083	7853	Constant A: -0.014884342456517. Constant B: 12.102309478898 Minimum in Density Delta: -0.0099683617487756. Maximum in Density Delta: 0.57067730100607.	58

E.6 Depth Consistency

File ID	Unique File ID	Reason	Manual Analysis ID
86214	13201	Start Depth or Stop Depth does not match. Header Start: -83.7762 Header Stop: -80.4858 Data Start At: -83.7762 Data Stop At: -83.7762	2
90090	14692	Start Depth or Stop Depth does not match. Header Start: 217.923 Header Stop: 3.44892 Data Start At: 217.923 Data Stop At: 195.987	2
90238	14721	Depths are not constantly incremented.	2
53303	7414	Depths are not constantly incremented.	10
61444	8568	Depths are not constantly incremented.	11
54588	7609	Start Depth or Stop Depth does not match. Header Start: 103.457 Header Stop: 31.9657 Data Start At: 103.457 Data Stop At: 3.2495	13
54632	7613	Start Depth or Stop Depth does not match. Header Start: 104.355 Header Stop: 76.1369 Data Start At: 104.355 Data Stop At: 3.2495	13
65679	9155	Depths are not constantly incremented.	17
19200	2504	Start Depth or Stop Depth does not match. Header Start: 46.3239 Header Stop: 2.85066 Data Start At: 46.3239 Data Stop At: 28.4759	21
19224	2508	Start Depth or Stop Depth does not match. Header Start: 46.0247 Header Stop: 3.05008 Data Start At: 46.0247 Data Stop At: 29.0742	21
19242	2511	Start Depth or Stop Depth does not match. Header Start: 45.925 Header Stop: 3.05008 Data Start At: 45.925 Data Stop At: 42.0364	21
89723	14509	Start Depth or Stop Depth does not match. Header Start: 107.545 Header Stop: 2.35212 Data Start At: 107.545 Data Stop At: 19.7015	21
90079	14683	Start Depth or Stop Depth does not match. Header Start: 217.126 Header Stop: 3.44891 Data Start At: 217.126 Data Stop At: 113.229	21
90080	14684	Start Depth or Stop Depth does not match. Header Start: 218.522 Header Stop: 3.54864 Data Start At: 218.522 Data Stop At: 168.069	21
90081	14685	Start Depth or Stop Depth does not match. Header Start: 217.126 Header Stop: 2.2524 Data Start At: 217.126 Data Stop At: 113.328	21
90082	14686	Start Depth or Stop Depth does not match. Header Start: 218.721 Header Stop: 3.14978 Data Start At: 218.721 Data Stop At: 208.351	21
90083	14687	Start Depth or Stop Depth does not match. Header Start: 217.923 Header Stop: 3.34921 Data Start At: 217.923 Data Stop At: 207.554	21
90084	14688	Start Depth or Stop Depth does not match. Header Start: 217.824 Header Stop: 4.04716 Data Start At: 217.824 Data Stop At: 207.454	21
90085	14689	Start Depth or Stop Depth does not match. Header Start: 218.199 Header Stop: 3.02707 Data Start At: 218.199 Data Stop At: 207.83	21
90086	14690	Start Depth or Stop Depth does not match. Header Start: 217.724 Header Stop: 3.64834 Data Start At: 217.724 Data Stop At: 167.271	21
90224	14717	Start Depth or Stop Depth does not match. Header Start: 79.8998 Header Stop: 1.22974 Data Start At: 79.8998 Data Stop At: 47.4945	21
3508	526	Depths are not constantly incremented.	32
6708	973	Depths are not constantly incremented.	32
88485	13939	Depths are not constantly incremented.	32
14265	1987	Depths are not constantly incremented.	33
31824	4409	Depths are not constantly incremented.	33
31848	4415	Depths are not constantly incremented.	33
32820	4552	Depths are not constantly incremented.	33
54764	7632	Depths are not constantly incremented.	33
67796	9506	Depths are not constantly incremented.	33
17295	2217	Start Depth or Stop Depth does not match. Header Start: 75.4389 Header Stop: 1.05589 Data Start At: 75.4389 Data Stop At: 3.05008	34
43322	6004	Start Depth or Stop Depth does not match. Header Start: 73.3451 Header Stop: 6.44019 Data Start At: 73.3451 Data Stop At: 3.14979	34
44653	6244	Start Depth or Stop Depth does not match. Header Start: 3.14979 Header Stop: 3.05008 Data Start At: 127.088 Data Stop At: 3.05008	34
60865	8523	Start Depth or Stop Depth does not match. Header Start: 0 Header Stop: 0 Data Start At: 95.6799 Data Stop At: 3.84776	34

File ID	Unique File ID	Reason	Manual Analysis ID
61747	8631	Start Depth or Stop Depth does not match. Header Start: 104.853 Header Stop: -1.33713 Data Start At: 104.853 Data Stop At: 3.05008	35
88144	13809	Start Depth or Stop Depth does not match. Header Start: 25.4667 Header Stop: 25.4667 Data Start At: Data Stop At:	35
85919	13182	Depths are not constantly incremented.	36
84805	13063	Depths are not constantly incremented.	37
86890	13371	Start Depth or Stop Depth does not match. Header Start: 37.1555 Header Stop: -2.462 Data Start At: 37.1555 Data Stop At: 36.2574	37
87683	13662	Depths are not constantly incremented.	37
88332	13856	Depths are not constantly incremented.	37
88472	13928	Start Depth or Stop Depth does not match. Header Start: 23.3396 Header Stop: 23.3396 Data Start At: Data Stop At:	37
89496	14350	Depths are not constantly incremented.	37
89513	14363	Depths are not constantly incremented.	37
89597	14410	Start Depth or Stop Depth does not match. Header Start: 2.88645 Header Stop: 2.88645 Data Start At: Data Stop At:	37
89621	14424	Depths are not constantly incremented.	37
89726	14512	Depths are not constantly incremented.	37
90396	14787	Start Depth or Stop Depth does not match. Header Start: 14.1357 Header Stop: 14.1357 Data Start At: Data Stop At:	37
16380	2093	Start Depth or Stop Depth does not match. Header Start: 138.954 Header Stop: 109.141 Data Start At: 138.954 Data Stop At: 3.14979	38
89600	14413	Start Depth or Stop Depth does not match. Header Start: 27.7575 Header Stop: 27.7575 Data Start At: Data Stop At:	39
89724	14510	Start Depth or Stop Depth does not match. Header Start: 76.1029 Header Stop: 2.85262 Data Start At: 76.1029 Data Stop At: 13.0208	39
90223	14716	Start Depth or Stop Depth does not match. Header Start: 230.3 Header Stop: -0.0281218 Data Start At: 230.3 Data Stop At: 6.35327	39
90370	14765	Start Depth or Stop Depth does not match. Header Start: 120.208 Header Stop: 3.05008 Data Start At: 120.208 Data Stop At: 3.14979	39
90379	14770	Start Depth or Stop Depth does not match. Header Start: 120.009 Header Stop: 2.95037 Data Start At: 120.009 Data Stop At: 3.2495	39
65165	9053	Start Depth or Stop Depth does not match. Header Start: 77.4996 Header Stop: 77.4996 Data Start At: Data Stop At:	40
89551	14378	Start Depth or Stop Depth does not match. Header Start: 102.207 Header Stop: 102.207 Data Start At: Data Stop At:	40

E.7 Fidelity

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
13207	13207	39020	220	233	LASCOUNT: 220 RDCOUNT: 233 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13207 UNIQUE RD FILE ID:10862	2
10862	10862	39020	220	233	LASCOUNT: 220 RDCOUNT: 233 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13207 UNIQUE RD FILE ID:10862	2
13111	13111	39558	221	229	LASCOUNT: 221 RDCOUNT: 229 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13111 UNIQUE RD FILE ID:11000	2
11000	11000	39558	221	229	LASCOUNT: 221 RDCOUNT: 229 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13111 UNIQUE RD FILE ID:11000	2
13199	13199	39618	228	230	LASCOUNT: 228 RDCOUNT: 230 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13199 UNIQUE RD FILE ID:11005	2
11005	11005	39618	228	230	LASCOUNT: 228 RDCOUNT: 230 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13199 UNIQUE RD FILE ID:11005	2
13201	13201	39642	205	251	LASCOUNT: 205 RDCOUNT: 251 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13201 UNIQUE RD FILE ID:11007	2
11007	11007	39642	205	251	LASCOUNT: 205 RDCOUNT: 251 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13201 UNIQUE RD FILE ID:11007	2
13193	13193	39901	230	236	LASCOUNT: 230 RDCOUNT: 236 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13193 UNIQUE RD FILE ID:11430	2
11430	11430	39901	230	236	LASCOUNT: 230 RDCOUNT: 236 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13193 UNIQUE RD FILE ID:11430	2
13205	13205	39937	247	366	LASCOUNT: 247 RDCOUNT: 366 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13205 UNIQUE RD FILE ID:11433	2
11433	11433	39937	247	366	LASCOUNT: 247 RDCOUNT: 366 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13205 UNIQUE RD FILE ID:11433	2
13652	13652	29205	1897	1897	LASCOUNT: 1897 RDCOUNT: 1897 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13652 UNIQUE RD FILE ID:5551	4
5551	5551	29205	1897	1897	LASCOUNT: 1897 RDCOUNT: 1897 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13652 UNIQUE RD FILE ID:5551	4
14716	14716	28247	2247	2311	LASCOUNT: 2247 RDCOUNT: 2311 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14716 UNIQUE RD FILE ID:5478	21
5478	5478	28247	2247	2311	LASCOUNT: 2247 RDCOUNT: 2311 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14716 UNIQUE RD FILE ID:5478	21
14686	14686	33804	105	2159	LASCOUNT: 105 RDCOUNT: 2159 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14686 UNIQUE RD FILE ID:7267	21
7267	7267	33804	105	2159	LASCOUNT: 105 RDCOUNT: 2159 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14686 UNIQUE RD FILE ID:7267	21
14689	14689	33808	105	2154	LASCOUNT: 105 RDCOUNT: 2154 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14689 UNIQUE RD FILE ID:7268	21
7268	7268	33808	105	2154	LASCOUNT: 105 RDCOUNT: 2154 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14689 UNIQUE RD FILE ID:7268	21
14429	14429	38396	585	843	LASCOUNT: 585 RDCOUNT: 843 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14429 UNIQUE RD FILE ID:9475	26
9475	9475	38396	585	843	LASCOUNT: 585 RDCOUNT: 843 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14429 UNIQUE RD FILE ID:9475	26
14436	14436	38448	625	778	LASCOUNT: 625 RDCOUNT: 778 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14436 UNIQUE RD FILE ID:9501	26
9501	9501	38448	625	778	LASCOUNT: 625 RDCOUNT: 778 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14436 UNIQUE RD FILE ID:9501	26
14437	14437	38450	434	787	LASCOUNT: 434 RDCOUNT: 787 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14437 UNIQUE RD FILE ID:9502	26
9502	9502	38450	434	787	LASCOUNT: 434 RDCOUNT: 787 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14437 UNIQUE RD FILE ID:9502	26
14438	14438	38464	216	743	LASCOUNT: 216 RDCOUNT: 743 LAS RD Pair Failed Fidelity Check:	26

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					UNIQUE LAS FILE ID: 14438 UNIQUE RD FILE ID:9509	
9509	9509	38464	216	743	LASCOUNT: 216 RDCOUNT: 743 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14438 UNIQUE RD FILE ID:9509	26
972	972	3031	1345	1344	LASCOUNT: 1345 RDCOUNT: 1344 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 972 UNIQUE RD FILE ID:474	31
474	474	3031	1345	1344	LASCOUNT: 1345 RDCOUNT: 1344 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 972 UNIQUE RD FILE ID:474	31
973	973	3036	1396	1395	LASCOUNT: 1396 RDCOUNT: 1395 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 973 UNIQUE RD FILE ID:475	31
475	475	3036	1396	1395	LASCOUNT: 1396 RDCOUNT: 1395 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 973 UNIQUE RD FILE ID:475	31
976	976	3051	1425	1424	LASCOUNT: 1425 RDCOUNT: 1424 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 976 UNIQUE RD FILE ID:478	31
478	478	3051	1425	1424	LASCOUNT: 1425 RDCOUNT: 1424 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 976 UNIQUE RD FILE ID:478	31
1004	1004	3197	1315	1314	LASCOUNT: 1315 RDCOUNT: 1314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1004 UNIQUE RD FILE ID:506	31
506	506	3197	1315	1314	LASCOUNT: 1315 RDCOUNT: 1314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1004 UNIQUE RD FILE ID:506	31
1007	1007	3218	1315	1314	LASCOUNT: 1315 RDCOUNT: 1314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1007 UNIQUE RD FILE ID:509	31
509	509	3218	1315	1314	LASCOUNT: 1315 RDCOUNT: 1314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1007 UNIQUE RD FILE ID:509	31
1010	1010	3239	1316	1315	LASCOUNT: 1316 RDCOUNT: 1315 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1010 UNIQUE RD FILE ID:512	31
512	512	3239	1316	1315	LASCOUNT: 1316 RDCOUNT: 1315 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1010 UNIQUE RD FILE ID:512	31
1017	1017	3288	1330	1329	LASCOUNT: 1330 RDCOUNT: 1329 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1017 UNIQUE RD FILE ID:519	31
519	519	3288	1330	1329	LASCOUNT: 1330 RDCOUNT: 1329 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1017 UNIQUE RD FILE ID:519	31
1020	1020	3309	1276	1275	LASCOUNT: 1276 RDCOUNT: 1275 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1020 UNIQUE RD FILE ID:522	31
522	522	3309	1276	1275	LASCOUNT: 1276 RDCOUNT: 1275 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1020 UNIQUE RD FILE ID:522	31
1022	1022	3323	1250	1249	LASCOUNT: 1250 RDCOUNT: 1249 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1022 UNIQUE RD FILE ID:524	31
524	524	3323	1250	1249	LASCOUNT: 1250 RDCOUNT: 1249 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1022 UNIQUE RD FILE ID:524	31
1025	1025	3344	1238	1237	LASCOUNT: 1238 RDCOUNT: 1237 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1025 UNIQUE RD FILE ID:527	31
527	527	3344	1238	1237	LASCOUNT: 1238 RDCOUNT: 1237 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1025 UNIQUE RD FILE ID:527	31
1028	1028	3365	1308	1307	LASCOUNT: 1308 RDCOUNT: 1307 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1028 UNIQUE RD FILE ID:530	31
530	530	3365	1308	1307	LASCOUNT: 1308 RDCOUNT: 1307 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1028 UNIQUE RD FILE ID:530	31
1034	1034	3407	1205	1204	LASCOUNT: 1205 RDCOUNT: 1204 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1034 UNIQUE RD FILE ID:536	31
536	536	3407	1205	1204	LASCOUNT: 1205 RDCOUNT: 1204 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1034 UNIQUE RD FILE ID:536	31
1035	1035	3414	1203	1202	LASCOUNT: 1203 RDCOUNT: 1202 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1035 UNIQUE RD FILE ID:537	31
537	537	3414	1203	1202	LASCOUNT: 1203 RDCOUNT: 1202 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1035 UNIQUE RD FILE ID:537	31
1037	1037	3428	1142	1141	LASCOUNT: 1142 RDCOUNT: 1141 LAS RD Pair Failed Fidelity	31

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					Check: UNIQUE LAS FILE ID: 1037 UNIQUE RD FILE ID:539	
539	539	3428	1142	1141	LASCOUNT: 1142 RDCOUNT: 1141 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1037 UNIQUE RD FILE ID:539	31
1038	1038	3435	1294	1293	LASCOUNT: 1294 RDCOUNT: 1293 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1038 UNIQUE RD FILE ID:540	31
540	540	3435	1294	1293	LASCOUNT: 1294 RDCOUNT: 1293 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1038 UNIQUE RD FILE ID:540	31
1039	1039	3442	1278	1277	LASCOUNT: 1278 RDCOUNT: 1277 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1039 UNIQUE RD FILE ID:541	31
541	541	3442	1278	1277	LASCOUNT: 1278 RDCOUNT: 1277 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1039 UNIQUE RD FILE ID:541	31
1048	1048	3505	1318	1317	LASCOUNT: 1318 RDCOUNT: 1317 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1048 UNIQUE RD FILE ID:550	31
550	550	3505	1318	1317	LASCOUNT: 1318 RDCOUNT: 1317 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 1048 UNIQUE RD FILE ID:550	31
2022	2022	6213	1067	1066	LASCOUNT: 1067 RDCOUNT: 1066 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2022 UNIQUE RD FILE ID:901	31
901	901	6213	1067	1066	LASCOUNT: 1067 RDCOUNT: 1066 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2022 UNIQUE RD FILE ID:901	31
2023	2023	6235	1066	1065	LASCOUNT: 1066 RDCOUNT: 1065 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2023 UNIQUE RD FILE ID:902	31
902	902	6235	1066	1065	LASCOUNT: 1066 RDCOUNT: 1065 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2023 UNIQUE RD FILE ID:902	31
2029	2029	6360	1109	1108	LASCOUNT: 1109 RDCOUNT: 1108 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2029 UNIQUE RD FILE ID:908	31
908	908	6360	1109	1108	LASCOUNT: 1109 RDCOUNT: 1108 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2029 UNIQUE RD FILE ID:908	31
2048	2048	6772	1089	1088	LASCOUNT: 1089 RDCOUNT: 1088 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2048 UNIQUE RD FILE ID:927	31
927	927	6772	1089	1088	LASCOUNT: 1089 RDCOUNT: 1088 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2048 UNIQUE RD FILE ID:927	31
2069	2069	7228	617	616	LASCOUNT: 617 RDCOUNT: 616 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2069 UNIQUE RD FILE ID:948	31
948	948	7228	617	616	LASCOUNT: 617 RDCOUNT: 616 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2069 UNIQUE RD FILE ID:948	31
2070	2070	7250	618	617	LASCOUNT: 618 RDCOUNT: 617 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2070 UNIQUE RD FILE ID:949	31
949	949	7250	618	617	LASCOUNT: 618 RDCOUNT: 617 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2070 UNIQUE RD FILE ID:949	31
2073	2073	7318	639	638	LASCOUNT: 639 RDCOUNT: 638 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2073 UNIQUE RD FILE ID:952	31
952	952	7318	639	638	LASCOUNT: 639 RDCOUNT: 638 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2073 UNIQUE RD FILE ID:952	31
2254	2254	7700	1150	1149	LASCOUNT: 1150 RDCOUNT: 1149 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2254 UNIQUE RD FILE ID:1003	31
1003	1003	7700	1150	1149	LASCOUNT: 1150 RDCOUNT: 1149 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 2254 UNIQUE RD FILE ID:1003	31
7683	7683	14728	921	920	LASCOUNT: 921 RDCOUNT: 920 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7683 UNIQUE RD FILE ID:2151	31
2151	2151	14728	921	920	LASCOUNT: 921 RDCOUNT: 920 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7683 UNIQUE RD FILE ID:2151	31
7763	7763	14978	800	799	LASCOUNT: 800 RDCOUNT: 799 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7763 UNIQUE RD FILE ID:2187	31
2187	2187	14978	800	799	LASCOUNT: 800 RDCOUNT: 799 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7763 UNIQUE RD FILE ID:2187	31
7767	7767	15010	804	803	LASCOUNT: 804 RDCOUNT: 803 LAS RD Pair Failed Fidelity Check:	31

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					UNIQUE LAS FILE ID: 7767 UNIQUE RD FILE ID:2191	
2191	2191	15010	804	803	LASCOUNT: 804 RDCOUNT: 803 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7767 UNIQUE RD FILE ID:2191	31
7775	7775	15038	1260	1259	LASCOUNT: 1260 RDCOUNT: 1259 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7775 UNIQUE RD FILE ID:2199	31
2199	2199	15038	1260	1259	LASCOUNT: 1260 RDCOUNT: 1259 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7775 UNIQUE RD FILE ID:2199	31
7786	7786	15084	1681	1680	LASCOUNT: 1681 RDCOUNT: 1680 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7786 UNIQUE RD FILE ID:2210	31
2210	2210	15084	1681	1680	LASCOUNT: 1681 RDCOUNT: 1680 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7786 UNIQUE RD FILE ID:2210	31
7787	7787	15092	1601	1600	LASCOUNT: 1601 RDCOUNT: 1600 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7787 UNIQUE RD FILE ID:2211	31
2211	2211	15092	1601	1600	LASCOUNT: 1601 RDCOUNT: 1600 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7787 UNIQUE RD FILE ID:2211	31
7788	7788	15100	1568	1567	LASCOUNT: 1568 RDCOUNT: 1567 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7788 UNIQUE RD FILE ID:2212	31
2212	2212	15100	1568	1567	LASCOUNT: 1568 RDCOUNT: 1567 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7788 UNIQUE RD FILE ID:2212	31
7795	7795	15156	1563	1562	LASCOUNT: 1563 RDCOUNT: 1562 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7795 UNIQUE RD FILE ID:2219	31
2219	2219	15156	1563	1562	LASCOUNT: 1563 RDCOUNT: 1562 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7795 UNIQUE RD FILE ID:2219	31
7797	7797	15172	1563	1562	LASCOUNT: 1563 RDCOUNT: 1562 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7797 UNIQUE RD FILE ID:2221	31
2221	2221	15172	1563	1562	LASCOUNT: 1563 RDCOUNT: 1562 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7797 UNIQUE RD FILE ID:2221	31
7808	7808	15260	1069	1068	LASCOUNT: 1069 RDCOUNT: 1068 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7808 UNIQUE RD FILE ID:2232	31
2232	2232	15260	1069	1068	LASCOUNT: 1069 RDCOUNT: 1068 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7808 UNIQUE RD FILE ID:2232	31
7821	7821	15364	1202	1201	LASCOUNT: 1202 RDCOUNT: 1201 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7821 UNIQUE RD FILE ID:2245	31
2245	2245	15364	1202	1201	LASCOUNT: 1202 RDCOUNT: 1201 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7821 UNIQUE RD FILE ID:2245	31
7822	7822	15372	1196	1195	LASCOUNT: 1196 RDCOUNT: 1195 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7822 UNIQUE RD FILE ID:2246	31
2246	2246	15372	1196	1195	LASCOUNT: 1196 RDCOUNT: 1195 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7822 UNIQUE RD FILE ID:2246	31
9266	9266	17143	1187	1186	LASCOUNT: 1187 RDCOUNT: 1186 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9266 UNIQUE RD FILE ID:2555	31
2555	2555	17143	1187	1186	LASCOUNT: 1187 RDCOUNT: 1186 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9266 UNIQUE RD FILE ID:2555	31
9281	9281	17260	2559	2558	LASCOUNT: 2559 RDCOUNT: 2558 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9281 UNIQUE RD FILE ID:2570	31
2570	2570	17260	2559	2558	LASCOUNT: 2559 RDCOUNT: 2558 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9281 UNIQUE RD FILE ID:2570	31
9293	9293	17329	2083	2082	LASCOUNT: 2083 RDCOUNT: 2082 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9293 UNIQUE RD FILE ID:2582	31
2582	2582	17329	2083	2082	LASCOUNT: 2083 RDCOUNT: 2082 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9293 UNIQUE RD FILE ID:2582	31
9657	9657	17782	583	582	LASCOUNT: 583 RDCOUNT: 582 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9657 UNIQUE RD FILE ID:2692	31
2692	2692	17782	583	582	LASCOUNT: 583 RDCOUNT: 582 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9657 UNIQUE RD FILE ID:2692	31
9659	9659	17792	996	995	LASCOUNT: 996 RDCOUNT: 995 LAS RD Pair Failed Fidelity Check:	31

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					UNIQUE LAS FILE ID: 9659 UNIQUE RD FILE ID:2694	
2694	2694	17792	996	995	LASCOUNT: 996 RDCOUNT: 995 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9659 UNIQUE RD FILE ID:2694	31
9755	9755	17952	2018	2017	LASCOUNT: 2018 RDCOUNT: 2017 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9755 UNIQUE RD FILE ID:2724	31
2724	2724	17952	2018	2017	LASCOUNT: 2018 RDCOUNT: 2017 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9755 UNIQUE RD FILE ID:2724	31
9785	9785	18092	1903	1902	LASCOUNT: 1903 RDCOUNT: 1902 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9785 UNIQUE RD FILE ID:2754	31
2754	2754	18092	1903	1902	LASCOUNT: 1903 RDCOUNT: 1902 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9785 UNIQUE RD FILE ID:2754	31
13078	13078	26209	300	299	LASCOUNT: 300 RDCOUNT: 299 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13078 UNIQUE RD FILE ID:4941	31
4941	4941	26209	300	299	LASCOUNT: 300 RDCOUNT: 299 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13078 UNIQUE RD FILE ID:4941	31
13574	13574	27243	1443	1442	LASCOUNT: 1443 RDCOUNT: 1442 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13574 UNIQUE RD FILE ID:5233	31
5233	5233	27243	1443	1442	LASCOUNT: 1443 RDCOUNT: 1442 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13574 UNIQUE RD FILE ID:5233	31
13576	13576	27251	1449	1448	LASCOUNT: 1449 RDCOUNT: 1448 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13576 UNIQUE RD FILE ID:5235	31
5235	5235	27251	1449	1448	LASCOUNT: 1449 RDCOUNT: 1448 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13576 UNIQUE RD FILE ID:5235	31
13582	13582	27275	1451	1450	LASCOUNT: 1451 RDCOUNT: 1450 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13582 UNIQUE RD FILE ID:5241	31
5241	5241	27275	1451	1450	LASCOUNT: 1451 RDCOUNT: 1450 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13582 UNIQUE RD FILE ID:5241	31
13583	13583	27279	1387	1386	LASCOUNT: 1387 RDCOUNT: 1386 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13583 UNIQUE RD FILE ID:5242	31
5242	5242	27279	1387	1386	LASCOUNT: 1387 RDCOUNT: 1386 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13583 UNIQUE RD FILE ID:5242	31
9634	9634	28440	2074	2075	LASCOUNT: 2074 RDCOUNT: 2075 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9634 UNIQUE RD FILE ID:5492	31
5492	5492	28440	2074	2075	LASCOUNT: 2074 RDCOUNT: 2075 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9634 UNIQUE RD FILE ID:5492	31
9635	9635	28454	1850	1874	LASCOUNT: 1850 RDCOUNT: 1874 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9635 UNIQUE RD FILE ID:5493	31
5493	5493	28454	1850	1874	LASCOUNT: 1850 RDCOUNT: 1874 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 9635 UNIQUE RD FILE ID:5493	31
7632	7632	29257	308	307	LASCOUNT: 308 RDCOUNT: 307 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7632 UNIQUE RD FILE ID:5555	31
5555	5555	29257	308	307	LASCOUNT: 308 RDCOUNT: 307 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7632 UNIQUE RD FILE ID:5555	31
7641	7641	29366	272	270	LASCOUNT: 272 RDCOUNT: 270 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7641 UNIQUE RD FILE ID:5564	31
5564	5564	29366	272	270	LASCOUNT: 272 RDCOUNT: 270 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7641 UNIQUE RD FILE ID:5564	31
7671	7671	29734	302	301	LASCOUNT: 302 RDCOUNT: 301 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7671 UNIQUE RD FILE ID:5594	31
5594	5594	29734	302	301	LASCOUNT: 302 RDCOUNT: 301 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7671 UNIQUE RD FILE ID:5594	31
7674	7674	29771	297	296	LASCOUNT: 297 RDCOUNT: 296 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7674 UNIQUE RD FILE ID:5597	31
5597	5597	29771	297	296	LASCOUNT: 297 RDCOUNT: 296 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7674 UNIQUE RD FILE ID:5597	31
8498	8498	31366	992	991	LASCOUNT: 992 RDCOUNT: 991 LAS RD Pair Failed Fidelity Check:	31

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					UNIQUE LAS FILE ID: 8498 UNIQUE RD FILE ID:5727	
5727	5727	31366	992	991	LASCOUNT: 992 RDCOUNT: 991 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 8498 UNIQUE RD FILE ID:5727	31
13702	13702	33845	1005	1004	LASCOUNT: 1005 RDCOUNT: 1004 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13702 UNIQUE RD FILE ID:7282	31
7282	7282	33845	1005	1004	LASCOUNT: 1005 RDCOUNT: 1004 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13702 UNIQUE RD FILE ID:7282	31
13843	13843	35322	356	355	LASCOUNT: 356 RDCOUNT: 355 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13843 UNIQUE RD FILE ID:7967	31
7967	7967	35322	356	355	LASCOUNT: 356 RDCOUNT: 355 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13843 UNIQUE RD FILE ID:7967	31
13850	13850	35339	304	303	LASCOUNT: 304 RDCOUNT: 303 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13850 UNIQUE RD FILE ID:7976	31
7976	7976	35339	304	303	LASCOUNT: 304 RDCOUNT: 303 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13850 UNIQUE RD FILE ID:7976	31
13951	13951	35925	202	201	LASCOUNT: 202 RDCOUNT: 201 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13951 UNIQUE RD FILE ID:8207	31
8207	8207	35925	202	201	LASCOUNT: 202 RDCOUNT: 201 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13951 UNIQUE RD FILE ID:8207	31
14294	14294	37093	260	259	LASCOUNT: 260 RDCOUNT: 259 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14294 UNIQUE RD FILE ID:8885	31
8885	8885	37093	260	259	LASCOUNT: 260 RDCOUNT: 259 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14294 UNIQUE RD FILE ID:8885	31
14349	14349	37697	315	314	LASCOUNT: 315 RDCOUNT: 314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14349 UNIQUE RD FILE ID:9051	31
9051	9051	37697	315	314	LASCOUNT: 315 RDCOUNT: 314 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14349 UNIQUE RD FILE ID:9051	31
14385	14385	37977	6	5	LASCOUNT: 6 RDCOUNT: 5 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14385 UNIQUE RD FILE ID:9200	31
9200	9200	37977	6	5	LASCOUNT: 6 RDCOUNT: 5 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14385 UNIQUE RD FILE ID:9200	31
14420	14420	38265	806	805	LASCOUNT: 806 RDCOUNT: 805 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14420 UNIQUE RD FILE ID:9377	31
9377	9377	38265	806	805	LASCOUNT: 806 RDCOUNT: 805 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14420 UNIQUE RD FILE ID:9377	31
13197	13197	39593	227	226	LASCOUNT: 227 RDCOUNT: 226 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13197 UNIQUE RD FILE ID:11003	31
11003	11003	39593	227	226	LASCOUNT: 227 RDCOUNT: 226 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13197 UNIQUE RD FILE ID:11003	31
13220	13220	39978	227	226	LASCOUNT: 227 RDCOUNT: 226 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13220 UNIQUE RD FILE ID:11439	31
11439	11439	39978	227	226	LASCOUNT: 227 RDCOUNT: 226 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13220 UNIQUE RD FILE ID:11439	31
13117	13117	40060	226	225	LASCOUNT: 226 RDCOUNT: 225 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13117 UNIQUE RD FILE ID:11455	31
11455	11455	40060	226	225	LASCOUNT: 226 RDCOUNT: 225 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13117 UNIQUE RD FILE ID:11455	31
14698	14698	40400	410	409	LASCOUNT: 410 RDCOUNT: 409 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14698 UNIQUE RD FILE ID:11500	31
11500	11500	40400	410	409	LASCOUNT: 410 RDCOUNT: 409 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14698 UNIQUE RD FILE ID:11500	31
14779	14779	40403	318	317	LASCOUNT: 318 RDCOUNT: 317 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14779 UNIQUE RD FILE ID:11505	31
11505	11505	40403	318	317	LASCOUNT: 318 RDCOUNT: 317 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 14779 UNIQUE RD FILE ID:11505	31
13175	13175	39130	221	232	LASCOUNT: 221 RDCOUNT: 232 LAS RD Pair Failed Fidelity Check:	48

File ID	Unique ID	LAS-RD Pair ID	LAS gamma count, number of rows in sequence	RD gamma count, number of rows in sequence	Flag Reason	Manual Analysis ID
					UNIQUE LAS FILE ID: 13175 UNIQUE RD FILE ID:10889	
10889	10889	39130	221	232	LASCOUNT: 221 RDCOUNT: 232 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13175 UNIQUE RD FILE ID:10889	48
13186	13186	39998	247	260	LASCOUNT: 247 RDCOUNT: 260 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13186 UNIQUE RD FILE ID:11443	48
11443	11443	39998	247	260	LASCOUNT: 247 RDCOUNT: 260 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13186 UNIQUE RD FILE ID:11443	48
8523	8523	31655	922	930	LASCOUNT: 922 RDCOUNT: 930 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 8523 UNIQUE RD FILE ID:5753	49
5753	5753	31655	922	930	LASCOUNT: 922 RDCOUNT: 930 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 8523 UNIQUE RD FILE ID:5753	49
3757	3757	33759	1932	1934	LASCOUNT: 1932 RDCOUNT: 1934 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 3757 UNIQUE RD FILE ID:7257	50
7257	7257	33759	1932	1934	LASCOUNT: 1932 RDCOUNT: 1934 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 3757 UNIQUE RD FILE ID:7257	50
3759	3759	33763	2085	2086	LASCOUNT: 2085 RDCOUNT: 2086 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 3759 UNIQUE RD FILE ID:7258	50
7258	7258	33763	2085	2086	LASCOUNT: 2085 RDCOUNT: 2086 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 3759 UNIQUE RD FILE ID:7258	50
8631	8631	32657	1022	1066	LASCOUNT: 1022 RDCOUNT: 1066 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 8631 UNIQUE RD FILE ID:6813	51
6813	6813	32657	1022	1066	LASCOUNT: 1022 RDCOUNT: 1066 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 8631 UNIQUE RD FILE ID:6813	51

Appendix F: Files Containing Null Values

Unique File ID	File ID	Filename	Total number of density measurements in file	Number of Nulls	% of the file containing null values
800	5165	TCp1FT3.LAS	449	442	98%
14411	89598	hhhhhhhhhhh.LAS	64	63	98%
6476	46379	LRTB9T1.LAS	769	756	98%
14379	89552	SCMLA1-LP2T1.LAS	769	756	98%
521	3493	P22T1.LAS	321	315	98%
523	3499	P23T1.LAS	321	315	98%
524	3502	P23T2.LAS	321	315	98%
505	3413	RW1P122T1.LAS	257	252	98%
525	3505	P27T1.LAS	257	252	98%
3538	25600	92880RWF1P231T1.LAS	193	189	98%
3539	25616	92880RWF1P232T1.LAS	193	189	98%
3540	25633	92880RWF1P232T2.LAS	193	189	98%
13810	88148	bata84pltube1.LAS	193	189	98%
4066	29862	CVPL5T1.LAS	65	63	97%
14217	89105	ddddddddddd.LAS	22	21	95%
13663	87694	TEST.LAS	16	15	94%
14221	89109	rrrrrrrrrrrrrrrrr.LAS	16	15	94%
14341	89465	P14P6T8.LAS	2289	439	19%
14362	89511	RWAP4T1.LAS	419	52	12%
13650	87552	P4-T1 Bad Data.LAS	2170	238	11%
14714	90210	1.LAS	9	8	89%
14216	89104	test.LAS	8	7	88%
14382	89555	TEST.LAS	7	6	86%
8568	61444	195.LAS	7	6	86%
9635	68748	test.LAS	5	4	80%
9506	67796	test.LAS	3	2	67%
6759	48468	T1.LAS	1634	434	27%
9251	66128	P12P6T6.LAS	2452	322	13%
9254	66140	P14P6T7.LAS	2312	238	10%
9250	66124	RWAP5T1.LAS	420	33	8%
9248	66116	RWAP4T2.LAS	422	25	6%
9608	68279	405braddocp3t1.LAS	292	16	5%
9253	66136	TEST 4.LAS	97	4	4%
3757	27110	RWAP2T2.LAS	422	12	3%
9252	66132	RWAP6T2.LAS	418	10	2%
2339	18090	RTE70b2p1t5.LAS	713	12	2%
9607	68277	LAgapcloserp77t1.LAS	419	4	1%
9605	68273	RTE70b2p1t4.LAS	717	5	1%
9606	68275	LHb1p10t4.LAS	751	5	1%
9604	68271	LHb1p10t3.LAS	756	5	1%
7339	52664	BENMPEIR6P4T6.LAS	1798	9	1%
9634	68729	BENMPEIR6P4T7.LAS	1800	9	1%
9610	68298	B4LT7.LAS	949	4	0%
9511	67816	LHb1p10t2.LAS	757	3	0%
1946	13836	B9LT1.LAS	608	2	0%
9505	67792	BENMPEIR6P4T8.LAS	1799	5	0%
9593	68102	p3lt2.LAS	751	2	0%
9622	68504	B12p1t3.las	899	2	0%
9247	66112	B4LT4.LAS	946	2	0%
9667	69015	CBV RetestB3P2T2.LAS	1056	2	0%
9661	69003	TESTAFTERCHIPING-BMP6P4T6.LAS	1795	3	0%
9507	67800	BMP10P3T1.LAS	2640	2	0%

Unique File ID	File ID	Filename	Total number of density measurements in file	Number of Nulls	% of the file containing null values
9513	67824	P7P8T5.LAS	2417	283	12%
9512	67820	P7P8T8.LAS	2402	278	12%
9508	67804	P7P8T4.LAS	2413	278	12%
9515	67832	P7P8T2.LAS	2415	273	11%
9523	67870	P14P3T6.LAS	2160	244	11%
9225	65933	P7P8T7.LAS	2412	272	11%
9668	69017	P7P8T6.LAS	2413	263	11%
9665	69011	RSL28RT3.LAS	735	80	11%
9630	68656	P14P3T5.LAS	2322	247	11%
9524	67875	P14P3T3.LAS	2332	247	11%
9591	68098	P14P3T4.LAS	2319	244	11%
9473	67419	P14P3T2.LAS	2316	242	10%
9611	68300	B10P1T13.LAS	874	91	10%
9628	68619	P14P3T7.LAS	2308	235	10%
2334	18045	benb12p7t3.LAS	2029	206	10%
9449	67142	bent20p1t7.LAS	965	97	10%
9603	68269	P12P6T5.LAS	2079	208	10%
9504	67788	P14P1T7.LAS	2311	229	10%
7335	52640	p14p5t2.LAS	2354	233	10%
9632	68692	P7P8T1.LAS	2412	238	10%
9521	67860	P15P1T7.LAS	2242	219	10%
9249	66120	P15P1T1.LAS	2196	213	10%
9592	68100	P12P6T7.LAS	2087	200	10%
9481	67487	benb12p7t5.LAS	2036	194	10%
9666	69013	benb12p7t4.LAS	2034	193	9%
9679	69053	P12P6T8.LAS	2088	198	9%
9520	67855	benb12p7t7.LAS	2036	193	9%
2333	18036	benb12p8t7.LAS	2076	196	9%
9624	68542	Beniciapier7tube3.LAS	2431	229	9%
9502	67780	P15P1T8.LAS	2240	211	9%
9609	68281	P15P1T5.LAS	2239	210	9%
9482	67494	P14P6T3.LAS	2324	217	9%
9633	68711	benb12p8t8.LAS	2080	194	9%
9625	68561	P14P1T5.LAS	2313	215	9%
9629	68637	PIER12PILE2TUBE5.LAS	2105	195	9%
9590	68096	P14P3T8.LAS	2324	215	9%
9601	68228	P14P6T1.LAS	2314	214	9%
9682	69065	RSL27RT2.LAS	791	73	9%
9589	68094	NBP11P7T5.LAS	2321	214	9%
9681	69061	P14P3T1.LAS	2323	213	9%
9451	67152	P12P6T4.LAS	2085	191	9%
9683	69069	B10P1T1.LAS	863	79	9%
9514	67828	P14P6T5.LAS	2316	212	9%
9509	67808	benb12p8t5.LAS	2076	190	9%
9602	68248	P7P8T3.LAS	2417	221	9%
9480	67480	P14P1T6.LAS	2306	210	9%
9503	67784	bent12pile3t5.LAS	2087	190	9%
9600	68208	P15P1T6.LAS	2243	204	9%
9588	68092	benpr15pl3t3.LAS	2234	203	9%
4575	32942	benb12p8t4.LAS	2080	189	9%
4574	32938	RSL27RT1.LAS	807	73	9%
9517	67840	p14p5t4.LAS	2310	208	9%
9522	67865	P12P6T2.LAS	2088	188	9%
9460	67197	P14P3T6R.LAS	2311	208	9%
9598	68167	bent12pile3t6.LAS	2085	187	9%

Unique File ID	File ID	Filename	Total number of density measurements in file	Number of Nulls	% of the file containing null values
2335	18054	P14P6T6.LAS	2321	208	9%
9417	67066	p14p5t5.LAS	2314	207	9%
9448	67137	P14P6T2.LAS	2328	207	9%
9662	69005	P14P1T4.LAS	2307	205	9%
7237	52097	P14P2T7.LAS	2320	206	9%
9680	69057	benpr15pl3t6.LAS	2235	198	9%
9483	67501	P14P1T3.LAS	2314	204	9%
9450	67147	benpr15pl3t5.LAS	2239	197	9%
9430	67092	NBP11P7T7.LAS	2320	202	9%
9693	69093	benpr15pl3t7.LAS	2229	194	9%
2338	18081	benb12p7t6.LAS	2034	176	9%
9414	67060	benb12p7t1.LAS	2021	174	9%
9664	69009	P14P2T8.LAS	2318	199	9%
9627	68600	bent12pile3t4.LAS	2086	179	9%
9677	69045	P12P6T3.LAS	2078	178	9%
2336	18063	P14P2T6.LAS	2317	198	9%
9594	68104	P14P1T2.LAS	2312	197	9%
9097	65488	B6PrT3.LAS	871	74	8%
9436	67104	B6PrT2.LAS	884	75	8%
9587	68090	benb12p8t1.LAS	2075	176	8%
7236	52093	benb12p8t6.LAS	2075	176	8%
9673	69033	P11P8T8.LAS	2311	196	8%
9419	67070	P14P2T4.LAS	2315	196	8%
9393	66974	RSL27RT3.LAS	793	67	8%
9672	69029	P11P3T5.LAS	2304	194	8%
9631	68674	NBP11P7T4.LAS	2318	195	8%
7233	52081	P15p1t2.las	2233	187	8%
9699	69105	rivbt3p1t3.LAS	878	73	8%
9415	67062	benpr15pl3t4.LAS	2239	186	8%
7234	52085	bent12pile3t7.LAS	2084	173	8%
7238	52101	NBP11P7T6.LAS	2325	193	8%
9479	67473	nbpier11p5t2.LAS	2301	191	8%
9431	67094	bm680p15p5t1.LAS	2229	185	8%
9671	69025	RSL28RT2.LAS	736	61	8%
9623	68523	P11P3T2.LAS	2305	191	8%
9446	67127	P15P1T4.LAS	2235	185	8%
9392	66969	p14p5t8.LAS	2318	190	8%
1947	13844	benpr15pl3t1.LAS	2235	183	8%
9597	68147	RSL27RT4.LAS	796	65	8%
6761	48500	P14P1T8.LAS	2311	188	8%
9674	69037	SR76P9LT7DN.LAS	713	58	8%
9670	69021	nbpier11p5t8.LAS	2302	187	8%
9396	66989	P14P1T1.LAS	2309	187	8%
9599	68187	rivbt3p1t2.LAS	865	70	8%
9510	67812	P15P2T5.LAS	2237	181	8%
9626	68580	P11P3T7.LAS	2304	186	8%
9518	67845	PIER10PILE8TUBE5.LAS	2652	214	8%
9457	67182	P15P2T4.LAS	2238	180	8%
9416	67064	P14P6T4.LAS	2326	187	8%
9516	67836	rivbt3p1t14.LAS	884	71	8%
9454	67167	bm680p15p5t7.LAS	2229	179	8%
9429	67090	P11P3T3.LAS	2304	185	8%
2327	18006	rivbt3p1t15.LAS	897	72	8%
7044	51004	rivbt3p1t4.LAS	886	71	8%
9519	67850	bent12pile3t3.LAS	2085	167	8%

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9459	67192	nbpier11p5t3.LAS	2303	184	8%
7052	51052	P15P2T3.LAS	2233	178	8%
9700	69107	p14p5t3.LAS	2318	184	8%
2346	18133	NBP11P7T2.LAS	2319	184	8%
9456	67177	PIER10PILE8TUBE4.LAS	2652	209	8%
7231	52073	bent20p1t8.LAS	965	76	8%
13522	87153	P14P2T3.LAS	2316	182	8%
9684	69073	P15P2T6.LAS	2242	176	8%
9698	69103	P15P2T2.LAS	2234	175	8%
9478	67466	PIER10PILE8TUBE8.LAS	2658	208	8%
9663	69007	P14P2T5.LAS	2315	181	8%
7346	52706	benb12p7t2.LAS	2022	158	8%
7141	51617	p14p5t7.LAS	2321	181	8%
7347	52712	benb12p8t2.LAS	2078	161	8%
9418	67068	P11P8T5.LAS	2311	179	8%
9394	66979	P11P3T4.LAS	2300	178	8%
9678	69049	benb12p7t8.LAS	2024	156	8%
13521	87151	P11P8T2.LAS	2312	178	8%
9676	69043	nbpier11p5t1.LAS	2307	176	8%
9458	67187	RSL25RT3.LAS	892	68	8%
9447	67132	RIVB14P1T13.LAS	922	70	8%
7348	52718	benb12p8t3.LAS	2078	157	8%
9697	69101	P11P8T7.LAS	2312	174	8%
7232	52077	RIVB14P1T7.LAS	904	68	8%
9420	67072	bm680p15p5t8.LAS	2224	167	8%
9387	66948	RSL29RT1.LAS	667	50	7%
7144	51629	P11P8T4.LAS	2309	173	7%
9501	67776	rivbt3p1t12.LAS	883	66	7%
7230	52069	RSL34LT1.LAS	1299	97	7%
13526	87161	benpr15pl3t8.LAS	2234	166	7%
7341	52676	bm680p15p5t6.LAS	2227	165	7%
9453	67162	bent12pile3t2.LAS	2085	152	7%
7336	52646	P15P1T3.LAS	2237	163	7%
13519	87147	B10P1T7.LAS	1304	95	7%
7147	51641	B2T3.LAS	928	67	7%
7338	52658	B10P1T8.LAS	1302	94	7%
9434	67100	P11P3T6.LAS	2304	166	7%
7241	52113	PIER10PILE8TUBE6.LAS	2652	191	7%
4576	32946	benpr15pl3t2.LAS	2236	161	7%
7240	52109	richb33t4.LAS	1125	81	7%
7340	52670	P15p2t8.las	1702	122	7%
4579	32958	P11P8T6.LAS	2311	165	7%
7139	51609	NBP11P7T3.LAS	2317	165	7%
7344	52694	B10P1T9.LAS	1301	92	7%
7133	51585	bm680p15p5t5.LAS	2226	157	7%
4578	32954	rivbt3p1t13.LAS	882	62	7%
7146	51637	P11P3T8.LAS	2298	161	7%
9694	69095	BMPIER10PILE7T7.LAS	2657	186	7%
7229	52065	B2T6.LAS	921	64	7%
4580	32963	P12P6T1.LAS	2081	144	7%
7145	51633	rivbt3p1t11.LAS	882	61	7%
2325	17996	richb34t1.LAS	1302	90	7%
13520	87149	B10P1T2.LAS	1304	90	7%
9433	67098	P11P8T1.LAS	2304	159	7%
7046	51016	B10P1T10.LAS	1305	90	7%

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9388	66951	richb33t2.LAS	1136	78	7%
7337	52652	B2T9.LAS	904	62	7%
9695	69097	B10P1T12.LAS	1302	89	7%
7343	52688	nbpier11p5t6.LAS	2303	157	7%
9477	67459	rivbt3p1t7.LAS	838	57	7%
7140	51613	B6PrT4.LAS	873	59	7%
7317	52518	rivbt3p1t6.LAS	881	59	7%
9432	67096	B10P1T14.LAS	1302	87	7%
13518	87145	B7LT1.LAS	958	64	7%
7345	52700	B2T15.LAS	925	61	7%
1945	13828	B10P1T5.LAS	1305	86	7%
7334	52635	B2T1.LAS	902	59	7%
6760	48484	B6PrT6.LAS	873	57	7%
13528	87165	B2T8.LAS	921	60	7%
7134	51589	bm680p15p5t2.LAS	2227	145	7%
13527	87163	rivbt3p1t10.LAS	876	57	7%
9595	68106	B7LT2.LAS	954	62	6%
9383	66936	B2T7.LAS	929	60	6%
9675	69041	RSL25RT1.LAS	885	57	6%
9435	67102	richb33t3.LAS	1126	72	6%
9669	69019	nbpier11p5t5.LAS	2301	146	6%
9621	68485	RIVB14P1T15.LAS	901	57	6%
9413	67058	BMPIER10PILE7T8.LAS	2659	168	6%
7243	52121	B10P1T11.LAS	1303	82	6%
7248	52141	bm680p15p5t3.LAS	2227	140	6%
2304	17891	B10P1T4.LAS	1307	81	6%
7253	52161	bent12pile3.LAS	2083	129	6%
13542	87193	B2T2.LAS	895	55	6%
7235	52089	RIVB8P1T8.LAS	995	61	6%
9484	67508	nbpier11p5t4.LAS	2317	141	6%
9488	67584	richb33t1.LAS	1135	69	6%
13545	87199	B10P1T6.LAS	1302	79	6%
4586	32993	bent20p1t6.LAS	959	58	6%
11658	77959	b10t13.LAS	1251	75	6%
3794	27543	richb34t3.LAS	1302	77	6%
13544	87197	B2T10.LAS	914	54	6%
7261	52193	richb34t2.LAS	1305	77	6%
3797	27570	P14P2T1.LAS	2323	137	6%
7312	52488	BMPIER10PILE7T3.LAS	2657	155	6%
13529	87167	P15p2t7.las	1938	113	6%
7245	52129	nbpier11p5t7.LAS	2303	134	6%
4577	32950	P15p2t1.las	1918	111	6%
1944	13820	p14p5t1.LAS	2325	134	6%
7413	53297	P11P3T1.LAS	2304	132	6%
9455	67172	rivbt3p1t9.LAS	891	51	6%
7250	52149	RVRSDBENT4t13.LAS	1102	63	6%
3795	27552	richb21t4.LAS	1090	62	6%
3796	27561	RVRSDBENT4t4.LAS	1100	62	6%
4584	32983	L36rt1.las	1341	75	6%
7137	51601	rivbt3p1t16.LAS	881	49	6%
7286	52329	bent12pile3t8.LAS	2088	116	6%
7256	52173	p12p4t4.LAS	2100	116	6%
13848	88321	L36rt4.las	1341	74	6%
7276	52259	B7RT2.LAS	725	40	6%
3799	27588	SASBT1P10T1.LAS	2180	119	5%

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7412	53291	L36rt3.las	1340	73	5%
9487	67561	RVRSDBENT5t11.LAS	829	45	5%
4342	31508	SASBT1P10T4.LAS	2175	118	5%
9386	66945	RIVB8P1T3.LAS	997	53	5%
3762	27192	richb34t4.LAS	1301	69	5%
7257	52177	RVRSDBENT4t10.LAS	1094	58	5%
7279	52280	B6PrT5.LAS	868	46	5%
7143	51625	bent20p1t5.LAS	954	50	5%
2337	18072	B15T12.LAS	958	50	5%
7264	52205	P11P8T3.LAS	2305	120	5%
7249	52145	RVRSDBENT4t15.LAS	1104	57	5%
7281	52294	SASBT1P10T2.LAS	2193	113	5%
7316	52512	SASBT1P10T3.LAS	2174	112	5%
7247	52137	B7LT6.LAS	953	49	5%
9226	65936	B2T13.LAS	897	46	5%
7136	51597	rivb6t7.LAS	940	48	5%
4343	31514	RVRSDBENT4t7.LAS	1099	56	5%
13523	87155	bcbb2plt1.LAS	1043	53	5%
7246	52133	rivb6t11.LAS	945	48	5%
7242	52117	SASBT1P10T6.LAS	2174	110	5%
7252	52157	B15T11.LAS	956	48	5%
7277	52266	p12p4t3.LAS	2098	105	5%
7491	53738	B3uP3T1.LAS	851	42	5%
4589	33008	BMPIER10PILE7T6.LAS	2660	131	5%
7255	52169	P4-T5.LAS	2173	107	5%
7258	52181	RVRSDBENT4t8.LAS	1103	54	5%
9390	66959	rivb6t14.LAS	940	46	5%
3761	27174	B2T5.LAS	921	45	5%
7278	52273	RSL28RT1.LAS	737	36	5%
13543	87195	RVRSDBENT5t14.LAS	828	40	5%
7287	52336	RVRSDBENT4t14.LAS	1104	53	5%
7342	52682	rivb6t2.LAS	938	45	5%
7251	52153	RIVB8P1T7.LAS	990	47	5%
4585	32988	RVRSDBENT4t12.LAS	1099	52	5%
7309	52470	Beniciapier7tube4.LAS	2453	116	5%
1938	13771	B2T12.LAS	889	42	5%
7283	52308	B3uP3T2.LAS	848	40	5%
4344	31520	RSL34LT2.LAS	1273	60	5%
7307	52458	RVRSDBENT4t11.LAS	1104	52	5%
7263	52201	rivbt3p1t8.LAS	830	39	5%
2303	17886	RVRSDBENT4t3.LAS	1102	51	5%
9485	67515	rivb6t12.LAS	939	43	5%
7488	53720	rivb5t13.LAS	1116	51	5%
4346	31532	B7RT5.LAS	1099	50	5%
7495	53762	RVRSDBENT4t6a.LAS	1101	50	5%
4588	33003	RVRSDBENT4t9.LAS	1103	50	5%
2326	18001	PIER10PILE8TUBE2.LAS	2652	120	5%
3759	27140	P4-T4.LAS	2168	98	5%
14786	90395	rivb6t13.LAS	937	42	4%
2349	18148	L36rt2.las	1341	60	4%
7135	51593	rivb6t8.LAS	939	42	4%
7311	52482	B10P1T3.LAS	1303	58	4%
7500	53792	RVRSDBENT4t2.LAS	1102	49	4%
7487	53714	B7RT1.LAS	1108	49	4%
7094	51301	RIVB8P1T14.LAS	1000	44	4%

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4347	31538	bent20p1t1.LAS	958	42	4%
9696	69099	rivb6t4.LAS	937	41	4%
7254	52165	B3uP3T3.LAS	851	37	4%
3798	27579	RIVB8P1T12.LAS	990	43	4%
7494	53756	RVRSDBENT5t13.LAS	831	36	4%
7239	52105	richb21t3.LAS	1044	45	4%
7387	53155	p12p4t1.LAS	2104	90	4%
7389	53163	rivb5t10.LAS	1099	47	4%
7275	52252	B3uP3T5.LAS	848	36	4%
7138	51605	rivb5t4.LAS	1113	47	4%
13557	87223	B7RT4.LAS	1102	46	4%
7376	53111	RSL25RT2A.LAS	893	37	4%
7493	53750	P4-T2.LAS	2175	90	4%
13556	87221	RSL29RT4.LAS	655	27	4%
7471	53632	B2T11.LAS	884	36	4%
7534	53930	RIVB8P1T2.LAS	991	40	4%
13458	86991	rivb5t9.LAS	1100	44	4%
7099	51321	rivb5t1.LAS	1140	45	4%
7386	53151	RIVB17T3.LAS	1319	52	4%
7262	52197	B3uP3T6.LAS	848	33	4%
7497	53774	bm680p15p5t4.LAS	2231	86	4%
4331	31464	RVRSDBENT4t5.LAS	1104	42	4%
7375	53107	SASBT1P10T5.LAS	2184	83	4%
7390	53167	rivb5t3.LAS	1117	42	4%
7519	53870	rivbt3p1t5.LAS	883	33	4%
13554	87217	rivbnt13p1t3.LAS	857	32	4%
7537	53942	rivbnt13p1t5.LAS	858	32	4%
7498	53780	rivb6t10.LAS	939	35	4%
7379	53123	B2T14.LAS	888	33	4%
9492	67674	Lbent7Rt4.LAS	945	35	4%
5093	36290	rivbnt12p1t6.LAS	678	25	4%
5087	36254	rivb5t2.LAS	1110	39	4%
7315	52506	Lbent7Rt3.LAS	944	33	3%
5089	36266	rivb3t8.LAS	781	27	3%
7282	52301	rivbent8t14.LAS	1014	35	3%
7378	53119	52INTP2P4T5.LAS	754	26	3%
5085	36242	RIVB17T8.LAS	1313	45	3%
7404	53243	rivbnt13p1t2.LAS	856	29	3%
1948	13852	RVRSDBENT5t12.LAS	834	28	3%
5086	36248	rivb5t6.LAS	1107	37	3%
7318	52524	sf2u4t1.LAS	1021	34	3%
7388	53159	rivbnt12p1t5.LAS	907	30	3%
6756	48420	rivbnt13p1t6.LAS	860	28	3%
1941	13796	rivbnt7t13.LAS	1015	33	3%
9596	68127	Lbent7Rt1.LAS	938	30	3%
7285	52322	rivbent8t4.LAS	408	13	3%
5090	36272	rivb5t7.LAS	1106	35	3%
13555	87219	rivbnt12p1t9.LAS	866	27	3%
7409	53273	p12p4t8.LAS	2102	65	3%
7088	51277	B7P1T8.LAS	1298	40	3%
3763	27210	B7P1T2.LAS	1314	40	3%
9385	66942	RIVB8P1T6.LAS	995	30	3%
5094	36296	B7P1T4.LAS	1297	39	3%
7392	53175	rivb6t3.LAS	941	28	3%
7268	52221	rivbnt12p1t8.LAS	877	26	3%

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5088	36260	B7P1T1.LAS	1284	38	3%
7391	53171	rivbnt14p1t4.LAS	922	27	3%
5091	36278	bent20p1t9.LAS	957	28	3%
7269	52225	B7P1T10.LAS	1299	38	3%
7304	52440	RIVB8P1T9.LAS	994	29	3%
5147	36589	rivbnt13p1t4.LAS	860	25	3%
7408	53267	bent20p1t2.LAS	952	27	3%
7496	53768	P14P2T2.LAS	2323	65	3%
6764	48548	rivb6t6.LAS	935	26	3%
9229	65945	B7P1T5.LAS	1302	36	3%
7369	53083	Lbent7Rt2.LAS	945	26	3%
4327	31448	rivbnt14p1t9.LAS	917	25	3%
7529	53910	RIVB17T12.LAS	1325	36	3%
9486	67538	P4-T6.LAS	2173	59	3%
7273	52241	BMPIER10PILE7T5.LAS	2655	72	3%
7586	54405	B7P1T9.LAS	1297	35	3%
7406	53255	rivbnt13p1t8.LAS	854	23	3%
5092	36284	RVRSDBENT5t4.LAS	828	22	3%
7400	53219	B7P1T3.LAS	1294	34	3%
13457	86990	rivbnt13p1t7.LAS	856	22	3%
7260	52189	B7P1T6.LAS	1301	33	3%
1326	9262	RVRSDBENT5t5.LAS	828	21	3%
7414	53303	RIVB8P1T1.LAS	994	25	3%
7090	51285	sjb3t4.LAS	358	9	3%
7581	54381	rivbnt14p1t8.LAS	919	23	3%
7536	53938	rivb5t5.LAS	1103	27	2%
7580	54377	beniciapier7tube7.LAS	2429	58	2%
7579	54373	rivbnt12p1t12.LAS	858	20	2%
9475	67439	sf2u4t3.LAS	873	19	2%
7525	53894	rivbent8t1.LAS	1014	22	2%
7272	52237	p12p4t2.LAS	2097	45	2%
7377	53115	RVRSDBENT5t9.LAS	837	17	2%
6437	46198	I91B2PW3T5.LAS	963	19	2%
7228	52061	rivbnt14p1t6.LAS	922	17	2%
6430	46156	B7P1T7.LAS	1297	23	2%
6429	46150	rivbnt14p1t15.LAS	913	16	2%
7142	51621	52INTP2P4T4.LAS	753	13	2%
7314	52500	RVRSDBENT5t10.LAS	828	14	2%
2340	18099	B15T13.LAS	1911	31	2%
7366	53071	RIVB17T14.LAS	1323	21	2%
9474	67429	Stage2Pw2T6.LAS	1011	16	2%
7372	53095	rivbent8t3.LAS	1016	16	2%
7489	53726	Stage2Pw2T5.LAS	1012	15	1%
7381	53131	Stage2Pw2T4.LAS	1013	15	1%
9389	66954	PIER12PILE2TUBE7.LAS	2095	31	1%
8633	61765	rivbnt7t6.LAS	1017	15	1%
7398	53207	RVRSDBENT5t8.LAS	833	12	1%
7265	52209	rivbnt12p1t7.LAS	867	12	1%
6907	49844	la101bd4p1t10.LAS	832	11	1%
7584	54395	rivbt3p1t1.LAS	882	11	1%
6444	46225	la101bd4p1t03.LAS	830	10	1%
7578	54369	la101bd4p1t02.LAS	831	10	1%
7374	53103	B2T4.LAS	918	11	1%
4582	32973	RIVB8P1T5.LAS	1007	12	1%
7380	53127	RSL28RT4.LAS	725	8	1%

Unique File ID	File ID	Filename	Total number of density measurements in file	Number of Nulls	% of the file containing null values
7047	51022	rivbnt12p1t1.LAS	910	10	1%
7583	54390	PiER12PILE2TUBE6.LAS	2108	23	1%
1325	9256	rivbnt12p1t2.LAS	919	10	1%
8738	62862	rivb5t11.LAS	1108	12	1%
8737	62853	rivbnt13p1t10.LAS	853	9	1%
4590	33013	PIER10PILE8TUBE1.LAS	2654	27	1%
7271	52233	B4RT3.LAS	1007	10	1%
6428	46144	rivbnt14p1t13.LAS	912	9	1%
8744	62918	RVRSDBENT5t15.LAS	825	8	1%
1332	9298	I91B2PW3T3.LAS	961	9	1%
9148	65665	la101bd5p1t06.LAS	755	7	1%
9149	65667	Stage2Pw2T3.LAS	1012	9	1%
7577	54365	rivbnt12p1t4.LAS	912	8	1%
1549	10705	B7LT4.LAS	953	8	1%
6814	49078	rivbnt13p1t1.LAS	860	7	1%
6771	48660	RIVB14P1T2.LAS	903	7	1%
6755	48404	I91B2PW3T2.LAS	960	7	1%
6816	49090	B7RT6.LAS	1099	7	1%
7092	51293	RVRSDBENT5t7.LAS	825	5	1%
3996	29438	la101bd4p1t01.LAS	831	5	1%
1322	9238	LHb1p12t2.LAS	753	4	1%
13455	86988	RTE70b3p1t4.LAS	579	3	1%
13460	86993	Stage2Pw2T2.LAS	1012	5	0%
8736	62844	T5.LAS	206	1	0%
11650	77895	RWAP12T2.LAS	416	2	0%
1330	9286	RWAP15T1.LAS	418	2	0%
11652	77911	RWAP2T1.LAS	420	2	0%
11675	78095	RWAP8T2.LAS	421	2	0%
3997	29444	RIVB17T16.LAS	1314	6	0%
7934	57314	RTE70b2p1t1.LAS	712	3	0%
9490	67630	52INTP2P4T2.LAS	754	3	0%
9150	65669	52INTP2P4T7.LAS	754	3	0%
4514	32553	405braddocp1t1.LAS	291	1	0%
2225	17401	RTE70b3p1t2.LAS	583	2	0%
6433	46174	405braddocp1t3.LAS	296	1	0%
7266	52213	405braddocp7t2.LAS	297	1	0%
6431	46162	b2p5t1.LAS	313	1	0%
6762	48516	p12p4t6.LAS	2106	6	0%
6766	48580	B34LT1.LAS	736	2	0%
6795	48964	la101bd4p1t06.LAS	827	2	0%
6813	49072	RVRSDBENT5t2.LAS	828	2	0%
6792	48946	la101bd4p1t04.LAS	829	2	0%
6152	44117	RWAP5T2.LAS	416	1	0%
10536	73168	RWAP7T2.LAS	417	1	0%
6809	49048	RWAP27T1.LAS	419	1	0%
7018	50825	RWAP12T1.LAS	419	1	0%
7397	53201	RWAP25T2.LAS	420	1	0%
9452	67157	B5RT4.LAS	841	2	0%
7274	52245	P4 T2.LAS	841	2	0%
3993	29420	RWAP10T1.LAS	421	1	0%
1820	12669	rivbnt14p1t12.LAS	910	2	0%
7490	53732	NBP11P7T8.LAS	2318	5	0%
9151	65671	rivb6t1.LAS	945	2	0%
13414	86947	rivb5t12.LAS	1105	2	0%
1091	7404	MRBA1P9T2.LAS	642	1	0%

Unique File ID	File ID	Filename	Total number of density measurements in file	Number of Nulls	% of the file containing null values
7531	53918	FBP3W4-2.T4.LAS	663	1	0%
1328	9274	rivbent8t11.LAS	695	1	0%
4560	32868	RTE70b2p1t7.LAS	703	1	0%
9941	70665	B30P1T1.LAS	728	1	0%
13447	86980	T1.LAS	751	1	0%
8070	58236	PIER2P2T1.LAS	751	1	0%
9636	68766	ESB5T1.LAS	754	1	0%
12757	83756	benbent14pile7t1.LAS	2315	3	0%
1344	9370	HSB4LP1T7.LAS	800	1	0%
12750	83735	RTE70b5p1t2.LAS	818	1	0%
3985	29372	HSB3LP2T9.LAS	819	1	0%
11345	76464	sf101p1lt2.LAS	823	1	0%
9274	66255	Bnt2L P1T7.LAS	881	1	0%
9271	66237	P8P3T5.LAS	2833	3	0%
7410	53279	P8P3T2.LAS	2842	3	0%
4482	32419	B15T1.LAS	961	1	0%
7306	52452	b4u2t6.LAS	968	1	0%
9461	67202	RIVB8P1T11.LAS	997	1	0%
9463	67246	P12P1T1.LAS	2085	2	0%
7849	56829	P12P1T3.LAS	2089	2	0%
9707	69191	SD5-805B8T9.LAS	1101	1	0%
7842	56773	P15P6T6.LAS	2213	2	0%
5031	35918	SD5-805B8T2.LAS	1114	1	0%
9227	65939	sjbent4t1.LAS	1120	1	0%
5338	37566	Beniciapier7tube5.LAS	2424	2	0%
9321	66532	mrbb3t5.LAS	1248	1	0%
9277	66273	P8P3T8.LAS	2834	2	0%
9785	69569	P16P8T6.LAS	1904	1	0%
9791	69602	P17P1T4.LAS	2034	1	0%
13706	87849	P17P1T4.LAS	2034	1	0%
9783	69561	P16P8T4.LAS	2067	1	0%
9787	69577	P16P8T8.LAS	2072	1	0%
9806	69659	p17p3t3.LAS	2123	1	0%
3760	27157	P4-T3.LAS	2166	1	0%
9557	67976	BENMP13P5T1.LAS	2201	1	0%
9558	67979	BENMP13P5T2.LAS	2204	1	0%
9833	69719	BMP17Pile6t6.LAS	2206	1	0%
9835	69723	BMP17Pile6t8.LAS	2209	1	0%
9275	66261	P8P3T6.LAS	2803	1	0%

Appendix G: Files Containing Zero Gamma Count Samples

LAS Unique ID	LAS File ID	Filename
9646	68850	p14p8t3.LAS
13063	84805	FIRST RUN.LAS
13856	88332	strat 115-147-195.LAS
14512	89726	strat 115-147-195.LAS
7993	57773	B2RP9T2.LAS
8924	64354	T3.LAS
9269	66222	P8P2T8.LAS
8995	64824	B3P9T2.LAS
526	3508	P27T2.LAS
5946	42992	ARDMOREPILE8EaT1.LAS
5948	43012	ARDMOREPILE8EaT2.LAS
14356	89502	A1PRT1.LAS
14363	89513	bctest.LAS
14357	89504	bc1.LAS
3757	27110	P4-T1 Bad Data.LAS
505	3413	RW1P122T1.LAS
521	3493	P22T1.LAS
523	3499	P23T1.LAS
524	3502	P23T2.LAS
525	3505	P27T1.LAS
800	5165	TCp1FT3.LAS
3538	25600	92880RWF1P231T1.LAS
3539	25616	92880RWF1P232T1.LAS
3540	25633	92880RWF1P232T2.LAS
6476	46379	LRTB9T1.LAS
14379	89552	SCMLA1-LP2T1.LAS

Appendix H: Correlation by the Empirical Sigma-Delta Analysis Method

The *Empirical Sigma-Delta Method* builds from the finding that the standard deviation of the differences in signals appeared to be a relatively strong indicator of similarity in two test data sets. This section presents the calculation steps involved, the validation of the method against a set of known reruns, and the application of a criteria based on this approach.

H.1 Steps in Calculating the Sigma-Delta

As a first step in calculating the sigma-delta, a series of differencing calculations is carried out for each tube-pair combination. The process uses a series of manual procedures and two customized Excel spreadsheets. Full data records are imported into the spreadsheets, a smoothing filter is applied to remove noise, and an iterative set of sigma-delta calculations are used to optimize tube-to-tube data alignment. In general, sigma-delta values can be consistently generated as the procedure requires only minimal judgment by the person carrying out the analysis in the selection of extent of data to be considered. A step-by-step explanation is presented here.

STEP 1 – Data from two tests are identified as being potentially a rerun of the same tube, as illustrated in the example in Figure H-1.

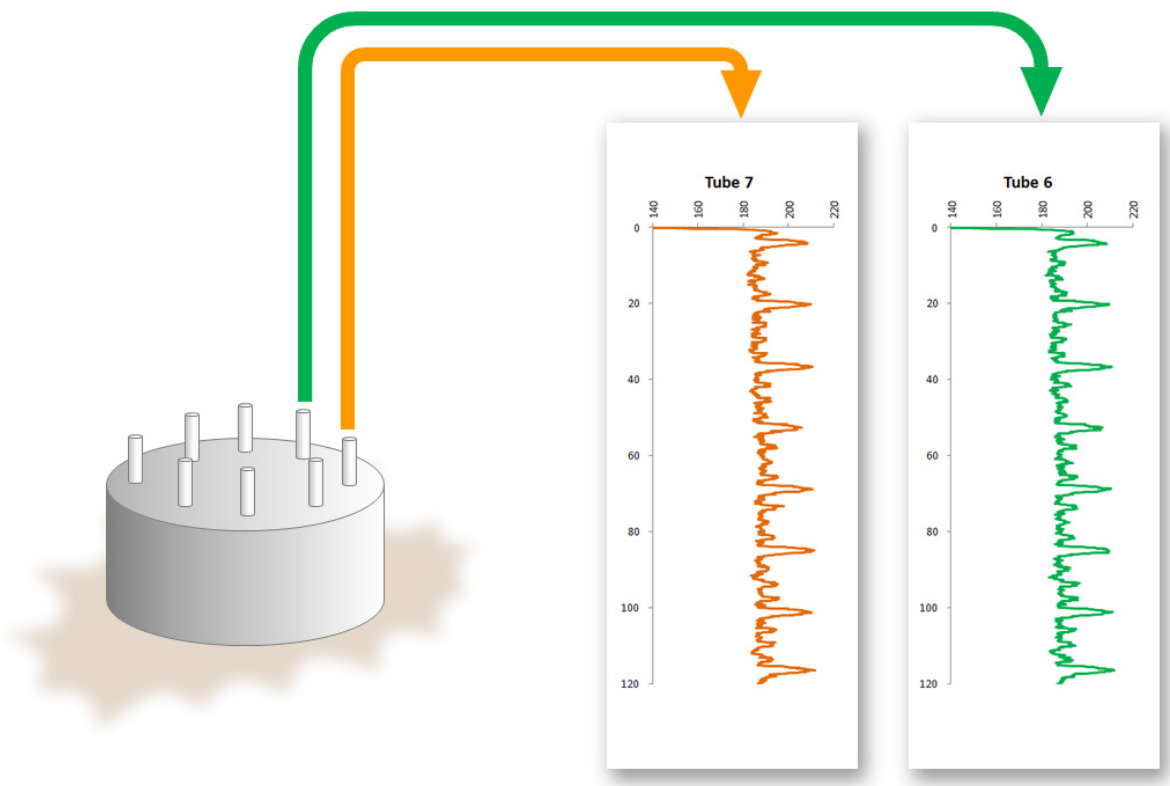


Figure H-1 – Two Tests with Suspected Rerun

STEP 2 – A moving average filter is applied to both data sets as shown in Figure H-2 to remove some of the naturally occurring variation in gamma counts. A 9-point moving average (0.9 ft) was determined to be an appropriate window for this averaging filter.

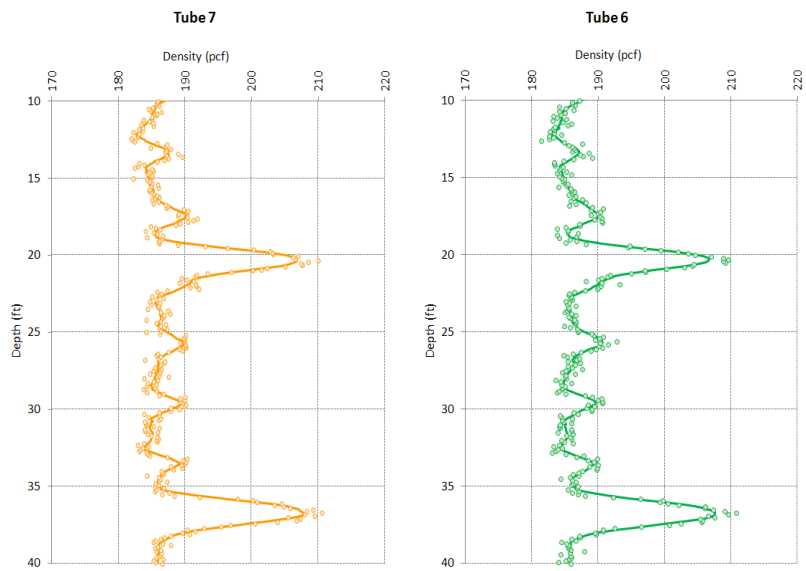


Figure H-2 – 9-Point Averaging Filter Applied

STEP 3 - At each 0.1 ft depth increment, the differences between density values are calculated, as illustrated in the example in Figure H-3.

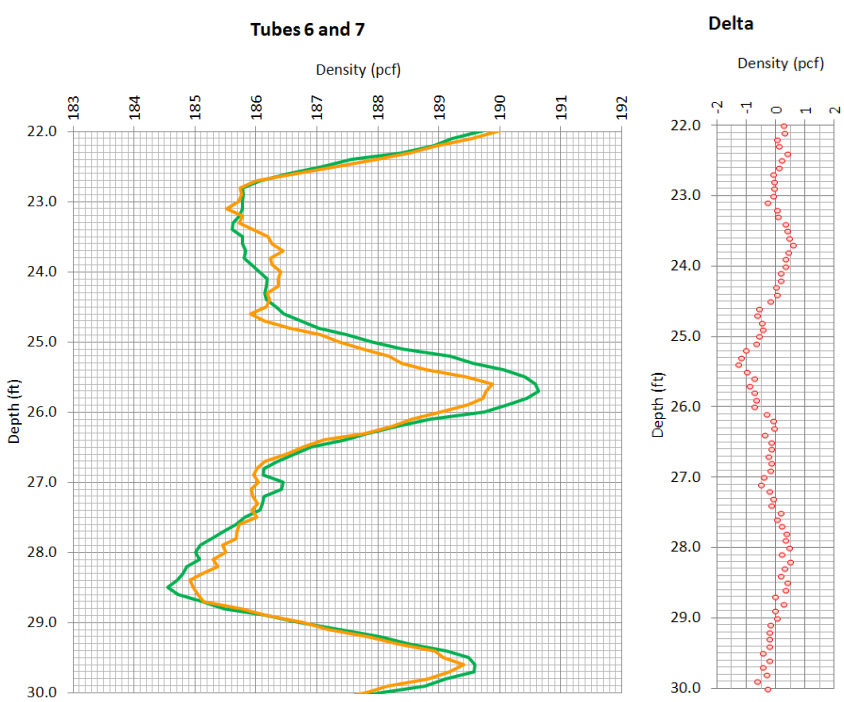


Figure H-3 – Calculating Differences

STEP 4 – Using the resulting differences, the standard deviation (sigma-delta) is calculated. The use of the standard deviation as a metric appears appropriate as the differences from several tests examined approach a normal distribution, as shown in Figure H-4.

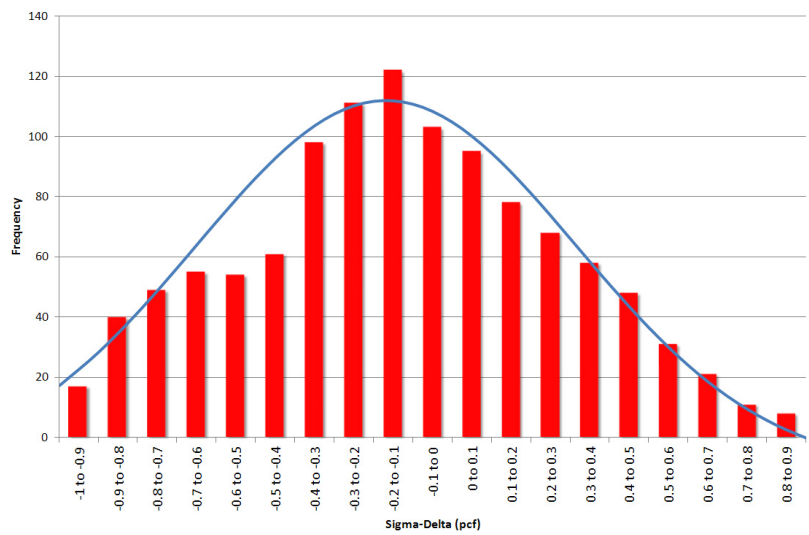


Figure H-4 – Normal Distribution of Differences

STEP 5 – The data sets are shifted on the depth axis relative to each other in 0.1 ft increments. For each shift a new sigma-delta is calculated. The shift producing the minimum sigma-delta reflects the optimum depth alignment between the two data sets. Shifting up to 1.5 ft in both directions is carried out.

STEP 6 – The optimized sigma-delta values for all tube-pair combinations are then presented in a matrix of final results. In the example presented in Figure H-5 below, test pairs of all combinations that involve tube "T6" and its retests manifest as low sigma-delta values.

	T1	T2	T3	T4	T5	T6	T6a	T6b
T1	--	1.55	1.49	1.64	1.88	1.22	1.26	1.30
T2	--	--	1.13	1.30	2.06	1.17	1.18	1.11
T3	--	--	--	1.30	2.08	1.41	1.43	1.42
T4	--	--	--	--	2.06	1.55	1.57	1.49
T5	--	--	--	--	--	1.54	1.59	1.64
T6	--	--	--	--	--	--	**0.41**	**0.47**
T6a	--	--	--	--	--	--	--	**0.36**
T6b	--	--	--	--	--	--	--	--

Figure H-5 – Example of Sigma-Delta Calculation Results

H.2 Validation Using Reference Data Sets

In order to establish the validity of using this standard deviation value as an indicator of degree of correlation, several sets of known GGL tests were compiled and sigma-delta values calculated. Some of the data sets were deliberately generated by FTB staff at the request of the GamDat Team for purposes of validation. Other past data sets were discovered where a retest had been carried out on a pile for other reasons. In each of these reference data sets, there were one or more tubes that had been tested multiple times. A summary of these reference data sets are presented in Table H-1.

Project	Foundation and Pile	Pile Diameter (in)	Number of Tubes Per Pile	Retest Tubes Evaluated	Number of Tests Per Tube	MSLog Test Mode	Median Probe Speed (ft/min)
High Street Sep OH	Bent 11, Pile R	94	9	Tube 3	3	depth-up	10.6
LaSierra OH	Bent 2, W2	70	6	Tubes 2, 3, 4, 6	2	depth-up	–
15th St. UC	Bent 3, Pile 7	78	6	Tube 2	2	depth-up	11.4
15th St. UC	Bent 2, Pile 4	78	6	Tube 2	2	depth-up	12.4
SFOBB	T1, Pile 1	98	6	Tubes 3, 4, 5, 6	2	depth-up	–
Greenwood Creek	Pier 3, Pile 4	60	6	Tubes 1, 5, 6	3	depth-up	12.5
Sawtelle Blvd. UC	Abut 1, Pile 5	24	4	Tubes 1, 2, 4	2	depth-up	–
Sawtelle Blvd. UC	Abut 1, Pile 24	24	4	Tubes 1, 2, 3	2	depth-up	–
East Merced OH	Bent 3, Pile 13	78	6	Tubes 1-6	2	depth-up	12.7
Loveridge Rd. OC	Bent 2; Piles 44, 45, 47	30	2	Pile 44, Tube 1	3	depth-up	12.6

Table H-1 – Reference Data Sets Used in Validation of Sigma-Delta Method

Some of the reference data sets had additional retest data, beyond what was analyzed in this validation exercise. Those additional data sets were not included in the validation process so that a reasonable balance could be maintained, assuring that no single data set would disproportionally bias the validation process. In total, 255 tube-pair combinations were analyzed. The representative proportions for each of the data sets are shown in Figure H-6.

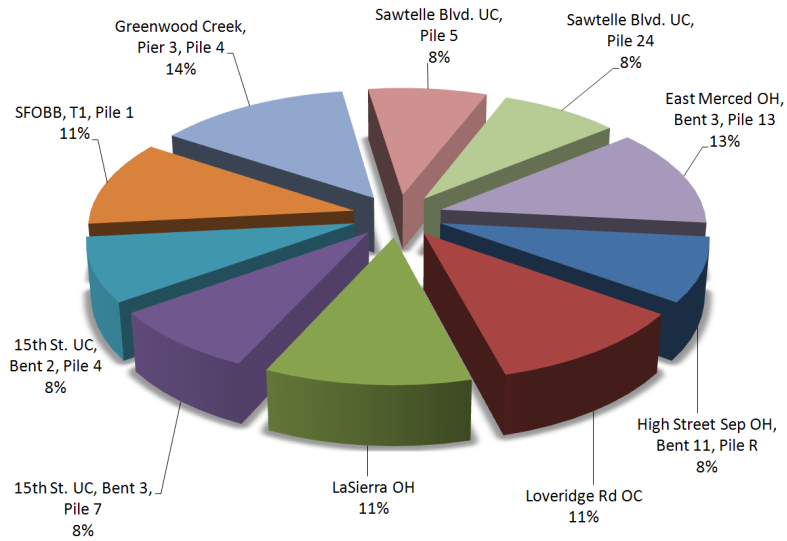


Figure H-6 – Use of Data from Reference Data Sets

Also, only those tests where typical field operating procedures were used were included. In this context "typical" is used to describe tests where:

- The median probe speed during data acquisition is between 10 to 15 ft/min during data acquisition. (Although, one record with a median speed of 20 ft/min was included.)
- Data acquisition was carried out with the probe moving in the upwards direction. (Depth-up mode in *MSLog* was used).
- No other unusual observations were found in the data (e.g. null values, zero gamma counts, drifting data counts, etc.).

Other data sets containing known reruns were available for consideration. However, many of those data sets were collected using atypical procedures, or were possibly influenced by other environmental or operational factors not well understood. For example, probe speeds approaching maximum operating limits were observed to degrade the resolution of the test data. And, in other tests the direction of probe travel has been observed to alter the data, in particular in data sets where data was captured in both directions in a single test. The variability introduced by these factors were difficult to isolate and quantify, and therefore, those data sets were not included in the reference data set presented here.

The standard deviation of signal differences (sigma-delta) was calculated for all 255 tube-pair combinations. In total, there were 37 instances of known retests and 218 instances of known independent tests. The sigma-delta values for all of these were counted in bins of 0.05 pcf increments. The results are presented as a histogram in Figure H-7 below.

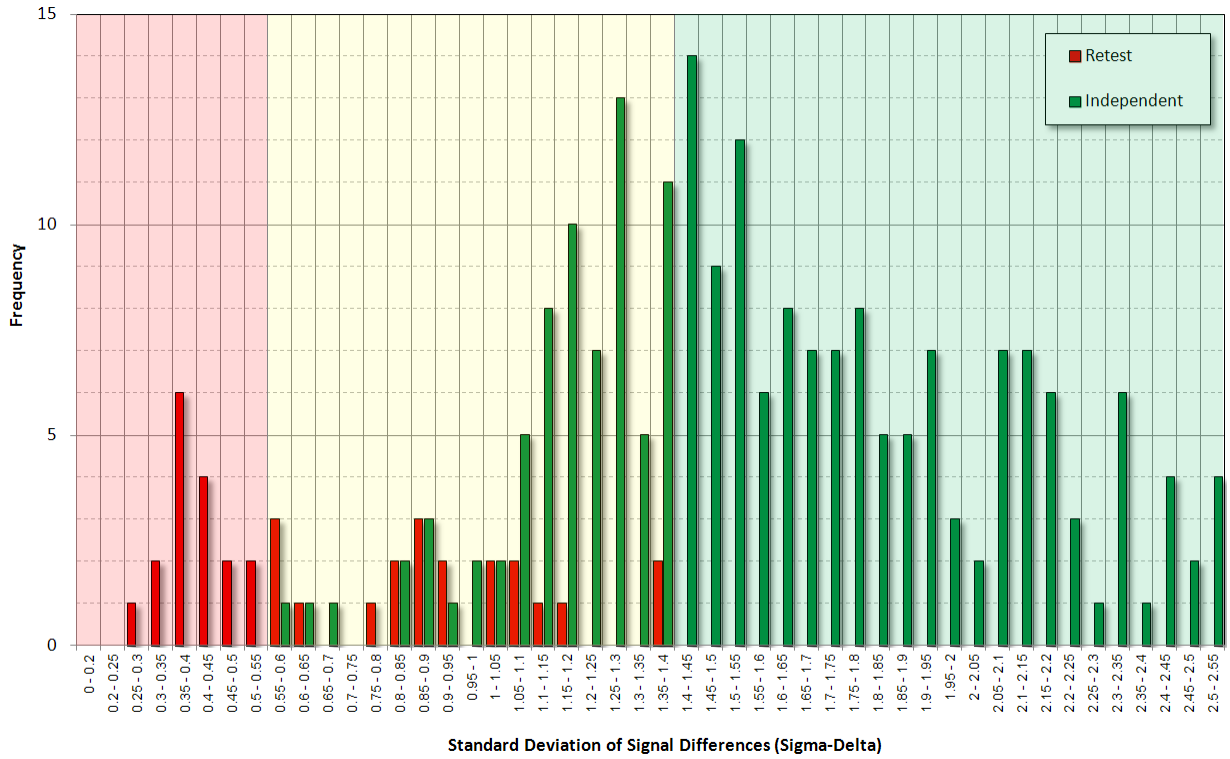


Figure H-7 – Distribution of Sigma-Delta Values from Reference Data Set

A few key observations can be made from the sigma-delta analysis of the reference data set, as follows:

- Below a sigma-delta of 0.55, all tube pairs analyzed are known rerun tests (red zone).
- Between a sigma-delta of 0.55 and 1.4, both rerun and independent tests were observed (yellow zone).
- Above a sigma-delta of 1.4, all tube pairs analyzed are known independent tests (green zone).

These observations formed the basis for application of the method to tube-pairs where rerun is unknown.

H.3 Applying the Method

The *Empirical Sigma-Delta Method* used for evaluating suspect tube pairs is identical to that carried out in the validation of the reference data set, as described in previous sections. Once the calculations are carried out and a sigma-delta value determined for the suspected tube-pair, it can be compared against the distribution of sigma-delta values developed from the reference data set, presented in the prior section, and an appropriate conclusion cited using criteria presented in Table H-2.

Sigma-Delta	Conclusion
< 0.55	**"When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where only rerun tests were observed. Based on this observation, the correlation analysis suggests that this is a rerun test."**
0.55 – 1.4	**"When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where a mixture of rerun and independent tests were observed. Based on this observation, the correlation analysis is inconclusive."**
> 1.4	**"When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where only independent tests were observed. Based on this observation, the correlation analysis suggests that this is not a rerun test."**

Table H-2 – Application of Sigma-Delta Results

In addition to citing one of the three observations, a statement of limitations should be included where correlation results are cited.

H.4 Strengths and Limitations of This Method

The *Empirical Sigma-Delta Method*, as presented here, appears to provide a reasonable basis for the evaluation of suspected retest data. However, the Team acknowledges that there are limitations, such as:

- An insufficient number of reference data sets may have been used in validation.
- The contributions of other testing variables (speed, direction, temperature, etc.) were not adequately studied.
- More appropriate signal-processing methods may exist, but were not identified nor evaluated.
- Changes in some of the data processing steps and calculations might result in better differentiation between rerun and non-rerun tests .

Despite the shortcomings of the method, there are a number benefits:

- The method involves relatively few calculation steps using common statistical concepts.
- Results are generally repeatable when carried out by different analysts.

- Conclusions are cited in the context of a known reference data set.
- The framework of basing conclusions by comparison with a set of known observations is likely to be understood by most readers.
- Using the reference data set, the method results in no false-positive/negative rerun conclusions. This "ground truth" raises confidence in application of methods.
- No conclusion is drawn in instances where the observations from the reference data set do not clearly support it.

Appendix I: Retest Discrimination Analysis (RDA) Method

The *Retest Discrimination Analysis (RDA) Method* is an extension of the interpretation of the *Empirical Method* results described in Appendix H. It is also based on the sigma-delta metric for correlating the similarity of tube pairs as described in section E.1. The key differences are:

1. Statistical tools and models are used to quantify uncertainty in the reference data sets;
2. Alternative scenarios are considered regarding which data in the reference sets are representative of the testing procedures in place during the time period being investigated by GamDat;
3. RDA results are expressed in terms of 'likelihood of retest' relative to the specified reference sets;
4. RDA allows consideration of 'local' sigma-delta values for a specified pile or project in addition to the 'global' values based on the reference sets; and
5. Application of RDA leads to different boundaries regarding the assignment of a sigma-delta value to being a retest or not.

This appendix presents background on method development and application.

I.1 RDA Reference Data Sets

Table I.1 summarizes the sigma-delta data sets considered by the RDA method. Each sigma-delta value represents a comparison of two GGL data sets identified by a tube pair. Tube pairs involving a known retest of the same tube (e.g. T1-T1a) are designated as "YES-Retest", while tube pairs involving known tests in two independent tubes (e.g. T1-T2) are designated as "NO-Retest". The totals of YES-Retest and NO-Retest values associated with each data set are listed in Table I.1.

The data sets are grouped under three broad categories:

- "Pre-GamDat Production Testing with Retests" is data from six piles at four sites where known retests were discovered in data that was acquired in production work prior to the GamDat investigation.
- "Post-GamDat Production Testing with Retests" is data from five piles at three sites where retests were performed at the request of the GamDat investigation.
- Various "High Street Sep OH" sets acquired at two locations (i.e. Bent 11 R and 12R) at one site. Work at this site involved both special testing performed at Bent 11R by the GamDat team as well as production testing that occurred at both Bent 11R and 12R. The subdivisions of the High Street data in Table I.1 are for convenience to document differing assumptions used in alternative models discussed herein.

An important feature of the RDA method is the explicit treatment of alternative assumptions regarding what portions of the reference data might be considered representative of the testing procedures in place during the time period being investigated by GamDat. Ultimately, different combinations of the data sets in Table I.1 are used to create three RDA models: a preferred model (i.e. "Best") and two bounding models (i.e. "Low" and "High"). The subset of data considered by the empirical method is also identified in Table I.1 and is used to create another preferred model (i.e. "Empirical Set"). The merits of alternative assumptions used to create the models and how these assumptions influence RDA results is presented in section I.3 after first introducing the general RDA methodology.

Data Set Group	Data Set	Number of Tube Pairs		Data Included in Model			
		YES-Retest	NO-Retest	RDA "Low" Model	RDA "Best" Model	RDA "High" Model	Empirical Set Model
Pre-GamDat Production Testing with Retests	- La Sierra OH, Bent 2, W2	4	24	All Yes	All Yes	All Yes	All Yes
	- 15th St. UC, Bent 2, Pile 4	1	20				
	- 15th St. UC, Bent 3, Pile 7	1	20				
	- SFOBB, T1, Pile 1	4	24				
	- Sawtelle Blvd. UC, Abut 1, Pile 5	3	18				
	- Sawtelle Blvd. UC, Abut 1, Pile 24	3	18				
Post-GamDat Production Testing with Retests	- Greenwood Creek, Pier 3, Pile 4	9	25	All Yes	All No	All No	All Yes
	- East Merced OH, Bent 3, Pile 13	6	26				
	- Loveridge Rd. OC, Bent 2, Piles 44, 45, 47	3	25				
High Street Sep OH Bent 11R Retests: GamDat Set	- Selected T3 Retests	2	0	Yes	Yes	No	Yes
	- Additional Selected T1-T9 Retests	13	0	Yes	Yes	No	No
	- Remaining T1-T9 Retests	68	0	Yes	No	No	No
High Street Sep OH Bent 11R Independent Tests	- GamDat Set	0	21	Yes	Yes	No	No
	- Production Set: T1-T5 Combos	0	18	Yes	No	No	Yes
	- Production Set: Remaining Combos	0	30	Yes	No	No	No
High Street Sep OH Bent 12R	- Production Set with Retests	6	36	Yes	No	No	No
	Total YES-Retest:	**123**	**0**	**123**	**31**	**16**	**36**
	Total NO-Retest:	**0**	**305**	**305**	**145**	**124**	**218**

Table I.1 – Reference Data Sets Used in Alternative RDA Models and Empirical Set Model

I.2 RDA Methodology Development

The RDA methodology involves: i) the use of simple statistical models to represent the YES-Retest and NO-Retest data in the reference sets, and ii) the development of a 'discriminator function' to assign the likelihood of retest based on a combination of these models. Identical steps are involved in the development of any single model of the four ultimately presented. For the remainder of this section, the 'Low' model is used to illustrate the steps since it uses *all* data sets presented in Table I.1. Discussion of the merits of considering specific subsets of data is presented in section I.3.

I.2.1 Lognormal Statistical Model for Representing Sigma-Delta Data Distributions

A lognormal statistical model was adopted to represent the distributions of YES-Retest and NO-Retest sigma-delta data observed in reference sets. By definition, a sigma-delta value cannot be negative since a perfect match of entire sequences of GGL data would result in a sigma-delta value of zero. Note, due to the random nature of the nuclear decay process, the smallest sigma-delta values for smoothed data observed by GamDat are on the order of 0.20 to 0.25 pcf where these values were obtained for two series of data acquired with a stationary probe. While sigma-delta is clearly constrained on the low end, it is virtually unbounded on the high end. A lognormal statistical model readily accommodates these basic constraints.

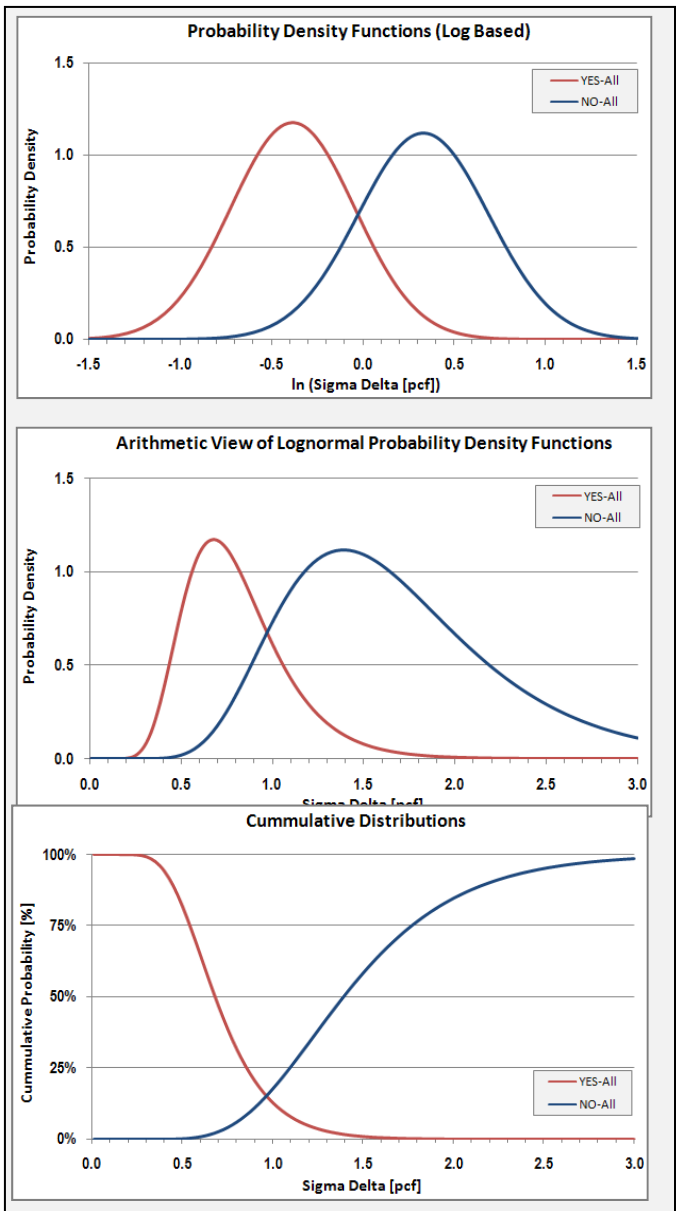


Figure F.1 – Three Views of Lognormal Models

A lognormal model is established in two steps. First, the lateral logarithm of each sigma-delta observation in a specified set is calculated. The lognormal model is then completely defined by the mean and the standard deviation of these log-based values.

Figure I.1 illustrates three views of the lognormal models that are important to keep in mind. These models represent all of the YES-Retest (red) and NO-Retest (blue) sigma-delta data sets in Table I.1.

The top figure shows probability density functions (PDF's) in log space (i.e. horizontal axis is the natural log of sigma-delta values). Note that in this space, the functions are simple symmetric normal distributions where the area beneath each curve is unity. For this particular pair of data sets, the standard deviation of the YES-Retest and NO-Retest are similar (0.340 and 0.357, respectively), so the shapes of the PDFs appear nearly identical. The peaks of the PDFs are located at the means of the YES-Retest and NO-Retest data sets (-0.385 and +0.331, respectively).

The middle figure shows a conversion of the log-based PDF onto an arithmetic horizontal axis. This view is convenient for comparing with frequency distributions of sigma-delta observations. Note that while the PDF's were symmetric in log-space, they are stretched to the right in arithmetic space. Also note that the area beneath these curves is no longer unity.

The bottom figure presents cumulative distribution functions (CDF's) for the YES-Retest and NO-Retest models. This perspective provides a convenient means to describe where a particular sigma-delta value lies relative to the reference data sets. The NO-Retest model (blue curve) defines the percentage of NO-Retest data in the modeled reference set having a *lower* sigma-delta value. For example, the sigma-delta value of 0.75 represents approximately the 4th percentile of the NO-Retest data in the modeled reference set; meaning that 4% of the reference set data has a lower sigma-delta value and 96% has a higher value. The YES-Retest model (red curve) is reversed (i.e. calculated as 1-CDF) so that the model approaches unity for lower values of sigma delta. This model defines the percentage of the YES-Retest data in the modeled reference set having a *higher* sigma-delta value. For example, the sigma-delta value of 0.75 corresponds to having approximately 39% of the modeled reference set data with a higher sigma-delta value and 61% with a lower value.

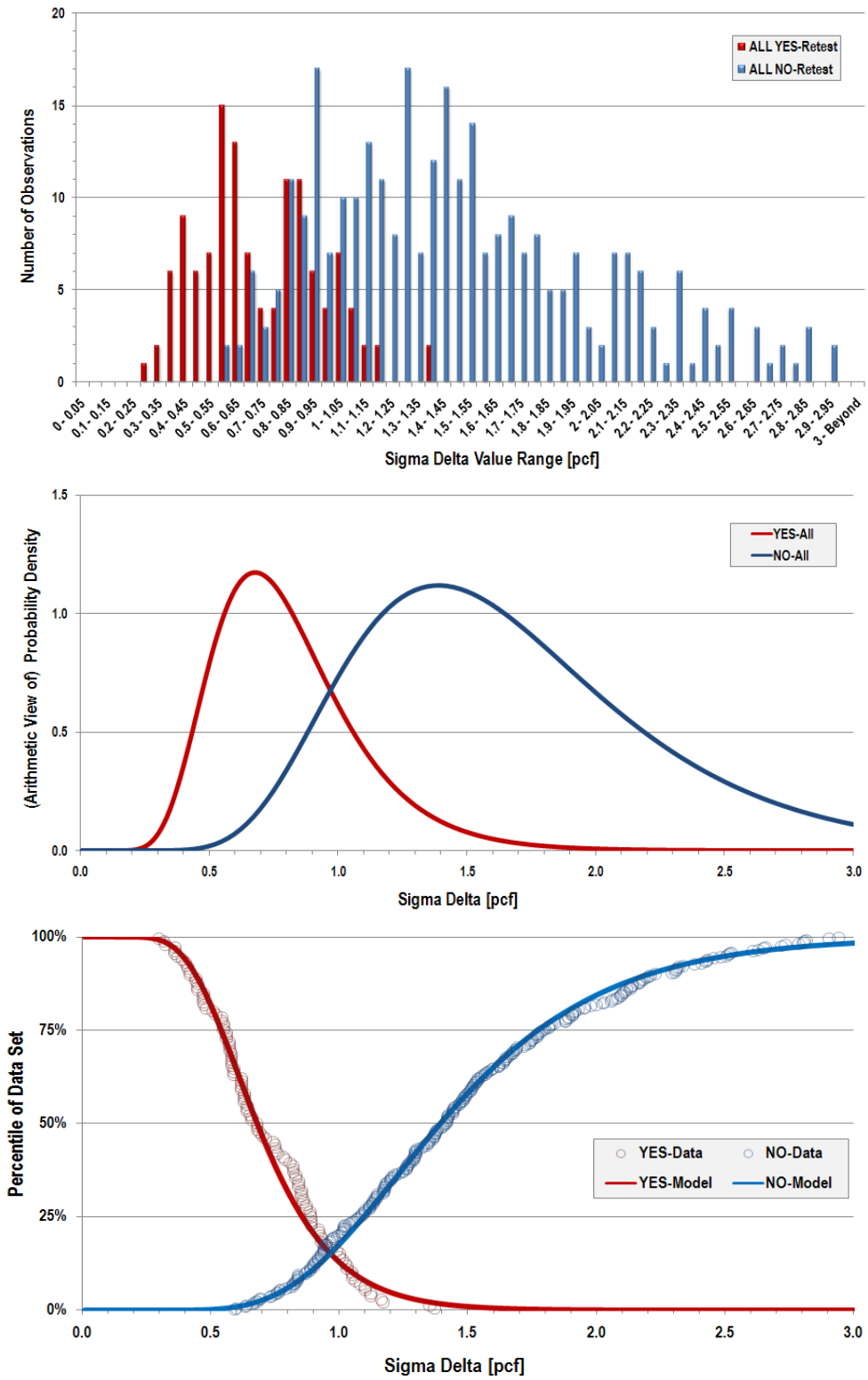


Figure I.2 – Frequency Distributions, PDF's, and CDF's for All YES-Retest and NO-Retest Data in RDA Reference Sets

Figure I.2 presents data and lognormal models for *all* of the reference sets listed in Table I.1. The top chart presents frequency distributions of sigma-delta values calculated for all 123 YES-Retest (red) and 305 NO-Retest (blue) instances. The smallest observed sigma-delta value for YES-Retest conditions is 0.30 pcf. This lower bound is generally consistent with the practical lower limit of 0.20 to 0.25 observed for a stationary probe. The largest observed sigma-delta values for YES-Retest conditions are 1.35 pcf and 1.37 pcf acquired during pre-GamDat production testing at two separate sites (La Sierra and Sawtelle P5). The smallest observed sigma-delta value for NO-Retest conditions is 0.59 pcf which was acquired during post-GamDat production testing at the High Street site. This and a group of 31 additional values acquired at the High Street site are less than the lowest value (0.89 pcf) obtained during pre-GamDat production testing. Again, the merits of including the various subsets of these data are considered in section I.3, and all of the data are used here to illustrate general methodology. Finally, note that the NO-Retest data tapers off toward high sigma-delta values, and the largest value in the reference set is 2.94 pcf. While conceptually unbounded if density anomalies are included, the GamDat team eliminated visually-obvious anomalies in NO-Retest data during preprocessing. This preprocessing strategy resulted in reference data sets where YES-Retest data could be compared against NO-Retest data representative of "clean" independent tests.

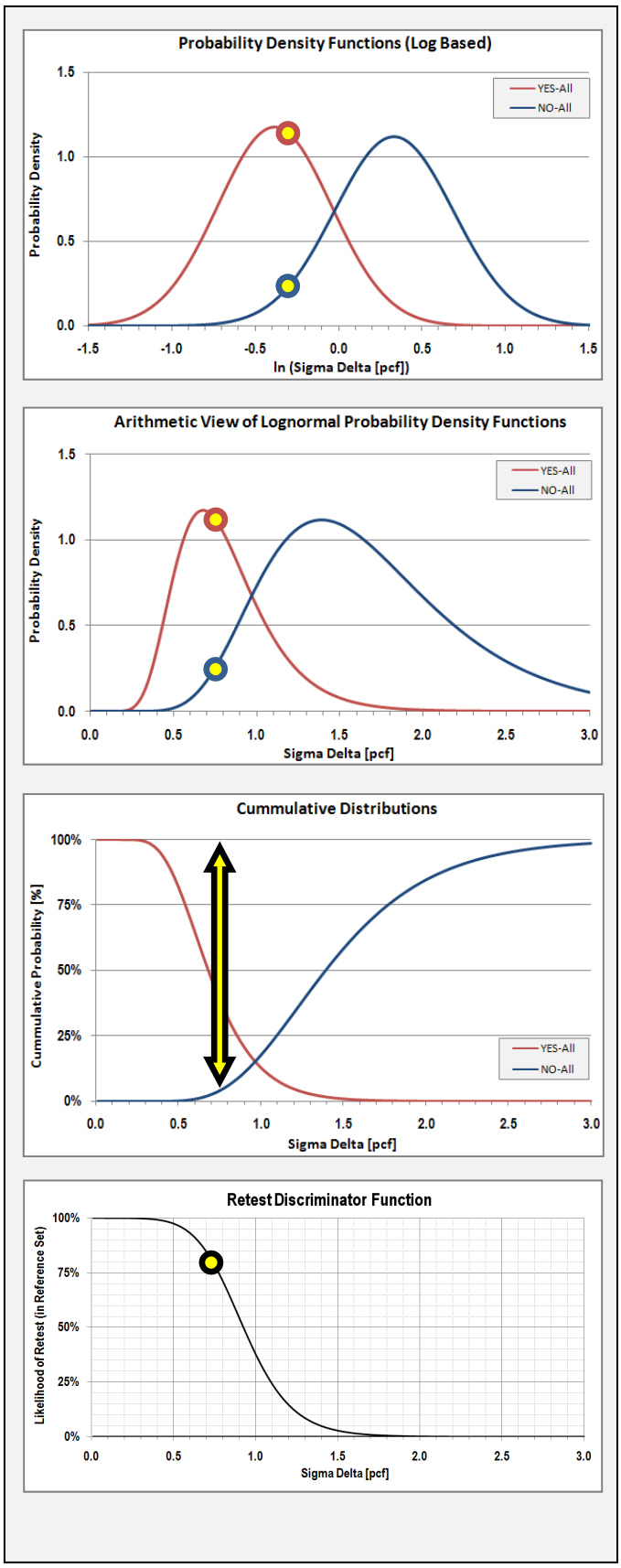
The middle chart in Fig. I.2 presents (the arithmetic view of) the PDF models used by the RDA methodology to represent the data distributions in the top chart. The general shapes of smooth models can be seen to be reasonable representations of the data distributions, and should be expected to become more similar if additional observations were available to fill in data gaps. Note that the vertical scale of the models is not affected by the different sample sizes for the YES- and NO-Retest data sets even though the later has roughly 2.5 times the number of observations. Rather, the vertical scale for each model is only a function of the mean and standard deviation of (the logarithm of) the data regardless of the number of observations in the set.

The bottom chart shows cumulative distributions for both the lognormal model (smooth curves) and the observed data (circular symbols). This perspective allows a direct comparison of the model to the data. The sigma-delta data for each set is plotted in rank order at midpoints of uniform percentile intervals, where the number of intervals equals the number of data points in the set. Overall, the lognormal models provide a very reasonable representation of the data, and again, the fit should be expected to become better if additional observations were available. Comparable fits were achieved for various subsets of these data used in the alternative models.

One difference between using a statistical model of data (i.e. in the RDA method) versus the data set directly (i.e. in the empirical method) is that the smooth statistical model has 'tails' beyond the existing set of observations. This affects the width of the range where both YES-Retest and NO-Retest conditions can occur. For the determination of retest, the significant limits are the high end of the YES-Retest data and the low end of the NO-Retest data in the reference sets. The lowest observed sigma-delta value for NO-Retest conditions is 0.59 pcf. The lognormal model for NO-Retest assigns that value to be the 1st percentile, meaning that the model would predict that 1% of a broader data set having the same statistics (mean and standard deviation) would have a value lower than 0.59. Similarly, the highest observed sigma-delta value for YES-Retest conditions is 1.37 pcf. The lognormal model for YES-Retest assigns that value to be the 2nd percentile, meaning that the model would predict that 2% of a broader data set having the same statistics (mean and standard deviation) would have a value higher than 1.37.

I.2.2 Assignment of 'Likelihood of Retest' Using the 'Retest Discriminator Function'

The second step in the RDA method is to assign a 'likelihood of retest' by combining the separate statistical models for the YES-Retest and NO-Retest conditions into a single function called the 'retest discriminator function'. This



function provides a convenient means to characterize the likelihood that a given sigma-delta value would be a retest in the reference set. It also provides a uniform and stable basis for comparison of the effects of independent changes to either the YES-Retest or NO-Retest models such as those considered in Section I.3.

The form of the 'retest discriminator function' can be expressed as:

$$\text{Likelihood} = \frac{PDF(Yes)}{(PDF(Yes) + PDF(No))} * (1 - CDF(No))$$

It consists of two terms: 1) a ratio of probabilities, and 2) a constraint. Figure I.3 illustrates these terms for a sigma-delta value of 0.75.

The first term is the ratio of the YES-Retest probability to total probability for a specified sigma-delta value. The YES-Retest probability is illustrated in Fig. I.3 as the red dot in either of the top two charts (log or linear horizontal axis). For this reference set (i.e. all data) and a sigma-delta value of 0.75, the YES-Retest probability value is 1.13. The denominator of the first term is the total probability, which is the sum or the YES-Retest and NO-Retest probability. The NO-Retest probability for this reference set and a sigma-delta value of 0.75 is 0.25, so the sum (i.e. total probability) is 1.38. The ratio of YES-Retest to total probability is then 1.13/1.38 or 0.82. If no constraint term was used, this would be interpreted to mean that a sigma-delta value of 0.75 would have an 82% likelihood of being a retest in the reference set.

The second term, the constraint, was added for numerical stability. It constrains the ratio term to zero as the cumulative distribution of NO-Retest data approaches 100%. The term is illustrated in the third chart in Figure I.3. For a sigma-delta value of 0.75, the constraint term has a value of 0.96. When the two terms (i.e. ratio and constraint) are combined, the retest discriminator function assigns a sigma-delta value of 0.75 a 79%

Figure F.3 – Calculation of Retest Discriminator Function

likelihood of retest for this reference set. This is illustrated in the bottom chart of Fig I.3.

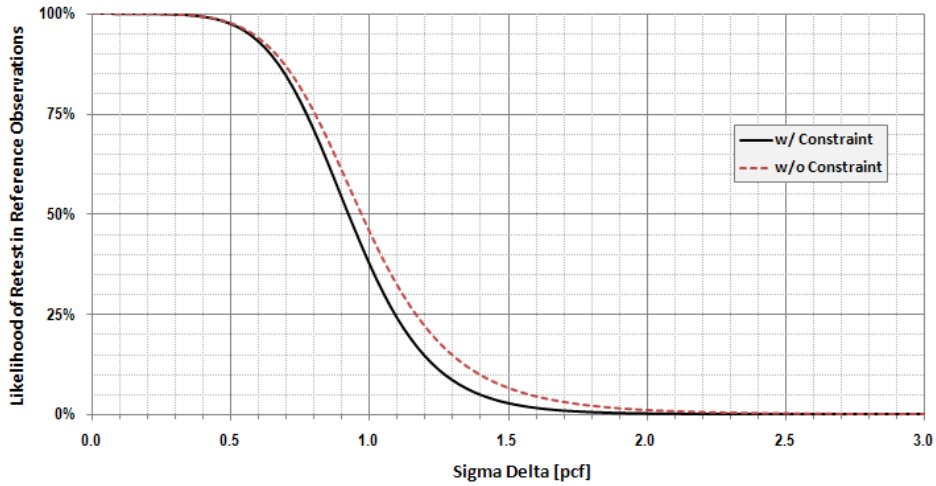


Figure I.4 – Effect of Constraint Term on Retest Discriminator Function

The retest discriminator function adopted herein is not the only means to effectively combine statistical models for YES-Retest and NO-Retest data. In fact, four alternative model forms were considered as part of this study, and performance of each was evaluated over five probability ranges using ten different combinations of available sigma-delta data. The two models that performed best are the constrained-PDF function presented above and an unconstrained version comprised of the ratio term only.

Figure I.4 compares results of the constrained (solid black line) and unconstrained (dashed red line) models for all of the reference set data. The constraint has the effect of reducing likelihood by as much as 7%, and therefore provides a slightly conservative estimate. This effect is largest for the entire reference data set shown above, and is somewhat smaller (as little as 3%) for alternative subsets considered in section I.4. The other effect of the constraint is pushes the lower tail of the discriminator curve to the left. For example, the sigma-delta value associated with 10% likelihood of retest is reduced by roughly 0.1 pcf. This effect is more pronounced at lower percentiles and can be on the order of 0.3 to 0.4 pcf for 1% likelihood of retest.

The performance of both the constrained and unconstrained models was found to be comparable when applied to "global" data sets involving multiple sites that have comparably-wide distributions (i.e. standard deviations) for the YES-Retest and NO-Retest data. However, numerical instability occurred in the unconstrained model when a broad YES-Retest distribution was combined with a narrow NO-Retest distribution. This combination will be discussed in Section I.4 and occurs when using a "local" NO-Retest data set to represent a specific location or project. The inclusion of the constraint term eliminated the numerical instability for these local applications, but did not degrade performance in validation studies. Therefore, the constrained-PDF model discussed above was selected as the preferred model for the RDA method.

I.3 Alternative RDA Models To Reflect Representativeness of Reference Data

The RDA model described in the prior section used *all* of the reference set data listed in table I.1. This section uses the same methods to establish two bounding models (i.e. "low" and "high") as well as two preferred models (i.e. "best" and "empirical set"). The difference between the four models depends solely on the selection of differing portions of the reference set data, where the selection is based on alternative assumptions regarding what might

be considered representative of the testing procedures in place during the time period being investigated by GamDat. The preferred models represent two different sets of reasonable assumptions from among a virtually unlimited list of possibilities. The bounding models represent two end-member sets of assumptions that establish reasonable limits for the range of likelihood estimates. Note that only the bounding models are used in criteria to establish whether data being evaluated by GamDat is considered a data irregularity. The preferred models simply help to illustrate the factors having significant influence on likelihood estimates.

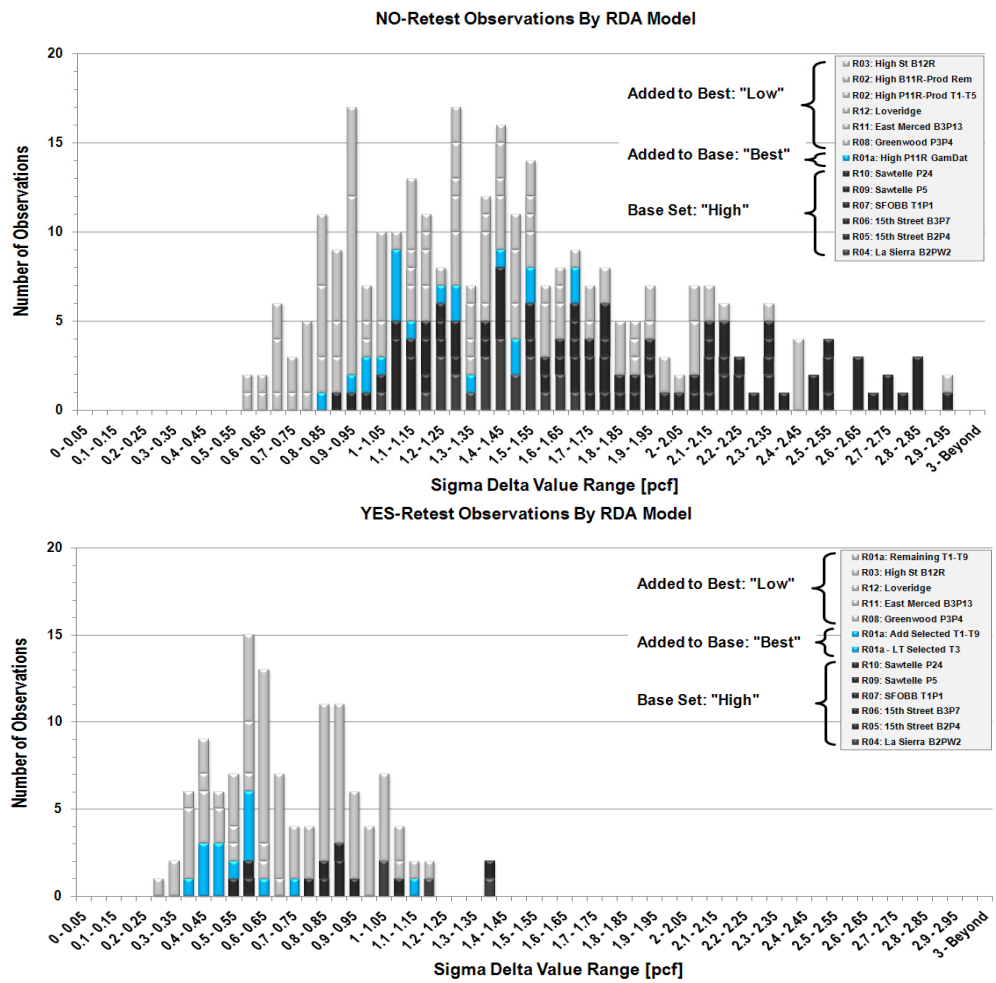


Figure I.5 – Portions of Reference Data Sets Used in Alternative RDA Models

I.3.1 RDA Bounding Models

Figure I.5 highlights the sigma-delta values that were used in each of the three RDA models listed in Table I.1. Figure I.6 shows the resulting three retest discriminator functions based on the data selections described by Table I.1 and Figure I.5. The RDA bounding models, "Low" and "High", provide *end-member interpretations* regarding what portion of the available reference-set data might be considered representative. Note that Table I.1 shows that the two bounding models use the most and least number of reference set observations of the four models considered.

The “High” model used only those data (shown in black in Fig. I.5) from piles where retest information is known to exist where the data was acquired over the time period prior to the GamDat investigation. The significance of this selection is these data have higher mean values for both the YES-Retest and NO-Retest observations than the remaining data, a fact attributed to the testing procedures in place at the time. Figure I.6 shows that this combination of higher means pushes the location of the discriminator function to the right, and leads to the highest estimates of retest likelihood for a given sigma-delta value. The argument for considering this set to be representative is that these are the only data that were collected under production conditions prior to the GamDat investigation, and therefore are likely to be most similar to retests that may have occurred during that time period.

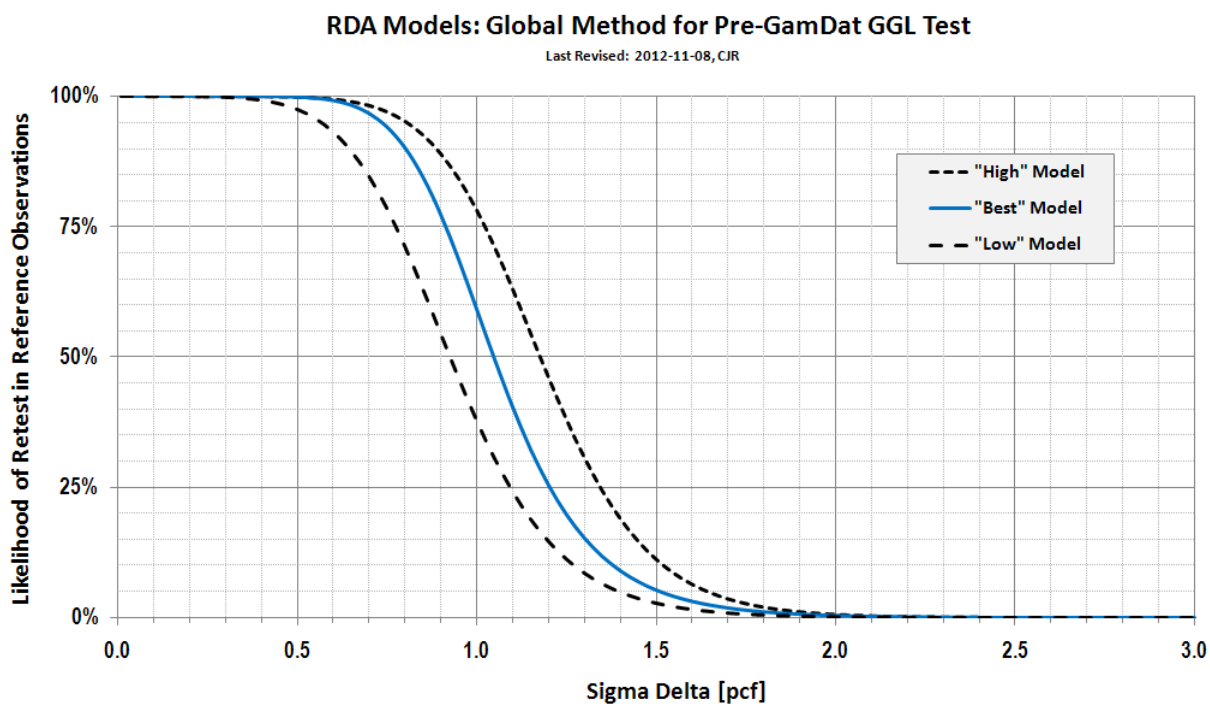


Figure I.6 – RDA Models: Bounding (black dashed lines) and Preferred (blue solid line)

The “Low” model includes *all* of data in the reference set including all of the data collected at the High Street Separation project and all of the data having retests collected under production conditions after the GamDat investigation. Figure I.5 shows these observations as the gray and blue bars in addition to the black bars. Note that the mean value of both the YES-Retest and NO-Retest distributions is shifted substantially to the left relative to the means for the pre-GamDat data alone. Figure I.6 shows that this combination of lower means pushes the discriminator function to the left, and leads to the lowest estimates of retest likelihood for a given sigma-delta value. The argument for considering this set to be representative is that it includes all data collected over all time periods and under the widest range of testing conditions, and is thus the most comprehensive data set available.

I.3.2 RDA Preferred Models

Within the limits of the bounding models discussed above, there are virtually an unlimited number of combinations of observations that might be considered ‘representative’ for use in RDA model building. Two substantially different sets of assumptions are used here to create the two preferred models (“Best” and

"Empirical Set"). Despite the different assumptions employed, these two preferred models will be shown to provide comparable estimates of likelihood-of-retest that are well within the limits of the bounding models.

Among other choices, the two preferred models include different subsets of data from the High Street Separation project. Work at the High Street site involved both special testing performed at Bent 11R under the supervision of the GamDat team as well as production testing that occurred at both Bent 11R and 12R. The "GamDat set" acquired at Bent 11R includes 83 YES-Retest tube combinations and 21 NO-Retest tube combinations. One primary purpose of the GamDat testing at this site was to evaluate GGL equipment performance under a wide range of both typical and atypical operating conditions. Factors varied included equipment and operator (two sets used), recording mode (depth or time), data-acquisition direction (up or down), and probe speed during recording (ranged from 10 to 41 fpm). Note that the "Low" bounding model discussed previously included all of these data.

I.3.2.1 "Best" RDA Model

The data incorporated into the "Best" RDA model are described in Table I.1 and the distribution is shown in Figure I.5. These data include the pre-GamDat production set already considered in the "High" model (black bars in Fig. I.5) plus a selection of the data acquired at Bent 11R at the High Street Separation site. A subset of 15 (of 83 available) YES-Retest values was selected using the following criteria: i) same equipment/operator, ii) upward testing direction, and iii) probe speed of up to 30 fpm. The NO-Retest data in the GamDat set met all of the same criteria, but probe speed was held at 12 fpm in all tests. The distributions of the 15 selected YES-Retest and 21 NO-Retest values are shown as the blue bars in Figure I.5. Both of these sets of data have somewhat smaller means than the pre-GamDat production data (black bars), but not as small as for the post-GamDat production set.

The arguments for incorporating this specific set of data into a preferred model are: 1) the 15 additional YES-Retest values essentially doubles the number of observations collected prior to GamDat and thus provides an improved basis to establish stable statistics, 2) the 21 NO-Retest values were obtained using the same equipment/operator as the YES-Retest values, and 3) the GamDat set is presumed to have used testing procedures not yet strongly influenced by the scrutiny of the GamDat investigation, and thus yield sigma-delta values that are more comparable to those observed for pre-GamDat production tests. The arguments for not including the remaining available data in the preferred model are: 1) the remaining YES-Retest data from the High Street site was acquired under highly atypical conditions (e.g. probe speeds >30 fpm, opposite testing directions, different equipment/operators), 2) the post-GamDat production sites (i.e. Greenwood, East Merced, Loveridge) as well as the remaining NO-Retest production testing at the High Street site (both Bent 11R and 12R) may have used a more meticulous testing procedure that results in lower sigma-delta values that appear inconsistent with pre-GamDat production testing results. Note that these or any other particular set of assumptions can be readily challenged, but nevertheless represent one rational interpretation of what data in the available set might be considered representative. Another set of assumptions, those used to establish the "Empirical Set", are explored in the next subsection.

Figure I.6 shows the discriminator function for the "Best" RDA model as the solid blue line located between the bounding models described earlier. It is insightful to explore the reasons behind this location in terms of how the data selections illustrated in Fig. I.5 affect the PDF's in Fig. I.7. The horizontal location of the top (100% likelihood) end of the discriminator function is governed by the low-side tail of the NO-Retest PDF, and the location of the bottom (0% likelihood) end of the discriminator function is governed by the location of the high-side tail of the YES-Retest PDF. Between these limits, the location of the discriminator function is determined by the relative proportions of YES-Retest to NO-Retest values in the PDF's. The blue bars in Fig. I.5 is what distinguishes the data

used in the "Best" RDA model from that used in the bounding models. The "Best" RDA model differs from the "High" model by the addition of the blue to the black bars in Fig. I.5. Figure I.7 shows this additional data has only a small effect on the lower tail of the NO-Retest distribution, so the top end of the discriminator function for the "Best" model is close to that for the "High" model. For higher sigma-delta values, the discriminator function for the "Best" RDA model is located between the bounding models. This shift is driven by the YES-Retest distribution which is nearly identical to that for the "Low" model, thus the probability of YES-Retest is reduced over the entire range of overlapping PDF's. Interestingly, the high-end tail of the YES-Retest PDF is largely unchanged even though the mean was reduced. This is why the bottom (0% likelihood) end of the discriminator function is relatively unchanged across all models.

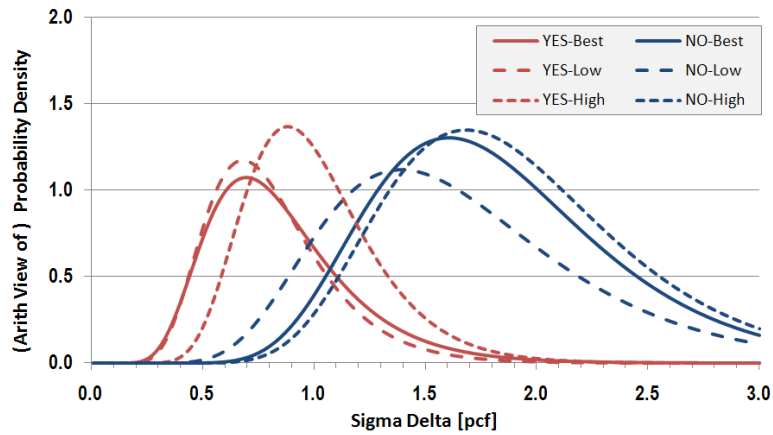


Figure I.7 – (Arithmetic View of) Probability Density Functions for Three RDA Models

It is worth noting here that what distinguishes the "Best" RDA model from the "Low" model is the distribution and lower limit of the NO-Retest data. In particular, the two production sets (Bent 11R and Bent 12R) at the High Street Separation site comprise the bulk of the NO-Retest data below a sigma-delta value of 1.0, and these data were not included in the "Best" RDA model because it was presumed that the test procedures employed at this site had been influenced by the scrutiny of the GamDat investigation.

I.3.2.2 "Empirical Set" Model

The second preferred model considers the exact data selections used in the Empirical Method, and the resulting model is called the "Empirical Set" model. The data incorporated into the "Empirical Set" model are described in Table I.1 and the distribution is shown in Fig. I.8. Like the "Best" RDA model, these data include the pre-GamDat production set (black bars in Fig. I.5). It also includes a selection of the data acquired at Bent 11R at the High Street Separation site, but the data selection differs from that used in the "Best" RDA model. In this model, only two YES-Retest values were selected based on more stringent selection criteria, and a representative selection of 18 NO-Retest values were chosen from the 'production set'. Most importantly, all of the post-GamDat production sites (i.e. Greenwood, East Merced, Loveridge) were included.

The arguments for incorporating this specific set of data into a preferred model are: 1) the High Street data selected was acquired using standard procedures (slower probe rates, etc.), 2) the inclusion of the post-GamDat production sites broadens the number of sites considered, and 3) the relatively limited amount of data from High Street assures that that site does not overwhelm the statistics. The gray bars in Fig. I.8 show the distribution of reference set data in Table I.1 that was excluded from the "Empirical Set" model. The YES-Retest exclusions are

mostly the High Street Bent 11R data acquired under highly-varied conditions but also include retests conducted at Bent 12R under production conditions. The NO-Retest exclusions are both the GamDat set and a portion of the production set at Bent 11R of High Street as well as the production set from Bent 12R at High Street. The argument for excluding these data is that it would place too much weight on data from a single site. Again, as in the case of the "Best" RDA model, the particular assumptions used in establishing the "Empirical Set" model can be challenged, but nevertheless represent another reasonable interpretation of what data within the available set might be considered representative.

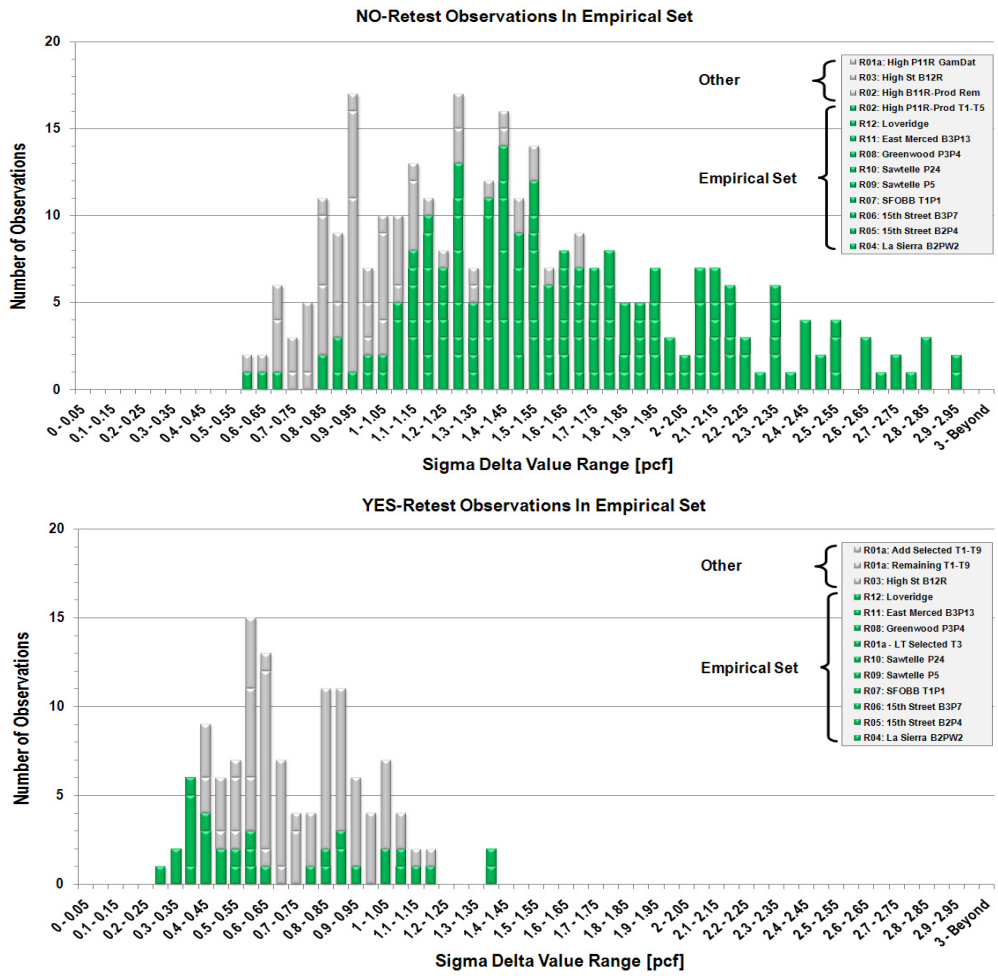


Figure I.8 – Portions of Reference Data Sets Used in "Empirical Set" Model

Figure I.9 shows the discriminator function for the "Empirical Set" model as the solid green line. The bounding RDA models ("Low" and "High") are shown as black dashed lines and the other preferred model ("Best") is shown as the solid blue line. Again, the "Empirical Set" preferred model falls well within the limits of the bounding models. The somewhat surprising finding is that although very different assumptions were used in the selection of data for the two preferred models, the discriminator functions are remarkably similar.

Again it is insightful to explore the reasons behind the location of the discriminator function in terms of the how the data selections in Fig. I.8 affect the PDF's which are presented in Figure I.10. The NO-Retest distribution for the "Empirical Set" is very similar to that for the "Best" RDA model and shifted only slightly left of the "High" model.

While the “Empirical Set” included several lower-valued NO-Retest data, that was largely offset by the addition of even more higher-valued data. The more interesting observation is the effect the selection of YES-Retest data where the post-GamDat production set included many low sigma-delta values. This had the effect of substantially reducing the mean of the YES-Retest distribution to be to the left of the bounding models. However, because these data were combined with the high sigma-delta values of the pre-GamDat set, the overall effect was to substantially increase the width (standard deviation) of the distribution so that the high-end tail of the YES-Retest distribution is actually above the bounding models.

Again, it is insightful to note that the “Low” RDA model has lower likelihood estimates than any other model largely because of the inclusion of more low-valued NO-Retest data from the High Street production sets. While the “Best” RDA model excluded these data altogether, the “Empirical Set” included a portion of these data, just not as many as the “Low” model which incorporated all of the High Street production sets

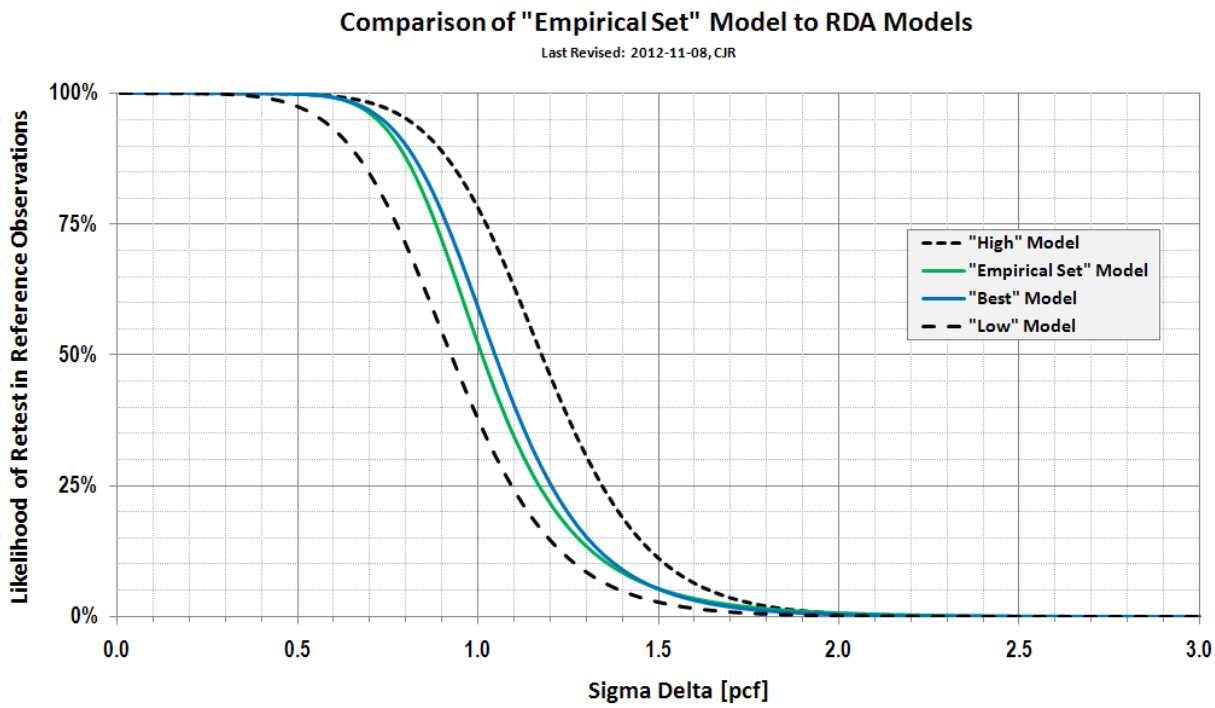


Figure I.9 – Comparison of Preferred “Empirical Set” Model to Bounding and Preferred RDA Models

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I.3.2.3 Summary Comments on RDA Discriminator Models

This section has presented an in-depth discussion of two bounding and two preferred models derived from various subsets of the data summarized in Table I.1. The power of the RDA method is that the effects of many different assumptions can be evaluated on a uniform basis. Results from this section have shown that very different assumptions regarding the optimal selection of ‘representative’ data can result in discriminator functions that are remarkably similar. Additionally, the data drivers causing the range in bounding RDA models have been isolated. While development of the preferred models has proven insightful, the GamDat application of the RDA method for identification of data irregularities is based solely on the bounding models where data selection considerations are minimal.

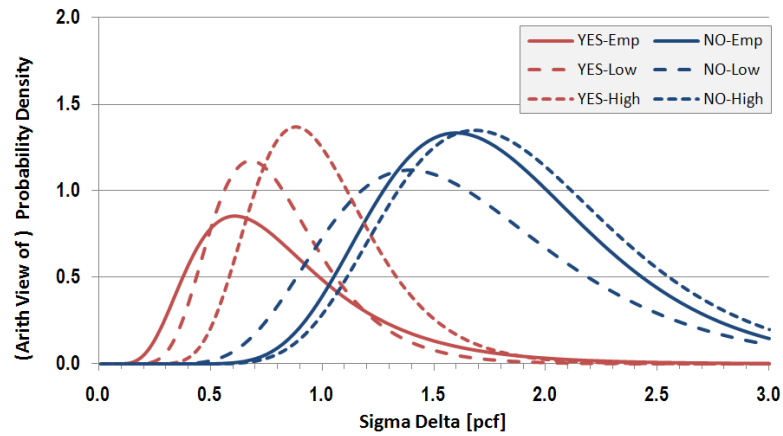


Figure I.10 – (Arithmetic View of) Probability Density Functions for "Empirical Set" Model and Bounding RDA Models

I.4 Global Versus Local Perspectives for NO-Retest Data

To this point, the determination of retest likelihood by the RDA method has been based on "global" distributions of YES-Retest and NO-Retest data derived from the reference set data which was collected at multiple sites. This section will illustrate how the same RDA methods can be applied using site-specific or "local" information, and why this local perspective is beneficial.

Figure I.11 presents "local" cumulative distributions of NO-Retest sigma-delta values for each of the 12 data sets in the reference set of Table I.1 (fine black dashed curves). Superimposed on these local distributions is the "global" distribution (heavy blue curve) obtained from the combination of all data from these same sites. Recognizing that the range in observed NO-Retest data for any individual site is the represented by the range of sigma-delta values from 0th to 100th percentile, it is readily observed that the global distribution has much higher variability than any of the individual local distributions. This is because the global distribution includes differences in mean values (i.e. at 50th percentile) of each of the local distributions.

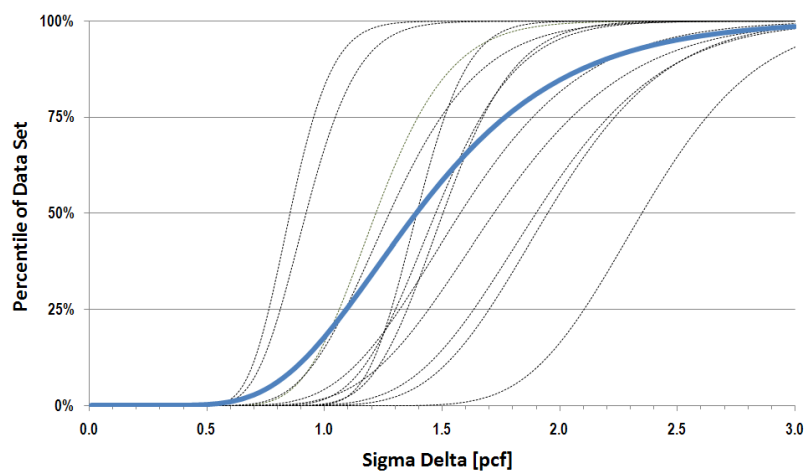


Figure I.11 – CDF's for NO-Retest Data in the Reference Set: Individual Sites (black) and Combination of All Sites (blue)

The impact of using a global distribution for determining retest likelihood is that a portion of the uncertainty in the likelihood estimate is associated with the very broad distributions of both YES-Retest and NO-Retest values. Some of the uncertainty can be eliminated by using local NO-Retest data within the same discriminator function. Instead of the global data derived from multiple sites, statistics for a local NO-Retest distribution are developed from a single pile or from piles within the same project or site. This strategy can be applied where most tube-combinations at a site are not being evaluated for potential retest. Note that while it is conceptually possible to develop a local YES-Retest data set, such data is very rarely collected in practice, thus the local method discussed herein only considers the use of site-specific NO-Retest data.

Figure I.12 uses an example of known retests from one reference set site (SFOBB, T1) to illustrate the effect and potential benefit of using a local versus a global NO-Retest distribution. The sigma-delta data from this site are from tube-pair combinations for 4 known retests (2 values are the same, so it appears as 3 values) and 24 known independent tests. The two top figures apply the global RDA method, and the two bottom figures apply the local RDA method. The chart on the upper right plots the sigma-delta values for the known retests on the global YES-Retest (red dots) and NO-Retest (blue dots) cumulative distributions. The chart on the bottom right shows these same values plotted against the *global* YES-Retest and the *local* NO-Retest cumulative distributions. The local NO-Retest distribution was developed using the 24 known independent tests from this site and the individual data points are plotted as '+' symbols. The charts on the left show the global and local retest discriminator functions (top and bottom, respectively) for each of the three RDA models ("Low", "High", and "Best"). The yellow dots in each figure show the discriminator-function value for each of the four known retests at this site.

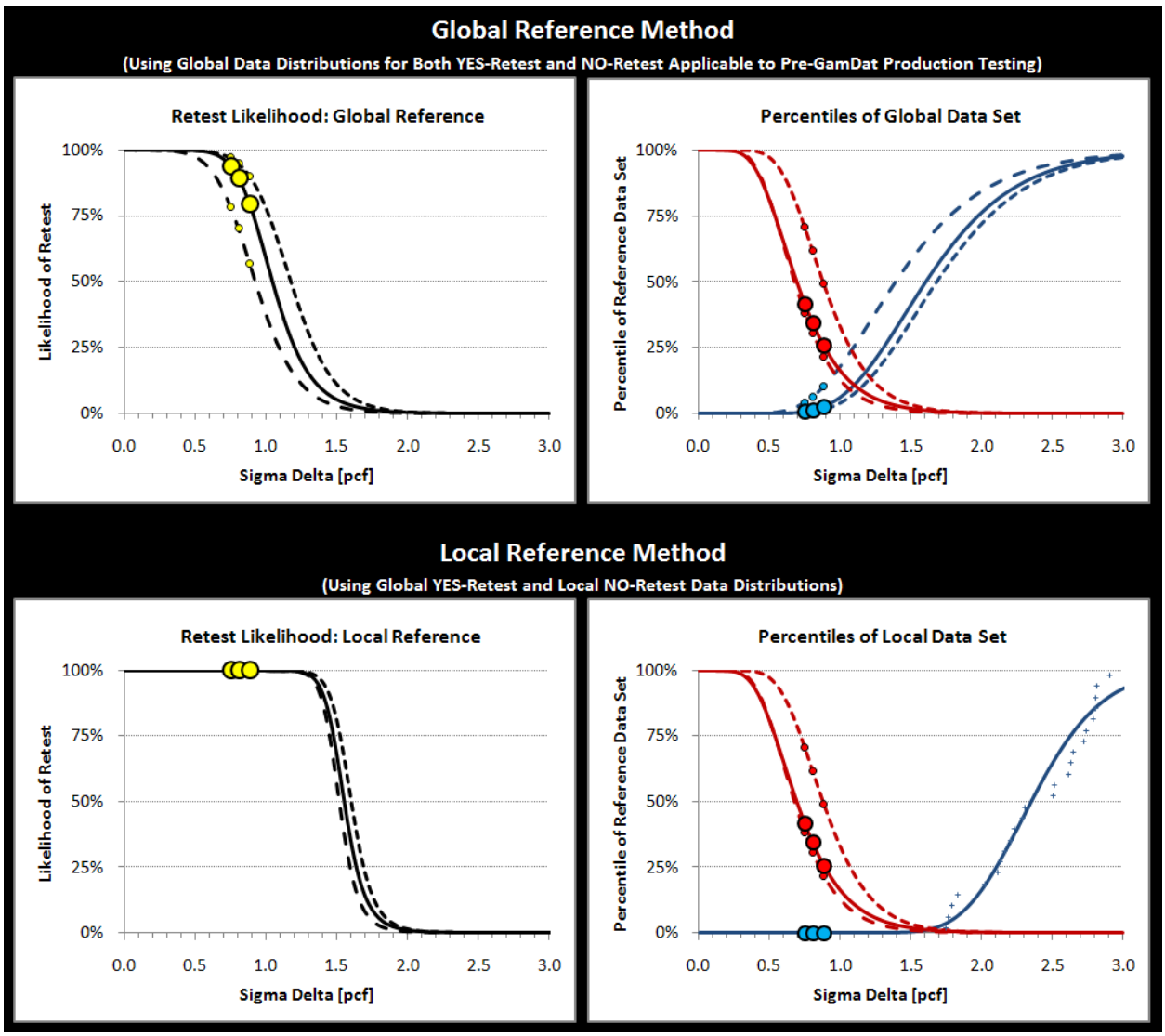


Figure I.12 – Example Application of Global and Local RDA Methods for the SFOBB T1 Reference Site

These data illustrate the impact of considering a local NO-Retest value. Note that the local NO-Retest model (blue curve in bottom right chart) has shifted to the right relative to the global NO-Retest models (blue curves in top right chart) indicating the local sigma-delta data distribution has a substantially higher mean than the global data distribution. This shift in the NO-Retest model causes the local discriminator function to also shift to the right and become much sharper (steeper). Whereas, the "Best" global discriminator function assigned retest likelihoods ranging from about 79% to 94% ("Low" models values as low as 57%), the local discriminator function shows 100% likelihood of retest regardless of reference basis ("Best", "Low", "High").

While the example shown in Fig. I.12 clearly illustrates the difference between the global and local methods, it must be emphasized that the local method does not always reduce the range of retest likelihood. The degree to which the local method differs from the global method depends upon where the local NO-Retest distribution lies relative to the global distribution. Regardless of outcome, due consideration of local conditions is viewed as an important contribution to a complete evaluation of available data.

I.5 GamDat Assignment of Data Irregularities Using RDA Methods

The primary purpose for developing the RDA methodology was to support GamDat's assessment of the potential for a retest-type data irregularity. This section recommends methods for converting both 'global' and 'local' RDA-method estimates for 'likelihood of retest' into GamDat criteria for the existence (and confidence) of a data irregularity. The sigma-delta thresholds defined by the global RDA-method criteria are compared with those proposed by the Empirical Method. The performance of both global and local RDA-method criteria is evaluated using the reference set data.

I.5.1 Recommended Assignment Criteria Using Global and Local RDA Methods

Table I.2 lists the applicable GamDat categories for the existence of a retest-type data irregularity along with recommended criteria for assignment to these categories using both the global and local RDA methods. The GamDat nomenclature provides separate designations for the existence of the irregularity (i.e. 'exists', 'does not exist', 'undetermined') and the confidence of the assignment (i.e. 'certain', 'likely', 'plausible'). The GamDat team has elected not to use of 'certain' level of confidence for correlation analysis results given the implied nature of the analysis. Rather, that designation is reserved for traceable alterations to digital data. Table I.2 lists the remaining applicable categories used for RDA-method assignment. Note that there was no attempt to define criteria for 'plausible does not exist' which has been combined with 'undetermined'.

The purpose of the assignment criteria is to convert the inherently smooth 'likelihood of retest' function into a set of discrete categories. The selection of criteria depends upon the intended application. The recommendations presented here yield four categories of results, each having distinctly different likelihoods of retest, which are generally consistent with the terms of the GamDat data-irregularity nomenclature. Other criteria meeting different objectives can be readily developed within this same framework.

GamDat Assignment		Assignment Criteria: 'Likelihood of Retest' Values	
Existence	Confidence	Global RDA Method	Local RDA Method
Exists	Likely	"Low" Global Model => 50%	Lowest Local Model => 50%
Exists	Plausible	"High" Global Model => 20%	Highest Local Model => 20%
Undetermined	na	0.5% <= "High" Global Model <20%	0.5% <= Highest Local Model <20%
Does NOT Exist	Likely	"High" Global Model <0.5%	Highest Local Model <0.5%

Table I.2 – Recommended Criteria for GamDat Assignment of Retest-Type Data Irregularity by RDA Methods

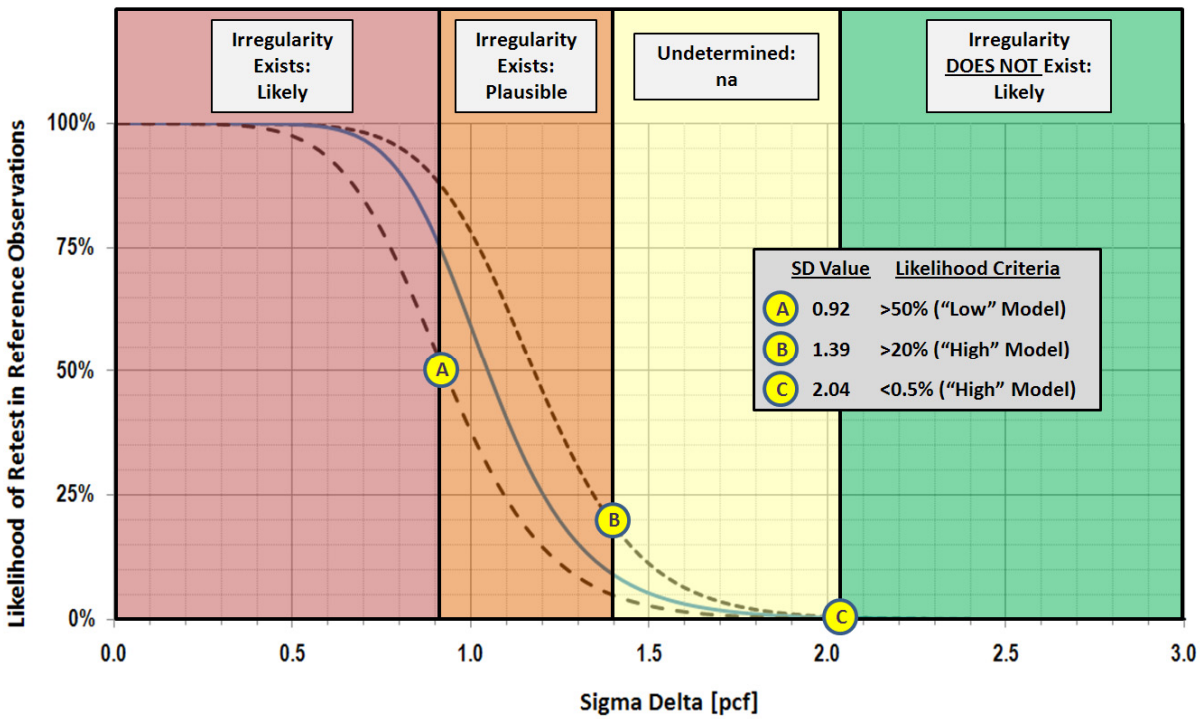


Figure I.13 – Illustration of Global RDA-Method Assignment Criteria and Resulting Threshold Sigma-Delta Values

Figure I.13 illustrates the assignment criteria described in Table I.2 by depicting the criteria as yellow dots (i.e. 'A', 'B', 'C') on the global models. Threshold sigma-delta values associated with each category boundary are also shown.

The 'likely exists' category for the global RDA method extends from the origin to a sigma-delta value of 0.92 pcf (see 'A' in Fig. I.13). The criteria defining 'likely' is that all models, particularly the "Low" bounding model, indicate that there is at least a 50% likelihood of retest in the reference set. Note that at the 0.92 pcf threshold, the "Best" model indicates a 75% likelihood of retest, and the "High" model indicates 87% likelihood of retest. Therefore, sigma-delta values assigned to this category have a much better than even chance of being a retest in the reference set data. This criterion is viewed as a conservative interpretation of the GamDat term "likely".

The 'plausible exists' category for the global RDA method extends over a sigma-delta range of 0.92 pcf to 1.39 pcf. The threshold criteria (see 'B' in Fig. I.13) is that the "High" bounding model has at least a 20% likelihood of retest in the reference set. Note that sigma-delta values assigned to this category can have likelihood of retest values that range from as little as 5% (i.e. for the "Low" model at 1.39 pcf) to as large as 88% (i.e. for the "High" model at 0.92 pcf). The selection of the upper sigma-delta boundary was set to correspond approximately to the largest known YES-Retest observation in the reference set. This selection is viewed as a reasonable interpretation of the GamDat term 'plausible' since it has been observed.

The final threshold criteria (see 'C' in Fig. I.13) for the global RDA method separates the 'undetermined' and the 'irregularity DOES NOT exist' categories. The criteria selected is that the bounding 'High" model (and therefore all models) have a likelihood of less than 0.5% or rounds to 0%, and yields a boundary sigma-delta value of 2.04 pcf. The emphasis in the selection of this criterion was placed on a conservative interpretation of the GamDat terms "likely" and 'does not exist' so that there can be a high degree of confidence that sigma-delta values assigned to this category are not retests.

The 'undetermined' category lies between thresholds 'B' and 'C' in Fig. I.13, and extends over a sigma-delta range of 1.39 pcf to 2.04 pcf. Within this range, the likelihood of retest in the reference sets ranged from 0% to 20%. Although the global RDA models indicated real potential for retest, there were no YES-Retest observations in this range. Given the theoretical potential implied by the models, but lack of corroborating empirical observations, this range seemed well characterized by the "undetermined" term of the GamDat nomenclature.

Local RDA method criteria were established to have comparable boundaries to those for the global method as shown in Table I.2. Essentially, the criteria are identical if the local models are used in lieu of the global models. One additional subtle difference is the term "Low" is replaced by "Lowest" and "High" by 'Highest". Whereas the bounding global models are clearly distinct over their entire range, the local models can cross by a small amount. This is the result of using the single locally-defined NO-Retest probability distribution with two globally-define YES-Retest distributions ("Low" and "Best") having very similar means, but slightly different standard deviations.

I.5.2 Comparison of Global RDA Method and Empirical Method

As illustrated in Fig. I.13 and discussed above, the global RDA method yields specific sigma-delta thresholds separating each of four GamDat data-irregularity existence categories. The Empirical Method discussed in appendix I yields different thresholds separating three categories. This section discusses differences between these two interpretations of the reference set data.

Figure I.14 presents an overlay of the four global RDA method categories on top of the frequency distribution of all data RDA reference set data listed in Table I.1. Comparison of this figure with Fig. E.5 reveals both similarities and differences between the 'Global RDA' and 'Empirical' methods. The first similarity occurs at sigma-delta values below 0.55 pcf which the Empirical method characterizes as 'suggests rerun' and the Global RDA method indicates the likelihood of retest is at least 95%. Another similarity is that both methods assign a boundary near the highest YES-Retest observation. The Empirical Method assigns a boundary of 1.4 pcf to delineate between the 'inconclusive' and 'suggests not a rerun' categories. Similarly, the global RDA method assigns a boundary of 1.39 pcf to delineate between the 'plausible exists' and 'undetermined' categories. Both methods recognize that for some range below these thresholds, there is a mixture of YES-Retest and NO-Retest data in the reference sets.

The first important distinction between the methods occurs at sigma-delta values between 0.55 and 1.4 pcf. Whereas the Empirical Method treats the entire range as 'undetermined', the Global RDA method uses two categories having distinctly different likelihoods of retest. As discussed earlier, the Global RDA method indicates that a sigma-delta value below 0.92 pcf has a much better than even chance of being a retest in the reference set data. Users of these methods must consider whether there is a need for their application to delineate between the virtual certainty of retest below 0.55 pcf and the high likelihood of retest below 0.92 pcf.

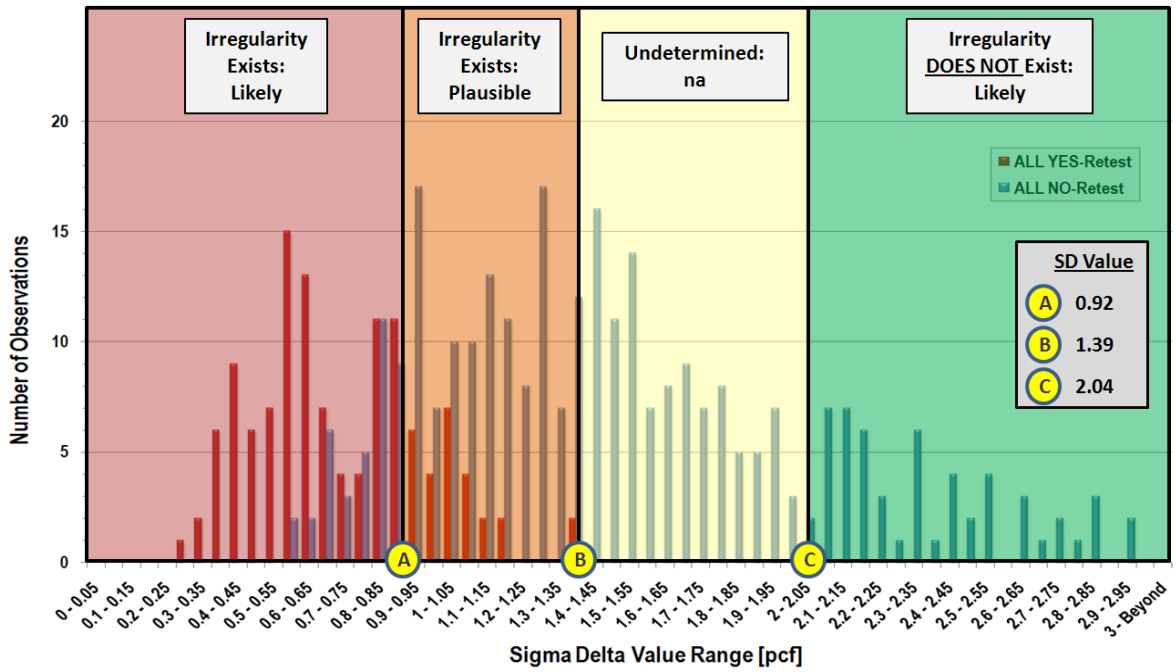


Figure I.14 – Overlay of Global RDA-Categories and All Reference Set Data

The second important distinction between the methods occurs in the sigma-delta range from 1.4 to 2.04 pcf. Over this range, the Empirical method designates the 'suggests not a rerun' category whereas the Global RDA method designates the 'undetermined' category. Both methods recognize the absence of YES-Retest observations within this region, but the statistically-based models of the Global RDA method suggests non-trivial potential for retests to occur within this range. Again, users of these methods will need to consider whether there is need for their application to use a more conservative (Global RDA) or less conservative (Empirical) boundary to delineate that a retest is unlikely to have occurred.

I.5.3 Performance of RDA Method and Assignment Criteria

The final step in the development of the RDA methods is to assess their performance along with the recommended assignment criteria. The assessment looks at how both known YES-Retest and NO-Retest data are categorized using the RDA methods. It is conducted for both the global and local methods individually as well as for the combination of the two.

Table I.3 shows a complete listing of assignments based on global-only criteria. The top block of data shows all YES-Retest data in the reference set, plus two additional known retests arising from double-transit cases (ID-10 and ID-17). The bottom block of data shows all NO-Retest data in the reference set plus the non-suspect independent tests from the two cases. For each site, sigma-delta values for all tube-pairs were assigned to one of

the four RDA categories listed in Table I.2. The percentage of assignments in each category is shown below each block. The percentages are color codes green for a correct assignment and red for an incorrect assignment. For the YES-Retest data, an assignment of irregularity exists, whether 'likely' or 'plausible', is considered a correct assignment. For the NO-Retest data, an assignment to either 'undetermined' or 'likely does not exist' is considered a correct assignment. Two sets of percentages are shown for each block with the distinction between the numbers highlighted in yellow. For the YES-Retest data, percentages are calculated separately including either just two or all 83 values from the High Street site so the effects of the large number of observations from that site could be isolated. For the NO-Retest data, the effects of the production testing at both Bents 11R and 12R at the High Street site are isolated as they were the drivers of the low-end of the NO-Retest data distribution.

Assignment Performance: Global-Only Criteria

	Number of Pairs In Each Assignment			
Known YES-Retest Data	**Exist Likely**	**Exist Plausible**	**Undeterm. na**	**NOT Exist Likely**
La Sierra OH, Bent 2, Pile W2	0	4	0	0
15th Street UC, Bent 2, Pile 4	1	0	0	0
15th Street UC, Bent 3, Pile 7	0	1	0	0
SFOBB, T1, Pile 1	4	0	0	0
Sawtelle Blvd. UC, Abut 1, Pile 5	2	1	0	0
Sawtelle Blvd. UC, Abut 1, Pile 24	3	0	0	0
Greenwood Creek, Pier 3, Pile 4	9	0	0	0
East Merced OH, Bent 3, Pile 13	5	1	0	0
Loveridge Rd. OC, Bent 2, Piles 44, 45, 47	3	0	0	0
High St. B11R, Selected T3	1	1	0	0
High St. B11R, Selected T1-T9	13	0	0	0
High St. B11R, Remaining	52	16	0	0
High St. B12R	6	0	0	0
ID 10 DT: Hwy 215 SE Connector, Bent 15	0	1	0	0
ID-17 DT: Benicia-Martinez, Pier 6, Pile 5	0	1	0	0
With Only 2 T3 Retests from High Street:	77%	23%	0%	0%
With all 83 Retests from High Street:	79%	21%	0%	0%
Known NO-Retest Data				
La Sierra OH, Bent 2, Pile W2	0	10	14	0
15th Street UC, Bent 2, Pile 4	1	12	7	0
15th Street UC, Bent 3, Pile 7	0	1	10	9
SFOBB, T1, Pile 1	0	0	5	19
Sawtelle Blvd. UC, Abut 1, Pile 5	0	6	5	7
Sawtelle Blvd. UC, Abut 1, Pile 24	0	5	9	4
Greenwood Creek, Pier 3, Pile 4	0	9	13	3
East Merced OH, Bent 3, Pile 13	0	4	11	11
Loveridge Rd. OC, Bent 2, Piles 44, 45, 47	0	10	15	0
High St. B11R, GamDat Set	1	13	7	0
High St. B11R, Production Set, All Combos	23	19	6	0
High St. B12R	18	17	1	0
ID 10 DT: Hwy 215 SE Connector, Bent 15	0	2	23	0
ID-17 DT: Benicia-Martinez, Pier 6, Pile 5	0	16	9	0
Without Production Sets from High Street:	1%	32%	47%	20%
With Production Sets from High Street:	12%	35%	38%	15%

Table I.3 –Performance of the RDA Method Using Global-Only Assignment Criteria

The results in Table I.3 are mixed, but generally align with expectations. All known YES-Retest values are correctly assigned to either the 'likely' or 'plausible' categories, and therefore, there are no "false negatives". This is not surprising because the 'B' criterion in Figs F13 and I.14 was set to correspond with the largest observed value. The more challenging issue is the proportion of NO-Retest data that are "false positives" or assigned to either of the 'irregularity exists' categories. It can be seen that 1% to 12% of known NO-Retest data are incorrectly assigned to

the 'likely exists' category and an additional third of the known NO-Retest data is assigned to the 'plausible exists' category. Overall, this performance indicates the thresholds are set conservatively to capture instances of retest.

An important observation in these results is that the 'likely exists' and 'plausible exists' categories have very distinct ratios of false positives. One way to interpret this is that sigma-delta values in the 'likely exists' range have on the order of 10:1 odds of being a retest whereas those in the 'plausible exists' category has on the order of a 2:3 odds of being a retest. This and the other categories seem generally consistent with the GamDat terminology and is useful for broadly corroborating or refuting the likelihood of retest originally identified by other means.

Assignment Performance: Local-Only Criteria

	Number of Pairs In Each Assignment			
Known YES-Retest Data	**Exist Likely**	**Exist Plausible**	**Undeterm. na**	**NOT Exist Likely**
La Sierra OH, Bent 2, Pile W2	2	1	1	0
15th Street UC, Bent 2, Pile 4	1	0	0	0
15th Street UC, Bent 3, Pile 7	1	0	0	0
SFOBB, T1, Pile 1	4	0	0	0
Sawtelle Blvd. UC, Abut 1, Pile 5	2	1	0	0
Sawtelle Blvd. UC, Abut 1, Pile 24	3	0	0	0
Greenwood Creek, Pier 3, Pile 4	9	0	0	0
East Merced OH, Bent 3, Pile 13	6	0	0	0
Loveridge Rd. OC, Bent 2, Piles 44, 45, 47	3	0	0	0
High St. B11R, Selected T3	1	1	0	0
High St. B11R, Selected T1-T9	13	0	0	0
High St. B11R, Remaining	50	17	1	0
High St. B12R	6	0	0	0
ID 10 DT: Hwy 215 SE Connector, Bent 15	1	0	0	0
ID-17 DT: Benicia-Martinez, Pier 6, Pile 5	0	1	0	0
With Only 2 T3 Retests from High Street:	89%	9%	2%	0%
With All 83 Retests from High Street:	82%	17%	2%	0%
Known NO-Retest Data				
La Sierra OH, Bent 2, Pile W2	1	4	19	0
15th Street UC, Bent 2, Pile 4	1	10	7	2
15th Street UC, Bent 3, Pile 7	1	1	9	9
SFOBB, T1, Pile 1	0	0	6	18
Sawtelle Blvd. UC, Abut 1, Pile 5	0	6	5	7
Sawtelle Blvd. UC, Abut 1, Pile 24	1	3	10	4
Greenwood Creek, Pier 3, Pile 4	0	6	15	4
East Merced OH, Bent 3, Pile 13	0	5	10	11
Loveridge Rd. OC, Bent 2, Piles 44, 45, 47	0	4	18	3
High St. B11R, GamDat Set	1	9	11	0
High St. B11R, Production Set, All Combos	7	25	8	0
High St. B12R	3	15	18	0
ID 10 DT: Hwy 215 SE Connector, Bent 15	0	2	19	4
ID-17 DT: Benicia-Martinez, Pier 6, Pile 5	1	4	20	0
Without Production Sets from High Street:	2%	20%	55%	23%
With Production Sets from High Street:	5%	27%	50%	18%

Table I.4 –Performance of the RDA Method Using Local-Only Assignment Criteria

However, if the intended application is the screening of large data sets for potential retest, one would want to only use the 'likely exists' (or more stringent) category and accept that some retests will be missed. For example, if the global-only 'likely exists' criterion were used to screen 1000 tube-pairs for the possibility of retest, it would correctly catch over 75% of retests but could also incorrectly flag on the order of 100 independent tests as retests.

Table I.4 shows the same listing of data and results as Table I.3, but these assignments are based on local-only criteria. These local results are somewhat improved relative to the global results. The percentage of known YES-Retest values categorized as 'likely exists' has increased, although one value has slipped into the 'undetermined

category. The rate of false positives on the NO-Retest data has decreased overall, and those assigned to the 'exists likely' category are now under 5%. These results suggest the local RDA method provides a valuable refinement to the global RDA method where it can be applied.

I.6 Summary

This appendix has provided a complete description of the development and evaluation of RDA methods. The RDA methodology is based on simple statistical models and provides a convenient, stable, and uniform basis to consider alternative assumptions regarding which data in the available reference sets are representative of the testing procedures in place during the time period being investigated by GamDat. Bounding RDA models were developed that characterize a full range of possible interpretations. The method was extended to allow explicit consideration of local data to account for site-specific conditions. Criteria for the assignment of potential retest cases were established in terms of bounding models, and were shown to yield results consistent with the GamDat nomenclature for defining data irregularities.

Appendix J: GamDat Data Check Tool

Although not originally planned as part of the GamDat work, a web-based GGL data integrity tool, called the *GamDat Data Check Tool*, was quickly developed using the same analysis codes from the main GamDat investigation. The tool was deployed on a secure Caltrans intranet server for immediate use by FTB staff.

The intended application of this to tool is to allow FTB engineers to assess integrity of small sets of GGL data files based on the five core analysis methods:

- Pattern Matching
- Depth Consistency
- Fidelity
- Timestamp RD-LAS
- Calibration Constant

The tool was developed using an open-source web application framework comprised of the following core technologies:

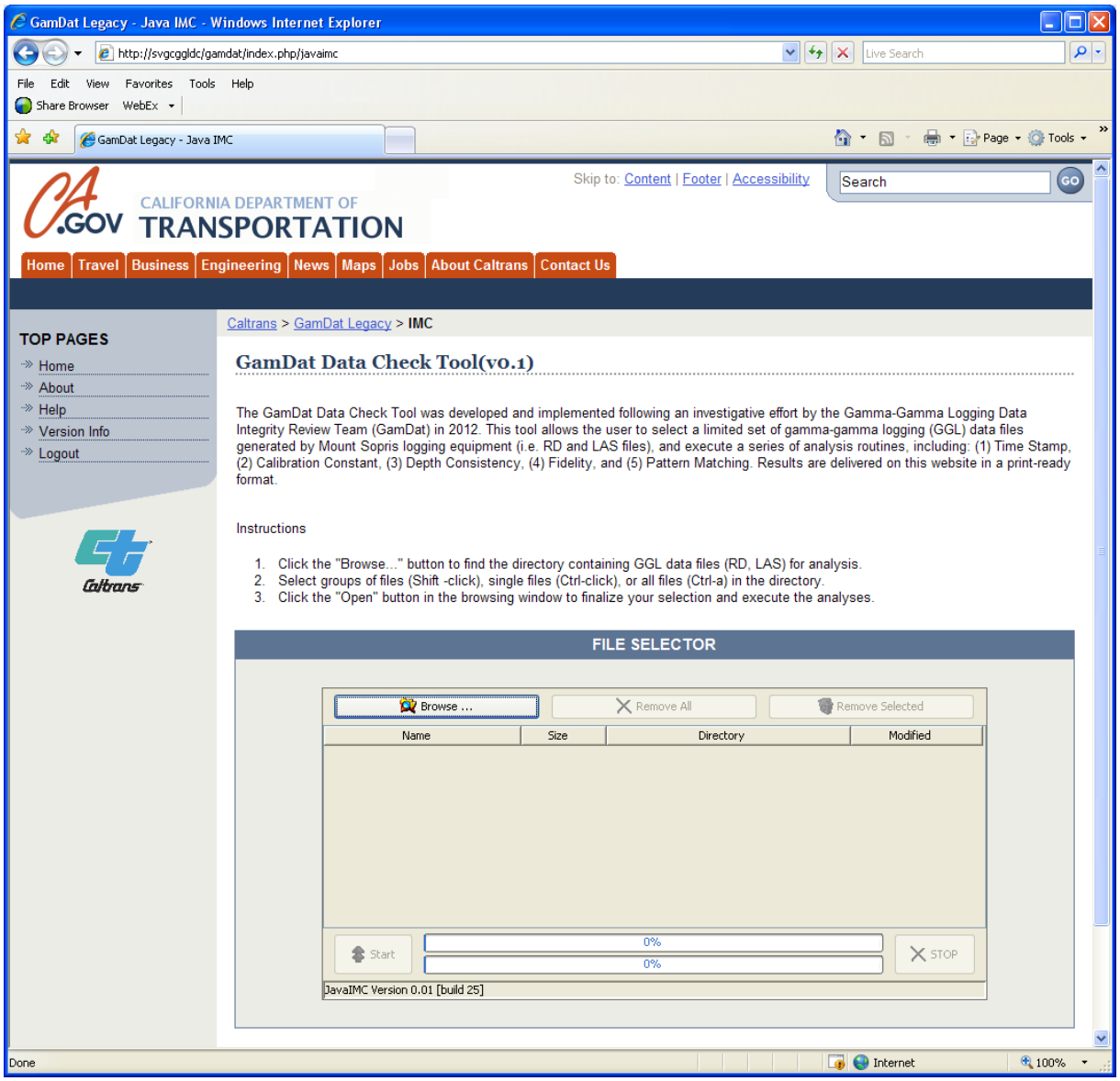
- *Apache HTTP Server* – web server software
- *PHP* – server side scripting language
- *Java* – coding language

The *GamDat Data Check Tool* subjects small sets of GGL data (e.g. data files for a single project or foundation location) to the suite of analyses. Both RD and LAS files are analyzed if available, however, LAS files can be examined alone if no RD files exist.

The user's interaction with the online tool is described here.

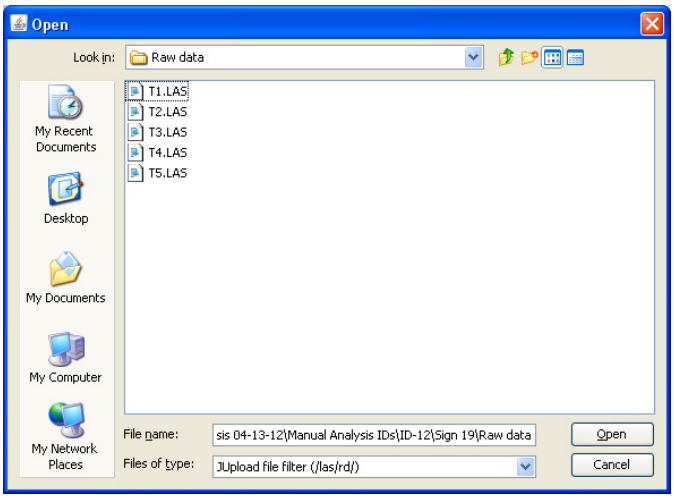
STEP 1: Main Page

Upon access to the secure website, the user is presented an interface prompting for the selection of GGL data files (RD and/or LAS) to be analyzed. The user selects a directory where the files reside using the Browse" button. All files within the directory (and any sub-directories) are considered in the analysis.



STEP 2: Select Directory Containing GGL Data Files

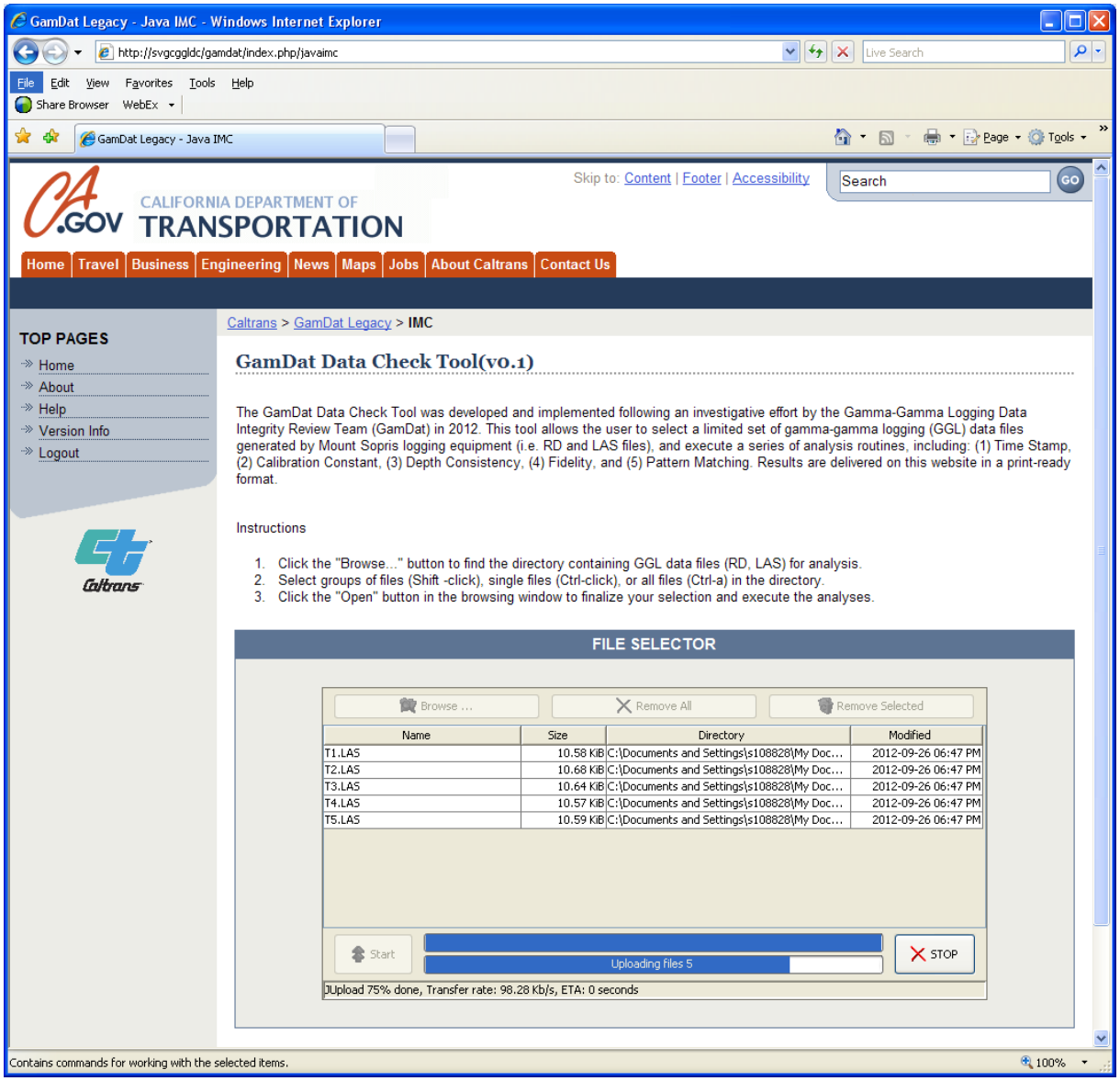
The directory selection window is presented when the “Browse” button is clicked, as shown here.



Note, individual files are not selected in this interface, only the directories.

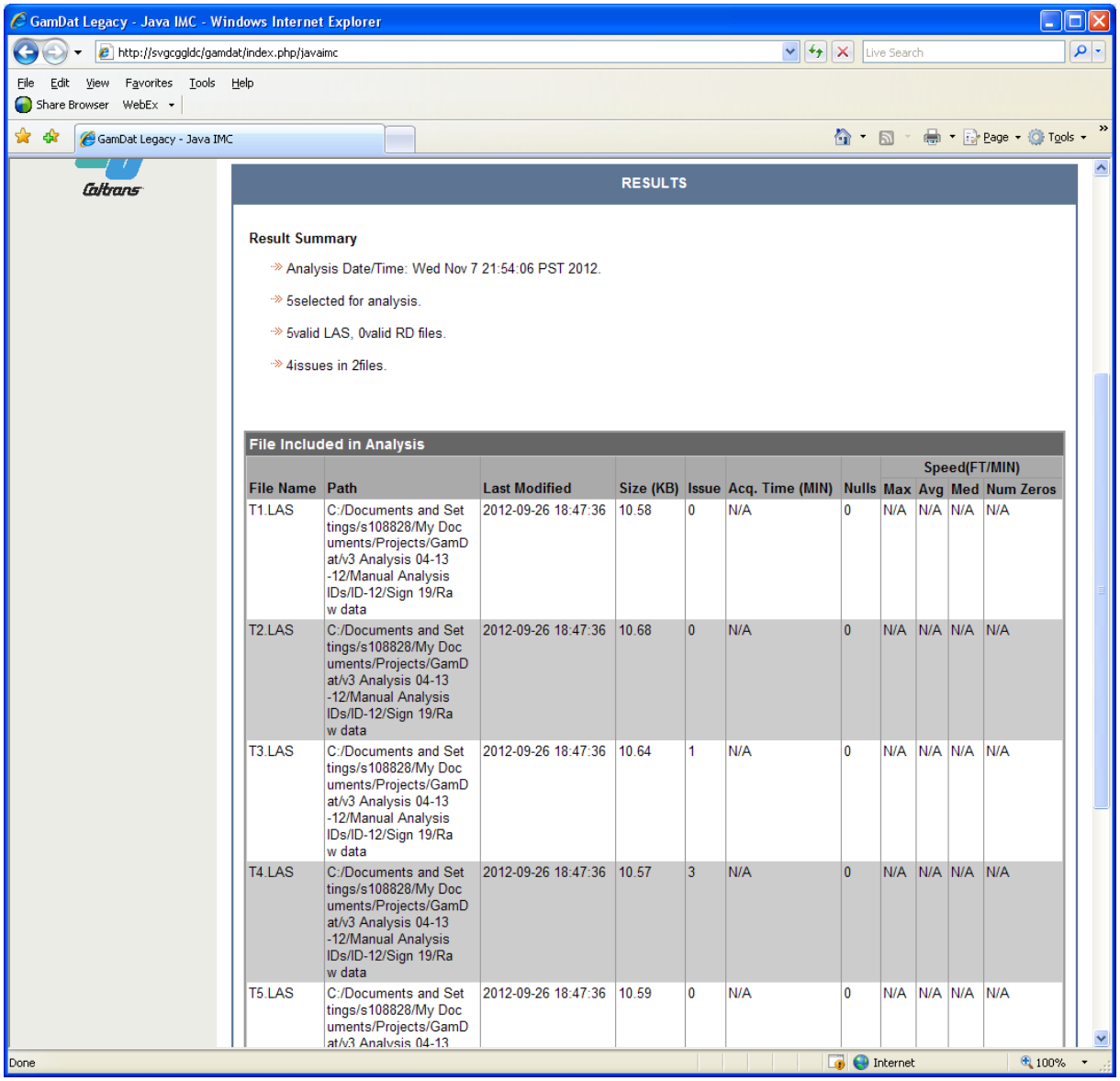
STEP 3: Analysis is Executed

Once the directory is selected, the tool automatically proceeds with the execution of the analyses. The user is presented with status information as files are uploaded to the server as part of the process.



STEP 4: Analysis Results Presented

Upon completion of the analyses, results are presented to the user. An overall summary is presented at the top of the page, showing the date of analysis, the number and types of files analyzed, and the number of issues identified.



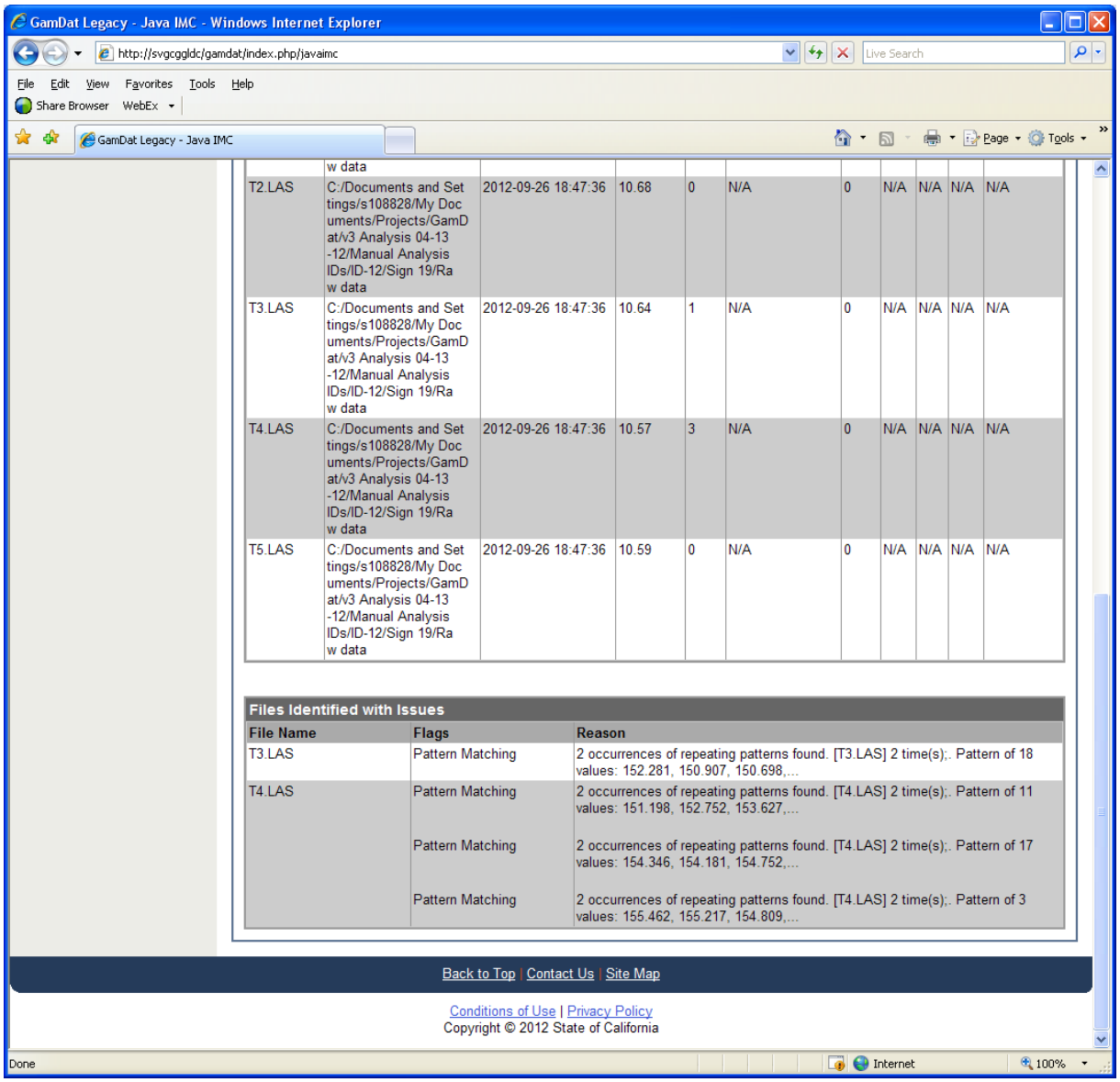
File Included in Analysis										
							Speed(FT/MIN)			
File Name	Path	Last Modified	Size (KB)	Issue	Acq. Time (MIN)	Nulls	Max	Avg	Med	Num Zeros
T1.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/v3 Analysis 04-13-12/Manual Analysis IDs/ID-12/Sign 19/Raw data	2012-09-26 18:47:36	10.58	0	N/A	0	N/A	N/A	N/A	N/A
T2.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/v3 Analysis 04-13-12/Manual Analysis IDs/ID-12/Sign 19/Raw data	2012-09-26 18:47:36	10.68	0	N/A	0	N/A	N/A	N/A	N/A
T3.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/v3 Analysis 04-13-12/Manual Analysis IDs/ID-12/Sign 19/Raw data	2012-09-26 18:47:36	10.64	1	N/A	0	N/A	N/A	N/A	N/A
T4.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/v3 Analysis 04-13-12/Manual Analysis IDs/ID-12/Sign 19/Raw data	2012-09-26 18:47:36	10.57	3	N/A	0	N/A	N/A	N/A	N/A
T5.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/v3 Analysis 04-13	2012-09-26 18:47:36	10.59	0	N/A	0	N/A	N/A	N/A	N/A

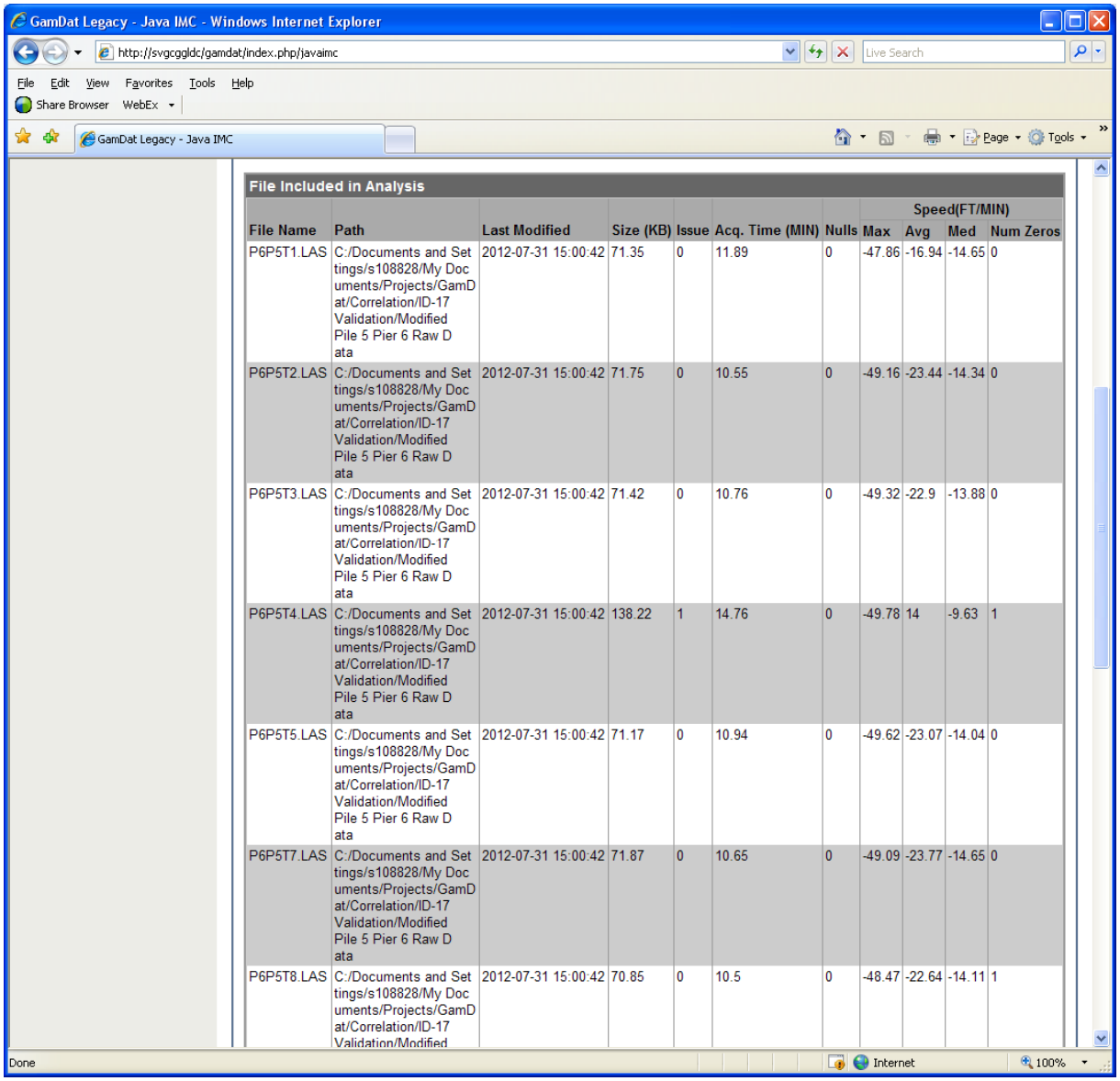
A detailed description of each file analyzed is presented in the middle section of the results page. This table includes:

- Filename
- File path
- File date and time
- File size
- Number of issues found

- Number of null values in the file
- Probe speed data
    - Maximum recorded speed
    - Average recorded speed
    - Median recorded speed
    - Number of zero-speed recordings

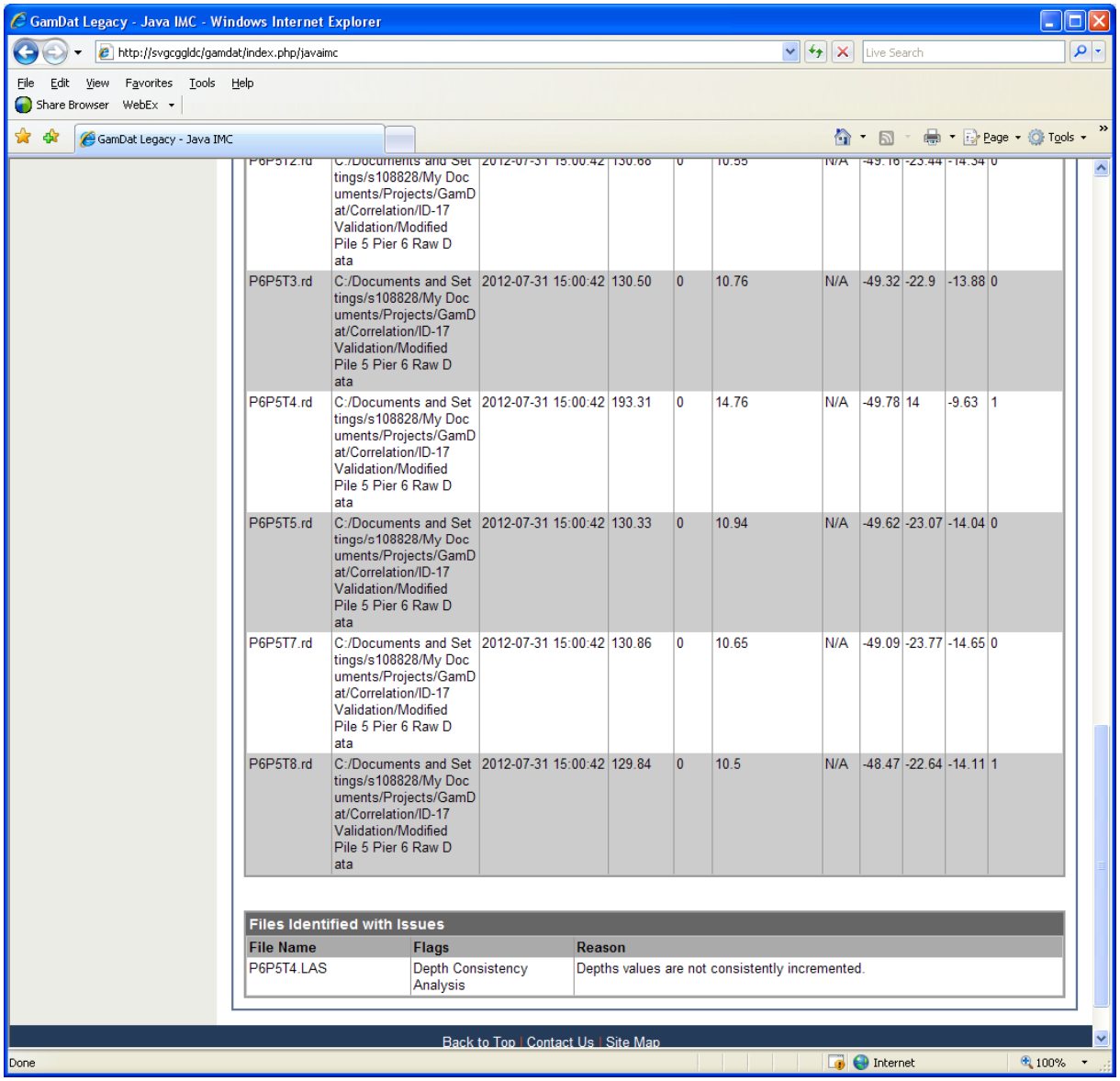
These file attributes allow FTB engineers to quickly assess if non-typical logging practices had been used.





File Included in Analysis

File Name	Path	Last Modified	Size (KB)	Issue	Acq. Time (MIN)	Nulls	Speed(FT/MIN) Max	Avg	Med	Num Zeros
P6P5T1.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	71.35	0	11.89	0	-47.86	-16.94	-14.65	0
P6P5T2.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	71.75	0	10.55	0	-49.16	-23.44	-14.34	0
P6P5T3.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	71.42	0	10.76	0	-49.32	-22.9	-13.88	0
P6P5T4.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	138.22	1	14.76	0	-49.78	14	-9.63	1
P6P5T5.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	71.17	0	10.94	0	-49.62	-23.07	-14.04	0
P6P5T7.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	71.87	0	10.65	0	-49.09	-23.77	-14.65	0
P6P5T8.LAS	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified	2012-07-31 15:00:42	70.85	0	10.5	0	-48.47	-22.64	-14.11	1



GamDat Legacy - Java IMC - Windows Internet Explorer

http://svgcggldc/gamdat/index.php/javaimc

File Edit View Favorites Tools Help

Share Browser WebEx

GamDat Legacy - Java IMC

P6P5T2.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	130.66	0	10.55	N/A	-49.16	-23.44	-14.34	0
P6P5T3.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	130.50	0	10.76	N/A	-49.32	-22.9	-13.88	0
P6P5T4.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	193.31	0	14.76	N/A	-49.78	14	-9.63	1
P6P5T5.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	130.33	0	10.94	N/A	-49.62	-23.07	-14.04	0
P6P5T7.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	130.86	0	10.65	N/A	-49.09	-23.77	-14.65	0
P6P5T8.rd	C:/Documents and Settings/s108828/My Documents/Projects/GamDat/Correlation/ID-17 Validation/Modified Pile 5 Pier 6 Raw Data	2012-07-31 15:00:42	129.84	0	10.5	N/A	-48.47	-22.64	-14.11	1

Files Identified with Issues

File Name	Flags	Reason
P6P5T4.LAS	Depth Consistency Analysis	Depths values are not consistently incremented.

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Appendix K: Codes and Database

K.1 Techology Platform for the GamDat Automated Screening Analysis Tools

The *GamDat Automated Screening Analysis Tools* (also referred to as "the machine") was developed using an open-source web application framework comprised of the following core technologies:

- *Apache HTTP Server* – web server software
- *MySQL* – relational database management system
- *PHP* – server side scripting language
- *phpMyAdmin* – web-based interface to MySQL

Collectively, this suite of software is referred to as a "*WAMP stack*," short for "Windows – Apache – MySQL – PHP." The software was deployed on virtual instance of *Windows 2008 Server*, running on a secured Caltrans IT intranet server.

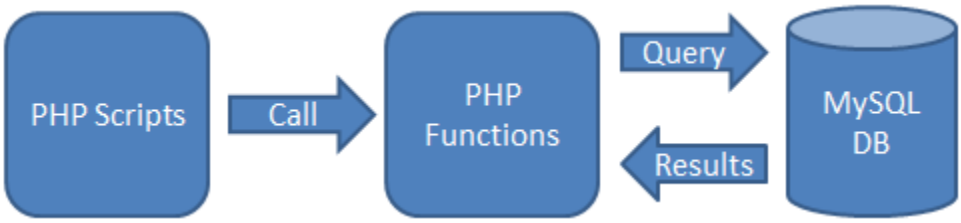
The analysis tools were comprised of a set of PHP functions, PHP scripts that execute the PHP functions, and a MySQL database for storing data. The MySQL database and the PHP functions are described in-depth in subsequent sections of this Appendix.

Due to the large size of the data set being analyzed (approximately 16GB), analysis, storage, and data caching using the server's hardware memory alone was not possible. Use of a database and the processing time overhead associated with database transactions resulted in an overall decrease in performance of the system.

K.2 Analysis Flow

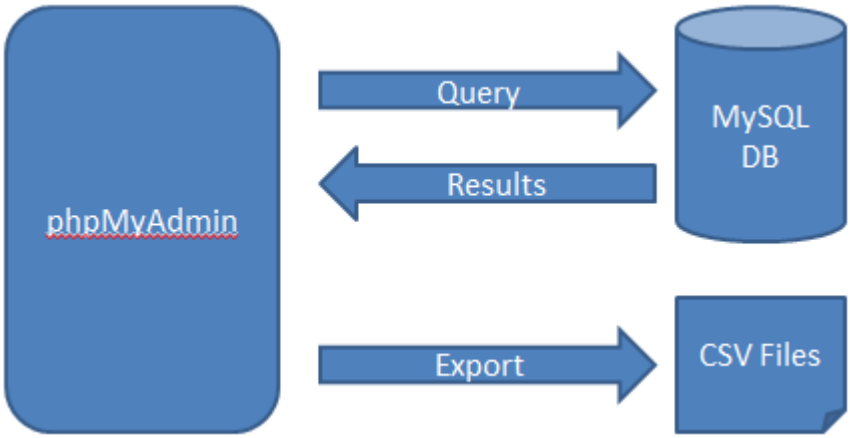
The machine was structured for a typical analysis flow:

- A PHP script makes a function call to an analysis function.
- The function communicates with the MySQL database to retrieve, update and/or store the data in the database as necessary.
- Once a function completes its process, results of the process are stored in the MySQL database.



K.3 Outputting Results

For most of the analysis results used in the GamDat work, results were retrieved by manually querying the database through a *PHPMyAdmin* interface. Results of the query were then exported as CSV text files for further evaluation.



K.4 MySQL Database

K.4.1 The Database

The MySQL database is comprised of eight tables, divided into two sets. One set is comprised of data extracted from GGL data files, while the other stores results of analyses.

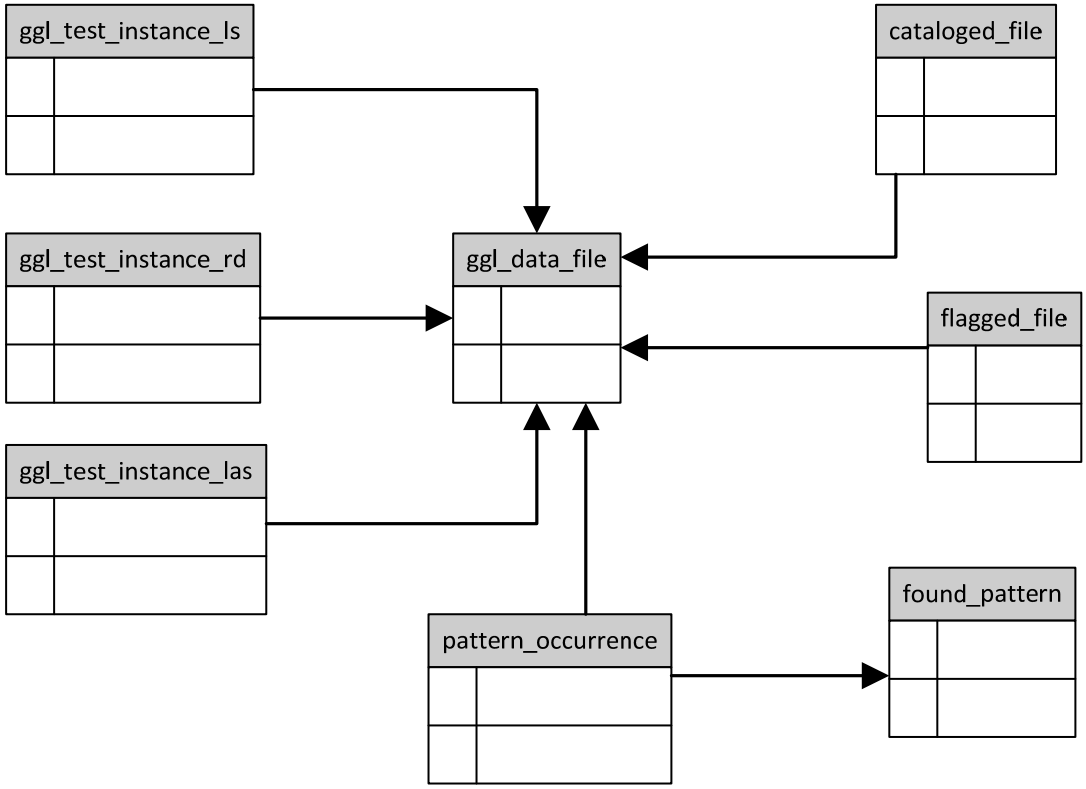
Data tables:

- *ggl_data_file*, stores a full list for all available data
- *ggl_test_instance_las*, stores representative data from LAS files
- *ggl_test_instance_ls*, stores representative data from LS files
- *ggl_test_instance_rd*, stores representative data from RD files

Result tables

- *cataloged_file*, stores cataloged files
- *flagged_file*, stores file flagged by the analyses
- found_pattern, stores repeated patterns
- *pattern_occurrence*, stores occurrences of a repeated pattern

The general structure and logical representation of the database is shown here:



The entity relationships between the various tables are not enforced at the database level within MySQL. Rather, the entity relationships and data integrity are enforced at the PHP script level as records are created and modified.

K.4.2 Table: ggl_data_file

This table serves as a look up table for all available GGL data files. The table is populated through an import of lists of data files generated using other tools. This table carries the following columns:

ggl_data_file			
Column Number	**Column Name**	**Data Type**	**Data Name**
1	ggl_data_file_id	int(11)	File ID
2	type	varchar(10)	File Type
3	unique_file_id	Int(11)	Unique File ID
4	is_parsed	Tinyint(1)	Representative File Flag
5	date	Timestamp	Last Modification Date
6	file_name	Varchar(100)	File Name
7	las_rd_pair_id	Int(11)	LAS-RD Pair ID
8	group_id	Int(11)	Group ID
9	is_cataloged	Tinyint(1)	Catalog Flag
10	filepath	Varchar(1000)	File Path

Elements in the table are defined as follows:

1. *File ID* – File unique identification number
2. *File Type* – Type of the file, LAS, RD, LS, XLS, or OPJ.

3. *Unique File ID* – Each set of files with the same content is assigned a unique file identification number, which is different from File ID. File ID uniquely identify the associated file, whereas Unique File ID uniquely identify the associated set of files.
4. *Representative File Flag* – This flag is default to 0. Only one file within the unique file set is read, stored, and having its Representative File Flag set to 1. LAS, LS and RD files with representative file flag set to 1 are attempted to read and stored in LAS Table, Log Shell Table, and RD Table respectively.
5. *Last Modification Date*
6. *File Name*
7. *LAS-RD Pair ID* – Each LAS should have a corresponding RD file. This identification number associates a LAS file with its corresponding RD file. This identification number is default to 0 for files without correspondents
8. *Group ID* – Each set of files within a single folder is assigned a group ID.
9. *Catalog Flag* – These flags are default to 0. Some of the representative files (Representative File Flags set to 1) are corrupted or incorrect types. Attempt to parse these files would fail and these flags are set to 1.
10. *File Path* – Paths to the files located on the GamDat team's secured server.

K.4.3 Table: ggl_test_instance_las

Table *ggl_test_instance_las* carries standard file information, LAS file specific header information, and the data within LAS files.

ggl_test_instance_las			
Column Number	**Column Name**	**Data Type**	**Data Name**
1	ggl_data_file_id	int(11)	File ID
2	ref_reported_ggl_test	int(10)	Reported Test Reference
3	file_type	varchar(10)	File Type
4	file_path	Varchar(1000)	File Path
5	file_name	Varchar(100)	File Name
6	unique_file_id	Int(11)	Unique File ID
7	header_count	Tinyint(2)	Header Count
8	file_creation_date	Timestamp	File Creation Date
9	file_modification_date	Timestamp	File Modification Date
10	file_size	Varchar(20)	File Size
11	ggl_data_depth	Text	Depth Data String
12	ggl_data_counts_1	Text	Raw Count Data String
13	ggl_data_counts_2	Text	DTC Count Data String
14	ggl_data_density	Text	Density Data String
15	ggl_data_depth_nonull	Text	No Null Depth String
16	ggl_data_counts_1_nonull	Text	No Null Raw Count String
17	ggl_data_counts_2_nonull	Text	No Null DTC Count String
18	ggl_data_density_nonull	Text	No Null Density String
19	is_gdtc_calculated	Tinyint(1)	Calculated DTC Count Flag
20	Uom	Varchar(10)	Unit of Measurement
21	Las_well_info_start_depth	Double	Start Depth
22	Las_well_info_stop_depth	Double	Stop Depth
23	Las_well_info_step	Double	Step Value
24	Las_well_info_null_value	Double	Null Value
25	Las_well_info_company	Varchar(100)	Company
26	Las_well_info_well	Varchar(100)	Well

27	Las_well_info_field	Varchar(100)	Field
28	Las_well_info_location	Varchar(100)	Location
29	Las_well_info_province	Varchar(100)	Province
30	Las_well_info_service_company	Varchar(100)	Service Company
31	Las_well_info_log_date	Varchar(100)	Log Date
32	Las_well_info_unique_well_id	Varchar(100)	Well ID
33	Las_curve_info_depth_uom	Varchar(10)	Depth UOM
34	Las_curve_info_gamma_uom	Varchar(10)	Raw Count UOM
35	Las_curve_info_gamma_dtc_uom	Varchar(10)	DTC Count UOM
36	Las_curve_info_density_dtc_uom	Varchar(10)	Density UOM
37	Depthlogger	Varchar(100)	Depth Logger
38	Bhfluid	Varchar(100)	BH Fluid
39	Company	Varchar(100)	Company 2
40	Depthdriller	Varchar(100)	Depth Driller
41	Filename	Varchar(100)	File Name 2
42	Witness	Varchar(100)	Witness
43	Casing	Varchar(100)	Casing
44	Casingtype	Varchar(100)	Casing Type
45	Location	Varchar(100)	Location 2
46	Date	Varchar(100)	Date 2
47	Loggedby	Varchar(100)	Logged By 2
48	Calibrationdata	Varchar(100)	Calibration Data
49	Tubeid	Varchar(100)	Tube ID
50	Well	Varchar(100)	Well 2
51	Recordedby	Varchar(100)	Recorded By
52	Filingno	Varchar(100)	Filing Number

Elements in the table are further defined as follows:

Standard File Information Columns

1. *File ID,* an ID used to look up the file in table ggl_data_file.
2. *Reported GGL Test,* an ID that references a reported GGL test.
3. *File Type*
4. *File Path*
5. *File Name*
6. *Unique File ID,* the ID for grouping a duplicated set of files.
7. *Header Count,* not used.
8. *File Creation Date*
9. *File Modification Date*
10. *File Size*

LAS File Data Columns

11. *Depth Data*, comma delimited string for depth from the file.
12. *Raw Count Data*, comma delimited string for raw count from the file.
13. *DTC Count Data*, comma delimited string for dead-time-corrected count from the file.
14. *Density Data*, comma delimited string for density data from the file.
15. *Depth Data without nulls*
16. *Raw Count Data without nulls*

17. *DTC Count without nulls*
18. *Density Data without nulls*
19. *Calculated DTC Count Flag*, a Boolean flag to indicate whether DTC counts are read in from the file or calculated from raw data count.

LAS File Header Columns

20 – 52. The purpose and usage of majority of the columns from column 20 to column 52 is not clear, and these columns are not important and are not used at all in any of the screening tools.

K.4.4 Table: ggl_test_instance_ls

Table *ggl_test_instance_ls* carries standard file information, Log Shell file specific header information, and Log Shell data.

ggl_test_instance_ls			
Column Number	**Column Name**	**Data Type**	**Data Name**
1	ggl_data_file_id	int(11)	File ID
2	Ref_reported_ggl_test	int(10)	Reported Test Reference
3	File_type	varchar(10)	File Type
4	File_path	Varchar(1000)	File Path
5	File_name	Varchar(100)	File Name
6	Unique_file_id	Int(11)	Unique File ID
7	Header_count	Tinyint(2)	Header Count
8	File_creation_date	Timestamp	File Creation Date
9	File_modification_date	Timestamp	File Modification Date
10	File_size	Varchar(20)	File Size
11	Las_well_info_start_depth	Double	Start Depth
12	Las_well_info_stop_depth	Double	Stop Depth
13	Ggl_data_depth	Text	Depth Data String
14	Ggl_data_speed	Text	Speed Data String
15	Ggl_data_4pi	Text	DTC Count Data String
16	Ggl_data_density	Text	Density Data String
17	Ggl_data_depth_nonull	Text	No Null Depth Data String
18	Ggl_data_speed_nonull	Text	No Null Speed Data String
19	Ggl_data_4pi_nonull	Text	No Null Count String
20	Ggl_data_density_nonull	Text	No Null Density String
21	Ggl_data_depth_uom	Text	Depth UOM
22	Ggl_data_speed_uom	text	Speed UOm
23	Ggl_data_4pi_uom	Text	Count UOM
24	Ggl_data_4pie_uom	Text	Density UOM
25 - 64			

Elements in the table are further defined as follows:

Standard File Information Columns (descriptions refer to table ggl_test_instance_las)

1. *File ID*
2. *Reported GGL Test*
3. *File Type*

4. *File Path*
5. *File Name*
6. *Unique File ID*
7. *Header Count*
8. *File Creation Date*
9. *File Modification Date*
10. *File Size*

Log Shell File Data Columns

11. *Start Depth*
12. *Stop Depth*
13. *Depth Data*
14. *Speed Data*
15. *DTC Count Data*
16. *Density Data*
17. *No Null Depth Data*
18. *No Null Speed Data*
19. *No Null DTC Count Data*
20. *No Null Density Data*
21. *Depth UOM*
22. *Speed UOM*
23. *DTC Count UOM*
24. *Density UOM*

Log Shell File Header Information Columns

25 - 63. These columns store standard LS header information. However, intent and usage of this header information is unclear. These columns are not used in the machine for analysis purpose.

K.4.5 Table ggl_test_instance_rd

Table *ggl_test_instance_rd* carries standard file information, rd data strings, and RD specific meta data.

ggl_test_instance_rd			
Column Number	**Column Name**	**Data Type**	**Data Name**
1	ggl_data_file_id	int(11)	File ID
2	Ref_reported_ggl_test	int(10)	Reported Test Reference
3	File_type	varchar(10)	File Type
4	File_path	Varchar(1000)	File Path
5	File_name	Varchar(100)	File Name
6	Unique_file_id	Int(11)	Unique File ID
7	Header_count	Tinyint(2)	Header Count
8	File_creation_date	Timestamp	File Creation Date
9	File_modification_date	Timestamp	File Modification Date
10	File_size	Varchar(20)	File Size
11	Ggl_data_count	Text	DTC Count String

12	Ggl_data_count_nonull	Text	No Null DTC Count String
13	Calibration_const_a	Double	Calibration Constant A
14	Calibration_const_b	Double	Calibration Constant B
15	Name	Varchar(20)	Tool Name
16	Tooltype	Varchar(20)	Tool Type
17	Logger	Varchar(100)	Logger
18	Location	Varchar(100)	Location
19	Filename_rd	Varchar(100)	File Name 2
20	Date	Timestamp	Date
21	Depthlogger	Varchar(100)	Depth Logger
22	Ghfluid	Varchar(100)	BH Fluid
23	Company	Varchar(100)	Company
24	Depthdriller	Varchar(100)	Depth Driller
25	Witness	Varchar(100)	Witness
26	Casingtype	Varchar(100)	Casing Type
27	Tubeid	Varchar(100)	Tube ID

Elements in the table are further defined as follows:

Standard File Information Columns(descriptions of the columns refer to table ggl_test_instance_las)

1. *File ID*
2. *Reported GGL Test*
3. *File Type*
4. *File Path*
5. *File Name*
6. *Unique File ID*
7. *Header Count*
8. *File Creation Date*
9. *File Modification Date*
10. *File Size*

RD Data Columns

11. *DTC Count Data*
12. *No Null DTC Count Data*
13. *Calibration Constant A, Calibration constant A defined in TOL file*
14. *Calibration Constant B, Calibration constant B define in TOL file*

RD Specific Header Information Columns(The intent and usage of these columns are not known, but are captured in the database.)

15. *Tool Name*
16. *Tool Type*
17. *Logger*
18. *Location*
19. *File Name 2*
20. *Date*
21. *Depth Logger*
22. *BH Fluid*

23. *Company*
24. *Depth Driller*
25. *Witness*
26. *Casing Type*
27. *Tube ID*

K.4.6 Table: cataloged_file

The PHP functions that parse files attempt to parse every representative files. However, functions would fail to parse representative files that are not in their standard format. These files are stored in table *cataloged_file* in addition to set the *Cataloged Flag* to 1 in the *ggl_data_file* table.

cataloged_file			
Column Number	**Column Name**	**Data Type**	**Data Name**
1	Id	Int(11)	Cataloged File ID
2	ggl_data_file_id	int(11)	File ID
3	File_type	varchar(10)	File Type
4	File_path	Varchar(1000)	File Path
5	File_name	Varchar(100)	File Name
6	File_creation_date	Timestamp	File Creation Date
7	File_modification_date	Timestamp	File Modification Date
8	File_size	Varchar(20)	File Size

Elements in the table are further defined as follows:

1. *Cataloged File ID,* unique id of the cataloged file
2. *File ID,* unique id that reference a row in table ggl_data_file
3. *File Type*
4. *File Path*
5. *File Name*
6. *File Creation Date*
7. *File Modification Date*
8. *File Size.*

K.4.7 Table: flagged_file

This table stores the results from the automated analyses, excluding the *Pattern Matching Analysis*. When a file is flagged as potential irregular, a row of data is inserted into this table.

flagged_file			
Column Num	**Column Name**	**Data Type**	**Data Name**
1	Flagg_id	Int(11)	Flag ID
2	File_id	int(11)	File ID
3	File_path	Varchar(1000)	File Path
4	Flagged_by	Tinyint(1)	Analysis ID
5	Flag_reason	Varchar(1000)	Flag Reason

Elements in the table are further defined as follows:

1. *Flag ID,* unique id that identifies the flagged file
2. *File ID,* unique id that reference the row in table ggl_data_file
3. *File Path*
4. *Analysis ID,* unique id that reference an analysis
5. *Flag Reason,* a string that explains why a file is flagged

K.4.8 Tables: found_pattern, pattern_occurrence

Table *found_pattern* and table *pattern_occurrence* together store the results from the *Pattern Matching Analysis.* Table *found_pattern* stores the repeated pattern and the total number of repeats of the pattern.

found_pattern			
Column Num	**Column Name**	**Data Type**	**Data Name**
1	Pattern_id	Int(11)	Pattern ID
2	Pattern	Text	Repeated Pattern
3	Num_occur	Int(11)	Total Repeats

Elements in the table are further defined as follows:

1. *Pattern ID,* unique pattern id that identifies a row.
2. *Repeated Pattern,* the actual repeated density sequence.
3. *Total Repeats,* the total number repeats of the pattern found in the data set.

Table *pattern_occurrence* stores the files where repeated pattern occurs.

pattern_occurrence			
Column Num	**Column Name**	**Data Type**	**Data Name**
1	Pattern_id	Int(11)	Pattern ID
2	File_id	Int(11)	File ID
3	Num_occur	Int(11)	Total Repeats

Elements in the table are further defined as follows:

1. *Pattern ID,* the id that references a row in table *found_pattern*
2. *File ID,* the id that references a row in table *ggl_data_file*
3. *Total Repeats,* the total number of repeats of the pattern within the file

K.5 PHP Files and Their Functions

K.5.1 Overview

A set of PHP files and functions were developed to prepare the data for the automated screening analyses and to automate the analyses that identify potential irregularities for all of the available GGL test data. This set of PHP files are grouped into three functional sets:

- *Helper Functions*
- *Data Preparation Functions*
- *Analysis Functions*

K.5.1.1 Helper Functions

Helper Functions are used to carry out high level global actions, database transactions, and generally assist the Data Preparation and Analysis Functions in performing their tasks. Although the Helper Functions do not perform any specific analysis tasks, they are required and included in other PHP scripts.

PHP File	Function
database.inc.php	Communicates with the MySQL database
util.inc.php	Provides various global helper functions

K.5.1.2 Data Preparation Functions

Data Preparation Functions are used to populate the four database tables containing GGL data: *ggl_data_file, ggl_test_instance_las, ggl_test_instance_ls, ggl_test_instance_rd*.

PHP File	Function
fileparser.inc.php	Provides LAS, LS, and RD files readers
fullist_parser.inc.php	Reads files from file paths in given text files

K.5.1.3 Analysis Functions

Analysis Functions analyze the data prepared by Data Preparation Functions for potential irregularities.

PHP File	Function
timestamp_check.inc.php	Performs timestamp analysis
calibration_const_check.inc.php	Performs calibration constant analysis
depth_consistancy_check.inc.php	Performs depth consistency analysis
fidelity_check.inc.php	Performs fidelity analysis
pattern_match_new.inc.php	Performs pattern matching

Finally, file *testscript_codesnap.inc.php* contains all of the code snippets that execute the functions from the files above. Corresponding code snippets are shown in sections that describe the files and the functionalities.

K.5.2 Populating Data Tables (fullist_parser.inc.php)

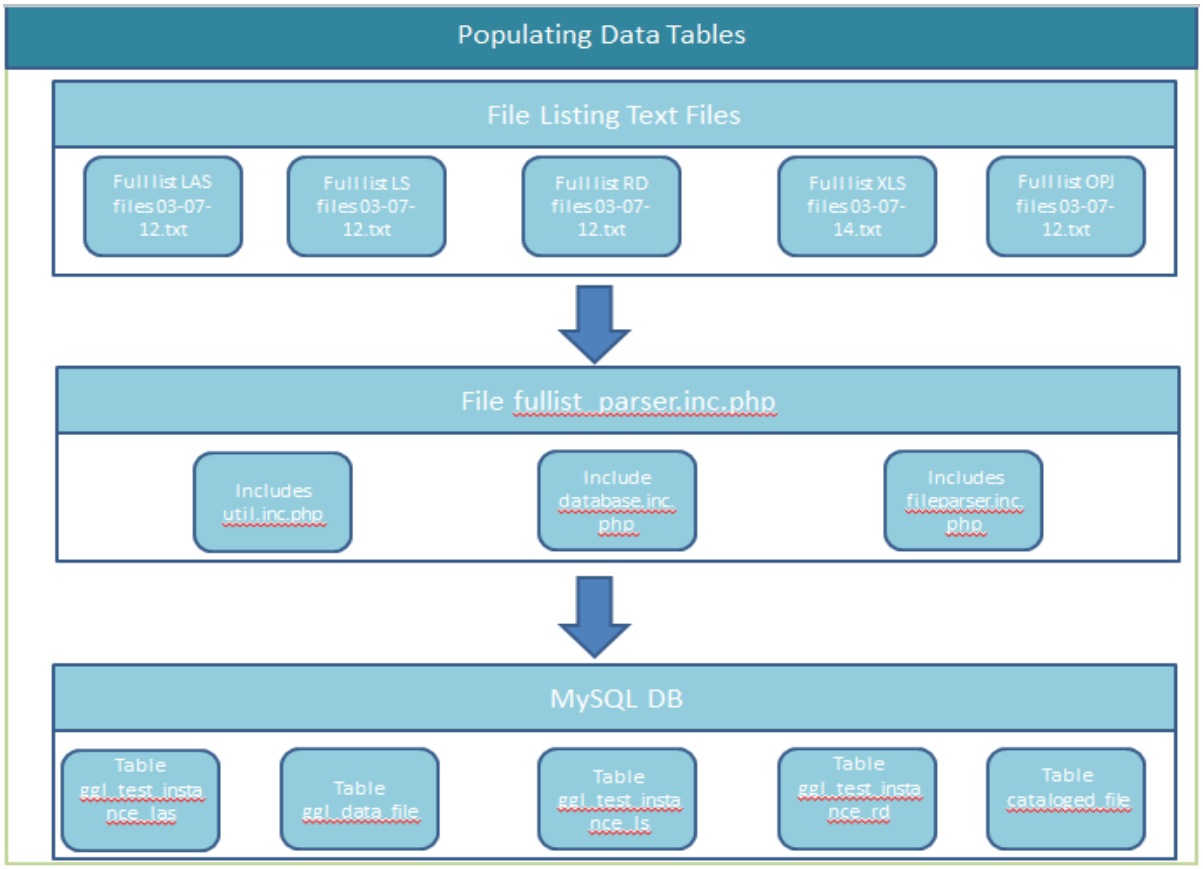
The *fullist_parser.inc.php* file includes *fileparser.inc.php, database.inc.php, and util.inc.php* to populate the content of *ggl_data_file, ggl_test_instance_las, ggl_test_instance_ls, ggl_test_instance_rd, and cataloged_file* tables.

The following code snippet shows how this file is used. Upon the code snippet execution completes, the MySQL database is ready for Analysis Files to analyze the data.

Code for Populating Data Tables

```
require_once('includes/database.inc.php');
require_once('includes/fullist_parser.inc.php');
require_once('includes/util.inc.php');
$basePath = 'D:/Data';
$fileLists["rd"] = "Full list RD files 03-07-12.txt";
$fileLists["las"] = "Full list LAS files 03-07-12.txt";
$fileLists["ls"] = "Full list LS files 03-07-12.txt";
$fileLists["opj"] = "Full list OPJ files 03-07-12.txt";
$fileLists["xls"] = "Full list XLS files 03-14-12.txt";

clearDB();
phonebookLists($basePath, $fileLists);
pairLASRD();
groupFiles();
```

The process is shown and described below.



1. Read file paths from *File Listing Text* files

2. Group files into unique sets and assign unique set IDs to the sets,
3. Identify *representative files* within the unique sets,
4. Insert files into table *ggl_test_file* along with their assigned unique set ID,
5. Attempt to read the *representative files*,
    a. If the *representative files* are in their standard formats, store the files in their corresponding data tables.
    b. Else if the representative files are not legitimate, cataloged the files into the *Cataloged File* table.
6. Select LAS and RD file paths from table *ggl_test_file*
7. Remove file extensions from the file paths,
8. Assign LAS-RD Pair IDs to LAS and RD files that have the same file path after removing extensions,
9. Update the LAS-RD Pair ID fields for the LAS and RD files with the assigned IDs,
10. Select all file paths from table *ggl_test_file* sorted by file paths,
11. Remove file names from the files paths,
12. Assign group ids to files that have the same file paths after removing the file names.
13. Update the Group ID field for all of the files with the assigned group ids.

K.5.3 Parsing Individual Files (fileparser.inc.php)

This file assists the previously described file *fullist_parser.inc.php* to complete its job. A file path is given to the file parser. The file parser first identifies the type of the file. If the file type is one of the three types (LAS, LS, and RD), the file parser executes the appropriate parser to read and store the file.

K.5.3.1 LAS File Parser

1. LAS Files are identified using the following criteria:
    a. Files that have extensions and the extensions are case-insensitively equal to 'las' OR files that do not have extensions AND
    b. Files that have all of the following lines(header lines), case-insensitive:
        i. ~VERSION INFORMATION
        ii. ~WELL INFORMATION
        iii. ~CURVE INFORMATION
        iv. ~PARAMETER INFORMATION
        v. ~OTHER
        vi. ~A
    c. Any files that failed the above criteria are considered non-LAS files

```
~VERSION INFORMATION
VERS    .2.0            :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP    .NO             :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT    .FT     32.3646         :START DEPTH
STOP    .FT     3.05008         :STOP DEPTH
STEP    .FT     -0.0997092      :STEP
NULL    .       -999.25         :NULL VALUE
COMP    .       N/A     :COMPANY
WELL    .       N/A     :WELL
FLD     .       N/A     :FIELD
LOC     .       N/A     :LOCATION
PROV    .       N/A     :PROVINCE
SRVC    .       N/A     :SERVICE COMPANY
DATE    .       N/A     :LOG DATE
UWI     .       N/A     :UNIQUE WELL ID
~CURVE INFORMATION
DEPT    .FT             :DEPTH
GAM     .CPS            :Gam
GAM(    .CPS            :gam(dtc)
DENS    .LBS/FT3                :Density(dtc)
~PARAMETER INFORMATION
Dept    .               :Depth Logger
BH F    .               :BH Fluid
Dept    .               :Depth Driller
COMP    .               :COMPANY:
File    .               :File Name
Witn    .               :Witness:
Casi    .               :Casing Type
Loca    .               :Location:
Date    .               :Date
Logg    .               :Logged by:
Cali    .               :Calibration Data
Tube    .               :Tube ID
~OTHER
~A
75.2395 14006   15349.7 163.29
75.1398 14334.5 15745.1 161.69
75.0401 14246.5 15639   162.116
74.9404 13887.5 15207.5 163.876
74.8407 14233   15622.7 162.181
```

Typical LAS File Opened in Notepad

2. Parsing LAS Files
    a. Locate the five header lines and read in the header information
        i. Search for a header line within the file
        ii. Continue to read lines from the file until a new header line is uncounted
        iii. Store the header information to the corresponding header
    b. Locate line with "~A" within the file
    c. Read lines after "~A" as data lines
    d. Data lines are expected to be the these formats:
        i. DEPTH RAW COUNT DTC COUNT DENSITY or
        ii. DEPTH RAW COUNT DENSITY
    e. Parse data lines, for each data line
        i. Split the tab delimited line
        ii. Calculate DTC Counts for the line if there are only 3 numerical values for the line
    f. Concatenate the parsed data into four comma delaminate strings
    g. Store the header information and data strings into the database

K.5.3.2 LS File Parser

1. LS Files are identified using the following criteria:
    a. Files that have extensions and the extensions are not case-insensitively equal to 'nsf' OR files that do not have extensions AND
    b. There are at least 14 lines in the files AND
    c. Line 14 of the file contains the text: *"Depth" "Speed" "4pi" "4P"*

```
"P: ACQSBC  1.29(1/28/1993)  Serial Number 0110 2/6/2001 09:49"
"W:t3neel.t1xxxx"
"N:  4"  "C:\LS\MXH2SE.PB2"
  "DD00"    "DS00"    "CS32"    "LS32"
   "I:0"         0         0     43011
"J:1000"      1000      1000      7818
 "Z:0.0"       0.0      0.00    100.00
"F:1000.0" 1000.0   1000.00    220.00
 "D:0.0"       0.0       0.0       0.0
"T:0001"         1      1101       201
 "L:0.0"       0.0      0.00    100.00
"R:100.0"    100.0   1000.00    200.00
"X:010100"   10100     10100     20222
 "Depth"  "Speed"     "4pi"     "4PI"
  "Feet" "Ft/Min"     "CPS" "LBS/FT3"
   211.1       0.0 20566.12    151.93
   211.1       0.0 20464.17    152.28
   211.1       0.0 20488.00    152.20
   211.1       0.0 20483.84    152.21
   211.1       0.0 20424.79    152.41
   211.0       1.5 20453.72    152.31
   210.9       3.3 19934.13    154.12
   210.8       5.0 18607.71    158.97
   210.7       5.2 18822.96    158.16
   210.6       5.3 18953.74    157.67
```

Typical LS File Opened in Notepad

2. Parsing LS Files
    a. Read header information from lines 4 – 13
    b. Read data lines from line 15 to the end of file
    c. Data lines are expected to be the following format:
        i. DEPTH SPEED DTC COUNT DENSITY
    d. Parse the data lines
        i. Split the tab delimited lines
        ii. A line is valid if and only if the line consists of four numeric values
    e. Concatenate the parsed data into four comma delaminate strings
    f. Store the header information and data strings into the database

K.5.3.3 RD File Parser

1. Identifying RD Files
    a. Files that have extensions that case-insensitively equal to ‘RD’ AND
    b. Have at least 3 lines of content AND
    c. Strings “Descrption” and “ToolName” are in the first three lines of the files.

```
;*A:B- [Description]
ToolName=HLP-2375-3551 GGDen 15cm spacer,3.05 tool zero for LAS
DriverName=MGXIISCRIPT
;9-20-00 pls new browsers, 2/25/02 JRS mod for CALTRANS, 3/21/02

[Protocol]
LengthMode=Fixed
Length=24
LengthMax=24
UpholeBaudRateDiv=50
DownholeBaudRateDiv=50
Parity=even
DataBits=8
```

Top Portion of a Typical RD File Open in Notepad

2. Parsing RD Files
   a. Readable text followed by the following strings are read in as meta data from RD files

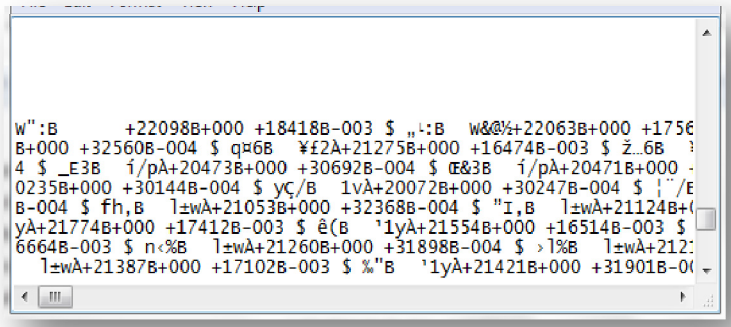
ID	String In RD	Location	Meta Data Name
1	CalA=	After "[Ch4]" is found	Calibration Constant A
2	CalB=	After "CalA=" is found	Calibration Constant B
3	Name=	After "[ToolAdapter]" is found	Tool Adapter Name
4	ToolType=	After "Name=" is found	Tool Type
5	Logged by:	Any location within the file	Logged By
6	Location:	Any location within the file	Location
7	Date	Any location within the file	Date
8	File Name	Any location within the file	File Name
9	Depth Logger	Any location within the file	Depth Logger
10	GH Fluid	Any location within the file	GH Fluid
11	COMPANY:	Any location within the file	Company
12	Depth Driller	Any location within the file	Depth Driller
13	Witness:	Any location within the file	Witness
14	Casing Type	Any location within the file	Casing Type
15	Tube ID	Any location within the file	Tube ID

Metadata from RD File

   b. Locate the beginning of data block. There is always a beginning point for data block in the RD files. Data is stored in a standard format for regular data rows. Null values are ignored from parsing since how null values are represented in RD files is not yet fully understood. The following strings are an exhaustive list for current available RD files. It is possible that data block may begin with some other unexpected strings. Prioritize the first string as it is the most commonly seen string in the current available RD files.

L÷ø<$	',ù<$	F÷ø<$	€,ù<$	š—ö<$	¡GL=$	<$

Beginning of data block in RD file



A Portion from the Beginning of a Typical RD Data Block

c. Identify data rows.
   i. Read data block in as a string
   ii. Search for substrings that satisfy the following condition
      1. The First character of the string is '$'
      2. The hexadecimal value of the second character is 0x00
      3. The hexadecimal value of the eighth character is 0x00
      4. The thirteen character of the string is '+'
      5. The fourteen character of the string is a numeric character, i.e. 0-9.

Examples of Data Row
$..K^B.....+19778B-001 +24292B-002
$.÷+^B..+ªƒ¾+20108B-001 +24344B-002
$.Ø.^B..+ªƒ¾+20415B-001 +24330B-002

d. Compare the data row strings with predefined regular expression to determine non-null value strings
   i. Define regular expression for data row: '/[+][0-9]*[B].[0][0-1][0-9]/'
   ii. Split the data row string into two parts
      1. Characters 1 to 12 as first part
      2. Characters 13 to 24 as second part
   iii. Compare both parts against the regular expression. If both parts pass regular expression checks against the regular expression defined in step i, the string is a non-null value.

e. Extract data characters from row string. Characters from position 3 to 6 is the depth value. Characters from 9 to 12 is the speed value. Characters from position 13 to 23 is the gamma count value.

Row Flag(2)	Depth String(4)	Unknown(2)	Speed String(4)	Count String(11)	Space	Unknown(11)
$.	.K^B	..	....	+19778B-001		+24292B-002
$.	÷+^B	..	+ªƒ¾	+20108B-001		+24344B-002
$.	Ø.^B	..	+ªƒ¾	+20415B-001		+24330B-002

f. Convert depth characters to floating point value.

i. Translate data characters into binary representation

Depth String(4)	In HEX	Reverse HEX	Reverse HEX in Binary
.K^B	16 4B 5E 42	42 5E 4B 16	0100 0010 0101 1110 0100 1011 0001 0110
÷+^B	F7 2B 5E 42	42 5E 2B F7	0100 0010 0101 1110 0010 1011 1111 0111
Ø.^B	D8 0C 5E 42	42 5E 0C D8	0100 0010 0101 1110 0000 1100 1101 1000

ii. Convert binary representation back to floating point representation.

Sign Bit	Exponent Bits	Exponent – 127	Fraction Bits	Fraction + 1	Value(M)	Value(FT)
0	100 0010 0	5	101 1110 0100 1011 0001 0110	1.73666644	55.5733	182.327
0	100 0010 0	5	101 1110 0010 1011 1111 0111	1.73571670	55.5429	182.227
0	100 0010 0	5	101 1110 0000 1100 1101 1000	1.73476696	55.5125	182.128

g. Convert speed characters to floating point value using the same manner as converting depth characters to floating point value.

i. Translate data characters into binary representation

Speed String(4)	In HEX	Reverse HEX	Reverse HEX in Binary
....	2B AA 83 BE	BE 83 AA 2B	0000 0000 0000 0000 0000 0000 0000 0000
+ªƒ¾	2B AA 83 BE	BE 83 AA 2B	1011 1110 1000 0011 1010 1010 0010 1011
+ªƒ¾	2B AA 83 BE	BE 83 AA 2B	1011 1110 1000 0011 1010 1010 0010 1011

ii. Convert binary representation back to floating point representation.

Sign Bit	Exponent Bits	Exponent – 127	Fraction Bits	Fraction + 1	Value(M)	Value(FT)
0	000 0000 0	0	000 0000 0000 0000 0000 0000	1	0.0000	0.000
1	011 1110 1	-2	000 0011 1010 1010 0010 1011	1.02863	-0.2571	-0.844
1	011 1111 1	-2	000 0011 1010 1010 0010 1011	1.02863	-0.2571	-0.844

h. Convert raw count characters to floating point

i. Raw count values are stored in the following format for non-null values:

+[Base Number]B[Exponent Sign]00[Exponent], where
Final Raw Count Value = Base Number * (2 ^ (Exponent Sign * Exponent)
Base Numbers are integer whose digits are stored as literal characters.
Exponent Sign can be either '+' or '-'.
Exponent can be characters from 1 to 9.

Count String	Base Number	Exponent	Exponent Sign	Count Value
+19778B-001	19778	1	-	9889
+20108B-001	20108	1	-	10054
+20415B-001	20415	1	-	10207.5

i. Concatenate the values into comma-delimited strings.
j. Store metadata and data string into the GamDat Database

K.5.4 Time Stamp Analysis (timestamp_check.inc.php)

File *timesteamp_check.inc.php* is responsible for performing time stamp analysis by group id and by las-rd pair id on available and paired RD files, which are files that their LAS files are also available. The analysis by group produces one result set. The analysis by las-rd pair id produces another result set of its own.
When collecting test data, a pair of RD file and LAS file should be written at the same moment, meaning the RD and LAS pair should be having the same time stamps. There is always a minimum time to collect data with the equipment, depending on the equipment's speed, the depth of the tube, and moving of the equipment from tube to tube.

K.5.4.1 The Analysis by Pair ID

This analysis is performed on non-cataloged files with LAS RD pair IDs. Files are selected from the database as pairs based on their LAS-RD pair IDs. Each pair of LAS and RD files is analyzed independently.

Code for Executing Analysis by Pair ID

```
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');
require_once('includes/timestamp_check.inc.php');

checkTimestampByPairID();
```

LAS file and RD file should have the same time stamp. However, accounting for file upload, system time offset, and/or any other reason, less than one minute in time stamp difference is considered insignificant. Pairs that have time differences greater than or equal to one minute are flagged as potential irregular pairs.

File Name	File Path	Time Stamp	Pair ID	Flag?
P2T1.RD	D:/Data/Machine 1/Project 1/RawData/p1,2/P2T1.RD	1	1	No
P2T1.LAS	D:/Data/Machine 1/Project 1/RawData/p1,2/P2T1.LAS	1	1	No
P1T1.RD	D:/Data/Machine 1/Project 1/RawData/p1,2/P1T1.RD	2	2	Yes
P1T1.LAS	D:/Data/Machine 1/Project 1/RawData/p1,2/P1T2.LAS	5	2	Yes

In this example, P2T1.RD and P2T1.LAS are paired and assigned pair ID 1. P1t1.RD and P1T1.LAS are assigned to pair ID2. Files with pair ID 1 are not flagged because they have the same time stamp. However, files with pair ID 2 are flag since their time stamp are difference.

K.5.4.2 Calculating Minimum Operation Time

So how minimum operation time is calculated? The calculation assumes the equipment is allowed to free-fall with a speed of 500 feet per minute and the minimum time to move the equipment from one tube to another is one minute.

The minimum operation time(minOpTime) for the file is calculated based on the speed data in the RD file. Time elapsed per depth increment(tpdi) equals to the depth increment(di) divided by the recorded speed(speed). Total time elapsed for the file is the summation of the time elapsed per depth increment. So, the formula for minimum operation for the files is:

minOpTime = (depth / 500 ft per min + sum(di/speed) minute + 1 minute)

K.5.5 Generating Speed Data CSV Files (speeddata_parser.inc.php)

This file is developed to generate two CSV files. One of them contains a list of paired RD files along with their identifying meta data, speed data, and some statistical values on the speed data. The other CSV file contains a list of LS files along with similar attributes of the other CSV files. The purpose of the CSV file is to assist the GamDat team to look at the speed data from a statistical point of view and to try to come up with more sophisticated criteria for flagging time stamp irregularity in GGL data files. However, this PHP file itself does not attempt to flag files.

K.5.5.1 Generating CSV File for Paired RD Files

Code for Generating CSV for Paired RD Files

```
require_once('includes/speeddata_parser.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

read_speedinfo_rd();
```

The process of generating the CSV file for paired RD files is as follows:

1. Select RD files from table ggl_data_file; for each selected RD files
2. Read meta-data of the RD file from its file path
3. Read depth data from the RD file
4. Calculation total depth
5. Read speed data from the RD file
6. Calculate mean, min, max, median, the number zero speed, data acquisition time from the speed data
7. Write meta-data and calculated data to rddata.txt

K.5.5.2 Generating CSV File for LS Files

Code for Generating CSV File for LS Files

```
require_once('includes/speeddata_parser.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

read_speedinfo_ls();
```

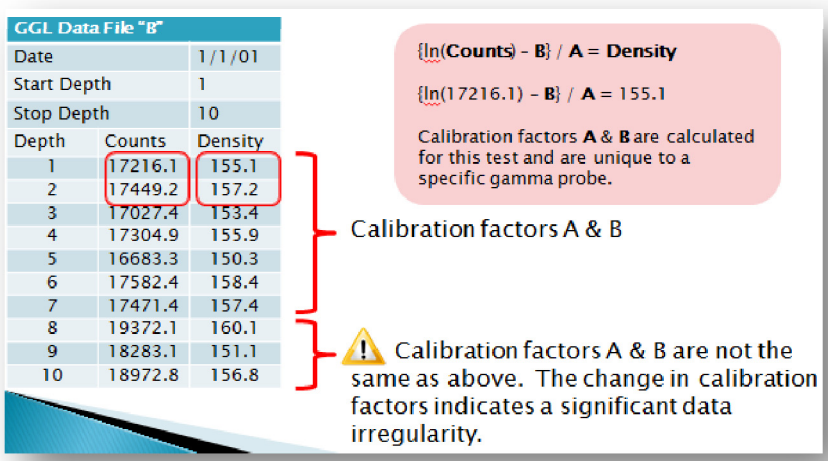
This process is simliar to generating the CSV file for RD files. The only different is that the process is working with LS data, not RD data.

K.5.6 Calibration Consistency Analysis (calibration_const_check.inc.php)

K.5.6.1 Background

There are four columns of data in LAS and Log Shell files, including depth, raw gamma count, dead time correct gamma count, and density. Density is a function of dead time corrected gamma count (DTC count) with two constants coefficients, A and B. The function is:

$$Density = \{ln(DTC\ count) - B\} / A$$



GGL Data File "B"

Date		1/1/01
Start Depth		1
Stop Depth		10
Depth	Counts	Density
1	17216.1	155.1
2	17449.2	157.2
3	17027.4	153.4
4	17304.9	155.9
5	16683.3	150.3
6	17582.4	158.4
7	17471.4	157.4
8	19372.1	160.1
9	18283.1	151.1
10	18972.8	156.8

K.5.6.2 The Analysis

Code for Executing Calibration Constant Analysis

```
require_once('includes/calibration_const_check.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

checkCalibrationConstant();
```

File *calibration_const_check.inc.php* is developed to perform *Calibration Constant Analysis* on each parsed LAS and Log Shell files in the phonebook.

1) Perform statistical least-squares regression method on *entire set of data* to establish "regressed calibration coefficients".
    a. Take the natural log of each reported gamma count value (C_{LnR}).
    b. Use C_{LnR} values as the known y-values in the regression.

c. Use reported density (γ_R) values as the known x-values in the regression.
d. The regressed coefficient 'a' is the slope of the best fit C_{LnR}-γ_R line.
e. The regressed coefficient 'b' is the intercept of the best fit C_{LnR}-γ_R line.

2) Establish a 'computed density value (γ_C)' using regressed calibration coefficients for each reported measurement.
   a. The equation form to compute (γ_C) for each depth interval (i) is:

$$\gamma_{C(i)} = (C_{LnR(i)} - b)/a$$

3) Calculate the difference ($\gamma_{C\text{-}R(i)}$) between computed density ($\gamma_{C(i)}$) and reported density ($\gamma_{R(i)}$) for each reported measurement.

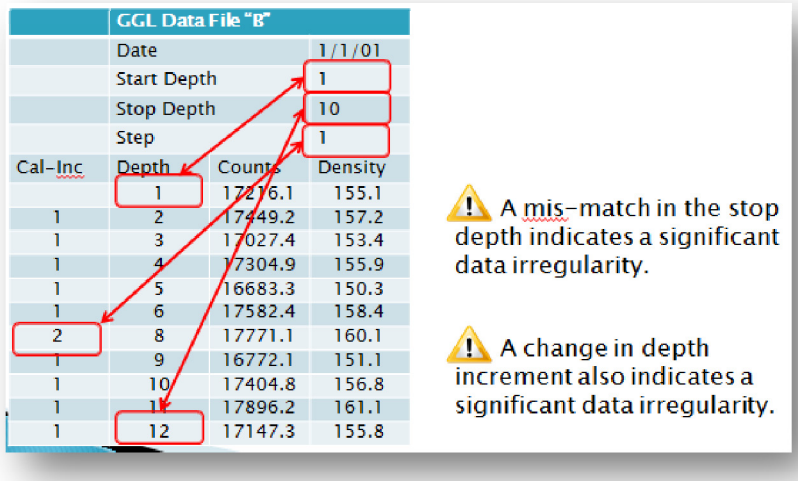
4) Establish the maximum and minimum difference values (Min $\gamma_{C\text{-}R}$, Max $\gamma_{C\text{-}R}$) for the entire set of difference values ($\gamma_{C\text{-}R(i)}$).

5) Set "Calibration Analysis Flag" based on whether maximum and minimum difference values are within or beyond an acceptable threshold range. The threshold is currently set to be the round-off error in reported density value (which varies by GGL software).
   a. Default value for Calibration Analysis Flag is "N"
   b. Change value of Calibration Analysis Flag to "Y" if either:
      i. For <u>LAS</u> files:
         1. Min $\gamma_{C\text{-}R} < -0.001$ lb/cf
         2. Max $\gamma_{C\text{-}R} > +0.001$ lb/cf
      ii. For <u>LogShell</u> files:
         1. Min $\gamma_{C\text{-}R} < -0.01$ lb/cf
         2. Max $\gamma_{C\text{-}R} > +0.01$ lb/cf

K.5.7 Depth Consistency Analysis (depth_consistancy_check.inc.php)

K.5.7.1 Background

For LAS files, start depth and stop depth values are written at the top of the files. These values should match with the depth column's first and last value respectively. Also, depth values in the depth column should decrement in a constant rate. The constant rate should also match with the recorded rate written at the top of the files.



	GGL Data File "B"		
	Date		1/1/01
	Start Depth		1
	Stop Depth		10
	Step		1
Cal-Inc	Depth	Counts	Density
	1	17276.1	155.1
1	2	17449.2	157.2
1	3	17027.4	153.4
1	4	17304.9	155.9
1	5	16683.3	150.3
1	6	17582.4	158.4
2	8	17771.1	160.1
1	9	16772.1	151.1
1	10	17404.8	156.8
1	11	17896.2	161.1
1	12	17147.3	155.8

K.5.7.2 The Analysis

Code for Executing Depth Consistency Analysis

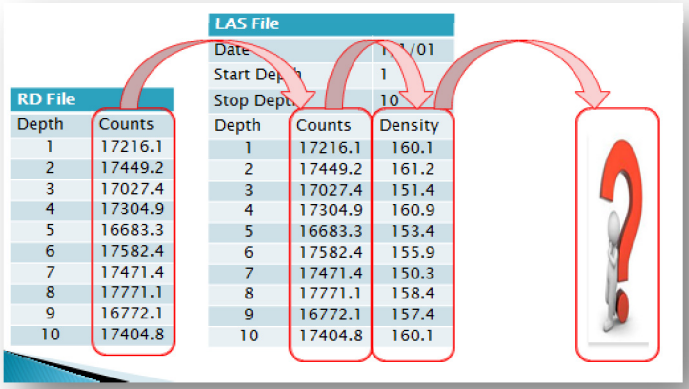
```
require_once('includes/depth_consistancy_check.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

checkDepthConsistancy();
```

File *depth_consistancy_check.inc.php* is developed to perform *Depth Consistency Analysis* on parsed LAS files. Each parsed LAS file is analyzed independently.

1. Select data from LAS data table.
2. Extract start and stop values from depth column.
3. Set potential irregularity flag for the file if the extract start and stop values do not equal to the value on the top of the files.
4. If step 3 did not set the flag, continue to verify the depths values are constantly incremented.
5. Try to identify potential irregularity
6. 1) If the recorded rate value is 0 and different depth values are found within the file, set potential irregularity flag.
   2) Else if the recorded rate is non-zero, for each two adjacent depth values
      a. Obtain the smaller precision value of the two depth values
      b. Calculate the incremented depth by subtracting the larger value to the smaller value
      c. Round the incremented depth using the obtained precision value
      d. Round the recorded rate value using the obtained precision value
      e. Set potential irregularity flag if the rounded incremented value does not equal to the rounded precision value.

K.5.8 Fidelity Analysis (fidelity_check.inc.php)

K.5.8.1 Background



GGL Data should be traceable throughout its lifecycle, from original data collection through to final reported results.

Raw gamma counts in RD files are transited to their corresponding paired LAS files. Dead time corrected gamma counts and density values are calculated from raw gamma counts using a standard formula across all files. However, since dead time corrected gamma count to density value analysis results can be obtained by the Calibration Constant Analysis, this part of the analysis is not included in this Fidelity Analysis. Fidelity automation feasibility from LAS to excel, origin, and report is still undetermined. This analysis is performed on non-cataloged unique LAS files with LAS-RD pair IDs.

Code for Executing Fidelity Analysis for RD-LAS

```
require_once('includes/fidelity_check.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

checkFidelityByPairID();
```

K.5.8.2 RD Raw Count – LAS Raw Count

1. Select RD raw count and LAS raw count from the database
2. Set irregularity flag for the pair if RD raw count string without null values does not equal to LAS raw count string without null values.

K.5.8.3 LAS Raw Count – DTC Count

1. Proceed with this check if the pair of LAS and RD is not flagged by RD Raw Count – LAS Raw Count
2. For each LAS raw count and LAS DTC count pair
    a. Obtained a precision value using the DTC count
    b. Calculate a DTC count from the raw count using formula:

    Calculated DTC Count = raw count / (1 – raw count * 0.00000625)

    c. Round the calculated DTC count using the obtained precision value
    d. Set irregularity flag if the rounded calculated DTC count does not equal to the recorded DTC count

K.5.8.4 DTC Count – Density

This is checked by Calibration Constant Analysis.

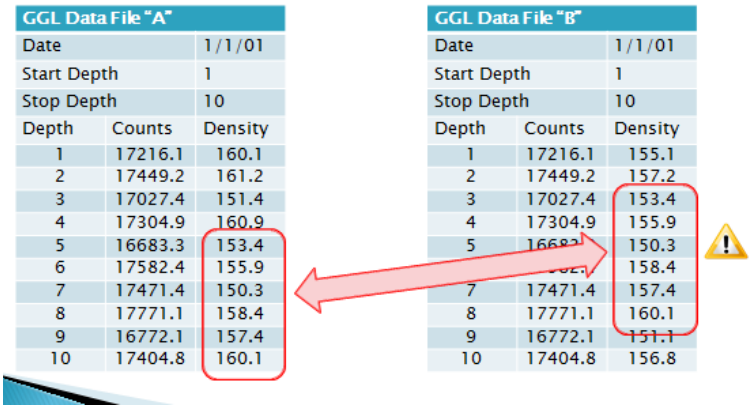
K.5.9 Pattern Matching (pattern_match_new.inc.php)

K.5.9.1 Background

A sequence of density measurements, minimum number of data points for LAS is 3 whereas for LogShell is 4, from file "A" found in file "B" or found within file "A" indicates a significant data irregularity.

This analysis is performed on parsed LAS and Log Shell files. Files are not matched across different file types. Patterns with more than 1 occurrence are flagged. Shorter patterns that have greater number of repeats than the longer patterns they are in are flagged as individual repeated patterns.

Due to the large size of the data set, pattern matching can be very time-consuming, in the order of months. Preprocessing to eliminate files without repeated pattern of any length is a must. File *pattern_match_new.inc.php* is created to perform the *Pattern Matching*.



GGL Data File "A"		
Date		1/1/01
Start Depth		1
Stop Depth		10
Depth	Counts	Density
1	17216.1	160.1
2	17449.2	161.2
3	17027.4	151.4
4	17304.9	160.9
5	16683.3	153.4
6	17582.4	155.9
7	17471.4	150.3
8	17771.1	158.4
9	16772.1	157.4
10	17404.8	160.1

GGL Data File "B"		
Date		1/1/01
Start Depth		1
Stop Depth		10
Depth	Counts	Density
1	17216.1	155.1
2	17449.2	157.2
3	17027.4	153.4
4	17304.9	155.9
5	[illegible]	150.3
[illegible]	[illegible]	158.4
7	17471.4	157.4
8	17771.1	160.1
9	16772.1	151.1
10	17404.8	156.8

Code for Executing Pattern Matching for LAS Files

```
require_once('includes/pattern_match_new.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

$matching = new PatternMatcher('las', 3);
$matching->matchMatchable();
```

Code for Executing Pattern Matching for LS Files

```
require_once('includes/pattern_match_new.inc.php');
require_once('includes/database.inc.php');
require_once('includes/util.inc.php');

$matching = new PatternMatcher('ls', 4);
$matching->matchMatchable();
```

K.5.9.2 Preprocess Data Collection

Pattern Matching Example Files				
File_0	File_1	File_2	File_3	File_4
A	B	A	B	B
B	C	B	C	K
C	D	C	D	D
	D	D	F	O
	A			
	F			

In this example, FILE_0, FILE_1, FILE_2, FILE_3, FILE_4 are the file IDs for the some LAS files. The letters represent the density values. For instance, FILE_0 has density values of A, B, and C.

1. Output minimum match length strings to a single text file. For each file,
    a. Split the density string into smaller strings of consecutive minimum number of points.
    b. Append the smaller strings to the output text file along with the file's file id.

Output File
FILE_0 A,B,C
FILE_1 B,C,D
FILE_1 C,D,D
FILE_1 D,D,A
FILE_1 D,A,F
FILE_2 A,B,C
FILE_2 B,C,D
FILE_3 B,C,D
FILE_3 C,D,F
FILE_4 B,K,D
FILE_4 K,D,O

After step 1, density string of three consecutive density values are created and stored into the Output Text File. For instance, lines 2, 3, 4, 4 are created using FILE_1 with density string A,B,C,D,E,F,G. Each line in the Output Text File is a pair of file ID and the string of three consecutive density values.

2. Perform an n-way external merge sort on the smaller strings in the text file.
    a. Sort the text file by smaller strings.
    b. Output the sorted strings to a text file.

Sorted File
FILE_0 A,B,C
FILE_2 A,B,C
FILE_1 B,C,D
FILE_2 B,C,D
FILE_3 B,C,D
FILE_4 B,K,D
FILE_1 C,D,D
FILE_3 C,D,F
FILE_1 D,A,F
FILE_1 D,D,A
FILE_4 K,D,O

After step 2, the output text file is sorted by the strings in ascending order.

3. Obtain "match-able" files that have the same smaller strings.
    a. Iterate through the sorted strings.
    b. Store the file ids in an array if any two adjacent strings are equal.

Match-able Files
FILE_0
FILE_1
FILE_2
FILE_3

After step 3, an array of "match-able" files are identified. In the sorted text file, string A,B,C occurs in both FILE_0 and FILE_2, and so FILE_0 AND FILE_2 are classified as "match-able". FILE_1 and FILE_3 are "match-able" because of string B,C,D.

K.5.9.3 The Pattern Matching

"Match-able" Files and Strings:

FILE	STRING
FILE_0	A,B,C
FILE_1	B,C,D,D,A,F
FILE_2	A,B,C,D
FILE_3	B,C,D,F

1. Cache the file data from the files obtained in step 3. For each "match-able" files,
2. Continue to step 3 through step 6 if the density string is not previously matched as part of any found patterns for each of density string from the cached files. Otherwise, skip step 3 through step 6.
3. Obtain the number of repeats and the files where the repeat occurs for the whole density string by comparing the whole string with all other density strings in the cached files
4. Flag the density string as a repeated pattern if the total number of repeats is greater than 1.

PROCESSING	PATTERN	NUM REPEATS	IN FILES	FLAG
FILE_0	A,B,C	2	FILE_0,FILE_2	YES
FILE_1	B,C,D,D,A,F	1	FILE_1	NO
FILE_2	A,B,C,D	1	FILE_2	NO
FILE_3	B,C,D,F	1	FILE_3	NO

Pattern A,B,C is immediately flagged as repeated pattern since the pattern is the full density string in FILE_0 and the pattern shows up in more than one file. Occurrences of the pattern are in FILE_0, FILE_3.

5. Obtain positions that begins a repeated pattern of minimum required length(3 for LAS, 4 for LS) from the density string
    a. Split the density string into smaller strings of consecutive minimum number of data points.
    b. Store the position value into an array if the smaller string that begins with the position has a total number of repeats that is greater than the total number of repeats of the whole density string.

PROCESSING	INDEX	PATTERN	NUM REPEAT	OBTAINED INDEX
FILE_0	0	A,B,C	2	YES
FILE_1	0	B,C,D	3	YES
	1	C,D,D	1	NO
	2	D,D,A	1	NO
	3	D,A,F	1	NO
FILE_2	0	A,B,C	1	NO
	1	B,C,D	2	Yes
FILE_3	0	B,C,D	1	NO
	1	C,D,F	1	NO

6. Search for patterns from the positions obtained in step 5.
    a. Set previous pattern ending position to 0, and set total number of repeats for previous pattern to 0.
    b. Process the position if (previous ending position – the minimum matching number) is less than the position OR if the number of repeats of the minimum number of data points for the position is different from the number of repeats for the previous processed position.
        i. Set current match length to the minimum number + 1
        ii. Set the number of repeats to the number of repeats for the position
        iii. Done with the position if current position plus current match length is greater than the length of the complete density string. If not, continue to step iv.
        iv. Build new sub string with the new length
        v. Set ending position to current position plus current match length.
        vi. Obtain repeat information for the new sub string
        vii. If the number of repeats of the new sub string is less than the number of repeats,
            1. Flag the pattern that begins with the processing position and ends with processing position plus current match length minus 1.
            2. Set the number of repeats to the number of repeats of the new sub string
        viii. Add one to the current match length
        ix. If the processing position plus current match length minus 1 equals the length of the density string,
            1. Build new sub string from the processing position to the end of the density string

2. Flag the new sub string if its number of repeats is greater than 1.
3. Set ending position to density string length.

x. Repeat iii to ix.

Note: Step 5 is using the following sets of data to better illustrate the process.

Example #1:

Three files are analyzed:

FILE	STRING
FILE_0	A,B,C,D,E,F,G,L,M,N
FILE_1	A,B,C,D,E,F,G
FILE_2	L,M,N

In this example, there are three files and their corresponding density value strings. Status after Step 5:

PROCESSING	INDEX	PATTERN	NUM REPEAT	OBTAINED INDEX
FILE_0 With Whole Sting: A,B,C,D,E,F,G, L,M,N; Number of Repeat: 1	0	A,B,C	2	YES
	1	B,C,D	2	YES
	2	C,D,E	2	YES
	3	D,E,F	2	YES
	4	E,F,G	2	YES
	5	F,G,L	1	NO
	6	G,L,M	1	NO
	7	L,M,N	2	YES

The analysis program is processing FILE_0. After step 5, the analysis looks patterns of 3 consecutive density value strings starting at index 0 up to the third to the last index(index 7 in this case). The analysis finds out that indexes 0,1,2,3,4 and 7 are indexes that need to be looked at further because patterns of three consecutive density strings beginning with those index occurs more than once in the data set. Results after Step 7:

Obtn INDEX	Start Index	End Index	LEN (i)	SUB STRING (iv)	REPEATS (vi)	FLAGED (vii)
0	0	2	3	A,B,C	2	NO
	0	3	4	A,B,C,D	2	NO
	0	4	5	A,B,C,D,E	2	NO
	0	5	6	A,B,C,D,E,F	2	NO
	0	6	7	A,B,C,D,E,F,G	2	NO
	0	7	8	A,B,C,D,E,F,G,L	1	FLAG LEN 7
7	7	9	3	L,M,N	2	NO
	7	10	4	L,M,N,(END)	1	FLAG LEN 3

For FILE_0 again, the analysis realizes indexes 0,1,2,3,4, and 7 are the indexes that need to be looked at further. Starting from index 0, strings with length 4,5,6,7 do not signal any flagging because they all have the same number of repeats with the strings with one less in length. However, string with length 8 signals a flag because the string length 8 has less repeat than string with length 7. Thus, pattern A,B,C,D,E,F,G is flagged with 2 repeats, the analysis also mark the end index to 7, which is the end index of the string that signals the flag. The analysis

continues to the next obtained index since string with length 8 has the same number of repeats as the whole density string.

Index 1,2,3,4 are skipped because their numbers of repeat are the same as the number of repeat s of the previous flagged pattern, and they are within the range of the previous flagged pattern.

Index 7 is processed because the index is outside of the range of the previous flagged pattern. Pattern L,M,N is flagged because the end of file is reached.

Example #2:

Three files are analyzed:

FILE	STRING
FILE_0	A,B,C,D,E,F,G,L,M,N
FILE_1	A,B,C,D,E,F,G,L
FILE_2	E,F,G,L,M,N

In this example, there are also three files. Overlapped repeated patterns are found within these files. Results after Step 5:

File	INDEX	PATTERN	NUM REPEAT	OBTAINED INDEX
FILE_0	0	A,B,C	2	YES
	1	B,C,D	2	YES
	2	C,D,E	2	YES
	3	D,E,F	2	YES
	4	E,F,G	3	YES
	5	F,G,L	3	YES
	6	G,L,M	2	YES
	7	L,M,N	2	YES

Indexes 0 through 7 are indexes that need to be looked at for FILE_0. Results after Step 7:

FILE	INDEX	STRT INDEX	END INDEX	LEN (i)	SUB STRING (iv)	REPTS (vi)	FLAGED (vii)
FILE_0	0	0	3	4	A,B,C,D	2	NO
		0	4	5	A,B,C,D,E	2	NO
		0	5	6	A,B,C,D,E,F	2	NO
		0	6	7	A,B,C,D,E,F,G	2	NO
		0	7	8	A,B,C,D,E,F,G,L	2	NO
		0	8	9	A,B,C,D,E,F,G,L,M	1	FLAG LEN 8
	4	4	7	4	E,F,G,L	3	NO
		4	8	5	E,F,G,L,M	2	FLAG LEN 4
		4	9	6	E,F,G,L,M,N	2	NO
		4	10	7	E,F,G,L,M,N,(END)	1	FLAG LEN 6

Starting from index 0, strings with length 4, 5, 6, 7, and 8 do not signal any flagging. However, string with length 9 signals to flag its previous string, A,B,C,D,E,F,G,L, because string with length 9 repeats only once. The analysis

continues to the next index since string with length 9 has the same repeating number as the whole density string, which is 1.

Indexes 1, 2, and 3 are skipped because these indexes are within the previous flagged string and their numbers of repeats are the same.

Even though index 4 is within the range of the previously flagged pattern, index 4 is not skipped because its number repeats are different from the previously flagged pattern.

For index 4, string with length 5 signals to flag string with length 4 since there is a decrease in the number of repeats between the two strings. The process continues to try longer strings since the number repeats for string with length 5 is still greater than the number of repeat for the whole density string. Then, string E,F,G,L,M,N is flagged because the end of string is reached and the number of repeat is greater than the number of repeat for the whole density string.

To summarize the result, A,B,C,D,E,F,G,L is flagged with two occurrences. E,F,G,L is flagged with three occurrences. E,F,G,L,M,N is flagged with two.

Appendix L: FTB Server Hard Drive Recovery

DriveSavers Inc.
400 Bel Marin Keys Blvd.
Novato, CA 94949

800.440.1904
415.382.2000
Fax 415.883.0780

www.drivesavers.com

1/14/2012

Saba Mohan
California Dept. of Transportation
916-227-7104
saba.mohan@dot.ca.gov
RE: JOB # P 371134

Hello Mr. Mohan,

Thank you for choosing DriveSavers for your data recovery needs for a 60GB Western Digital hard drive (serial number WD600AB-00BVA0). As you and I discussed over the phone, we regret that data recovery was not possible in this case.

This drive has suffered from severe media damage and what is known as a "head crash." This is a mechanical malfunction that causes the read/write heads to make physical contact with the surface of the disks inside the drive, leading to abrasive damage to the magnetic coating that stores the data.

Our engineers worked on the drive in our ISO 5 certified class 100 cleanroom. The lead engineer assigned to this project noted that not only did the drive have multiple "head slaps," but there were also dust rings on the outer diameter of all platters. This dust represents the actual media coating that had been scratched off the platter surface by the read/write heads and distributed by the spinning of the disks. Unfortunately, there is no way to undo this type of damage and turn that dust back into data. The lead engineer attempted to work around this failure, but the damage was too extensive to allow even a partial recovery of even a single file. These results were verified by a second senior cleanroom engineer.

The initial cause of this type of sudden failure is usually unknown but the most common causes are power surges, power sags or overheating. Again, we regret that we do not have better news for you. Thank you again for giving us an opportunity to work on this drive. If you have any questions please feel free to contact Customer Service at 800-609-2301.

Best Regards,

Rebecca Patrascu
Customer Service Manager
DriveSavers Data Recovery, Inc.
800.609.2301
rebecca.patrascu@drivesavers.com

cc: Hubert Law, Earth Mechanics

Western Digital
www.westerndigital.com
WD Caviar ™
Enhanced IDE Hard Drive
WD1200
Drive Parameters: LBA 234441648 ■ 120.0 GB
S/N : WMA8C1356973
5VDC 0.80A
12VDC 0.45A
MDL : WD1200BB-00CAA0
DATE: 25 DEC 2001
DCM : HSEANV2AH
Product of Malaysia
Product warranty will be void if seal, label or cover is removed or damaged
WD P/N: WD1200BB-00CAA0
J6 JUMPER SETTINGS
40 Pin Conn.
POWER
CABLE SELECT SETTING
Standard Settings
Master Single
Slave Present Master
LR68850
E101559
N3565
APL
FTB Server Data
Removal Date:
-Unable to xfer data w/USB interface
3/2007
(mdl)

Western Digital
www.westerndigital.com
WD Caviar ™
Enhanced IDE Hard Drive
WD600
Drive Parameters: LBA 117231408 ■ 60.0 GB
S/N : WMA7E1038194
5VDC 0.63A
12VDC 0.35A
MDL : WD600AB-00BVA0
DATE : 06 FEB 2001
DCM : HSBABT2AA
Made in Malaysia
Product warranty will be void if seal, label or cover is removed or damaged
WD P/N: WD600AB-00BVA0
J6 JUMPER SETTINGS
40 Pin Conn.
POWER
Most drives are shipped with a jumper as shown above. No need to remove for single drive setting
Standard Settings
Slave Master Single
LR68850
E101559
N3565
APL
FTB Server Data Drive F:
Removed
-Unable to xfer data

Appendix M: January 2009 FTB Investigation Report

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. MARK WILLIAN
Chief, Office of Geotechnical Support

Date: January 20, 2009

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – MS 5

Subject: Results of Investigation of Gamma–Gamma Logging Test Data for Duane Wiles Pursuant to Data Fabrication Incident of September 19, 2008

The investigation of Duane Wiles regarding the potential fabrication of Gamma-Gamma Logging (GGL) test data revealed that no other incidences of impropriety exist other than the singular event of September 19, 2008. Since the fabrication event of September 19, 2008 was detected before any report was issued, no falsified data was reported by this office to contractors.

The investigation consisted of two portions, a multi-year overview of GGL test data for internal consistency and an intensive analysis of data collected in 2008. Each utilized the passive time stamps that the Windows operating system automatically places into files being created or modified. This review was to verify the assertion by Mr. Wiles that the event of September 19, 2008 was a singular event without precedence.

For the multi-year overview, Michael Morgan from the Foundation Testing Branch analyzed the test archives for all piles to examine dates of creation and modification. Specifically, since all tubes of an individual pile are collected on a single day, all of the tubes should have the same creation date. If a subsequent modification of one of the data sets had taken place, then certain individual tubes would reveal a different date. This is one of the means that showed that the data of September 19, 2008 did not appropriately pair with the originally collected data. The analysis by Michael Morgan revealed only a few piles of interest, all of which were adequately explained by valid retesting of piles for blocked tubes or water within the tubes. Mr. Morgan's analysis was not limited to work performed by Mr. Wiles, so his check verifies the integrity of all of the Gamma-Gamma Logging data collected by the Branch.

The intensive analysis of Duane Wiles Gamma-Gamma Logging work was performed by Tejinderjit Singh of the Foundation Testing Branch. All of the projects worked on by Duane Wiles in the previous 18 months to the incident were reviewed and the GGL test data extracted. The time stamp of the test data was compared against the date that pile was tested according to Mr. Wiles' contemporaneous handwritten Daily Field Reports. In all cases except one, the Daily Field Reports matched exactly against the test data. In the one final case, the date on the Daily Field Report was determined to be likely in error, as the day of the week did not match the date, but was consistent with

"Caltrans improves mobility across California"

the collected data. As such, the conclusion is that this was an error in the Daily Field report when collecting the data.

During the course of the investigation, one additional problem was brought to light. It does not directly involve the integrity of the Gamma-Gamma Logging data. In preparation for performing Gamma-Gamma Logging in the field, technicians perform a probe functionality test as required by California Test Method 233. For most of 2006 and into 2007, it appears as if Mr. Wiles either did not perform functionality test or did not keep a regular record of them. This is a concern for both compliance with the applicable test method and keeping complete and accurate records for each gamma-gamma test performed.

Appropriate efforts will be made to ensure that Mr. Wiles is aware of the unacceptable nature of his behavior in these instances. Additionally, corresponding disciplinary actions are being pursued.

If you have any questions or comments regarding this report, please contact me at (916) 227-1000.

BRIAN LIEBICH, P.E.
Senior Transportation Engineer
Foundation Testing Branch
Office of Geotechnical Support

BAL/

Appendix N: November 2011 FHWA Investigation Report

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **ACTION:** Gamma Gamma Testing
Review of Caltrans Records

Date: 11-17-11

From: Bill Forrester Jr.
Director, Office of Infrastructure
Sacramento, California

In Reply Refer To:
HAD-CA

To: Mr. Vince Mammano
Division Administrator

My staff was involved in analyzing the statewide Gamma Gamma Logging test data that was provided by Caltrans for the period of 2005-2010. We performed a data query of the subject data (searching for repeating data strings in multiple files) and were able to determine the following based on that analysis:

- The SFOBB test data for the SAS Tower foundation T1 was included in our data analysis and we did not find any duplication of data.
- We did find three statewide locations that had data duplication and it is our understanding that Caltrans found these three locations as well:
  - 56C-0045 La Sierra Overhead
  - 53-1258 Braddock Drive UC
  - 33-MI-580 OH Sierra.

We are in the process of finalizing our report that summarizes the review of the Caltrans Foundation Testing Branch and anticipate finalizing it in the next couple of weeks.

Sincerely,

Bill Forrester Jr.

Appendix O: Transportation Pooled Fund Study Solicitation

Information obtained on the National Cooperative Highway Research Program's website (http://www.pooledfund.org/Details/Solicitation/1321) about the TPF solicitation, accessed January 9, 2013, is presented below.

TRANSPORTATION POOLED FUND PROGRAM

Username: Password: Login

Forgot your username or password? What is an authorized user?

Home | About TPF | How to Participate | Open Solicitations | Search | Forms | Success Stories | Related Links | Email Alerts

Home > Search Solicitations and Studies > Solicitation Detail View

Solicitation Detail View

A Peer Exchange and Review of Deep Foundation Testing Methodologies at Caltrans

General Information

Solicitation Number: 1321

Status: Cleared by FHWA

Last Updated: Mar 8, 2012

Solicitation Expires: Mar 31, 2012

Lead Agency: Federal Highway Administration

Contact Information:

Lead Agency Contact:

Silas Nichols
silas.nichols@dot.gov
Phone: 202-366-1554

FHWA Technical Liason(s):

Silas Nichols
silas.nichols@dot.gov
Phone: 202-366-1554

Financial Summary:

Commitment Start Year: 2012

Commitment End Year: 2012

Commitments Required: $120,000.00

Commitments Received: $120,000.00

Commitments by Organization:

Agency	Year	Commitments
California Department of Transportation	2012	$120,000.00

Study Description

Background:

Caltrans has a history of adopting new technologies and methodologies to evaluate foundations on their construction projects; this is particularly true for deep foundations. Some of their current test methods,

practices and procedures are to use both gamma-gamma logging (GGL) and crosshole-sonic logging (CSL) to accept cast-in-drilled-hole (CIDH or drilled shafts) constructed in wet conditions.

In an effort to keep with the tradition of adopting new technologies, Caltrans proposes this peer exchange and GGL data review as an opportunity to improve their practices.

Objectives:
There are two objectives of this study; first to perform a peer review of the Caltrans Geotechnical Services Foundation Testing Branch (FTB). This review will evaluate current practices used to for deep foundations (piles) on Caltrans construction projects. Some of the current test methods, practices and procedures include gamma-gamma logging (GGL); crosshole sonic logging (CSL); pile load testing, Pile Driving Analyses ,Sonic Caliper Testing and Vibration Monitoring.
Information to be reviewed includes current operational practices and procedures associated with managing the testing program, conducting the tests, and managing the analysis and reports generated for Caltrans projects. In addition to reviewing Caltrans current practice, the review will identify best practices and improvements that can be made to the current methodologies used to accept deep foundations. Included in this effort will be the identification of new technologies that should be considered by Caltrans for adoption.

The second objective of this review effort is to be available to provide advice to the Department regarding their continuing effort of reviewing existing GGL data and to evaluate processes for adequacy.

Scope of Work:
For the first objective in this study, the peer review panel consisting of both national and State DOT experts will be assembled to review Caltrans current test methods, practices and procedures for foundation testing that includes test methods used, record archiving, policy and procedure manuals used, training of staff and other relevant information that will facilitate the review so that best practices and recommendations for improvement can be identified. In addition to reviewing information, the panel will interview Caltrans and Industry staff from construction, structures construction, bridge design, and geotechnical services. The peer review panel will also draw on personal expertise and familiarity with the industry to make recommendations for new technologies and methodologies for Caltrans to evaluate and possibly adopt into practice.

With regard to objective two, Caltrans is currently assembling a comprehensive set of existing GGL data. The analysis of this data will identify irregularities, strengthen the management of data integrity, and improve the current GGL data collection process. The peer review panel will review the methodology used for this Caltrans effort and be available to provide advice.

Comments:
Benefits:
Caltrans, and other states, will be able to improve the methods and procedures used to evaluate foundations constructed on their projects. This will improve the quality of deep foundations testing methods, practices and processes.

Time Schedule:
The first objective, the peer exchange, of this study will take place from February 4, 2012 to April 30, 2012. The target date for the final report is May 1, 2012. The second objective, GGL data analysis, will start on February 4, 2012 and is expected to take approximately six months.

Deliverables:
There will be a report that documents the review process and identifies best practices and recommendations for improvement that relate to the Caltrans Foundation Testing Branch and the practices used to both evaluate deep foundations and manage the overall testing and acceptance program.

Documents:

Title	Type	Private
Detailed Study Description: A Peer Exchange and Review of Deep Foundation Testing Methodologies at Caltrans	Other	N

Appendix P: Manual Analysis Documentation

A full list of all 100 Manual Analysis IDs is summarized in the table below. The eleven Manual Analysis IDs that became cases are highlighted. More detailed documentation for each can be found after the table.

Manual Analysis ID	Description	Foundation or Test Location
ID-1	LAS header modified	28-0153, Benicia-Martinez
ID-2	**Qualification Testing of FTB Standard Reference Blocks**	**Standard Reference Blocks**
ID-3	GGL Consultant LAS & LS calibration and output format	Various
ID-4	**Manual alteration of density and count data in calibration file**	**Calibration**
ID-5	Depth in header not matching data block	23-0215, Benicia-Martinez, Bent 20, Right Pile, Tube 4
ID-6	(Included in ID-51)	N/A
ID-7	RD-LAS fidelity issue	26-0050, Dry Creek, Pile 7, Tube 1
ID-8	(Included in ID-2)	N/A
ID-9	Depth in Header Not Matching Data Block	53-2918, Rte 57 and 60 HOV Brea, Bent 18, Tube 7
ID-10	**Irregular testing chronology**	**56-0802F, SE Connector, Bent 15**
ID-11	**Irregular testing chronology**	**57-1134, Lake Hodges Abut 6, Piles 1-5**
ID-12	**Previously identified falsification case**	**580 OH Sign #19**
ID-13	**Previously identified falsification case**	**56C0571, La Sierra OH**
ID-14	Files opened & saved in Excel but no data integrity compromises	Various
ID-15	(Included in ID-2)	N/A
ID-16	(Included in ID-21)	N/A
ID-17	**Irregular testing chronology**	**28-0153, Benicia-Martinez, Pier 6, Pile 5, Tube 4**
ID-18	**File Rename**	**53-1403, Sawtelle Blvd, Abut 1L, Piles 69 and 72**
ID-19	File rename	57-1177G, N125-W54 Conn Sweetwater, Bent 4, Pile 3
ID-20	LAS file header edited and data removed	57-1133, Green Valley Cr I-15, Abut 4, Pile 5
ID-21	Corrupted or truncated LAS and LS files are flagged	Various
ID-22	Calibration Constant irregularity, low counts	28-0100, Richmond San Rafael, Bent 4, Pile L
ID-23	RD-LAS Timestamp	34-0126RL, SFOBB, Stage 5, Bent 5L, Pile 3, Tube 1
ID-24	(Files flagged from prior analysis)	N/A
ID-25	Modified LAS file	53-2917 Brea Cyn Rd UC Onramp, Anchor Pile 1
ID-26	Pattern Match in file pairs	34-0126RL SFOBB Mainline Structure, Bents 4L, 6L, 7L
ID-27	Files opened, annotated, & saved in Excel but no data integrity compromises	Various
ID-28	(Included in ID-31)	N/A
ID-29	Single data point removed from LAS file	Functionality
ID-30	File contains only one row of data	Various
ID-31	LAS files with extra row of data at end	Various
ID-32	Depths Not Constantly Incremented-RD Files Exist	Various
ID-33	**(a) Depths Not Constantly Incremented - No RD Files** **(b) Possible tube retest**	**(a) Various** **(b) 28-0153, Benicia-Martinez, Pier 12, Pile 6**
ID-34	Header Start /Stop Depths do not match data block	26-0050, Dry Creek
ID-35	(Included in ID-30 and ID-51)	N/A
ID-36	(Included in ID-2)	N/A
ID-37	Calibration / Qualification Files Flagged For depth irregularity	Calibration
ID-38	(Included in ID-5)	N/A
ID-39	(Included in ID-21)	N/A
ID-40	(Included in ID-30)	N/A
ID-41	RD-LAS Time Discrepancy	56-0802F, SE Connector SB215-EB215, Bent 11
ID-42	RD-LAS Date Discrepancy	57-1134, Lake Hodges, Pier 3R, Right Pile
ID-43	Files renamed to include the location information	Various
ID-44	File opened/closed and new file extension added	33-0061LR, Oakland Separation Distribution Structure
ID-45	Filename changed to identify issue with file or retest	Various
ID-46	Windows to DOS 8.3 filename conversion files flagged	Various
ID-47	Windows backup or restore files flagged	Various
ID-48	(Included in ID-2)	N/A
ID-49	(Included in ID-20)	N/A
ID-50	Null values in data files causing analysis flags	Various
ID-51	Rows of data above top of concrete deleted	57-1134, Lake Hodges, Pier 4, Right Pile
ID-52	**Previously identified falsification case, file rename**	**53-1258, Braddock Dr. UC, P50 P51**

Manual Analysis ID	Description	Foundation or Test Location
ID-53	Files from initial investigation flagged	Various
ID-54	Analysis of RD-LAS Timestamp Discrepancies Under 2 minutes	Various
ID-55	RD-LAS Timestamp Discrepancies	34-0126RL, SFOBB West Approach, B4L, B6L, B7L
ID-56	LogShell files with low count data flagged	Various
ID-57	(Included in ID-56)	N/A
ID-58	(Included in ID-50)	N/A
ID-59	RD-LAS Time Discrepancy	57-1134, Lake Hodges, B4RT1
ID-60	RD-LAS Timestamp Discrepancy	Various
ID-61	RD-LAS Timestamp Comparison Replayed RD Files, No Data Editing	Various
ID-62	RD-LAS Timestamp Discrepancy; Tube Retested	Marysville Maintenance Station Communication Tower
ID-63	File renamed to correct location information	Various
ID-64	File renamed to include Tube number.	Various
ID-65	Files renamed to indicate subsequent iteration of testing.	Various
ID-66	No data below header - associated as "Renamed."	Various
ID-67	(Included in ID-47)	N/A
ID-68	File name changed to include date information.	Various
ID-69	File rename as result of null value problem.	Various
ID-70	Renamed files requiring red folder follow up.	Various
ID-71	Data In LAS-RD Pair Does Not Match	53-1403, Sawtelle Blvd, 435Bp4t3
ID-72	RD-LAS Files Flagged for Timestamp Diff of less than 4 minutes	Various
ID-73	File renamed upon receipt by Engineer	Various
ID-74	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez
ID-75	Irregular testing chronology (RD files)	57-1133, Green Vly I-15 Managed Lanes, Abut 4 Piles 3&4
ID-76	**(a) Irregular testing chronology (RD files) (b) Duplicated Data in Excel file**	**28-0153, Benicia-Martinez, Pier 14, Pile 8**
ID-77	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 15, Pile 6
ID-78	Irregular testing chronology (RD files)	34-0006, SFOBB, T1, Pile 2A
ID-79	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 8, Pile 1, Tube 4
ID-80	Irregular testing chronology (RD files)	23-0212G, N680-W780 Connector OH, Bent 18, Pile 5
ID-81	Irregular testing chronology (RD files)	57-1134RL, Lake Hodges, P3 T6
ID-82	Irregular testing chronology (RD files)	23-0212G, N680-W780 Connector OH, Bent 18, Pile 4
ID-83	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 14, Pile 6
ID-84	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 14, Pile 4
ID-85	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 12, Pile 1
ID-86	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 16, Pile 6
ID-87	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 8, Pile 5
ID-88	Irregular testing chronology (RD files)	34-0006, SFOBB, T1, Pile 5
ID-89	Irregular testing chronology (RD files)	34-0006, SFOBB, T1, Pile 3
ID-90	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 11, Pile 8
ID-91	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Pier 10, Pile 3
ID-92	Irregular testing chronology (RD files)	23-0212G, N680-W780 Connector OH, Bent 18, Pile 6
ID-93	Irregular testing chronology (RD files)	23-0212G, N680-W780 Connector OH, Bent 18, Pile 2
ID-94	Irregular testing chronology (RD files)	28-0153, Benicia-Martinez, Various
ID-95	Irregular testing chronology (LS files)	Sound Wall Piles
ID-96	Irregular testing chronology (RD files); minor discrepancy in timing	Various
ID-97	RD and LS aquisition times overestimated from speed data	Various
ID-98	LS Chronology Files Flagged Due To Incorrect File Save Date and Time	Various
ID-99	Irregular testing chronology (LS files); minor discrepancy in timing	28-0153, Benicia-Martinez, Pier 9
ID-100	Irregular testing chronology (LS files); minor discrepancy in timing	Various

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **1(a-h)**

Name: **Benicia – Header Relabeling**

Status: ☐ Inactive ☒ Active ☐ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☒ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner, Zhu, Roblee **Date:** 3/2/12

Summarized by: Roblee **Date:** 12/10/12

Reviewed by: Hannenian **Date:** 11/5/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The same potential irregularity was flagged for eight separate pairs of unique GGL data files associated with testing at Pier 17, Pile 1 in Tubes 1 through 8 of the Benicia-Martinez Bridge (28-0153R) on 1/17/2004. For each LAS file pair, the entire density data sequence is identical, but a portion of the metadata in the header was modified on 1/21/2004.

Discussion of Findings

All indications are that the changes in the metadata for each file pair was a manual correction of inaccurate information within the original header of the field LAS file. It appears that the field technician(s) simply had not updated the prior jobsite information in the file header prior to testing at Pier 17, Pile 1 on 1/17/2004. It is unclear who revised the metadata, but the outcome was to have the LAS files accurately reflect actual testing location and conditions. There is no evidence to suggest that density data used for both analysis and reporting was affected in any way, thus the impact of the irregularity is considered inconsequential.

Attachment 1A illustrates key steps in the analysis of ID-1.

Fig. 1A.1 summarizes why the 'Pattern Match' analysis flagged these files and what data was altered. For each of the eight tubes tested at Pile 1 of Pier 17, a pair of files was found to have matching data. Using manual analysis ID-1a as an example, density data pattern ID 481 was found to exist in both unique LAS file 13703, last modified on 1/17/2004 at 8:26am, and unique LAS file 9788, last modified on 1/21/2004 at 8:09am. It is shown that the number of data points in the pattern equals the total number of data points in both associated data files, thus all of the density data appearing in both files in the pair are identical. Manual comparison of each file pair showed that, in each instance, a portion of the metadata in the header was modified on 1/21/2004. For each file pair, the 'Location' field was changed from "Pier 8, Pile 3" to "Pier 17, Pile 1"; the 'Date' field was changed from 1/15/2004 to

1/17/2004, and the 'Logged By' field was changed from "Wiles/Ruben" to "Wiles/Dekens". An example of the metadata changes within the LAS files for ID-1a is shown in Fig. 1A.2.

All indications are that the changes in metadata for each file pair were manual corrections of inaccurate information in the original header of the field LAS file. The daily field report for shown on left in Fig. 1A.3 indicates that testing on 1/17/2004 actually occurred at Benicia Main at Pier 17, Pile 1. All files (both RD and LAS for each pair) were stored in a directory indicating that location. The metadata in the header of the original field LAS file shows information corresponding to the prior location and date (i.e. Pier 8, Pile 3 on 1/15/2004) as indicated in the daily field report for 1/15/2004 shown on the right in Fig. 1A.3. Figure 1A.4, which presents the master list of all LAS files sorted by date, shows that no testing occurred between those dates, so the original header information was indeed associated to the last use of the equipment. Figure 1A.5, which presents the master list of all pattern match results sorted by 'unique file ID' shows that no data obtained at Pier 8, Pile 3 on 1/15/2004 appears in the data obtained at Pier 17, Pile 1 on 1/17/2004 since unique file ID's 9270-9277 do not appear in the pattern match analysis results.

In summary, although the pattern match analysis correctly identified a data irregularity (i.e. alteration of the metadata), there is no indication to suggest that density data used for analysis and reporting on concrete conditions in Pile 1 of Pier 17 was affected in any way, and the metadata changes entered on 1/21/2004 sought to correct inaccuracies in the original data so as to have the LAS files accurately reflect actual testing location and conditions.

References

- Attachment 1A: Figures for Manual Analysis of ID-1(a-h)
- GGL Report: "Gamma-Gamma Logging Acceptance Test Results: Pile 1 at Pier 17"
- GGL Report: "Gamma-Gamma Logging Acceptance Test Results: Pile 3 at Pier 8"
- Master List of GGL Files (3/20/2012 version)
- Pattern Match Analysis Results (4/13/2012 version)
- Original LAS Files for P17P1T1-8 As Recorded Upon Testing on 1/17/2004 (Unique File ID's 13703-13710)
- Relabeled LAS Files for P17P1T1-8 As Modified on 1/21/2004 (Unique File ID's 9788-9795)
- LAS Files for P8P3T1-8 As Recorded Upon Testing on 1/15/2004 (Unique File ID's 9270-9277)

Attachment 1A

Figures for Manual Analysis of ID-1(a-h)

28-0153R Benicia Martinez Main
Pile 1 at Pier 17
Testing Date: 1/17/2004

Fig. 1A.1: Documentation of File Data Consistency & Metadata Changes

Manual Analysis ID	From Pattern Match Analysis Output					MetaData Changes		
	Pattern ID	LAS Unique File ID	Pattern Data Points	LAS File Data Points	Date File Last Modified	Location	Date	Logged By
1a	481	9788	2117	2117	1/21/2004 8:09	Pier 17, Pile 1	1/17/2004	Wiles / ruben
	481	13703	2117	2117	1/17/2004 8:25	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1b	482	9789	2113	2113	1/21/2004 8:11	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	482	13704	2113	2113	1/17/2004 8:46	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1c	483	9790	2108	2108	1/21/2004 8:12	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	483	13705	2108	2108	1/17/2004 9:05	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1d	484	9791	2033	2033	1/21/2004 8:12	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	484	13706	2033	2033	1/17/2004 9:27	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1e	485	9792	1827	1827	1/21/2004 8:13	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	485	13707	1827	1827	1/17/2004 9:43	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1f	486	9793	1823	1823	1/21/2004 8:14	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	486	13708	1823	1823	1/17/2004 10:05	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1g	487	9794	2116	2116	1/21/2004 8:15	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	487	13709	2116	2116	1/17/2004 10:24	Pier 8, Pile 3	1/15/2004	Wiles / Dekens
1h	488	9795	2110	2110	1/21/2004 8:15	Pier 17, Pile 1	1/17/2004	Wiles / Ruben
	488	13710	2110	2110	1/17/2004 10:43	Pier 8, Pile 3	1/15/2004	Wiles / Dekens

Pattern match analysis (for density measurements) shows that file pairs have same number of 'Pattern Data Points' as 'LAS File Data Points'. This indicates that all density data in file pair are identical.

Extent of metadata changes identified by manual comparison of LAS files (see example on next page).

Fig. 1A.2: Example of Metadata Changes (Using Files for ID-1a)

Modified on 1/21/2004

9788.las - Notepad

```
~VERSION INFORMATION
VERS     .2.0                  :CWLS LOG ASCII STANDARD
WRAP     .NO                   :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT     .FT      214.234      :START DEPTH
STOP     .FT      3.2495       :STOP DEPTH
STEP     .FT      -0.0997092          :STEP
NULL     .        -999.25      :NULL VALUE
COMP     .        N/A          :COMPANY
WELL     .        N/A          :WELL
FLD      .        N/A          :FIELD
LOC      .        N/A          :LOCATION
PROV     .        N/A          :PROVINCE
SRVC     .        N/A          :SERVICE COMPANY
DATE     .        N/A          :LOG DATE
UWI      .        N/A          :UNIQUE WELL ID
~CURVE INFORMATION
DEPT     .FT                   :DEPTH
GAM      .CPS                  :Gam
GAM(     .CPS                  :gam(dtc)
DENS     .LBS/FT3                     :Density(dtc)
~PARAMETER INFORMATION
Dept     .                     :Depth Logger
BH F     .                     :BH Fluid
File     .        Benicia main        :File Name
COMP     .       Malclolm             :COMPANY:
Dept     .        85m          :Depth Driller
OTHE     .                     :OTHER SERVICES
Witn     .                     :witness:
Loca     .        Pier17  Pile1       :Location:
Casi     .
Date     .        1/17/2004           :Date
Well     .
Logg     .        wiles / ruben       :Logged by:
~OTHER
~A
214.234 8326     8783.05 189.939
214.134 8493.5   8969.65 188.764
214.035 8563.5   9047.75 188.28
213.935 8638.5   9131.52 187.765
213.835 8814.5   9328.41 186.573
213.736 8949     9479.18 185.677
213.636 8916     9442.16 185.896
213.536 9063     9607.19 184.928
213.436 9166     9723.01 184.258
213.337 8970.5   9503.31 185.535
213.237 9366.5   9948.92 182.975
213.137 9351     9931.43 183.073
213.038 9488.5   10086.7 182.206
```

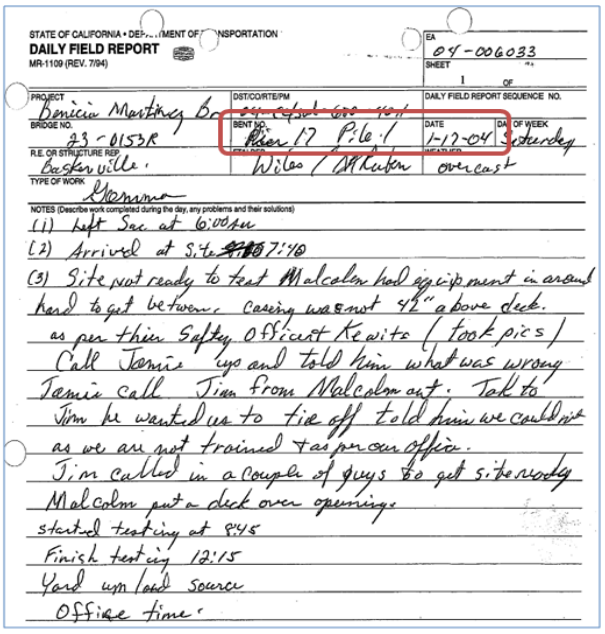
Recorded Upon Testing on 1/17/2004

13703.las - Notepad

```
~VERSION INFORMATION
VERS     .2.0                  :CWLS LOG ASCII STANDARD-
WRAP     .NO                   :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT     .FT      214.234      :START DEPTH
STOP     .FT      3.2495       :STOP DEPTH
STEP     .FT      -0.0997092          :STEP
NULL     .        -999.25      :NULL VALUE
COMP     .        N/A          :COMPANY
WELL     .        N/A          :WELL
FLD      .        N/A          :FIELD
LOC      .        N/A          :LOCATION
PROV     .        N/A          :PROVINCE
SRVC     .        N/A          :SERVICE COMPANY
DATE     .        N/A          :LOG DATE
UWI      .        N/A          :UNIQUE WELL ID
~CURVE INFORMATION
DEPT     .FT                   :DEPTH
GAM      .CPS                  :Gam
GAM(     .CPS                  :gam(dtc)
DENS     .LBS/FT3                     :Density(dtc)
~PARAMETER INFORMATION
Dept     .                     :Depth Logger
BH F     .                     :BH Fluid
File     .        Benicia main        :File Name
COMP     .       Malclolm             :COMPANY:
Dept     .        85m          :Depth Driller
OTHE     .                     :OTHER SERVICES
Witn     .                     :witness:
Loca     .        Pier8   Pile3       :Location:
Casi     .
Date     .        01/15/2004          :Date
Well     .
Logg     .        wiles / Dekens      :Logged by:
~OTHER
~A
214.234 8326     8783.05 189.939
214.134 8493.5   8969.65 188.764
214.035 8563.5   9047.75 188.28
213.935 8638.5   9131.52 187.765
213.835 8814.5   9328.41 186.573
213.736 8949     9479.18 185.677
213.636 8916     9442.16 185.896
213.536 9063     9607.19 184.928
213.436 9166     9723.01 184.258
213.337 8970.5   9503.31 185.535
213.237 9366.5   9948.92 182.975
213.137 9351     9931.43 183.073
213.038 9488.5   10086.7 182.206
```

Fig. 1A.3: Daily Field Reports Documenting Actual Testing Locations

1/17/2004 Testing at Pier 17, Pile 1



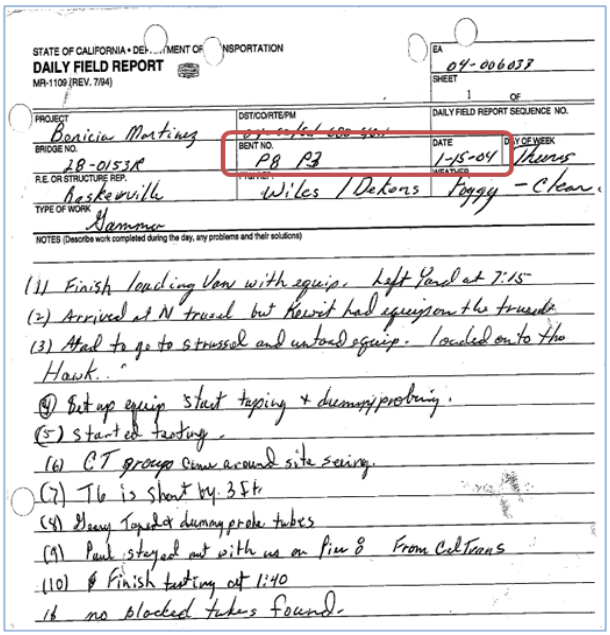
STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
DAILY FIELD REPORT
MR-1109 (REV. 7/94)

EA: 04-006033
SHEET 1 OF

PROJECT: Benicia Martinez Br
DST/CO/RTE/PM: 04-Cal/Sol 680 19.01
DAILY FIELD REPORT SEQUENCE NO.
BRIDGE NO.: 23-0153R
BENT NO.: Pier 17 Pile 1
DATE: 1-17-04
DAY OF WEEK: Saturday
R.E. OR STRUCTURE REP.: Baskerville.
INSPECTOR: Wiles / Mcluten
WEATHER: overcast
TYPE OF WORK: Hammer

NOTES (Describe work completed during the day, any problems and their solutions)
(1) Left Sac at 6:00 am
(2) Arrived at Site 7:40
(3) Site not ready to test Malcolm had equipment in around hard to get between. Casing was not 42" above deck. as per their Safty Officer Kewitz (took pics) Call Jamie up and told him what was wrong Jamie call Jim from Malcolm out. Talk to Jim he wanted us to tie off told him we could not as we are not trained to as per our office. Jim called in a Couple of guys to get site ready Malcolm put a deck over opening.
started testing at 8:45
Finish testing 12:15
Yard up load source
Office time.

1/15/2004 Testing at Pier 8, Pile 3



STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
DAILY FIELD REPORT
MR-1109 (REV. 7/94)

EA: 04-006033
SHEET 1 OF

PROJECT: Benicia Martinez
DST/CO/RTE/PM: 04-Cal/Sol 680 19.01
DAILY FIELD REPORT SEQUENCE NO.
BRIDGE NO.: 28-0153R
BENT NO.: P8 P3
DATE: 1-15-04
DAY OF WEEK: Thurs
R.E. OR STRUCTURE REP.: Baskerville
INSPECTOR: Wiles / Dekens
WEATHER: Foggy - Clear.
TYPE OF WORK: Hammer

NOTES (Describe work completed during the day, any problems and their solutions)
(1) Finish loading Van with equip. Left Yard at 7:15
(2) Arrived at N trussel but Kewit had equipment the truck
(3) Had to go to S trussel and unload equip. loaded on to the Hawk.
(4) Set up equip start taping + dummy probing.
(5) Started testing.
(6) CT groups clean around site seaing.
(7) T6 is short by 3 ft
(8) Heavy Topsoil + dummy probe tubes
(9) Paul stayed out with us on Pier 8 From CalTrans
(10) Finish testing at 1:40
(11) no blocked tubes found.

Fig. 1A.4: Documentation That No Testing Occurred Between P8P3 and P17P1

Portion of Master LAS File List Sorted by Date (of Last File Modification).

	A	B	C	D	E	F
1	File ID	Unique ID	Parsed	Date	LAS-RD Pair ID	File Name
7448	66278	9277	0	1/15/2004 13:38	17226	P8P3T8.LAS
7449	66261	9275	1	1/15/2004 13:58	17209	P8P3T6.LAS
7450	66262	9275	0	1/15/2004 13:58	17210	P8P3T6.LAS
7451	66267	9276	1	1/15/2004 14:17	17215	P8P3T7.LAS
7452	66268	9276	0	1/15/2004 14:17	17216	P8P3T7.LAS
7453	66273	9277	1	1/15/2004 14:38	17221	P8P3T8.LAS
7454	66274	9277	0	1/15/2004 14:38	17222	P8P3T8.LAS
7455	87843	13703	1	1/17/2004 8:25	18106	P17P1T1.LAS
7456	87845	13704	1	1/17/2004 8:46	18112	P17P1T2.LAS
7457	87847	13705	1	1/17/2004 9:05	18118	P17P1T3.LAS
7458	87844	13703	0	1/17/2004 9:25	18107	P17P1T1.LAS
7459	87849	13706	1	1/17/2004 9:27	18124	P17P1T4.LAS
7460	87851	13707	1	1/17/2004 9:43	18130	P17P1T5.LAS
7461	87846	13704	0	1/17/2004 9:46	18113	P17P1T2.LAS
7462	87848	13705	0	1/17/2004 10:05	18119	P17P1T3.LAS
7463	87853	13708	1	1/17/2004 10:05	18136	P17P1T6.LAS
7464	87855	13709	1	1/17/2004 10:24	18142	P17P1T7.LAS
7465	87850	13706	0	1/17/2004 10:27	18125	P17P1T4.LAS
7466	87852	13707	0	1/17/2004 10:43	18131	P17P1T5.LAS
7467	87857	13710	1	1/17/2004 10:43	18148	P17P1T8.LAS

Last Test on 1/15/2004

First Test on 1/17/2004

No Testing Occurred Between These Dates

Fig. 1A.5: Documentation of No Pattern Matches to Pier 8, Pile 3 Data

Portion of Pattern Match Analysis Output Sorted by LAS Unique File ID.

LAS Unique File Numbers for P8P3 are 9270 to 9277.

These File Numbers Do Not Appear On the Sorted Pattern Match Results (Indicating No Match Exists).

Note: Pattern Matches for Modified P17P1 Files Appear Under LAS Unique File Numbers 9788 to 9795.

	A	B	C	D	E	F	G	H	I	J
1	Pattern ID	Pattern ID (from v2 Results)	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	Logged By
54	341	256	54692	7625	52	1054	1054	1	9/17/08 9:20	BOND / WILES
55	342	262	54696	7626	150	1054	1054	1	9/17/08 9:32	BOND / WILES
56	346	260	54696	7626	215	1054	1054	1	9/17/08 9:32	BOND / WILES
57	340	255	54704	7628	85	1059	1059	1	9/17/08 9:53	BOND / WILES
58	344	258	54704	7628	39	1059	1059	1	9/17/08 9:53	BOND / WILES
59	345	259	54704	7628	94	1059	1059	1	9/17/08 9:53	BOND / WILES
60	386	283	62644	8712	326	790	790	1	12/6/06 13:16	
61	479	329	68466	9620	2247	2311	2311	1	7/16/04 9:42	WILES / DEKENS
62	481	330	69581	9788	2117	2117	2117	1	1/21/04 8:09	Wiles / ruben
63	482	331	69588	9789	2113	2113	2113	1	1/21/04 8:11	Wiles / Ruben
64	483	332	69595	9790	2108	2108	2108	1	1/21/04 8:12	Wiles / Ruben
65	484	333	69602	9791	2033	2034	2033	1	1/21/04 8:12	Wiles / Ruben
66	485	334	69609	9792	1827	1827	1827	1	1/21/04 8:13	Wiles / Ruben
67	486	335	69616	9793	1823	1823	1823	1	1/21/04 8:14	Wiles / Ruben
68	487	336	69623	9794	2116	2116	2116	1	1/21/04 8:15	Wiles / Ruben
69	488	337	69630	9795	2110	2110	2110	1	1/21/04 8:15	Wiles / Ruben
70	497	346	71964	10292	1019	1019	1019	1	9/30/11 17:47	R.Medina
71	506	355	72680	10436	640	743	743	1	6/1/11 17:29	R.Medina
72	552	401	83472	12678	915	915	915	1	10/14/11 18:26	R.Medina
73	553	402	83583	12705	352	352	352	1	12/2/11 9:05	
74	497	346	84273	12888	1019	1019	1019	1	10/14/11 11:04	R.Medina
75	554	403	84630	13006	254	254	254	1	12/3/10 15:43	Chavez
76	555	404	84638	13009	255	255	255	1	12/3/10 15:42	Chavez

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **2(a-f)**

Name: **Qualification Of Standard Reference Blocks**

Status: ☐ Inactive ☒ Active ☐ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☒ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☒ Time Stamp

Code Version: V3

Analyzed by: Turner, Zhu, Roblee **Date:** 3/2/12

Summarized by: Roblee **Date:** 12/10/12

Reviewed by: Hannenian **Date:** 12/11/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

A clear and varied sequence of data manipulations occurred on 1/24/2007 between the acquisition and transmittal of six LAS data files associated with qualification of "standard reference" blocks per CTM-233, Part 2B. The manipulations had the effect of eliminating spurious data in those files that would have lead to rejection of test results. The cause of the original spurious data is uncertain, but is believed by the GamDat team to be related to having a second gamma source within the range of detection of the GGL equipment that was recording at the time.

The standard reference blocks are concrete blocks carried in equipment vans for purposes of conducting daily "functionality evaluations" per CTM-233, Part 4A. The qualification testing procedure for each block involves taking two sets of measurements, one each while the block is in a horizontal and vertical position. While the qualification testing program involved all source/probe-block combinations, all of the detected data irregularities involved the single source/probe "D" (3551-041).

LAS files transmitted by the technician to the engineer for six (D1V, D3H, D5V, D6V, D8V, and D9V) of the 18 tests conducted on 1/24/2007 with source/probe D were flagged for potential irregularities by several GamDat analysis methods. Regeneration of the test data originally acquired was possible due to the availability of RD files, and pattern-matching results allowed for manual re-creation of the complete sequence of data manipulations needed to fully account for all transmitted data.

The extent of alterations varied considerably between files. Two cases (D3H and D5V) involved simple deletion of a small number of data points (8 and 2 points, respectively). The remaining four cases involved substantial deletion of originally recorded data (approx. 40% to 80% of sequence) and replacement with data copied from testing within the same block in the other orientation. One of these cases (D6V) also included padding of the end of the data file with a single repeated value. D1V was the most complex case as it involved copy/paste of six different and overlapping data snippets as a means to replace about 80% of the original data.

The file modification chronology also fully supports the data manipulation scenario. Time stamps (of last file

modification) for unaltered LAS files were identical between the 'acquired' and 'transmitted' files, and these matched the RD file time stamp. However, for the altered files, the transmitted LAS file had a time stamp approximately 4 hours later than both the original LAS and RD files.

Discussion of Findings

The six irregular test sets (D1V, D3H, D5V, D6V, D8V, and D9V) are labeled as ID-2a through ID-2f, respectively, and supporting documentation for each case is presented in attachment 2A through 2F, respectively. Each attachment presents three figures. The first figure in each attachment graphically illustrates the data alterations performed between acquisition by the technician and transmittal to the engineer. In each case, original data files for the vertically-oriented block are depicted at the top of the figure in blue and original data files for the horizontally-oriented block are depicted at the bottom in red. Repeated data patterns identified by the pattern-matching analysis are shown as darker shades of blue and red at the relative positions found within both the acquired and transmitted files. The data patterns are labeled in each figure using small-case letters and associated to a unique 'pattern ID' generated by the pattern-matching analysis code. The second figure in each attachment provides a complete list of density values included in each pattern. The third figure in each attachment shows the originally acquired gamma-count data sequence, and highlights the data that was eliminated prior to transmittal to the engineer.

All indications are that the technician intentionally removed and/or replaced recorded data in six files prior to transmittal to the engineer. The purpose of the alterations appears to be to eliminate inconsistent readings in the original data files where both 'spikes' and 'offsets' in gamma count were recorded. Spikes consistently trended toward higher count values (inferring lower density) with spike amplitudes ranging from approximately 120% to 180% of normal readings. Original recordings show shifts/offsets in data moving both from lower-to-higher and from higher-to-lower gamma count. The maximum shift is approximately 125%. Deleted data was invariably the larger count values.

Due to time and schedule constraints, the GamDat team did not conduct a thorough investigation into the cause the spurious spikes and offsets appearing in the original data, though three viable hypotheses were considered:

1. Adjacent Source: A second gamma source may have been within the range of detection of the GGL equipment that was recording at the time of the qualification testing.
2. Probe Repositioning: The recording GGL probe may have been repositioned within the functionality block during the qualification testing.
3. Intermittent Equipment Malfunction: The GGL equipment may have not been operating properly during the qualification testing.

The GamDat team considers the 'adjacent source' hypothesis to be most likely as data spikes and offsets similar to those observed in the 2007 testing were observed again during 2012 testing for re-qualification of the functionality blocks under what is thought to be comparable testing conditions. This hypothesis accounts for shifts toward higher counts and is the simplest explanation that accounts for all observations. The 'probe repositioning' hypothesis was tested by members of the GamDat team who were able to reproduce comparable data spikes and offsets by physically moving the probe within the functionality blocks during testing. While this can account for the 2007 observations, it is considered unlikely by the GamDat team because it would have required sustained and deliberate effort to gradually move and hold the probe to various positions within the vertically-oriented functionality block. The 'intermittent equipment malfunction' scenario, while potentially viable, has not been demonstrated. GGL experts on the GamDat advisory panel have identified several common scenarios (e.g. cracked detector crystal, detector crystal fogging, and minor cable degradation short of breakage) for intermittent malfunction or poor function short of clear malfunction (i.e. complete signal loss). However, all of the malfunction scenarios considered result in *reduced* gamma counts which do not explain the spikes of *increased* gamma count observed in the original 2007 data files. Thus the equipment malfunction scenario is viewed as unlikely by the GamDat team. To rule out this hypothesis altogether, additional investigation would be needed to establish a complete understanding of equipment malfunction scenarios, and that the observed spikes could not be explained by any such scenario.

The impact of the observed irregularity depends upon the cause of the irregularity. If either the 'adjacent source' or the 'probe repositioning' hypothesis is correct, the downstream consequences are minimal. This is because the properties (i.e. density) of the concrete functionality blocks change little over time, and the recent (2012) requalification implies the blocks were in good functioning order throughout their use. However, if 'intermittent equipment malfunction' was the original cause, it raises the possibility that the equipment could have been malfunctioning during months of production testing. Again, the GamDat team unanimously concurs that the 'adjacent source' hypothesis best accounts for the 2007 observations, but does not have sufficient basis at this time to rule out the other hypotheses with certainty.

Overall, the series of GGL test results conducted for the 2007 qualification of the functionality blocks presents a clear and unambiguous case of intentional data falsification.

References

- Attachment 2A: Figures for Manual Analysis of ID-2a
- Attachment 2B: Figures for Manual Analysis of ID-2b
- Attachment 2C: Figures for Manual Analysis of ID-2c
- Attachment 2D: Figures for Manual Analysis of ID-2d
- Attachment 2E: Figures for Manual Analysis of ID-2e
- Attachment 2F: Figures for Manual Analysis of ID-2f
- Master List of GGL Files (3/20/2012 version)
- Pattern Match Analysis Results (4/13/2012 version)
- LAS Files for D1V (ID-2a):
  - As Recorded (Unique File ID's 13192 and 14719)
  - As Transmitted (Unique File ID 13193)
- LAS Files for D3H (ID-2b):
  - As Recorded (Unique File ID 14720)
  - As Transmitted (Unique File ID 13111)
- LAS Files for D5V (ID-2c):
  - As Recorded (Unique File ID's 14710)
  - As Transmitted (Unique File ID 13199)
- LAS Files for D6V (ID-2d):
  - As Recorded (Unique File ID's 13200 and 14721)
  - As Transmitted (Unique File ID 13201)
- LAS Files for D8V (ID-2e):
  - As Recorded (Unique File ID's 13204 and 14711)
  - As Transmitted (Unique File ID 13205)
- LAS Files for D9V (ID-2f):
  - As Recorded (Unique File ID's 13206 and 14715)
  - As Transmitted (Unique File ID 13207)

Attachment 2A: Figures for Manual Analysis of ID-2a

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D1V.LAS

Fig. 2A.1 Illustration of Alteration of D1V.LAS File (ID-2a)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks

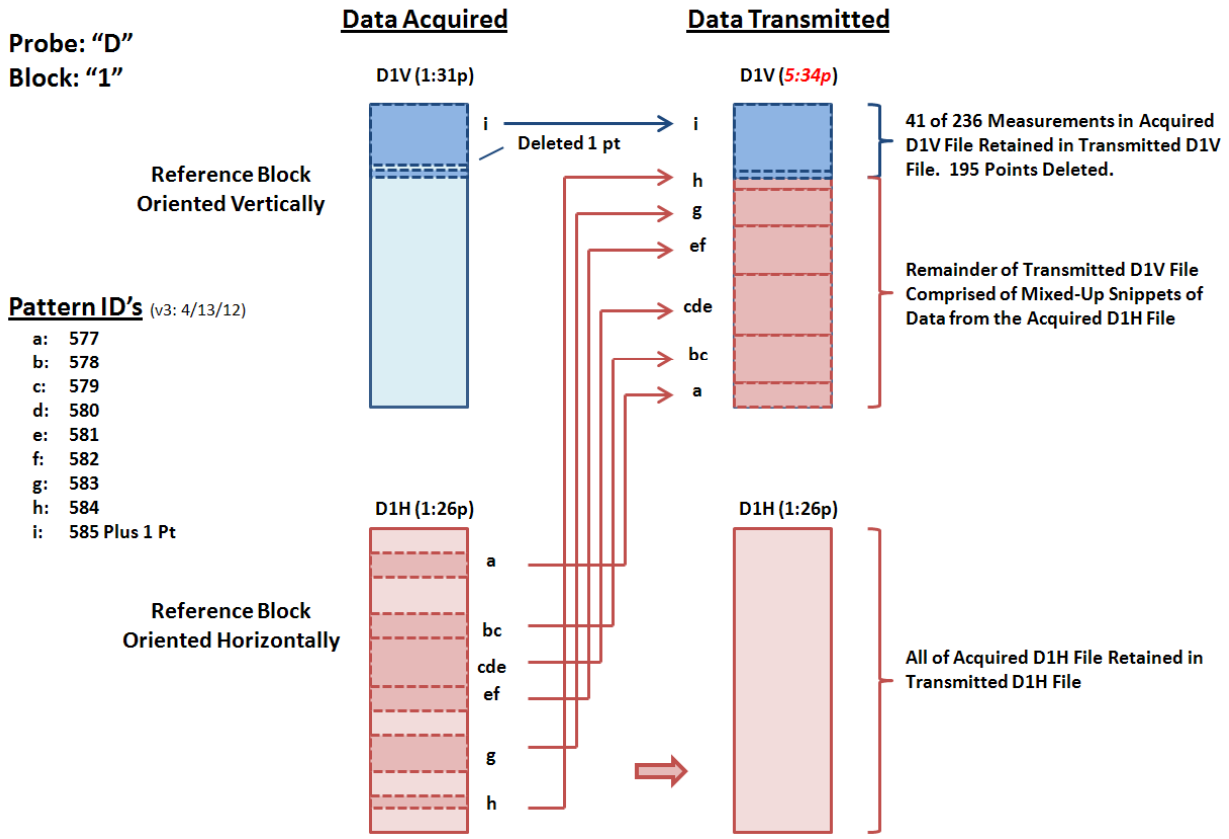
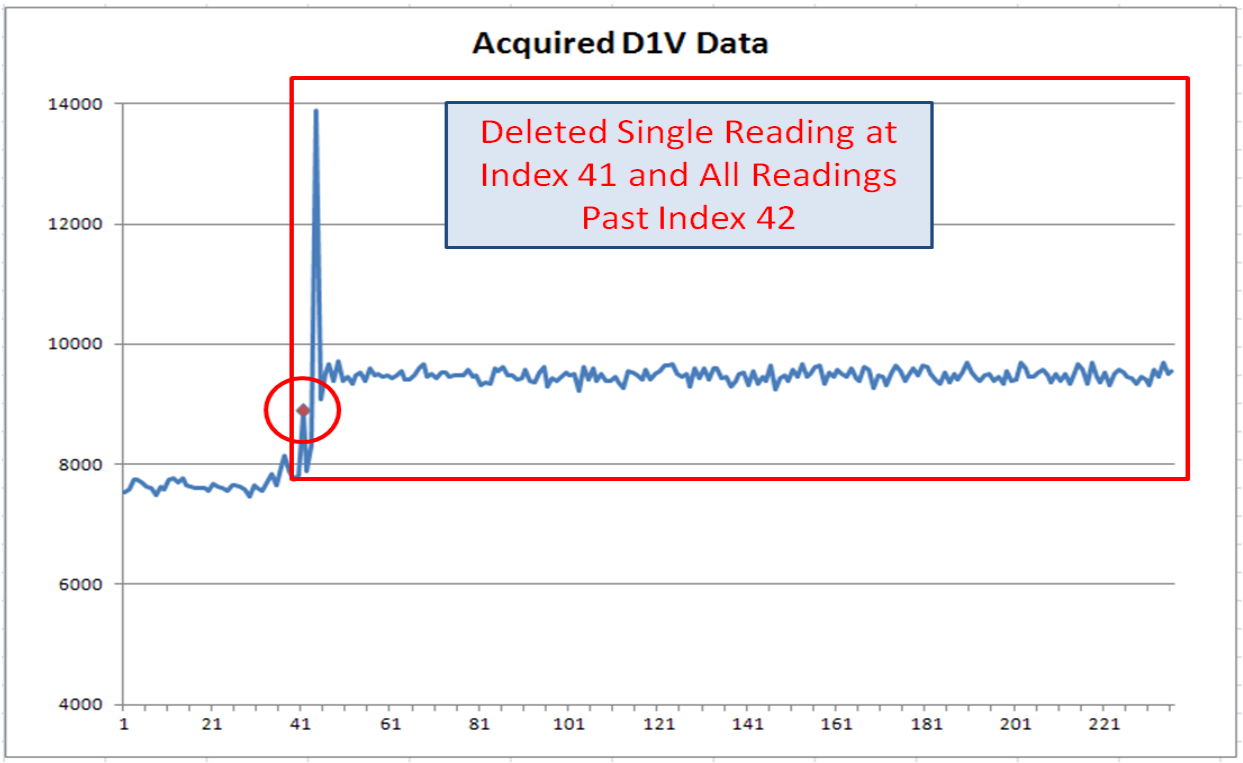


Fig. 2A.2 Patterns Used in Alteration of D1V.LAS File (ID-2a)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
577	30	222.742,224.276,221.715,223.243,223.746,221.850,222.522,223.157,223.482,222.394,223.459,224.921,222.092,223.377,222.673,223.174,222.000,223.279,221.525,221.791,221.619,223.352,223.057,222.284,223.009,223.647,222.825,222.986,223.697,223.432
578	45	223.224,222.929,222.986,223.991,223.140,222.367,222.420,221.741,224.015,222.222,223.174,222.696,221.627,222.690,222.825,223.048,222.659,222.578,223.304,223.352,222.371,223.168,223.843,223.740,223.474,224.253,223.573,223.837,223.342,223.447,223.293,221.175,223.759,222.462,222.495,222.971,223.036,222.971,222.607,223.611,222.514,221.881,222.696,223.224,222.946
579	15	223.293,221.175,223.759,222.462,222.495,222.971,223.036,222.971,222.607,223.611,222.514,221.881,222.696,223.224,222.946
580	40	223.293,221.175,223.759,222.462,222.495,222.971,223.036,222.971,222.607,223.611,222.514,221.881,222.696,223.224,222.946,223.377,222.270,223.115,223.291,223.373,222.158,222.144,221.533,223.541,223.262,222.572,221.037,222.690,222.646,223.105,221.303,222.842,221.723,224.121,223.115,223.069,224.607,223.816,223.527,221.877
581	17	223.541,223.262,222.572,221.037,222.690,222.646,223.105,221.303,222.842,221.723,224.121,223.115,223.069,224.607,223.816,223.527,221.877
582	21	223.541,223.262,222.572,221.037,222.690,222.646,223.105,221.303,222.842,221.723,224.121,223.115,223.069,224.607,223.816,223.527,221.877,222.917,222.800,221.179,224.068
583	33	224.206,223.955,221.791,224.008,222.439,221.450,223.279,223.293,223.487,224.040,222.371,222.208,222.667,222.253,223.027,222.894,221.922,222.998,222.607,224.223,222.648,222.902,222.765,223.664,223.057,223.331,223.312,223.285,222.848,223.828,222.522,222.400,223.132
584	20	222.202,222.536,223.619,222.779,222.619,222.673,221.907,221.108,221.676,222.309,222.454,221.541,222.646,223.209,223.558,222.806,222.284,223.073,223.105,222.827
585	40	222.748,222.338,221.199,221.088,221.435,221.981,222.261,223.151,222.014,222.352,221.250,220.961,221.452,220.930,221.864,222.031,222.140,222.259,222.228,222.536,221.690,222.010,222.276,222.632,221.784,221.791,222.076,222.447,223.285,221.877,222.284,222.655,221.458,220.469,221.858,219.597,218.287,220.071,221.139,220.706

Fig. 2A.3 Data Deleted from Acquired D1V.LAS File (ID-2a)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks



Attachment 2B: Figures for Manual Analysis of ID-2b

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D3H.LAS

Fig. 2B.1 Illustration of Alteration of D3H.LAS File (ID-2b)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

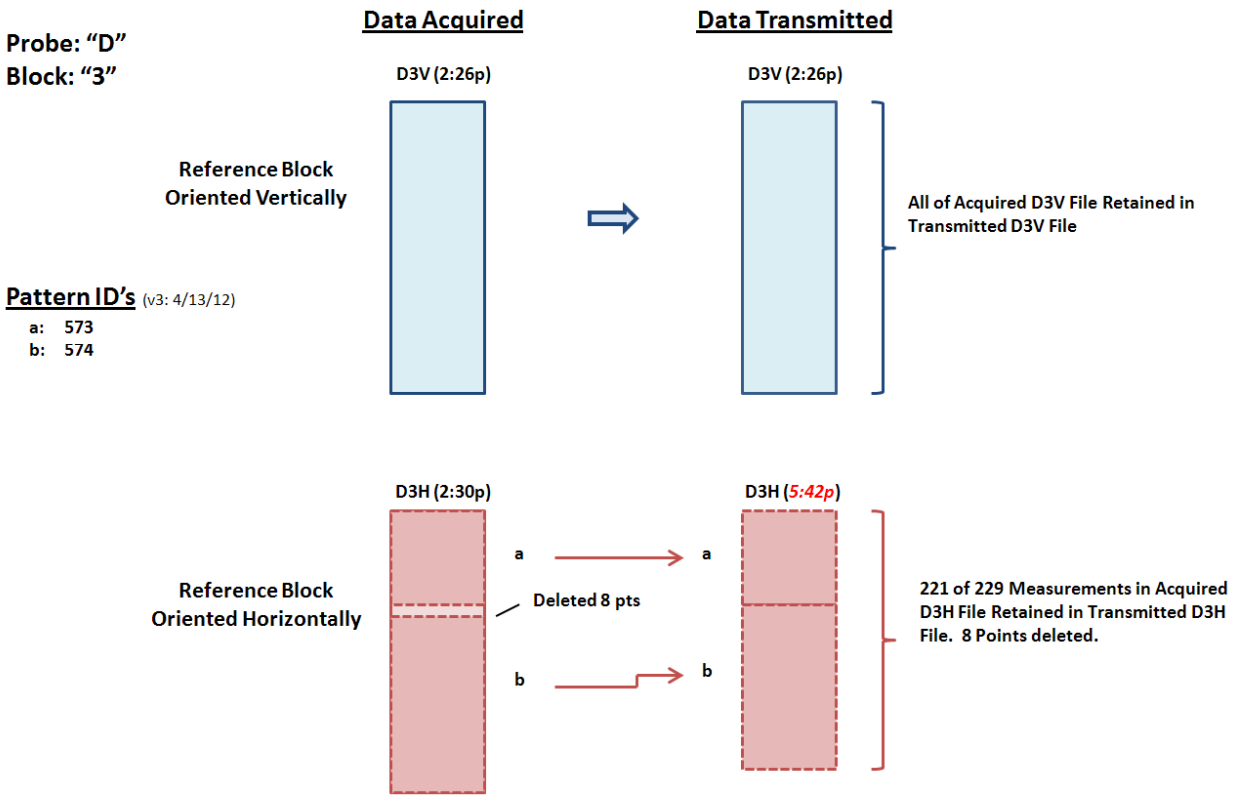


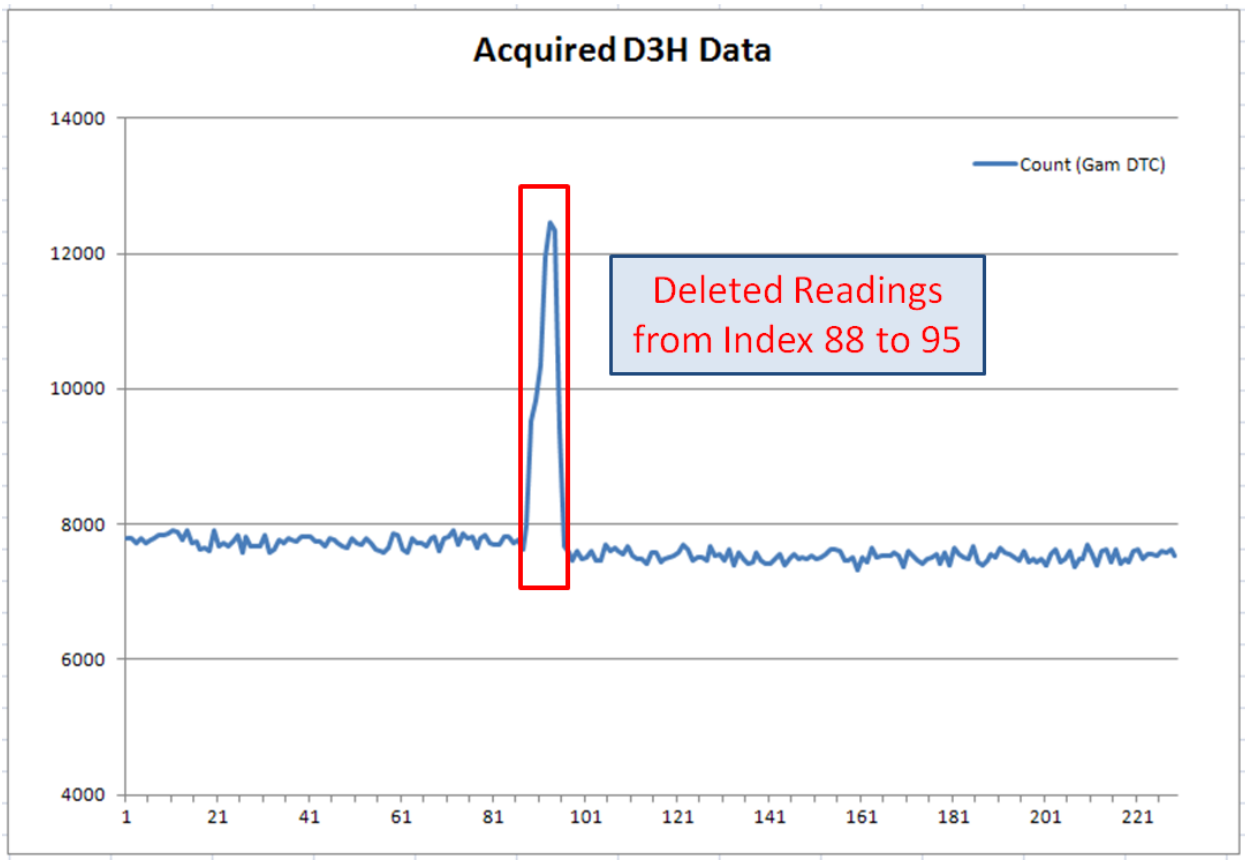
Fig. 2B.2 Patterns Used in Alteration of D3H.LAS File (ID-2b)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
573	87	220.825,220.819,221.295,220.745,221.403,220.918,220.880,220.423,220.463,220.391,220.044,220.211,220.924,219.952,221.327,221.155,222.035,221.866,222.193,219.926,221.605,221.368,221.609,221.153,220.463,222.325,220.676,221.676,221.660,221.752,220.455,222.398,221.994,221.054,221.321,220.874,220.997,221.220,220.676,220.678,220.570,221.088,221.220,221.641,220.745,221.039,221.336,221.727,221.791,220.799,221.403,221.553,220.866,221.429,221.994,222.212,222.321,221.918,220.311,220.556,222.103,222.311,220.874,221.411,221.260,221.750,220.839,220.658,222.193,220.743,220.692,219.984,221.445,220.349,220.791,220.636,221.817,220.910,220.497,221.295,221.592,221.533,220.598,220.604,221.277,220.914,221.967
574	134	221.744,222.342,223.237,222.243,223.193,222.956,222.288,223.348,223.262,221.541,222.193,221.819,222.296,222.489,221.635,222.821,223.034,223.067,223.562,222.406,222.447,223.459,223.057,222.973,222.777,222.466,221.600,222.070,223.304,222.921,222.863,223.279,221.635,222.717,222.626,223.222,221.994,223.786,222.338,223.109,223.647,223.535,222.371,223.209,223.613,223.733,223.067,222.507,223.767,223.159,222.489,223.021,222.988,223.117,222.777,223.193,222.979,222.659,222.043,222.111,222.296,223.339,223.363,222.904,224.330,222.846,223.482,221.784,222.929,222.819,222.723,222.800,222.406,222.827,223.958,222.171,222.759,223.289,223.674,223.075,222.869,222.572,223.647,222.342,223.786,221.893,222.572,222.971,223.061,221.621,223.482,223.913,223.331,222.659,222.888,221.836,222.379,222.516,222.888,223.209,222.253,223.398,223.178,223.493,223.025,223.879,222.607,222.010,223.432,223.021,222.160,224.093,223.168,223.048,221.600,222.530,223.879,222.243,221.996,223.535,221.967,223.632,223.193,223.451,222.171,222.129,223.021,222.626,222.599,222.700,222.220,222.406,222.035,222.686

Fig. 2B.3 Data Deleted from Acquired D3H.LAS File (ID-2b)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks



Attachment 2C: Figures for Manual Analysis of ID-2c

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D5V.LAS

Fig. 2C.1 Illustration of Alteration of D5V.LAS File (ID-2c)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks

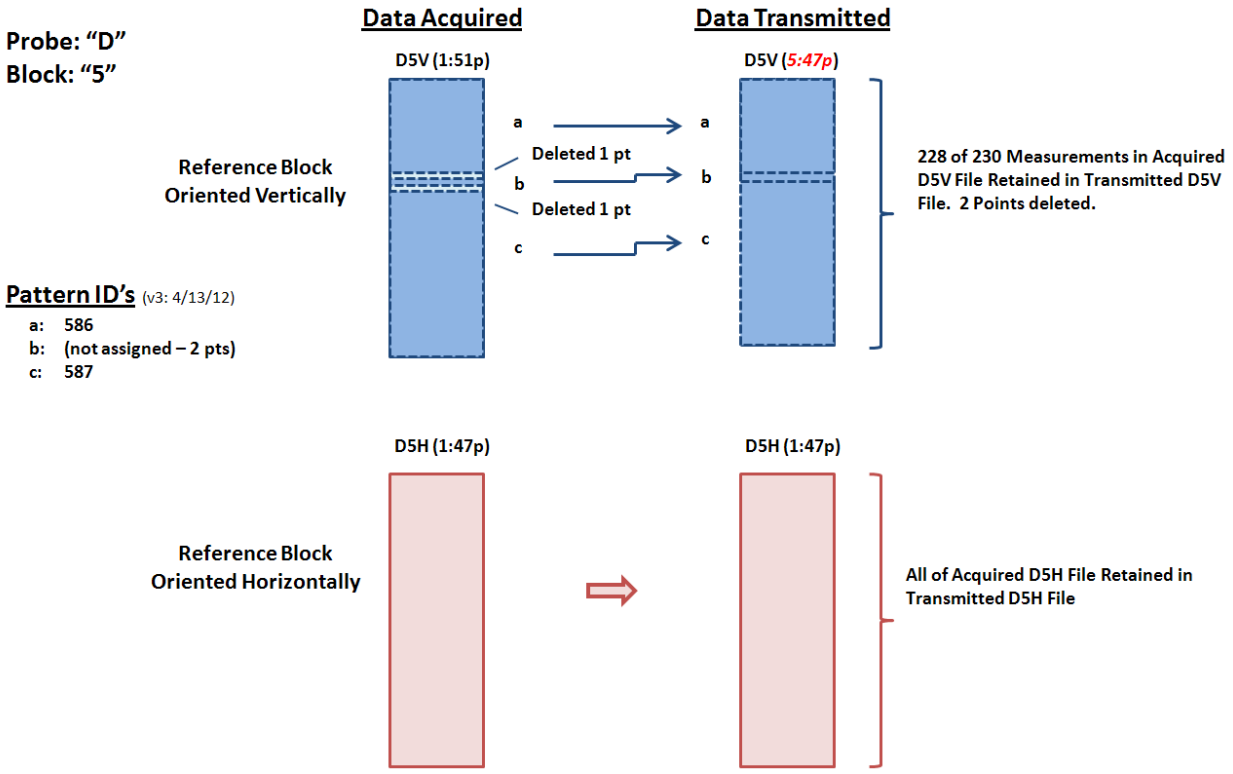
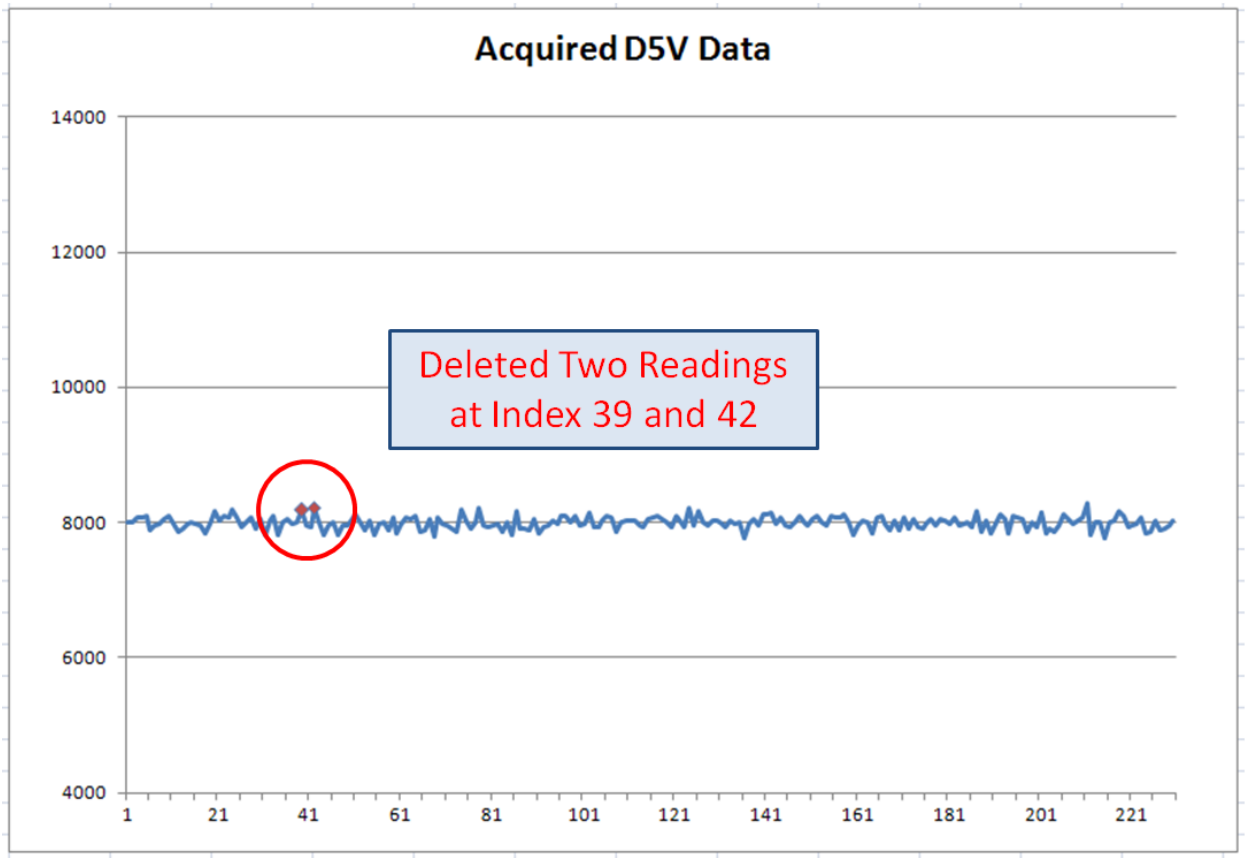


Fig. 2C.2 Patterns Used in Alteration of D5V.LAS File (ID-2c)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
586	38	219.232,219.354,218.785,218.852,218.709,220.085,219.579,219.540,218.951,218.598,219.532,220.257,219.926,219.484,219.376,219.524,219.559,220.562,219.459,218.214,219.185,218.668,218.775,218.013,218.762,219.739,219.346,218.834,219.998,218.899,220.690,219.134,218.709,220.690,219.228,218.899,219.447,219.228
587	188	219.271,220.578,219.676,219.295,220.570,219.595,219.716,218.969,218.388,219.267,220.079,219.079,220.684,219.427,219.271,220.079,218.826,220.431,219.546,218.740,218.987,218.612,220.239,220.113,219.026,220.771,218.756,219.441,219.664,220.008,220.251,218.013,219.130,219.886,219.248,217.770,219.577,219.761,219.603,219.401,220.259,219.258,220.606,218.140,219.926,219.988,220.057,218.987,220.544,219.868,219.668,219.059,219.405,218.594,218.709,219.289,218.608,219.702,219.386,218.295,219.799,219.799,219.087,218.581,218.865,220.325,219.228,219.183,219.130,219.163,219.569,219.855,218.963,218.779,218.588,218.995,219.295,219.763,218.645,219.303,219.821,217.791,219.700,218.192,219.368,219.603,219.199,219.171,219.427,219.829,219.159,219.419,219.315,221.019,219.435,218.922,219.664,218.509,218.392,218.375,219.474,218.834,219.577,219.763,219.271,218.606,219.372,219.656,218.995,218.565,219.376,219.702,218.668,218.762,218.762,218.458,219.250,220.644,219.569,219.146,219.275,220.429,218.731,218.637,219.490,220.129,219.049,220.103,218.865,220.018,219.000,219.773,219.972,219.524,218.904,219.625,218.922,219.193,219.520,218.844,219.563,219.530,219.289,219.773,218.167,220.233,219.138,220.479,219.492,218.526,218.969,220.511,218.711,218.818,219.020,220.297,219.275,219.789,218.309,220.503,219.926,220.349,219.650,218.411,218.963,219.451,219.104,218.848,217.278,220.584,219.258,219.372,220.985,219.315,219.124,218.104,218.637,219.813,219.611,219.451,218.824,220.423,220.243,219.065,220.163,219.912,219.700,219.153

Fig. 2C.3 Data Deleted from Acquired D5V.LAS File (ID-2c)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks



Attachment 2D: Figures for Manual Analysis of ID-2d

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D6V.LAS

Fig. 2D.1 Illustration of Alteration of D6V.LAS File (ID-2d)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

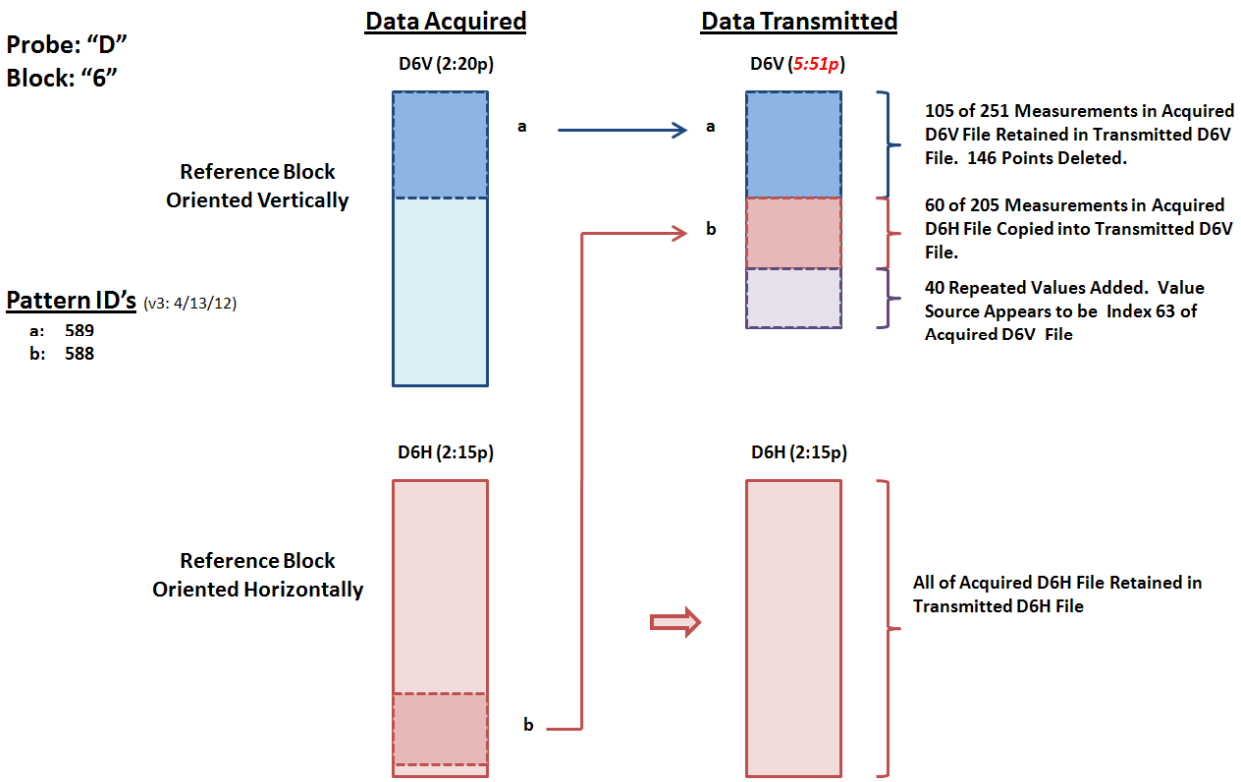


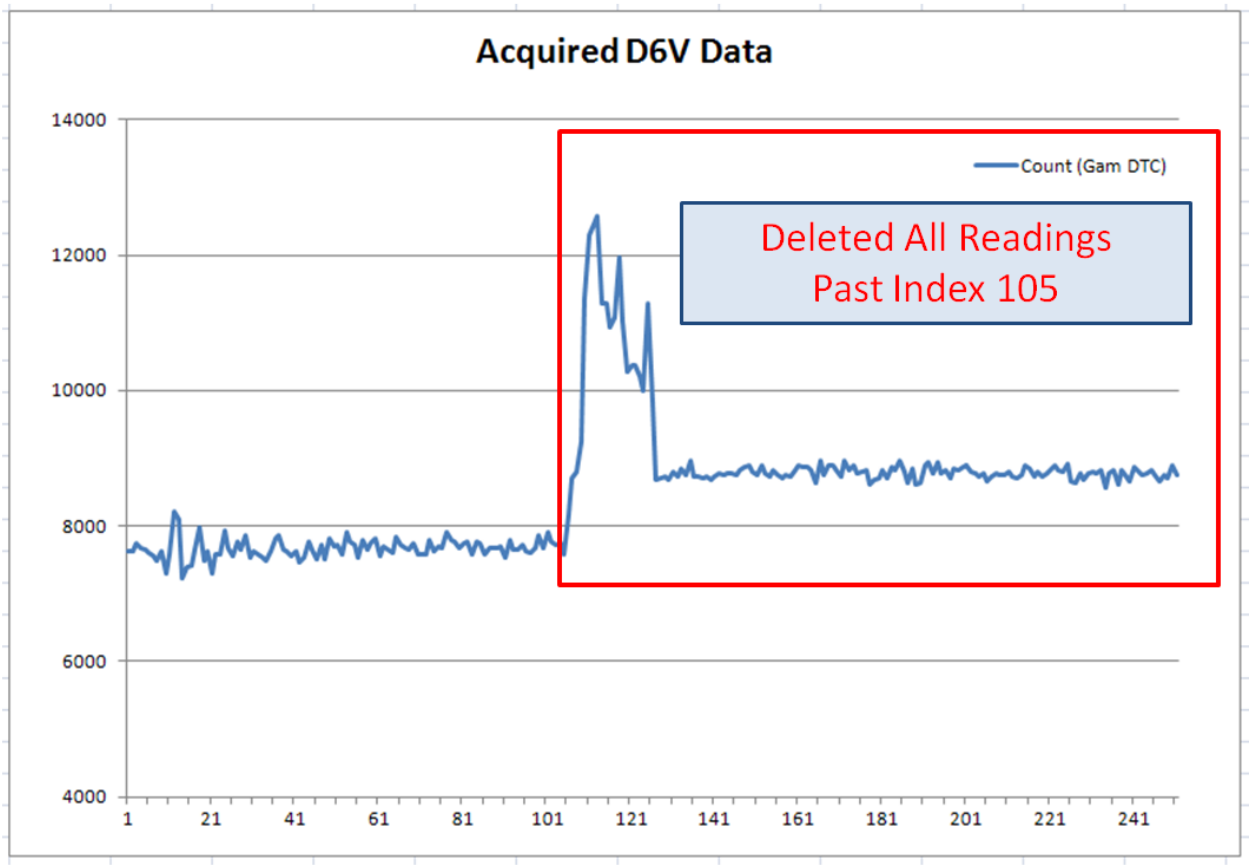
Fig. 2D.2 Patterns Used in Alteration of D6V.LAS File (ID-2d)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
588	60	223.405,220.946,221.866,222.247,221.283,223.048,221.899,221.959,222.717,222.597,222.861,223.115,222.460,223.168,221.303,221.615,222.472,221.287,222.276,221.368,221.456,221.317,222.549,221.301,221.584,220.676,222.301,222.202,221.844,221.688,221.967,222.431,222.232,223.013,222.243,222.977,221.201,221.973,221.490,223.063,221.764,223.279,221.690,221.490,223.021,222.103,221.666,222.344,223.201,222.062,222.921,221.782,222.241,220.813,222.503,222.010,222.640,223.027,221.668,223.168
589	105	222.090,222.076,221.187,221.647,221.782,222.173,222.557,223.138,222.099,224.599,222.352,217.751,218.614,225.150,223.900,223.626,221.799,219.498,223.042,222.057,224.571,222.439,222.365,219.743,221.647,222.626,221.045,221.871,220.297,222.771,221.988,222.476,222.756,223.180,222.070,220.662,220.297,221.871,222.064,222.522,221.975,223.199,222.690,220.932,221.852,222.963,221.419,222.963,220.636,221.484,221.317,222.315,219.944,221.031,221.368,222.680,220.819,221.852,221.179,220.710,222.626,221.537,221.926,222.212,220.497,221.403,221.762,221.901,221.187,222.456,222.483,222.454,220.829,222.092,221.584,221.744,220.000,220.751,221.080,221.750,221.173,220.938,222.352,221.080,221.206,222.425,221.701,221.768,221.717,221.486,222.736,220.906,221.838,221.866,221.378,222.035,222.296,221.735,220.365,221.770,219.904,220.946,221.419,221.098,222.379
591-597	40	Padded Transmitted File with 40 Repeated Values of 221.926

Fig. 2D.3 Data Deleted from Acquired D6V.LAS File (ID-2d)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks



Attachment 2E: Figures for Manual Analysis of ID-2e

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D8V.LAS

Fig. 2E.1 Illustration of Alteration of D8V.LAS File (ID-2e)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks

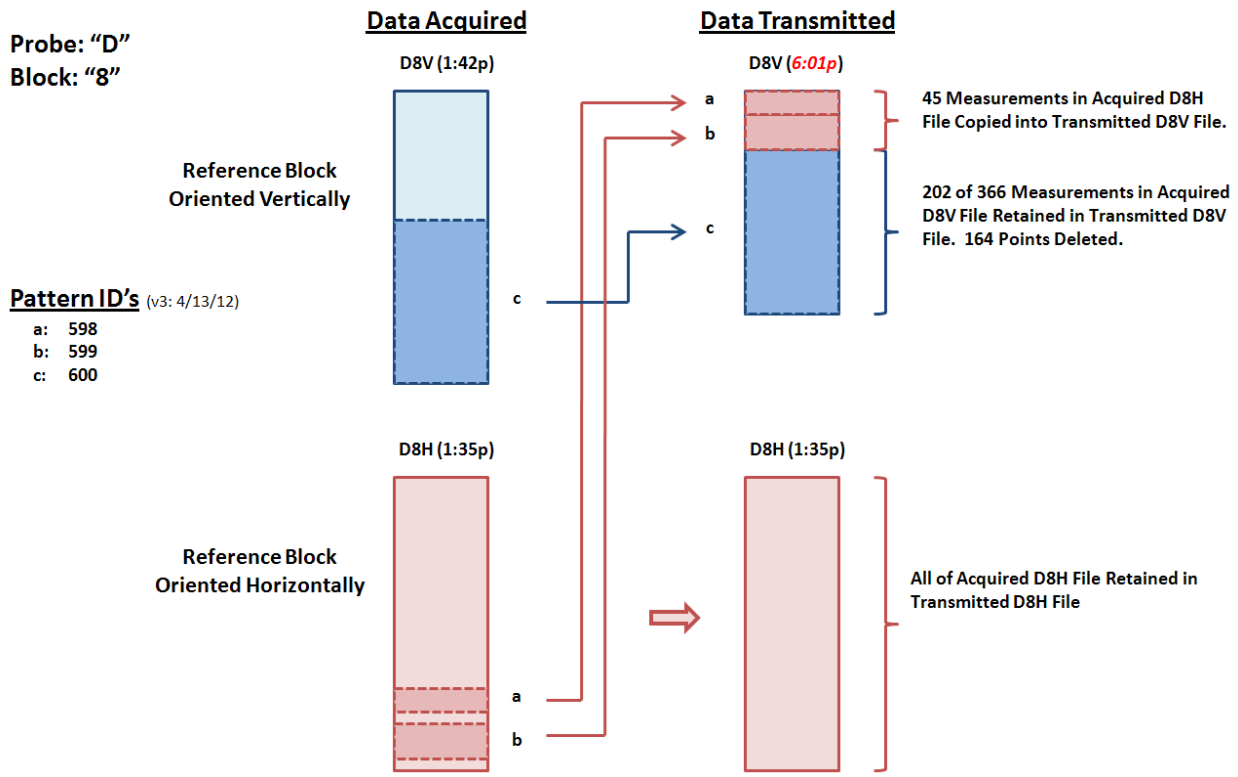
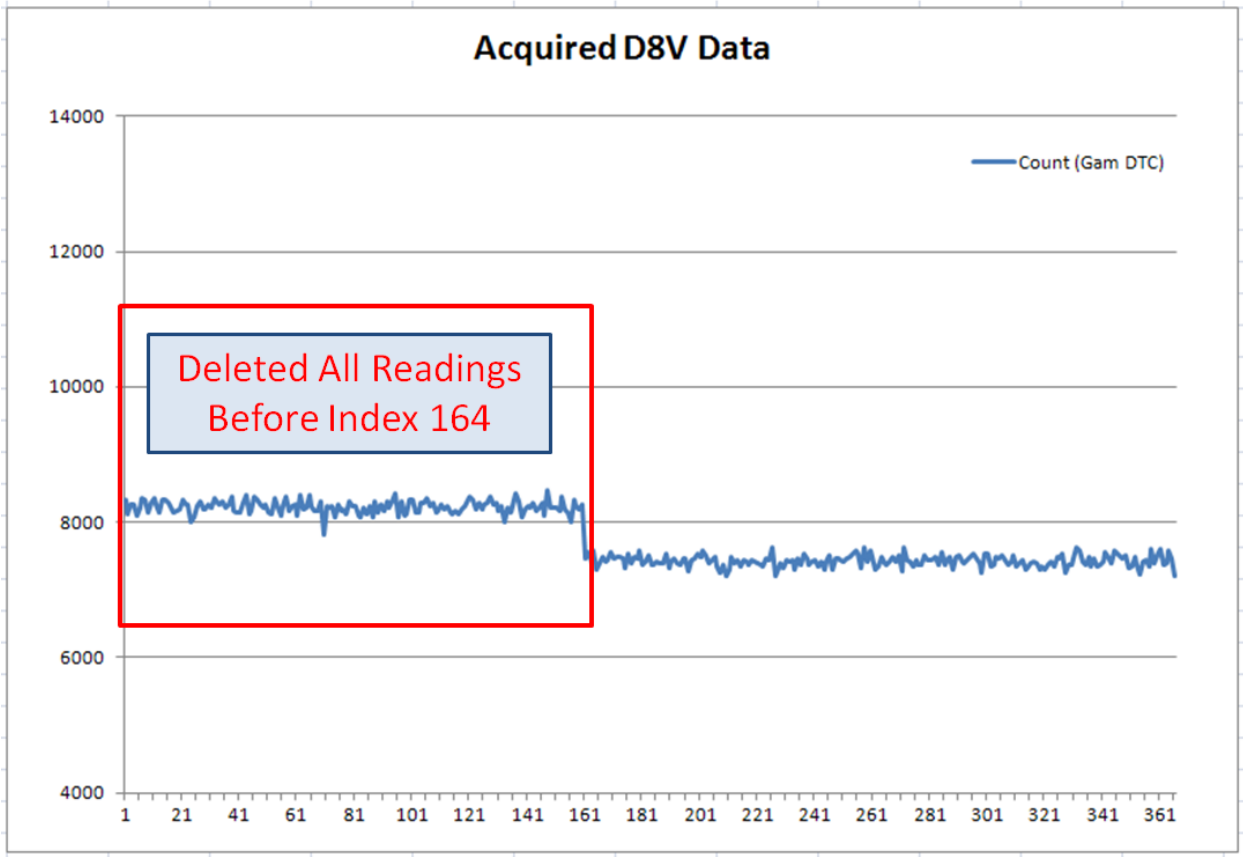


Fig. 2E.2 Patterns Used in Alteration of D8V.LAS File (ID-2e)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
598	20	225.165,224.580,224.938,224.308,225.044,225.477,224.475,224.565,225.670,226.206,224.878,224.708,225.496,226.253,224.964,225.158,226.099,225.777,225.040,225.096
599	25	224.404,225.738,225.440,225.238,225.642,226.577,225.970,225.771,224.599,225.225,225.353,225.468,225.040,225.635,224.362,224.552,224.466,225.373,225.193,224.949,224.938,224.545,225.483,224.665,225.273
600	202	224.528,223.913,223.168,223.600,223.543,222.655,223.297,223.174,223.088,223.335,224.460,222.673,223.801,223.193,223.199,222.472,224.093,223.723,222.988,224.025,223.987,223.678,223.769,223.746,222.827,224.411,223.619,223.270,223.849,223.921,223.209,223.249,224.738,223.501,223.230,222.784,223.021,222.394,222.979,223.888,223.508,223.182,224.161,224.981,223.921,225.340,224.588,223.182,223.746,223.508,224.155,223.402,223.706,224.006,223.381,223.657,223.773,224.000,224.225,223.258,223.465,222.062,225.210,224.432,223.888,224.432,223.440,223.569,223.396,224.494,223.310,224.004,222.777,223.266,224.061,223.716,223.411,224.181,223.706,224.528,223.655,222.894,224.518,223.270,223.199,223.552,223.647,223.264,223.055,222.750,222.350,222.732,224.291,222.090,223.636,222.454,223.019,224.588,224.204,223.193,223.767,224.091,223.628,223.140,223.710,223.009,224.816,222.123,223.415,223.613,224.255,223.482,224.015,223.949,222.852,223.432,223.438,223.331,223.130,223.921,222.563,224.057,223.243,223.040,224.466,223.159,222.852,223.619,223.837,223.472,223.098,222.811,223.291,223.767,224.938,222.825,222.707,224.134,223.945,223.140,223.321,222.858,223.527,223.955,223.653,222.888,224.195,223.888,223.440,224.595,224.302,223.888,223.604,223.917,224.588,224.170,224.522,223.949,223.723,224.198,223.030,223.335,222.769,224.887,224.008,224.076,223.207,222.002,222.321,223.604,223.945,223.182,224.127,223.293,224.217,223.962,223.725,222.555,223.090,223.871,222.336,222.667,222.929,223.249,223.004,224.340,224.149,223.115,223.983,225.102,223.619,223.527,224.198,222.235,223.740,222.963,222.228,223.945,223.902,222.447,223.352,225.353

Fig. 2E.3 Data Deleted from Acquired D8V.LAS File (ID-2e)
1/24/2007 Qualification Testing of FTB Standard Reference Blocks



Attachment 2F: Figures for Manual Analysis of ID-2f

Qualification Testing of FTB Standard Reference Blocks
Testing Date: 1/24/2007
Altered File: D9V.LAS

Fig. 2F.1 Illustration of Alteration of D9V.LAS File (ID-2f)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

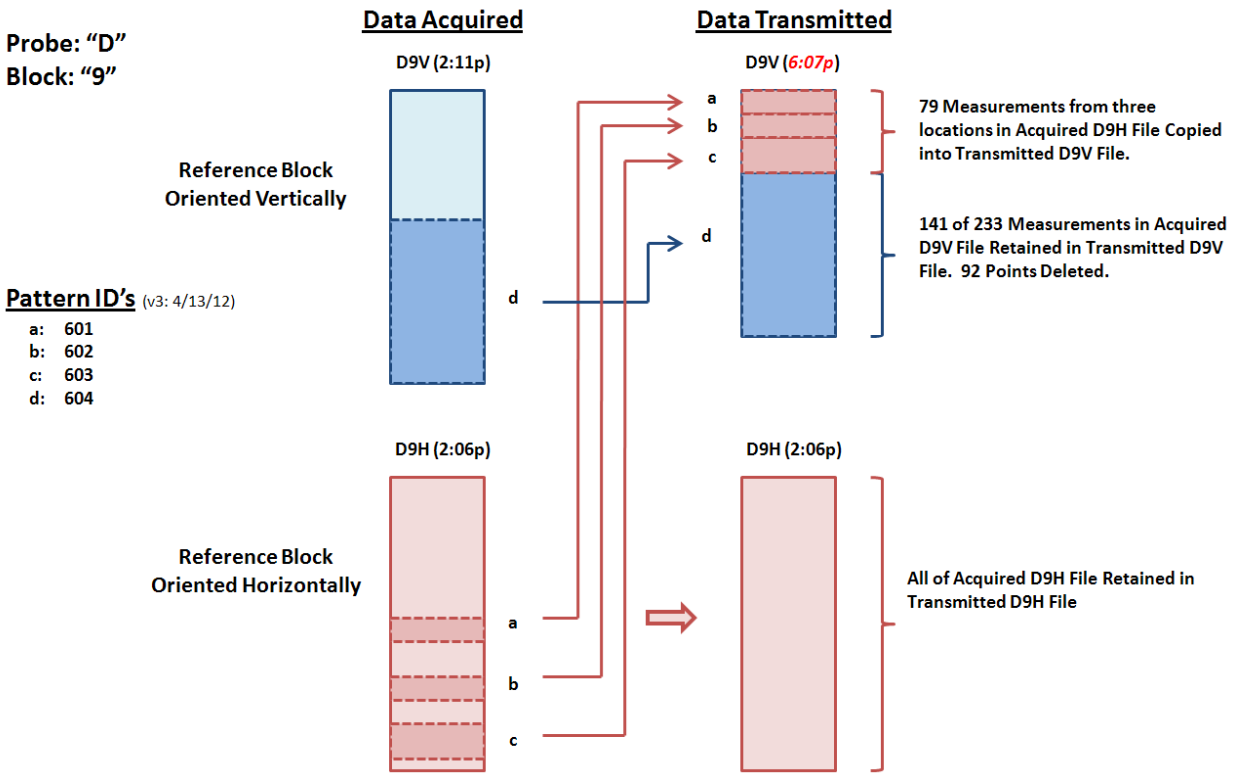


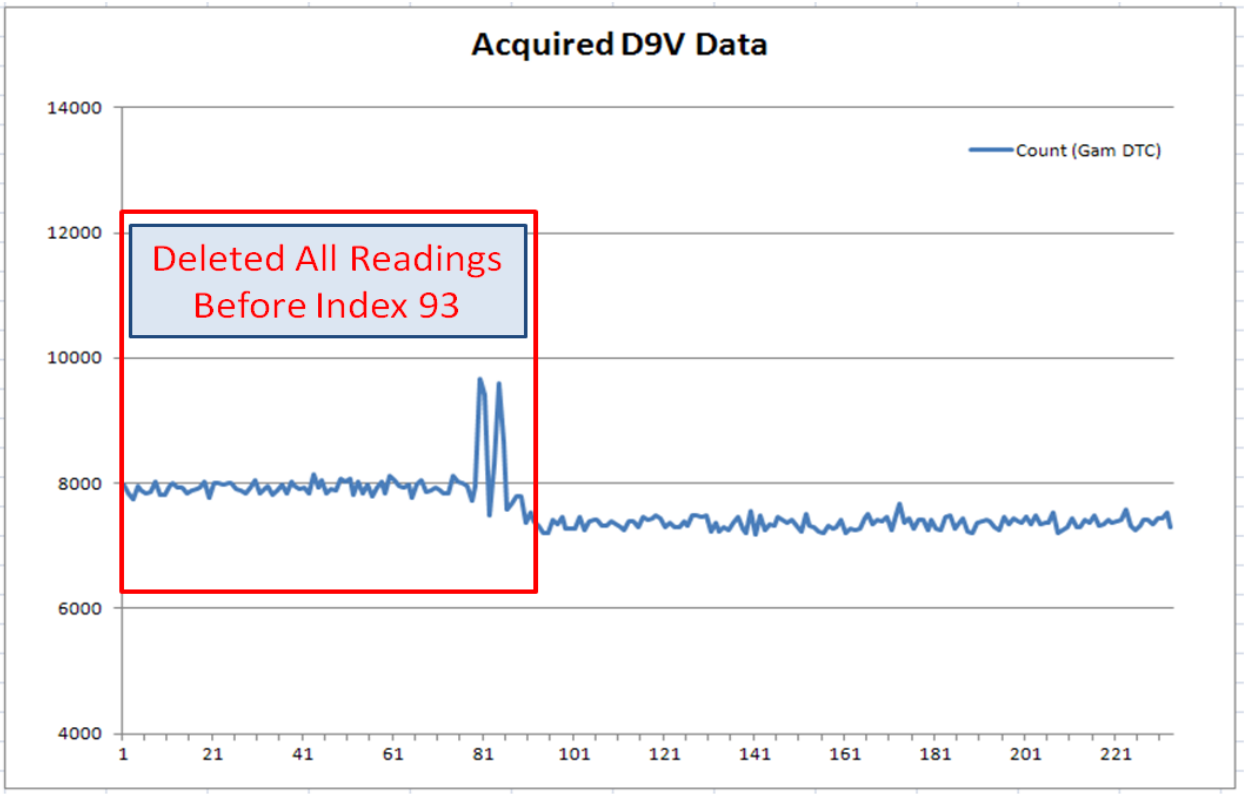
Fig. 2F.2 Patterns Used in Alteration of D9V.LAS File (ID-2f)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
601	24	224.859,224.867,226.116,224.646,225.325,224.863,226.094,224.163,226.411,224.503,225.867,224.460,224.417,224.902,225.963,225.405,224.051,225.570,225.635,226.026,224.760,223.689,226.312,225.258
602	25	225.917,223.577,226.108,224.674,224.310,225.396,225.351,224.710,225.590,225.416,226.224,226.610,224.949,224.217,226.002,226.007,226.143,225.786,225.124,225.425,225.651,224.693,224.560,224.528,225.150
603	30	225.334,223.790,225.338,224.614,224.736,225.742,224.607,224.841,225.009,225.318,224.580,225.858,225.431,225.230,225.273,224.953,225.195,225.727,223.915,224.586,225.468,224.988,225.052,224.721,225.217,224.642,224.700,224.975,225.381,226.283
604	141	224.458,225.362,225.325,223.613,224.104,223.207,224.753,224.723,224.708,223.354,224.835,223.894,223.689,223.704,224.460,224.287,223.885,224.240,224.554,224.964,223.913,223.775,224.603,223.241,223.611,223.396,223.124,223.474,224.642,224.085,224.580,224.642,223.828,224.387,223.048,223.151,223.335,223.030,225.035,224.078,225.063,224.565,225.016,223.930,223.373,224.717,225.230,222.503,225.540,223.057,224.850,224.249,224.460,223.291,223.604,224.042,223.691,224.396,225.035,222.994,224.424,224.490,225.063,225.353,224.421,224.753,224.616,223.619,225.290,224.730,224.850,224.659,223.440,222.854,224.127,223.706,223.843,223.335,224.910,222.979,221.727,223.970,223.423,224.659,223.653,223.636,224.895,223.573,224.816,224.844,223.300,223.073,224.657,224.246,223.474,225.130,225.230,224.068,223.858,223.697,223.790,224.545,224.906,223.346,224.274,223.472,223.765,224.100,223.209,224.127,223.151,224.163,223.936,223.983,222.673,225.360,224.921,224.545,223.531,224.554,224.588,223.664,224.076,223.180,224.368,224.155,223.583,224.025,223.902,223.723,222.480,224.443,224.996,224.287,223.725,223.712,224.104,223.398,223.508,222.784,224.528

Fig. 2F.3 Data Deleted from Acquired D9V.LAS File (ID-2f)

1/24/2007 Qualification Testing of FTB Standard Reference Blocks



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 3

Name: GGL Consultant LAS & LS files use linear calibration and different output format

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☒ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 3/13/12

Summarized by: Turner **Date:** 3/13/12

Reviewed by: Hannenian **Date:** 10/16/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Two groups of GGL Data Files, one LAS and one LS group, were flagged for irregularities during the calibration constant analysis. For the LAS files the tool found significant differences between the reported density and density determined from a calculation using the gamma count data and the regression to compute calibration constants. For the LogShell (LS) files, the same types of differences were found.

Discussion of Findings

Upon inspection of the LAS and LS files, it was found that these files contained density measurements based on a calibration using linear regression. Caltrans practice is to use a natural log based method for calibrating gamma count with density. At the time these tests were conducted, CTM-233 was not in place and a consultant could use any acceptable calibration method, including a linear calibration. Since the GamDat calibration constant tool performs a screening based on natural log, these files were flagged. No irregularity exists for these files.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 4

Name: **Manual Alteration of Density and Count Data in Calibration File**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☒ Calibration Constant ☐ Correlation
☐ Depth Consistency ☒ Time Stamp
☒ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 10/22/12
Summarized by: Wahleithner **Date:** 10/22/12
Reviewed by: Hannenian **Date:** 11/6/2012

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Calibration Analysis

The MSLog program converts gamma counts to density through application of a set of calibration factors and the presence of additional calibration constants within the same data set indicates gamma counts and/or density values were changed.

The LAS file shown in Table 1 was flagged by the Calibration Analysis because the file contains one or more rows of data with calibration constants that do not match the calibration constants for the rest of the data set.

Table 1: ID-4 Calibration Results

Unique File ID	Date	Filename	File Path	Reason
13652	10/19/04 10:00	568-147.LAS	…avorites/GAMMA/cal/568-147.LAS	Inconsistent Calibration Constant. Constant A: -0.017220407107414. Constant B: 12.641245075628 Minimum in Density Delta: -1.003577372946. Maximum in Density Delta: 0.8753170507847.

RD-LAS Fidelity

The same LAS file shown above in Table 1 was also flagged by the RD-LAS Fidelity Analysis indicating the data in the LAS file is not identical to the data contained in the RD file (raw data file), as shown below in Table 2.

Table 2: ID-4 RD-LAS Fidelity Results

las_rd_pair_id	unique_file_id	File Path	Flag Reason
29205	13652	…avorites/GAMMA/cal/568-147.LAS	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13652 UNIQUE RD FILE ID:5551
29205	5551	…Favorites/GAMMA/cal/568-147.rd	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13652 UNIQUE RD FILE ID:5551

RD-LAS Timestamp

The same LAS file shown above in Tables 1 and 2 has a 'file modified' timestamp that is more than 11 minutes later than the 'file modified' timestamp for the corresponding RD file. This discrepancy between the LAS and RD 'file modified' timestamps indicates the LAS file was opened and edited after logging the inspection pipe.

Table 3: ID-4 RD-LAS Timestamp Discrepancy

las_rd_pair_id	unique_file_id	filepath	flag_reason	Diff (h:m:s)	Diff (days)
29205	5551	…Favorites/GAMMA/cal/568-147.rd	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 09:49:36	0:11:22	0
29205	13652	…avorites/GAMMA/cal/568-147.LAS	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 10:00:58	0:11:22	0

Discussion of Findings

The findings of the Calibration Analysis, RD-LAS Fidelity Analysis, and RD-LAS Timestamp Analysis indicate the LAS file was edited after data collection. The RD file was replayed through the MSLog software and a new LAS file was generated. The new LAS file was compared to the original LAS file with the 'file modified' timestamp approximately 11 minutes later than the corresponding RD file. The comparison found that 8 rows of data were deliberately edited. The data appears to have been manually edited rather than changed through a 'copy' and 'paste' method. Density values were increased by an integer, or whole, number of 1, 2, and so forth. Likewise, the corresponding gamma counts for the gamma count and 'dead time' corrected counts were also changed by integer values of 100, 200, and so forth. This resulted in artificial calibration constants for the edited rows of data. A comparison of the original LAS file found on the technician's computer and the new LAS file generated through replay is shown below.

Table 4: ID-4 Comparison of Original

Original Data From Technician's Computer				Replay Data Generated From RD File				Differences			
-21495.4	21157	24380.9	147.482	-21495.4	21157	24380.9	147.482	0	0	0	0
-21495.4	21320	24597.6	146.97	-21495.4	21320	24597.6	147.97	0	0	0	1
-21495.4	21400	24704.2	146.72	-21495.4	21400	24704.2	147.72	0	0	0	1
-21495.4	21601	24972.4	146.096	-21495.4	21601	24472.4	147.096	0	0	-500	1
-21495.4	21923	25403.8	145.106	-21495.4	21923	24403.8	147.106	0	0	-1000	2
-21495.4	22999	26859.9	141.884	-21495.4	21999	24259.9	147.884	0	-1000	-2600	6
-21495.4	23123	27029.2	141.521	-21495.4	21123	24129.2	148.521	0	-2000	-2900	7
-21495.4	23910	28110.8	139.253	-21495.4	21910	24110.8	147.253	0	-2000	-4000	8
-21495.4	22426	26081.7	143.584	-21495.4	22426	24181.7	147.584	0	0	-1900	4
-21495.4	21021	24200.5	147.911	-21495.4	21021	24200.5	147.911	0	0	0	0

There appears to be no subsequent impacts to projects as a result of the editing of the LAS file. The GamDat team confirmed that the altered data file was not used for establishing calibration parameters. However this irregular LAS file was designated a case because it represented a key finding of the GamDat team. This is the earliest known example of a technician opening a LAS file and changing the data (October 2004). It also represents the only known case where data was edited manually one value at a time.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 5

Name: Depth in Header Not Matching Depth In Data Set (Br. 23-0215, Bent 20 Right, Tube 4)

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

This file was flagged because the 'Stop' Depth in the file header does not match the actual stop depth in the data set.

```
~WELL INFORMATION
STRT    .FT                138.954   :START DEPTH
STOP    .FT                109.141   :STOP DEPTH
STEP    .FT                      0   :STEP
NULL    .                  -999.25   :NULL VALUE
~PARAMETER INFORMATION
Dept    .                      105   :Depth Logger
COMP    .        ANDERSON           :COMPANY:
Dept    .                           :Depth Driller
File    .        215-60-91 BENT 16  :File Name
Date    .                 4/12/2005 :Date
Logg    .        WILES  DEKENS      :Logged by:
~OTHER
~A
138.954   19516        22227.2                    154.996
138.854   19726          22500                    154.234

3.44891   27173        32731.9                    130.806
3.34921   27012        32498.6                    131.254
 3.2495   26719        32075.4                    132.073
3.14979   27493        33197.3                    129.924
```

Company and Highway Do Not Match Benicia North Approach Project and was likely left unchanged from previous testing.

Rows are hidden for presentation.

The file was deliberately edited.

RD files were not recovered so there was no chronology check by the program. However, even without the RD files and the actual acquisition time, the LAS files indicate the actual chronology has problems. These inspection pipes were 138' so the estimated test time is (15 seconds to move, 2.7 minutes to lower the probe, 15 seconds to setup the computer, and 9.2 minutes to acquire data (138 feet at 15 fpm). The total is 12.4 minutes. The actual time is 8 minutes 50 seconds elapsed time between saving Tube 6 and 4 (the last two files).

Table 1: Br. 23-0215R Bent 20 Right Tube 4

File ID	File Save Time	Elapsed Time
B20rt7.las	11:51:18	
B20rt8.las	12:05:40	14:22.0
B20rt1.las	12:20:18	14:38.0
B20rt2.las	12:35:20	15:02.0
B20rt3.las	12:49:08	13:48.0
B20rt5.las	13:16:58	27:50.0
B20rt6.las	13:31:56	14:58.0
B20rt4.las	**13:40:46**	**08:50.0**

9 minutes required to collect data on way up.

Discussion of Findings

Without the RD files the extent of editing is unknown.

It's likely the chronology shown above may be explained if the Tube 4 inspection pipe was logged between Tubes 3 and 5, and then opened and edited after testing was completed. This has been confirmed by the Daily Field Report where the technician noted the file save times and testing sequence.

The "Step=0" in the header suggests that the data was collected in Time Mode and a partial double-transit occurred. If the Tube 4 file had been opened and edited to delete redundant down travel data, it would explain why the header 'Stop' depth does not match the data set 'Stop' depth. This also explains why the time stamp for the Tube 4 data file follows Tube 6.

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

DAILY FIELD REPORT

MR-1109 (REV. 7/94)

EA 04-006063	SHEET 1 OF	
PROJECT: Seismic Retrofit Contractor	DST/CO/RTE/PM: 04-ca/Sol-680 & 780	DAILY FIELD REPORT SEQUENCE NO.
BRIDGE NO.: 23-0215R	BENT NO.: Bent 20 P1 & 2	DATE: 5-13-08 / DAY OF WEEK
R.E. OR STRUCTURE REP.: Leah Stevenson	FT&I REP.: Wiles / Dekein	WEATHER: Clear.

TYPE OF WORK: Gamma Gamma

NOTES (Describe work completed during the day, any problems and their solutions)

Arrived job site 8:30AM B20 L

started taping 9:19AM

P2T1 9:35 T2 9:55 T3 10:09 T4 1026

T5 10:40 T6 1055 T7 11:11 T8 11:24

Finish PP 11:34

Start PR 11:35 Brian said to give Lab Files to Jamie

PR T1 11:41 T8 11:57 T1-1209 T2 12:27

T3 12:42 T4 1255 T5 100 T6 1:22

Finish 2:10pm

Gave copy of Lab files to Condon foreman on job site as per Nancy

HOURS WORKED	REGULAR HOURS	OVERTIME HOURS	CONTINUED
10	8	2	☐

RECEIVED BY: COPY GIVEN TO:

FM 1883 M 94 PROJECT FOLDER: OFFICE-WHITE, FIELD-CANARY, STRUCTURE REP-GOLDENROD

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**6**
Name:	*(This irregularity has been documented under ID-51.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 7

Name: RD-LAS Fidelity Issue

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☒ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 9/24/12

Summarized by: Wahleithner **Date:** 9/24/12

Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

A fidelity and time stamp discrepancy was found between the following RD and LAS files from the same bridge, abutment, pile and inspection tube location:

…/26-0050 - Dry Creek Bridge (Replace) (GGL)/Abutment 4/Piles 7-10/Raw data/P7T1.LAS and

…/FTB_Server_2007_WD1200/C/WILES/doc/My Documents/Favorites/GAMMA/DryCreek/ABUT 4/P7T1.rd

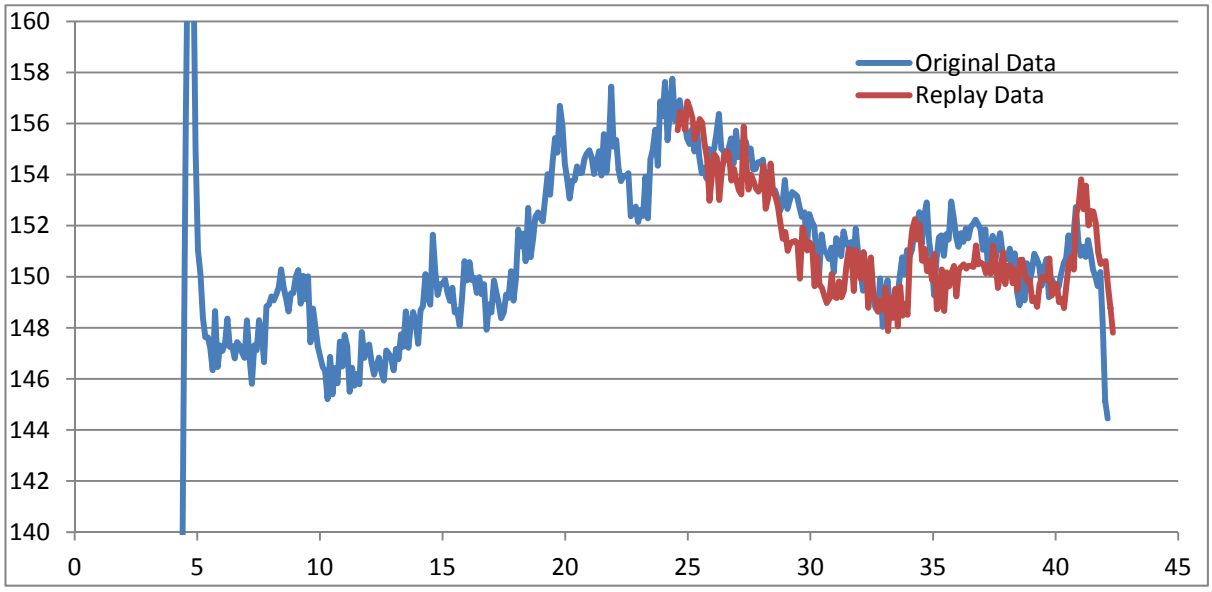
Forensic copy of the Technician's hard drive contains a folder of gamma data for the 'Dry Creek' project. This folder has 3 sub-folders for Abutment 4, Pier 2, and Pier 3. It was noted through observation that Abutment 4 contained only a single partially-complete rd file for Pile 7, Tube 1 (P7T1.rd) whereas Pier 2 and Pier 3 contain both rd and las files for all tubes and are complete. It was further noted that the FTB archive contained only a LAS file for Pile 7, Tube 1 (P7T1.LAS). It was noted that there was a timestamp discrepancy between the rd file on technician's hard drive and the LAS file found on the FTB archive.

Location Found	File Name	Time Stamp
Technician's Computer Hard Drive	P7T1.rd	Friday, July 29, 2005, 8:54:24 PM
FTB Archive	P7T1.LAS	Friday, July 29, 2005, 9:11:08 AM

.

Discussion of Findings

A new LAS file (Replay Data) generated from the RD file found on technician's computer hard drive was compared and found to contain different data than the LAS file found on the FTB Archive (Original Data) and used in the engineering analysis.



The RD file, which has a time stamp of 17 minutes earlier than the LAS file, was rerun through the MSLog program and a new LAS file generated. This file is incomplete and is missing data between the top of pile and a depth of approximately 24.5 feet.

It is likely that the tube was immediately retested in the field and the RD file from the technician's computer hard drive represents the first test and the LAS file found on the FTB Archive represents the retest.

A correlation analysis using the *Empirical Sigma-Delta Analysis Method* appears to support the assertion that both data sets were collected from the same tube. Note, however, that correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

Summary of Empirical Sigma-Delta Analysis

Manual Analysis ID: 7

Name: RD-LAS Fidelity Issue at 26-0050 Dry Creek Br., Abut 4, Pile 7, T1

Analyzed by: L. Turner **Date:** 10/23/12

Calculation of Sigma-Delta

A Sigma-Delta value was calculated for two sets of data assumed to have been run on Tube 1. The calculated sigma-delta results were then evaluated using the Empirical Sigma-Delta Method. Results are summarized in the table below.

	T1a	T1b						
T1a	--	0.54	--	--	--	--	--	--
T1b	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--
	--	--	--	--	--	--	--	--

Were the two files for P7T1 from the same tube?

The sigma-delta value for this tube-pair combination was calculated to be 0.54. When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where only rerun tests were observed.

Limitations

A correlation analysis using the *Empirical Sigma-Delta Analysis Method* appears to support the assertion that both data sets were collected from the same tube. Note, however, that correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**8**
Name:	*(This irregularity has been documented under ID-2.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 9

Name: **Depth in Header Not Matching Data Block & Irregular Testing Chronology (Br. 53-2918 Bent 18)**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☐ Calibration Constant ☐ Correlation
☒ Depth Consistency ☒ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12
Summarized by: Wahleithner **Date:** 6/26/12
Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

This file was flagged because the 'Start Depth' in the header does not match the start depth in the data set.

```
~VERSION INFORMATION
VERS      .2.0                          :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP      .NO                           :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT      .FT                 3.14979   :START DEPTH
STOP      .FT                 3.05008   :STOP DEPTH
STEP      .FT                       0   :STEP
NULL      .                    -999.25  :NULL VALUE
COMP      .       C&J                   :COMPANY:
Dept      .                             :Depth Driller
File      .       brea                  :File Name
Witn      .                             :Witness:
Loca      .       bent 18               :Location:
Date      .                 8/22/2005   :Date
Logg      .       WILES  PEROUTKA       :Logged by:
~OTHER
~A
 127.088  16506          18404.7              155.122
 127.188  16398          18270.5               155.54
 126.989  16871          18859.6              153.727
 126.889  16857          18842.1               153.78
 3.14979  31659          39468.6              111.528
```

The Start Depth in Header and Data Set Do Not Agree.

There is an unusual change in depth readings and reversal in probe direction over last three depth measurements.

Rows of Data Hidden For Presentation

3.05008	32190	40297.3	110.34

Discussion of Findings

The file was deliberately edited. RD files were not recovered so full extent of editing is unknown.

One possible explanation is that this is a case of a 'double-transit' where the recording started at the top of the tube and continued for both the 'down' direction and then the 'up' direction. The file was then saved when the probe returned to the top of the tube. After testing of the pile was completed, this file may have been opened in the field and the data recorded in the 'down' direction deleted. This would explain why the last three depths are not consistently decreasing. The technician inadvertently left depth 127.088 when cutting out all data from the 'down' trip.

This scenario would also explain the chronology problem that exists between Tube 10 and Tube 7 as shown below in Table 1.

Table 1: Br. 53-2918 Bent 18 Chronology

Unique File ID	File Name	Approximate Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
6237	breab18t1.las	128	2005-08-23 15:08:44	0:00:00	0:00:00
6239	breab18t2.las	128	2005-08-23 15:21:26	0:12:42	0:12:16
6240	breab18t3.las	128	2005-08-23 15:35:46	0:14:20	0:12:22
6241	breab18t4.las	128	2005-08-23 15:49:12	0:13:26	0:12:21
6242	breab18t5.las	128	2005-08-23 16:03:36	0:14:24	0:12:19
6243	breab18t6.las	128	2005-08-23 16:18:34	0:14:58	0:12:34
6245	breab18t8.las	128	2005-08-23 16:45:54	0:27:20	0:12:22
6246	breab18t9.las	128	2005-08-23 16:59:08	0:13:14	0:12:20
6238	breab18t10.las	128	2005-08-23 17:14:34	0:15:26	0:12:19
6244	breab18t7.las	128	**2005-08-23 17:20:02**	**0:05:28**	**0:12:19**

The pile was approximately 128' in length and recording in the 'up' direction alone would require approximately 9 minutes. The elapsed time between Tubes 10 and 7 is approximately 5.5 minutes. There is not enough time to move the probe from Tube 10 to Tube 7, setup the file, lower the probe to the bottom of Tube 7, and raise and record in Tube 7.

There is enough time to complete the Tube 7 testing if we assume the Tube 7 test occurred chronologically between the Tube 6 test and Tube 8 tests. There is more than 27 minutes of elapsed time between tests at Tube 6 and 8. This amount of time would cover testing both Tubes 7 and 8, estimated to require approximately 24 minutes, as shown below in Table 2.

Table 2. Estimated Test Time for Tube 7 and Tube 8

		Estimated Duration (Minutes)
Tube 6	Save Tube 6 File	0.00
Tube 7	Move From Tube 6 to Tube 7	0.25
	Lower To Bottom of Tube 7	2.44
	Setup Tube 7 File	0.25
	Raise and Acquire Data Tube 7	9.07
	Save Tube 7 File	0.00
	Total Time	12.01
Tube 8	Move From Tube 7 to Tube 8	0.25
	Lower To Bottom of Tube 8	2.44
	Setup Tube 8 File	0.25
	Raise and Acquire Data Tube 8	9.07
	Save Tube 8 File	0.00
	Total Time	12.01
	Total Time Tube 6 and 8	24.03

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 10

Name: Irregular Testing Chronology, 56-0802F, SE Connector, Bent 15, Tube 14

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☒ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Roblee **Date:** 4/12/12
Summarized by: Roblee **Date:** 12/10/12
Reviewed by: Hannenian **Date:** 12/11/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☐ Certain ☐ Likely ☒ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

ID-10 is a plausible instance of an inappropriate retest occurring on May 3, 2005 at Bent 15 of the SE Connector (SB 215 – EB 215). It is suspected that data acquired by a retest of tube 13 was reported as independent data for tube 14. The impact of this irregularity is that the Department may have no GGL data to assess the uniformity of concrete surrounding tube 14.

Discussion of Findings

Summary

The existence of a GGL data irregularity is based on strong chronological evidence whereby it was physically infeasible to complete testing as reported using typical procedures within the constraints of documented chronological facts, while the suspected retest is fully consistent with these same facts. Consideration was given to alternative testing scenarios involving use of three atypical procedures (i.e. free-wheel down-transit, free-wheel up-transit, and faster recording speed), but all of these were found to be physically infeasible when considered separately. Additional scenarios were considered involving various combinations of the atypical procedures. Only the combined use of *all three atypical* procedures yielded equipment-repositioning time intervals approaching those observed at this site for other tests using *typical* procedures. The GamDat team considered the potential for sudden change in all three operational procedures for this single test to be unrealistic relative to the retest scenario which fully accounts for the chronology facts using only typical procedures. Prototype correlation analysis yielded mixed results, but did not refute the possibility of retest. The lower 'plausible' level of confidence is assigned in this case because of the judgments required for interpretation of the chronology scenarios and because of the mixed correlation analysis results. The cause of the irregularity, whether intentional or inadvertent, could not be determined through examination of the data alone.

Background

ID-10 is one of three instances of retest irregularity (also see ID-11 and ID-17) that involve the isolated use of an atypical testing procedure referred to herein as a "double-transit". The *typical* testing procedure used on nearly all (>99.9%) Caltrans GGL tests to date involves lowering the probe to the bottom of tube (i.e. 'down-transit') without recording data, then initializing the DAQ (to 'depth-up mode') and recording data with the probe moving back up to the top of the tube (i.e. 'up-transit'). The data file is typically (but not necessarily) saved with the probe at the top of the tube where data was acquired. The *atypical* 'double-transit' procedure involves initializing the DAQ (to 'time mode') after the probe is lowered to the bottom of the tube, then recording for both an 'up-transit' and a subsequent 'down-transit'. The data file is necessarily saved at the end of the second down-transit while the probe is at the bottom of the tube for a second time. This is a critical fact for establishing chronology evidence in these double-transit cases; that is, by DAQ software design, the 'time mode' setting saves the data file immediately after recording is stopped at the logged probe position at that time.

It is important to note again that there is nothing improper about either using the 'time mode' DAQ setting or in testing the tube twice (i.e. up-transit and down-transit). However, it is precisely because of the use of this atypical testing sequence that a compelling chronological case for retest could be established. *Similar retests could have occurred when using the typical testing procedure that could not be definitively detected using chronological evidence.*

Unlike ID-17 where the raw data (RD) file was able to be recovered, no RD file could be located for ID-10. Therefore, chronological analysis of this case (and ID-11) required that certain testing procedures be assumed regarding the probe speed during both the non-recording down-transit and recording up-transit. Both typical and atypical procedures were considered in the analysis as detailed below. Chronological data is presented for testing of adjacent tubes to demonstrate the reasonableness of the assumptions employed.

Details of ID-10 Chronology Analysis

Turning to the specifics of ID-10, the chronological analysis is summarized in attachment 10A. Figure 10A.1 provides a key to the graphics used in subsequent figures. GGL tests were reported to have occurred in fourteen tubes in the pile at Bent 15 before noon on 5/3/2005. Chronological evidence for a representative selection of these tests (tubes 6 through 14) is summarized in attachment 10A. Testing in tubes 1 through 12 and 14 employed the typical testing procedure involving the following steps:

1. The probe was positioned at the top of a tube (e.g. positions 7a, 8a, etc.).
2. The probe was lowered to the bottom of the tube (e.g. positions 7b, 8b, etc.). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'depth-up mode' while the probe was at the bottom of the tube.
4. The probe was raised to the top of the tube while recording (depicted as a red arrow for a 'recording transit').
5. The probe was repositioned to the next tube (e.g. moved from position 7c to 8a), and the process was repeated.

For unknown reasons, an atypical procedure (herein called a "double-transit") was employed for testing of tube 13. In this instance, the following steps were involved:

1. The probe was positioned at the top of a tube (i.e. position 13a).
2. The probe was lowered to the bottom of the tube (i.e. position 13b). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'time mode' while at the bottom of the tube (i.e. position 13b).
4. The probe was raised to the top of the tube (i.e. positions 13b to 13c) while recording, then the direction was reversed and the probe was returned to the bottom of the tube (i.e. positions 13c to 13d) while continuing to record (depicted as a pair of red arrows for the double 'recording transits').
5. At the end of recording, the probe was again at the bottom of tube 13 (i.e. position 13d) where the data file was saved.
6. If the typical testing procedures implied in the GGL report were to have occurred, the probe would need to be raised to the top of tube 13 (i.e. positions 13d to 13e), repositioned onto tube 14 (i.e. positions 13e to 14a), then lowered to the bottom of tube 14 (i.e. positions 14a to 14b) before data could have been acquired in tube 14 during the up-transit (i.e. position 14b to 14c). However, the chronology data indicate this was highly unlikely, and instead, data reported for tube 14 is suspected to have been recorded on the

final up-transit in tube 13 (i.e. positions 13d to 13e).

A complete description of the testing chronology requires knowledge of both time and probe position. The time stamp on the GGL data file unambiguously establishes the time when the file was saved. In figures 10A.2, 10A.3 and 10A.4, the assumed positions associated with the time stamp are denoted by flags. Using the typical 'depth up mode' procedure, the file save location was assumed to be at the top of the tube immediately after the recording transit (e.g. positions 7c, 8c, etc.). This assignment is based on common practice both observed and stated by Caltrans GGL technicians. However, it must be noted that the GamDat team has determined that it is feasible to reposition the probe to as far as the bottom of the subsequent tube before saving the file while the DAQ is in depth-up mode. That scenario is not considered typical practice, and more importantly, has no bearing on the ID-10 analysis since the suspect data was acquired immediately after the double-transit where the DAQ had been set to 'time mode'. The key feature of using the 'time mode' setting on the DAQ is that the probe position is known at the time the file was saved. In ID-10, that position is the bottom of tube 13 (i.e. position 13d). The nearest position which data reported as tube 14 could have been recorded is at the top of tube 14 (i.e. position 14c).

Figures 10A.2, 10A.3 and 10A.4 consider alternative chronological scenarios for where and how data reported for tube 14 may have actually been recorded. The information highlighted in yellow pertains directly to the assumptions and calculations that change between scenarios. Figures 10A.2 and 10A.3 consider alternative procedural scenarios assuming the data reported for tube 14 indeed came from tube 14 (i.e. recording from positions 14b to 14c). Figure 10A.4 considers the suspected retest scenario where the data reported for tube 14 actually came from tube 13 (i.e. recording from positions 13d to 13e). Timelines are presented for each scenario. For all scenarios, data is also presented for testing of adjacent tubes (i.e. 6 through 12) to illustrate that the analysis yields reasonable results for all but the suspect test reported for tube 14 as well as to demonstrate the effects of alternative procedural assumptions.

Figure 10A.2 presents the timeline assuming testing occurred as reported and the typical probe rate of 15 fpm was used for the recording transits (red arrows). Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as tube 14 is located at position 14c. Based on time stamps, the time interval between positions 13d and 14c is known to be 6 minutes and 34 seconds. The fastest time required to record data from position 14b to 14c using typical procedures is 5 minutes and 01 seconds assuming the probe speed was 15 fpm while in concrete (67 ft) and 52 fpm while above concrete (28.5 ft). This leaves <u>1 minute and 33 seconds for the probe to be moved from position 13d to 14b</u>.

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 13d-to-13e and 14a-to-14b) as discussed below:

i. Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 98.5 feet, approximately 1 minute and 50 seconds is required for each non-recording transit. Therefore, a total of 3 minutes and 40 seconds would be required just for the transits. <u>This exceeds the 1 minute and 33 seconds available by approximately 2 minutes and 7 seconds</u>, without considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). This scenario <u>is physically infeasible</u>.

ii. The first of two scenarios involving atypical procedures assumes the probe was disengaged from the winch and allowed to 'free-wheel' on the downward non-recording transit (i.e. positions 14a to 14b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 10 seconds. Assuming the winch is used to raise the probe, a total of 2 minutes is required for the transits. However, this <u>exceeds the 1 minute and 33 seconds available by approximately 27 seconds</u>, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). Thus, this scenario <u>is also physically infeasible</u>.

iii. The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on *both* the upward and downward non-recording transits (i.e. positions 13d-to-13e and 14a-to-14b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 19 seconds, and total time for both non-recording transits could be reduced to 29 seconds. Under these assumptions, <u>a positive 1 minute and 4 seconds is available</u> for repositioning the probe to the new tube (i.e. positions 13e to 14a). While this is physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a

chronology that is considered feasible, but unusual.

Figure 10A.3 considers the same three operational scenarios as those discussed above except, in addition, that an atypical probe speed of 20 fpm, rather than 15 fpm, is assumed while the probe was in concrete for the recording transits (red arrows). In this scenario, a total of 3 minutes and 54 seconds is required to complete the up-transit in tube 14 (i.e. position 14b to 14c), thus leaving 2 minutes and 40 seconds available for the probe to be moved from position 13d to 14b. The three operational scenarios for the non-recording transits are discussed below:

i. The first scenario assumes the winch is engaged for both non-recording transits. Again assuming a typical maximum winch speed of 52 fpm, approximately 1 minute and 50 seconds is still required for each non-recording transit (i.e. positions 13d to 13e, and 14a to 14b). The total of 3 minutes and 40 seconds required for just the transits exceeds the 2 minutes and 40 seconds available by approximately 1 minute, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 13e to 14a). Thus, this scenario is also physically infeasible.

ii. The next scenario considered combined use of two atypical procedures where both a recording speed of 20 fpm is assumed and the probe is allowed to fall the full length of tube 14 under free-wheel conditions. Under these assumptions, a positive 40 seconds is available for repositioning the probe to the new tube (i.e. positions 13e to 14a). While this is physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

iii. The final scenario to account for the reported test location considered combined use of all three atypical procedures: the recording speed is 20 fpm, the probe is free-wheeled on the down-transit at 550 fpm and also free-wheeled (i.e. manually pulled) on the up-transit at 300 fpm. Under these assumptions, a positive 2 minutes and 11 seconds is available for repositioning the probe to the new tube (i.e. positions 13e to 14a). This time interval is clearly feasible and approaches those observed at this site for other tests using *typical* procedures. However, the GamDat team considered the potential for sudden and isolated change in all three operational procedures for this single test to be unrealistic.

Finally, Fig. 10A.4 presents a timeline for the suspected scenario where data reported for tube 14 actually came from tube 13 (i.e. recorded from positions 13d to 13e) and normal testing procedures are used. Physically, this scenario eliminates the need for repositioning the equipment to the bottom of tube 14, and the only tasks required to be completed within 1 minute and 33 seconds in non-recording time available is to initialize the DAQ system for recording. Experienced GamDat team members estimate approximately 15 seconds is required to complete this task. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

Overall, the only two operational scenarios that yield chronologies that are reasonably consistent with other tests at this site are the suspected retest or the sudden and isolated use of three atypical procedures for this single test. The GamDat team considered the retest scenario to be a more reasonable explanation, and concluded that it is at least plausible that results reported for tube 14 were actually retest data obtained in tube 13.

Findings of ID-10 Correlation Analysis

A supplemental prototype 'correlation analysis' based on the 'sigma-delta (SD)' metric was also conducted for ID-10 to examine the similarity between data recorded in tube 13 and the suspect data reported for tube 14. Sigma delta is one of many alternative metrics that could be used to quantify the similarity of two GGL test data sets. It is evaluated as the standard deviation (i.e. 'sigma') of the difference (i.e. 'delta') between pairs of depth-aligned density values for two reported GGL tests over a selected depth range. Attachment 10B presents results of the correlation analysis.

Figure 10B.1 presents two tables of SD values calculated independently by two GamDat analysts for various tube-pair combinations within the pile. Because this case involved a double-transit, the data included one SD value for a known retest pair (T13up-T13down) and two SD values for the suspected retests (T13up-T14up, T13down-T14up) where the 'T14' label indicates data reported for tube 14 but is suspected of being a retest of tube 13. In Fig 10B.1, the SD value for the known retest is highlighted in green, and those for the suspected retests are highlighted in red and orange. Those highlighted in black represent the NO-Retest values that were smaller than either the known or suspected YES-Retest values.

Two sets of independent calculations are presented in Fig. 10B.1 to illustrate the effects of data preprocessing decisions made by the analyst. The most important decision is the selection of 'depth range considered', but the alignment of data traces can also affect the SD value. The two sets of SD values presented in Fig. 10B.1 used different specific limits for depth-range considered where those limits are listed below each table. Even using somewhat different depth ranges, the SD values for the known and suspected YES-Retest values are quite similar.

Likewise, although some differences are observed between individual NO-Retest values, the overall trends are comparable. The values in the left table are used in various correlation analysis methods. For both the 'empirical method' and the 'global RDA method', only the YES-Retest values are used, so the small variations between analyst's decisions have insignificant effect on the results. For the local RDA method, the NO-Retest values are used to establish NO-Retest statistics for this specific pile, and the values in the table on the left are representative.

Figure 10B.2 presents processed GGL data as a function of depth. Note that the vertical axis in both plots in Fig. 10B.2 is the index of the data point considered in the sigma-delta analysis. Since tubes are logged from the bottom, smaller numbers appear near the bottom. The 600 data points in the logs shown in Fig. 10B.2 represent approximately 60 ft of pile length.

The plot on the left in Fig. 10B.2 shows 'tube remainders' for individual GGL tests in ID-10. A tube remainder is a processed GGL test logs where the acquired data has been smoothed to eliminate high-wavenumber variations (chatter), the 1-D layer-cake density profile common to all tubes ('pile average') has been removed, and any uniform offset (DC component) is removed so the average over depth is zero. The tube remainder contains a combination of localized density variations unique to each tube ('tube signal') and random test-to-test variations ('testing noise'). The relative amplitude of the tube signal to testing noise determines the ease with which a GGL log can be uniquely identified. In the plot on the left in Fig 10B.2, the tube remainder for the two known transits in tube 13 (T13up, T13down) are shown in green, and the suspected retest (T14up) is shown in red. The tube remainders for the rest of the tubes are shown in light gray to illustrate typical NO-Retest data.

The plot on the right in Fig. 10B.2 shows 'tube remainder differences' for various tube-pair combinations for which SD values are tabulated. The 'tube remainder difference' is determined as the difference between tube remainders as a function of depth for a *pair* of GGL logs. Note that while only eight data traces are shown in the left plot (one for each tube), a total of 28 traces are shown in the right plot (one for each tube *combination*). Also note that the standard deviation of the tube remainder difference over the depth range considered *is* the sigma delta value. Small sigma delta values are indicative of greater similarity between tube signals, with random testing noise comprising most of the value. Large sigma delta values are indicative of large differences between tube signals in addition to the random testing noise. The traces in the right plot of Fig 10B.2 are color-coded to correspond to the SD values in the left table of Fig. 10B.1. The known retest pair (T13up-T13down) is shown as a green trace to correspond with the SD value is highlighted in green in Fig. 10B.1. Similarly, the two SD values for the suspected retest pairs (T13up-T14up, T13down-T14up) are shown in orange and red colors. The five NO-Retest tube pairs having low SD values highlighted in black in Fig. 10B.1 are shown as black traces. The remaining NO-Retest traces are shown as thin gray lines, and provide a comparative reference for the degree of tube remainder deltas that are observed in this pile.

Results of the correlation analysis for each of three SD values (1 known retest pair and 2 suspected retest pairs) are summarized in the table and associated charts in Fig. 10B.3. The 1.22 value for both the known retest pair (T13up-T13down) and one suspected retest pair (T13down-T14) is within, but toward the high end of the range where instances of both YES-Retest and NO-Retest were observed in a global reference set developed by GamDat for use in correlation analysis. The 1.52 value for the second suspected retest pair (T13up-T14) is beyond the range of YES-Retest observations in the global reference set.

Figure 10B.3 presents several additional comparisons of the ID-10 SD values to statistical models of the global reference set data including percentiles of YES-Retest and NO-Retest data and 'Retest Likelihood'. Retest likelihood is the probability that a specific SD value being evaluated would be a YES-Retest in the reference set data as determined by the "Retest Discrimination Analysis (RDA)" method. For these purposes, three subsets of the global reference set data were considered, two that yield bounding (low and high) interpretations, and an intermediate 'best' estimate. The bounding subsets consider: 1) solely production GGL tests having known retests conducted prior to the GamDat investigation, and 2) all reference set data collected before and after the GamDat investigation. The difference between the bounding models is because the pre-GamDat data has higher mean SD values for both YES-Retest and NO-Retest conditions than the post-GamDat data; a difference which is attributed to tighter testing control in recent tests. The pre-GamDat data yields the 'high estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the low estimate of 'Percentile of No-Retest' data. Conversely, the use of all data (pre-GamDat and post-GamDat) yields the 'low estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the high estimate of 'Percentile of No-Retest' data.

Turning to findings for the three SD values evaluated for ID-10. The 1.22 SD value for both the known retest pair (T13up-T13down) and one suspected retest pair (T13down-T14) represents between the 4th and 16th percentile of YES-Retest values, and between the 14th and 36th percentile of all NO-Retest values in the global reference subsets. RDA indicates the 1.22 SD value would have between a 13% and 43% likelihood of retest in the global reference subsets. The RDA method also considered a 'local' reference for the NO-Retest model based on SD values for the other 25 tube pair combinations from the same pile (i.e. values not highlighted in color in Fig 10B.1). Figure 10B.3 shows the 1.22 SD value corresponds to 82% and 93% likelihood of retest using the local method. The 1.22 SD value is assigned the designation of plausible data irregularity by the global RDA method and likely

data irregularity by the local RDA method.

The 1.52 SD value for the second retest pair (T13up-T14) is beyond YES-Retest observations (max = 1.37) and near the high end of the YES-Retest model distribution. It represents between 1st and 4th percentile of YES-Retest and between the 40th and 60th percentile of all NO-Retest values in the global reference subsets. The RDA (both global and local) methods indicate the suspect-retest value of 1.52 would have between a 2% and 10% likelihood of being a retest in the reference subsets, and would assign a designation of undetermined to this value. The 'undetermined' designation means the SD value is not supportive of the possibility of retest, but is also insufficiently large to confidently refute the possibility of retest.

Overall, correlation analysis results for ID-10 yield mixed results regarding the likelihood of retest. Given that one SD value (1.22) is consistent with a known retest, it is concluded that it is at least plausible that the GGL test results reported for tube 14 were actually retest data obtained in tube 13.

References

Flagged by Depth Consistency

Flag ID	File ID	Unique File ID	Date	Filename	File Path	Reason
14	53303	7414	5/3/05 11:17	B15T13.LAS	…at Bent 15/Raw data/B15T13.LAS	Depths are not constantly incremented

All files for this pile:

Group ID	File ID	Unique ID	Date/Time	Filename	File Path
2735	53279	7410	2005-05-03 08:59:24	B15T1.LAS	… at Bent 15/Raw data/B15T1.LAS
2735	53315	7416	2005-05-03 09:10:06	B15T2.LAS	… at Bent 15/Raw data/B15T2.LAS
2735	53321	7417	2005-05-03 09:20:08	B15T3.LAS	… at Bent 15/Raw data/B15T3.LAS
2735	53327	7418	2005-05-03 09:30:16	B15T4.LAS	… at Bent 15/Raw data/B15T4.LAS
2735	53333	7419	2005-05-03 09:40:26	B15T5.LAS	… at Bent 15/Raw data/B15T5.LAS
2735	53339	7420	2005-05-03 09:49:42	B15T6.LAS	… at Bent 15/Raw data/B15T6.LAS
2735	53345	7421	2005-05-03 10:01:36	B15T7.LAS	… at Bent 15/Raw data/B15T7.LAS
2735	53351	7422	2005-05-03 10:11:48	B15T8.LAS	… at Bent 15/Raw data/B15T8.LAS
2735	53357	7423	2005-05-03 10:21:28	B15T9.LAS	… at Bent 15/Raw data/B15T9.LAS
2735	53285	7411	2005-05-03 10:30:52	B15T10.LAS	…at Bent 15/Raw data/B15T10.LAS
2735	53291	7412	2005-05-03 10:56:04	B15T11.LAS	…at Bent 15/Raw data/B15T11.LAS
2735	53297	7413	2005-05-03 11:05:02	B15T12.LAS	…at Bent 15/Raw data/B15T12.LAS
2735	53303	7414	2005-05-03 11:17:00	B15T13.LAS	…at Bent 15/Raw data/B15T13.LAS
2735	53309	7415	2005-05-03 11:23:34	B15T14.LAS	…at Bent 15/Raw data/B15T14.LAS

- Attachment 10A: Manual Chronology Analysis for ID-10
- Attachment 10B: Correlation Analysis Results for ID-10

Attachment 10A

Manual Chronology Analysis for ID-10

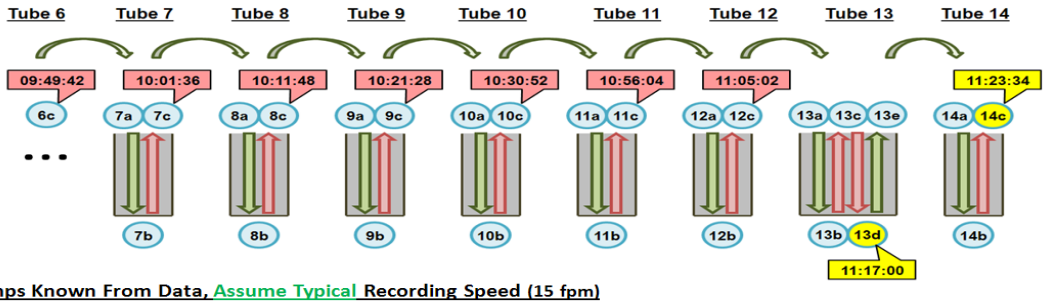
56-0802F – SE Connector (SB 215 – EB 215)
Pile at Bent 15
Testing Date: 5/3/2005

Concern: Retest of Tube 13 Reported As Independent Test of Tube 14

Fig 10A.1) ID-10 Chronology Analysis: Orientation to Figures

Concern: Retest of Tube 13 Reported As Independent Test of Tube 14

Fig. 10A.2) Chronology Analysis: Recording at Typical Rate



Time Stamps Known From Data, Assume Typical Recording Speed (15 fpm)

Probe Position:	6c	7a	7b	7c	8a	8b	8c	9a	9b	9c	10a	10b	10c	11a	11b	11c	12a	12b	12c	13a	13b	13c	13d	13e	14a	14b	14c
File Time Stamp:	09:49:42			10:01:36			10:11:48			10:21:28			10:30:52			10:56:04			11:05:02				11:17:00				11:23:34
Elapsed Time (Min:Sec)																											
Total Between Time Stamps:		11:54			10:12			09:40			09:24			25:12			08:58			11:58				06:34			
Recording (Estimated*):			05:01			05:01			05:01			05:01			05:01			05:01				06:51**				05:01
Non-Recording (Remainder):		06:53			05:11			04:39			04:23			20:11			03:57			05:07				01:33		

Assume Typical Procedure for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																											
Min NR Transit Time (Approx):		01:50			01:50			01:50			01:50			01:50			01:50			01:50				01:50			01:50
Balance for Repositioning:		05:03			03:21			02:49			02:33			18:21			02:07			03:17					-02:07		

Not Feasible

Assume Atypical Procedure for Down-Transit (Freewheel at 550 fpm)

Probe FreeWheeled Down Only (550 fpm)																											
Min NR Transit Time (Approx):		00:10			00:10			00:10			00:10			00:10			00:10			00:10				01:50			00:10
Balance for Repositioning:		06:43			05:01			04:29			04:13			20:01			03:47			04:57					-00:27		

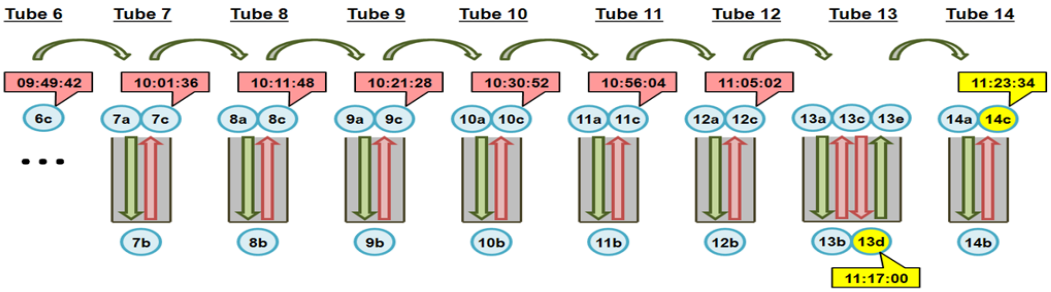
Not Feasible

Assume Additional Atypical Procedure for Up-Transit (Freewheel at 300 fpm)

Probe FreeWheeled Down (550 fpm) & Up for T13d-e (300 fpm)																											
Min NR Transit Time (Approx):		00:10			00:10			00:10			00:10			00:10			00:10			00:10				00:19			00:10
Balance for Repositioning:		06:43			05:01			04:29			04:13			20:01			03:47			04:57					01:04		

Feasible, But Unusual

Fig. 10A.3) Chronology Analysis: Recording at Atypical Rate



Time Stamps Known From Data, Assume Atypical Recording Speed (20 fpm)

Probe Position:	6c	7a	7b	7c	8a	8b	8c	9a	9b	9c	10a	10b	10c	11a	11b	11c	12a	12b	12c	13a	13b	13c	13d	13e	14a	14b	14c
File Time Stamp:	09:49:42			10:01:36			10:11:48			10:21:28			10:30:52			10:56:04			11:05:02				11:17:00				11:23:34
Elapsed Time (Min:Sec)																											
Total Between Time Stamps:		11:54			10:12			09:40			09:24			25:12			08:58			11:58				06:34			
Recording (Estimated*):			03:54			03:54			03:54			03:54			03:54			03:54				05:44**				03:54
Non-Recording (Remainder):		08:00			06:18			05:46			05:30			21:18			05:04			06:14				02:40		

Assume Typical Procedure for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																											
Min NR Transit Time (Approx):		01:50			01:50			01:50			01:50			01:50			01:50			01:50				01:50			01:50
Balance for Repositioning:		06:10			04:28			03:56			03:40			19:28			03:14			05:24					-01:00		

Not Feasible

Assume Atypical Procedure for Down-Transit (Freewheel at 550 fpm)

Probe FreeWheeled Down Only (550 fpm)																											
Min NR Transit Time (Approx):		00:10			00:10			00:10			00:10			00:10			00:10			00:10				01:50			00:10
Balance for Repositioning:		07:50			06:08			05:36			05:20			21:08			04:54			06:04					00:40		

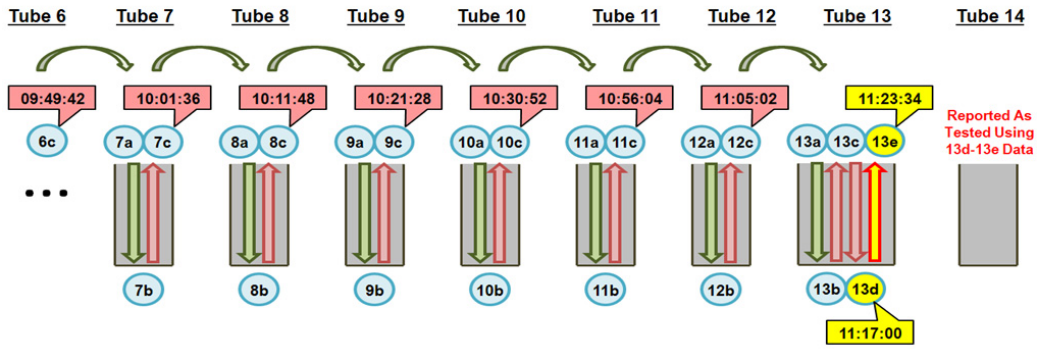
Feasible But Unusual

Assume Additional Atypical Procedure for Up-Transit (Freewheel at 300 fpm)

Probe FreeWheeled Down (550 fpm) & Up for T13d-e (300 fpm)																											
Min NR Transit Time (Approx):		00:10			00:10			00:10			00:10			00:10			00:10			00:10				00:19			00:10
Balance for Repositioning:		07:50			06:08			05:36			05:20			21:08			04:54			06:04					02:11		

Feasible

Fig. 10A.4) Chronology Analysis: Suspected Retest Scenario



Time Stamps Known From Data, Assume Typical Recording Speed (15 fpm)

Probe Position:	6c	7a	7b	7c	8a	8b	8c	9a	9b	9c	10a	10b	10c	11a	11b	11c	12a	12b	12c	13a	13b	13c	13d	13e
File Time Stamp:	09:49:42			10:01:36			10:11:48			10:21:28			10:30:52			10:56:04			11:05:02				11:17:00	11:23:34
Elapsed Time (Min:Sec)																								
Total Between Time Stamps:		11:54			10:12			09:40			09:24			25:12			08:58			11:58			06:34	
Recording (Estimated*):				05:01			05:01			05:01			05:01			05:01			05:01			06:50**		05:01
Non-Recording (Remainder):		06:53			05:11			04:39			04:23			20:11			03:57			06:57			01:33	

Assume Typical Procedures for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																								
Min NR Transit Time (Approx):		01:50			01:50			01:50			01:50			01:50			01:50			01:50			00:00	
Balance for Repositioning:	05:03			03:21			02:49			02:33			18:21			02:07			04:07			01:33*	

Feasible

NOTE: File-save location after double-transit is necessarily at bottom of Tube 13 (position 13d) based on DAQ constraints.

Attachment 10B

Correlation Analysis Results for ID-10

56-0802F – SE Connector (SB 215 – EB 215)
Pile at Bent 15
Testing Date: 5/3/2005

Concern: Retest of Tube 13 Reported As Independent Test of Tube 14

Sigma Delta Analysis Results

Foundation Location: ID-10: 56-0802F SE Connector Bent 15

TUBE LABEL		4	6	8	10	12	13u	13d	14
	Calc ID	1	2	3	4	5	6	7	8
4	1		1.59	1.59	1.65	1.63	1.77	1.58	1.49
6	2			1.49	1.56	1.75	2.03	1.94	1.71
8	3				1.31	1.69	2.01	1.97	1.74
10	4					1.82	1.68	1.80	1.82
12	5						1.63	1.49	1.38
13u	6							1.22	1.52
13d	7								1.22
14	8								

Depth Range Considered: Data Index 40-640

Sigma Delta Analysis Results

Foundation Location: ID 10: Hwy 215 SE Connector (SB 215 - EB215)

TUBE LABEL		4u-s	6u-s	8u-s	10u-s	12u-s	13u-s	13du-s	14u-s
	Calc ID	1	2	3	4	5	6	7	8
4u-s	1		1.62	1.65	1.73	1.61	1.88	1.69	1.58
6u-s	2			1.47	1.54	1.71	2.03	2.03	1.74
8u-s	3				1.32	1.65	2.03	1.99	1.72
10u-s	4					1.67	1.63	1.78	1.77
12u-s	5						1.61	1.43	1.29
13u-s	6							1.14	1.47
13du-s	7								1.21
14u-s	8								

Depth Range Considered: Data Index 1-565

Figure 10B.1) Independent calculations of sigma delta for ID-10 tube pairs. Numbers on left used in analyses.

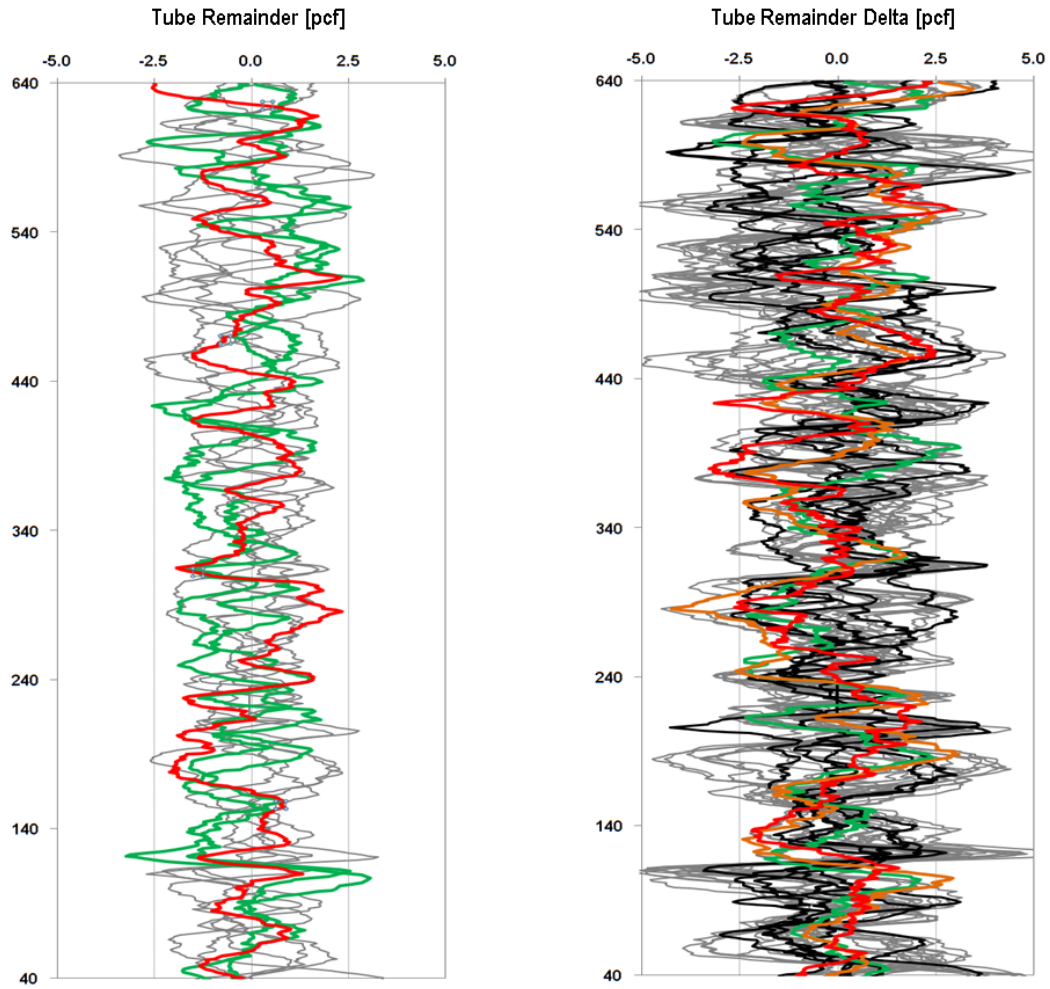


Figure 10B.2) ID-10 'tube remainder' and 'tube remainder delta' plots. (Green: known retest; Red: suspected retest)

Summary of Findings of Retest Discrimination Analysis

ID: ID-10 (C02-R14): Hwy 215 SE Connector, Bent 15

Finding: The two sigma delta values evaluated for this site yield mixed results. One value is in the range considered 'plausible' to 'likely' retest while the other is in the range considered 'undetermined'.

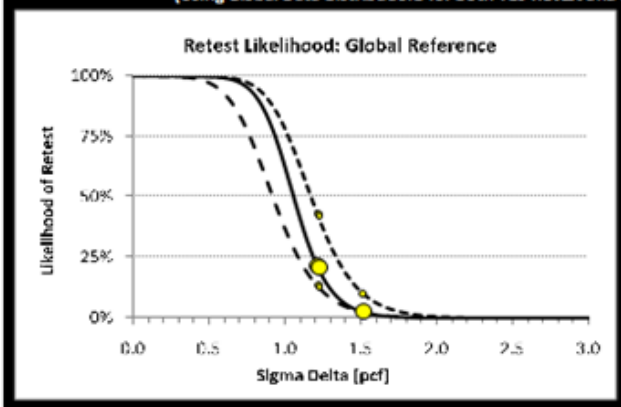
Analyst: Roblee
Date: 12/8/2012

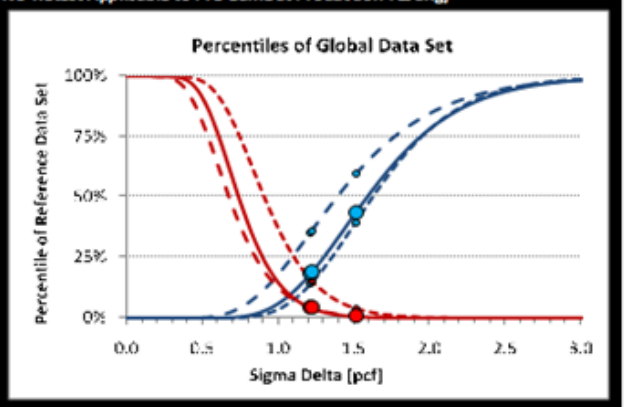
Source of SD Values: (LT) ID-10v3 SD Analyzer.xlsx (9/11/2012)
Considered Range: Depth Indices 40-640

Evaluated Tube Pair		Global Reference						Local Reference		
		Retest Likelihood		%tile of YES-Retest		%tile of NO-Retest		Retest Likelihood		%tile of
ID	SD	Best Est.	Range	Best Est.	Range	Best Est.	Range	Best Est.	Range	NO-Retest
T13d-T14	1.22	21%	13% - 43%	4%	4% - 16%	18%	14% - 35%	85%	82% - 93%	0%
T13u-T14	1.52	3%	3% - 10%	1%	1% - 4%	44%	40% - 60%	2%	2% - 9%	18%
Known Retest										
T13u-T13d	1.22	21%	13% - 42%	4%	4% - 16%	19%	14% - 36%	82%	80% - 92%	0%

Global Reference Method

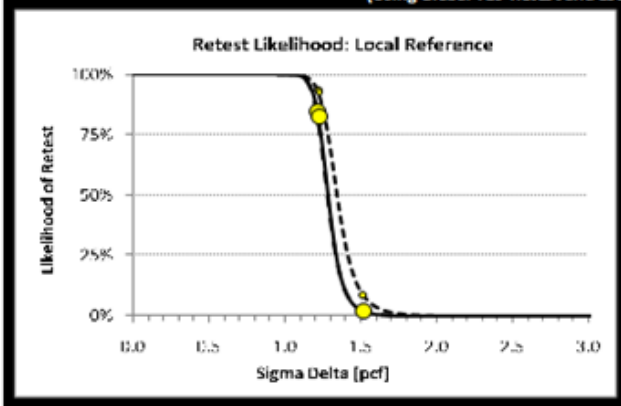
(Using Global Data Distributions for Both YES-Retest and NO-Retest Applicable to Pre-GamDat Production Testing)

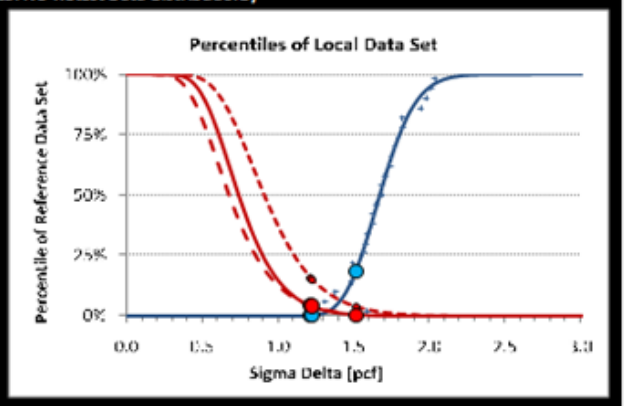




Local Reference Method

(Using Global YES-Retest and Local NO-Retest Data Distributions)





Basis for NO-Retest Local Reference: 25 tube pairs from the same pile

Figure 10B.3) Summary of findings of Retest Discrimination Analysis for ID-10

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 11

Name: Irregular Testing Chronology, 57-1134R, Lake Hodges Br., Abutment 6, Pile 1

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☒ Correlation ☒ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Roblee **Date:** 4/12/12

Summarized by: Roblee **Date:** 12/10/12

Reviewed by: Hannenian **Date:** 12/11/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☐ Certain ☐ Likely ☒ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

ID-11 is a plausible instance of an inappropriate retest occurring on January 20, 2005 at Abutment 6, Pile 1 of the Lake Hodges Bridge (I-15 Managed Lanes). It is suspected that data acquired by a retest of tube 1 was reported as independent data for tube 2. The impact of this irregularity is that the Department may have no GGL data to assess the uniformity of concrete surrounding tube 2.

Discussion of Findings

Summary

The existence of a GGL data irregularity is based on strong chronological evidence whereby it was physically infeasible to complete testing as reported using typical procedures within the constraints of documented chronological facts, while the suspected retest is fully consistent with these same facts. Consideration was given to alternative testing scenarios involving use of three atypical procedures (i.e. free-wheel down-transit, free-wheel up-transit, and faster recording speed), but all of these were found to be physically infeasible when considered separately. Additional scenarios were considered involving various combinations of the atypical procedures. Only the combined use of *all three atypical* procedures yielded equipment-repositioning time intervals approaching those observed at this site for other tests using *typical* procedures. The GamDat team considered the potential for sudden change in all three operational procedures for this single test to be unrealistic relative to the retest scenario which fully accounts for the chronology facts using only typical procedures. Prototype correlation analysis was inconclusive, and yielded a sigma-delta value (metric of similarity) that is larger than those observed in a reference set. The lower 'plausible' level of confidence is assigned in this case because of the judgments required for interpretation of the chronology scenarios and because of the inconclusive correlation analysis results. The cause of the irregularity, whether intentional or inadvertent, could not be determined through examination of the data

alone.

Background

ID-11 is one of three instances of retest irregularity (also see ID-10 and ID-17) that involve the isolated use of an atypical testing procedure referred to herein as a "double-transit". The *typical* testing procedure used on nearly all (>99.9%) Caltrans GGL tests to date involves lowering the probe to the bottom of tube (i.e. 'down-transit') without recording data, then initializing the DAQ (to 'depth-up mode') and recording data with the probe moving back up to the top of the tube (i.e. 'up-transit'). The data file is typically (but not necessarily) saved with the probe at the top of the tube where data was acquired. The *atypical* 'double-transit' procedure involves initializing the DAQ (to 'time mode') after the probe is lowered to the bottom of the tube, then recording for both an 'up-transit' and a subsequent 'down-transit'. The data file is necessarily saved at the end of the second down-transit while the probe is at the bottom of the tube for a second time. This is a critical fact for establishing chronology evidence in these double-transit cases; that is, by DAQ software design, the 'time mode' setting saves the data file immediately after recording is stopped at the logged probe position at that time.

It is important to note again that there is nothing improper about either using the 'time mode' DAQ setting or in testing the tube twice (i.e. up-transit and down-transit). However, it is precisely because of the use of this atypical testing sequence that a compelling chronological case for retest could be established. *Similar retests could have occurred when using the typical testing procedure that could not be definitively detected using chronological evidence*.

Unlike ID-17 where the raw data (RD) file was able to be recovered, no RD file could be located for ID-11. Therefore, chronological analysis of this case (and ID-10) required that certain testing procedures be assumed regarding the probe speed during both the non-recording down-transit and recording up-transit. Both typical and atypical procedures were considered in the analysis as detailed below. Chronological data is presented for testing of adjacent tubes to demonstrate the reasonableness of the assumptions employed.

Details of ID-11 Chronology Analysis

Turning to the specifics of ID-11, the chronological analysis is summarized in attachment 11A. Figure 11A.1 provides a key to the graphics used in subsequent figures. GGL tests were reported to have occurred in four tubes of each of four piles at Abutment 6 before noon on 1/20/2005. The testing sequence progressed from high-numbered piles to low-numbered piles. Chronological evidence for a representative selection of these tests in pile 2 (tubes 1-4) and pile 1 (tubes 1-4) is summarized in attachment 11A. Probe position is denoted using a labeling convention of "X.Yz" where 'X' is the pile number, 'Y' is the tube number, and 'z' is the position within the tube. Testing in all tubes at this site except pile 1, tube 1 employed the typical testing procedure involving the following steps:

1. The probe was positioned at the top of a tube (e.g. positions 2.1a, 2.2a, etc.).
2. The probe was lowered to the bottom of the tube (e.g. positions 2.1b, 2.2b, etc.). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'depth-up mode' while the probe was at the bottom of the tube.
4. The probe was raised to the top of the tube while recording (depicted as a red arrow for a 'recording transit').
5. The probe was repositioned to the next tube (e.g. moved from position 2.1c to 2.2a), and the process was repeated.

For unknown reasons, an atypical procedure (herein called a "double-transit") was employed for testing of tube 1 in pile 1. In this instance, the following steps were involved:

1. The probe was positioned at the top of a tube (i.e. position 1.1a).
2. The probe was lowered to the bottom of the tube (i.e. position 1.1b). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'time mode' while at the bottom of the tube (i.e. position 1.1b).
4. The probe was raised to the top of the tube (i.e. positions 1.1b to 1.1c) while recording, then the direction was reversed and the probe was returned to the bottom of the tube (i.e. positions 1.1c to 1.1d) while continuing to record (depicted as a pair of red arrows for the double 'recording transits').
5. At the end of recording, the probe was again at the bottom of tube 1 (i.e. position 1.1d) where the data file was saved.
6. If the typical testing procedures implied in the GGL report were to have occurred, the probe would need to

be raised to the top of tube 1.1 (i.e. positions 1.1d to 1.1e), repositioned onto tube 2 (i.e. positions 1.1e to 1.2a), then lowered to the bottom of tube 2 (i.e. positions 1.2a to 1.2b) before data could have been acquired in tube 2 during the up-transit (i.e. position 1.2b to 1.2c). However, the chronology data indicate this was highly unlikely, and instead, data reported for tube 2 is suspected to have been recorded on the final up-transit in tube 1 (i.e. positions 1.1d to 1.1e).

A complete description of the testing chronology requires knowledge of both time and probe position. The time stamp on the GGL data file unambiguously establishes the time when the file was saved. In figures 11A.2, 11A.3 and 11A.4, the assumed positions associated with the time stamp are denoted by flags. Using the typical 'depth up mode' procedure, the file save location was assumed to be at the top of the tube immediately after the recording transit (e.g. positions 2.1c, 2.2c, etc.). This assignment is based on common practice both observed and stated by Caltrans GGL technicians. However, it must be noted that the GamDat team has determined that it is feasible to reposition the probe to as far as the bottom of the subsequent tube before saving the file while the DAQ is in depth-up mode. That scenario is not considered typical practice, and more importantly, has no bearing on the ID-11 analysis since the suspect data was acquired immediately after the double-transit where the DAQ had been set to 'time mode'. The key feature of using the 'time mode' setting on the DAQ is that the probe position is known at the time the file was saved. In ID-11, that position is the bottom of tube 1 (i.e. position 1.1d). The nearest position which data reported as tube 2 could have been recorded is at the top of tube 2 (i.e. position 1.2c).

Figures 11A.2, 11A.3 and 11A.4 consider alternative chronological scenarios for where and how data reported for tube 2 of pile 1 may have actually been recorded. The information highlighted in yellow pertains directly to the assumptions and calculations that change between scenarios. Figures 11A.2 and 11A.3 consider alternative procedural scenarios assuming the data reported for tube 2 indeed came from tube 2 (i.e. recording from positions 1.2b to 1.2c). Figure 11A.4 considers the suspected retest scenario where the data reported for tube 2 actually came from tube 1 (i.e. recording from positions 1.1d to 1.1e). Timelines are presented for each scenario. For all scenarios, data is also presented for testing of adjacent tubes to illustrate that the analysis yields reasonable results for all but the suspect test reported for tube 2 of pile 1 as well as to demonstrate the effects of alternative procedural assumptions.

Figure 11A.2 presents the timeline assuming testing occurred as reported and the typical probe rate of 15 fpm was used for the recording transits (red arrows). Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as tube 2 is located at position 1.2c. Based on time stamps, the time interval between positions 1.1d and 1.2c is known to be 6 minutes and 18 seconds. The fastest time required to record data from position 1.2b to 1.2c using typical procedures is 5 minutes and 24 seconds assuming the probe speed was 15 fpm while in concrete (80 ft) and 52 fpm while above concrete (3 ft). This leaves <u>54 seconds for the probe to be moved from position 1.1d to 1.2b</u>.

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 1.1d-to-1.1e and 1.2a-to-1.2b) as discussed below:

i. Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 83 feet, approximately 1 minute and 36 seconds is required for each non-recording transit. Therefore, a total of 3 minutes and 12 seconds would be required just for the transits. <u>This exceeds the 54 seconds available by approximately 2 minutes and 18 seconds</u>, without considering the additional time required for repositioning the probe to a new tube (1.1e to 1.2a). This scenario <u>is physically infeasible</u>.

ii. The first of two scenarios involving atypical procedures assumes the probe was disengaged from the winch and allowed to 'free-wheel' on the downward non-recording transit (i.e. positions 1.2a to 1.2b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 9 seconds. Assuming the winch is used to raise the probe, a total of 1 minute and 45 seconds is required for the transits. However, this <u>exceeds the 54 seconds available by approximately 51 seconds</u>, again without considering the additional time required for repositioning the probe to a new tube (1.1e to 1.2a). Thus, this scenario <u>is also physically infeasible</u>.

iii. The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on *both* the upward and downward non-recording transits (i.e. positions 1.1d-to-1.1e and 1.2a-to-1.2b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 17 seconds, and total time for both non-recording transits could be reduced to 26 seconds. Under these assumptions, <u>a positive 28 seconds is available</u> for repositioning the probe to the new tube (i.e. positions 1.1d-to-1.1e). While this is marginally feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is

considered feasible, but unusual.

Figure 11A.3 considers the same three scenarios as those discussed above except, in addition, that an atypical probe speed of 20 fpm, rather than 15 fpm, is assumed while the probe was in concrete for the recording transits. In this scenario, a total of 4 minutes and 04 seconds is required to complete the up-transit in tube 2 of pile 1 (i.e. position 1.2b to 1.2c), thus leaving 2 minutes and 14 seconds available for the probe to be moved from position 1.1d to 1.2b. The three operational scenarios for the non-recording transits are discussed below:

i. The first scenario assumes the winch is engaged for both non-recording transits. Again assuming a typical maximum winch speed of 52 fpm, approximately 1 minute and 36 seconds is still required for each non-recording transit (i.e. positions 1.1d to 1.1e, and 1.2a to 1.2b). The total of 3 minutes and 12 seconds exceeds the 2 minutes and 14 seconds available by approximately 58 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 1.1e to 1.2a). Thus, this scenario is also physically infeasible.

ii. The next scenario considered combined use of two atypical procedures where both a recording speed of 20 fpm is assumed and the probe is allowed to fall the full length of tube 1.2 under free-wheel conditions. Under these assumptions, a positive 29 seconds is available for repositioning the probe to the new tube (i.e. positions 1.1e to 1.2a). While this is on the borderline of being physically feasible, the time is far less than that determined for repositioning the probe between any other tube combinations under the same assumptions. Thus, this scenario yields a chronology that is considered feasible, but unusual.

iii. The final scenario to account for the reported test location considered combined use of all three atypical procedures: the recording speed is 20 fpm, the probe is free-wheeled on the down-transit at 550 fpm and also free-wheeled (i.e. manually pulled) on the up-transit at 300 fpm. Under these assumptions, a positive 1 minute and 48 seconds is available for repositioning the probe to the new tube (i.e. positions 1.1e to 1.2a). This time interval is clearly feasible and approaches those observed at this site for other tests using *typical* procedures. However, the GamDat team considered the potential for sudden and isolated change in all three operational procedures for this single test to be unrealistic.

Finally, Fig. 11A.4 presents a timeline for the suspected scenario where data reported for tube 2 actually came from tube 1 (i.e. recorded from positions 1.1d to 1.1e) and normal testing procedures were used. Physically, this scenario eliminates the need for repositioning the equipment to the bottom of tube 2, and the only task required to be completed within 54 seconds in non-recording time available is to initialize the DAQ system for recording. Experienced GamDat team members estimate approximately 15 seconds is required to complete this task. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

Overall, the only two operational scenarios that yield chronologies that are reasonably consistent with other tests at this site are the suspected retest or the sudden and isolated use of three atypical procedures for this single test. The GamDat team considered the retest scenario to be a more reasonable explanation, and concluded that it is at least plausible that results reported for tube 1.2 were actually retest data obtained in tube 1.1.

Findings of ID-11 Correlation Analysis

A supplemental prototype 'correlation analysis' based on the 'sigma-delta (SD)' metric was also conducted for ID-11 to examine the similarity between data recorded in tube 1.1 and the suspect data reported for tube 1.2. Sigma delta is one of many alternative metrics that could be used to quantify the similarity of two GGL test data sets. It is evaluated as the standard deviation (i.e. 'sigma') of the difference (i.e. 'delta') between pairs of depth-aligned density values for two reported GGL tests over a selected depth range. Attachment 11B presents results of the correlation analysis.

Figure 11B.1 presents two tables of SD values calculated independently by two GamDat analysts for various tube-pair combinations within the pile. Although ID-11 involved a double-transit, the quality of data for the recording down-transit (positions 1.1c to 1.1d) was extremely poor and consisted of a high proportion of null values (coded by the DAQ as -999.25). The poor data quality on the down-transit precluded establishment of local sigma-delta value for the known retest, and thereby differs from both ID-10 and ID-17 where a local retest value could be determined. In Fig 11B.1, the suspected retest value is highlighted in red. ID-11 also differs from the other double-transit cases in that only four tubes were tested in each pile. Therefore, the SD values in the tables of Fig. 11B.1 involve three regions. The upper-left grouping of six values highlighted in shades of purple is for tube-pairs where both tubes are within pile 2. The lower-right grouping of six values highlighted in shades of blue (except for retest in red) is for tube-pairs where both tubes are within pile 1. The upper-right grouping of 16 values with white or black highlighting is for tube pairs where one tube in the pair comes from each of pile 1 and pile 2. Those SD values with dark highlights represent the NO-Retest values that were smaller than the suspected retest values.

Two sets of independent calculations are presented in Fig. 11B.1 to illustrate the effects of data preprocessing decisions made by the analyst. The most important decision is the selection of 'depth range considered', but the alignment of data traces can also affect the SD value. The two sets of SD values presented in Fig. 11B.1 used different specific limits for depth-range considered where those limits are listed below each table. Even using somewhat different depth ranges, the SD values for the suspected YES-Retest are quite similar. Likewise, although some differences are observed between individual NO-Retest values, the overall trends are comparable. The values in the left table are used in various correlation analysis methods. For both the 'empirical method' and the 'global RDA method', only the YES-Retest value is used, so the small variations between analyst's decisions have insignificant effect on the results. For the local RDA method, the NO-Retest values are used to establish NO-Retest statistics for these specific piles, and the values in the table on the left are representative.

Figure 11B.2 presents processed GGL data as a function of depth. Note that the vertical axis in both plots in Fig. 11B.2 is the index of the data point considered in the sigma-delta analysis. Since tubes are logged from the bottom, smaller numbers appear near the bottom. The 700 data points in the logs shown in Fig. 11B.2 represent approximately 70 ft of pile length.

The plot on the left in Fig. 11B.2 shows 'tube remainders' for individual GGL tests in ID-11. A tube remainder is a processed GGL test logs where the acquired data has been smoothed to eliminate high-wavenumber variations (chatter), the 1-D layer-cake density profile common to all tubes ('pile average') has been removed, and any uniform offset (DC component) is removed so the average over depth is zero. The tube remainder contains a combination of localized density variations unique to each tube ('tube signal') and random test-to-test variations ('testing noise'). The relative amplitude of the tube signal to testing noise determines the ease with which a GGL log can be uniquely identified. In the plot on the left in Fig 11B.2, the tube remainder for tube 1 (P1T1) is shown in green and the suspected retest (P1T2) is shown in red. The tube remainders for the other tubes in pile 1 (P1T3, P1T4) are shown as thin solid lines, and those for pile 2 are shown as thin dashed lines. Together, these illustrate typical NO-Retest data.

The plot on the right in Fig. 11B.2 shows 'tube remainder differences' for various tube-pair combinations for which SD values are tabulated. The 'tube remainder difference' is determined as the difference between tube remainders as a function of depth for a *pair* of GGL logs. Note that while only eight data traces are shown in the left plot (one for each tube), a total of 28 traces are shown in the right plot (one for each tube *combination*). Also note that <u>the standard deviation of the tube remainder difference over the depth range considered *is* the sigma delta value</u>. Small sigma delta values are indicative of greater similarity between tube signals, with random testing noise comprising most of the value. Large sigma delta values are indicative of large differences between tube signals in addition to the random testing noise. The traces in the right plot of Fig 11B.2 are color-coded to correspond to the SD values in the left table of Fig. 11B.1. The suspected retest pair (P1T1-P1T2) is shown as a red trace and corresponds to the SD value highlighted in red in Fig 11B.1. The six NO-Retest tube pairs having low SD values highlighted in purple, black, and blue in Fig. 11B.1 are shown as dark traces. The remaining traces (light purple for pile 2 pairs, light blue for pile 1 pairs, and dashed black for mixed-pile pairs) provide a comparative reference for the degree of tube remainder deltas that are observed in these piles.

Results of the correlation analysis for the suspect retest pair SD value of 1.62 is summarized in the table and associated charts in Fig. 11B.3. The 1.62 value is beyond the range of YES-Retest observations in a global reference set developed by GamDat for use in correlation analysis.

Figure 11B.3 also presents several additional comparisons of the ID-11 suspect-retest SD value to statistical models of the global reference set data including percentiles of YES-Retest and NO-Retest data and 'Retest Likelihood'. Retest likelihood is the probability that a specific SD value being evaluated would be a YES-Retest in the reference set data as determined by the "Retest Discrimination Analysis (RDA)" method. For these purposes, three subsets of the global reference set data were considered, two that yield bounding (low and high) interpretations, and an intermediate 'best' estimate. The bounding subsets consider: 1) solely production GGL tests having known retests conducted prior to the GamDat investigation, and 2) all reference set data collected before and after the GamDat investigation. The difference between the bounding models is because the pre-GamDat data has higher mean SD values for both YES-Retest and NO-Retest conditions than the post-GamDat data; a difference which is attributed to tighter testing control in recent tests. The pre-GamDat data yields the 'high estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the low estimate of 'Percentile of No-Retest' data. Conversely, the use of all data (pre-GamDat and post-GamDat) yields the 'low estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the high estimate of 'Percentile of No-Retest' data.

Turning to findings for ID-11, the 1.62 SD value represents between the 0th and 2nd percentile of YES-Retest values, and between the 50th and 67th percentile of all NO-Retest values in the global reference subsets. RDA indicates the 1.62 SD value would have between a 1% and 6% likelihood of retest in the global reference subsets. The RDA method also considered a 'local' reference for the NO-Retest model based on SD values for the other 27 tube pair combinations from the same piles (i.e. values not highlighted in red in Fig 11B.1). Figure 11B.3 shows the 1.62 SD value corresponds to 2% and 6% likelihood of retest using the local method. Both RDA methods would assign a

designation of undetermined to this value. The 'undetermined' designation means the SD value is not supportive of the possibility of retest, but is also insufficiently large to confidently refute the possibility of retest.

Overall, correlation analysis results for ID-11 yield inconclusive results regarding the likelihood of retest. Therefore, determination of the existence of a data irregularity for ID-11 needed to be established solely on the basis of chronology analysis.

References

Flagged by Depth Consistency

Flag ID	File ID	Unique File ID	Date	Filename	File Path	Reason
19	61444	8568	1/20/05 10:26	T1.LAS	…LES 1-5/Pile 1/Raw data/T1.LAS	Depths are not constantly incremented.

All files for the pile in question (Pile 1) and the next pile (Pile 2):

File ID	Unique ID	Group ID	Date	Filename	Filepath
61444	8568	3192	1/20/05 10:26 AM	T1.LAS	…LES 1-5/Pile 1/Raw data/T1.LAS
61449	8569	3192	1/20/05 10:32 AM	T2.LAS	…LES 1-5/Pile 1/Raw data/T2.LAS
61453	8570	3192	1/20/05 10:42 AM	T3.LAS	…LES 1-5/Pile 1/Raw data/T3.LAS
61457	8571	3192	1/20/05 10:52 AM	T4.LAS	…LES 1-5/Pile 1/Raw data/T4.LAS
61462	8572	3194	1/20/05 9:46 AM	T1.LAS	…/Pile 2/Raw Data Pile 2/T1.LAS
61467	8573	3194	1/20/05 9:56 AM	T2.LAS	…/Pile 2/Raw Data Pile 2/T2.LAS
61472	8574	3194	1/20/05 10:06 AM	T3.LAS	…/Pile 2/Raw Data Pile 2/T3.LAS
61477	8575	3194	1/20/05 10:15 AM	T4.LAS	…/Pile 2/Raw Data Pile 2/T4.LAS

- Attachment 11A: Manual Chronology Analysis for ID-11
- Attachment 11B: Correlation Analysis Results for ID-11

Attachment 11A

Manual Chronology Analysis for ID-11

57-1134R – Lake Hodges Bridge (I-15 Managed Lanes)
Abutment 6, Pile 1
Testing Date: 1/20/2005

Concern: Retest of Pile 1, Tube 1 Reported As Independent Test of Pile 1, Tube 2

Fig 11A.1) ID-11 Chronology Analysis: Orientation to Figures

Concern: Retest of Pile 1, Tube 1 Reported As Independent Test of Pile 1, Tube 2

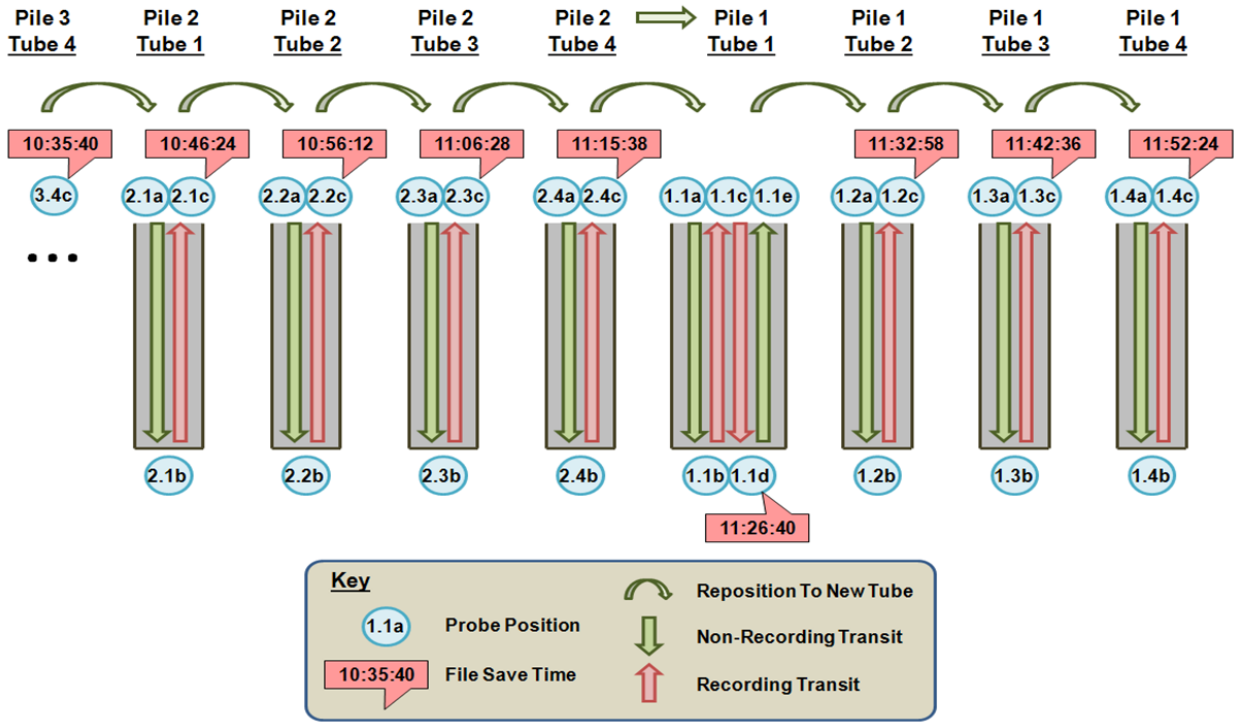
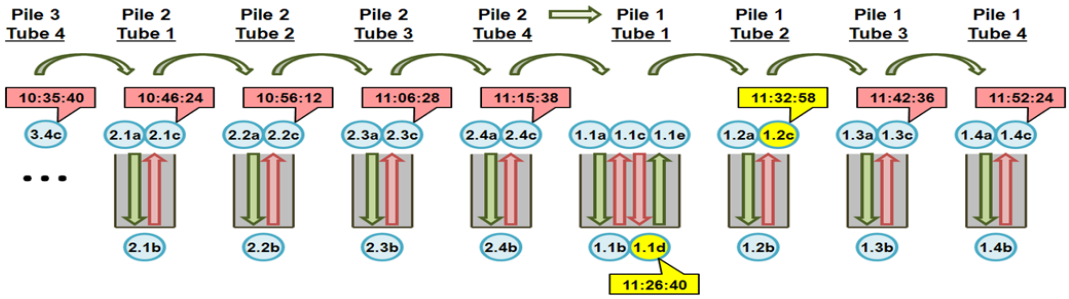


Fig. 11A.2) Chronology Analysis: Recording at Typical Rate



Time Stamps Known From Data, Assume Typical Recording Speed (15 fpm)

Probe Position:	3.4c	2.1a	2.1b	2.1c	2.2a	2.2b	2.2c	2.3a	2.3b	2.3c	2.4a	2.4b	2.4c	1.1a	1.1b	1.1c	1.1d	1.1e	1.2a	1.2b	1.2c	1.3a	1.3b	1.3c	1.4a	1.4b	1.4c
File Time Stamp:	10:35:40			10:46:24			10:56:12			11:06:28			11:15:38				11:26:40				11:32:58			11:42:36			11:52:24
Elapsed Time (Min:Sec)																											
Total Between Time Stamps:		10:44			09:48			10:16			09:10			11:02				06:18				09:38			09:48		
Recording (Estimated*):				05:24			05:24			05:24			05:24			07:00**					05:24			05:24			05:24
Non-Recording (Remainder):		05:20			04:24			04:52			03:46			04:02				00:54				04:14			04:24		

Assume Typical Procedure for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																											
Min NR Transit Time (Approx):		01:36			01:36			01:36			01:36			01:36				01:36		01:36			01:36			01:36	
Balance for Repositioning:		03:44			02:48			03:16			02:10			02:26				-02:18				02:38			02:48		

Not Feasible

Assume Atypical Procedure for Down-Transit (Freewheel at 550 fpm)

Probe FreeWheeled Down Only (550 fpm)																											
Min NR Transit Time (Approx):		00:09			00:09			00:09			00:09			00:09				01:36		00:09			00:09			00:09	
Balance for Repositioning:		05:11			04:15			04:43			03:37			03:53				-00:51				04:05			04:15		

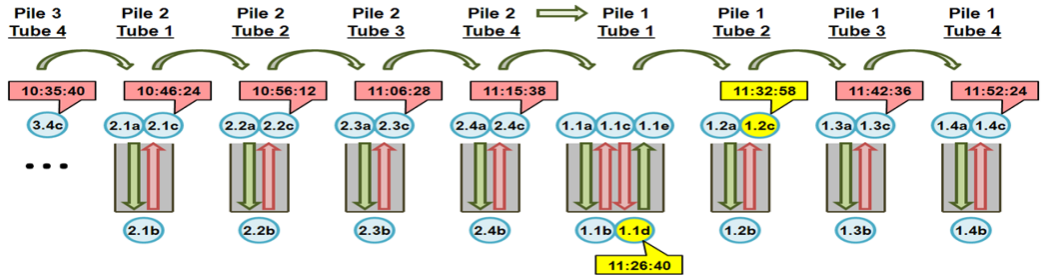
Not Feasible

Assume Additional Atypical Procedure for Up-Transit (Freewheel at 300 fpm)

Probe FreeWheeled Down (550 fpm) & Up for 1.1d-e (300 fpm)																											
Min NR Transit Time (Approx):		00:09			00:09			00:09			00:09			00:09				00:17		00:09			00:09			00:09	
Balance for Repositioning:		05:11			04:15			04:43			03:37			03:53				00:28				04:05			04:15		

Feasible, But Unusual

Fig. 11A.3) Chronology Analysis: Recording at Atypical Rate



Time Stamps Known From Data, Assume Atypical Recording Speed (20 fpm)

Probe Position:	3.4c	2.1a	2.1b	2.1c	2.2a	2.2b	2.2c	2.3a	2.3b	2.3c	2.4a	2.4b	2.4c	1.1a	1.1b	1.1c	1.1d	1.1e	1.2a	1.2b	1.2c	1.3a	1.3b	1.3c	1.4a	1.4b	1.4c
File Time Stamp:	10:35:40			10:46:24			10:56:12			11:06:28			11:15:38				11:26:40				11:32:58			11:42:36			11:52:24
Elapsed Time (Min:Sec)																											
Total Between Time Stamps:		10:44			09:48			10:16			09:10			11:02					06:18			09:38			09:48		
Recording (Estimated*):				04:04			04:04			04:04			04:04			05:40**					04:04			04:04			04:04
Non-Recording (Remainder):		06:40			05:44			06:12			05:06			05:22					02:14				05:34			05:44	

Assume Typical Procedure for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																											
Min NR Transit Time (Approx):		01:36			01:36			01:36			01:36			01:36				01:36		01:36			01:36			01:36	
Balance for Repositioning:	05:04			04:08			04:36			03:30			03:46				-00:58					03:58			04:08		

Not Feasible

Assume Atypical Procedure for Down-Transit (Freewheel at 550 fpm)

Probe FreeWheeled Down Only (550 fpm)																											
Min NR Transit Time (Approx):		00:09			00:09			00:09			00:09			00:09				01:36		00:09			00:09			00:09	
Balance for Repositioning:	06:31			05:35			06:03			04:57			05:13				00:29					05:25			05:35		

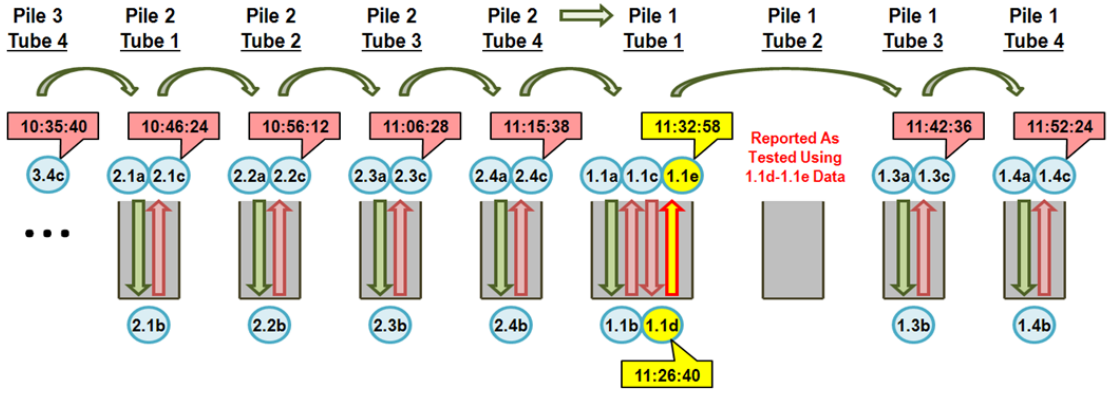
Feasible, But Unusual

Assume Additional Atypical Procedure for Up-Transit (Freewheel at 300 fpm)

Probe FreeWheeled Down (550 fpm) & Up for 1.1d-e (300 fpm)																											
Min NR Transit Time (Approx):		00:09			00:09			00:09			00:09			00:09				00:17		00:09			00:09			00:09	
Balance for Repositioning:	06:31			05:35			06:03			04:57			05:13				01:48					05:25			05:35		

Feasible

Fig. 11A.4) Chronology Analysis: Suspected Retest Scenario



Time Stamps Known From Data, Assume Typical Recording Speed (15 fpm)

Probe Position:	3.4c	2.1a	2.1b	2.1c	2.2a	2.2b	2.2c	2.3a	2.3b	2.3c	2.4a	2.4b	2.4c	1.1a	1.1b	1.1c	1.1d	1.1e	1.3a	1.3b	1.3c	1.4a	1.4b	1.4c
File Time Stamp:	10:35:40			10:46:24			10:56:12			11:06:28			11:15:38				11:26:40		11:32:58			11:42:36			11:52:24
Elapsed Time (Min:Sec)																									
Total Between Time Stamps:		10:44			09:48			10:16			09:10			11:02				06:18			09:38			09:48	
Recording (Estimated*):				05:24			05:24			05:24			05:24			07:00**			05:24			05:24			05:24
Non-Recording (Remainder):		05:20			04:24			04:52			03:46			04:02				00:54			04:14			04:24	

Assume Typical Procedures for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																											
Min NR Transit Time (Approx):		01:36			01:36			01:36			01:36			01:36				00:00			01:36			01:36		
Balance for Repositioning:	03:44			02:48			03:16			02:10			02:26				00:54*			02:38			02:48		

Feasible

Attachment 11B

Correlation Analysis Results for ID-11

57-1134R – Lake Hodges Bridge (I-15 Managed Lanes)
Abutment 6, Pile 1
Testing Date: 1/20/2005

Concern: Retest of Pile 1, Tube 1 Reported As Independent Test of Pile 1, Tube 2

Sigma Delta Analysis Results

Foundation Location: ID-11: 57-1134 Lake Hodges Abut 6 Piles 1-5

TUBE LABEL		P2-T1	P2-T2	P2-T3	P2-T4	P1-T1	P1-T2	P1-T3	P1-T4
	Calc ID	1	2	3	4	5	6	7	8
P2-T1	1		1.88	1.61	1.51	1.39	1.34	1.80	1.61
P2-T2	2			1.83	2.14	2.17	1.74	1.73	2.06
P2-T3	3				1.93	2.17	1.69	1.94	2.12
P2-T4	4					1.78	1.92	2.06	1.99
P1-T1	5						1.62	2.00	1.67
P1-T2	6							1.39	1.72
P1-T3	7								1.73
P1-T4	8								

Depth Range Considered: Data Index 40-840

Sigma Delta Analysis Results

Foundation Location: ID-11: 57-1134 Lake Hodges, Abut 6, Pile 1

TUBE LABEL		P2-T1	P2-T2	P2-T3	P2-T4	P1-T1	P1-T2	P1-T3	P1-T4
	Calc ID	1	2	3	4	5	6	7	8
P2-T1	1		1.63	1.29	1.39	1.41	1.33	1.69	1.64
P2-T2	2			1.80	2.09	2.07	1.69	1.68	2.00
P2-T3	3				1.73	1.52	1.42	1.73	1.80
P2-T4	4					1.71	1.94	2.06	2.00
P1-T1	5						1.65	2.07	1.73
P1-T2	6							1.29	1.76
P1-T3	7								1.73
P1-T4	8								

Depth Range Considered: Data Index 25-750

Figure 11B.1) Independent calculations of sigma delta for ID-11 tube pairs. Numbers on left used in analyses.

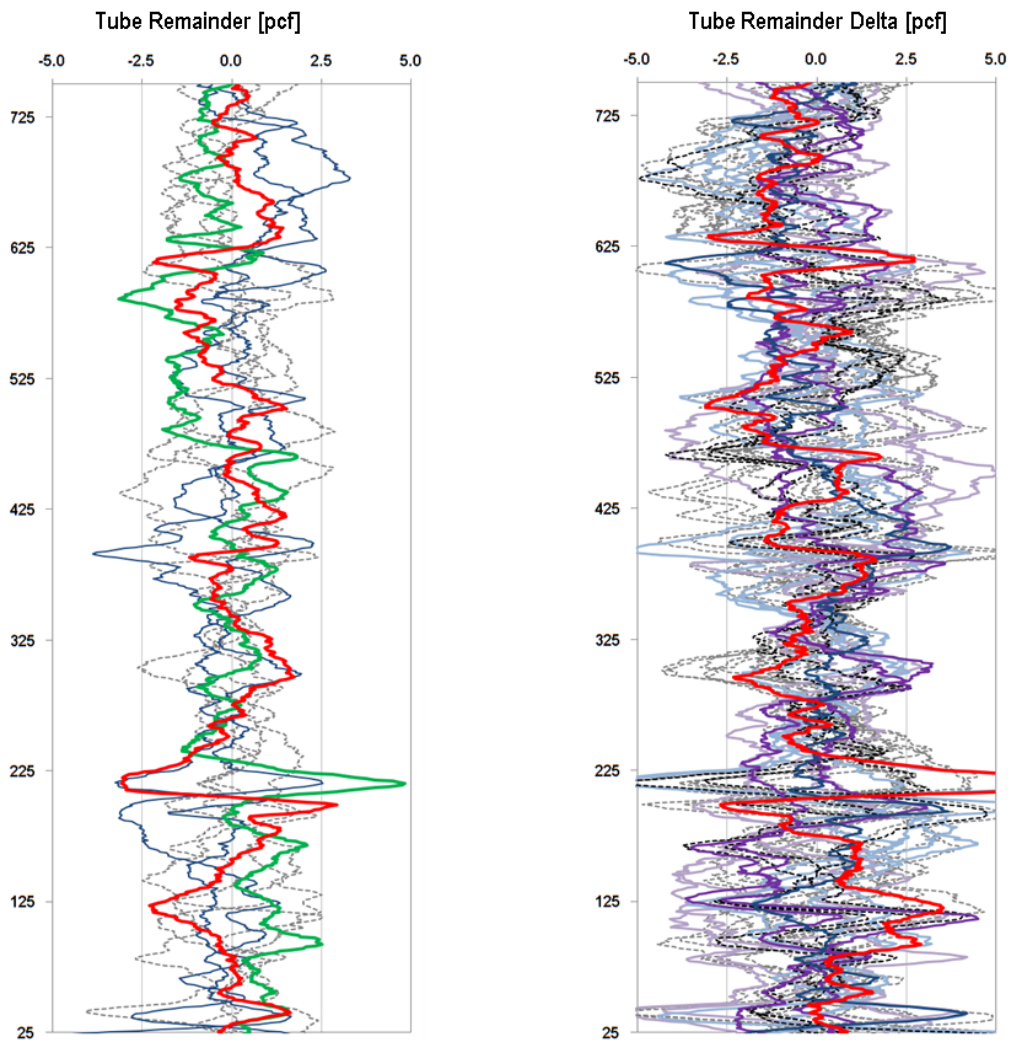


Figure 11B.2) ID-11 'tube remainder' and 'tube remainder delta' plots. (Green: Tube 1; Red: suspected retest)

Summary of Findings of Retest Discrimination Analysis

ID: ID-11 (C03): Lake Hodges, Abut 6, Piles 1-5

Finding: The sigma delta value evaluated for this site is in the range considered 'undetermined'.

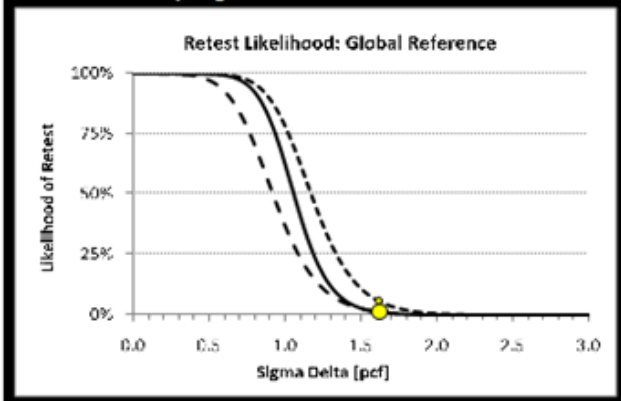
Analyst: Roblee
Date: 12/8/2012

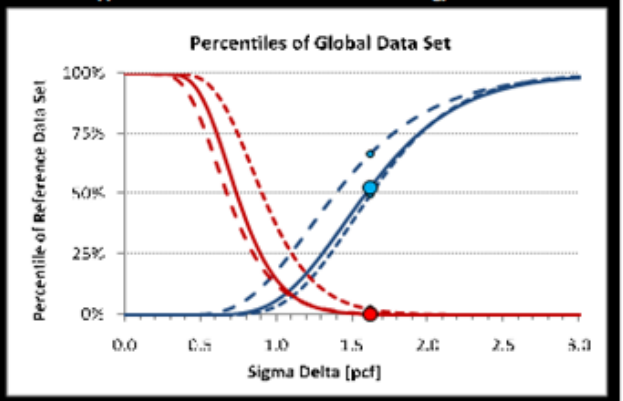
Source of SD Values: (LT) ID-11 v3 Sigma-Delta Analyzer.xlsx (8/2/2012)
Considered Range: Depth Indices 40-840

Evaluated Tube Pair		Global Reference						Local Reference		
		Retest Likelihood		%tile of YES-Retest		%tile of NO-Retest		Retest Likelihood		%tile of
ID	SD	Best Est.	Range	Best Est.	Range	Best Est.	Range	Best Est.	Range	NO-Retest
P1-T1 - P1-T2	1.62	1%	1% - 6%	0%	1% - 2%	53%	50% - 67%	1%	2% - 6%	23%

Global Reference Method

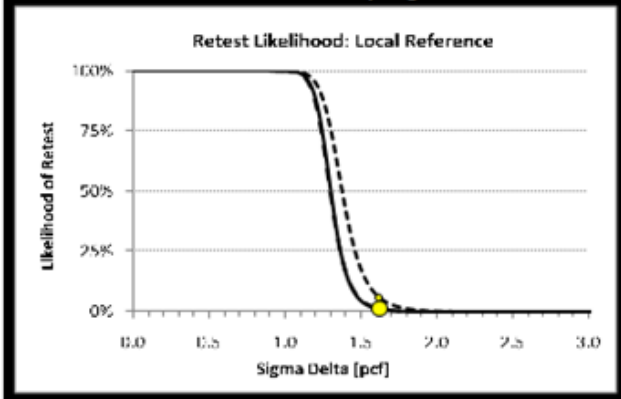
(Using Global Data Distributions for Both YES-Retest and NO-Retest Applicable to Pre-GamDat Production Testing)

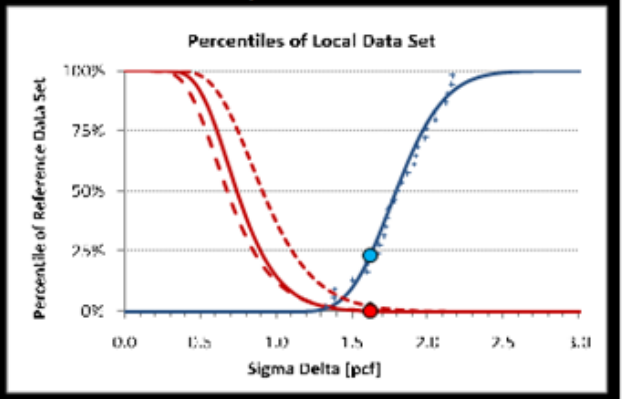




Local Reference Method

(Using Global YES-Retest and Local NO-Retest Data Distributions)





Basis for NO-Retest Local Reference: 27 tube pairs from the same pile

Figure 11B.3) Summary of findings of Retest Discrimination Analysis for ID-11

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 12

Name: 580 OH Sign #19

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☒ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 10/12/12

Summarized by: Wahleithner **Date:** 10/12/12

Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Pattern Match

LAS files shown in Table 1 were flagged by the Pattern Matching Analysis because they contained one or more recurring sequences of data.

Table 1: ID-12 Pattern Match Results

Unique File ID	Pattern Data Points	Data Points in Files	Occurrence	Date	Path
2743	18	327	2	3/19/2008 14:45	…(GGL)/Sign 19/Raw data/T3.LAS'
2744	11	325	2	3/19/2008 14:49	…(GGL)/Sign 19/Raw data/T4.LAS'
2744	17	325	2	3/19/2008 14:49	…(GGL)/Sign 19/Raw data/T4.LAS'

Timestamp

There is a discrepancy in the 'file modified' timestamp for these LAS files when compared to the other LAS files from the pile. This discrepancy was not found through any of the GamDat tools but identified through observation alone back in 2009 by an Engineer within FTB. This discrepancy is shown in Table 2 below.

Table 2: ID-12 Timestamp Discrepancy

Name	Date Modified
T1.LAS	3/19/2008 8:01:18 AM
T2.LAS	3/19/2008 8:06:16 AM
T3.LAS	**3/19/2008 2:45:48 PM**
T4.LAS	**3/19/2008 2:49:06 PM**
T5.LAS	3/19/2008 8:22:34 AM

The 'file modified' date for the LAS files representing GGL tests at inspection pipes T3 and T4 is on the same calendar day as the other inspection pipes within the pile. However, the 'file modified' time is significantly different, over 6 hours later, than the other files for the remaining three inspection pipes within the pile.

Discussion of Findings

From the information presented in Tables 1 and 2 it is clear there was deliberate editing of GGL test data collected at Tubes 3 and 4 of OH Sign #19. The pattern matching analysis found that two LAS files representing two of five inspection pipes at this pile contained duplicated sequences of data. In both cases this data was copied from one part of the data set and pasted to another part of the data set. This is shown below in Figures 1 and 2.

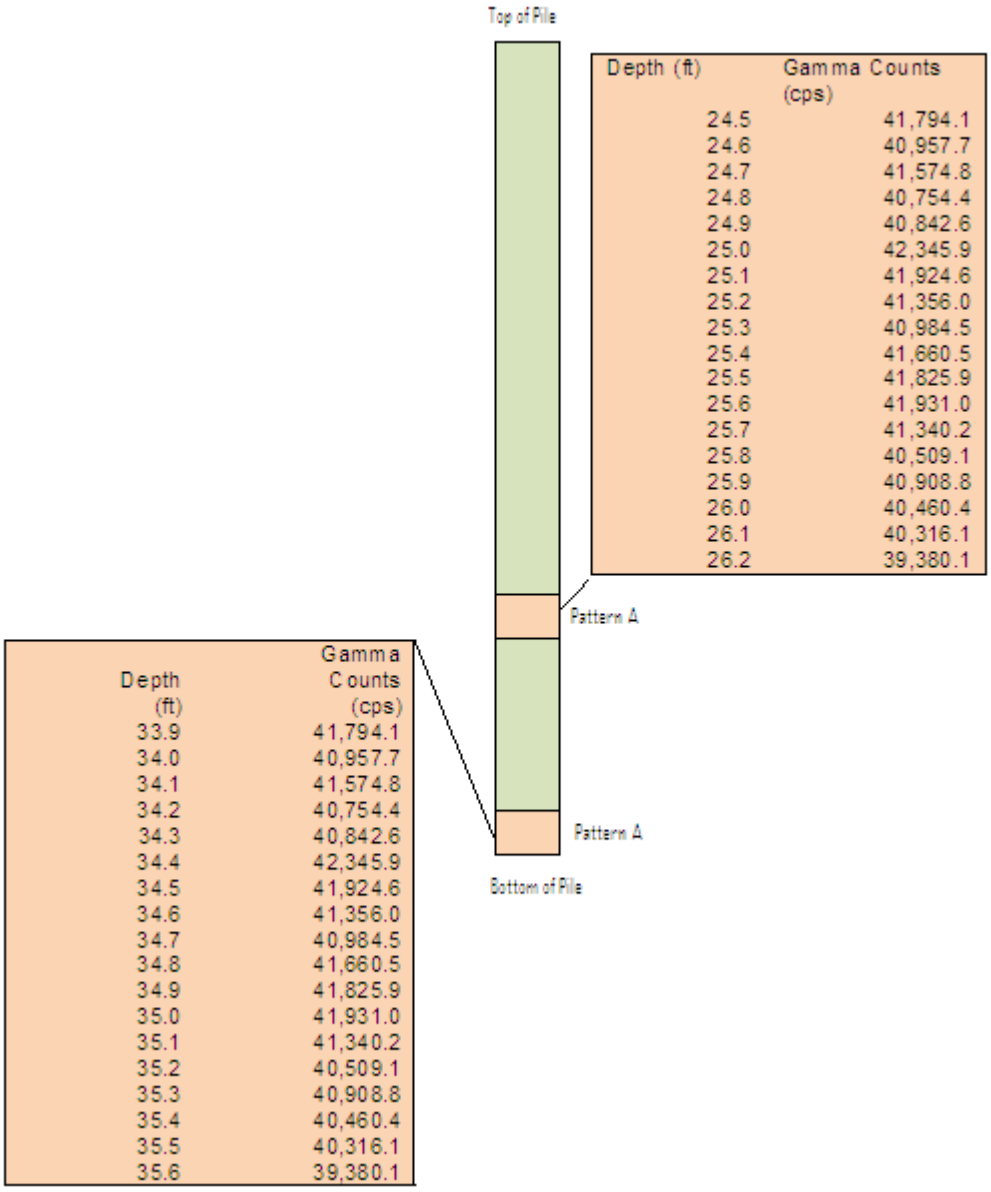
RD files were not recovered so an unaltered LAS file could not be compared to the edited LAS files found in order to determine what part of the file was genuine and which part of the file was falsified. Conclusions can be drawn from the fact that duplicated sequences of data were placed at the bottom of the pile for both tests. In the case of Tube 4, where there are three duplicated sequences of data, all three sequences were found grouped together at the very bottom of the pile (Figure 2). The three duplicated sequences of data originated from three non-contiguous locations along the pile. This indicates a string of original data at the very bottom of the pile was likely replaced by randomly grabbing the three sequences from other parts of the same data set.

It is also notable that one of the three duplicated sequences of data for Tube 4 was a sequence of three values and was not presented in the final pattern matching results. Patterns of three were generally ignored in the analysis results as their occurrence in most instances was random, as described in the Final Report. The sequence of three was included in this particular case, because of the proximity to the other two sequences suggesting an extension of the deliberate editing of this data set.

Other significant findings include:

- RD files were not recovered therefore the following tools did not flag these files for irregularities: Fidelity (RD-LAS) and Timestamp (RD-LAS). However, a review of the 'File Modified' times attached to the LAS files show Tube 3 and 4 LAS files were saved at a later time than Tubes 1, 2, and 5, which further supports that these files were opened and edited hours after testing (Table 2).
- The method of data editing was 'copy and paste' of data within the same inspection tube. The data was collected using the same GGL probe therefore the falsification was not found through the calibration tool.
- This case of data falsification was discovered by an FTB Engineer in 2009. The falsified data was used in the pile acceptance analysis in 2008.

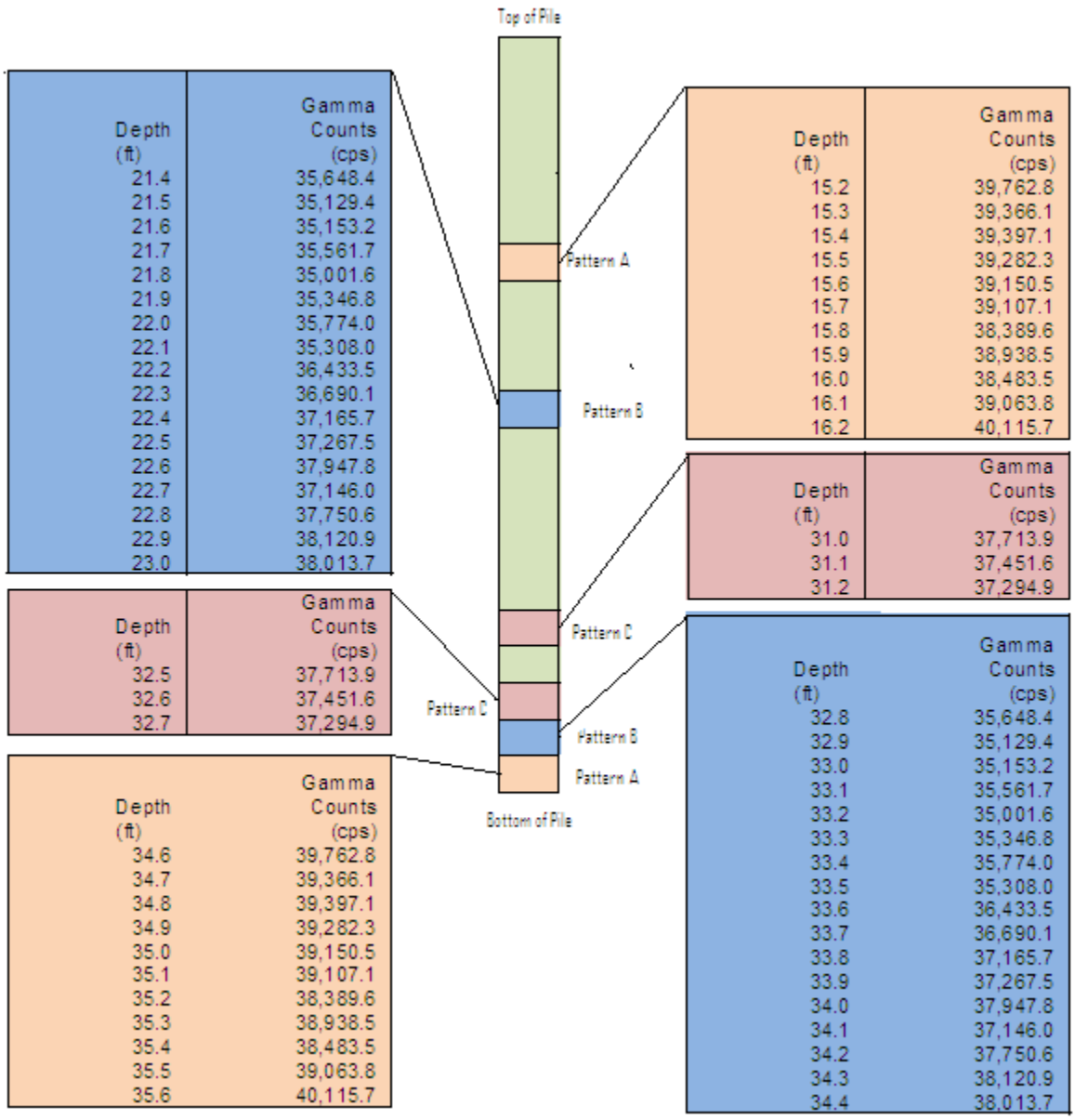
Figure 1: ID-12 Sign Pile No.19 Tube 3 LAS File



Depth (ft)	Gamma Counts (cps)
24.5	41,794.1
24.6	40,957.7
24.7	41,574.8
24.8	40,754.4
24.9	40,842.6
25.0	42,345.9
25.1	41,924.6
25.2	41,356.0
25.3	40,984.5
25.4	41,660.5
25.5	41,825.9
25.6	41,931.0
25.7	41,340.2
25.8	40,509.1
25.9	40,908.8
26.0	40,460.4
26.1	40,316.1
26.2	39,380.1

Depth (ft)	Gamma Counts (cps)
33.9	41,794.1
34.0	40,957.7
34.1	41,574.8
34.2	40,754.4
34.3	40,842.6
34.4	42,345.9
34.5	41,924.6
34.6	41,356.0
34.7	40,984.5
34.8	41,660.5
34.9	41,825.9
35.0	41,931.0
35.1	41,340.2
35.2	40,509.1
35.3	40,908.8
35.4	40,460.4
35.5	40,316.1
35.6	39,380.1

Figure 2: ID-12 Sign Pile No.19 Tube 4 LAS File



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 13

Name: Br. 56C-0571, La Sierra OH

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☒ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 10/12/12

Summarized by: Wahleithner **Date:** 10/12/12

Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Pattern Match

LAS files shown in Table 1 were flagged by the Pattern Matching Analysis because they contained one or more recurring sequences of data that matched files from other tests performed in other inspection tubes from both the same pile and an adjacent pile.

Table 1: ID-13 Pattern Match Results

Unique File ID	Pattern Data Points	Data Points in Files	Occurrence	Date	Filepath
7609	718	1006	1	9/19/2008 10:00	…ta/Copy of W2 Raw Data/T1.LAS'
7615	718	718	1	9/17/2008 10:29	…a/Original W2 Raw Data/T1.LAS'
7609	33	1006	1	9/19/2008 10:00	…ta/Copy of W2 Raw Data/T1.LAS'
7613	33	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7615	33	718	1	9/17/2008 10:29	…a/Original W2 Raw Data/T1.LAS'
7609	85	1006	1	9/19/2008 10:00	…ta/Copy of W2 Raw Data/T1.LAS'
7628	85	1059	1	9/17/2008 9:53	…045 Bent 2 W3 Raw Data/T6.LAS'
7609	52	1006	1	9/19/2008 10:00	…ta/Copy of W2 Raw Data/T1.LAS'
7625	52	1054	1	9/17/2008 9:20	…045 Bent 2 W3 Raw Data/T3.LAS'
7613	284	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7616	284	284	1	9/17/2008 11:10	…a/Original W2 Raw Data/T5.LAS'
7613	39	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7628	39	1059	1	9/17/2008 9:53	…045 Bent 2 W3 Raw Data/T6.LAS'
7613	94	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'

7628	94	1059	1	9/17/2008 9:53	…045 Bent 2 W3 Raw Data/T6.LAS'
7613	215	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7626	215	1054	1	9/17/2008 9:32	…045 Bent 2 W3 Raw Data/T4.LAS'
7613	187	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7624	187	1059	1	9/17/2008 9:09	…045 Bent 2 W3 Raw Data/T2.LAS'
7613	150	1015	1	9/19/2008 9:49	…ta/Copy of W2 Raw Data/T5.LAS'
7626	150	1054	1	9/17/2008 9:32	…045 Bent 2 W3 Raw Data/T4.LAS'

Timestamp

There is a discrepancy in the 'file modified' timestamp for two of six LAS files when compared to the other LAS files from the pile. This discrepancy was not found through any of the GamDat tools but identified through observation alone back in 2008 by an Engineer within FTB. This discrepancy is shown in Table 2 below.

Table 2: ID-12 Timestamp Discrepancy

Name	Date Modified
T1.LAS	**Friday, September 19, 2008, 10:00:52 AM**
T2.LAS	Wednesday, September 17, 2008, 10:42:22 AM
T3.LAS	Wednesday, September 17, 2008, 10:53:16 AM
T4.LAS	Wednesday, September 17, 2008, 11:03:32 AM
T5.LAS	**Friday, September 19, 2008, 9:49:18 AM**
T6.LAS	Wednesday, September 17, 2008, 11:27:20 AM

The 'file modified' date for the LAS files representing GGL tests at inspection pipes T1 and T5 is on a different calendar day as the other inspection pipes within the pile.

Depth

There is a discrepancy between the 'Header Stop' and the 'Data Stop' values for the same two GGL tests performed at inspection pipes T1 and T5 that were noted above in the pattern match and timestamp discrepancy discussion.

Table 3: ID-13 Depth Analysis

Unique File ID	Date	Filename	Reason
7609	9/19/08 10:00	T1.LAS	Start Depth or Stop Depth does not match. Header Start: 103.457 Header Stop: 31.9657 Data Start At: 103.457 Data Stop At: 3.2495
7613	9/19/08 9:49	T5.LAS	Start Depth or Stop Depth does not match. Header Start: 104.355 Header Stop: 76.1369 Data Start At: 104.355 Data Stop At: 3.2495

Discussion of Findings

From the information presented in Tables 1 and 2 it is clear there was deliberate editing of GGL test data collected at Tubes 1 and 5 of Bent 2 Pile W2. The pattern matching analysis found that two LAS files representing two of six inspection pipes at this pile contained repeating sequences of data. In both cases data was copied from a different GGL test representing test data from either a different inspection tube from Pile W2 or an inspection tube from adjacent pile W3. This is shown below in Figures 1 and 2 where each distinct pattern is designated with an alphabetic letter and the location where each pattern was copied from, and the location where each pattern was pasted into Tubes 1 and 5.

Other significant findings include:

- RD files were not recovered therefore the following tools would not find irregularities: Fidelity (RD-LAS) and Timestamp (RD-LAS). However, a review of the 'File Modified' times attached to the LAS files showed the Tube 1 and 5 LAS files were saved at a later time than Tubes 2, 3, 4, and 6.
- The method of data editing was 'copy and paste' from inspection pipes located in the same and an adjacent pile. The data used in the 'cut and paste' operation was all collected using the same GGL probe therefore the falsification was not found through the calibration tool.
- The data falsification addressed in ID-13 was discovered by an FTB Engineer in 2008 during analysis of the test data. The falsified data was not used in the pile acceptance report and the pile was re-tested shortly after the falsification was discovered.

Figure 1: ID-13 Pile W2 Tube 1 LAS File Pattern Matching Source and Destination of Data (Patterns G, H, I)

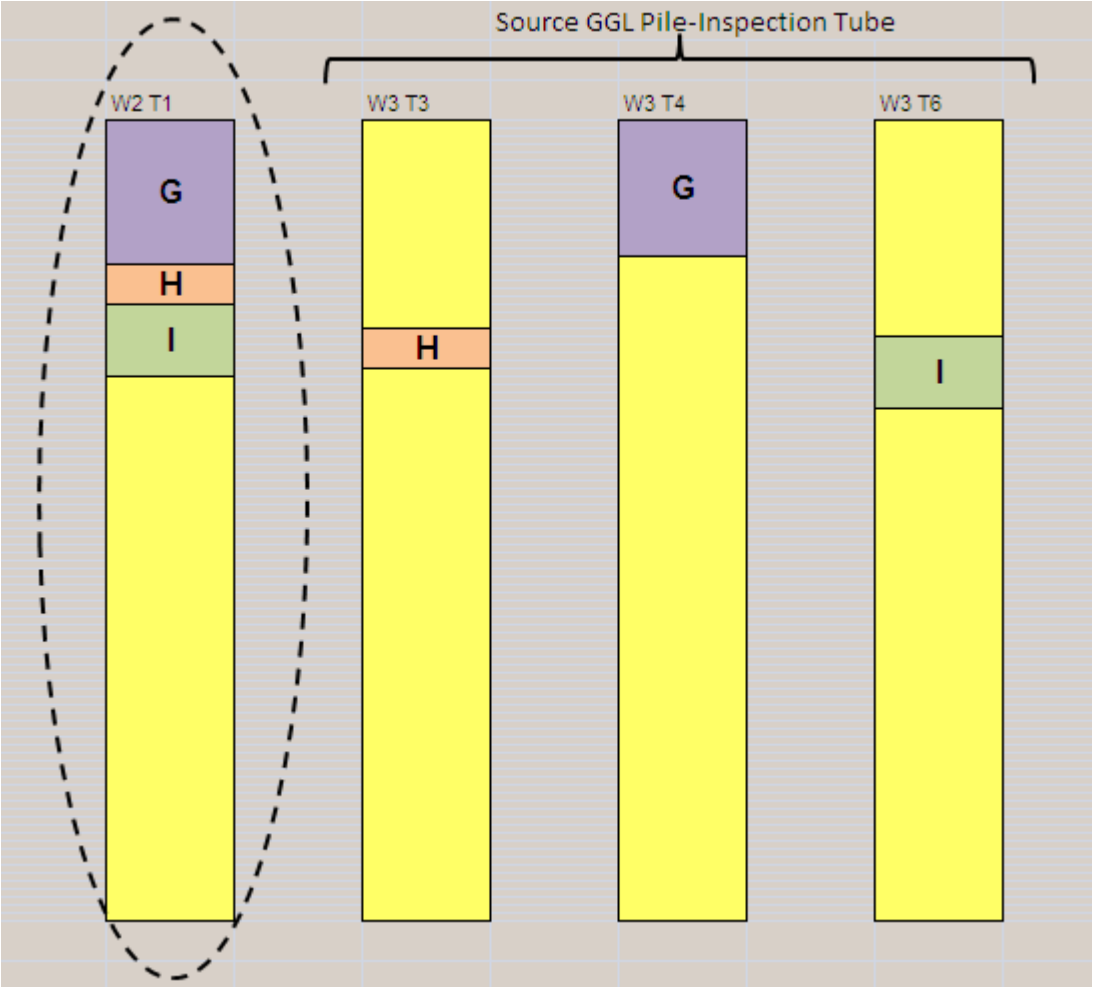
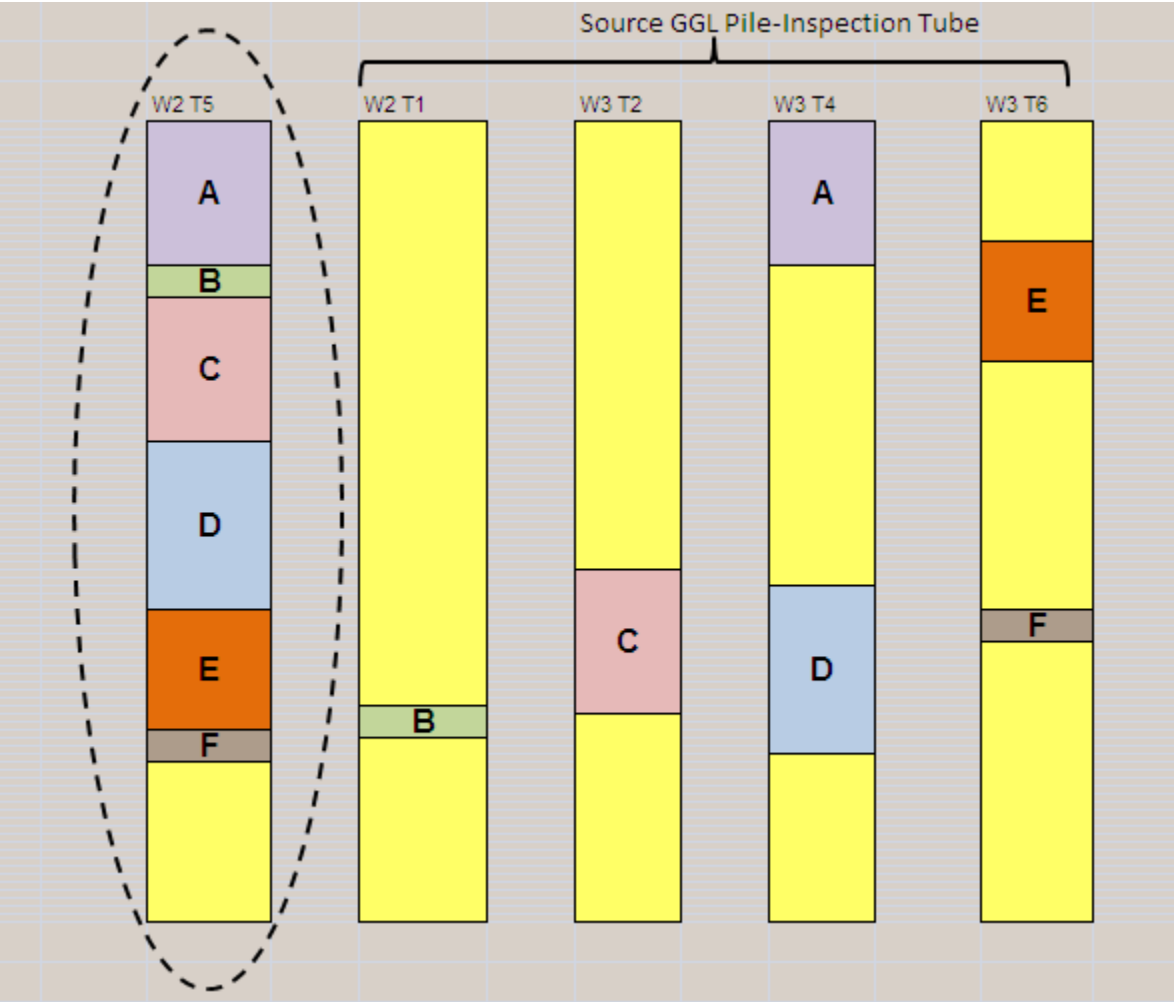


Figure 2: ID-13 Pile W2 Tube 5 LAS File Pattern Matching Source and Destination of Data (Patterns A- F)



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 14

Name: Files opened & saved in Excel but no data integrity compromises

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☒ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 3/28/12

Summarized by: Turner **Date:** 8/24/12

Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

There are a number of LAS files identified by the pattern match routine where the contents appear identical. The differences in the files are due to subtle changes in the text formatting – inclusion of additional tab characters or changes to date formats.

Discussion of Findings

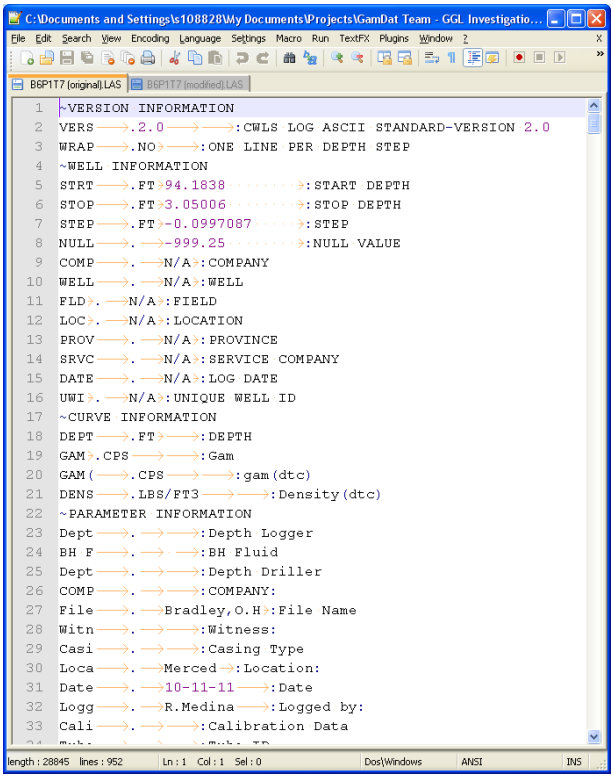
In all of the flagged instances, one file is an original LAS file while the other is the same LAS file that had been opened in Excel and then saved from within Excel. The practice of saving from Excel introduces multiple irregularities in to the file:

- The date and time stamps are changed.
- Additional hidden tab characters are added to the resaved file.
- Additional quote characters are added.
- Formatting of dates is changed.

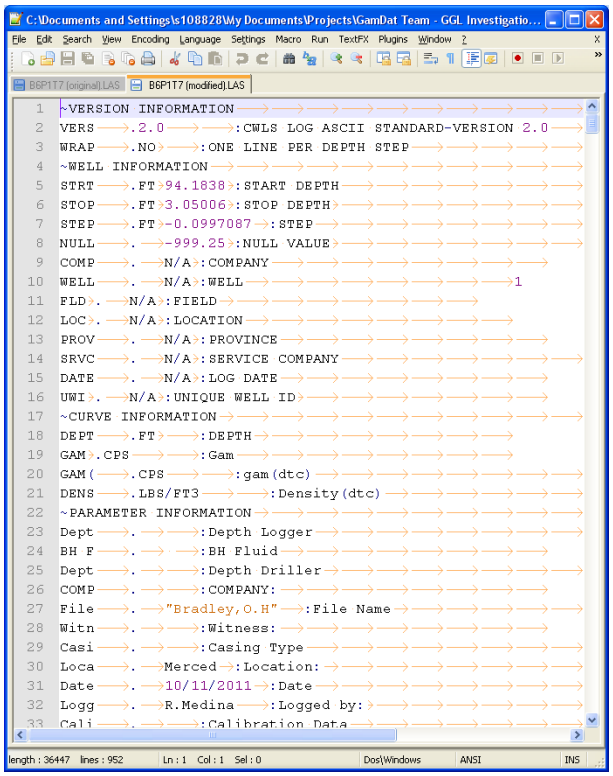
These changes are detected by the MD5/SHA-1 routines in the pattern matching and file renaming tools, and they are flagged as having different content but same density sequence.

Example of the changes to an Excel file – original (left) and modified (right) shown below. Note the changes to the date format in the header, the extra quotes around “Bradley,O.H”, and the extra tabs introduced in the file (yellow arrows).

Original LAS File



Modified LAS File



These changes are introduced to the file when a LAS file is opened with Excel and subsequently saved when closing the file from Excel. These alterations do not change or compromise the integrity of the GGL test measurements.

References

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	Path
401	83472	12678	915	915	915	1	10/14/2011 18:26	…top/Bradley/bent 6/B6P1T7.LAS'
401	89517	14365	915	915	915	1	10/11/2011 13:28	…Merced,Bradley O.H/B6P1T7.LAS'
403	84630	13006	254	254	254	1	12/3/2010 15:43	…oke Creek Bridge/Bnt3P2T1.LAS'
403	88763	14043	254	254	254	1	12/1/2010 12:06	…oke Creek Bridge/Bnt3P2T1.LAS'
404	84638	13009	255	255	255	1	12/3/2010 15:42	…oke Creek Bridge/Bnt3P2T4.LAS'
404	88764	14044	255	255	255	1	12/1/2010 12:22	…oke Creek Bridge/Bnt3P2T4.LAS'
405	84766	13052	289	289	289	1	4/22/2011 15:55	…e creek Briidge/Bnt2 P4T3.LAS'
405	88765	14045	289	289	289	1	4/19/2011 13:09	…e creek Briidge/Bnt2 P4T3.LAS'
411	85165	13118	438	438	438	1	6/30/2009 14:12	…29Jun09/W1328P3581S429 B1.LAS'
411	88621	13971	438	438	438	1	6/30/2009 9:52	…0, 2009/W1328P3581S429 B1.LAS'
454	88331	13855	252	252	252	1	10/26/2011 15:53	…26-2011/200 count block 3.LAS
454	89725	14511	252	252	252	1	10/26/2011 16:15	…1 by JT/200 count block 3.LAS
455	88332	13856	930	1044	930	1	10/26/2011 14:06	…-26-2011/strat 115-147-195.LAS
455	89726	14512	930	1044	930	1	10/26/2011 15:28	…-26-2011/strat 115-147-195.LAS
346	71964	10292	1019	1019	1019	1	9/30/2011 17:47	…Rohnert Park,Hwy101/B2P6P1.LAS
346	84273	12888	1019	1019	1019	1	10/14/2011 11:04	…Park,Hwy101 TESTING/B2P6P1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **15(a-c)** ***(See also ID-2 for related data and testing irregularities)***

Name: **February 2007 Testing Of Standard Reference Blocks**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☒ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☒ Time Stamp ☒ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner, Turner, Roblee **Date:** 3/2/12-12/11/12

Summarized by: Roblee **Date:** 12/12/12

Reviewed by: Hannenian **Date:** 12/13/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☒ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

ID-15(a-c) pertains to three GGL files having certain data irregularities that are associated with a second round of testing performed on 2/23/2007 for purposes of qualification of "standard reference" blocks per CTM-233, Part 2B. The first round of qualification testing occurred on 1/24/2007, and certain data irregularities were found in six files as described under ID-2(a-f). Background on the purpose of the qualification testing is presented under ID-2.

Similar copy/paste/delete means were used to alter data files for both the January and February testing rounds. In both cases, the alterations occurred between the acquisition of the data by the technician and transmittal of the LAS data files to the engineer. However, there are several important distinctions between these cases:

1. The GamDat team understands that the January tests were used to qualify the functionality blocks, thus consequential impacts of ID-2 irregularities is considered 'certain'. In contrast, it is understood that the February test results were not considered as the basis for block qualification, thus consequential impacts of ID-15 irregularities are only considered 'plausible'.
2. In both cases, the data manipulations were done to conceal spurious data that would have lead to rejection of test results. However, the causes of the spurious data in ID-15 may differ from those observed in ID-2.
3. The January testing involved only source/probe combination 3551-041. The February testing involved that same equipment as well as source/probe combination 2947-038.

Two different types of data irregularities occurred in the February test results. Two cases (1V and 7H) involved simple deletion of a small number of data points (11 and 13 points, respectively) that was detected by 'RD-LAS Fidelity Analysis'. The third case (2V) involved copying 31 data points from the beginning to the end of the file, and was detected by 'Pattern Matching Analysis'. In all three cases, the LAS files as originally acquired could not be

located in the archives, but two files (1V and 7H) could be regenerated due to the availability of RD files.

Discussion of Findings

The three irregular test sets (1V, 7H, and 2V) are labeled as ID-15a through ID-15c, respectively, and supporting documentation for each case is presented in attachment 15A through 15C, respectively.

Attachments 15A and 15B describe the first two cases (1V and 7H) involving data deletions and present three figures each. The first figure in each attachment graphically illustrates the data alterations performed between acquisition by the technician (shown at left) and transmittal to the engineer (shown at right). The data patterns consistent between the two sets are shown as darker shades of blue or red at the relative positions found within both the acquired and transmitted files. The data patterns are labeled in each figure using small-case letters, and the complete list of density values included in each pattern is presented in the second figure in each attachment. Note that these patterns were not identified by pattern match analysis since the original LAS file was not found in the archive. Rather, these patterns were manually generated by comparison of the regenerated LAS file (from acquired RD file) and the transmitted LAS file found in the archive. The third figure in each attachment shows the originally acquired gamma-count data sequence, and highlights the data that was eliminated prior to transmittal to the engineer.

For these two cases (1V and 7H), all indications are that the technician intentionally removed recorded data prior to transmittal to the engineer. The purpose of the alterations appears to be to eliminate inconsistent readings in the original data files.

The spurious data in the '1V' file (see Fig. 15A.3) consisted of an isolated spike of extremely large amplitude and a single data point at the end of the file. The maximum gamma count (DTC) value of 68792 in the spike is nearly an order of magnitude (~900%) larger than the remaining data. This differs from the 'spikes' observed in ID-2 which had amplitudes in the range of 120% to 180% of normal and are believed to be associated with an adjacent source. A definitive cause for the spurious 1V data spike is not understood at this time, but may be indicative of a brief disconnect between the probe and the DAQ. There is nothing unusual about the single data point deleted from the end of the file, and the purpose for removing it is unclear.

The spurious data in the '7H' file (see Fig. 15B.3) consisted of two small spikes having amplitudes less than 110% of the remaining data. Note that the complete extent of the second spike was not deleted from the file. Potential causes for these spikes appear consistent with those discussed in ID-2.

Attachment 15C describes the third case (2V) involving copy/paste of a string of 31 data points from the top of the file to the end of the file. This is graphically depicted in Fig. 15C.1 and the repeated pattern of density values is presented in Fig. 15C.2. The reason for extending the record with this pattern is not determined, but may have been done to yield a file having at least 200 data points to meet requirements of the test method. The original data set had 175 data points, and the addition of the repeated pattern brought the total to 206 data points.

Overall, ID-15 presents a clear and unambiguous case of intentional data falsification occurring in February 2007 involving three data files. However, the impact of these irregularities may be minimal as these data do not appear to have been used for the qualification of the standard reference blocks.

References

- Attachment 15A: Figures for Manual Analysis of ID-15a
- Attachment 15B: Figures for Manual Analysis of ID-15b
- Attachment 15C: Figures for Manual Analysis of ID-15c
- Master List of GGL Files (3/20/2012 version)
- Pattern Match Analysis Results (4/13/2012 version)
- Files for 1V (ID-15a):
  - RD As Recorded (Unique File ID's 10889)
  - LAS As Transmitted (Unique File ID 13175)
- Files for 7H (ID-15b):
  - RD As Recorded (Unique File ID 11443)
  - LAS As Transmitted (Unique File ID 13186)
- File for 2V (ID-15c):
  - As Transmitted (Unique File ID 14745)

Timestamp Irregularities with 1V.LAS and 7H.LAS

RD-LAS Pair ID	Unique ID	Filepath	Reason	Diff (h:m:s)	Diff (days)
39130	10889	…ktop/85 7`/85 7777777777/1V.rd	Time Difference: 0 2:5:31 LAST MODIFIED: 2007-02-23 21:04:04	2:5:31	0
39130	13175	…top/85 7`/85 7777777777/1V.LAS	Time Difference: 0 2:5:31 LAST MODIFIED: 2007-02-23 23:09:36	2:5:31	0
39998	13186	…top/85 7`/85 7777777777/7h.LAS	Time Difference: 0 4:17:30 LAST MODIFIED: 2007-02-23 23:15:58	4:17:30	0
39998	11443	…ktop/85 7`/85 7777777777/7h.rd	Time Difference: 0 4:17:30 LAST MODIFIED: 2007-02-23 18:58:28	4:17:30	0

Fidelity Irregularities with 1V.LAS and 7H.LAS (2947-038)

File ID	Unique ID	LAS-RD Pair ID	Filepath	Flag Reason
13175	13175	39130	…top/85 7`/85 7777777777/1V.LAS	LASCOUNT: 221 RDCOUNT: 232 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13175 UNIQUE RD FILE ID:10889
10889	10889	39130	…ktop/85 7`/85 7777777777/1V.rd	LASCOUNT: 221 RDCOUNT: 232 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13175 UNIQUE RD FILE ID:10889
13186	13186	39998	…top/85 7`/85 7777777777/7h.LAS	LASCOUNT: 247 RDCOUNT: 260 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13186 UNIQUE RD FILE ID:11443
11443	11443	39998	…ktop/85 7`/85 7777777777/7h.rd	LASCOUNT: 247 RDCOUNT: 260 LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13186 UNIQUE RD FILE ID:11443

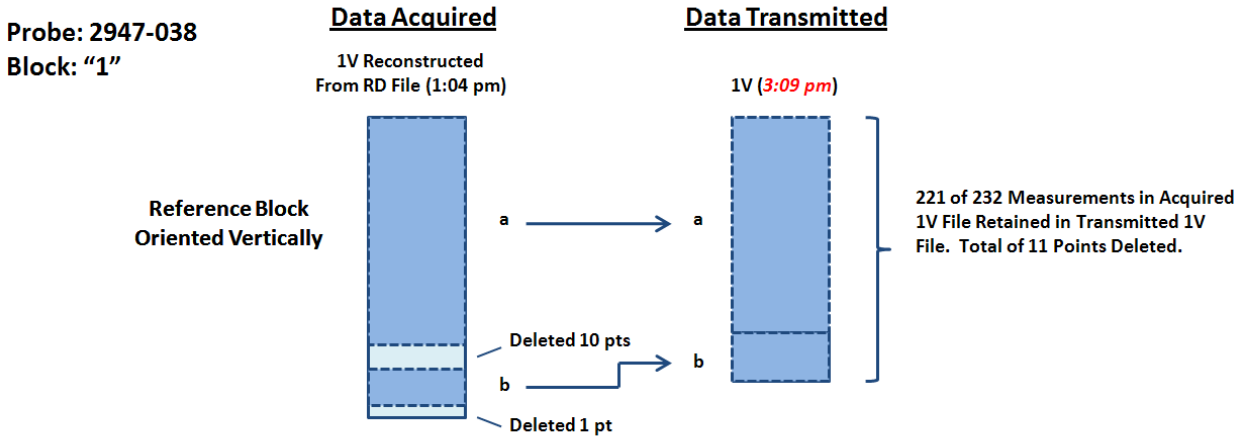
Pattern Match in 3551-2v.LAS (3551)

Pattern ID	File ID	Unique File ID	Pattern Data Points	Occurrence	Date	Path	Pattern
685	90331	14745	31	2	2/23/07 2:36 PM	…STD Ref #2/28Feb07/3551-2v.LAS	199.034,199.512,199.998,198.571,…

Attachment 15A: Figures for Manual Analysis of ID-15a

February 2007 Testing of FTB Standard Reference Blocks
Testing Date: 2/23/2007
Altered File: 1V.LAS

Fig. 15A.1 Illustration of Alteration of 1V.LAS File (ID-15a)
2/23/2007 Testing of FTB Standard Reference Blocks



Pattern ID's

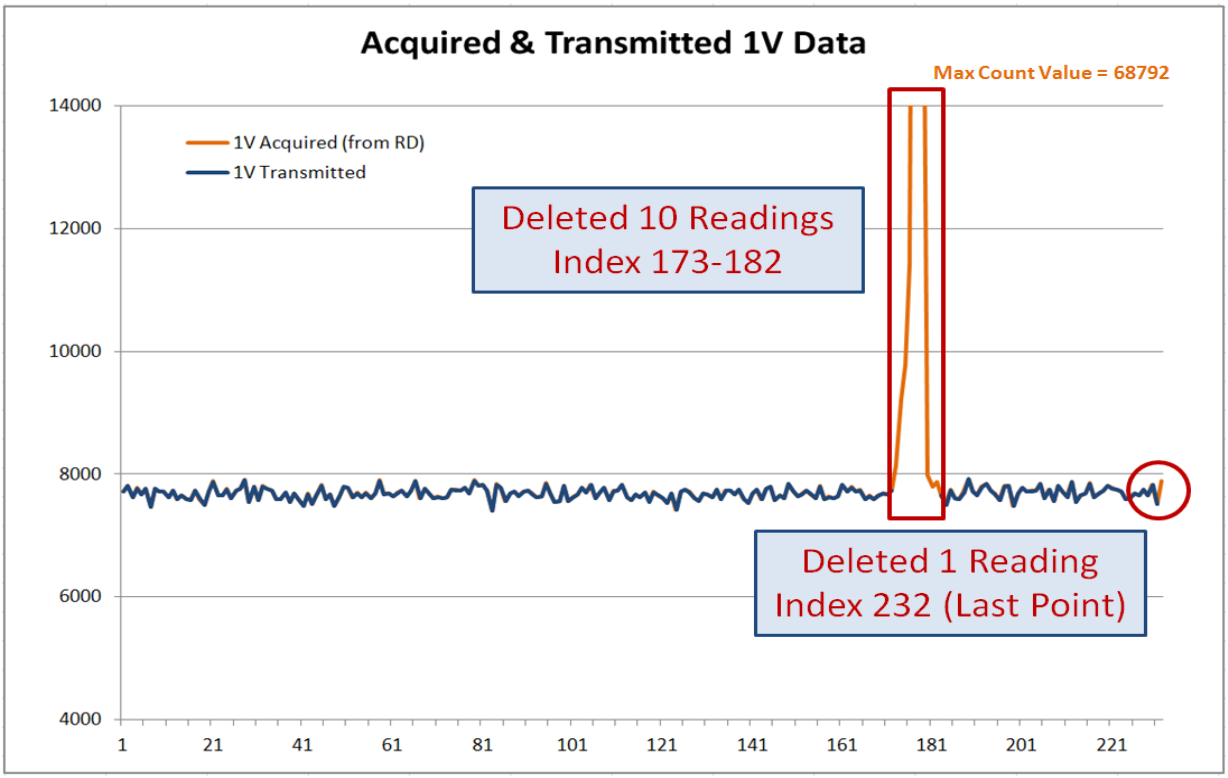
Patterns were not detected by 'Pattern Match Analysis' and therefore not assigned a unique pattern ID number. This is because the acquired 1V.LAS file was not found in the archive, but rather was reconstructed from RD file.

Fig. 15A.2 Patterns Used in Alteration of 1V.LAS File (ID-15a)

2/23/2007 Testing of FTB Standard Reference Blocks

Pattern ID	Length (# values)	Pattern
a	172	219.513, 218.792, 220.241, 219.076, 219.875, 219.168, 221.496, 219.189, 219.486, 219.513, 220.264, 219.429, 220.468, 220.002, 220.466, 220.538, 219.36, 220.491, 221.166, 219.549, 218.245, 219.987, 219.949, 219.195, 220.398, 219.408, 219.122, 218.072, 220.794, 218.896, 220.609, 218.848, 219.147, 219.411, 220.423, 220.46, 219.582, 220.865, 219.749, 220.496, 221.31, 219.814, 221.058, 219.959, 218.74, 220.455, 219.89, 221.375, 220.071, 218.918, 218.985, 220.277, 219.694, 220.268, 219.69, 220.347, 219.793, 218.134, 219.799, 219.711, 220.139, 219.675, 219.367, 220.107, 219.411, 218.218, 220.398, 219.131, 219.721, 220.332, 220.173, 220.362, 220.192, 219.264, 219.319, 219.342, 219.035, 219.749, 218.144, 218.765, 218.667, 219.388, 221.955, 218.607, 219.008, 220.681, 219.78, 219.499, 220.044, 219.505, 219.383, 219.814, 220.251, 220.061, 218.498, 219.744, 220.807, 220.765, 218.815, 220.709, 220.234, 219.835, 219.016, 219.652, 218.696, 220.307, 219.599, 219.008, 220.581, 219.438, 219.383, 218.63, 220.243, 220.545, 219.833, 220.247, 219.667, 220.782, 219.57, 220.033, 220.332, 220.944, 219.727, 221.773, 219.515, 219.277, 219.555, 220.362, 220.651, 219.744, 219.854, 220.262, 219.289, 220.491, 219.36, 219.36, 219.837, 219.258, 220.413, 220.91, 219.721, 219.247, 220.434, 219.166, 218.952, 220.581, 220.002, 220.353, 218.589, 219.444, 220.15, 219.795, 219.408, 219.883, 220.374, 218.848, 220.496, 220.167, 220.343, 220.131, 218.696, 219.478, 218.96, 219.513, 219.316, 220.496, 220.044, 220.468, 220.018, 219.793, 219.856, 219.402
b	49	218.372, 219.953, 221.148, 219.333, 220.321, 220.449, 219.574, 217.945, 219.501, 219.917, 218.918, 218.581, 219.394, 219.812, 220.647, 218.842, 218.815, 221.278, 219.753, 219.043, 219.465, 219.444, 219.417, 218.572, 220.304, 219.256, 220.711, 218.756, 219.511, 220.167, 218.331, 220.794, 219.976, 219.77, 218.486, 220.279, 219.77, 219.402, 218.75, 219.081, 219.222, 219.532, 220.483, 220.336, 219.778, 219.966, 219.241, 219.949, 218.667, 221.043

Fig. 15A.3 Data Deleted from Acquired 1V.LAS File (ID-15a)
2/23/2007 Testing of FTB Standard Reference Blocks

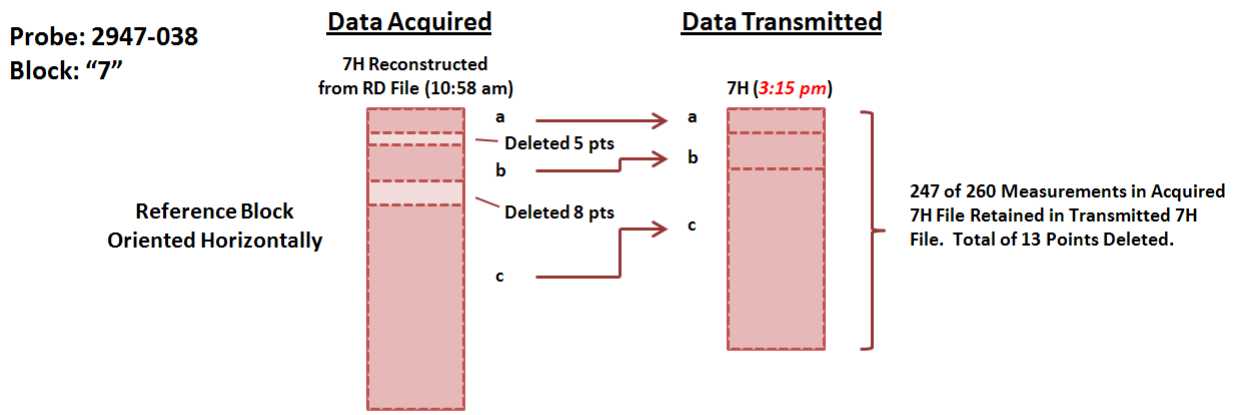


Attachment 15B: Figures for Manual Analysis of ID-15b

February 2007 Testing of FTB Standard Reference Blocks
Testing Date: 2/23/2007
Altered File: 7H.LAS

Fig. 15B.1 Illustration of Alteration of 7H.LAS File (ID-15b)

2/23/2007 Testing of FTB Standard Reference Blocks



Pattern ID's

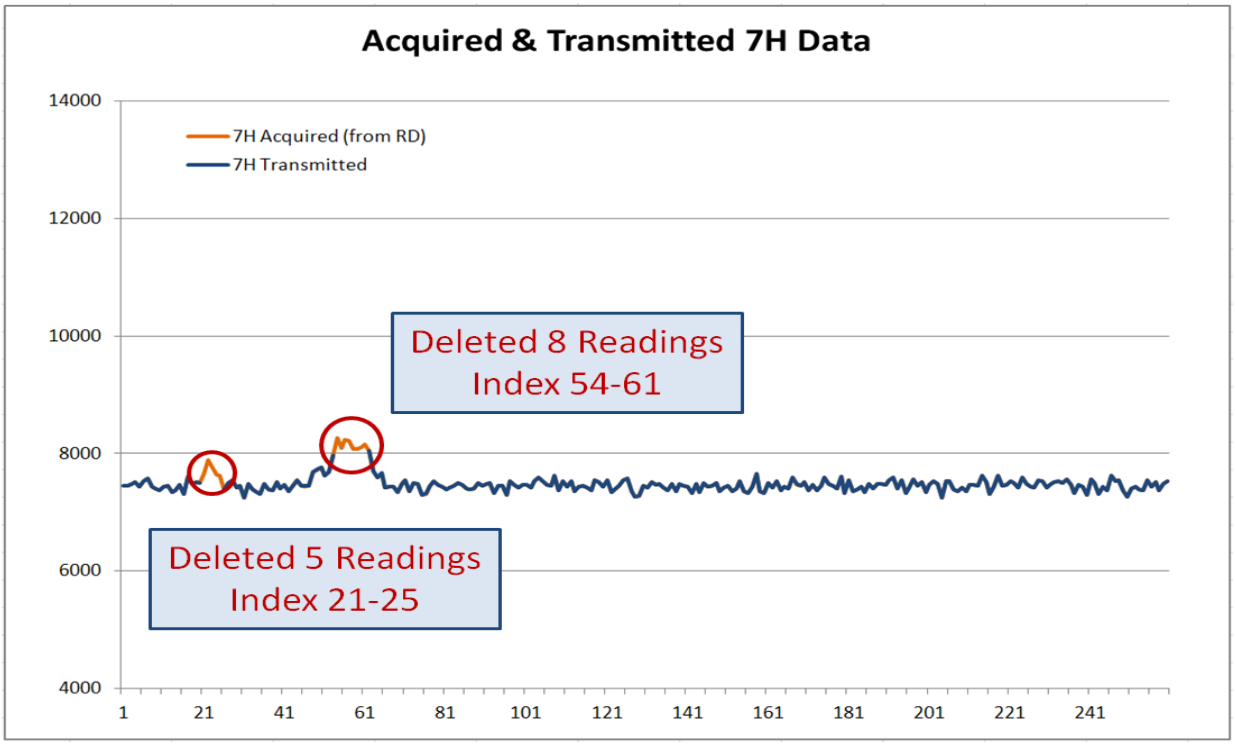
Patterns were not detected by 'Pattern Match Analysis' and therefore not assigned a unique pattern ID number. This is because the acquired 1V.LAS file was not found in the archive, but rather was reconstructed from RD file.

Fig. 15B.2 Patterns Used in Alteration of 7H.LAS File (ID-15b)

2/23/2007 Testing of FTB Standard Reference Blocks

Pattern ID	Length (# values)	Pattern
a	20	146.59, 146.542, 146.171, 145.842, 146.626, 145.804, 145.222, 146.704, 147.068, 147.369, 146.686, 146.517, 147.592, 147.361, 146.406, 147.988, 145.001, 146.148, 145.837, 146.02
b	28	147.234, 146.126, 145.649, 146.806, 146.466, 148.606, 146.284, 147.152, 147.718, 148.037, 146.214, 147.236, 147.285, 145.914, 146.946, 146.406, 147.428, 146.507, 145.646, 146.469, 146.61, 146.502, 144.227, 143.823, 143.401, 144.847, 144.247, 141.47
c	199	140.768, 143.984, 145.132, 144.427, 146.839, 146.676, 146.616, 147.594, 146.214, 145.639, 147.523, 146.09, 146.231, 148.14, 147.882, 146.633, 145.699, 146.431, 146.699, 147.182, 146.895, 146.6, 146.108, 146.398, 147.065, 147.131, 146.935, 146.048, 146.57, 146.239, 146.075, 147.746, 146.578, 146.552, 148.176, 145.739, 146.375, 146.905, 146.416, 146.368, 146.872, 145.799, 145.165, 145.679, 146.332, 146.552, 144.839, 147.305, 145.721, 146.755, 145.781, 147.487, 146.755, 146.593, 146.831, 147.287, 145.649, 145.922, 146.661, 145.559, 147.594, 147.109, 146.481, 145.534, 145.242, 147.538, 148.489, 148.303, 146.552, 146.879, 145.957, 146.347, 146.171, 146.811, 147.372, 146.272, 147.497, 146.292, 146.54, 146.666, 147.805, 146.259, 147.569, 146.138, 146.737, 146.469, 146.015, 147.423, 146.778, 146.55, 147.446, 146.953, 145.781, 147.412, 147.743, 146.651, 144.476, 147.43, 147.82, 146.131, 146.839, 145.721, 147.338, 146.737, 147.04, 145.189, 146.292, 146.542, 145.894, 147.369, 146.418, 147.346, 146.542, 145.152, 146.148, 146.57, 146.935, 144.926, 147.872, 145.629, 147.515, 147.236, 146.636, 147.584, 146.234, 146.974, 146.199, 146.153, 146.426, 145.616, 145.172, 147.017, 145.539, 147.769, 146.89, 145.429, 146.565, 145.904, 147.718, 146.31, 145.804, 146.181, 148.606, 145.699, 145.781, 147.116, 147.523, 146.851, 147.543, 146.408, 146.385, 146.527, 144.847, 145.912, 147.923, 146.616, 144.886, 146.56, 146.325, 145.721, 146.126, 146.923, 145.127, 146.284, 146.616, 146.902, 145.671, 145.771, 146.78, 146.153, 145.897, 145.706, 146.1, 145.364, 146.416, 147.82, 146.426, 146.699, 148.132, 145.424, 146.037, 147.892, 146.768, 147.389, 144.847, 145.679, 145.639, 147.32, 148.451, 146.974, 146.674, 147.088, 147.277, 145.556, 146.717, 145.924, 147.318, 146.234, 145.771

Fig. 15B.3 Data Deleted from Acquired 7H.LAS File (ID-15b)
2/23/2007 Testing of FTB Standard Reference Blocks



Attachment 15C: Figures for Manual Analysis of ID-15c

February 2007 Testing of FTB Standard Reference Blocks
Testing Date: 2/23/2007
Altered File: 2V.LAS

Fig. 15C.1 Illustration of Alteration of 2V.LAS File (ID-15c)

2/23/2007 Testing of FTB Standard Reference Blocks

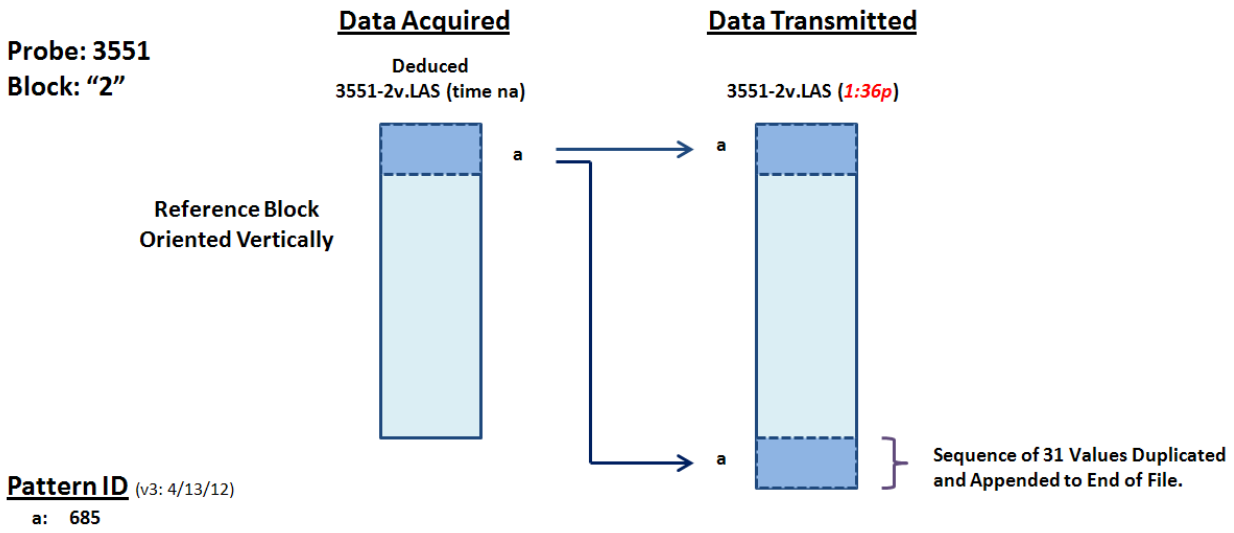


Fig. 15C.2 Pattern Used in Alteration of 2V.LAS File (ID-15c)

2/23/2007 Testing of FTB Standard Reference Blocks

Pattern ID (v3: 4/13/12)	Length (# values)	Pattern
685	31	199.034, 199.512, 199.998, 198.571, 199.824, 198.348, 197.634, 198.842, 199.143, 198.96, 197.706, 198.563, 198.897, 197.615, 198.032, 198.051, 199.378, 197.962, 198.58, 197.717, 197.583, 198.237, 198.939, 198.069, 197.49, 198.627, 198.707, 197.985, 198.682, 198.599, 197.392

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**16**
Name:	*(This irregularity has been documented under ID-21.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 17

Name: Irregular Testing Chronology, 28-0153 Benicia-Martinez, Pier 6, Pile 5, Tube 5

Status: ☐ Inactive ☒ Active ☐ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☒ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Roblee **Date:** 4/12/12
Summarized by: Roblee **Date:** 12/10/12
Reviewed by: Hannenian **Date:** 12/11/12

Conclusions		Confidence
Existence of GGL Data Irregularity	☒ Exists ☐ Does not exist	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

ID-17 is a near-certain instance of an inappropriate retest occurring on April 4, 2004 at Pier 6, Pile 5 of the Benicia-Martinez Bridge. It is suspected that data acquired by a retest of tube 4 was reported as independent data for tube 5. The impact of this irregularity is that the Department may have no GGL data to assess the uniformity of concrete surrounding tube 5.

Discussion of Findings

Summary

The 'near-certain' level of confidence in the existence of a GGL data irregularity is based primarily on exceptionally strong chronological evidence whereby the only physically-feasible explanation which could be identified by the GamDat team to account for documented chronological facts is the stated retest. This conclusion is generally corroborated by correlation analysis results. The cause of the irregularity, whether intentional or inadvertent, could not be determined through examination of the data alone.

Background

The circumstances enabling detection of the retest irregularity in ID-17 are unique and provide compelling indirect evidence of retest. It is one of three instances of retest irregularity (also see ID-10 and ID-11) that involve the isolated use of an atypical testing procedure referred to herein as a "double-transit". The *typical* testing procedure used on nearly all (>99.9%) Caltrans GGL tests to date involves lowering the probe to the bottom of tube (i.e. 'down-transit') without recording data, then initializing the DAQ (to 'depth-up mode') and recording data with the probe

moving back up to the top of the tube (i.e. 'up-transit'). The data file is typically (but not necessarily) saved with the probe at the top of the tube where data was acquired. The *atypical* 'double-transit' procedure involves initializing the DAQ (to 'time mode') after the probe is lowered to the bottom of the tube, then recording for both an 'up-transit' and a subsequent 'down-transit'. The data file is necessarily saved at the end of the second down-transit while the probe is at the bottom of the tube for a second time. This is a critical fact for establishing chronology evidence in these double-transit cases; that is, by DAQ software design, the 'time mode' setting saves the data file immediately after recording is stopped at the logged probe position at that time.

It is important to note again that there is nothing improper about either using the 'time mode' DAQ setting or in testing the tube twice (i.e. up-transit and down-transit). However, it is precisely because of the use of this atypical testing sequence that a compelling chronological case for retest could be established. *Similar retests could have occurred when using the typical testing procedure that could not be definitively detected using chronological evidence*.

ID-17 is particularly unique and compelling among the three double-transit cases because the raw data (RD) file for this test was recovered. The RD file contained probe speed data and readings at least every second. This allowed for the determination of the time interval over which data was recorded to within a few seconds. The existence of the RD file, and firm estimate of testing time, is what makes ID-17 the most compelling of the three double-transit cases. RD files were not recovered for the other two double-transit cases (i.e. ID-10 and ID-11), though the chronological evidence in those instances is also strong.

Details of ID-17 Chronology Analysis

Turning to the specifics of ID-17, the chronological analysis is summarized in attachment 17A. Figure 17A.1 provides a key to the graphics used in subsequent figures. It shows that GGL testing at Pier 6, Pile 5 was reported to have occurred in seven of eight tubes in that pile. No results were reported for Tube 6, and that is not a consideration in this analysis. Testing in tubes 1, 2, 3, 7, and 8 employed the typical testing procedure involving the following steps:

1. The probe was positioned at the top of a tube (e.g. positions 1a, 2a, etc.).
2. The probe was lowered to the bottom of the tube (e.g. positions 1b, 2b, etc.). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'depth-up mode' while the probe was at the bottom of the tube.
4. The probe was raised to the top of the tube while recording (depicted as a red arrow for a 'recording transit').
5. The probe was repositioned to the next tube (e.g. moved from position 1c to 2a), and the process was repeated.

For unknown reasons, an atypical procedure (herein called a "double-transit") was employed for testing of tube 4. In this instance, the following steps were involved:

1. The probe was positioned at the top of a tube (i.e. position 4a).
2. The probe was lowered to the bottom of the tube (i.e. position 4b). Data was not recorded as the probe traveled to bottom of the tube (depicted as a green arrow for a 'non-recording transit').
3. The DAQ system was initialized for recording in 'time mode' while at the bottom of the tube (i.e. position 4b).
4. The probe was raised to the top of the tube (i.e. positions 4b to 4c) while recording, then the direction was reversed and the probe was returned to the bottom of the tube (i.e. positions 4c to 4d) while continuing to record (depicted as a pair of red arrows for the double 'recording transits').
5. At the end of recording, the probe was again at the bottom of tube 4 (i.e. position 4d) where the data file was saved.
6. If the typical testing procedures implied in the GGL report were to have occurred, the probe would need to be raised to the top of tube 4 (i.e. positions 4d to 4e), repositioned onto tube 5 (i.e. positions 4e to 5a), then lowered to the bottom of tube 5 (i.e. positions 5a to 5b) before data could have been acquired in tube 5 during the up-transit (i.e. position 5b to 5c). However, the chronology data shows this was not physically feasible, and instead, data reported for tube 5 was actually recorded on the final up-transit in tube 4 (i.e. positions 4d to 4e).

A complete description of the testing chronology requires knowledge of both time and probe position. The time stamp on the GGL data file unambiguously establishes the time when the file was saved. In figures 17A.2 and 17A.3, the assumed positions associated with the time stamp are denoted by flags. Using the typical 'depth up mode' procedure, the file save location was assumed to be at the top of the tube immediately after the recording transit (e.g. positions 1c, 2c, etc.). This assignment is based on common practice both observed and stated by

Caltrans GGL technicians. However, it must be noted that the GamDat team has determined that it is feasible to reposition the probe to as far as the bottom of the subsequent tube before saving the file while the DAQ is in depth-up mode. That scenario is not considered typical practice, and more importantly, has no bearing on the ID-17 analysis since the suspect data was acquired immediately after the double-transit where the DAQ had been set to 'time mode'. The key feature of using the 'time mode' setting on the DAQ is that the probe position is known at the time the file was saved. In ID-17, that position is the bottom of tube 4 (i.e. position 4d). The nearest position which data reported as tube 5 could have been recorded is at the top of tube 5 (i.e. position 5c).

Figures 17A.2 and 17A.3 consider alternative chronological scenarios for where and how data reported for tube 5 may have actually been recorded. The information highlighted in yellow pertains directly to the assumptions and calculations that change between scenarios. Figure 17A.2 assumes the data reported for tube 5 indeed came from tube 5 (i.e. recording from positions 5b to 5c), whereas Fig. 17A.3 assumes the data reported for tube 5 actually came from tube 4 (i.e. recording from positions 4d to 4e). Timelines are presented for each scenario. In both scenarios, the entire test sequence for pile 5 is shown to illustrate that the analysis yields reasonable results for all but the suspect test reported for tube 5 as well as to demonstrate the effects of alternative procedural assumptions.

Figure 17A.2 presents the timeline if testing occurred as reported. Probe positions are shown as flags at the top of the timeline, and time stamps are connected to a position by the vertical lines. Note that for this analysis, the time stamp for data reported as tube 5 is located at position 5c. Based on time stamps, the time interval between positions 4d and 5c is known to be 11 minutes and 34 seconds. Analysis of the probe speed data appearing in the RD file showed that the time required to record data from position 5b to 5c is 10 minutes and 56 seconds. This leaves only 38 seconds for the probe to be moved from position 4d to 5b.

Three different combinations of assumptions were considered regarding the probe speeds during non-recording transits (i.e. positions 4d-to-4e and 5a-to-5b) as discussed below:

i. Typical procedures are considered first where it is assumed the probe was both lowered and raised while the winch was engaged. Assuming a typical maximum winch speed of 52 fpm and a depth interval for probe travel of 178 feet, approximately 3 minutes and 26 seconds are required for each non-recording transit. Therefore, a total of 6 minutes and 52 seconds would be required just for the transits. This exceeds the 38 seconds available by approximately 6 minutes and 14 seconds, without considering the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). This scenario is simply physically infeasible.

ii. The first of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch and allowed to 'free-wheel' on the downward non-recording transit (i.e. positions 5a to 5b). Assuming down-transit free-wheel speeds of approximately 550 fpm could be achieved throughout the transit; the down-transit time could be reduced to approximately 20 seconds. Assuming the winch is used to raise the probe, a total of 3 minutes and 46 seconds is required for the transits. However, this exceeds the 38 seconds available by approximately 3 minutes and 8 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). This scenario is also physically infeasible.

iii. The second of two atypical procedures considered a scenario where it is assumed the probe was disengaged from the winch on *both* the upward and downward non-recording transits (i.e. positions 4d-to-4e and 5a-to-5b, respectively). While gravity drives down-transit probe movement, up-transit movement without the winch engaged requires that the operator manually pull and store cable. The GamDat team estimated the maximum probe speed for this process of approximately 300 fpm. For this assumption, the up-transit time interval could be reduced to approximately 36 seconds, and total time for both non-recording transits could be reduced to 56 seconds. However, this exceeds the 38 seconds available by approximately 18 seconds, again without considering the additional time required for repositioning the probe to a new tube (i.e. positions 4e to 5a). Therefore, this scenario is also physically infeasible.

Figure 17A.3 presents a similar chronology analysis for the suspected scenario where data reported for tube 5 actually came from tube 4 (i.e. recorded from positions 4d to 4e). Physically, this scenario eliminates the need for repositioning the equipment to the bottom of tube 5, and the only task required to be completed within 38 seconds in non-recording time available is to initialize the DAQ system for recording. Experienced GamDat team members estimate approximately 15 seconds is required to complete this task. Thus, this scenario is physically feasible and provides a reasonable explanation consistent with all observed chronological facts.

The GamDat team was unable to envision any other operational procedure that could account for the observed chronological facts, and based on chronological evidence alone, concluded that results reported for tube 5 were actually retest data obtained in tube 4.

Findings of ID-17 Correlation Analysis

A supplemental prototype 'correlation analysis' based on the 'sigma-delta (SD)' metric was also conducted for ID-17 to examine the similarity between data recorded in tube 4 and the suspect data reported for tube 5. Sigma delta is one of many alternative metrics that could be used to quantify the similarity of two GGL test data sets. It is evaluated as the standard deviation (i.e. 'sigma') of the difference (i.e. 'delta') between pairs of depth-aligned density values for two reported GGL tests over a selected depth range. Attachment 17B presents results of the correlation analysis.

Figure 17B.1 presents two tables of SD values calculated independently by two GamDat analysts for various tube-pair combinations within the pile. Because this case involved a double-transit, the data included one SD value for a known retest pair (T4up-T4down) and two SD values for the suspected retests (T4up-T5up, T4down-T5up) where the 'T5' label indicates data reported for tube 5 but is suspected of being a retest of tube 4. In Fig 17B.1, the SD value for the known retest is highlighted in green, and those for the suspected retests are highlighted in red and orange. Those highlighted in black represent the NO-Retest values that were smaller than either the known or suspected YES-Retest values.

Two sets of independent calculations are presented in Fig. 17B.1 to illustrate the effects of data preprocessing decisions made by the analyst. The most important decision is the selection of 'depth range considered', but the alignment of data traces can also affect the SD value. The two sets of SD values presented in Fig. 17B.1 used different specific limits for depth-range considered where those limits are listed below each table. Even using substantially different depth ranges, the SD values for the known and suspected YES-Retest values are very similar. There are significant differences between individual NO-Retest values, with the values in the left table typically smaller than those in the right table. This is because a smaller depth range was considered, and the data traces are more similar over this depth interval. The values in the left table are used in various correlation analysis methods. For both the 'empirical method' and the 'global RDA method', only the YES-Retest values are used, so the small variations between analyst's decisions have insignificant effect on the results. For the local RDA method, the NO-Retest values are used to establish NO-Retest statistics for this specific pile, and the values in the table on the left are conservative.

Figure 17B.2 presents processed GGL data as a function of depth. Note that the vertical axis in both plots in Fig. 17B.2 is the index of the data point considered in the sigma-delta analysis. Since tubes are logged from the bottom, smaller numbers appear near the bottom. The 700 data points in the logs shown in Fig. 17B.2 represent approximately 70 ft of pile length.

The plot on the left in Fig. 17B.2 shows 'tube remainders' for individual GGL tests in ID-17. A tube remainder is a processed GGL test logs where the acquired data has been smoothed to eliminate high-wavenumber variations (chatter), the 1-D layer-cake density profile common to all tubes ('pile average') has been removed, and any uniform offset (DC component) is removed so the average over depth is zero. The tube remainder contains a combination of localized density variations unique to each tube ('tube signal') and random test-to-test variations ('testing noise'). The relative amplitude of the tube signal to testing noise determines the ease with which a GGL log can be uniquely identified. In the plot on the left in Fig 17B.2, the tube remainder for the two known transits in tube 4 (T4up, T4down) are shown in green, and the suspected retest (T5up) is shown in red. The tube remainders for the rest of the tubes are shown in light gray to illustrate typical NO-Retest data.

The plot on the right in Fig. 17B.2 shows 'tube remainder differences' for various tube-pair combinations for which SD values are tabulated. The 'tube remainder difference' is determined as the difference between tube remainders as a function of depth for a *pair* of GGL logs. Note that while only eight data traces are shown in the left plot (one for each tube), a total of 28 traces are shown in the right plot (one for each tube *combination*). Also note that the standard deviation of the tube remainder difference over the depth range considered *is* the sigma delta value. Small sigma delta values are indicative of greater similarity between tube signals, with random testing noise comprising most of the value. Large sigma delta values are indicative of large differences between tube signals in addition to the random testing noise. The traces in the right plot of Fig 17B.2 are color-coded to correspond to the SD values in the left table of Fig. 17B.1. The known retest pair (T4up-T4down) is shown as a green trace to correspond with the SD value is highlighted in green in Fig. 17B.1. Similarly, the two SD values for the suspected retest pairs (T4up-T5up, T4down-T5up) are shown in orange and red colors. The three NO-Retest tube pairs having low SD values highlighted in black in Fig. 17B.1 are shown as black traces. The remaining NO-Retest traces are shown as thin gray lines, and provide a comparative reference for the degree of tube remainder deltas that are observed in this pile.

Results of the correlation analysis for each of three SD values (1 known retest pair and 2 suspected retest pairs) are summarized in the table and associated charts in Fig. 17B.3. All three SD values (1.16 for known retest pair; 0.61 and 1.09 for suspected retest pairs) fall within a range where instances of both YES-Retest and NO-Retest were observed in a global reference set developed by GamDat for use in correlation analysis.

Figure 17B.3 presents several additional comparisons of the ID-17 SD values to statistical models of the global reference set data including percentiles of YES-Retest and NO-Retest data and 'Retest Likelihood'. Retest likelihood is the probability that a specific SD value being evaluated would be a YES-Retest in the reference set data as determined by the "Retest Discrimination Analysis (RDA)" method. For these purposes, three subsets of the global reference set data were considered, two that yield bounding (low and high) interpretations, and an intermediate 'best' estimate. The bounding subsets consider: 1) solely production GGL tests having known retests conducted prior to the GamDat investigation, and 2) all reference set data collected before and after the GamDat investigation. The difference between the bounding models is because the pre-GamDat data has higher mean SD values for both YES-Retest and NO-Retest conditions than the post-GamDat data; a difference which is attributed to tighter testing control in recent tests. The pre-GamDat data yields the 'high estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the low estimate of 'Percentile of No-Retest' data. Conversely, the use of all data (pre-GamDat and post-GamDat) yields the 'low estimate' for both 'Percentile of YES-Retest' data and 'Retest Likelihood', and the high estimate of 'Percentile of No-Retest' data.

Turning to findings for the three SD values evaluated for ID-17. The suspected retest SD value of 0.61 is well within the range of YES-Retest data and close to the lowest NO-Retest value (0.59) observed in the global reference set. It represents between the 63rd and 92nd percentile of YES-Retest values, and between the 0th and 1st percentile of all NO-Retest values in the global reference subsets. RDA indicates the suspect 0.61 SD value would have between a 93% and 100% likelihood of retest in the global reference subsets. The RDA method also considered a 'local' reference for the NO-Retest model based on SD values for the other 25 tube pair combinations from the same pile (i.e. values not highlighted in color in Fig 17B.1). Figure 17B.3 shows the suspect 0.61 SD value corresponds to 100% likelihood of retest using the local method regardless of which subset of the global YES-Retest data is considered. Both the global and local reference RDA methods indicate the suspect 0.61 SD value represents a <u>likely data irregularity</u>.

Both the suspected retest SD value of 1.09 and the known retest SD value of 1.16 are toward the higher end of YES-Retest values observed in the global reference set and represent between the 6th and 27th percentile of that data. These values also correspond to between the 7th and 30th percentile of all NO-Retest values in the global reference set, so percentiles are similar. The RDA (both global and local) methods indicate the suspect-retest SD value of 1.09 would have between a 25% and 65% likelihood of being a retest in the reference subsets, and the <u>known-retest</u> SD value of 1.16 would have between a 15% and 53% likelihood of retest. Both SD values (1.09 and 1.16) are within a range that the RDA method (both global and local) indicates is a <u>plausible data irregularity</u>.

Overall, correlation analysis results are generally supportive, and do not refute, the chronologically-based conclusion that GGL test results reported for tube 5 were actually retest data obtained in tube 4.

References

- Attachment 17A: Manual Chronology Analysis for ID-17
- Attachment 17B: Correlation Analysis Results for ID-17

Attachment 17A

Manual Chronology Analysis for ID-17

28-0153 – Benicia Martinez Bridge
Pier 6, Pile 5
Testing Date: 4/4/2004

Concern: Retest of Tube 4 Reported As Independent Test of Tube 5

Fig 17A.1) ID-17 Chronology Analysis: Orientation to Figures

Concern: Retest of Tube 4 Reported As Independent Test of Tube 5

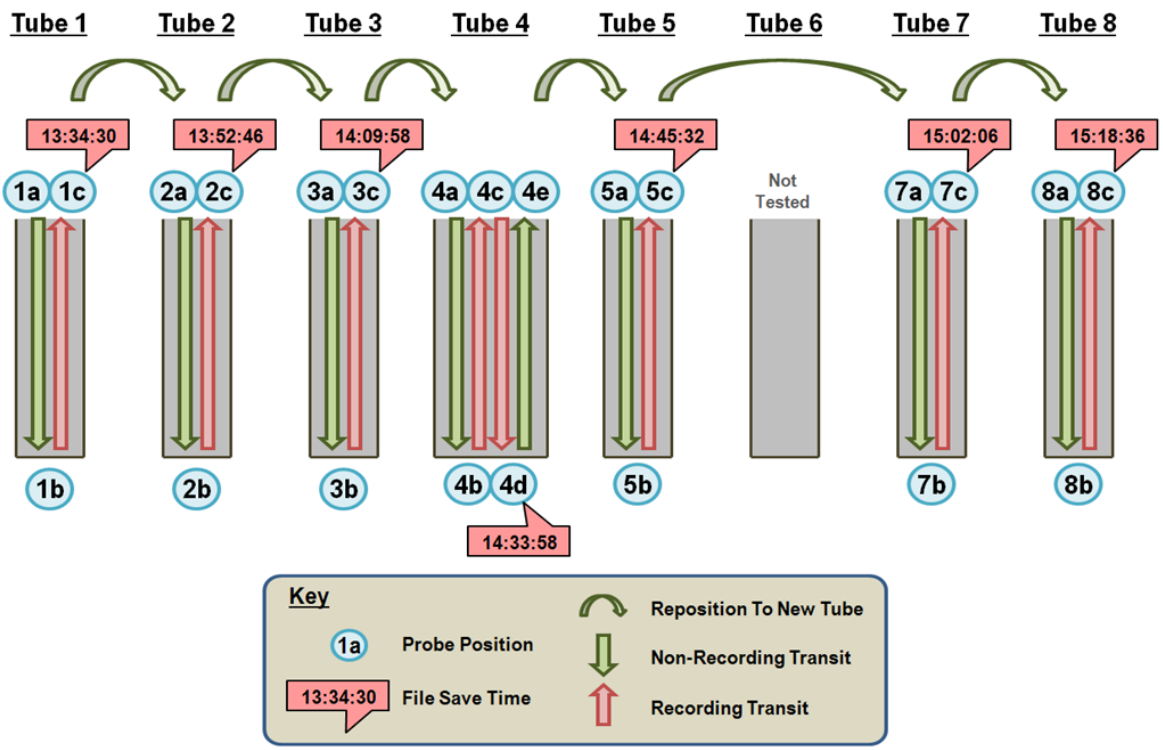
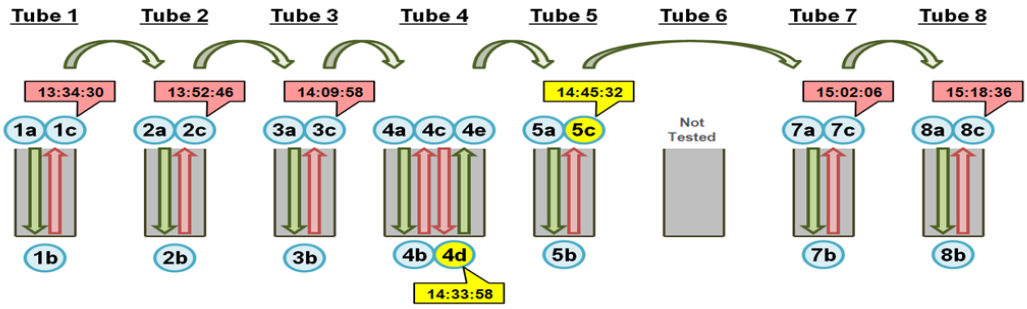


Fig. 17A.2) ID-17 Chronology Analysis: Testing As Reported



Known From Data

Probe Position:	1a	1b	1c	2a	2b	2c	3a	3b	3c	4a	4b	4c	4d	4e	5a	5b	5c	7a	7b	7c	8a	8b	8c							
File Time Stamp:	?		13:34:30			13:52:46			14:09:58				14:33:58				14:45:32			15:02:06			15:18:36							
Elapsed Time (Min:Sec)																														
Total Between Time Stamps:		?		18:16			17:12			24:00				11:34				16:34			16:30									
Recording (Known from Data):			11:53			10:33			10:45			14:42					10:56			10:39			10:27							
Non-Recording (Remainder):		?		07:43			06:27			09:18				00:38				05:55			06:03									

Assume Typical Procedure for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																														
Min NR Transit Time (Approx):			03:26			03:26			03:26				03:26		03:26				03:26				03:26							
Balance for Repositioning:		04:17			03:01			05:52						-06:14				02:29				02:37								

Not Feasible

Assume Atypical Procedure for Down-Transit (Freewheel at 550 fpm)

Probe FreeWheeled Down Only (550 fpm)																														
Min NR Transit Time (Approx):			00:20			00:20			00:20				03:26		00:20				00:20				00:20							
Balance for Repositioning:		07:23			06:07			08:58						-03:08				05:35				05:43								

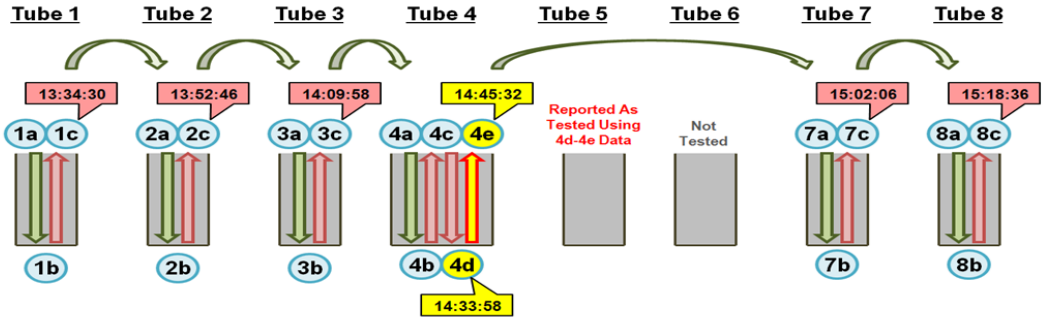
Not Feasible

Assume Additional Atypical Procedure for Up-Transit (Freewheel at 300 fpm)

Probe FreeWheeled Down (550 fpm) & Up for T4d-e (300 fpm)																														
Min NR Transit Time (Approx):			00:20			00:20			00:20				00:36		00:20				00:20				00:20							
Balance for Repositioning:		07:23			06:07			08:58						-00:18				05:35				05:43								

Not Feasible

Fig. 17A.3) ID-17 Chronology Analysis: Suspected Retest Scenario



Known From Data

Probe Position:	1a	1b	1c	2a	2b	2c	3a	3b	3c	4a	4b	4c	4d	4e	7a	7b	7c	8a	8b	8c										
File Time Stamp:	?		13:34:30			13:52:46			14:09:58				14:33:58		14:45:32			15:02:06			15:18:36									
Elapsed Time (Min:Sec)																														
Total Between Time Stamps:		?		18:16			17:12			24:00				11:34			16:34			16:30										
Recording (Known from Data):			11:53			10:33			10:45			14:42			10:56			10:39			10:27									
Non-Recording (Remainder):		?		07:43			06:27			09:18				00:38			05:55			06:03										

Assume Typical Procedures for Down-Transit (Max Winch Speed of 52 fpm)

Probe @ Max Winch Speed (~52 fpm) Down or Up																														
Min NR Transit Time (Approx):			03:26			03:26			03:26				00:00		03:26				03:26				03:26							
Balance for Repositioning:		04:17			03:01			05:52					00:38*					02:29				02:37								

Feasible

Attachment 17B

Correlation Analysis Results for ID-17

28-0153 – Benicia Martinez Bridge
Pier 6, Pile 5
Testing Date: 4/4/2004

Concern: Retest of Tube 4 Reported As Independent Test of Tube 5

Sigma Delta Analysis Results

Foundation Location: ID-17: 28-0153 Benicia Martinez Pier 6 Pile 5 Tube 4

TUBE LABEL		1	2	3	4u	4d	5	7	8
	Calc ID	1	2	3	4	5	6	7	8
1	1		1.16	1.30	1.17	1.25	1.26	1.38	1.07
2	2			0.98	1.35	1.26	1.21	1.50	1.34
3	3				1.32	1.30	1.23	1.46	1.49
4u	4					1.16	1.09	1.52	1.44
4d	5						0.61	1.60	1.51
5	6							1.59	1.55
7	7								1.39
8	8								

Depth Range Considered: Data Index 70-790

Sigma Delta Analysis Results

Foundation Location: Benicia Bridge, Pier 6, Pile 5

TUBE LABEL		1-s	2-s	3-s	4u-s	4du-s	5-s	7-s	8-s
	Calc ID	1	2	3	4	5	6	7	8
1-s	1		1.50	1.57	1.35	1.28	1.27	1.49	1.28
2-s	2			1.16	1.42	1.45	1.30	1.56	1.47
3-s	3				1.33	1.34	1.22	1.58	1.58
4u-s	4					1.15	1.08	1.60	1.63
4du-s	5						0.66	1.64	1.57
5-s	6							1.49	1.46
7-s	7								1.31
8-s	8								

Depth Range Considered: Data Index 20-1210

Figure 17B.1) Independent calculations of sigma delta for ID-17 tube pairs. Numbers on left used in analyses.

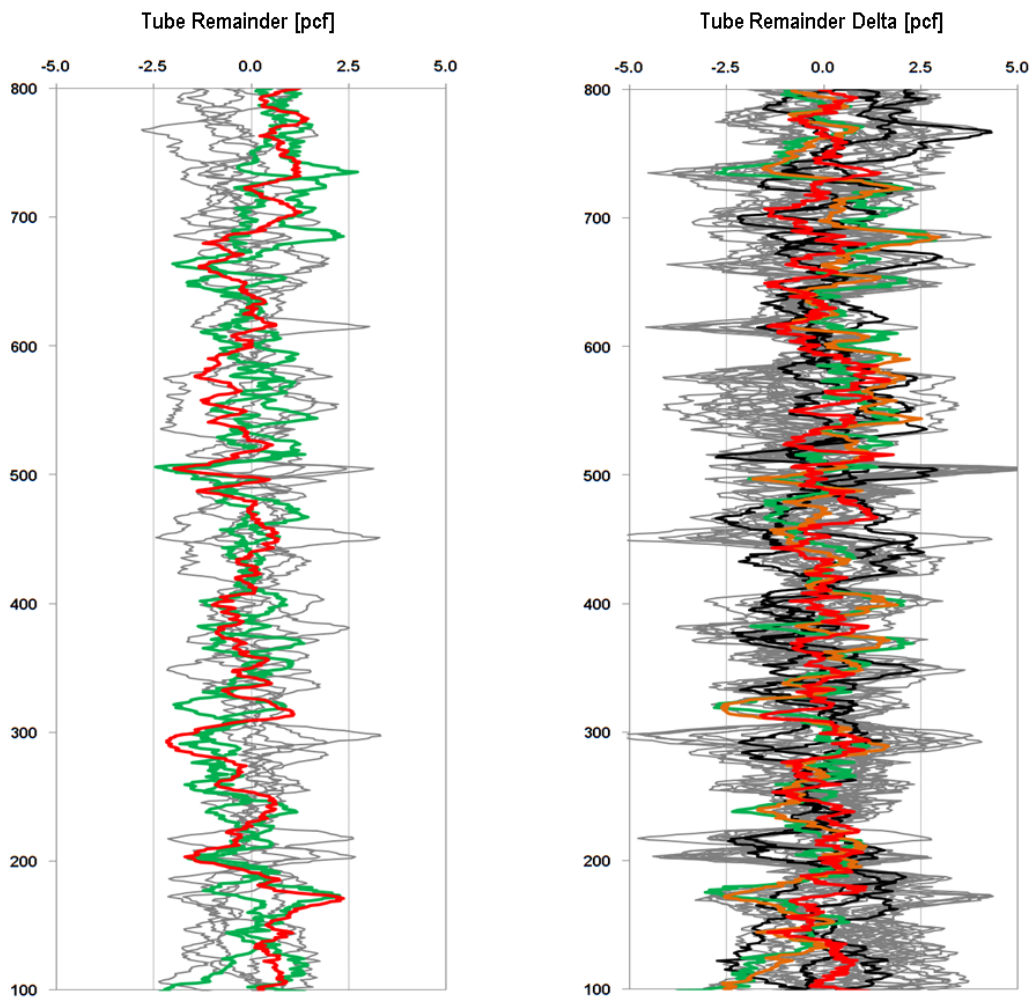


Figure 17B.2) ID-17 'tube remainder' and 'tube remainder delta' plots. (Green: known retest; Red: suspected retest)

Summary of Findings of Retest Discrimination Analysis

ID: ID-17 (C04-R15): Benicia-Martinez, Pier 6, Pile 5

Finding: The two sigma delta values evaluated for this site yield mixed results. One value is in the range considered 'likely' retest while the other is in the range considered 'plausible' retest.

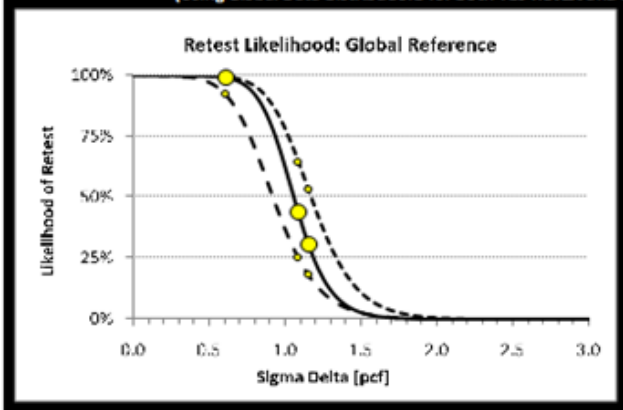
Analyst: Roblee
Date: 12/8/2012

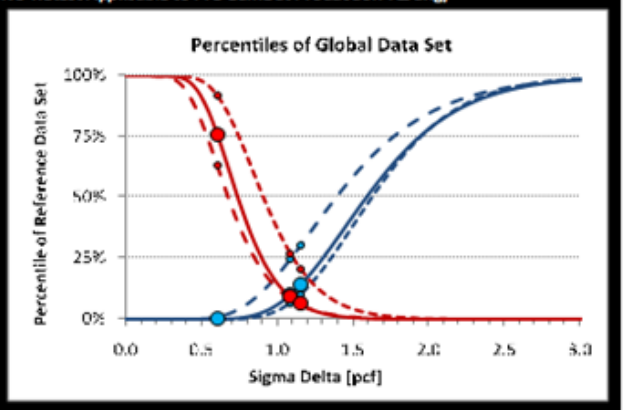
Source of SD Values: (LT) ID-17 v3 SD Analyzer.xlsx (10/4/2012)
Considered Range: Depth Indices 70-790

Evaluated Tube Pair		Global Reference						Local Reference		
		Retest Likelihood		%tile of YES-Retest		%tile of NO-Retest		Retest Likelihood		%tile of
ID	SD	Best Est.	Range	Best Est.	Range	Best Est.	Range	Best Est.	Range	NO-Retest
T4d-T5	0.61	99%	93% - 100%	76%	63% - 92%	0%	0% - 1%	100%	100% - 100%	0%
T4u-T5	1.09	44%	25% - 65%	9%	8% - 27%	10%	7% - 25%	38%	32% - 54%	5%
Known Retest										
T4u-T4d	1.16	31%	18% - 53%	6%	6% - 21%	14%	10% - 30%	18%	15% - 32%	13%

Global Reference Method

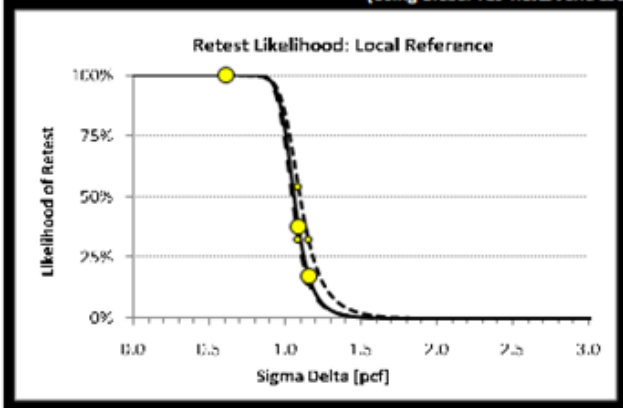
(Using Global Data Distributions for Both YES-Retest and NO-Retest Applicable to Pre-GamDat Production Testing)

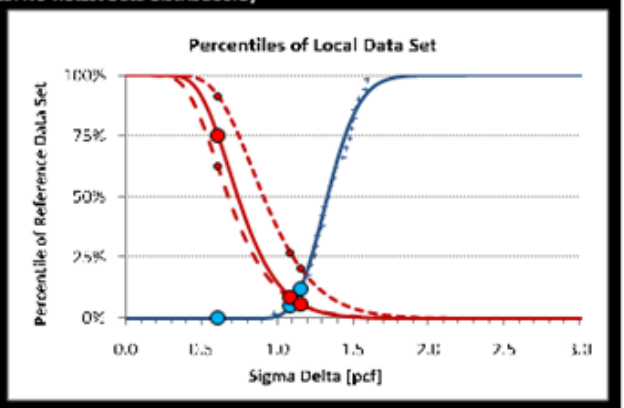




Local Reference Method

(Using Global YES-Retest and Local NO-Retest Data Distributions)





Basis for NO-Retest Local Reference: 25 tube pairs from the same pile

Figure 17B.3) Summary of findings of Retest Discrimination Analysis for ID-17

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 18

Name: File Rename, Retaining Wall 435B at Br. 53-1403, Sawtelle Blvd. UC

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner/Morgan **Date:** 3/26/12

Summarized by: Morgan **Date:** 11/11/12

Reviewed by: Hannenian **Date:** 11/14/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The file rename analysis flagged two files for having identical content but different filenames. The files were associated with GGL tests on two piles within the same foundation conducted on the same day. As named in the project folders, the two files are “P69T4.LAS” and “P72T4.LAS.” “P69T4.LAS” was used to represent Tube 4 of CIDH Pile RW-69. “P72T4.LAS” was used to represent Tube 4, CIDH Pile RW-72. Both CIDH piles are part of Retaining Wall No. 435B at Bridge # 53-1403, Sawtelle Blvd. UC.

Both the P69T4.LAS and P72T4.LAS files are identical except for the file name. Both have identical 'file modified' date and times of Thursday, May 17, 2007, 13:46:10 PM. The chronological sequence of the files indicates that P72T4.LAS is a renamed copy of P69T4.LAS. P69T4.LAS coincides with the chronological sequence of logging at Pile 69 and therefore is assumed to be legitimate data from Pile 69.

The pile acceptance analysis of the data from the renamed file was reported in a FTB memorandum dated May 21, 2007. The RD files associated with testing at Retaining Wall 435B have not been retained and were not used in this analysis. The ggl data used in the testing engineer’s excel spreadsheet for the analysis of Pile RW-69 Tube 4 and Pile RW-72 Tube 4 are identical.

The end result is that for CIDH Pile RW-72, the ggl analysis only evaluated data from 3 of the 4 gamma tubes in the pile. The 4th gamma tube in Pile RW-72 was falsely represented by data from Pile RW-69 Tube 4.

Table 1: ID-18 Compare Pile RW-69 file sequence to Pile RW-72 file sequence

Pile RW-69 Testing Chronology		Pile RW-72 Testing Chronology	
Filename	**File Date/Time Stamp**	**Filename**	**File Date/Time Stamp**
P69T1.LAS	5/17/2007 13:36	P72T1.LAS	5/17/2007 14:04
P69T2.LAS	5/17/2007 13:39	P72T2.LAS	5/17/2007 14:07
P69T3.LAS	5/17/2007 13:42	P72T3.LAS	5/17/2007 14:10
P69T4.LAS	5/17/2007 13:46	**P72T4.LAS**	**5/17/2007 13:46**

ID-18: Analysis Output

All of the files listed are identical except for the file name and/or location.

5/17/2007 13:46	P69T4.LAS	…s tested 5-17-07/Raw data/P69T4.LAS
5/17/2007 13:46	P69T4.LAS	…s tested 5-17-07/Raw data/P69T4.LAS
5/17/2007 13:46	P72T4.LAS	… tested 5-17-07/Raw data/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	…s tested 5-17-07/Raw data/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	…d Settings/DWiles/Desktop/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	… Settings/s122458/Desktop/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	…yne Miles/s122458/Desktop/P72T4.LAS

Discussion of Findings

The gamma-gamma report, engineers worksheet, and LAS files are not filed under the bridge number on the FTB archive. They are located within Mike Harris' "Working folders."

The data file for Pile RW-72 Tube 4 should fall in sequence between Pile RW-72 Tube 3 and RW-73 Tube 1. There are LAS files for 107 tubes that were logged on May 17, 2007 and nearly all tubes in sequence are separated by 3 to 4 minutes. One of the few exceptions is an 8 minute gap between RW-72 Tube 3 and RW-73 Tube 1. The 8 minute gap would allow enough time for RW-72 Tube 4 to have been logged in sequence. However, no unique file in correct sequence was found for RW-72 Tube 4.

There is a significant fact that can be discerned from the collection of 107 unique files available for gamma logging performed on May 17, 2007 at Retaining Wall No. 435B. For all files except P72T4.LAS, only two copies of each unique LAS file exist. In all cases, the two copies are found in folders associated with the engineer who conducted the analysis. One of the files is found on the engineer's laptop computer, and the other is found on the FTB archive under the engineer's name. The one exception is for P72T4.LAS. In addition to the two copies of the file found in folders associated with the engineer, three copies of P72T4.LAS exist in folders contained on the technician's laptop computer. Also, no copies of the other 106 unique files created by the technician on the same date were found on the technician's laptop.

Table 2: ID-18 Files in time sequence

Date	File Name	File Path
5/17/2007 13:46	P69T4.LAS	…s tested 5-17-07/Raw data/P69T4.LAS
5/17/2007 13:46	P72T4.LAS	…s tested 5-17-07/Raw data/P72T4.LAS
5/17/2007 13:46	P69T4.LAS	…s tested 5-17-07/Raw data/P69T4.LAS
5/17/2007 13:46	P72T4.LAS	…s tested 5-17-07/Raw data/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	…d Settings/DWiles/Desktop/P72T4.LAS
5/17/2007 13:46	P72T4.LAS	… Settings/s122458/Desktop/P72T4.LAS
5/17/2007 14:46	P72T4.LAS	…yne Miles/s122458/Desktop/P72T4.LAS
5/17/2007 13:49	P71T1.LAS	…s tested 5-17-07/Raw data/P71T1.LAS
5/17/2007 13:49	P71T1.LAS	…s tested 5-17-07/Raw data/P71T1.LAS
5/17/2007 13:53	P71T2.LAS	…s tested 5-17-07/Raw data/P71T2.LAS
5/17/2007 13:53	P71T2.LAS	…s tested 5-17-07/Raw data/P71T2.LAS
5/17/2007 13:57	P71T3.LAS	…s tested 5-17-07/Raw data/P71T3.LAS
5/17/2007 13:57	P71T3.LAS	…s tested 5-17-07/Raw data/P71T3.LAS
5/17/2007 14:00	P71T4.LAS	…s tested 5-17-07/Raw data/P71T4.LAS
5/17/2007 14:00	P71T4.LAS	…s tested 5-17-07/Raw data/P71T4.LAS
5/17/2007 14:04	P72T1.LAS	…s tested 5-17-07/Raw data/P72T1.LAS
5/17/2007 14:04	P72T1.LAS	…s tested 5-17-07/Raw data/P72T1.LAS
5/17/2007 14:07	P72T2.LAS	…s tested 5-17-07/Raw data/P72T2.LAS
5/17/2007 14:07	P72T2.LAS	…s tested 5-17-07/Raw data/P72T2.LAS
5/17/2007 14:10	P72T3.LAS	…s tested 5-17-07/Raw data/P72T3.LAS
5/17/2007 14:10	P72T3.LAS	…s tested 5-17-07/Raw data/P72T3.LAS
P72T4.LAS should have been found in time sequence here. Note 8 minute time gap.		
5/17/2007 14:18	P73T1.LAS	…s tested 5-17-07/Raw data/P73T1.LAS
5/17/2007 14:18	P73T1.LAS	…s tested 5-17-07/Raw data/P73T1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **19**

Name: **File Rename Br. 57-1177G, N125-W54 Conn Sweetwater, Bent 4, Pile 3**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 11/8/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

An analysis was performed to identify data files with the same content but different names. The analysis identified LAS data files that had been renamed within Pile 3 of Bent 4 of Bridge 57-1177G. During testing the technician named the data files as: T1, T2, T3, and T2A. Later the files were transmitted to the Engineer as: T1, T4, T3, and T2. The analysis found that T2 was renamed as T4, and T2A was renamed as T2, as shown below in Table 1.

Table 1: ID-19 Original and Revised File Names

Original File Names	Revised File Names	Time
T1.LAS	T1.LAS	9:36:36 AM
T2.LAS	T4.LAS	9:49:54 AM
T3.LAS	T3.LAS	9:59:28 AM
T2A.LAS	T2.LAS	10:08:30 AM

The original unmodified RD-LAS file pairs were found in a folder on the FTB server at:

…/FTB/00_FTB_Server_2007_WD1200/C/WILES/GAMMA/SAN DIEGO/125-54/B4P

ID-19: Analysis Output

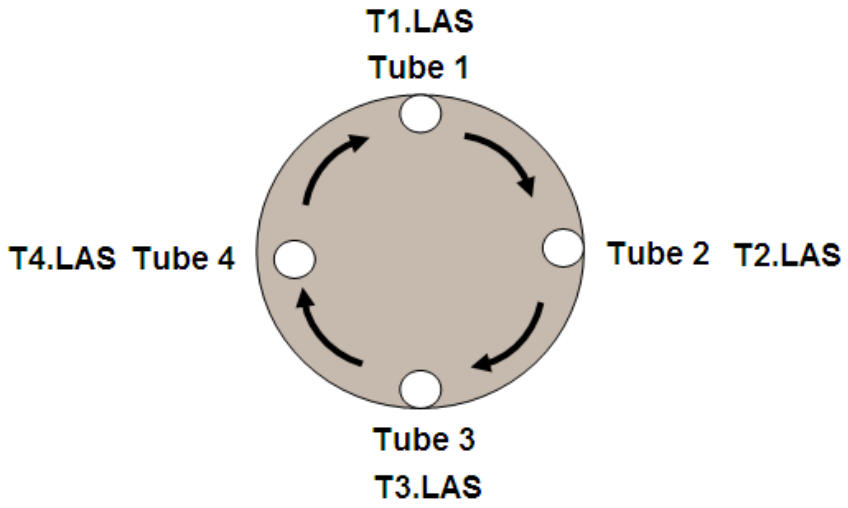
4/19/2006 9:49	T4.LAS	D:/Data/FTB/00_FTB_Archive_Aug_2010_FHWA/57-1177G - N125 W-54 Conn Sweetwater Riv Br (GGL)/GGL/Bent 4, Pile 3/Raw data/T4.LAS
4/19/2006 9:49	**T2.LAS**	**D:/Data/FTB/00_FTB_Server_2007_WD1200/C/WILES/GAMMA/SAN DIEGO/125-54/B4P/T2.LAS**
4/19/2006 10:08	T2.LAS	D:/Data/FTB/00_FTB_Archive_Aug_2010_FHWA/57-1177G - N125 W-54 Conn Sweetwater Riv Br (GGL)/GGL/Bent 4, Pile 3/Raw data/T2.LAS
4/19/2006 10:08	**T2A.LAS**	**D:/Data/FTB/00_FTB_Server_2007_WD1200/C/WILES/GAMMA/SAN DIEGO/125-54/B4P/T2A.LAS**

Discussion of Findings

This is not a case where the same data was used to represent two separate logging runs. There are 4 unique logging runs for this pile. Two of the files were renamed at a later date. Original file T2 was renamed T4. Original file T2A was renamed T2.

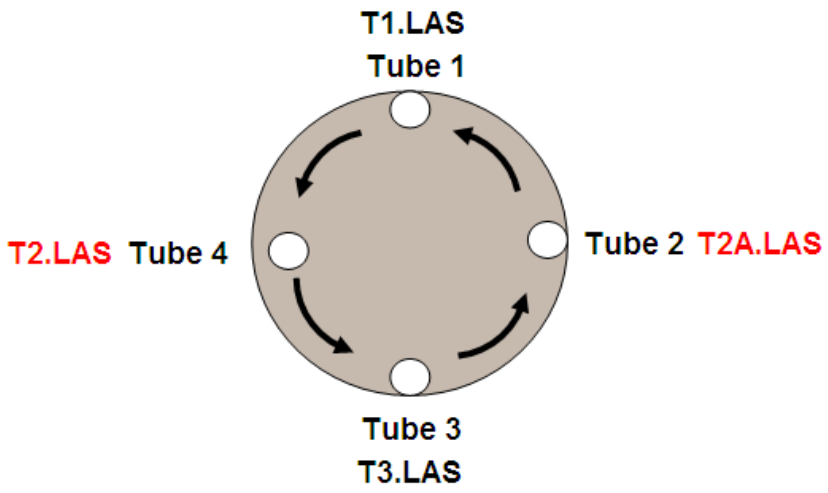
One explanation is that the technician tested in a counter-clockwise sequence rather than clockwise. The standard practice within FTB is to label inspection pipes beginning with 'Tube 1' nearest magnetic north. The tubes are numbered sequentially around the pile in a clockwise direction. This is shown in Figure 1 below with the appropriate LAS file name next to the inspection tube designation

Figure 1: Normal Test Sequence and File Naming Convention



The likely explanation for the file re-name is that the technician tested in a counter-clockwise direction and tested Tube 4 after Tube 1 believing he was testing Tube 2. The LAS file was therefore named T2.LAS. The mistake was realized after testing Tube 4 and incorrectly saving the test data as T2.LAS, but prior to testing Tube 2. Rather than write over the Tube 4 data, the technician save the Tube 2 data as 'T2A.LAS'. The files were then re-named subsequent to all testing at the pile. This scenario is shown in Figure 2 with the LAS file names shown next the inspection pipe designation.

Figure 2: Incorrect Test Sequence



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 20

Name: LAS File Header Edited & Data Removed (Br. 57-1133 Abutment 4 Pile 5)

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The LAS file was flagged for depth irregularities. The RD file was located and compared to the LAS file used in the analysis. 'Start' and 'Stop' depths in the header rows do not agree with the actual start and stop depths in the data set. The stop depth in the data set has a corresponding gamma count of 2 and no corresponding density.

LAS File Generated In 2012 From RD File

```
STRT    .FT      95.6799   :START DEPTH
STOP    .FT      3.05008   :STOP DEPTH
STEP    .FT     -0.09971   :STEP
NULL    .        -999.25   :NULL VALUE
~A
 95.6799   9417.5   10006.5   183.704
 95.5802   9269.5   9839.55   184.743
 4.14688    12971   14115.3   162.468
 4.04717  13980.5     15319   157.417
 3.94747  16005.5   17784.6   148.205
 3.84776    19322   21975.9   135.142
 3.74805    23639     27737    120.77
 3.64834    28237   34288.2   107.682
 3.54863    33068   41682.8   95.6269
 3.44892    37298   48635.6   86.1043
 3.34921    42178   57276.9   76.0091
  3.2495    46646   65841.2   67.4074
 3.14979    51632   76232.1   58.3619
 3.05008    58128   91295.7   47.2309
```

LAS File Provided By Technician

```
STRT    .FT         0   :START DEPTH
STOP    .FT         0   :STOP DEPTH
STEP    .FT         0   :STEP
NULL    .      -999.25   :NULL VALUE
~A
 95.6799   9417.5   10006.5   183.704
 95.5802   9269.5   9839.55   184.743
 4.14688    12971   14115.3   162.468
 4.04717  13980.5     15319   157.417
 3.94747  16005.5   17784.6   148.205
 3.84776    19322   21975.9   135.142
 3.74805        2
```

'Start' and 'Stop' Depths in Header Do Not Agree with data set.
Data at bottom of data set was deleted from the file.

The RD file time does not match the LAS time. They are different by approximately 2 minutes.

T1.LAS	29 KB	LAS File	8/4/2005 9:28 PM
T1.rd	101 KB	RD File	8/4/2005 9:28 PM
T2.LAS	29 KB	LAS File	8/4/2005 9:53 PM
T2.rd	100 KB	RD File	8/4/2005 9:53 PM
T3.LAS	29 KB	LAS File	8/4/2005 10:04 PM
T3.rd	101 KB	RD File	8/4/2005 10:04 PM
T4.LAS	29 KB	LAS File	8/4/2005 10:13 PM
T4.rd	101 KB	RD File	8/4/2005 10:13 PM
ta1.LAS	29 KB	LAS File	8/9/2005 5:08 PM
ta1.rd	101 KB	RD File	8/9/2005 5:06 PM

Discussion of Findings

Both irregularities indicate the LAS file provided to the Engineer was edited. Replaying the RD file showed only data at the very top of the inspection tube and above top of concrete was deleted from LAS file used in the pile acceptance analysis.

It appears the technician edited the header information also.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 21

Name: Corrupted or truncated LAS and LS files are flagged

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/26/12
Summarized by: Turner **Date:** 8/24/12
Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Pairs of LAS and LS files where one has a corrupted and/or truncated data block are being flagged by depth consistency, fidelity, and pattern matching codes. These files had been considered as “unique” files since the content in each pair was different.

Discussion of Findings

In all of the flagged instances, one file is an unmodified file while the other appears to have been modified as a result of operating system, hard drive corruption, or file transfer errors. Many of these files were recovered deleted files from workstations and laptops.

The types of changes introduced to these file include:

- Truncated content
- Content from multiple unrelated files embedded in a LAS or LS file (e.g. Word document, LAS file, and binary data all mixed in a single file).

An example of a corrupted LAS file:

```
47.6939    9390    153.902
47.5942    9380    153.911
47.4945    9285    153.993
47.3948"4" time="2012-01-31T13:48:09" type="3">Product(s) running the latest
DATs.</Log><Log component="4" time="2012-01-31T13:48:09" type="3">Update
Finished</Log></naLog>
.1015    9641    153.683
45.0018    9485.5    153.819
```

```
        44.9021    9446.5    153.853
```

These flagged files are not considered significant, as no true irregularity exists.

References

Flagged by Calibration Constant Analysis:

Unique ID	File ID	Flag ID	Filepath	Reason
6216	20634	98	…nt1112/RawDataB1112/137B11L.T3	…/RawDataB1112/137B11L.T3 has inconsistant Calibration Constant. Constant A: -0.014625016858208. Constant B: 11.956275744181 Minimum in Density Delta: -0.022760303786782. Maximum in Density Delta: 1.6335324220685.
6882	21330	102	…Data/BentWL-25RL/34w25npr.t1.Z	…/Data/BentWL-25RL/34w25npr.t1.Z has inconsistant Calibration Constant. Constant A: -0.00057424459434962. Constant B: 10.042577183854 Minimum in Density Delta: -94.809199856661. Maximum in Density Delta: 140.99662392262.

Flagged by Depth Consistency Analysis:

Flag ID	File ID	Unique File ID	Date	File Path	Reason
42	90079	14683	11/8/2006 13:05	…1_L3K2665/C/Lost Files/T22.LAS	Start Depth or Stop Depth does not match. Header Start: 217.126 Header Stop: 3.44891 Data Start At: 217.126 Data Stop At: 113.229
43	90080	14684	11/15/2006 12:05	…1_L3K2665/C/Lost Files/T42.LAS	Start Depth or Stop Depth does not match. Header Start: 218.522 Header Stop: 3.54864 Data Start At: 218.522 Data Stop At: 168.069
44	90081	14685	11/8/2006 13:55	…1_L3K2665/C/Lost Files/T43.LAS	Start Depth or Stop Depth does not match. Header Start: 217.126 Header Stop: 2.2524 Data Start At: 217.126 Data Stop At: 113.328
45	90082	14686	1/12/2007 12:37	…61_L3K2665/C/Lost Files/T5.LAS	Start Depth or Stop Depth does not match. Header Start: 218.721 Header Stop: 3.14978 Data Start At: 218.721 Data Stop At: 208.351
46	90083	14687	11/15/2006 12:21	…1_L3K2665/C/Lost Files/T52.LAS	Start Depth or Stop Depth does not match. Header Start: 217.923 Header Stop: 3.34921 Data Start At: 217.923 Data Stop At: 207.554
47	90084	14688	11/8/2006 14:16	…1_L3K2665/C/Lost Files/T53.LAS	Start Depth or Stop Depth does not match. Header Start: 217.824 Header Stop: 4.04716 Data Start At: 217.824 Data Stop At: 207.454
48	90085	14689	11/15/2006 12:37	…61_L3K2665/C/Lost Files/T6.LAS	Start Depth or Stop Depth does not match. Header Start: 218.199 Header Stop: 3.02707 Data Start At: 218.199 Data Stop At: 207.83
49	90086	14690	11/8/2006 14:32	…1_L3K2665/C/Lost Files/T61.LAS	Start Depth or Stop Depth does not match. Header Start: 217.724 Header Stop: 3.64834 Data Start At: 217.724 Data Stop At: 167.271
52	90224	14717	12/6/2006 14:16	…tractor's raw data/a6p11-2.LAS	Start Depth or Stop Depth does not match. Header Start: 79.8998 Header Stop: 1.22974 Data Start At: 79.8998 Data Stop At: 47.4945

Flagged by Pattern Matching

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	File Path
137	26888	3740	1043	2144	2144	1	11/9/2006 8:19	…mpletion Pour)/Raw Data/T2.LAS
137	90079	14683	1043	1043	1043	1	11/8/2006 13:05	…1_L3K2665/C/Lost Files/T22.LAS
138	26910	3742	1042	2156	2156	1	11/9/2006 8:17	…mpletion Pour)/Raw Data/T4.LAS
138	90081	14685	1042	1042	1042	1	11/8/2006 13:55	…1_L3K2665/C/Lost Files/T43.LAS
139	26921	3743	105	2145	2145	1	11/9/2006 8:17	…mpletion Pour)/Raw Data/T5.LAS
139	90084	14688	105	105	105	1	11/8/2006 14:16	…1_L3K2665/C/Lost Files/T53.LAS
140	26932	3744	507	2148	2148	1	11/9/2006 8:17	…mpletion Pour)/Raw Data/T6.LAS
140	90086	14690	507	507	507	1	11/8/2006 14:32	…1_L3K2665/C/Lost Files/T61.LAS
141	27092	3755	105	2163	2163	1	1/12/2007 12:37	…-Pier T1/T1-P3 Raw Data/T5.LAS
141	90082	14686	105	105	105	1	1/12/2007 12:37	…61_L3K2665/C/Lost Files/T5.LAS
142	27438	3785	507	2157	2157	1	11/15/2006 15:28	…le 008-Pier T1/Raw Data/T4.LAS
142	90080	14684	507	507	507	1	11/15/2006 12:05	…1_L3K2665/C/Lost Files/T42.LAS
143	27453	3786	105	2153	2153	1	11/15/2006 15:29	…le 008-Pier T1/Raw Data/T5.LAS
143	90083	14687	105	105	105	1	11/15/2006 12:21	…1_L3K2665/C/Lost Files/T52.LAS
144	27468	3787	105	2159	2159	1	11/15/2006 15:29	…le 008-Pier T1/Raw Data/T6.LAS

144	90085	14689	105	105	105	1	11/15/2006 12:37	…61_L3K2665/C/Lost Files/T6.LAS
99	19164	2499	171	432	432	1	7/26/2004 14:26	…le 10/Raw Data/A84P10P10T2.LAS
99	19224	2508	171	171	171	1	8/4/2004 13:57	…data from disk/A84P10P10T2.LAS
100	19172	2500	441	441	441	1	7/26/2004 13:57	…le 10/Raw Data/A84P10P12T1.LAS
100	19236	2510	441	441	441	1	8/4/2004 14:09	…data from disk/A84P10P12T1.LAS
101	19180	2501	40	431	431	1	7/26/2004 14:05	…le 10/Raw Data/A84P10P12T2.LAS
101	19242	2511	40	40	40	1	8/4/2004 14:10	…data from disk/A84P10P12T2.LAS
102	19206	2505	439	439	439	1	8/4/2004 13:46	…data from disk/A84P10P06T2.LAS
102	19254	2513	439	439	439	1	8/3/2004 14:48	…ata from email/A84P10P06T2.LAS
103	19212	2506	441	441	441	1	8/4/2004 13:46	…data from disk/A84P10P08T1.LAS
103	19260	2514	441	441	441	1	8/3/2004 15:01	…ata from email/A84P10P08T1.LAS
104	19218	2507	443	443	443	1	8/4/2004 13:47	…ata from disk/A84P10P08T2A.LAS
104	19266	2515	443	443	443	1	8/3/2004 15:17	…ta from email/A84P10P08T2A.LAS
105	19230	2509	444	444	444	1	8/4/2004 14:08	…data from disk/A84P10P11T2.LAS
105	19278	2517	444	444	444	1	8/3/2004 15:35	…ata from email/A84P10P11T2.LAS
283	62664	8712	326	790	790	1	12/6/2006 13:16	…tractor's raw data/a6p11-2.LAS
283	90224	14717	326	326	326	1	12/6/2006 14:16	…tractor's raw data/a6p11-2.LAS
80	12669	1820	882	1056	1054	1	6/30/2010 13:53	…tual date/CBV RetestB3P2T2.LAS
80	89723	14509	882	882	882	1	6/30/2010 17:22	… by email/CBV RetestB3P2T2.LAS
355	72680	10436	640	743	743	1	6/1/2011 17:29	…8, Bent 2/Raw data/B2P18T2.LAS
355	89724	14510	640	640	640	1	6/1/2011 17:29	…8, Bent 2/Raw data/B2P18T2.LAS
147	27720	3810	220	2152	2152	1	11/29/2006 12:12	…(GGL)/Pile 012/Raw Data/T5.LAS
147	90090	14692	220	221	221	1	1/24/2007 13:59	…alification/STD Ref #3/A3v.LAS

Flagged by Fidelity:

Flag ID	**File ID**	**Unique ID**	**LAS-RD Pair ID**	**LAS gamma count sequence**	**RD gamma count sequence**	**Filepath**	**flag_reason**
101	14716	14716	28247	2247	2311	… MAIN/PIER14/PILE4/P14P4T8.LAS	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7797 UNIQUE RD FILE ID:2221
102	5478	5478	28247	2247	2311	…A MAIN/PIER14/PILE4/P14P4T8.rd	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 7797 UNIQUE RD FILE ID:2221
129	14686	14686	33804	105	2159	…61_L3K2665/C/Lost Files/T5.LAS	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13576 UNIQUE RD FILE ID:5235
130	7267	7267	33804	105	2159	…R61_L3K2665/C/Lost Files/T5.rd	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13576 UNIQUE RD FILE ID:5235
131	14689	14689	33808	105	2154	…61_L3K2665/C/Lost Files/T6.LAS	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13582 UNIQUE RD FILE ID:5241
132	7268	7268	33808	105	2154	…R61_L3K2665/C/Lost Files/T6.rd	LAS RD Pair Failed Fidelity Check: UNIQUE LAS FILE ID: 13582 UNIQUE RD FILE ID:5241

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 22

Name: Calibration Constant flag for Richmond San Rafael

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☒ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 3/27/12

Summarized by: Turner **Date:** 8/24/12

Reviewed by: Hannenian **Date:** 10/17/12

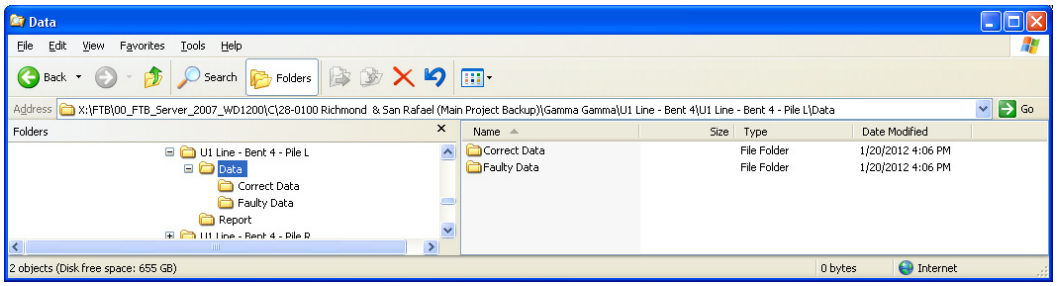
Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

A group of four LAS files associated with a single pile was flagged by the calibration constant analysis. The gamma counts in all four files were all very low (less than 200), suggesting that an incorrect setup file (TOL file) or software settings had been used. The specific location is on 28–0100, Richmond–San Rafael Bridge Retrofit, U1 Line, Bent 4, Pile L.

Discussion of Findings

This set of data had been collected originally. However, the technician or the engineer appears to have recognized the issue with the data and had the pile retested. The new test data was used in the final report. Both the old and new files were retained on the FTB Archive, and placed in directories to indicate the "Faulty Data" and the "Correct Data."



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **23**

Name: **RD-LAS Timestamp 34-0126L, SFOBB, Stage 5, Bent 5L, Pile 3, Tube 1**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

This pile was flagged due to a timestamp discrepancy between the RD and LAS file for one tube.

Date	LAS-RD Pair ID	File Name
6/13/2007 10:51	0	wap3Lt1.LAS
6/13/2007 10:18	34325	wap3Lt1.rd

Discussion of Findings

The LAS file was opened and saved 33 minutes after the test was completed. The RD file was processed through the program by a GamDat team member and the new LAS file compared to the LAS file used in the analysis and shown above. There was no evidence that editing was performed on the LAS file used in the analysis. This appears to be a case where the technician opened the LAS file to verify good data was collected and inadvertently saved the file instead of closing without saving thereby preserving the test time in the LAS timestamp.

LAS File Used In Analysis

STRT	.FT	92.3895	:START DEPTH	
STOP	.FT	2.75095	:STOP DEPTH	
STEP	.FT	-0.0997092	:STEP	
NULL	.	-999.25	:NULL VALUE	
DATE	.	N/A	:LOG DATE	13-Jun-07
UWI	.	N/A	:UNIQUE WELL ID	
~CURVE INFORMATION				
~A				
92.3895	18605	21053.1	164.711	
92.2898	18737	21222.3	164.229	
92.1901	18820	21328.8	163.927	
2.85066	13792.5	15093.6	184.757	
2.75095	13244.5	14439.8	187.425	
Check Sums:				
42,813.203	23,597,448.500	30,519,947.600	131,536.254	

LAS File Generated from RD File in 2012

STRT	.FT	92.3895	:START DEPTH
STOP	.FT	2.75095	:STOP DEPTH
STEP	.FT	-0.0997092	:STEP
NULL	.	-999.25	:NULL VALUE
DATE	.		:DATE
UWI	.	N/A	:UNIQUE WELL ID
~CURVE INFORMATION			
~A			
92.3895	18605	21053.1	164.711
92.2898	18737	21222.3	164.229
92.1901	18820	21328.8	163.927
2.85066	13792.5	15093.6	184.757
2.75095	13244.5	14439.8	187.425
42,813.203	23,597,448.500	30,519,947.600	131,536.254

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 25

Name: LAS File Edited Br. 53-2917 Brea Anchor Pile 1

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☐ Calibration Constant ☐ Correlation
☒ Depth Consistency ☒ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12
Summarized by: Wahleithner **Date:** 6/26/12
Reviewed by: Hannenian **Date:** 10/17/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The LAS file was flagged for depth irregularities.

'Stop' depth in the header row does not agree with the actual stop depth in the data set.

```
~WELL INFORMATION
STRT        .FT                          73.3451   :START DEPTH
STOP        .FT                          6.44019   :STOP DEPTH
STEP        .FT                                0   :STEP
NULL        .                             -999.25   :NULL VALUE
BH F        .                                       :BH Fluid
COMP        .          Condon & Johnson             :COMPANY:
Dept        .                                       :Depth Driller
File        .          anchp1.t1                    :File Name
Witn        .                                       :Witness:
Loca        .          Brea Canyon                  :Location:
~OTHER
~A
    73.3451     15314.5      16935.5      157.895
    73.2453     15178.5      16769.3      158.433
    73.1456       15296      16912.9      157.968
    73.0459       15283        16897      158.019

    3.54863      7067.5      7394.11      203.075
    3.44892     6287.75      6544.96      209.726
    3.14979     6370.75      6634.93      208.982
```

'Stop' Depth in Header Does Not Agree with data set.

The RD file was not found and therefore cannot be compared against the LAS file used in the analysis. A chronology analysis of the LAS files suggest the LAS file was opened after testing and edited. There is approximately 3 minutes between saving the tube 4 and tube 1 files. This is not sufficient time to actually move from tube 4 to tube 1, lower the probe and log the pile (length of approximately 73 feet). The fact that tube 1 is out of sequence suggest it was actually logged prior to t2, then re-opened at the end of the test, edited and saved at 10:07 am.

bcanchp1t2.LAS	23 KB	LAS File	8/7/2003 9:39 AM
bcanchp1t3.LAS	23 KB	LAS File	8/7/2003 9:52 AM
bcanchp1t4.LAS	23 KB	LAS File	8/7/2003 10:04 AM
bcanchp1t1.LAS	23 KB	LAS File	8/7/2003 10:07 AM

Discussion of Findings

Irregularities indicate the LAS file provided to the Engineer was edited. It appears the probe was lowered back down to depth 6.44019 feet and that the redundant data was deleted from the LAS file.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 26

Name: Pattern Match in file pairs for 34-0126RL SFOBB Mainline Structure, Bent 4L, Pile 4

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/2/12
Summarized by: Turner **Date:** 8/30/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

There are four pairs of LAS files flagged by the Pattern Matching analysis all with the same observation. One set of LAS files were found in a single directory on a field laptop, and all contain a subset of density and count readings found within a matched set of LAS files on another source. These matched files were generated with the "replay" function in MSLog.

Discussion of Findings

Observations:

- In all four cases the LAS files on the FTB Archive have more data than the corresponding files on the Toughbook.
- The file names for pair matched pairs are substantially similar and infer the same test.
- The LAS files on the FTB Archive are consistent with the RD files – fidelity is maintained.
  - These larger files were used in subsequent analyses.
  - Rerunning the RD produced a LAS file that matches the FTB Archive, not the one on the Toughbook.
- The LAS files on the Toughbook all appear to be unmodified, given:
  - The START/STOP depths are consistent with the data block.
  - No evidence of having been opened/saved in Excel (e.g. extra tabs, date format changes)
- RD timestamps for the files on the Toughbook are consistent with LAS timestamps on the FTB Archive.
- There are no RD files on the FTB Archive.

Based on these observations, it appears that the technician used the “Replay” feature in the Mt. Sopris MSLog application to regenerate LAS files using the original RD files at a later time. During the “replay” the technician stopped the data writing process prior to completion. As such, a valid LAS file was generated using the same gamma count and density measurements in the RD but over a shorter depth range.

References

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/	Data Points in Files	Occurrence	Date	Path
154	30760	4212	585	843	843	1	6/5/2007 11:05	…ile 4 GGL/Raw Data/B4LP4T1.LAS
154	89632	14429	585	585	585	1	6/20/2007 12:34	…DATA/WEST APPROACH/B4LP4T1.LAS
155	31023	4252	625	778	778	1	6/19/2007 16:10	… & 4 GGL/Raw data/B6LP 3T6.LAS
155	89646	14436	625	625	625	1	6/20/2007 12:37	…DATA/WEST APPROACH/B6LP4T6.LAS
156	31032	4253	434	787	787	1	6/19/2007 16:21	… & 4 GGL/Raw data/B6LP 3T7.LAS
156	89648	14437	434	434	434	1	6/20/2007 12:49	…DATA/WEST APPROACH/B6LP4T7.LAS
157	31166	4267	216	743	743	1	6/25/2007 12:13	…ile 4 GGL/Raw Data/B7LP4T7.LAS
157	89650	14438	216	216	216	1	9/11/2007 14:42	…DATA/WEST APPROACH/B7LP4T7.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **27**

Name: **Files opened, annotated, & saved in Excel but no data integrity compromises**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/3/12
Summarized by: Turner **Date:** 10/4/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Pattern matching analysis flagged several LAS files that had been modified from the original. In all of these instances, the modifications appear to have been made (possibly by the engineer) to insert markers within the data file for downstream processing.

Discussion of Findings

Insertion of additional text in one of multiple LAS files generated from the same test resulted in multiple unique files that were considered further for pattern matching. During the extraction of data from the LAS files with additional text, the parsing stopped at the depth where the unexpected text was encountered. The partial sequence of density measurements were then flagged for matching against an original unmodified LAS version of the same data. The changes appear to be inconsequential to subsequent engineering analyses.

Shown here is an example of how additional text is added to a LAS file. Note the presence of “point 1” added to the file.

```
~VERSION INFORMATION
VERS    .2.0        :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP    .NO        :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT    .FT    -48.3947    :START DEPTH
STOP    .FT    -48.3947    :STOP DEPTH
STEP    .FT    0    :STEP
NULL    .    -999.25    :NULL VALUE
COMP    .    N/A    :COMPANY
WELL    .    N/A    :WELL
FLD    .    N/A    :FIELD
```

```
LOC     .    N/A    :LOCATION
PROV    .    N/A    :PROVINCE
SRVC    .    N/A    :SERVICE COMPANY
DATE    .    N/A    :LOG DATE
UWI     .    N/A    :UNIQUE WELL ID
~CURVE INFORMATION
DEPT    .FT        :DEPTH
GAM    .CPS        :Gam
GAM(    .CPS        :gam(dtc)
DENS    .LBS/FT3        :Density(dtc)
~PARAMETER INFORMATION
…
~OTHER
~A
-48.3947    10872    11664.6    227.241
-48.3947    10839.5    11627.2    227.445
-48.3947    10721.5    11491.5    228.193
-48.3947    10943    11746.4    226.796
-48.3947    10807    11589.8    227.65
-48.3947    10840.5    11628.4    227.439
-48.3947    10768    11545    227.897
-48.3947    10965    11771.7    226.658
-48.3947    10976.5    11785    226.587
-48.3947    10903.5    11700.9    227.043
-48.3947    10906.5    11704.3    227.024
-48.3947    10896    11692.2    227.09
-48.3947    10929    11730.2    226.883
-48.3947    10751.5    11526    228.002
-48.3947    10831    11617.4    227.499        point 1
-48.3947    10857.5    11647.9    227.332
-48.3947    10896.5    11692.8    227.087
-48.3947    10981.5    11790.8    226.555
-48.3947    11093    11919.4    225.864
-48.3947    10751.5    11526    228.002
-48.3947    10812.5    11596.1    227.615
-48.3947    10908.5    11706.6    227.011
```

References

Pattern Matching analysis flagged these files:

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	Path
406	84842	13069	318	318	318	1	7/27/2011 13:57	…/3581 27jul11 fuctionality.LAS
406	90388	14779	318	318	318	1	7/27/2011 12:31	…/3581 27jul11 fuctionality.LAS
407	85020	13097	222	222	222	1	12/30/2009 13:57	… by JT/Block #5 New by JT.LAS
407	88761	14041	222	222	222	1	12/30/2009 11:15	…-1537046117-1035/Block #5.LAS
407	89745	14519	222	222	222	1	1/6/2010 14:07	…-09 JT/Block #5 New by JT.LAS
412	85167	13119	302	302	302	1	4/15/2010 11:49	…-429) 04-15-10 JT/Block 1.LAS
412	89501	14355	302	302	302	1	4/15/2010 9:58	…3581 , 1328 , 429/Block 1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**28**
Name:	*(This irregularity has been documented under ID-31.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **29**

Name: **Single gam(dtc) data point removed from LAS file**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/3/12
Summarized by: Turner **Date:** 8/30/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

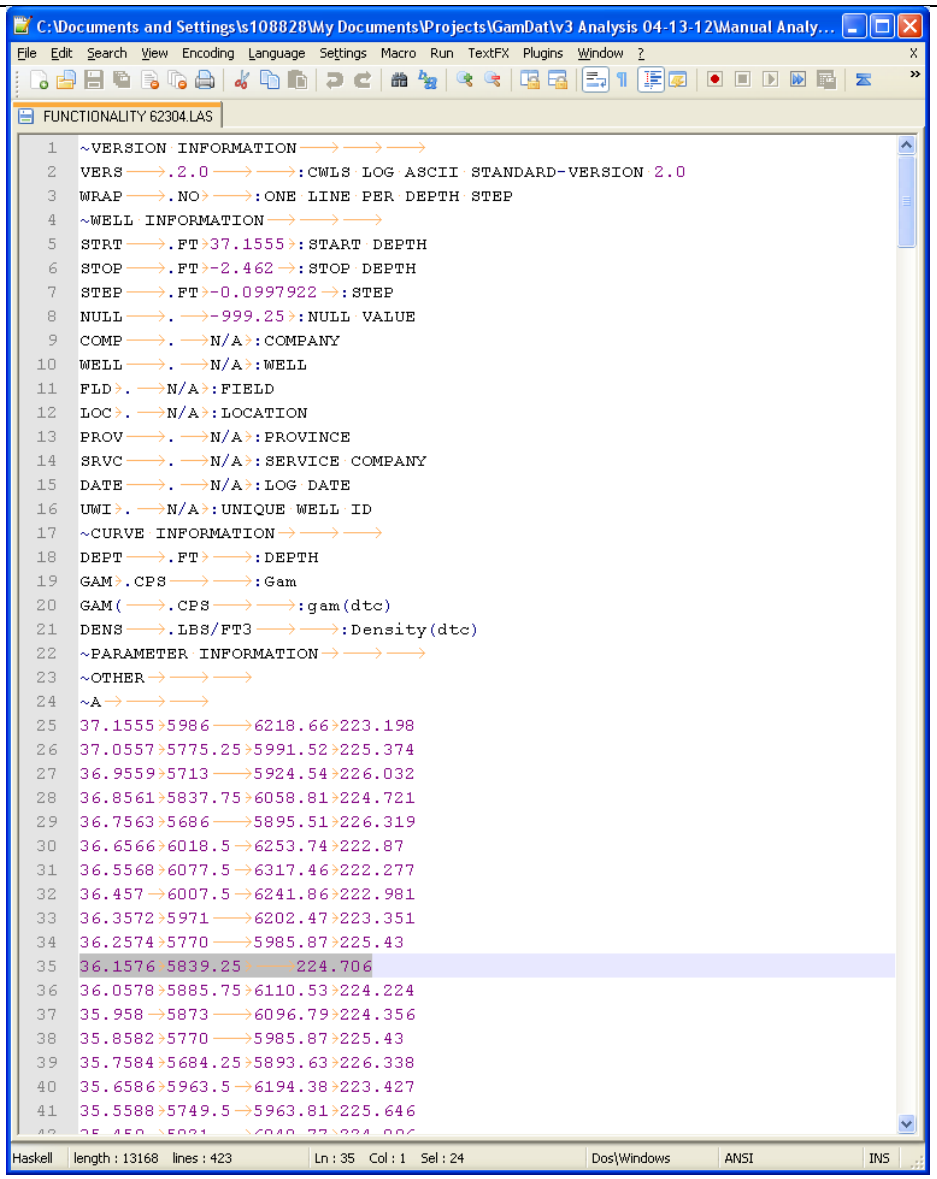
Irregularity Description

A single LAS file was flagged by both Pattern Matching and Depth Consistency for an irregularity where one gamma count in one row of data, “gam(dtc),” was missing or removed.

Discussion of Findings

The LAS file that was flagged appears to have been opened, modified, and saved in Excel due to presence of tabs. Note the additional tab characters in the first line.

Line 35 in the screenshot below shows the absence of a “gam(dtc)” measurement.



The missing gamma count caused the LAS data parser to truncate the sequence of densities measurements at the row where the value was removed. This, in turn, was flagged by the pattern matching analysis as a sub-pattern to an un-altered version of the same LAS file that was found on another source. The depth consistency also flagged the file with the missing gamma count value, since the parsed file was effectively truncated, and the depth range in the LAS header no longer matched the depths in the data block.

Potential Impacts

The 3 variants of this LAS file were all found in higher level directories titled, “GGL DATA” or “GGL FUNCTIONALITY,” and not associated with any specific project. Based upon the directory where found, these files appear to be related to the development of a paper-based functionality field form or represent a single daily functionality test. Since functionality tests are not typically recorded or used in the testing procedure, the impacts of the modifications to this file are inconsequential.

References

Pattern Matching results:

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	Path
445	86890	13371	10	10	10	1	7/7/2004 16:36	…NALITY/FUNCTIONALITY 62304.LAS
445	86902	13376	10	398	398	1	6/23/2004 16:27	…L DATA/FUNCTIONALITY 62304.LAS

Depth Consistency results:

Flag ID	File ID	Unique File ID	Date	Filename	File Path	Reason
27	86890	13371	7/7/2004 16:36	FUNCTIONALITY 62304.LAS	…/FUNCTIONALITY 62304.LAS	Start Depth or Stop Depth does not match. Header Start: 37.1555 Header Stop: -2.462 Data Start At: 37.1555 Data Stop At: 36.2574

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 30

Name: File contains only one row of data

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☒ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/3/12

Summarized by: Turner **Date:** 10/4/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LAS and LS files were flagged by both the calibration constant and depth consistency analyses due to only a single row in the data block.

Discussion of Findings

Neither analysis tool (calibration constant and depth consistency) can complete calculations in the absence of at least 2 or more rows of data. Although unusual to have data files with only a single row of data, these flagged files do not appear to have been modified in any way.

References

Calibration Constant analysis flagged these files:

Flag ID	File ID	Unique File ID	Date	File Path	Reason
36	88144	13809	6/11/2007	…nbarten bridge/bata84pl1t1.LAS	Inconsistant Calibration Constant. Constant A: . Constant B: 10.250825542468 Minimum in Density Delta: -146.878. Maximum in Density Delta: -146.878.
37	88472	13928	6/11/2007	…05534141-1017/aaaaaaaaaaaa.LAS	Inconsistant Calibration Constant. Constant A: . Constant B: 10.183691735132 Minimum in Density Delta: -150.922. Maximum in Density Delta: -150.922.
2504	10133	49		…/Raw data/Bent 10/556B10T5.SA0	… Truck Connector (GGL)/Bents 9, 10/Raw data/Bent 10/556B10T5.SA0 has inconsistant Calibration Constant. Constant A: . Constant B: 9.7551499440232 Minimum in Density Delta: -157.69. Maximum in Density Delta: -157.69.
7828	22286	106		…es/Volume4/53-866K/101B3T2.SA1	…/Volume4/53-866K/101B3T2.SA1 has inconsistant Calibration Constant. Constant A: . Constant B: 10.170272799275 Minimum in Density Delta: -132.73. Maximum in Density Delta: -132.73.

Depth Consistency analysis flagged these files:

Flag ID	File ID	Unique File ID	Date	File Path	Reason
31	88472	13928	6/11/2007	…05534141-1017/aaaaaaaaaaaa.LAS	Start Depth or Stop Depth does not match. Header Start: 23.3396 Header Stop: 23.3396 Data Start At: Data Stop At:
29	88144	13809	6/11/2007	…nbarten bridge/bata84pl1t1.LAS	Start Depth or Stop Depth does not match. Header Start: 25.4667 Header Stop: 25.4667 Data Start At: Data Stop At:
20	61747	8631	10/26/2005	… Pile at Pier 4/data/B4RT1.LAS	Start Depth or Stop Depth does not match. Header Start: 104.853 Header Stop: -1.33713 Data Start At: 104.853 Data Stop At: 3.05008
29	88144	13809	6/11/2007	…nbarten bridge/bata84pl1t1.LAS	Start Depth or Stop Depth does not match. Header Start: 25.4667 Header Stop: 25.4667 Data Start At: Data Stop At:
21	65165	9053	6/2/2010	…ile 1/raw data/SR76A10P1T1.LAS	Start Depth or Stop Depth does not match. Header Start: 77.4996 Header Stop: 77.4996 Data Start At: Data Stop At:
35	89551	14378	9/24/2007	…05534141-1016/SCMLA-1LP2T1.LAS	Start Depth or Stop Depth does not match. Header Start: 102.207 Header Stop: 102.207 Data Start At: Data Stop At:

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 31

Name: LAS files with extra row of data at end

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☒ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/3/12

Summarized by: Turner **Date:** 10/4/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

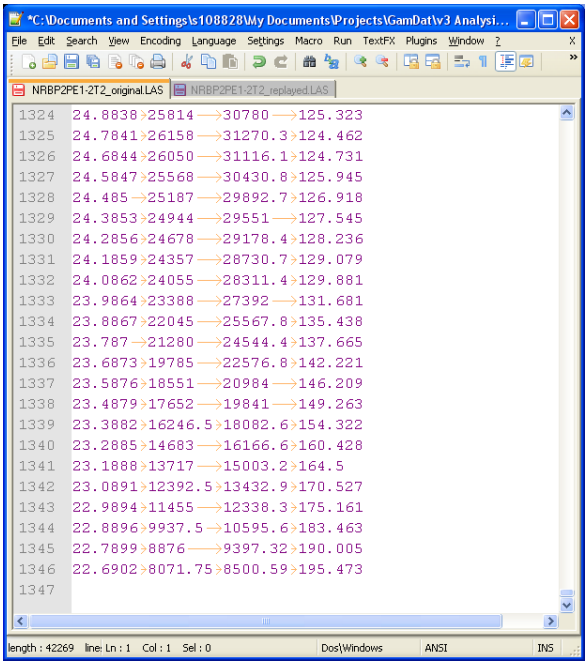
Fidelity and Pattern Matching tools flagged multiple sets of files where the LAS file appears to have one additional row of data when compared against the data found within the corresponding RD file. In all cases, it is the last row of data missing.

Discussion of Findings

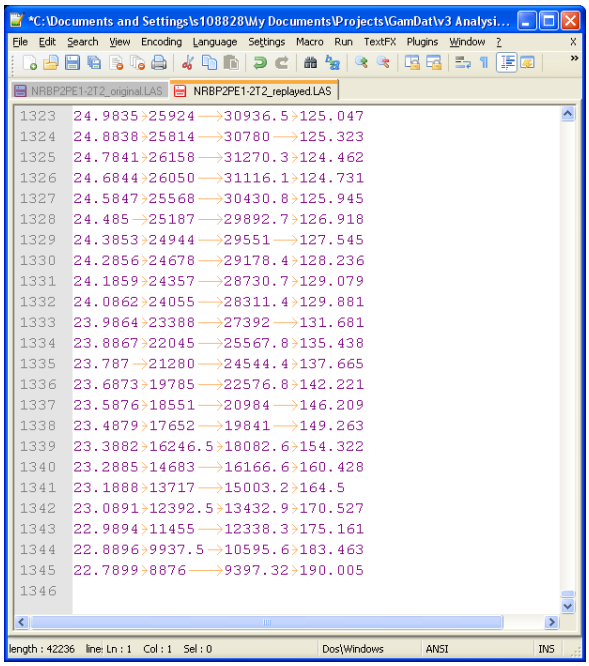
In most of these instances there is no evidence to suggest that the LAS file had been modified, an additional row of data created, and then saved at a later time. The occurrence of this observation appears to be due to the file storage and file writing functions within the *MSLog* software and does not represent a data integrity issue.

Typical for this group of files is the observation of the additional last row of data in the LAS file as shown in an example from one of the files below. The original file appears to be unmodified from when originally written. The LAS file regenerated from the original RD file has one less row of data at the top of the pile.

Original LAS As-Found



Replayed RD File



There were also two occurrences related to the single additional row. In one instance pattern matching flagged two LAS files for having a shared pattern of 259 density values – one file had a sequence of 259 density values while the other had 260. Upon initial inspection, it appears that one file may have been edited to remove a row and the header changed to reflect the changed start depth. However, it seems likely that the editing of the file and the discrepancy with one row of data is coincidental.

References

Fidelity flagged 69 sets of LAS-RD file pairs.

Flag ID	File ID	Unique ID	LAS-RD Pair ID	LAS gamma count sequence	RD gamma count sequence	LAS has one extra row of data?	Filepath
1	972	972	3031	1345	1344	yes	…E2-4/Raw Data/NRBP2PE1-2T2.LAS
2	474	474	3031	1345	1344	yes	… E2-4/Raw Data/NRBP2PE1-2T2.rd
3	973	973	3036	1396	1395	yes	…E2-4/Raw Data/NRBP2PE1-2T3.LAS
4	475	475	3036	1396	1395	yes	… E2-4/Raw Data/NRBP2PE1-2T3.rd
5	976	976	3051	1425	1424	yes	…E2-4/Raw Data/NRBP2PE2-4T3.LAS
6	478	478	3051	1425	1424	yes	… E2-4/Raw Data/NRBP2PE2-4T3.rd
7	1004	1004	3197	1315	1314	yes	…ier 2/Raw Data/P2W-PW3-3T1.LAS
8	506	506	3197	1315	1314	yes	…Pier 2/Raw Data/P2W-PW3-3T1.rd
9	1007	1007	3218	1315	1314	yes	…ier 2/Raw Data/P2W-PW3-3T4.LAS
10	509	509	3218	1315	1314	yes	…Pier 2/Raw Data/P2W-PW3-3T4.rd
11	1010	1010	3239	1316	1315	yes	…ier 2/Raw Data/P2W-PW4-1T3.LAS
12	512	512	3239	1316	1315	yes	…Pier 2/Raw Data/P2W-PW4-1T3.rd
13	1017	1017	3288	1330	1329	yes	…r 2/Raw Data/PIER2-W3-1-T2.LAS
14	519	519	3288	1330	1329	yes	…er 2/Raw Data/PIER2-W3-1-T2.rd
15	1020	1020	3309	1276	1275	yes	…t/Raw Data/PEIR2 PILE1W2T2.LAS
16	522	522	3309	1276	1275	yes	…st/Raw Data/PEIR2 PILE1W2T2.rd
17	1022	1022	3323	1250	1249	yes	…4/Raw Data/PEIR2 PILE1W4T1.LAS
18	524	524	3323	1250	1249	yes	…-4/Raw Data/PEIR2 PILE1W4T1.rd
19	1025	1025	3344	1238	1237	yes	…4/Raw Data/PEIR2 PILE1W4T4.LAS
20	527	527	3344	1238	1237	yes	…-4/Raw Data/PEIR2 PILE1W4T4.rd
21	1028	1028	3365	1308	1307	yes	…4/Raw Data/PEIR2 PILE2W2T3.LAS
22	530	530	3365	1308	1307	yes	…-4/Raw Data/PEIR2 PILE2W2T3.rd
23	1034	1034	3407	1205	1204	yes	…4/Raw Data/PEIR2 PILE3W2T1.LAS
24	536	536	3407	1205	1204	yes	…-4/Raw Data/PEIR2 PILE3W2T1.rd
25	1035	1035	3414	1203	1202	yes	…4/Raw Data/PEIR2 PILE3W2T2.LAS
26	537	537	3414	1203	1202	yes	…-4/Raw Data/PEIR2 PILE3W2T2.rd
27	1037	1037	3428	1142	1141	yes	…4/Raw Data/PEIR2 PILE3W2T4.LAS
28	539	539	3428	1142	1141	yes	…-4/Raw Data/PEIR2 PILE3W2T4.rd
29	1038	1038	3435	1294	1293	yes	…4/Raw Data/PEIR2 PILE3W4T1.LAS
30	540	540	3435	1294	1293	yes	…-4/Raw Data/PEIR2 PILE3W4T1.rd
31	1039	1039	3442	1278	1277	yes	…4/Raw Data/PEIR2 PILE3W4T2.LAS
32	541	541	3442	1278	1277	yes	…-4/Raw Data/PEIR2 PILE3W4T2.rd
33	1048	1048	3505	1318	1317	yes	…4/Raw Data/PEIR2 PILE4W3T3.LAS
34	550	550	3505	1318	1317	yes	…-4/Raw Data/PEIR2 PILE4W3T3.rd
35	2022	2022	6213	1067	1066	yes	…ent 19/Pile 11/BENT19P11T3.LAS
36	901	901	6213	1067	1066	yes	…Bent 19/Pile 11/BENT19P11T3.rd
37	2023	2023	6235	1066	1065	yes	…ent 19/Pile 11/BENT19P11T4.LAS
38	902	902	6235	1066	1065	yes	…Bent 19/Pile 11/BENT19P11T4.rd
39	2029	2029	6360	1109	1108	yes	…ent 19/Pile 12/BENT19P12T5.LAS
40	908	908	6360	1109	1108	yes	…Bent 19/Pile 12/BENT19P12T5.rd
41	2048	2048	6772	1089	1088	yes	… Bent 19/Pile 5/BENT19P5T4.LAS
42	927	927	6772	1089	1088	yes	…a Bent 19/Pile 5/BENT19P5T4.rd
43	2069	2069	7228	617	616	yes	… Bent 19/Pile 8/BENT19P8T2.LAS
44	948	948	7228	617	616	yes	…a Bent 19/Pile 8/BENT19P8T2.rd
45	2070	2070	7250	618	617	yes	… Bent 19/Pile 8/BENT19P8T3.LAS
46	949	949	7250	618	617	yes	…a Bent 19/Pile 8/BENT19P8T3.rd
47	2073	2073	7318	639	638	yes	… Bent 19/Pile 8/BENT19P8T6.LAS

48	952	952	7318	639	638	yes	…a Bent 19/Pile 8/BENT19P8T6.rd
49	2254	2254	7700	1150	1149	yes	… Bent 12 - Pile L/pile11t2.LAS
50	1003	1003	7700	1150	1149	yes	…- Bent 12 - Pile L/pile11t2.rd
51	7683	7683	14728	921	920	yes	…nt 3L/Raw Data/PIER3P3LRT1.LAS
52	2151	2151	14728	921	920	yes	…ent 3L/Raw Data/PIER3P3LRT1.rd
53	7763	7763	14978	800	799	yes	…tment 12/Raw Data/BENT11T4.LAS
54	2187	2187	14978	800	799	yes	…utment 12/Raw Data/BENT11T4.rd
55	7767	7767	15010	804	803	yes	…tment 12/Raw Data/BENT11T8.LAS
56	2191	2191	15010	804	803	yes	…utment 12/Raw Data/BENT11T8.rd
57	7775	7775	15038	1260	1259	yes	…-056/72303/805100703/B14T3.LAS
58	2199	2199	15038	1260	1259	yes	…5-056/72303/805100703/B14T3.rd
59	7786	7786	15084	1681	1680	yes	… Bent 16/Raw Data/BENT16T5.LAS
60	2210	2210	15084	1681	1680	yes	…t Bent 16/Raw Data/BENT16T5.rd
61	7787	7787	15092	1601	1600	yes	…Bent 16/Raw Data/BENT16T5A.LAS
62	2211	2211	15092	1601	1600	yes	… Bent 16/Raw Data/BENT16T5A.rd
63	7788	7788	15100	1568	1567	yes	… Bent 16/Raw Data/BENT16T6.LAS
64	2212	2212	15100	1568	1567	yes	…t Bent 16/Raw Data/BENT16T6.rd
65	7795	7795	15156	1563	1562	yes	…18, 19 & 20/Raw Data/B17T4.LAS
66	2219	2219	15156	1563	1562	yes	… 18, 19 & 20/Raw Data/B17T4.rd
67	7797	7797	15172	1563	1562	yes	…18, 19 & 20/Raw Data/B17T6.LAS
68	2221	2221	15172	1563	1562	yes	… 18, 19 & 20/Raw Data/B17T6.rd
69	7808	7808	15260	1069	1068	yes	…18, 19 & 20/Raw Data/B18T8.LAS
70	2232	2232	15260	1069	1068	yes	… 18, 19 & 20/Raw Data/B18T8.rd
71	7821	7821	15364	1202	1201	yes	…18, 19 & 20/Raw Data/B20T2.LAS
72	2245	2245	15364	1202	1201	yes	… 18, 19 & 20/Raw Data/B20T2.rd
73	7822	7822	15372	1196	1195	yes	…18, 19 & 20/Raw Data/B20T3.LAS
74	2246	2246	15372	1196	1195	yes	… 18, 19 & 20/Raw Data/B20T3.rd
77	9266	9266	17143	1187	1186	yes	…CD5/Pile 2/Raw Data/P8P2T4.LAS
78	2555	2555	17143	1187	1186	yes	… CD5/Pile 2/Raw Data/P8P2T4.rd
79	9281	9281	17260	2559	2558	yes	…5/GGL original data/P8P5T4.LAS
80	2570	2570	17260	2559	2558	yes	… 5/GGL original data/P8P5T4.rd
81	9293	9293	17329	2083	2082	yes	…)/raw GGL data/bmpier8p6t8.LAS
82	2582	2582	17329	2083	2082	yes	…a)/raw GGL data/bmpier8p6t8.rd
83	9657	9657	17782	583	582	yes	…tPile E/Data/PIER14PILEET6.LAS
84	2692	2692	17782	583	582	yes	…stPile E/Data/PIER14PILEET6.rd
85	9659	9659	17792	996	995	yes	…tPile E/Data/PIER14PILEETB.LAS
86	2694	2694	17792	996	995	yes	…stPile E/Data/PIER14PILEETB.rd
87	9755	9755	17952	2018	2017	yes	…16 CD5/Pile 4/Data/P16P4T2.LAS
88	2724	2724	17952	2018	2017	yes	… 16 CD5/Pile 4/Data/P16P4T2.rd
89	9785	9785	18092	1903	1902	yes	…Pile 8/Data by Art/P16P8T6.LAS
90	2754	2754	18092	1903	1902	yes	…/Pile 8/Data by Art/P16P8T6.rd
91	13078	13078	26209	300	299	yes	… 21,2009-2359-569-1278/B#2.LAS
92	4941	4941	26209	300	299	yes	…y 21,2009-2359-569-1278/B#2.rd
93	13574	13574	27243	1443	1442	yes	…west Pile/Data/PIER48PSW10.LAS
94	5233	5233	27243	1443	1442	yes	…hwest Pile/Data/PIER48PSW10.rd
95	13576	13576	27251	1449	1448	yes	…est Pile/Data/PIER48PSWT11.LAS
96	5235	5235	27251	1449	1448	yes	…west Pile/Data/PIER48PSWT11.rd
97	13582	13582	27275	1451	1450	yes	…west Pile/Data/PIER48PSWT6.LAS
98	5241	5241	27275	1451	1450	yes	…hwest Pile/Data/PIER48PSWT6.rd
99	13583	13583	27279	1387	1386	yes	…west Pile/Data/PIER48PSWT7.LAS
100	5242	5242	27279	1387	1386	yes	…hwest Pile/Data/PIER48PSWT7.rd
103	9634	9634	28440	2074	2075		… MAIN/PIER14/PILE6/P14P6T7.LAS
104	5492	5492	28440	2074	2075		…A MAIN/PIER14/PILE6/P14P6T7.rd
105	9635	9635	28454	1850	1874		… MAIN/PIER14/PILE6/P14P6T8.LAS
106	5493	5493	28454	1850	1874		…A MAIN/PIER14/PILE6/P14P6T8.rd
109	7632	7632	29257	308	307	yes	…/CARMEL MOUNTAIN B3/FLP2T2.LAS
110	5555	5555	29257	308	307	yes	…A/CARMEL MOUNTAIN B3/FLP2T2.rd
111	7641	7641	29366	272	270		…/CARMEL MOUNTAIN B3/FLP7T1.LAS
112	5564	5564	29366	272	270		…A/CARMEL MOUNTAIN B3/FLP7T1.rd
113	7671	7671	29734	302	301	yes	…CARMEL MOUNTAIN B3/R/RP4T1.LAS

114	5594	5594	29734	302	301	yes	…/CARMEL MOUNTAIN B3/R/RP4T1.rd
115	7674	7674	29771	297	296	yes	…CARMEL MOUNTAIN B3/R/RP5T2.LAS
116	5597	5597	29771	297	296	yes	…/CARMEL MOUNTAIN B3/R/RP5T2.rd
119	8498	8498	31366	992	991	yes	…GO/ABUT1 GREENVALLEY/P4/T3.LAS
120	5727	5727	31366	992	991	yes	…EGO/ABUT1 GREENVALLEY/P4/T3.rd
133	13702	13702	33845	1005	1004	yes	…ia Main/PIER14/PILE E/20FT.LAS
134	7282	7282	33845	1005	1004	yes	…cia Main/PIER14/PILE E/20FT.rd
137	13843	13843	35322	356	355	yes	…w1194p3551s041 10-06-2008.LAS
138	7967	7967	35322	356	355	yes	…/w1194p3551s041 10-06-2008.rd
139	13850	13850	35339	304	303	yes	…0 COUNT BLOCK 4/300 COUNTS.LAS
140	7976	7976	35339	304	303	yes	…00 COUNT BLOCK 4/300 COUNTS.rd
141	13951	13951	35925	202	201	yes	…on/12-28-11 Calibration/B2.LAS
142	8207	8207	35925	202	201	yes	…ion/12-28-11 Calibration/B2.rd
143	14294	14294	37093	260	259	yes	…ma/Functionality/funtc2947.LAS
144	8885	8885	37093	260	259	yes	…mma/Functionality/funtc2947.rd
145	14349	14349	37697	315	314	yes	… , 038 & block 1/Barrel 3.LAS
146	9051	9051	37697	315	314	yes	…2 , 038 & block 1/Barrel 3.rd
147	14385	14385	37977	6	5	yes	…-1605534141-1020/Barrel 1.LAS
148	9200	9200	37977	6	5	yes	…0-1605534141-1020/Barrel 1.rd
151	14420	14420	38265	806	805	yes	…TION/1273-2575-568 13MAR08.LAS
152	9377	9377	38265	806	805	yes	…ATION/1273-2575-568 13MAR08.rd
167	13197	13197	39593	227	226	yes	…e/Desktop/TEST/test355/D4V.LAS
168	11003	11003	39593	227	226	yes	…le/Desktop/TEST/test355/D4V.rd
177	13220	13220	39978	227	226	yes	…/Desktop/TEST/TEST3581/F8H.LAS
178	11439	11439	39978	227	226	yes	…e/Desktop/TEST/TEST3581/F8H.rd
181	13117	13117	40060	226	225	yes	…esktop/GAMMA/cal/func/TEST.LAS
182	11455	11455	40060	226	225	yes	…Desktop/GAMMA/cal/func/TEST.rd
183	14698	14698	40400	410	409	yes	… p2947 s038/functionaklity.LAS
184	11500	11500	40400	410	409	yes	…2 p2947 s038/functionaklity.rd
185	14779	14779	40403	318	317	yes	…/3581 27jul11 fuctionality.LAS
186	11505	11505	40403	318	317	yes	…A/3581 27jul11 fuctionality.rd

Pattern Matching flagged two sets of files:

Pattern ID	File ID	Unique File ID	Pattern Data Points	Data Points in Files w/ Nulls	Data Points in Files	Occurrence	Date	Path
450	88120	13786	259	260	260	1	6/11/2007 12:03	…0-1605534141-1017/dumpr2t1.LAS
450	89576	14395	259	259	259	1	6/13/2007 9:30	…barton Field Data/dumpr2t1.LAS
572	85073	13110	356	356	356	1	10/6/08 16:47	…w1194p3551s041 10-06-2008.LAS
572	88311	13843	356	356	356	1	10/6/08 15:16	…w1194p3551s041 10-06-2008.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 32

Name: Unusual Depth Increments in LAS Files and RD Files Exist

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☒ Time Stamp

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12
Summarized by: Wahleithner **Date:** 6/26/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The following files were flagged for discrepancies with depth information. All files were logged in time mode.

P27T2.LAS, NRBP2PE1-2T3.LAS, b31-r3581.LAS

P27T2.LAS at 04-264204 - SM-101-KP21.7,28.5 RW#1, #2 & Signs (GGL,CSL)\RW#2 - CIDH Piles\Piles 14-44\GGL

```
STRT      .FT     36.5933   :START DEPTH
STOP      .FT     3.05008   :STOP DEPTH
STEP      .FT           0   :STEP
NULL      .       -999.25   :NULL VALUE
  36.5933   0           0            62821
  36.5933   0           0            62821
  36.5933   0           0            62821
  36.5933   0           0            62821
  36.4296   0           0            62821

  3.37733   0           0            62821
   3.2137   0           0            62821
  3.05008   0           0            62821
  3.05008   0           0            62821
  3.05008   0           0            62821
```

NRBP2PE1-2T3.LAS at 10-0176 - Noyo River Bridge (Replace) (GGL, MIT)/GGL/Pier 2/Pile E1-2, E2-4

```
STRT        .FT          151.019   :START DEPTH
STOP        .FT          15.8129   :STOP DEPTH
STEP        .FT                0   :STEP
NULL        .            -999.25   :NULL VALUE
~A
   151.019     14136.5     15506.6        162.701
   150.919       14484     15925.7        161.247
   150.819     14571.5     16031.5        160.886
   150.719       14535     15987.4        161.036
    150.62     14510.5     15957.7        161.137
   154.309       14308     15713.1        161.979
   154.209     14259.5     15654.7        162.182
   154.109       14261     15656.5        162.176
```

b31-r3581.LAS is a calibration file so the fact that a depth irregularity was flagged is not a concern.

Discussion of Findings

P27T2.LAS does not have any evidence of data editing. This was an unusual logging event (time mode, zero counts throughout data set, repetitive depths at start and stop of logging). P27T2.LAS was re-tested several days later.

A new LAS file was generated for NRBP2PE1-2T3.LAS from the RD file. No evidence of data editing was found.

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	151.019	:START DEPTH			
STOP	.FT	15.7131	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
Dept	.		:Depth Driller			
COMP	.	MCM	:COMPANY:			
File	.	NOYO RIVER BR	:File Name			
Witn	.		:Witness:			
Casi	.		:Casing Type			
Loca	.	PEIR 2	:Location:			
Date	.	2/4/2003	:Date			
Logg	.	WILES/VALENTE	:Logged by:			
Cali	.		:Calibration Data			
Tube	.	EI-2-T3	:Tube ID			
~OTHER						
~A					Calc'd Step	
151.019	14136.5	15506.6	162.701			
150.919	14484	15925.7	161.247		-0.100	
150.819	14571.5	16031.5	160.886		-0.100	
150.719	14535	15987.4	161.036		-0.100	
150.62	14510.5	15957.7	161.137		-0.099	
154.309	14308	15713.1	161.979		3.689	
154.209	14259.5	15654.7	162.182		-0.100	
154.109	14261	15656.5	162.176		-0.100	
154.01	14453	15888.2	161.375		-0.099	
153.91	14301	15704.7	162.009		-0.100	
153.81	14604	16070.9	160.752		-0.100	
153.711	14766	16267.3	160.09		-0.099	
153.611	14284.5	15684.8	162.078		-0.100	
153.511	14629	16101.1	160.649		-0.100	
	Rows Hidden For Presentation					
16.0123	4869.75	5022.62	224.159			
15.9126	5075	5241.25	221.836		-0.100	
15.8129	4830	4980.34	224.62		-0.100	
15.7131	4628.75	4766.65	227.011		-0.100	
ARCHIVED LAS FILE						

See above.

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	151.019	:START DEPTH			
STOP	.FT	15.8129	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
~OTHER						
~A					Calc'd Step	
151.019	14136.5	15506.6	162.701			
150.919	14484	15925.7	161.247		-0.100	
150.819	14571.5	16031.5	160.886		-0.100	
150.719	14535	15987.4	161.036		-0.100	
150.62	14510.5	15957.7	161.137		-0.099	
154.309	14308	15713.1	161.979		3.689	
154.209	14259.5	15654.7	162.182		-0.100	
154.109	14261	15656.5	162.176		-0.100	
154.01	14453	15888.2	161.375		-0.099	
153.91	14301	15704.7	162.009		-0.100	
153.81	14604	16070.9	160.752		-0.100	
153.711	14766	16267.3	160.09		-0.099	
153.611	14284.5	15684.8	162.078		-0.100	
153.511	14629	16101.1	160.649		-0.100	
	Rows Hidden For Presentation					
16.112	5100	5267.91	221.56			
16.0123	4869.75	5022.62	224.159		-0.100	
15.9126	5075	5241.25	221.836		-0.100	
15.8129	4830	4980.34	224.62		-0.100	
LAS GENERATED FROM REPLAY OF RD FILE						

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 33

Name: Depths Not Constantly Incremented – No RD Files – Double (and Partial) Transits

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 11/7/2012

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

The files presented in Table 1 were flagged for depth consistency irregularities. Specifically, in each of these files the calculated depth increment does not match the step value reported in the header. This is typical of data files recorded in "time mode". Corresponding RD files were not found for these LAS files. The data indicates a double-transit or partial double-transit had occurred.

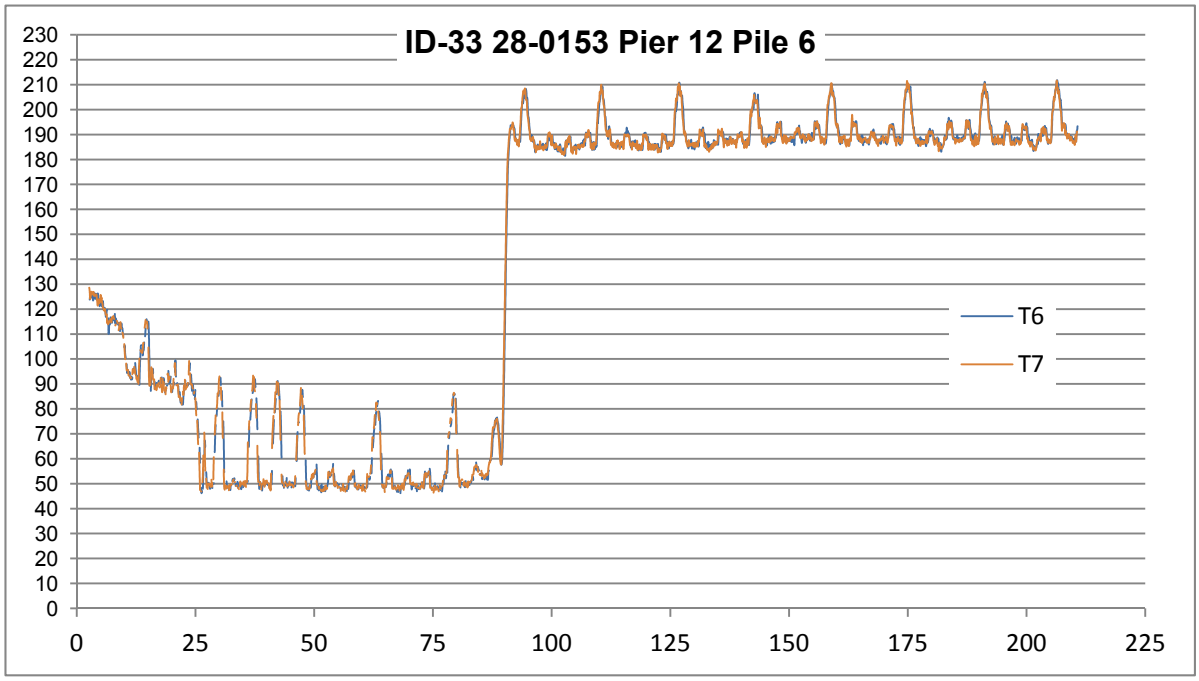
Table 1: ID-33 Files Flagged for Depth Irregularities

Unique File ID	Date-Time	Filename
9506	8/16/04 13:18	P12P6T6.LAS
1987	4/19/04 14:30	BENbent18p6t3no.LAS
4409	3/16/04 14:27	hwy80b7up2t1.LAS
4415	5/17/04 13:05	SFOBBBBENT7UPILE3TUBE5.LAS
4552	6/11/04 12:37	Wab32rt7.las
7632	2/9/05 8:55	FLP2T2.LAS

Discussion of Findings

Each LAS file was examined and the depth consistency irregularities are addressed in the narrative below. Because these files were collected in time mode and some show indications of a 'double-transit' (where data was collected in an 'up' direction and then back down the inspection pipe in a 'down' direction) the additional step of comparing consecutive tests was conducted to evaluate chronology. Comparing data from consecutive files at Pier 12 Pile 6 identified a potential re-test in one instance. Based on visual observation alone, Tube 6 was observed to be similar to Tube 7 (Figure 1). The similarity suggests both data sets were collected from the same inspection pipe.

Figure 1: Br. 28-0153 Pier 12 Pile 6



Summary of Examination of Files Listed in Table 1:

The depth irregularities in the remaining five files listed in Table 1 are the result of data collection in “time mode” which assigns the “Step” value to zero rather than the actual depth increment(s). No misrepresentation of data occurred these files.

BENbent18p6t3no.LAS

No evidence of data editing. Non-typical logging event occurred (Double Transit). Tube was re-tested two days later. Re-test file was not flagged by GamDat.

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	3.14979	:START DEPTH			
STOP	.FT	3.2495	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
Dept	.		:Depth Driller			
File	.	BENAPPRbent18p6	:File Name			
Witn	.		:Witness:			
Loca	.	BENICIA CONECTOR	:Location:			
Casi	.		:Casing			
Well	.		:Well			
Date	.	4/19/2004	:Date			
Logg	.	Dekens/Merriman	:Logged by:			
~OTHER						
~A						
3.14979	28278	34348.7	109.747		-0.100	
3.2495	28751	35049.1	108.559		-0.100	
3.34921	29150	35643.9	107.569		-0.100	
3.44892	29258	35805.5	107.303		-0.100	
	Rows Hidden For Presentation					
191.301	8348	8807.53	189.803		-0.100	
191.401	8221.5	8666.84	190.75		-0.099	
191.5	8365.5	8827.01	189.673		-0.100	
191.6	8324.5	8781.38	189.978		0.399	
191.201	8075	8504.2	191.864		0.099	
	Rows Hidden For Presentation					
3.34921	31675	39493.5	101.537		0.100	
3.2495	30818	38170	103.542			
	Archived LAS File.					

hwy80b7up2t1.LAS

No evidence of data editing. Non-typical logging event occurred (Partial Double Transit).

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	72.348	:START DEPTH			
STOP	.FT	12.8216	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
Dept	.		:Depth Driller			
File	.	hwy80b7up2t1	:File Name			
Witn	.		:Witness:			
Loca	.	west ap	:Location:			
Casi	.		:Casing			
Well	.		:Well			
Date	.	3/16/2004	:Date			
Logg	.	Dekens & Velei	:Logged by:			
~OTHER						
~A						
72.348	16480	18372.4	151.555			
72.2483	16041	17828.4	153.347		0.0997	
	Rows Hidden For Presentation					
3.2495	49060	70755.4	71.1554		0.09971	
3.14979	47948	68465.4	73.1171		0.09971	
3.05008	46052	64663.9	76.5233		0.09971	
3.14979	51072	75017.6	67.6675		-0.09971	
3.2495	52500	78139.5	65.2364		-0.09971	
	Rows Hidden For Presentation					
12.6222	17466	19606.3	147.679		-0.0997	
12.7219	17491	19637.8	147.584		-0.0997	
12.8216	17812	20043.3	146.365		-0.0997	
	Archived LAS File					

SFOBBBBENT7UPILE3TUBE5.LAS

Non-typical depth increment of 0.299 ft occurred after depth reading of 95.979 ft. (Partial Double Transit)

No evidence of data editing. Non-typical logging event occurred.

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	3.14979	:START DEPTH			
STOP	.FT	91.4921	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
Dept	.		:Depth Driller			
File	.	SFOBBBENT7UPILE3tube5	:File Name			
Well	.		:Well			
Date	.	17-May-04	:Date			
Logg	.		:Logged by:			
~OTHER						
~A						
3.14979	55004	83818.8	68.6907			
3.2495	53532	80447.8	70.9683		-0.09971	
3.34921	54808	83364.5	68.9922		-0.09971	
	Rows Hidden For Presentation					
95.7796	17068	19106.1	150.735		-0.0997	
95.8793	16949	18957.2	151.169		-0.0997	
95.979	17126	19178.9	150.524		-0.0997	
95.6799	18044	20337.6	147.269		0.2991	
95.5802	17686	19883.9	148.521		0.0997	
95.4805	17220	19296.8	150.184		0.0997	
	Rows Hidden For Presentation					
91.6915	17516	19669.3	149.123		0.0997	
91.5918	17265	19353.3	150.022		0.0997	
91.4921	17121	19172.6	150.542		0.0997	
	Archived LAS File.					

Wab32rt7.las

Non-typical depth increment of 0.598 ft occurred after depth reading of 73.8436 ft.

No evidence of data editing. Non-typical logging event occurred.

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	73.3451	:START DEPTH			
STOP	.FT	2.65124	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
Logg	.		:Logged by:			
~OTHER						
~A						
73.3451	17758	19975	154.957		0.0997	
73.4448	17914	20172.6	154.382		0.0997	
73.5445	17891	20143.4	154.466		0.0997	
73.6442	17304	19402.4	156.658		0.0997	
73.7439	17658	19848.5	155.329		0.0997	
73.8436	17584	19755.1	155.605		0.0997	
73.9433	17671	19865	155.28		-0.5982	
73.3451	17819	20052.2	154.732		-0.0998	
73.2453	17837	20075	154.665		-0.0997	
73.1456	17657	19847.3	155.332		-0.0997	
73.0459	17891	20143.4	154.466		-0.0997	
	Rows Hidden For Presentation					
2.85066	22515	26202.1	139.088		-0.09971	
2.75095	21927	25409.2	140.885		-0.09971	
2.65124	21126	24339.8	143.4			

FLP2T2.LAS

Non-typical depth increment of 0.000 ft occurred at beginning of data collection where probe recorded multiple readings at 29.3733 ft.

No evidence of data editing. Non-typical logging event occurred. (Partial Double Transit)

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	29.3733	:START DEPTH			
STOP	.FT	2.65124	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
COMP	.	N/A	:COMPANY			
BH F	.		:BH Fluid			
File	.	5/805/57	:File Name			
COMP	.	CONDON	:COMPANY:			
Dept	.		:Depth Driller			
OTHE	.		:OTHER SERVICES			
Witn	.		:Witness:			
Loca	.	CARMEL M	:Location:			
Casi	.		:Casing			
Date	.	2/9/2005	:Date			
Well	.		:Well			
Logg	.		:Logged by:			
~OTHER						
~A						
29.3733	12955.5	14097	149.053			
29.3733	13291.5	14495.7	147.372		0	
29.3733	12992	14140.2	148.868		0	
29.3733	13047	14205.4	148.591		0	
29.3733	13114	14284.8	148.255		0	
29.3733	13024	14178.1	148.707		0	
29.3733	12907.5	14040.1	149.296		0	
29.3733	12906	14038.4	149.304		0	
29.3733	12857.5	13981	149.55		0	
29.3733	13113	14283.6	148.26		0	
29.2736	12879.5	14007	149.438		-0.0997	
29.1739	12943.5	14082.8	149.113		-0.0997	
	Rows Hidden For Presentation					
1.45473	21727	25141	114.201		-0.09971	
1.35502	19142	21743.3	122.947		-0.09971	
1.25531	18742	21228.7	124.39		-0.09971	
1.1556	20766	23863.1	117.343		-0.09971	
	Rows Hidden For Presentation					
2.45182	19827	22631.5	120.536		0.09971	
2.55153	19948	22789.2	120.117		0.09971	
2.65124	19966	22812.7	120.055		0.09971	

P12P6T6.LAS

Non-typical depth increment of 28.1180 ft occurred after depth reading of 30.7692 ft. No evidence of data editing. Non-typical logging event occurred. (Partial Double Transit)

~VERSION INFORMATION						
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0			
WRAP	.NO		:ONE LINE PER DEPTH STEP			
~WELL INFORMATION						
STRT	.FT	210.744	:START DEPTH			
STOP	.FT	81.8203	:STOP DEPTH			
STEP	.FT	0	:STEP			
NULL	.	-999.25	:NULL VALUE			
~OTHER						
~A						
210.744	9039.5	9580.78	193.35		-0.0990	
210.645	9299	9872.79	191.624		-0.1000	
210.545	9363.5	9945.53	191.202		-0.1000	
	Rows Hidden For Presentation					
30.5698	44040	60765.8	87.165		0.0997	
30.6695	-999.25	-999.25	-999.25		0.0997	
30.7692	41312	55691.6	92.1773		28.1180	
58.8872	63118	104239	56.1441		0.0997	
58.9869	-999.25	-999.25	-999.25		0.0997	
59.0866	63750	105974	55.1952		0.0997	
	Rows Hidden For Presentation					
81.6209	-999.25	-999.25	-999.25		0.0997	
81.7206	67948	118104	48.9659		0.0997	
81.8203	68012	118297	48.8718			

Summary of Empirical Sigma-Delta Analysis

Manual Analysis ID: 33

Name: Benicia, Pier 12, Pile 6, Tubes 6 and 7

Analyzed by: L. Turner **Date:** 10/10/12

Calculation of Sigma-Delta

Sigma-Delta values were calculated for all tube-pair combinations for Pile 6. The calculated sigma-delta results were then evaluated using the Empirical Sigma-Delta Method. Results are summarized in the table below.

Foundation Location: Benicia, Pier 12, Pile 6

TUBE LABEL		T1	T2	T3	T4	T5	T6	T7	T8
	Calc ID	1	2	3	4	5	6	7	8
T1	1		1.42	2.43	2.22	1.86	1.72	1.67	1.57
T2	2			2.11	1.76	1.49	1.72	1.77	1.57
T3	3				1.62	1.48	1.74	1.88	1.65
T4	4					1.32	1.76	1.83	1.67
T5	5						1.26	1.36	1.37
T6	6							0.46	1.33
T7	7								1.34
T8	8								

Is Tube 7 a Rerun of Tube 6?

During a review of this data set, it was observed that the data for Tube 7 was visually similar to Tube 6. The sigma-delta value for this tube-pair combination was calculated to be 0.46. When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where only rerun tests were observed.

Limitations

A correlation analysis using the *Empirical Sigma-Delta Analysis Method* appears to support the assertion that both data sets were collected from the same tube. Note, however, that correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 34

Name: Header Start / Stop Depths – No RD Files-Br. 26-0050 Dry Creek

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☐ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12
Summarized by: Wahleithner **Date:** 6/26/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

dc104p2p2t2.LAS

Stop Depth in the Header does not match the Stop Depth in the data set. Header Stop: 1.05589 Data Stop At: 3.05008

~VERSION INFORMATION			
VERS	.2.0		:CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP	.NO		:ONE LINE PER DEPTH STEP
~WELL INFORMATION			
STRT	.FT	75.4389	:START DEPTH
STOP	.FT	1.05589	:STOP DEPTH
STEP	.FT	-0.09971	:STEP
NULL	.	-999.25	:NULL VALUE
~OTHER			
~A			
75.4389	20669	23735.1	150.353
75.3392	21087	24288	149.059
75.2395	20757	23851.3	150.079
75.1398	21057	24248.2	149.151
	Rows Hidden For Presentation		
3.2495	50026	72782.3	87.4023
3.14979	49890	72494.8	87.6247
3.05008	47136	66821.7	92.2026

Stop Depth in Header Does Not Match Last Depth in Data Set

Discussion of Findings
No RD file available to compare against. Evidence of data editing. Data between 3.05008 and 1.05589 appears to have been deleted in the LAS file. However, this data is from above the top of concrete and would not be used in the Engineer's analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**35**
Name:	*(This irregularity has been documented under ID-30 and ID-51.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **36** ***(See also ID-2 for related data and testing irregularities)***

Name: **February 2007 Testing Of Standard Reference Blocks**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner, Turner, Roblee **Date:** 11/11/12-12/12/12

Summarized by: Roblee **Date:** 12/12/12

Reviewed by: Hannenian **Date:** tbd

Conclusions		Confidence
Existence of GGL Data Irregularity	☐ Exists ☒ Does not exist	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

'Depth Consistency' analysis flagged file '5H.LAS' acquired during the 2/23/2007 round of qualification testing of standard reference block 5 in the horizontal position using probe 2947-038. Other tests acquired during the same testing program on that date were found to have clear irregularities (see ID-15). However, in this instance, the depth consistency flag appears only to be associated with intermittent movement of the cable during testing. While this operating procedure may be considered atypical, there is no evidence that data manipulation occurred and it is likely that a GGL data irregularity does not exist. Furthermore, the GamDat team understands that data acquired in the February 2007 round of tests were not used for purposes block qualification, and therefore the impact is likely to be inconsequential.

Discussion of Findings

The plots below are of data found in file 5H.LAS. The top figure shows raw gamma count and the bottom figure shows the encoded depth value in feet, both plotted as a function of data row index. The qualification testing procedure involves collecting at least 200 data points while the probe is stationary in the standard reference block.

The depth encoder plot shows several distinct intervals of testing in time mode. Initially, the cable was not moved for 181 readings, or approximately 3 minutes. This is followed by two isolated periods of cable movement, first spooling in, then spooling back out, with an intervening 38-second period of no movement. Maximum cable movement was approximately 24 feet. Block dimensions are such that movements of the probe on that order are impossible within the block. It is hypothesized that excess cable was moved through the depth encoder during

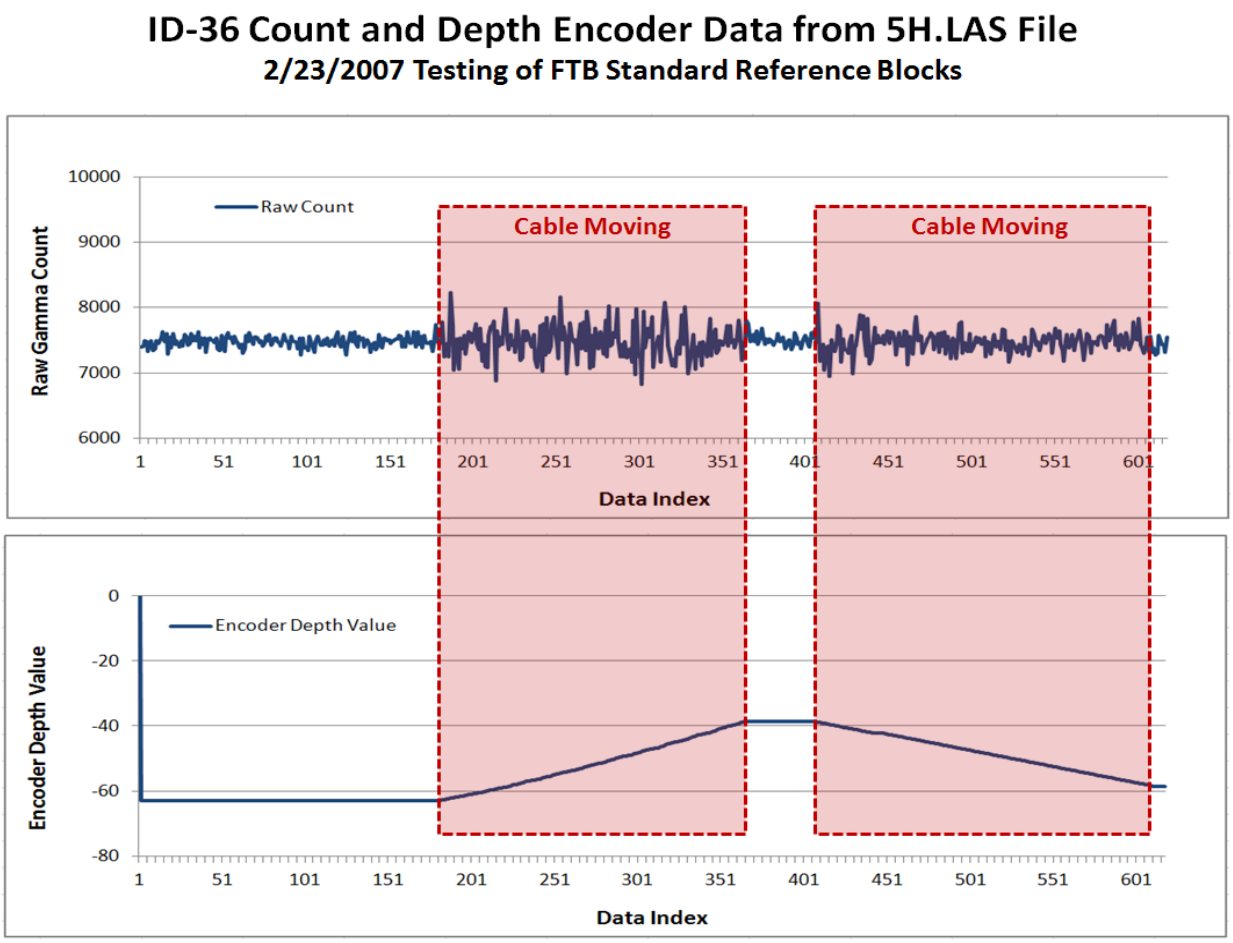
testing, either manually or in combination with the winch, while the probe was left stationary in the block.

Two notable observations can be made from the plot of raw gamma count:

1) The mean value is consistent throughout all testing intervals. This supports the hypothesis that the probe was stationary during the entire testing period.

2) The data scatter about the mean is larger during the periods of cable movement than when it is stationary. While stationary in 'time mode', a sampling interval of one second is used to establish a count value. When the cable is moved faster than 6 fpm, the DAQ automatically switches to recording at uniform depth increments of approximately 0.1 ft, and a shorter sampling interval occurs. This occurred during the periods of movement for the 5H test, though actual sampling intervals have not been determined. For typical testing rates of 10-15 fpm, the sampling interval is on the order of 0.5 seconds. This, or even shorter sampling intervals, may be the source of the higher data scatter. Alternatively, the cable movement itself may be the source of the additional scatter if such movement introduced noise or otherwise affected the analog signal traveling through the cable.

Overall, manual analysis of this file shows no indications of improper data manipulations after acquisition. However, the testing procedure used to collect data for this block is atypical and unexplained. Possible explanations are that the operator was purposefully investigating the effect of either sampling time or cable movement on data scatter.



References

- Master List of GGL Files (3/20/2012 version)
- LAS File for 5H: Unique File ID 13182
- Flagged by Depth Consistency Analysis:

File ID	Unique File ID	Date	Filename	File Path	Reason
85919	13182	2/23/07 11:39 AM	5h.LAS	… Ref Qual by JDW/2947-038 CFUNCTION BLOCK CERT REDO/5h.LAS	Depths are not constantly incremented.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 37

Name: Calibration / Qualification Files Flagged For Depth Irregularity

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☒ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These calibration and/or qualification files were flagged for depth inconsistencies.

Flag ID	File ID	Unique File ID	Date	Filename	Observation
24	84805	13063	7/27/11 11:12	FIRST RUN.LAS	Calibration data collected in time mode with constant depth (constant amount of cable outside of winch). At the very end of data collection there is a 0.05' change in cable length interpreted as a depth change. This was flagged as an unusual depth change.
27	86890	13371	7/7/04 16:36	FUNCTIONALITY 62304.LAS	Checked LAS file and the header start and stop match the data set start and stop. This should not have been flagged.
30	88332	13856	10/26/11 14:06	strat 115-147-195.LAS	Calibration data collected in time mode with constant depth (constant amount of cable outside of winch). At the very end of data collection there is a very small change in cable length interpreted as a depth change. This was flagged as an unusual depth change.
31	88472	13928	6/11/07 10:50	aaaaaaaaaaaa.LAS	LAS file contains only one row of data. This file is useless and of no concern.
33	89496	14350	7/15/10 10:31	Block 1.LAS	Functionality data collected in time mode. Likely technician had extra cable pulled out of winch and at some point during data collection activated the winch to pull cable into the machine. Resulted in a non-uniform depth increment. Depth information is not needed when collecting data to

					determine functionality limits.
34	89513	14363	9/30/08 11:56	bctest.LAS	LAS file does not contain any counts. This file is useless and of no concern.
36	89597	14410	9/29/08 10:19	gggggggggg.LAS	LAS file contains only one row of data. This file is useless and of no concern.
38	89621	14424	1/16/09 12:03	1273-2575-568-B5 16JAN09.LAS	Calibration data collected in time mode with constant depth (constant amount of cable outside of winch). Mid way through data collection there is a very small change in cable length interpreted as a depth change. This was flagged as an unusual depth change.
41	89726	14512	10/26/11 15:28	strat 115-147-195.LAS	Calibration data collected in time mode with constant depth (constant amount of cable outside of winch). At the very end of data collection there is a very small change in cable length interpreted as a depth change. This was flagged as an unusual depth change.
56	90396	14787	12/6/11 19:49	TEST 5.LAS	LAS file contains only one row of data. This file is useless and of no concern.

Discussion of Findings

The files above contain data collected for determining functionally limits or calibration factors. The files were flagged for irregularities in the depth information. Depth is not used when determining functionality limits or calibration factors. Typically this type of data can be collected in time mode with a constant amount of winch cable pulled outside the winch to facilitate moving the probe between standard reference blocks or calibration barrels. It is likely extra cable length can be inadvertently pulled out of the winch resulting in a small increment of depth change.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**38**
Name:	*(This irregularity has been documented under ID-5.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**39**
Name:	*(This irregularity has been documented under ID-21.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**40**
Name:	*(This irregularity has been documented under ID-30.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 41

Name: RD-LAS Time Discrepancy -56-0802F, SE Connector SB215-EB215, Bent 11

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

56-0802F Bent 11 Raw Data has numerous tubes where LAS file date is 1 to 4 days after RD file date.

Discussion of Findings

Daily Field Report notes that technicians did not see the LAS file after logging the pile and left the job with only RD files. The DFR notes that the technicians called an FTB Engineer and he advised that the RD files would be sent to Mt. Sopris and they would generate new LAS files at a later date. This explains the date discrepancy between the RD and LAS files.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 42

Name: RD-LAS Date Discrepancy, 57-1134, Lake Hodges, Pier 3R, Right Pile

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Data was collected on 11/1/2005. RD files are dated 11/1/2005. LAS files are dated 11/3/2005.

Discussion of Findings

Replayed RD files and generated new LAS files. No evidence of data editing.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **43**

Name: **File was renamed to include the location information**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☒ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/19/12

Summarized by: Turner **Date:** 7/6/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LAS and LS files were identified during the pattern matching (file renaming) analysis. The pairs of files identified were generally found on two separate computers, one having been renamed with the pile number or foundation location appended to the filename.

Discussion of Findings

There are no indications that this file renaming resulted in any misrepresentation of data.

References

LAS files:

File ID	Unique ID	Date	File Path	Details of Filename Change
3580	549	12/21/2007 11:30	…NINSULA Sam Mateo/psmrw2t1.LAS	psmrw2t1.LAS, psmrw2p126t1.LAS
3588	550	12/21/2007 11:38	…NINSULA Sam Mateo/psmrw2t2.LAS	psmrw2t2.LAS, psmrw2p126t2.LAS
60263	8484	8/16/2005 8:37	…GO/ABUT1 GREENVALLEY/P1/T1.LAS	T1.LAS, Pile 1T1.LAS
60279	8485	8/16/2005 8:57	…GO/ABUT1 GREENVALLEY/P1/T2.LAS	T2.LAS, Pile 1T2.LAS
60294	8486	8/16/2005 9:07	…GO/ABUT1 GREENVALLEY/P1/T3.LAS	T3.LAS, Pile 1T3.LAS
60311	8487	8/16/2005 8:47	…GO/ABUT1 GREENVALLEY/P1/T4.LAS	T4.LAS, Pile 1T4.LAS
60326	8488	8/16/2005 7:55	…GO/ABUT1 GREENVALLEY/P2/T1.LAS	T1.LAS, Pile 2T1.LAS
60342	8489	8/16/2005 8:15	…GO/ABUT1 GREENVALLEY/P2/T2.LAS	T2.LAS, Pile 2T2.LAS
60358	8490	8/16/2005 8:26	…GO/ABUT1 GREENVALLEY/P2/T3.LAS	T3.LAS, Pile 2T3.LAS

60374	8491	8/16/2005 8:05	…GO/ABUT1 GREENVALLEY/P2/T4.LAS	T4.LAS, Pile 2T4.LAS
60390	8492	8/16/2005 7:12	…GO/ABUT1 GREENVALLEY/p3/T1.LAS	T1.LAS, Pile 3T1.LAS
60406	8493	8/16/2005 7:23	…GO/ABUT1 GREENVALLEY/p3/T2.LAS	T2.LAS, Pile 3T2.LAS
60421	8494	8/16/2005 7:44	…GO/ABUT1 GREENVALLEY/p3/T3.LAS	T3.LAS, Pile 3T3.LAS
60437	8495	8/16/2005 7:34	…GO/ABUT1 GREENVALLEY/p3/T4.LAS	T4.LAS, Pile 3T4.LAS
60453	8496	8/15/2005 14:56	…GO/ABUT1 GREENVALLEY/P4/T1.LAS	T1.LAS, Pile 4T1.LAS
60469	8497	8/15/2005 15:17	…GO/ABUT1 GREENVALLEY/P4/T2.LAS	T2.LAS, Pile 4T2.LAS
60485	8498	8/15/2005 15:29	…GO/ABUT1 GREENVALLEY/P4/T3.LAS	T3.LAS, Pile 4T3.LAS
60500	8499	8/15/2005 15:07	…GO/ABUT1 GREENVALLEY/P4/T4.LAS	T4.LAS, Pile 4T4.LAS
60516	8500	8/15/2005 14:23	…GO/ABUT1 GREENVALLEY/P5/T1.LAS	T1.LAS, Pile 5T1.LAS
60532	8501	8/15/2005 14:12	…GO/ABUT1 GREENVALLEY/P5/T2.LAS	T2.LAS, Pile 5T2.LAS
60547	8502	8/15/2005 14:34	…GO/ABUT1 GREENVALLEY/P5/T3.LAS	T3.LAS, Pile 5T3.LAS
60563	8503	8/15/2005 14:45	…GO/ABUT1 GREENVALLEY/P5/T4.LAS	T4.LAS, Pile 5T4.LAS
60579	8504	8/4/2005 10:16	…GO/ABUT4 GREENVALLY/P1/T2.LAS	T2.LAS, P1 T2.LAS
60594	8505	8/4/2005 10:35	…GO/ABUT4 GREENVALLY/P1/T3.LAS	T3.LAS, P1 T3.LAS
60609	8506	8/4/2005 10:46	…GO/ABUT4 GREENVALLY/P1/T4.LAS	T4.LAS, P1 T4.LAS
60624	8507	8/4/2005 10:05	…GO/ABUT4 GREENVALLY/P1/TI.LAS	TI.LAS, P1 TI.LAS
60639	8508	8/4/2005 11:00	…GO/ABUT4 GREENVALLY/P2/T1.LAS	T1.LAS, P2 T1.LAS
60654	8509	8/4/2005 11:13	…GO/ABUT4 GREENVALLY/P2/T2.LAS	T2.LAS, P2 T2.LAS
60669	8510	8/4/2005 11:23	…GO/ABUT4 GREENVALLY/P2/T3.LAS	T3.LAS, P2 T3.LAS
60684	8511	8/4/2005 11:33	…GO/ABUT4 GREENVALLY/P2/T4.LAS	T4.LAS, P2 T4.LAS
60700	8512	8/4/2005 11:47	…GO/ABUT4 GREENVALLY/P3/T1.LAS	T1.LAS, P3 T1.LAS
60716	8513	8/4/2005 11:58	…GO/ABUT4 GREENVALLY/P3/T2.LAS	T2.LAS, P3 T2.LAS
60731	8514	8/9/2005 8:50	…GO/ABUT4 GREENVALLY/P3/t3.LAS	t3.LAS, P3 t3.LAS
60747	8515	8/4/2005 12:07	…GO/ABUT4 GREENVALLY/P3/T4.LAS	T4.LAS, p3T4.LAS
60763	8516	8/4/2005 12:44	…GO/ABUT4 GREENVALLY/P4/T1.LAS	T1.LAS, P4 T1.LAS
60778	8517	8/4/2005 12:58	…GO/ABUT4 GREENVALLY/P4/T2.LAS	T2.LAS, P4 T2.LAS
60793	8518	8/4/2005 13:08	…GO/ABUT4 GREENVALLY/P4/T3.LAS	T3.LAS, P4 T3.LAS
60808	8519	8/4/2005 13:18	…GO/ABUT4 GREENVALLY/P4/T4.LAS	T4.LAS, P4 T4.LAS
60823	8520	8/4/2005 13:53	…GO/ABUT4 GREENVALLY/P5/T2.LAS	T2.LAS, P5 T2.LAS
60839	8521	8/4/2005 14:04	…GO/ABUT4 GREENVALLY/P5/T3.LAS	T3.LAS, P5 T3.LAS
60854	8522	8/4/2005 14:13	…GO/ABUT4 GREENVALLY/P5/T4.LAS	T4.LAS, P5 T4.LAS
60869	8523	8/9/2005 9:08	…O/ABUT4 GREENVALLY/P5/ta1.LAS	ta1.LAS, p5 ta1.LAS
61079	8548	12/15/2004 8:54	…A/SAN DIEGO/ABUT1/PILE1/T1.LAS	T1.LAS, Pile 1 T1.LAS
61097	8549	12/15/2004 9:06	…A/SAN DIEGO/ABUT1/PILE1/T2.LAS	T2.LAS, Pile 1 T2.LAS
61115	8550	12/15/2004 9:16	…A/SAN DIEGO/ABUT1/PILE1/T3.LAS	T3.LAS, Pile 1 T3.LAS
61134	8551	12/15/2004 9:26	…A/SAN DIEGO/ABUT1/PILE1/T4.LAS	T4.LAS, Pile 1 T4.LAS
61153	8552	12/15/2004 9:41	…A/SAN DIEGO/ABUT1/PILE2/T1.LAS	T1.LAS, Pile 2 T1.LAS
61171	8553	12/15/2004 9:54	…A/SAN DIEGO/ABUT1/PILE2/T2.LAS	T2.LAS, Pile 2 T2.LAS
61189	8554	12/15/2004 10:04	…A/SAN DIEGO/ABUT1/PILE2/T3.LAS	T3.LAS, Pile 2 T3.LAS
61209	8555	12/15/2004 10:15	…A/SAN DIEGO/ABUT1/PILE2/T4.LAS	T4.LAS, Pile 2 T4.LAS
61227	8556	12/15/2004 10:37	…A/SAN DIEGO/ABUT1/PILE3/T1.LAS	T1.LAS, Pile 3 T1.LAS
61245	8557	12/15/2004 10:47	…A/SAN DIEGO/ABUT1/PILE3/T2.LAS	T2.LAS, Pile 3 T2.LAS
61263	8558	12/15/2004 10:56	…A/SAN DIEGO/ABUT1/PILE3/T3.LAS	T3.LAS, Pile 3 T3.LAS
61281	8559	12/15/2004 11:08	…A/SAN DIEGO/ABUT1/PILE3/T4.LAS	T4.LAS, Pile 3 T4.LAS
61299	8560	12/15/2004 11:19	…A/SAN DIEGO/ABUT1/PILE4/T1.LAS	T1.LAS, Pile 4 T1.LAS
61317	8561	12/15/2004 11:29	…A/SAN DIEGO/ABUT1/PILE4/T2.LAS	T2.LAS, Pile 4 T2.LAS
61335	8562	12/15/2004 11:40	…A/SAN DIEGO/ABUT1/PILE4/T3.LAS	T3.LAS, Pile 4 T3.LAS
61353	8563	12/15/2004 11:49	…A/SAN DIEGO/ABUT1/PILE4/T4.LAS	T4.LAS, Pile 4 T4.LAS
61373	8564	12/15/2004 12:02	…A/SAN DIEGO/ABUT1/PILE5/T1.LAS	T1.LAS, Pile 5 T1.LAS
61392	8565	12/15/2004 12:11	…A/SAN DIEGO/ABUT1/PILE5/T2.LAS	T2.LAS, Pile 5 T2.LAS
61411	8566	12/15/2004 12:20	…A/SAN DIEGO/ABUT1/PILE5/T3.LAS	T3.LAS, Pile 5 T3.LAS
61430	8567	12/15/2004 12:29	…A/SAN DIEGO/ABUT1/PILE5/T4.LAS	T4.LAS, Pile 5 T4.LAS
65042	9023	4/19/2006 10:08	…A/SAN DIEGO/125-54/B4P/T2A.LAS	T2A.LAS, T2.LAS

LS Files:

File ID	Unique ID	Date	File Path	Details of Filename Change
20837	6416	11/3/2005 7:36	…0_24_B/Gamma21/Data/33ws92r.t3	33ws92r.t3, 33b92r.t3
21014	6588	11/3/2005 7:36	…0_24_B/Gamma21/Data/33ws92r.t4	33ws92r.t4, 33b92r.t4
21099	6669	11/3/2005 7:36	…0_24_B/Gamma21/Data/33ws92r.t5	33ws92r.t5, 33b92r.t5

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **44**

Name: **File opened/closed and new file extension added**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☒ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☒ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/19/12
Summarized by: Turner **Date:** 7/6/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

This single LAS file was flagged by the pattern matching file renaming tool due to the addition of ".LAS" appended to the filename.

Discussion of Findings

The file was clearly opened and saved with the revised filename. However, the contents of the files are identical. There are no indications that this file renaming resulted in any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
19417	2533	8/2/2007 17:09	…Gamma/Oakland Separation/OSB20P3T2.LAS.LAS	OSB20P3T2.LAS.LAS, OSB20P3T2.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **45**

Name: **Filename changed to identify issue with file or retest**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☒ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/19/12

Summarized by: Turner **Date:** 7/6/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the pattern matching (file renaming) tool due to the addition of phrases (e.g. “retested”) appended to the filename.

Discussion of Findings

These files were intentionally renamed. However, there are no indications that this file renaming resulted in any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
70047	9859	8/14/2006 12:23	…C/WILES/GAMMA/W APP/2L2/T1.LAS	T1.LAS, T1(water in tube).LAS
75338	11107	9/30/2010 17:28	…Chester Ave. UC/BNT5RTP1T1.LAS	BNT5RTP1T1.LAS, BNT5RTP1T1 (short data need retest).LAS
75428	11116	10/5/2010 14:50	…C/bent 5/PILE 1/CAUCB5P1T1.LAS	CAUCB5P1T1.LAS, CAUCB5P1T1 (retest data).LAS
76862	11433	6/29/2011 15:23	…/Gamma/Pala 6-29-11/A1P1T4.LAS	A1P1T4.LAS, A1P1T4 retested.LAS
76861	11433	6/29/2011 16:23	… 1/Raw Data/A1P1T4retested.LAS	A1P1T4retested.LAS, A1P1T4.LAS
84926	13086	6/5/2009 9:43	…29Jun09/DO NOT USE block#5.LAS	DO NOT USE block#5.LAS, block#5.LAS
24580	4265	6/29/2011 15:23	…C/Gamma/Pala 6-29-11/A1P1T4.rd	A1P1T4.rd, A1P1T4 retested.rd

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 46

Name: Windows to DOS 8.3 filename conversion files flagged

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/19/12

Summarized by: Turner **Date:** 6/18/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LS files with differing filenames and identical content were flagged by the pattern matching (file rename) routine. Filenames differed due to inclusion of the tilde character (or "~") within the filename of one of the files.

Discussion of Findings

In these instances, these files were renamed by the Windows operating system during a file transfer process that enforced a DOS 8.3 convention of limiting the filename to 8 characters, 3 of which constitutes the file extension. This process can occur when transferring files between DOS-based and Windows based computers. It is not clear at what point the renaming occurred. However, there are no indications that this irregularity resulted in any misrepresentation of data.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 47

Name: **Windows backup or restore files flagged**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☒ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/19/12
Summarized by: Turner **Date:** 6/18/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LS files with differing filenames and identical content were flagged by the pattern matching (file rename) routine.

Discussion of Findings

In these instances, pairs of files with different names but identical content were found in directories associated with Windows operating system directories where backup and restoration files are stored. However, there are no indications that this irregularity resulted in any misrepresentation of data.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**48**
Name:	*(This irregularity has been documented under ID-2.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**49**
Name:	*(This irregularity has been documented under ID-20.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 50

Name: Null values in data files causing analysis flags

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☒ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☒ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/20/12
Summarized by: Turner **Date:** 7/25/12
Reviewed by: Hannenian **Date:** 11/14/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LAS, RD, and LS files have been flagged by fidelity and calibration constant analysis codes due to occurrence of null values in the data blocks.

Discussion of Findings

In LAS files, null values appear in density and gamma count readings as “-999.25”. This value is user configured, assigned by the Mount Sopris software, and does not represent a calculated density value.

Of the 14,450 unique LAS files with data that were evaluated:

- 531 files were found to contain one or more null values.
- 52 of these files had sequences of two or more consecutive null values.
- 20 of the 52 files had sequences of 10 or more consecutive null values. Of these files, 17 were predominantly null values – that is, greater than 90% of the density values in the file were null values.

Based on discussions with Mount Sopris technical support staff, it is our understanding that null values occur and are written to file when data acquisition buffers are filled faster than the software can process data. In LS files, null values seem to manifest as very high density values (e.g. “1518.0 pct”), and a single consistent null value was not necessarily observed. In either of the cases, the measurements at the depths where null values are recorded cannot be determined. Although the calibration constant and fidelity analysis tools flagged these files due to the presence of null values, there are no indications that this irregularity resulted in any misrepresentation of data.

A spreadsheet that lists the density data in columns for all 531 files found to contain one or more null values was created. All data was referenced to a common depth scale for consistency. The spreadsheet was used to identify all cases where null values appeared within the pile concrete. In most cases, null values appear in the data above

the top of pile concrete during high speed retrieval of the gamma probe. The occurrence of null values above the top of concrete was not considered to be important for the purpose of pile acceptance analysis and therefore was not scrutinized here.

Furthermore, there were many data logs found where only one or a few scattered null values were found were found within the pile concrete. A few scattered null values within the pile concrete were not considered to be important for the purpose of pile acceptance analysis and therefore were not scrutinized here. There were cases where logs with relatively few null values were found in association with a log or logs where a significant number of null values were found. In those cases, the logs with relatively few null values were included in the findings in Table 1 below.

In the data logs where a significant number of null values were found within the pile concrete, some follow-up work was done to determine the impact of the null values. In several of the cases, the files were not used in the pile acceptance analysis and therefore there was no impact to consider. In a few remaining cases, data logs with a significant number of null values within the pile concrete were used by the engineer in the pile acceptance analysis. In those cases, a review of the spreadsheets used for the analysis indicates that the null values were not considered in the analysis. It appears that the engineer either omitted the data point or replaced it with the mean concrete value for the pile. The set of data files that were used for pile acceptance, and that contain a significant number of null values occurring within the pile, are listed in Table 1 below.

Table 1: Data files with significant null values within the pile concrete.

File Path	File Name	Null Values In Pile	Testing Date
…s 1-7 and 13-22/02/RWAP2T2.LAS	RWAP2T2.LAS	17	12/20/2006 13:40
…s 1-7 and 13-22/04/RWAP4T1.LAS	RWAP4T1.LAS	52	12/20/2006 12:06
…s 1-7 and 13-22/04/RWAP4T2.LAS	RWAP4T2.LAS	25	12/20/2006 12:15
…s 1-7 and 13-22/05/RWAP5T1.LAS	RWAP5T1.LAS	33	12/20/2006 12:25
…s 1-7 and 13-22/06/RWAP6T2.LAS	RWAP6T2.LAS	15	12/20/2006 13:02
…/Raw data/LAgapcloserp77t1.LAS	LAgapcloserp77t1.LAS	4	1/11/2007 15:59
… 4, 5/Raw data/RTE70b2p1t5.LAS	RTE70b2p1t5.LAS	17	1/25/2007 11:34
… 4, 5/Raw data/RTE70b2p1t4.LAS	RTE70b2p1t4.LAS	5	1/25/2007 11:22
…t)/braddock/405braddocp3t1.LAS	405braddocp3t1.LAS	21	2/27/2007 12:11

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **51**

Name: **Rows of data above top of concrete deleted**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☒ Depth Consistency
☒ Fidelity (RD-LAS)
☐ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Turner **Date:** 4/20/12
Summarized by: Turner **Date:** 10/1/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Alteration ☐ Inadvertent Alteration	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Fidelity and Depth Consistency analyses flagged a pair of LAS-RD files. The LAS file had been edited with over 4 feet of data deleted from the file. The deleted portion of data was approximately 15 ft above top of concrete and did not impact downstream engineering analysis.

Discussion of Findings

The pair of LAS and RD files were found:

Flag ID	File ID	Unique ID	LAS-RD Pair ID	LAS gamma count sequence	RD gamma count sequence	Filepath
123	8631	8631	32657	1022	1066	…/GAMMA/SAN DIEGO/b4r/B4RT1.LAS
124	6813	6813	32657	1022	1066	…S/GAMMA/SAN DIEGO/b4r/B4RT1.rd

The LAS as found looked like this:

```
~VERSION INFORMATION
VERS           .2.0           :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP            .NO           :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT            .FT    104.853 :START DEPTH
STOP            .FT    -1.33713       :STOP DEPTH
STEP            .FT    -0.0997092     :STEP
NULL              .    -999.25 :NULL VALUE
COMP              .    N/A     :COMPANY
…
[Data hidden for presentation]
…
~A
104.853       16388    18258.1 167.29
104.753       16092    17891.4 168.558
104.654       16247    18083.2 167.892
104.554     16352.5    18214   167.441
104.454       17216    19291.8 163.848
104.355       18489    20904.7 158.83
…
[Data hidden for presentation]
…
3.44891       44638    61910.2 90.973
3.3492        44368    61392   91.4983
3.2495        44424    61499.3 91.3892
3.14979       43004    58810.9 94.1828
3.05008       43274    59317   93.6473
```

Of significance, the “STOP” depth in the header did not match the last measurement in the data block.

When the RD was replayed through MSLog software, the resulting LAS file looked like this:

```
~VERSION INFORMATION
VERS           .2.0           :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP            .NO           :ONE LINE PER DEPTH STEP
~WELL INFORMATION
STRT            .FT    104.853               :START DEPTH
STOP            .FT    -1.33713              :STOP DEPTH
STEP            .FT    -0.0997092            :STEP
NULL              .    -999.25               :NULL VALUE
COMP              .           :COMPANY
…
[Data hidden for presentation]
…
~A
104.853       16388    18258.1 167.29
104.753       16092    17891.4 168.558
104.654       16247    18083.2 167.892
104.554     16352.5    18214   167.441
104.454       17216    19291.8 163.848
104.355       18489    20904.7 158.83
104.255       20292    23239.3 152.213
104.155       19890    22713.6 153.643
…
[Data hidden for presentation]
…
3.3492        44368    61392   91.4983
3.2495        44424    61499.3 91.3892
3.14979       43004    58810.9 94.1828
3.05008       43274    59317   93.6473
2.95037       46290    65134.1 87.8003
2.85066       47052    66653   86.3596
2.75095       46776    66100.5 86.8798
```

2.65124	47118	66785.5	86.2354
2.55153	46864	66276.3	86.7137
2.45182	45534	63647.2	89.2436
2.35211	45604	63784	89.1093
2.2524	45432	63448.1	89.4394
2.15269	45156	62911.1	89.9707
2.05299	44980	62570	90.3104
1.95328	44734	62095	90.7867
1.85357	43762	60237.8	92.6846
1.75386	43910	60518.6	92.3939
1.65415	43158	59099.3	93.8771
1.55444	42520	57909.4	95.1483
1.45473	41936	56831.5	96.3226
1.35502	41684	56369.7	96.8325
1.25531	39832	53035.1	100.644
1.1556	40700	54585.1	98.8433
1.05589	39350	52184	101.655
0.956185	38176	50139.2	104.153
0.856476	37458	48908	105.707
0.756766	37640	49218.7	105.311
0.657057	38004	49842.9	104.523
0.557348	38728	51095.7	102.972
0.457639	37876	49623	104.8
0.35793	37520	49013.7	105.572
0.25822	37274	48594.8	106.109
0.158511	35476	45582.9	110.108
0.0588021	34876	44597	111.474
-0.0409071	34760	44407.5	111.74
-0.140616	35956	46378.4	109.026
-0.240325	36636	47516	107.512
-0.340035	37632	49205	105.329
-0.439744	38956	51493.3	102.488
-0.539453	40186	53664.5	99.9063
-0.639162	40202	53693	99.8731
-0.738871	38014	49860.1	104.502
-0.838581	38118	50039.2	104.278
-0.93829	36866	47903.6	107.004
-1.038	36606	47465.5	107.578
-1.13771	36856	47886.7	107.026
-1.23742	35578	45751.4	109.877
-1.33713	33688	42672.7	114.231

The “STOP” depth in the replayed file matches the header. It is clear that the block of data between depths of 3.05008 ft and 1.33713 had been removed.

The block of data that had been removed is approximately 15 ft above the top of the concrete and was not used in any subsequent engineering analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **52**

Name: **Br. 53-1258, Braddock Dr. UC, P50, P51**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 10/12/12

Summarized by: Wahleithner **Date:** 10/12/12

Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Irregularities between two files representing data for two separate piles and inspection pipes, P50T2 and P51T2, were discovered in the Bridge 53-1258, Braddock Dr, folder stored on the FTB archive.

Analysis of File Rename

Two files were flagged by the File Rename analysis which found the files had identical contents but different names. Both files were located in the same folder existing on the FTB server.

Table 1: ID-52 File Rename

File ID	Unique File ID	Date	File Path	Details of Filename Change
40279	5662	4/4/2007	… backup/braddock 4-5/P51T2.LAS	P51T2.LAS, P50T2.LAS

Timestamp Discrepancy

The two files flagged by the File Rename Analysis were also found to have the exact same 'file modified' time and calendar date. This fact was first discovered in 2009 by an Engineer within FTB.

Table 2: ID-12 Timestamp Discrepancy

Name	Date Modified
P50T1.LAS	Wednesday, April 04, 2007, 9:38:30 AM
P50T2.LAS	**Wednesday, April 04, 2007, 9:44:24 AM**
P50T3.LAS	Wednesday, April 04, 2007, 9:50:34 AM
P50T4.LAS	Wednesday, April 04, 2007, 9:55:46 AM
P51T1.LAS	Wednesday, April 04, 2007, 1:32:00 PM
P51T2.LAS	**Wednesday, April 04, 2007, 9:44:24 AM**
P51T3.LAS	Wednesday, April 04, 2007, 1:42:02 PM
P51T4.LAS	Wednesday, April 04, 2007, 1:47:26 PM

Discussion of Findings

As shown above, the two files P50T2.LAS and P51T2.LAS have identical content and 'File Modified' times. Based on the timestamp analysis it appears that P51T2.LAS has a 'File Modified' time 4 hours earlier than other tests of inspection pipes at the same pile. This indicates P51T2 is a copy of P50T2.

Supporting that conclusion is the fact that the GamDat Master File Index of LAS files has record of another file with the name P51T2 and a 'File Modified' date and time of Wednesday, April 04, 2007, 1:36 PM. The time of 1:36 PM is consistent with GGL tests at the other P51 inspection pipes (see Table 2 above). Based on the date and time of this file, this appears to be the correct LAS file for P51T2. Upon further examination it was found that this LAS file has incomplete data and there may have been some error during logging. This indicates there was a problem with the original P51T2 LAS file and a new file was generated by simply renaming a copy of P50T2 as P51T2. No RD file corresponding to the original LAS file P51T2 (April 04, 2007, 1:36 PM) was located. The original and incomplete LAS file, P51T2, is found only on technician's field computer (toughbook).

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 53

Name: Files From Initial Investigation Flagged

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

Files on Wahleithner's computer were flagged. Comparison of RD-LAS file times shows a discrepancy between the file modified time of corresponding RD and LAS files.

las_rd_pair_id	unique_file_id	filepath
33804	7267	…R61_L3K2665/C/Lost Files/T5.rd
33804	14686	…61_L3K2665/C/Lost Files/T5.LAS
33808	7268	…R61_L3K2665/C/Lost Files/T6.rd
33808	14689	…61_L3K2665/C/Lost Files/T6.LAS
30788	3767	…1_L3K2665/C/Lost Files/T41.LAS
30788	5681	…61_L3K2665/C/Lost Files/T41.rd

Discussion of Findings

These files are found only on Wahleithner's machine and were placed there during the initial investigation. The modified time of the LAS files is within the time of the current investigation and well after data was used for analysis and reporting.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **54**

Name: **Analysis of RD-LAS Timestamp Discrepancies Under 2 Minutes**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

ID-54 represents **75** of the **189** total pairs flagged for RD-LAS Timestamp Discrepancies.

This ID represents those RD-LAS file pairs that were flagged because of a difference between the 'file modified' time of the RD and the LAS file where the time difference is 2 minutes or less. It is unlikely data editing or substitution would occur in an elapsed time of 2 minutes or less between saving the RD file and saving the LAS file. There may be instances where the field technician has opened the LAS file immediately after it was written to the field computer, for the purpose of verifying good data, and then saved the LAS file on closing thereby introducing a time stamp discrepancy between RD and LAS.

Discussion of Findings

A portion of the total number of these RD-LAS file pairs with a time difference of less than 2 minutes between the RD and LAS file were selected at random and replayed through the program for the purpose of generating a new LAS file. The new LAS file was compared to the LAS file that was archived for this project. There were no signs of editing or changes to the original data. Pairs below with an asterisk next to the row were replayed and LAS files compared.

Potential Impacts

Projects:

Unique ID	Diff (h:m:s)	Diff (days)
1853	0:01:00	0
794	0:01:00	0
4912	0:01:00	0
1689	0:01:00	0
9074	0:01:01	0
2469	0:01:01	0
4476	0:01:01	0
11643	0:01:01	0
36	0:01:01	0
23	0:01:01	0
2652	0:01:01	0
9544	0:01:01	0
8026	0:01:01	0
2375	0:01:01	0
10964	0:01:01	0
2649	0:01:01	0
3536	0:01:03	0
10704	0:01:03	0
3961	0:01:03	0
11129	0:01:03	0
5486	0:01:03	0
1964	0:01:03	0
6695	0:01:03	0
5537	0:01:03	0
1587	0:01:06	0
679	0:01:06	0
13865	0:01:06	0
7991	0:01:06	0
8048	0:01:06	0
2397	0:01:06	0
9345	0:01:06	0
13150	0:01:06	0
3377	0:01:07	0
10545	0:01:07	0
3918	0:01:07	0
11086	0:01:07	0
4229	0:01:11	0
11397	0:01:11	0
7573	0:01:11	0

Unique ID	Diff (h:m:s)	Diff (days)
2136	0:01:11	0
1200	0:01:11	0
9039	0:01:11	0
11510	0:01:11	0
9057	0:01:11	0
3933	0:01:14	0
11101	0:01:14	0
4418	0:01:14	0
11585	0:01:14	0
13770	0:01:14	0
7372	0:01:14	0
3259	0:01:14	0
1407	0:01:14	0
14735	0:01:14	0
11498	0:01:14	0
4274	0:01:15	0
11442	0:01:15	0
11593	0:01:15	0
4426	0:01:15	0
1871	0:01:15	0
812	0:01:15	0
4238	0:01:15	0
7579	0:01:15	0
8043	0:01:16	0
2392	0:01:16	0
1953	0:01:18	0
883	0:01:18	0
8686	0:01:19	0
6930	0:01:19	0
3909	0:01:20	0
11077	0:01:20	0
206	0:01:20	0
66	0:01:20	0
9738	0:01:20	0
2707	0:01:20	0
4780	0:01:20	0
8688	0:01:20	0
14498	0:01:20	0
9764	0:01:20	0

Unique ID	Diff (h:m:s)	Diff (days)
10883	0:01:22	0
3715	0:01:22	0
4456	0:01:22	0
11623	0:01:22	0
1826	0:01:23	0
767	0:01:23	0
9829	0:01:23	0
2790	0:01:23	0
3547	0:01:24	0
9298	0:01:24	0
2678	0:01:26	0
1152	0:01:26	0
7374	0:01:26	0
13772	0:01:26	0
3830	0:01:27	0
10998	0:01:27	0
4422	0:01:30	0
11589	0:01:30	0
9565	0:01:30	0
2665	0:01:30	0
8457	0:01:30	0
6834	0:01:30	0
2057	0:01:32	0
936	0:01:32	0
2434	0:01:32	0
1054	0:01:32	0
1550	0:01:32	0
8050	0:01:32	0
9572	0:01:34	0
2672	0:01:34	0
4784	0:01:34	0
8692	0:01:34	0
4924	0:01:35	0
1701	0:01:35	0
8495	0:01:37	0
14081	0:01:37	0
4947	0:01:38	0
1724	0:01:38	0
8543	0:01:38	0

Unique ID	Diff (h:m:s)	Diff (days)
2404	0:01:38	0
6975	0:01:38	0
8998	0:01:38	0
7694	0:01:38	0
4767	0:01:38	0
9573	0:01:39	0
2673	0:01:39	0
5734	0:01:42	0
8505	0:01:42	0
7645	0:01:46	0
5568	0:01:46	0
3743	0:01:47	0
10911	0:01:47	0
5753	0:01:47	0
8523	0:01:47	0
3854	0:01:49	0
9459	0:01:49	0
4785	0:01:50	0
8693	0:01:50	0
8289	0:01:51	0
9144	0:01:51	0
4331	0:01:52	0
11499	0:01:52	0
1540	0:01:52	0
662	0:01:52	0
9744	0:01:54	0
2713	0:01:54	0
3121	0:01:56	0
1362	0:01:56	0
312	0:01:58	0
74	0:01:58	0
1690	0:01:58	0
700	0:01:58	0
7267	23:09:24	4
14686	23:09:24	4
7268	23:24:18	62
14689	23:24:18	62
3767	1 17:16:19	761
5681	1 17:16:19	761

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 55

Name: RD-LAS Timestamp Discrpancies: 34-0126, SFOBB West Approach, B4L, B6L, B7L

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The files in question are located on a technician's toughbook.

… of Interest/GGL DATA/WEST APPROACH/

There is a discrepancy between the 'file modified time' of the RD and LAS files.

las_rd_pair_id	unique_file_id	filepath	flag_reason	Diff (h:m:s)
38434	4259	B6LP3T6.LAS	Time Difference: 0 0:41:21 LAST MODIFIED: 2007-06-19 14:11:01	0:41:21
38434	9494	B6LP3T6.rd	Time Difference: 0 0:41:21 LAST MODIFIED: 2007-06-19 13:29:40	0:41:21
38432	4258	B6LP3T5.LAS	Time Difference: 0 1:6:44 LAST MODIFIED: 2007-06-19 14:20:23	1:6:44
38432	9493	B6LP3T5.rd	Time Difference: 0 1:6:44 LAST MODIFIED: 2007-06-19 13:13:39	1:6:44
38428	4256	B6LP3T3.LAS	Time Difference: 0 1:33:3 LAST MODIFIED: 2007-06-19 14:28:10	1:33:3
38428	9491	B6LP3T3.rd	Time Difference: 0 1:33:3 LAST MODIFIED: 2007-06-19 12:55:06	1:33:3
38430	4257	B6LP3T4.LAS	Time Difference: 0 1:42:3 LAST MODIFIED: 2007-06-19 14:46:08	1:42:3
38430	9492	B6LP3T4.rd	Time Difference: 0 1:42:3 LAST MODIFIED: 2007-06-19 13:04:05	1:42:3
38426	9490	B6LP3T2.rd	Time Difference: 0 1:53:43 LAST MODIFIED: 2007-06-19 12:47:47	1:53:43
38426	4255	B6LP3T2.LAS	Time Difference: 0 1:53:43 LAST MODIFIED: 2007-06-19 14:41:30	1:53:43
38424	9489	B6LP3T1.rd	Time Difference: 0 1:54:8 LAST MODIFIED: 2007-06-19 12:40:27	1:54:8
38424	4254	B6LP3T1.LAS	Time Difference: 0 1:54:8 LAST MODIFIED: 2007-06-19 14:34:35	1:54:8
38448	9501	B6LP4T6.rd	Time Difference: 0 20:26:47 LAST MODIFIED: 2007-06-19 16:10:31	20:26:47

38448	14436	B6LP4T6.LAS	Time Difference: 0 20:26:47 LAST MODIFIED: 2007-06-20 12:37:18	20:26:47
38450	9502	B6LP4T7.rd	Time Difference: 0 20:27:47 LAST MODIFIED: 2007-06-19 16:21:21	20:27:47
38450	14437	B6LP4T7.LAS	Time Difference: 0 20:27:47 LAST MODIFIED: 2007-06-20 12:49:08	20:27:47
38442	9498	B6LP4T3.rd	Time Difference: 0 20:58:8 LAST MODIFIED: 2007-06-19 15:41:59	20:58:8
38442	4249	B6LP4T3.LAS	Time Difference: 0 20:58:8 LAST MODIFIED: 2007-06-20 12:40:08	20:58:8
38396	9475	B4LP4T1.rd	Time Difference: 15 1:29:24 LAST MODIFIED: 2007-06-05 11:05:35	1:29:24
38396	14429	B4LP4T1.LAS	Time Difference: 15 1:29:24 LAST MODIFIED: 2007-06-20 12:34:59	1:29:24
38464	9509	B7LP4T7.rd	Time Difference: 78 2:28:32 LAST MODIFIED: 2007-06-25 12:13:34	2:28:32
38464	14438	B7LP4T7.LAS	Time Difference: 78 2:28:32 LAST MODIFIED: 2007-09-11 14:42:07	2:28:32

Discussion of Findings

There is no discrepancy between the RD and LAS files that are located on the FTB server or the FTB Engineer's computer. Therefore the LAS files transmitted to the Engineer following testing and used in the analysis contain the same 'file modified' time as the RD file and no editing of these LAS files is suspected.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **56**

Name: **LogShell files with low count data flagged**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☒ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 4/26/12
Summarized by: Turner **Date:** 6/18/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

LS files were identified through the calibration constant analysis where a single occurrence of an unusually low gamma count and high density spike is accompanied by a low speed in the recorded data.

Discussion of Findings

It appears that these isolated and single occurrences are an artifact of the Mount Sopris data acquisition software (LogShell) and/or the hardware. These types of readings are observed at a depth in the record where a sudden change in probe speed had occurred. There is a sudden drop in gamma count with a corresponding spike in calculated density. The observation is not completely understood, nor can it be recreated due to the software and equipment no longer being in use. These single measurement spikes do not appear to be a significant irregularity nor do they appear to be a product of an Intentional Action.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**57**
Name:	*(This irregularity has been documented under ID-56.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**58**
Name:	*(This irregularity has been documented under ID-50.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 59

Name: RD-LAS Time Discrepancy (57-1134, Lake Hodges, B4RT1)

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/23/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

ID-59: 57-1134 R B4RT1 RD-LAS Time Discrepancy

RD file was replayed and a new LAS file was generated. The new LAS file was compared to the LAS file used in the analysis and archived on the FTB server. The new LAS file has 44 additional rows of data at the top of the pile between depth -1.33 and 3.05 feet.

Discussion of Findings

The discrepancy between the 'file modified' times of the LAS file stored on the archive and the RD file suggests the LAS file was opened and changed after the test. Comparison of the original LAS file and a new LAS file generated from the RD file shows that data from above the pile was deleted. This data is from above the top of concrete and does not change the pile acceptance results.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 60

Name: RD-LAS Time Discrepancy (Various Projects)

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

A number of files were flagged due to a time discrepancy between the LAS file and corresponding RD file.

RD-LAS Pair ID	Unique ID	File	Reason
19421	3124	B2P6P1.rd	Time Difference: 13 18:17:10 LAST MODIFIED: 2011-09-30 16:47:40
19421	12888	B2P6P1.LAS	Time Difference: 13 18:17:10 LAST MODIFIED: 2011-10-14 11:04:50
38336	3826	SFOBBWR4P1T1.LAS	Time Difference: 13 4:24:39 LAST MODIFIED: 2007-10-23 15:45:29
38336	9439	SFOBBWR4P1T1.rd	Time Difference: 13 4:24:39 LAST MODIFIED: 2007-10-10 11:20:50

Discussion of Findings
These LAS files exist on the technician's computer and have a 'file save' time that is different from the corresponding RD files stored on the FTB archive server. The FTB archives contain the same LAS files but the 'file save' time of these files match their corresponding RD files. This indicates the files on the technician's computer were inadvertently modified when they were moved to a particular folder on the technician's computer. Also, the 'file save' time of the LAS file on the technician's computer is later than the date of the pile acceptance report. Any attempt to fabricate data or modify data would occur prior to the report being issued. These files are not suspicious since LAS files with the same date as the RD file exist in the project folder and were used for the Pile Acceptance Report.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **61**

Name: **RD-LAS Timestamp Comparison Replayed RD Files, No Data Editing**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The files below were flagged for RD-LAS time discrepancies where the difference between the RD 'file modified' time and the LAS 'file modified' time is more than 4 minutes. There are 23 RD-LAS pairs flagged.

RD-LAS Pair ID	Unique ID	Filename	flag_reason
34174	7408	SJ87p1t2.rd	Time Difference: 2 22:1:58 LAST MODIFIED: 2007-03-30 12:50:02
34174	13781	SJ87p1t2.LAS	Time Difference: 2 22:1:58 LAST MODIFIED: 2007-04-02 10:52:01
34172	7407	SJ87p1t1.rd	Time Difference: 2 22:4:33 LAST MODIFIED: 2007-03-30 12:43:46
34172	13780	SJ87p1t1.LAS	Time Difference: 2 22:4:33 LAST MODIFIED: 2007-04-02 10:48:20
34407	1463	0p4t1.LAS	Time Difference: 0 0:5:7 LAST MODIFIED: 2007-05-21 09:52:39
34407	7659	70p4t1.rd	Time Difference: 0 0:5:7 LAST MODIFIED: 2007-05-21 09:47:31
38074	9293	P217T1.rd	Time Difference: 0 0:4:55 LAST MODIFIED: 2008-08-21 11:39:42
38074	14413	P217T1.LAS	Time Difference: 0 0:4:55 LAST MODIFIED: 2008-08-21 11:34:47
17152	9267	P8P2T6.LAS	Time Difference: 0 0:5:35 LAST MODIFIED: 2003-11-05 13:55:34
17152	2556	P8P2T6.rd	Time Difference: 0 0:5:35 LAST MODIFIED: 2003-11-05 13:49:58
31545	5743	P3/t3.rd	Time Difference: 0 0:5:54 LAST MODIFIED: 2005-08-09 08:44:34
31545	8514	P3/t3.LAS	Time Difference: 0 0:5:54 LAST MODIFIED: 2005-08-09 08:50:28
32819	8706	P5M/T8.LAS	Time Difference: 0 0:7:4 LAST MODIFIED: 2006-10-26 09:47:54
32819	6967	P5M/T8.rd	Time Difference: 0 0:7:4 LAST MODIFIED: 2006-10-26 09:40:49
34501	12351	sawp84t3.LAS	Time Difference: 0 0:8:39 LAST MODIFIED: 2007-05-30 09:53:26
34501	7754	sawp84t3.rd	Time Difference: 0 0:8:39 LAST MODIFIED: 2007-05-30 09:44:46

29205	5551	568-147.rd	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 09:49:36
29205	13652	568-147.LAS	Time Difference: 0 0:11:22 LAST MODIFIED: 2004-10-19 10:00:58
34399	1455	70p10t1.LAS	Time Difference: 0 0:17:0 LAST MODIFIED: 2007-05-21 12:23:42
34399	7651	70p10t1.rd	Time Difference: 0 0:17:0 LAST MODIFIED: 2007-05-21 12:06:41
32322	5803	3551-115.rd	Time Difference: 0 0:54:32 LAST MODIFIED: 2006-01-23 13:54:55
32322	13657	3551-115.LAS	Time Difference: 0 0:54:32 LAST MODIFIED: 2006-01-23 14:49:27
34480	12303	sawp122t3.LAS	Time Difference: 0 0:3:1 LAST MODIFIED: 2007-05-29 12:58:24
34480	7733	sawp122t3.rd	Time Difference: 0 0:3:1 LAST MODIFIED: 2007-05-29 12:55:22
25101	4604	MV60_215A1P1T2.rd	Time Difference: 2 21:30:33 LAST MODIFIED: 2011-11-29 11:34:52
25101	12705	MV60_215A1P1T2.LAS	Time Difference: 2 21:30:33 LAST MODIFIED: 2011-12-02 09:05:26
24988	4577	B6P1T7.rd	Time Difference: 3 4:58:10 LAST MODIFIED: 2011-10-11 13:28:30
24988	12678	B6P1T7.LAS	Time Difference: 3 4:58:10 LAST MODIFIED: 2011-10-14 18:26:40
2171	835	/tcbb3p3bt10.LAS	Time Difference: 0 0:4:7 LAST MODIFIED: 2008-10-22 16:15:56
2171	349	tcbb3p3bt10.rd	Time Difference: 0 0:4:7 LAST MODIFIED: 2008-10-22 16:11:48
21382	3561	HSB5LP2T1.rd	Time Difference: 0 0:6:6 LAST MODIFIED: 2010-10-28 09:50:42
21382	10729	HSB5LP2T1.LAS	Time Difference: 0 0:6:6 LAST MODIFIED: 2010-10-28 09:56:48
24880	4548	ABT15 P5T5.rd	Time Difference: 0 0:10:26 LAST MODIFIED: 2011-12-09 15:12:42
24880	12545	ABT15 P5T5.LAS	Time Difference: 0 0:10:26 LAST MODIFIED: 2011-12-09 15:23:08
35347	14511	200 count block 3.LAS	Time Difference: 0 0:22:7 LAST MODIFIED: 2011-10-26 16:15:27
35347	7981	200 count block 3.rd	Time Difference: 0 0:22:7 LAST MODIFIED: 2011-10-26 15:53:20
26237	4950	Block 1.rd	Time Difference: 0 0:50:37 LAST MODIFIED: 2010-04-15 10:58:50
26237	13119	Block 1.LAS	Time Difference: 0 0:50:37 LAST MODIFIED: 2010-04-15 11:49:28
35349	14512	strat 115-147-195.LAS	Time Difference: 0 1:22:16 LAST MODIFIED: 2011-10-26 15:28:31
35349	7982	strat 115-147-195.rd	Time Difference: 0 1:22:16 LAST MODIFIED: 2011-10-26 14:06:14
26107	4916	Bnt2 P4T3.rd	Time Difference: 3 2:45:52 LAST MODIFIED: 2011-04-19 13:09:50
26107	13052	Bnt2 P4T3.LAS	Time Difference: 3 2:45:52 LAST MODIFIED: 2011-04-22 15:55:42
25982	4873	Bnt3P2T4.rd	Time Difference: 2 3:20:56 LAST MODIFIED: 2010-12-01 12:21:24
25982	13009	Bnt3P2T4.LAS	Time Difference: 2 3:20:56 LAST MODIFIED: 2010-12-03 15:42:20
25973	13006	Bnt3P2T1.LAS	Time Difference: 2 3:37:22 LAST MODIFIED: 2010-12-03 15:43:36
25973	4870	Bnt3P2T1.rd	Time Difference: 2 3:37:22 LAST MODIFIED: 2010-12-01 12:06:14

Discussion of Findings

A total of 7 different RD-LAS pairs were chosen at random and checked for post-test editing by replaying the RD files, generating new LAS files, and comparing the new LAS file against the original LAS file used in the pile analysis and archived on the FTB server. No post-test editing was found.

Carroll Canyon ABT15 P5T5
Following LAS-RD pairs flagged for timestamp discrepancies: ABT15 P5T5
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set.

12-0202 - Gold Run Cr Br RD-LAS Timestamp Comparison
Following LAS-RD pairs flagged for timestamp discrepancies: 70p
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set.

Moreno Valley 60_215 HOV Conn
Following LAS-RD pairs flagged for timestamp discrepancies:
MV60_215A1P1T2
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set.

04-438804-87 HOV Santa Clara RD-LAS Timestamp Comparison
Following LAS-RD pairs flagged for timestamp discrepancies:
SJ87p1t1
SJ87p1t2
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set

39-0044 - Bradley OH (Rplc) (GGL) Bent6L RD-LAS Timestamp Comparison
Following LAS-RD pairs flagged for timestamp discrepancies:
B6P1T7
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set.

8-0165 - Thomes Cr Br Phase I 2009 RD-LAS Timestamp Comparison
Following LAS-RD pairs flagged for timestamp discrepancies:
tcbb3p3bt10
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set

33-0732 -High Street
Following LAS-RD pairs flagged for timestamp discrepancies:
HSB5LP2T1
Generated a new LAS file by replaying RD file. Compared New and Old LAS files and found no difference in data set.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 62

Name: RD-LAS Timestamp Comparison Marysville Maintenance Communication Tower

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The files below were flagged for RD-LAS time discrepancy where the difference between the RD 'file modified' time and the LAS 'file modified' time is more than 4 minutes.

las_rd_pair_id	unique_file_id	filepath	flag_reason
321	66	C.TP4T2.LAS	Time Difference: 0 0:4:3 LAST MODIFIED: 2009-10-22 09:27:22
321	52	C.TP4T2.rd	Time Difference: 0 0:4:3 LAST MODIFIED: 2009-10-22 09:23:18

Discussion of Findings

RD file not replayed since LAS file does not contain data and there is documentation that the inspection pipe was retested.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 63

Name: Filename changed to correct inaccurate location information

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☒ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Morgan **Date:** 5/01/12

Summarized by: Morgan **Date:** 7/12/12

Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. This write up specifically addresses files that were renamed in order to correct inaccurate location information.

Discussion of Findings

These files were intentionally renamed. In all cases the renaming did not affect the file modified time of the files. Also, all of the new names given to the files matched the associated foundation location addressed by the subsequent analysis and report. The files with original names were all contained within folders associated with same structure as the renamed files. There are no indications that the renaming of these files resulted in any misrepresentation of data.

References

File ID	Unique ID	Date	Filepath	Details of Filename Change
2793	407	5/5/2008 11:54	…-145-150-155-157/sw2p136t1.LAS	sw2p136t1.LAS, sw2p135t1.LAS
16962	2168	11/16/2006 11:53	…GL, CSL)/GGL/RawData/B2-T1.LAS	B2-T1.LAS, B1-T1.LAS
16969	2169	11/16/2006 12:00	…GL, CSL)/GGL/RawData/B2-T2.LAS	B2-T2.LAS, B1-T2.LAS
16976	2170	11/16/2006 12:17	…GL, CSL)/GGL/RawData/B2-T3.LAS	B2-T3.LAS, B1-T3.LAS
16983	2171	11/16/2006 12:26	…GL, CSL)/GGL/RawData/B2-T4.LAS	B2-T4.LAS, B1-T4.LAS
16990	2172	11/16/2006 13:05	…GL, CSL)/GGL/RawData/B3-T1.LAS	B3-T1.LAS, B2-T1.LAS
16997	2173	11/16/2006 13:14	…GL, CSL)/GGL/RawData/B3-T2.LAS	B3-T2.LAS, B2-T2.LAS
17004	2174	11/16/2006 13:33	…GL, CSL)/GGL/RawData/B3-T3.LAS	B3-T3.LAS, B2-T3.LAS
17011	2175	11/16/2006 13:42	…GL, CSL)/GGL/RawData/B3-T4.LAS	B3-T4.LAS, B2-T4.LAS
30973	4247	6/19/2007 15:23	…DATA/WEST APPROACH/B6LP4T1.LAS	B6LP4T1.LAS, B6LP 3T1.LAS
30984	4248	6/19/2007 15:32	…DATA/WEST APPROACH/B6LP4T2.LAS	B6LP4T2.LAS, B6LP 3T2.LAS
30995	4249	6/20/2007 12:40	…DATA/WEST APPROACH/B6LP4T3.LAS	B6LP4T3.LAS, B6LP 3T3.LAS
31006	4250	6/19/2007 15:51	…DATA/WEST APPROACH/B6LP4T4.LAS	B6LP4T4.LAS, B6LP 3T4.LAS
31017	4251	6/19/2007 16:01	…DATA/WEST APPROACH/B6LP4T5.LAS	B6LP4T5.LAS, B6LP 3T5.LAS
31046	4254	6/19/2007 14:34	…DATA/WEST APPROACH/B6LP3T1.LAS	B6LP3T1.LAS, B6LP 4T1.LAS
31057	4255	6/19/2007 14:41	…DATA/WEST APPROACH/B6LP3T2.LAS	B6LP3T2.LAS, B6LP 4T2.LAS
31068	4256	6/19/2007 14:28	…DATA/WEST APPROACH/B6LP3T3.LAS	B6LP3T3.LAS, B6LP 4T3.LAS
31079	4257	6/19/2007 14:46	…DATA/WEST APPROACH/B6LP3T4.LAS	B6LP3T4.LAS, B6LP 4T4.LAS
31090	4258	6/19/2007 14:20	…DATA/WEST APPROACH/B6LP3T5.LAS	B6LP3T5.LAS, B6LP 4T5.LAS
31101	4259	6/19/2007 14:11	…DATA/WEST APPROACH/B6LP3T6.LAS	B6LP3T6.LAS, B6LP 4T6.LAS
31112	4260	6/19/2007 15:00	…DATA/WEST APPROACH/B6LP3T7.LAS	B6LP3T7.LAS, B6LP 4T7.LAS
33870	4690	6/29/2010 12:48	…-10 RT101 Doyle Dr/PV4L T7.LAS	PV4L T7.LAS, PV4L T6.LAS
33877	4691	6/29/2010 13:01	…nt 4L GGL/RAW DATA/PV4L T7.LAS	PV4L T7.LAS, PV4L T7 A.LAS
38497	5420	5/28/2008 12:24	…ge 2/Raw Data/HUEROB3P26T1.LAS	HUEROB3P26T1.LAS, HUEROB2P26T1.LAS
38506	5421	5/28/2008 12:33	…ge 2/Raw Data/HUEROB3P26T2.LAS	HUEROB3P26T2.LAS, HUEROB2P26T2.LAS
38515	5422	5/28/2008 12:46	…ge 2/Raw Data/HUEROB3P27T1.LAS	HUEROB3P27T1.LAS, HUEROB2P27T1.LAS
38524	5423	5/28/2008 12:55	…ge 2/Raw Data/HUEROB3P27T2.LAS	HUEROB3P27T2.LAS, HUEROB2P27T2.LAS
46145	6428	4/1/2005 8:42	…a/Floppy Data/la101bd5p2t1.LAS	la101bd5p2t1.LAS, la101bd4p1t01.LAS
46151	6429	4/1/2005 8:51	…a/Floppy Data/la101bd5p2t2.LAS	la101bd5p2t2.LAS, la101bd4p1t02.LAS
46157	6430	4/1/2005 9:00	…a/Floppy Data/la101bd5p2t3.LAS	la101bd5p2t3.LAS, la101bd4p1t03.LAS
46163	6431	4/1/2005 9:09	…a/Floppy Data/la101bd5p2t4.LAS	la101bd5p2t4.LAS, la101bd4p1t04.LAS
46169	6432	4/1/2005 9:19	…a/Floppy Data/la101bd5p2t5.LAS	la101bd5p2t5.LAS, la101bd4p1t05.LAS
46175	6433	4/1/2005 9:28	…a/Floppy Data/la101bd5p2t6.LAS	la101bd5p2t6.LAS, la101bd4p1t06.LAS
46181	6434	4/1/2005 9:40	…a/Floppy Data/la101bd5p2t7.LAS	la101bd5p2t7.LAS, la101bd4p1t07.LAS
46187	6435	4/1/2005 9:52	…a/Floppy Data/la101bd5p2t8.LAS	la101bd5p2t8.LAS, la101bd4p1t08.LAS
46193	6436	4/1/2005 10:01	…a/Floppy Data/la101bd5p2t9.LAS	la101bd5p2t9.LAS, la101bd4p1t09.LAS
46199	6437	4/1/2005 10:10	…/Floppy Data/la101bd5p2t10.LAS	la101bd5p2t10.LAS, la101bd4p1t10.LAS
46205	6438	4/1/2005 10:19	…/Floppy Data/la101bd5p2t11.LAS	la101bd5p2t11.LAS, la101bd4p1t11.LAS
64077	8905	12/4/2007 10:32	…ata/Retest Tube 4/I15P3RT4.LAS	I15P3RT4.LAS, I15P3RT1.LAS
66532	9321	5/27/2004 11:15	…/Pile 3 Raw Data/BMP10P3T1.LAS	BMP10P3T1.LAS, BMP10P2T1.LAS
66540	9322	5/27/2004 11:37	…/Pile 3 Raw Data/BMP10P3T2.LAS	BMP10P3T2.LAS, BMP10P2T2.LAS
66548	9323	5/27/2004 11:58	…/Pile 3 Raw Data/BMP10P3T3.LAS	BMP10P3T3.LAS, BMP10P2T3.LAS
66556	9324	5/27/2004 12:20	…/Pile 3 Raw Data/BMP10P3T4.LAS	BMP10P3T4.LAS, BMP10P2T4.LAS
66564	9325	5/27/2004 12:42	…/Pile 3 Raw Data/BMP10P3T5.LAS	BMP10P3T5.LAS, BMP10P2T5.LAS
66572	9326	5/27/2004 13:04	…/Pile 3 Raw Data/BMP10P3T6.LAS	BMP10P3T6.LAS, BMP10P2T6.LAS
66580	9327	5/27/2004 13:27	…/Pile 3 Raw Data/BMP10P3T7.LAS	BMP10P3T7.LAS, BMP10P2T7.LAS

66588	9328	5/27/2004 13:49	…/Pile 3 Raw Data/BMP10P3T8.LAS	BMP10P3T8.LAS, BMP10P2T8.LAS
71631	10179	8/3/2010 12:32	…GGL/RAW Data/PILE 1/B3W P1.LAS	B3W P1.LAS, B2W P1 T1.LAS
71634	10180	8/3/2010 12:39	…GGL/RAW Data/PILE 1/B3W P2.LAS	B3W P2.LAS, B2W P1 T2.LAS
71637	10181	8/3/2010 12:48	…/RAW Data/PILE 2/B3W P2 T1.LAS	B3W P2 T1.LAS, B2W P2 T1.LAS
71640	10182	8/3/2010 12:55	…/RAW Data/PILE 2/B3W P2 T2.LAS	B3W P2 T2.LAS, B2W P2 T2.LAS
71643	10183	8/3/2010 13:04	…/RAW Data/PILE 3/B3W P3 T1.LAS	B3W P3 T1.LAS, B2W P3 T1.LAS
71646	10184	8/3/2010 13:12	…/RAW Data/PILE 3/B3W P3 T2.LAS	B3W P3 T2.LAS, B2W P3 T2.LAS
71649	10185	8/3/2010 13:53	…/RAW Data/PILE 4/B3W P4 T1.LAS	B3W P4 T1.LAS, B2W P4 T1.LAS
71652	10186	8/3/2010 14:00	…/RAW Data/PILE 4/B3W P4 T2.LAS	B3W P4 T2.LAS, B2W P4 T2.LAS
71655	10187	8/3/2010 13:38	…/RAW Data/PILE 5/B3W P5 T1.LAS	B3W P5 T1.LAS, B2W P5 T1.LAS
71658	10188	8/3/2010 13:45	…/RAW Data/PILE 5/B3W P5 T2.LAS	B3W P5 T2.LAS, B2W P5 T2.LAS
71661	10189	8/3/2010 13:23	…/RAW Data/PILE 6/B3W P6 T1.LAS	B3W P6 T1.LAS, B2W P6 T1.LAS
71664	10190	8/3/2010 13:30	…/RAW Data/PILE 6/B3W P6 T2.LAS	B3W P6 T2.LAS, B2W P6 T2.LAS
73631	10637	10/21/2011 14:05	…ctual Bent 5)/14MILEB6P1T1.LAS	14MILEB6P1T1.LAS, 14MILEB5P1T1.LAS
73637	10638	10/21/2011 14:14	…ctual Bent 5)/14MILEB6P1T2.LAS	14MILEB6P1T2.LAS, 14MILEB5P1T2.LAS
73643	10639	10/21/2011 14:23	…ctual Bent 5)/14MILEB6P2T1.LAS	14MILEB6P2T1.LAS, 14MILEB5P2T1.LAS
73649	10640	10/21/2011 14:32	…ctual Bent 5)/14MILEB6P2T2.LAS	14MILEB6P2T2.LAS, 14MILEB5P2T2.LAS
73655	10641	10/21/2011 14:40	…ctual Bent 5)/14MILEB6P3T1.LAS	14MILEB6P3T1.LAS, 14MILEB5P3T1.LAS
73661	10642	10/21/2011 14:50	…ctual Bent 5)/14MILEB6P3T2.LAS	14MILEB6P3T2.LAS, 14MILEB5P3T2.LAS
73987	10737	10/29/2010 9:33	…ring of piles/HS B4L P1 T2.LAS	HS B4L P1 T2.LAS, HS B4L P1 T1.LAS
73989	10738	10/29/2010 11:43	…nd 2)/PILE 1/HS B4L P1 T1A.LAS	HS B4L P1 T1A.LAS, HS B4L P1 T1.LAS
80209	11995	5/9/2007 9:51	…awtelle (5-10-07)/sawp14t3.LAS	sawp14t3.LAS, saw14t3.LAS
84692	13027	4/8/2011 13:02	…DATA/MinklerCreek/MCA5P5T1.LAS	MCA5P5T1.LAS, MCA4P5T1.LAS
84728	13039	4/8/2011 10:01	…A DATA/MinklerCreek/MCB4T4.LAS	MCB4T4.LAS, MCB3P4T4.LAS
87591	13653	12/15/2004 10:30	…AMMA/SAN DIEGO/ABUT1/PILE3.LAS	PILE3.LAS, BENT34L.LAS
87592	13653	8/20/2004 10:43	…tes/GAMMA/west app/BENT34L.LAS	BENT34L.LAS, 1234.LAS
87893	13727	10/20/2003 10:46	…11/GGL original data/p11t1.LAS	p11t1.LAS, p10t1.LAS
87897	13728	10/20/2003 10:41	…11/GGL original data/p11t2.LAS	p11t2.LAS, p10t2.LAS
87899	13729	10/20/2003 11:02	…WILES/GAMMA/odds/3rd/p11t1.LAS	p11t1.LAS, p10t1.LAS
87903	13730	10/20/2003 11:07	…WILES/GAMMA/odds/3rd/p11t2.LAS	p11t2.LAS, p10t2.LAS
87907	13731	10/20/2003 11:32	…ILES/GAMMA/odds/3rd/p11t2a.LAS	p11t2a.LAS, p10t2a.LAS
89832	14570	12/16/2011 11:46	…5 Widening/gamma/CRB5AP4T1.LAS	CRB5AP4T1.LAS, CBB5AP4T1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **64**

Name: **Filename changed to correct or include tube number**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☒ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Morgan **Date:** 5/02/12
Summarized by: Morgan **Date:** 7/13/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. This write up specifically addresses files that were renamed in order to include or correct tube number information.

The files were initially given a name without a tube number or with an incorrect tube number. The problem appears to have been identified and corrected by the Technician.

All internally identical files, regardless of file name, should be located in folders associated with a single structure/pile. Internally identical files found in folders associated with more than a single structure/pile would be cause for concern and would trigger a more thorough investigation.

Discussion of Findings

These files were intentionally renamed. In all cases the renaming did not affect the file modified time of the files. Also, all of the new names given to the files matched the associated foundation location addressed by the subsequent analysis and report. The files with original names were all contained within folders associated with same structure as the renamed files. There are no indications that the renaming of these files resulted in any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
5496	829	12/4/2008 11:20	…utment 1/Pile 3/ThomasCrkA1P3T1.LAS	ThomasCrkA1P3T1.LAS, ThomasCrkA1P3.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **65**

Name: **Filename changed to indicate subsequent iteration of testing**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☒ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Morgan **Date:** 5/03/12
Summarized by: Morgan **Date:** 7/13/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. This write up specifically addresses files that were renamed in order to include or correct tube number information.

The files were initially given a name without a tube number or with an incorrect tube number. The problem appears to have been identified and corrected by the Technician.

All internally identical files, regardless of file name, should be located in folders associated with a single structure/pile. Internally identical files found in folders associated with more than a single structure/pile would be cause for concern and would trigger a more thorough investigation.

Discussion of Findings

These files were intentionally renamed. In all cases the renaming did not affect the file modified time of the files. Also, all of the new names given to the files matched the associated foundation location addressed by the subsequent analysis and report. The files with original names were all contained within folders associated with same structure as the renamed files. There are no indications that the renaming of these files resulted in any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
16419	2100	6/15/2004 9:51	…e 11 June 04/BMB19P11T1-04.LAS	BMB19P11T1-04.LAS, BMB19P11T1.LAS
16451	2101	6/15/2004 10:01	…e 11 June 04/BMB19P11T2-04.LAS	BMB19P11T2-04.LAS, BMB19P11T2.LAS
16483	2102	6/15/2004 10:11	…n of Pile 12/BMB19P12T1-04.LAS	BMB19P12T1-04.LAS, BMB19P12T1.LAS
16515	2103	6/15/2004 10:22	…n of Pile 12/BMB19P12T2-04.LAS	BMB19P12T2-04.LAS, BMB19P12T2.LAS
16545	2104	6/15/2004 10:36	…le 04 June 04/BMB19P4T1-04.LAS	BMB19P4T1-04.LAS, BMB19P4T1.LAS
16565	2105	6/15/2004 10:50	…le 04 June 04/BMB19P4T2-04.LAS	BMB19P4T2-04.LAS, BMB19P4T2.LAS
16585	2106	6/15/2004 10:58	…le 04 June 04/BMB19P4T3-04.LAS	BMB19P4T3-04.LAS, BMB19P4T3.LAS
16605	2107	6/15/2004 11:08	…le 04 June 04/BMB19P4T4-04.LAS	BMB19P4T4-04.LAS, BMB19P4T4.LAS
25403	3510	8/18/2008 14:15	…aw Data/92880RWF1P217T1Old.LAS	92880RWF1P217T1Old.LAS, 92880RWF1P217T1.LAS
25410	3511	8/18/2008 14:19	…aw Data/92880RWF1P217T2Old.LAS	92880RWF1P217T2Old.LAS, 92880RWF1P217T2.LAS
68281	9609	8/23/2004 11:52	…ta Pile 3 Pier 14/P14P3T6R.LAS	P14P3T6R.LAS, P14P3T6.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **66**

Name: **No data below header – associated as renamed**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☒ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Morgan **Date:** 5/04/12
Summarized by: Morgan **Date:** 7/13/12
Reviewed by: Hannenian **Date:** 10/18/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. This write up specifically addresses files that were not actually renamed; they were associated as renamed because they contain identical file contents with different file names. These files contain no gamma data below the headers.

Discussion of Findings

There are no indications that the files associated under this ID are the result of any misrepresentation of data. The files appear to have been truncated or corrupted by having been written over or otherwise changed through file handling by the operating system. Exact cause is unknown.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
65201	9057	6/2/2010 14:23	…le 1/raw data/SR76A10P1T2b.LAS	SR76A10P1T2b.LAS, BENT4.LAS
65207	9057	5/17/2006 11:22	…GAMMA/old/santa rosa/BENT4.LAS	BENT4.LAS, BENT1K.LAS
65208	9057	5/3/2006 8:28	…N DIEGO/SABERSPRING/BENT1K.LAS	BENT1K.LAS, 147.5.LAS
87591	13653	12/15/2004 10:30	…AMMA/SAN DIEGO/ABUT1/PILE3.LAS	PILE3.LAS, BENT34L.LAS
87592	13653	8/20/2004 10:43	…tes/GAMMA/west app/BENT34L.LAS	BENT34L.LAS, 1234.LAS
88098	13777	6/18/2008 15:42	…ktop/Gamma/Ret Wall G/p167.LAS	p167.LAS, lhba6p.LAS
88099	13777	6/18/2008 14:03	…op/Gamma/Ret Wall G/P174T@.LAS	P174T@.LAS, p167.LAS
88467	13925	3/17/2010 11:25	…amma gamma/testing/hb1p1t1.LAS	hb1p1t1.LAS, 4.LAS
88468	13925	3/17/2010 11:30	…amma gamma/testing/hb1p1t2.LAS	hb1p1t2.LAS, hb1p1t1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary	
Manual Analysis ID:	**67**
Name:	*(This irregularity has been documented under ID-47.)*

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 68

Name: File renamed to include date information

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Morgan **Date:** 5/04/12

Summarized by: Morgan **Date:** 7/13/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. ID-68 is only associated with data collected for the qualification of two functionality blocks.

Discussion of Findings

The file name was modified to include the date. There are no indications that the files associated under this ID are the result of any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
89609	14418	1/30/2008 11:19	…ock 7 cert 1273-3552-568 H.LAS	block 7 cert 1273-3552-568 H.LAS, block 7 cert 1273-3552-568 H 1Feb08.LAS
89613	14419	1/30/2008 11:24	…ock 7 cert 1273-3552-568 V.LAS	block 7 cert 1273-3552-568 V.LAS, block 7 cert 1273-3552-568 V 1Feb08.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **69**

Name: **File renamed to include date information**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching
☐ Calibration Constant
☐ Depth Consistency
☐ Fidelity (RD-LAS)
☒ File Rename
☐ Correlation
☐ Time Stamp

Code Version: V3

Analyzed by: Morgan **Date:** 8/08/12
Summarized by: Morgan **Date:** 9/05/12
Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. The files under this ID were not renamed. In this case the identical data within the files was the result of identical start and stop elevations as well as entirely null values in the data.

Discussion of Findings

There are no indications that the files associated under this ID are the result of any misrepresentation of data. The tubes associated with this problem were subsequently re-logged on a later date. Entirely null values within the data block may be the result of disconnecting the probe without re-booting the logging computer.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
25601	3538	8/18/2008 12:11	…T/Raw Data/92880RWF1P231T2.LAS	92880RWF1P231T2.LAS, 92880RWF1P231T1.LAS
25617	3539	8/18/2008 11:57	…T/Raw Data/92880RWF1P233T2.LAS	92880RWF1P233T2.LAS, 92880RWF1P232T1.LAS

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **70**

Name: **Corrupted RD files associated as renamed**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☒ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Morgan **Date:** 7/21/2012
Summarized by: Morgan **Date:** 9/06/2012
Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical RD file having different file names. This write up specifically addresses files that were not actually renamed; they were associated as renamed because they contain identical file contents with different file names. In all cases checked, the files appear to have missing or corrupted data blocks. The LAS files that were used for analysis, and associated with these RD files, appear to be unique and were not associated as renamed.

Discussion of Findings

There are no indications that the files associated under this ID are the result of any misrepresentation of data. The files appear to have been truncated or corrupted by having been written over or otherwise changed through file handling by the operating system or a file archiving program. Most of the files are found in various “Wiles” directories. All of the files on the renamed summary list were not evaluated. If the RD files were not corrupted and contained valid data that were used to produce the corresponding LAS files, then the LAS files would have also been caught by the other GamDat analysis tools. Exact cause of the problem is unknown.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 71

Name: RD-LAS Timestamp Discrepancy – Data In LAS-RD Pair Does Not Match 53-1403 Sawtelle Blvd

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☒ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 9/25/12

Summarized by: Wahleithner **Date:** 9/25/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

A pair of RD-LAS files found at the following location has a timestamp discrepancy of 18 hours and 36 minutes :

Table 1: ID-71 Files Flagged for Timestamp Discrepancy

File ID	Unique ID	Date	LAS-RD Pair ID	File Name	File Path
88143	13808	4/4/2007 8:59	34378	435Bp4t3.LAS	…60-1605534141-500/435Bp4t3.LAS
37029	7629	4/3/2007 14:23	34378	435Bp4t3.rd	…060-1605534141-500/435Bp4t3.rd

Discussion of Findings

The RD file (7629) was replayed and the resulting LAS file was found to be entirely different than the LAS file (13808) found in the same directory.

LAS files listed in Table 2 have the same timestamp as the RD file above and were found on the FTB Archive.

Table 2: LAS Files identical to RD File (Unique ID-7629)

File ID	Unique ID	Date	LAS-RD Pair ID	File Name	File Path
82503	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS
82504	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS
82505	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS
82506	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS
82507	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS
82508	12457	4/3/2007 14:23		435Bp4t3.LAS	…5)/435B data only/435Bp4t3.LAS

The LAS file flagged by the timestamp analysis and shown above in Table 1 was only found in a 'recycler' folder of one field computer. It appears that the LAS file (13808) recovered from the recycler folder is corrupted, resulting in a fidelity and time stamp flag.

The LAS files in Table 2 are correctly paired with the RD file (7629) in Table 1.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 72

Name: RD-LAS Files Flagged For Timestamp Diff of less than 4 minutes

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The files below were flagged for RD-LAS time discrepancy where the difference between the RD 'file modified' time and the LAS 'file modified' time is less than 4 minutes.

las_rd_pair_id	unique_file_id	filepath	flag_reason
17733	9580	P13P7T8.LAS	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-03-10 16:15:44
17733	2680	P13P7T8.rd	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-03-10 16:13:36
28272	5480	p14p5t2.rd	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-07-30 12:31:08
28272	9622	p14p5t2.LAS	Time Difference: 0 0:2:7 LAST MODIFIED: 2004-07-30 12:33:16
23386	11299	P12L T7.LAS	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-08-19 11:28:46
23386	4131	P12L T7.rd	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-08-19 11:26:36
24745	4503	ABT15 P8T4.rd	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-12-08 13:13:28
24745	12500	ABT15 P8T4.LAS	Time Difference: 0 0:2:9 LAST MODIFIED: 2011-12-08 13:15:38
21282	3533	HSB8LP2T5.rd	Time Difference: 0 0:2:12 LAST MODIFIED: 2010-10-12 16:32:00
21282	10701	HSB8LP2T5.LAS	Time Difference: 0 0:2:12 LAST MODIFIED: 2010-10-12 16:34:12
17379	9310	P8P9T1.LAS	Time Difference: 0 0:2:12 LAST MODIFIED: 2003-11-18 11:25:26
17379	2591	P8P9T1.rd	Time Difference: 0 0:2:12 LAST MODIFIED: 2003-11-18 11:23:14
14254	6495	P1T1.LAS	Time Difference: 0 0:2:13 LAST MODIFIED: 2005-12-29 09:43:18
14254	2075	P1T1.rd	Time Difference: 0 0:2:13 LAST MODIFIED: 2005-12-29 09:41:04
34271	7505	sawp48t1RW.rd	Time Difference: 0 0:2:15 LAST MODIFIED: 2007-05-10 12:04:49
34271	12049	sawp48t1RW.LAS	Time Difference: 0 0:2:15 LAST MODIFIED: 2007-05-10 12:07:04
37997	14410	ggggggggg.LAS	Time Difference: 0 0:2:15 LAST MODIFIED: 2008-09-29 10:19:14
37997	9216	ggggggggg.rd	Time Difference: 0 0:2:15 LAST MODIFIED: 2008-09-29 10:16:58
22525	3923	Bent4RTP1T5.rd	Time Difference: 0 0:2:18 LAST MODIFIED: 2010-09-30 13:27:58
22525	11091	Bent4RTP1T5.LAS	Time Difference: 0 0:2:18 LAST MODIFIED: 2010-09-30 13:30:16
37998	9217	hhhhhhhhhh.rd	Time Difference: 0 0:2:18 LAST MODIFIED: 2008-09-29 10:19:41

37998	14411	hhhhhhhhhhh.LAS	Time Difference: 0 0:2:18 LAST MODIFIED: 2008-09-29 10:22:00
40409	14785	TEST 3.LAS	Time Difference: 0 0:2:18 LAST MODIFIED: 2011-12-06 19:44:02
40409	11511	TEST 3.rd	Time Difference: 0 0:2:18 LAST MODIFIED: 2011-12-06 19:41:43
21401	3570	HS B4L P1 T1A.rd	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-10-29 11:41:24
21401	10738	HS B4L P1 T1A.LAS	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-10-29 11:43:46
38536	14500	B3LT1 041310 Squire.LAS	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-04-13 14:13:52
38536	9769	B3LT1 041310 Squire.rd	Time Difference: 0 0:2:22 LAST MODIFIED: 2010-04-13 14:11:30
24570	4450	Abt2 P6T4.rd	Time Difference: 0 0:2:23 LAST MODIFIED: 2011-02-01 12:51:10
24570	11617	Abt2 P6T4.LAS	Time Difference: 0 0:2:23 LAST MODIFIED: 2011-02-01 12:53:34
29881	2220	p2lt1.LAS	Time Difference: 0 0:2:23 LAST MODIFIED: 2005-07-18 10:31:40
29881	5607	p2lt1.rd	Time Difference: 0 0:2:23 LAST MODIFIED: 2005-07-18 10:29:16
34538	7791	sawp94t1.rd	Time Difference: 0 0:2:23 LAST MODIFIED: 2007-05-30 13:06:42
34538	12388	sawp94t1.LAS	Time Difference: 0 0:2:23 LAST MODIFIED: 2007-05-30 13:09:06
40410	11512	TEST 4.rd	Time Difference: 0 0:2:38 LAST MODIFIED: 2011-12-06 19:46:19
40410	14786	TEST 4.LAS	Time Difference: 0 0:2:38 LAST MODIFIED: 2011-12-06 19:48:58
9156	2954	P174T2.LAS	Time Difference: 0 0:2:41 LAST MODIFIED: 2008-06-18 13:59:06
9156	1235	P174T2.rd	Time Difference: 0 0:2:41 LAST MODIFIED: 2008-06-18 13:56:24
32858	7006	B3P8T2.rd	Time Difference: 0 0:2:46 LAST MODIFIED: 2006-04-18 15:50:18
32858	8993	B3P8T2.LAS	Time Difference: 0 0:2:46 LAST MODIFIED: 2006-04-18 15:53:04
23713	4227	Bnt5R P5R T3.rd	Time Difference: 0 0:2:47 LAST MODIFIED: 2011-07-14 11:50:26
23713	11395	Bnt5R P5R T3.LAS	Time Difference: 0 0:2:47 LAST MODIFIED: 2011-07-14 11:53:14
16522	8885	lhp3p7t4.LAS	Time Difference: 0 0:2:47 LAST MODIFIED: 2007-12-27 09:02:42
16522	2420	lhp3p7t4.rd	Time Difference: 0 0:2:47 LAST MODIFIED: 2007-12-27 08:59:54
26501	4980	405p14t1.rd	Time Difference: 0 0:2:58 LAST MODIFIED: 2007-03-05 15:37:46
26501	11854	405p14t1.LAS	Time Difference: 0 0:2:58 LAST MODIFIED: 2007-03-05 15:40:44
1919	802	TCp1FT4.LAS	Time Difference: 0 0:3:11 LAST MODIFIED: 2010-06-28 15:10:58
1919	326	TCp1FT4.rd	Time Difference: 0 0:3:11 LAST MODIFIED: 2010-06-28 15:07:46
40412	11514	xxxx.rd	Time Difference: 0 0:3:21 LAST MODIFIED: 2011-12-08 16:18:06
40412	14788	xxxx.LAS	Time Difference: 0 0:3:21 LAST MODIFIED: 2011-12-08 16:21:27
24462	4414	ABT1 P1T1.rd	Time Difference: 0 0:3:24 LAST MODIFIED: 2011-03-10 10:23:48
24462	11581	ABT1 P1T1.LAS	Time Difference: 0 0:3:24 LAST MODIFIED: 2011-03-10 10:27:12
8003	2428	PEIR3 PILE 31 T2.LAS	Time Difference: 0 0:3:40 LAST MODIFIED: 2003-05-22 12:51:26
8003	1048	PEIR3 PILE 31 T2.rd	Time Difference: 0 0:3:40 LAST MODIFIED: 2003-05-22 12:47:46
11342	4670	B2T1.LAS	Time Difference: 0 0:3:57 LAST MODIFIED: 2010-05-27 11:44:38
11342	1547	B2T1.rd	Time Difference: 0 0:3:57 LAST MODIFIED: 2010-05-27 11:40:40
34138	7378	third run.rd	Time Difference: 0 0:3:57 LAST MODIFIED: 2009-08-06 10:15:32
34138	13776	third run.LAS	Time Difference: 0 0:3:57 LAST MODIFIED: 2009-08-06 10:19:30
19310	10270	B2 P10 T3.LAS	Time Difference: 0 0:4:1 LAST MODIFIED: 2011-09-13 15:45:50
19310	3102	B2 P10 T3.rd	Time Difference: 0 0:4:1 LAST MODIFIED: 2011-09-13 15:41:48

Discussion of Findings

RD-LAS pairs were chosen at random and checked for post-test editing by replaying the RD files, generating new LAS files, and comparing the new LAS file against the original LAS file used in the pile analysis and archived on the FTB server. No post-test editing was found.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 73

Name: File renamed to include date information

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☒ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☐ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Morgan **Date:** 8/09/12

Summarized by: Morgan **Date:** 9/05/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These files were flagged by the file renaming tool due to the existence of more than one internally identical file having different file names. The files under this ID were renamed upon receipt by the engineer. In this case the files as named by the technician appear only on floppy drive media recovered from the FTB warehouse. The renamed versions appear on computer hard drives or copies of hard drives. All are Log Shell files. None of the renamed files indicate different locations.

Discussion of Findings

There are no indications that the files associated under this ID are the result of any misrepresentation of data.

References

File ID	Unique ID	Date	File Path	Details of Filename Change
3052	1213	1/15/2002 8:47	…006/bent2Left/B2lP3a/SMC1A.SA1	SMC1A.SA1, B2lp1at1.sa1
3059	1214	1/15/2002 7:53	…ent2Left/B2lP1a/SMB2LP1AT1.SA1	SMB2LP1AT1.SA1, B2lP3aT1.sa1
3066	1215	1/15/2002 9:05	…006/bent2Left/B2lP3a/SMC1A.SA3	SMC1A.SA3, B2lP1aT2.sa3
3069	1216	1/15/2002 7:06	…a/Bent 2, Pile 3A/B2lP3at2.sa3	B2lP3at2.sa3, B2LP1AT2.SA3
3080	1217	1/15/2002 9:16	…006/bent2Left/B2lP3a/SMC1A.SA5	SMC1A.SA5, B2lP1aT3.sa5
3083	1218	1/15/2002 7:19	…a/Bent 2, Pile 3A/B2lP3aT3.sa5	B2lP3aT3.sa5, B2LP1AT3.SA5
3238	1242	1/23/2002 7:56	…, 4A, 5A, 6A/Raw Data/B2rP4aT3	B2rP4aT3, B2R2.SA5
3245	1243	1/23/2002 8:53	…, 4A, 5A, 6A/Raw Data/B2rP5aT3	B2rP5aT3, B2R2.SAD
3252	1244	1/23/2002 7:32	…, 5A, 6A/Raw Data/B2rP4aT1.sa1	B2rP4aT1.sa1, B2R2.SA1
3266	1246	1/23/2002 7:44	…, 5A, 6A/Raw Data/B2rP4aT2.sa3	B2rP4aT2.sa3, B2R2.SA3
3295	1251	1/23/2002 8:16	…, 5A, 6A/Raw Data/B2rP5aT1.sa8	B2rP5aT1.sa8, B2R2.SA8
3309	1253	1/23/2002 8:27	…, 5A, 6A/Raw Data/B2rP5aT2.saa	B2rP5aT2.saa, B2R2.SAA
3554	1290	1/30/2002 11:25	…010/B3Left/B3lP6B/B3LP6BT3.SA5	B3LP6BT3.SA5, B3LA.SA5
3994	1357	2/8/2002 10:34	…/bent2Left/B2lP4b/B4lP4bT2.sad	B4lP4bT2.sad, B2lP4bT2.sad
4001	1358	2/8/2002 10:45	…/bent2Left/B2LP6B/B4lP6bT1.saf	B4lP6bT1.saf, B2lP6bT1.saf
4008	1359	2/8/2002 10:57	…/bent2Left/B2LP6B/B4lP6bT2.sah	B4lP6bT2.sah, B2lP6bT2.sah
4015	1360	2/8/2002 11:07	…/bent2Left/B2LP6B/B4lP6bT3.saj	B4lP6bT3.saj, B2lP6bT3.saj
4050	1365	2/10/2002 9:55	…/B3Right/B3rP4a/B3rP4aT2q1.sa3	B3rP4aT2q1.sa3, B3rP4aT2.sa3

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 74

Name: RD-LAS Files Flagged For Timestamp Diff of less than 4 minutes

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These 9 files are part of the 130 total files flagged for RD Chronology issues. These files were flagged because the actual test time, derived from a chronology analysis of file save times, was less than the estimated test time.

File ID	Unique File ID	Group ID	File Name	Date	Data Aquisition Time(min)	File Save Time	Time between File Saves (min)
38523	8169	19220	etib52asp2t1.rd	07/10/2008 11:19:53	4.49	11:19:53	5.35
36851	7452	19016	sawp14t4.rd	05/09/2007 09:57:51	2.02	9:57:51	2.48
33001	5774	18178	6U1T5.rd	08/20/2004 16:46:15	2.05	16:46:15	2.40
16165	2278	2992	MCGBP3P10T2.rd	01/09/2003 10:21:50	4.7	10:21:50	5.07
1793	301	18586	PILE92T1.rd	11/03/2003 11:32:23	4.21	11:32:23	4.85
22666	3761	19314	Bnt2P22T2.rd	04/26/2011 10:13:22	7.07	10:13:22	7.97
5097	781	623	CBVP5T1a.rd	07/01/2010 10:09:36	7.99	10:09:36	9.17
17258	2453	3345	SR76A10P1T2c.rd	06/02/2010 14:30:40	6.34	14:30:40	7.63
17520	2491	3367	SR76P9LT7.rd	06/22/2010 18:25:12	5.32	18:25:12	5.97

Discussion of Findings

Parameters were set at the following:

Tube to Tube movement of 30 seconds, lowering speed of 52 feet per minute, and computer setup of 30 seconds.

The data acquisition time was calculated from the recorded speed information. The estimated test time was calculated as the sum of these 4 parts; Tube to Tube movement + lowering speed 52 feet per minute+computer setup 30 seconds+data acquisition time.

These files are grouped together because the Chronology indicates there was an actual partial double run of the inspection pipe. The chronology analysis shows the inspection pipe was partially logged and then re-logged for legitimate reasons and no deception is suspected. Because there is a partial double run of the inspection tube, the time between file saves does not include the time to move the probe from a previous inspection pipe, the time to lower the probe to the bottom of the pipe, and the time to setup the computer.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 75

Name: RD Chronology at Br. 57-1133 Abutment 4

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 8/7/12

Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tube 4 of Pile 3 and Tube 4 of Pile 4 on 8/4/05 at Abutment 4 of Br. 57-1133 Green Valley were flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 4 of Pile 3 is 9.67 minutes and is less than the *estimated total test time* which was calculated to be 9.81 minutes. The *time between file saves* at Tube 4 of Pile 4 is 9.07 minutes and is less than the *estimated total test time* which was calculated to be 9.36 minutes. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube using a winch rate of 52 feet per minute, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving the probe and setting up the computer file.

Table 1: ID-75 Chronology

Unique File ID	Las-RD Pair ID	File Name	Date	Data Acquisition Time(min)	Total Depth(ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5736	31466	TI.rd	08/04/2005 10:05:00	6.83	90.2	10:05:00	0.00	9.07
5733	31433	T2.rd	08/04/2005 10:16:18	6.42	90.7	10:16:18	11.30	8.66
5734	31444	T3.rd	08/04/2005 10:34:12	7.69	92.1	10:34:12	17.90	9.96
5735	31455	T4.rd	08/04/2005 10:46:30	7.23	90.9	10:46:30	12.30	9.48
5737	31477	T1.rd	08/04/2005 11:00:00	6.9	91.8	11:00:00	13:50	9.17

5738	31488	T2.rd	08/04/2005 11:13:06	7.37	92.0	11:13:06	13.10	9.64
5739	31499	T3.rd	08/04/2005 11:23:30	7.31	91.7	11:23:30	10.40	9.57
5740	31510	T4.rd	08/04/2005 11:33:42	7.78	91.5	11:33:42	10.20	10.04
5741	31522	T1.rd	08/04/2005 11:47:00	7.86	91.8	11:47:00	13:30	10.13
5742	31534	T2.rd	08/04/2005 11:57:16	7.47	92.2	11:57:16	10.27	9.74
5744	31556	T4.rd	08/04/2005 12:06:56	7.56	90.8	12:06:56	**9.67**	9.81
5743	31545	t3.rd	08/09/2005 08:44:34	7.54	90.8	8:44:34	**	9.79
5745	31567	T1.rd	08/04/2005 12:44:52	7.42	91.8	12:44:52		9.69
5746	31578	T2.rd	08/04/2005 12:58:22	6.93	91.3	12:58:22	13.50	9.19
5747	31589	T3.rd	08/04/2005 13:08:54	6.64	91.5	13:08:54	10.53	8.90
5748	31600	T4.rd	08/04/2005 13:17:58	7.1	91.5	13:17:58	**9.07**	9.36
5749	31611	T1.rd	08/04/2005 13:28:12	7.27	92.6	13:28:12	10:23	9.55
5750	31622	T2.rd	08/04/2005 13:53:46	7.25	92.4	13:53:46	25.57	9.53
5751	31633	T3.rd	08/04/2005 14:04:06	7.25	93.1	14:04:06	10.33	9.54
5752	31644	T4.rd	08/04/2005 14:13:30	6.88	92.9	14:13:30	9.40	9.17
5753	31655	ta1.rd	08/09/2005 09:06:20	11.17	92.6	9:06:20	**	13.45

** Tested on later date than other inspection pipes within same pile.

Discussion of Findings

The chronology analysis flagged both files because of discrepancies between the actual and estimated test times on the order of 20 seconds or less. These small time discrepancies could be the result of error within the assumptions used to calculate the estimated test times (ex. Lowering the probe at a rate faster than the assumed 52 feet per minute).

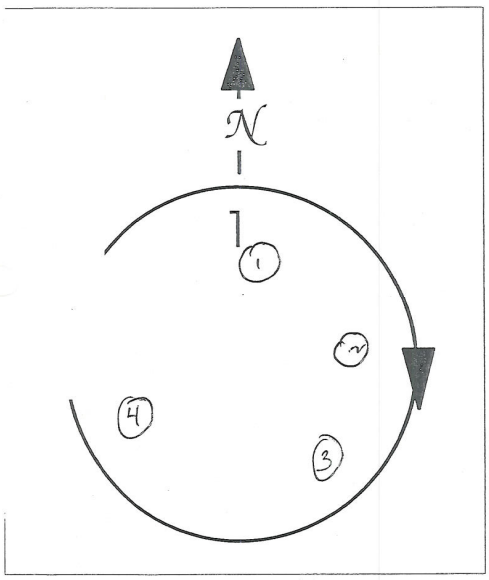
An additional observation came to light during review of these files. Pile 3 Tube 3 data was collected 5 days after the other three tubes because the dummy probe was lost in Tube 3 on the original day of testing. This is documented in the DFR and on the GGL setup sheet as shown below.

GGL Test Set-Up Sheet Pile 3

CALIFORNIA FTB Improving Mobility

Gamma Test Set-Up Sheet

Structure Name: Green Valley
Date Tested: 8-4-05
Structure No.: 53-1133R/E.A.: 11-080923
Operator: Wiles
Dist./Co./Rte./PM: 11-SD-I15
Dia: 4' Spec. Length: 95
IER No.: About 4 Pile No.: 3
No. of Inspection Tubes: 4



Tube No.	Taped Depth	Dummy Depth	Spacing Distance	Stick up	Depth of Water Wet/dry
1	95.1	95.1		54"	
2	95.1	95.3		54"	
3				5	
4	95.8	95.8		54"	
5	↓				
6	95.8				
7	29.20				
8			1-37		
9					
10					
11					
12					
13					
14					
15					

Missing Tubes Yes No
Kinked Tubes Yes No
Water in Tubes Yes No
WINCH S/N: 1194
PROBE No. 2840
SOURCE No. 041

Calibration NO: _____ Calibration Date _____ Functionality Preformed _____

Remarks:/ Observation:
Lost dummy probe in T3
Retest Tube T2 on 8/9/05 — Tei.

Daily Field Report Abutment 4

ID-75

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
DAILY FIELD REPORT
MR-1109 (REV. 7/94)

EA: 11-080923
SHEET 1 OF

PROJECT: Green Valley	DST/CO/RTE/PM: 11-SD-I15	DAILY FIELD REPORT SEQUENCE NO.
BRIDGE NO.: 53-1133 R/L	BENT NO.: Abt 4 P 1-5	DATE: 8-4-05 / DAY OF WEEK: Thurs.
R.E. OR STRUCTURE REP.: Dunaway	FT&I REP.: Wiles	WEATHER: Clear

TYPE OF WORK: Gamma.

NOTES (Describe work completed during the day, any problems and their solutions)

Started taping tubes at 7:45 had to wait until
contractor started blowing out tubes
dummy probe broke off in P3 T3 will test
the rest of pile.
Test all piles
Water in T1 at P5 47 ft

Finish testing at 5pm..

TIME WORKED: 10 hr. REGULAR HOURS: 8 OVERTIME HOURS: 2 ☐ CONTINUED

RECEIVED BY: COPY GIVEN TO:

FM 1883 M 94 PROJECT FOLDER: OFFICE-WHITE, FIELD-CANARY, STRUCTURE REP-GOLDENROD

Had the 4'-long dummy probe been lost and left at the bottom of Tube 3, then the subsequent GGL test in Tube 3 should have resulted in 4 fewer feet of data as compared to the other three tubes in the pile. This is not the case and either the dummy probe was retrieved from the tube prior to the GGL test or the data is not actually from Tube 3. The GamDat investigation could not resolve the discrepancy after reviewing available documents. Possible sources for resolution could include a review of construction field reports or discussions with field employees.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **76**

Name: **Irregular testing chronology (RD files); and altered Excel file for 28-0153 Benicia-Martinez, Pier 14, Pile 8**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☒ Yes ☐ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☒ Time Stamp
☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Turner **Date:** 9/14/12
Summarized by: Turner **Date:** 11/2/12
Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☒ Consequential ☐ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

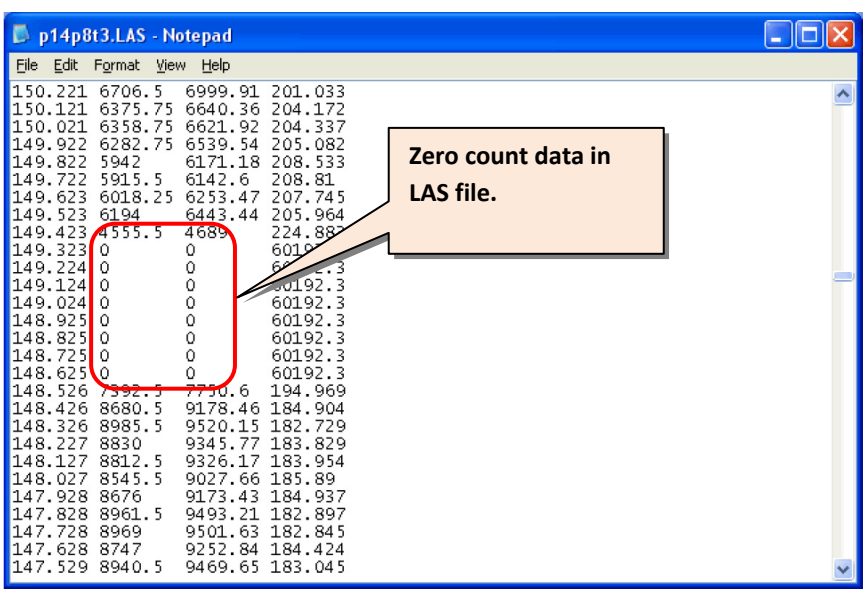
Irregularity Description

Two types of irregularities were identified for this group of files. Initially, this group of files was flagged for a chronology irregularity. Upon further inspection, an irregularity in the engineer's Excel file was found.

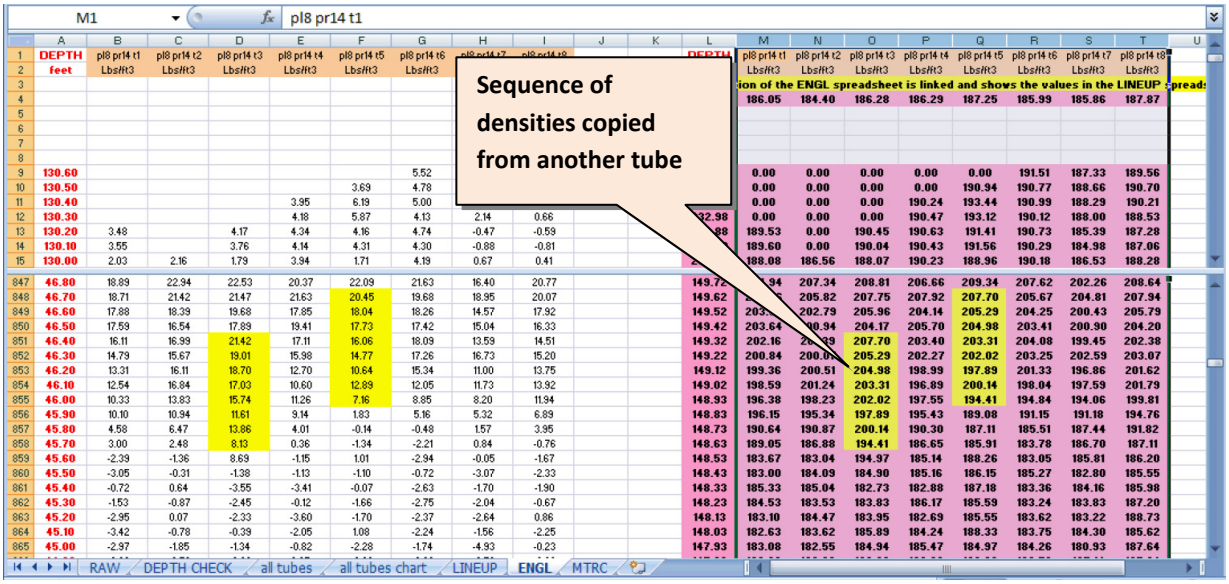
The GGL tests performed on Tubes 3, 4, 5, 6, and 7 of Pier 14 Pile 8 were flagged by the chronology analysis. Each of these tests was approximately 1 to 3 minutes shorter than the *estimated total test time* using the calculated data acquisition time and the following assumptions: 15 seconds to move the probe, 15 seconds to setup the software, and lowering the probe at 52 feet per minute. A summary is presented in the table below.

				(A)	(B)	(C)	(D)	(E)	(F = B+C+D+E)	(G = A-F)
Tube	**File Name**	**Date/Time**	**Total Depth(ft)**	**Time between File Saves (min)**	**Time to Move Probe (min)**	**Time to Lower Probe @ 52 fpm (min)**	**Time to Setup Software (min)**	**Data Acquisition Duration (min)**	**Estimated Total Time Needed (min)**	**Time Deficiency, or Balance of Time (min)**
1	p14p8t1.rd	08/07/2004 09:36:48	231.7241		0.25	4.46	0.25	11.78	16.74	
2	p14p8t2.rd	08/07/2004 09:53:18	229.2314	16.50	0.25	4.41	0.25	11.54	16.45	0.05
8	p14p8t8.rd	08/07/2004 10:12:42	229.9294	19.40	0.25	4.42	0.25	11.5	16.42	2.98
7	p14p8t7.rd	08/07/2004 10:28:26	230.1288	15.73	0.25	4.43	0.25	11.76	16.69	**-0.96**
6	p14p8t6.rd	08/07/2004 10:43:56	230.5276	15.50	0.25	4.43	0.25	11.89	16.82	**-1.32**
5	p14p8t5.rd	08/07/2004 10:59:22	230.2285	15.43	0.25	4.43	0.25	11.56	16.49	**-1.06**
4	p14p8t4.rd	08/07/2004 11:13:36	229.4308	14.23	0.25	4.41	0.25	11.73	16.64	**-2.41**
3	p14p8t3.rd	08/07/2004 11:26:52	230.1288	13.27	0.25	4.43	0.25	11.41	16.34	**-3.07**

During the examination of the data files associated with this ID, the team discovered that the LAS data file for Tube 3 contained a sequence of 8 consecutive zero count measurements. (Zero count recordings are unusual and the team has not determined the source of zero count measurements.) The data, as appears in the LAS file, is shown in this screenshot:



The zero count data in the LAS file, however, were not found in the data plots used for the GGL Report. An examination of the Excel spreadsheet used to generate the plots in the GGL Report revealed that data from Tube 5 had been copied to replace the cells with the zero count data in Tube 3. The resulting densities were carried over to the Origin plots and presented in the GGL Report.



Discussion of Findings

Discussion of the Chronology Irregularity

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) ranges from 1 to 3 minutes for the flagged tubes given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

Discussion of the Irregularity in the Excel File

It is certain that a sequence of 8 data points (over a length of 0.8 ft) was copied/pasted within the Excel file as a means of mitigating the zero count measurements. The copied data over this 0.8 ft interval was reported in the plots in the GGL Report.

Overall Conclusion

Based on the chronology irregularity alone, the conclusion for this group of files would have been that the existence of the irregularity is certain and the impact is likely inconsequential. However, due to the discovery of the irregularity in the Excel file, the conclusion is that the existence of a copy/paste irregularity is certain.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 77

Name: RD Chronology at Br. 28-0153, Pier 15, Pile 6

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 8/3/12

Summarized by: Wahleithner **Date:** 8/3/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒Undetermined	

Irregularity Description

The GGL test performed on Tube 3 of Pile 6 at Pier 15 on 9/16/2004 was flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 3 is 11.73 minutes and is less than the *estimated total test time* which was calculated to be 16.32 minutes.

The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Pier 15, Pile 6

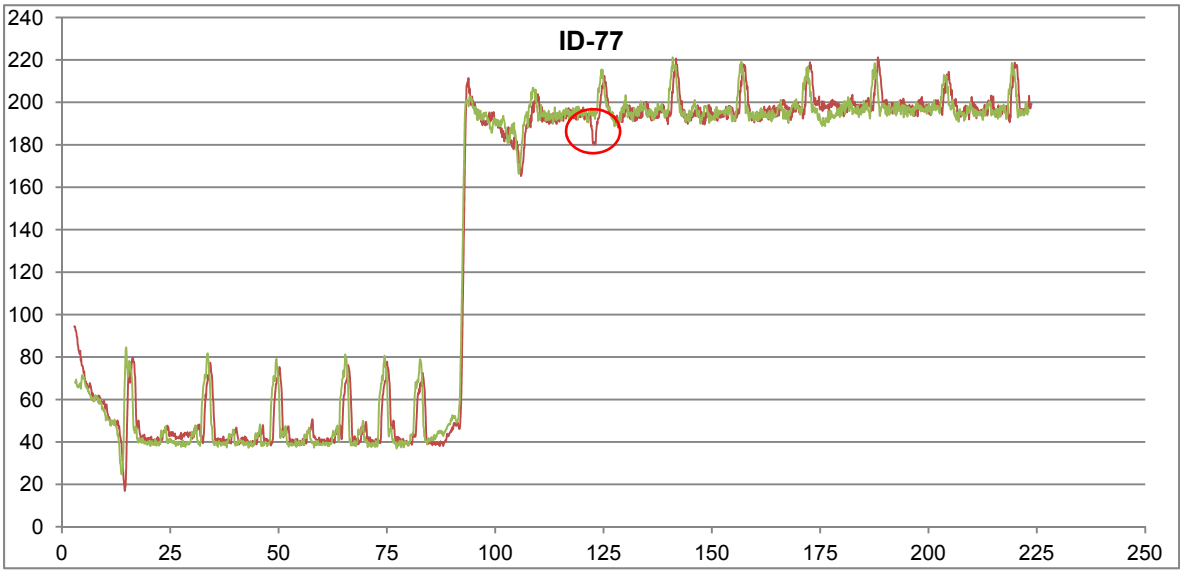
Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5502	P15P6T1.rd	12.22	221.06	10:05:56	0.00	16.97
5503	P15P6T2.rd	11.19	220.96	10:22:18	16.37	15.94
5504	P15P6T3.rd	**11.59**	220.06	10:34:02	**11.73**	16.32
5505	P15P6T4.rd	11.56	220.66	10:51:04	17.03	16.30
5506	P15P6T5.rd	11.93	221.06	11:32:12	41.13	16.68
5507	P15P6T6.rd	12.07	220.56	11:59:14	27.03	16.81
5508	P15P6T7.rd	5.94	126.13	12:06:06	**6.87****	8.87
5509	P15P6T8.rd	11.22	220.46	12:29:40	23.57	15.96

** Tube partially blocked and tested again on different date.

Discussion of Findings

One possible explanation for the irregular chronology associated with Tube 3 of Pile 6 is that Tube 3 is a rerun of Tube 2. Raw data from the LAS file for Tube 3 was plotted against Tube 2 to determine if any qualitative observations could rule out that the Tube 3 data is a re-test of Tube 2. The Plotted data shows one distinct difference between the two sets of data (Figure 1).

Figure 1: Pier 15 Pile 6 Raw Data Plot For Tube 2 and Tube 3



The irregular chronology associated with Tube 3 of Pile 6 represents an extreme case flagged by the RD-LAS chronology tool. If normal testing practices are assumed, then the 11 minutes and 44 seconds to accomplish GGL testing in Tube 3 is inadequate and requires explanation. As shown in Figure 1 and Table 1A below, after subtracting out both the estimated time to lower the probe to the bottom of Tube 3, and the actual time to collect data in Tube 3, there is a negative 4 minutes left to relocate the probe from Tube 2 to Tube 3 and perform any necessary file setup prior to logging. Table 1B shows that even when non-standard probe lowering such as 'free-wheeling' is considered, there remains negative time left to relocate the probe from Tube 2 to Tube 3 and perform any necessary file setup. These results indicate there is not enough time associated with the Tube 3 test for a standard test sequence to have occurred.

One possible explanation is that the technician re-tested Tube 2 and identified the re-test data as Tube 3 before moving on to Tube 4. This scenario is shown in Figure 2. However, as shown in Table 2A, after subtracting out both the estimated time to lower the probe to the bottom of Tube 2, the actual time to collect data in Tube 2, and the estimated time to again lower the probe back to the bottom of Tube 2, there is a negative 3.3 minutes left to account for the initial relocation of the probe from Tube 1 to Tube 2. This would rule out the re-test scenario if standard probe lowering methods are assumed. The retest scenario is possible if a non-standard probe lowering method was used such as 'free-wheeling', as shown in Table 2B.

Another possible explanation that does not include a re-test scenario is shown in Figure 3. This involves a non-standard testing sequence where the data file from an inspection tube is not saved until the probe is lowered to the bottom of the next inspection tube. This is physically possible if data is collected in the 'depth up' mode and the probe is relocated from one tube to another without requiring excess cable to be reeled in during the relocation. As shown in Table 3, the apparent lack of time to test Tube 3 can be explained by a scenario where the Tube 2 data was saved after the probe was lowered to the bottom of Tube 3 and then the Tube 3 data was saved immediately following the logging run in Tube 3.

Figure 1: Standard Test Sequence

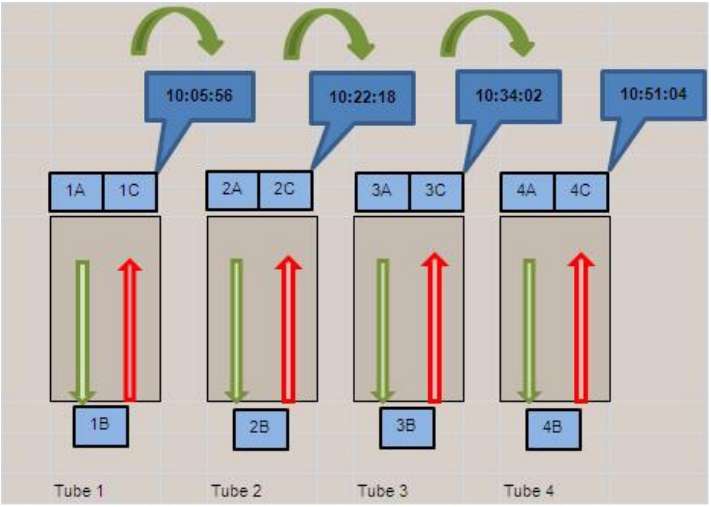


Table 1A: Typical Test Sequence with Standard Probe Lowering

Probe Position:	1C	2A	2B	2C	3A	3B	3C	4A	4B	4C
File Time Stamp:	10:05:56 AM			10:22:18 AM			10:34:02 AM			10:51:04 AM
Elapsed Time (min.):		0:16:22			0:11:44			0:17:02		
Est. Probe Lowering Time (min.):			4.23			4.23			4.23	
Data Acquisition Time (min.):				11.19			11.59			11.56
Remaining Time For Probe Move and Setup (min.):		1.0			-4.1			1.2		

Table 1B: Typical Test Sequence with Non-standard Probe Lowering (Free-wheel):

Probe Position:	1C	2A	2B	2C	3A	3B	3C	4A	4B	4C
File Time Stamp:	10:05:56 AM			10:22:18 AM			10:34:02 AM			10:51:04 AM
Elapsed Time (min.):		0:16:22			0:11:44			0:17:02		
Est. Probe Lowering Time (min.):			0.40			0.40			0.40	
Data Acquisition Time (min.):				11.19			11.59			11.56
Remaining Time For Probe Move and Setup (min.):		4.8			-0.3			5.1		

Figure 2: Re-Test Sequence

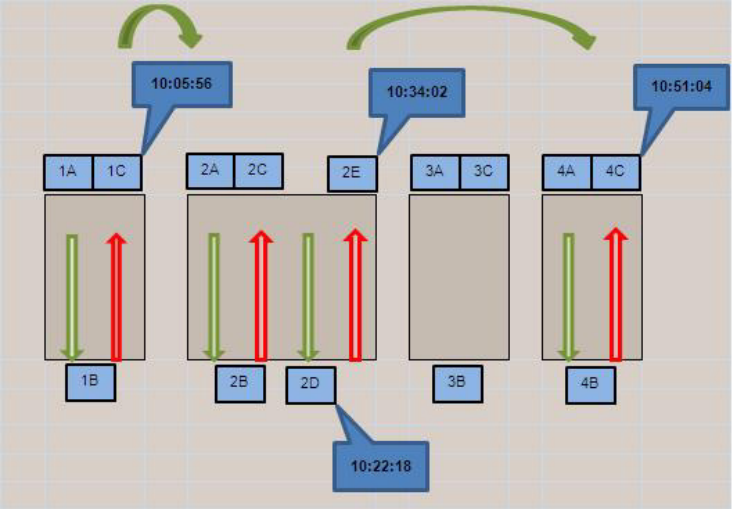


Table 2A: Re-test Sequence with Typical Probe Lowering

Probe Position:	1C	2A	2B	2C	2D	2E	3A	3B	3C	4A	4B	4C
File Time Stamp:	10:05:56 AM				10:22:18 AM	10:34:02 AM						10:51:04 AM
Elapsed Time (min.):		0:16:22				0:11:44				0:17:02		
Est. Probe Lowering Time (min.):			4.23		4.23	0.00					4.23	
Data Acquisition Time (min.):				11.19		11.59						11.56
Remaining Time For Probe Move and Setup (min.):		-3.3				0.15				1.2		

Table 2B: Re-test Sequence with Atypical Probe Lowering (Free-wheel):

Probe Position:	1C	2A	2B	2C	2D	2E	3A	3B	3C	4A	4B	4C
File Time Stamp:	10:05:56 AM				10:22:18 AM	10:34:02 AM						10:51:04 AM
Elapsed Time (min.):		0:16:22				0:11:44				0:17:02		
Est. Probe Lowering Time (min.):			0.40		0.40	0.00					0.40	
Data Acquisition Time (min.):				11.19		11.59						11.56
Remaining Time For Probe Move and Setup (min.):		4.4				0.15				5.1		

Figure 3: Atypical Sequence (Saving File With Probe at Bottom of Next Tube)

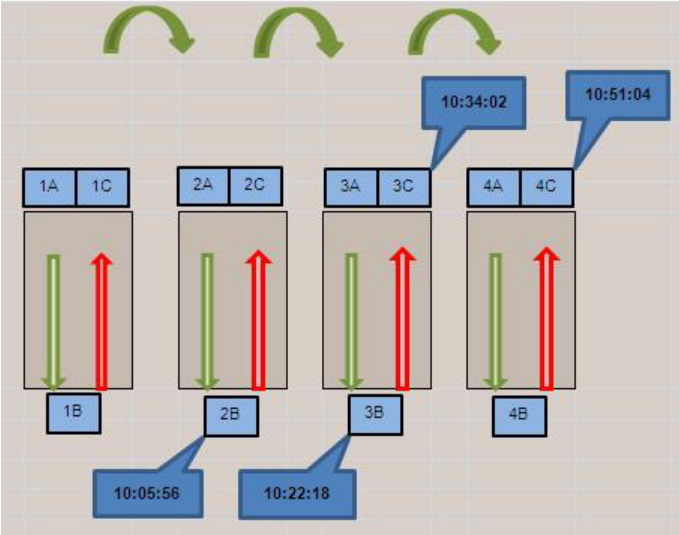


Table 3: Atypical Sequence (Saving File With Probe at Bottom of Next Tube)

Probe Position:	2B	2C	3A	3B	3C	4A	4B	4C
File Time Stamp:	10:05:56 AM			10:22:18 AM	10:34:02 AM			10:51:04 AM
Elapsed Time (min.):		0:16:22			0:11:44	0:17:02		
		16.4			11.7	17.0		
Est. Probe Lowering Time (min.):				4.23	0.00		4.23	
Data Acquisition Time (min.):		11.19			11.59			11.56
Remaining Time For Probe Move and Setup (min.):			0.6		0.15	1.2		

A correlation analysis using the *Empirical Sigma-Delta Analysis Method* appears to support the assertion that there were no rerun tests in Pile 6. Note, however, that correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

Summary of Empirical Sigma-Delta Analysis

Manual Analysis ID: 77

Name: RD Chronology at Br. 28-0153, Pier 15, Pile 6

Analyzed by: L. Turner **Date:** 10/24/12

Calculation of Sigma-Delta

Sigma-Delta values were calculated for all tube-pair combinations for Pile 6, excluding Tube 7. The calculated sigma-delta results were then evaluated using the Empirical Sigma-Delta Method. Results are summarized in the table below.

	T1	T2	T3	T4	T5	T6	T7	T8
T1		2.43	2.01	2.61	2.85	2.23		1.56
T2			**2.32**	2.41	2.42	2.60		2.64
T3				2.54	2.92	2.49		2.12
T4					2.12	2.80		2.55
T5						2.47		2.76
T6								2.27
T7								
T8								

Is Tube 3 a Rerun of Tube 2?

The chronology analysis suggests that one possible explanation for the irregular test time for Pile 6 Tube 3 is that Tube 3 is a rerun of Tube 2. The sigma-delta value for this tube-pair combination was calculated to be 2.32. When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, the calculated sigma-delta value falls in a range where only independent tests were observed. Based on this observation, the correlation analysis suggests that this is not a rerun test.

Limitations

Correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 78

Name: RD Chronology at Br. 34-0006, SFOBB, T1 Pile 2 (Re-test)

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/24/12

Summarized by: Wahleithner **Date:** 8/7/12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 6 of Pile 2 (11/8/2006) was flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 6 is significantly lower at 15.4 minutes. The *estimated total test time* is calculated as the sum of the following: assumed durations of 15 seconds each for moving from tube to tube, and setting up the computer file, the time to lower the probe to the bottom of the inspection tube assuming a lowering rate of 52 feet per minute, and the actual data acquisition time derived from the data file. The *estimated total test time* needed to test Tube 6 was calculated to be 16.52 minutes and exceeds the *time between file saves* of 15.40 minutes as shown below in Table 1.

Table 1: SFOBB Tower 1 Pile 2 GGL Test Chronology (11/8/2006)

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
7245	T1.rd	11.7	212.58	12:43:58	0.00	16.29
7246	T2.rd	11.49	213.68	13:05:11	21.22	16.10
7247	T3.rd	12.53	213.78	13:29:19	24.13	17.14
7248	T4.rd	12.64	214.87	13:55:07	25.80	17.27
7249	T5.rd	11.65	213.78	14:16:39	21.53	16.26
7250	T6.rd	11.9	214.08	14:32:03	15.40	16.52

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is ~1.1 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis. Furthermore, conversations with the FTB engineer who moved the probe from tube to tube, confirms that retesting of tubes did not occur.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 79

Name: 28-0153, Pier 8-Pile 1

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/6/12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 4 of Pier 8 Pile 1 was flagged by the Time Stamp chronology analysis. The *time between file saves* for Tube 4 is approximately 3.5 minutes less than any other test within Pile 1. The Tube 4 test is also approximately 2 minutes shorter than the *estimated total test time* using the actual data collection time and the following assumptions: 15 seconds to move from Tube 3 to Tube 4, 15 seconds to setup the computer, and lowering the probe to the bottom of Tube 4 at 52 feet per minute.

Table 1: Br. 28-0153: Pier 8-Pile 1

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
7284	P8P1T1.rd	15.81	287.56	11:42:58	0.00	21.84
7285	P8P1T2.rd	15.42	289.16	12:14:36	31.63	21.48
7286	P8P1T3.rd	16.11	291.65	12:40:21	25.75	22.22
7287	P8P1T4.rd	16.52	291.95	13:01:02	**20.68**	22.63
7288	P8P1T5.rd	15	256.25	13:29:29	28.45	20.43
7289	P8P1T6.rd	15.65	289.36	14:01:54	32.42	21.71
7290	P8P1T7.rd	15.19	286.36	14:26:02	24.13	21.20
7291	P8P1T8.rd	15.55	288.66	15:07:55	41.88	21.60

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 2 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 80

Name: RD Chronology at 23-0212, Bent 18-Pile 5

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/7//12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☒ Plausible
	☐ Undetermined	
Cause of Irregularity	☒ Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tubes 2 through 5 of Bent 18 Pile 5 were flagged by the Time Stamp chronology analysis. The *time between file saves* for these 4 tubes is approximately 2 minutes less than tubes tested on the adjacent Pile 2 tested the same day (12/5/03). The tests are also approximately 1 minute shorter than the *estimated total test time* using the actual data acquisition time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and lowering the probe at 52 feet per minute.

Table 1: Br. 23-0212: Bent 18-Pile 5

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
845	B18P5T1.rd	11.25	177.482339	12:28:30		15.16
846	B18P5T2.rd	11.23	177.482344	12:42:42	**14.20**	15.14
847	B18P5T3.rd	11.22	174.29165	12:57:08	**14.43**	15.07
848	B18P5T4.rd	12.1	176.485244	13:11:46	**14.63**	15.99
849	B18P5T5.rd	11.36	176.884084	13:25:40	**13.90**	15.26

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 0.6 to 1.4 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 81

Name: RD Chronology at 57-1134R, Middle Pile at Pier 3

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/7//12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed at Tube 6 was flagged by the Time Stamp chronology analysis. The *time between file saves* for the tube is less than 15 seconds shorter than the *estimated total test time* using the actual data collection time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and lowering the probe to the bottom of tube 4 at 52 feet per minute.

Table 1: Br. 57-1134R: Middle Pile at Pier 3

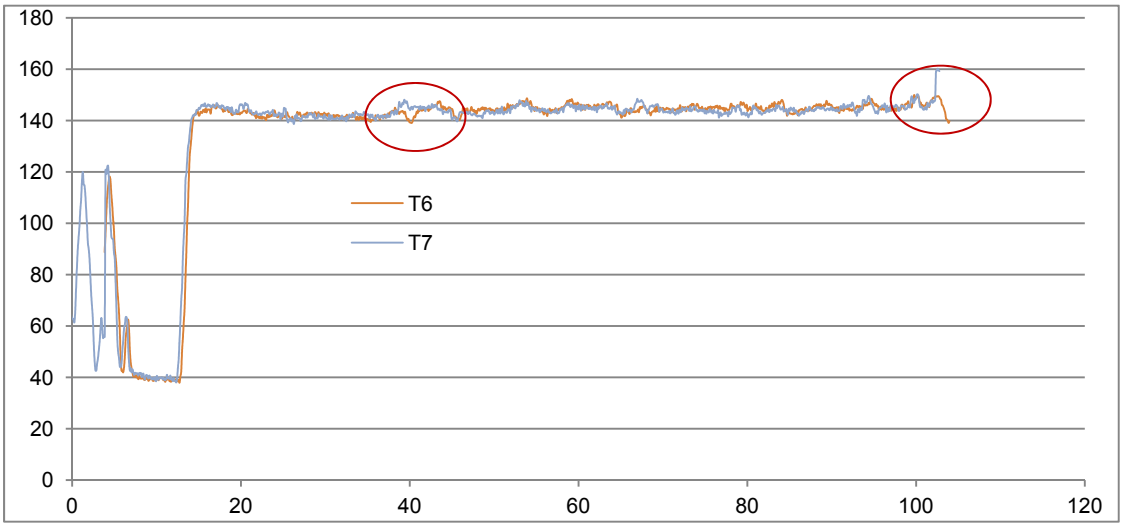
Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
6927	T1.rd	6.63	98.71	8:37:34	0.00	9.03
6931	T5.rd	7.07	100.11	9:16:43	39.15	9.50
6934	T8.rd	6.69	100.11	9:32:38	15.92	9.12
6933	T7.rd	6.62	102.90	10:26:44	54.10	9.10
6932	T6.rd	6.66	100.11	10:35:34	8.83	9.09
6929	T3.rd	6.66	99.81	10:50:36	15.03	9.08
6928	T2.rd	6.72	99.01	10:59:49	9.22	9.12
6930	T4.rd	6.85	99.51	11:11:54	12.08	9.26

Discussion of Findings

One possible explanation is that the probe was never moved from Tube 7 to Tube 6, and Tube 6 is a rerun of Tube 7. Another possible explanation is that the assumptions are incorrect. For example, the time required to lower the probe is estimated incorrectly or the technician disengaged the cable spool from the winch while lowering the probe thereby lowering at a rate faster than 52 feet per minute.

The raw data for the Middle Pile at Pier 3 was plotted to determine if there were any obvious distinctions between Tube 6 and Tubes 7 raw data.

Figure 1: Br. 57-1134R: Middle Pile at Pier 3



As shown above in Figure 1, there are distinctions between the plotted data for Tubes 6 through 7. Based on a comparison of the raw data and the fact that the file was flagged for a discrepancy of less than 15 seconds between the *actual and estimated test time,* it is not likely Tube 6 is a rerun of Tube 7.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 82

Name: RD Chronology at 23-0212, Bent 18-Pile 4

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/7/12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tubes 2 through 5 of Bent 18 Pile 4 were flagged by the Time Stamp chronology analysis. The *time between file saves* for these 4 tubes is approximately 2 minutes less than tubes tested on the adjacent Pile 6 tested the same day (11/26/03). The tests are also approximately 1 minute shorter than the *estimated total test time* using the actual data acquisition time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and lowering the probe at 52 feet per minute.

Table 1: Br. 23-0212: Bent 18-Pile 4

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
850	B18P4T1.rd	11.74	179.78	11:30:48		15.70
851	B18P4T2.rd	11.28	178.98	11:44:53	14.08	15.22
852	B18P4T3.rd	11.32	178.58	11:58:36	13.72	15.25
853	B18P4T4.rd	11.34	179.78	12:12:26	13.83	15.30
854	B18P4T5.rd	11.35	178.98	12:26:16	13.83	15.29

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 1.1 to 1.5 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

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GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 83

Name: RD Chronology at 28-0153, Pier 14, Pile 6

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☐ Certain ☐ Likely ☒ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

The GGL tests performed on Tubes 2 through 8 of Pier 14 Pile 6 were flagged by the Time Stamp chronology analysis. In these cases the *time between file saves* for several of these tubes is less than the *estimated total test time* which is calculated using the actual data collection time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and probe lowering rate of 52 feet per minute.

The chronology at Pile 6 is shown below in Table 1.

Table 1: Br. 28-0153: Bent 14, Pile 6

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5486	P14P6T1.rd	10.98	230.63	11:18:50	0.00	15.92
5487	P14P6T2.rd	12.08	232.02	11:35:42	**16.87**	17.04
5488	P14P6T3.rd	11.29	231.62	11:51:34	**15.87**	16.24
5489	P14P6T4.rd	11.13	231.82	12:07:10	**15.60**	16.09
5490	P14P6T5.rd	11.01	230.83	12:28:08	20.97	15.95
5491	P14P6T6.rd	10.98	231.33	12:42:28	**14.33**	15.93
5492	P14P6T7.rd	10.76	230.33	12:56:30	**14.03**	15.69
5493	P14P6T8.rd	10.97	228.03	13:08:16	**11.77**	15.86

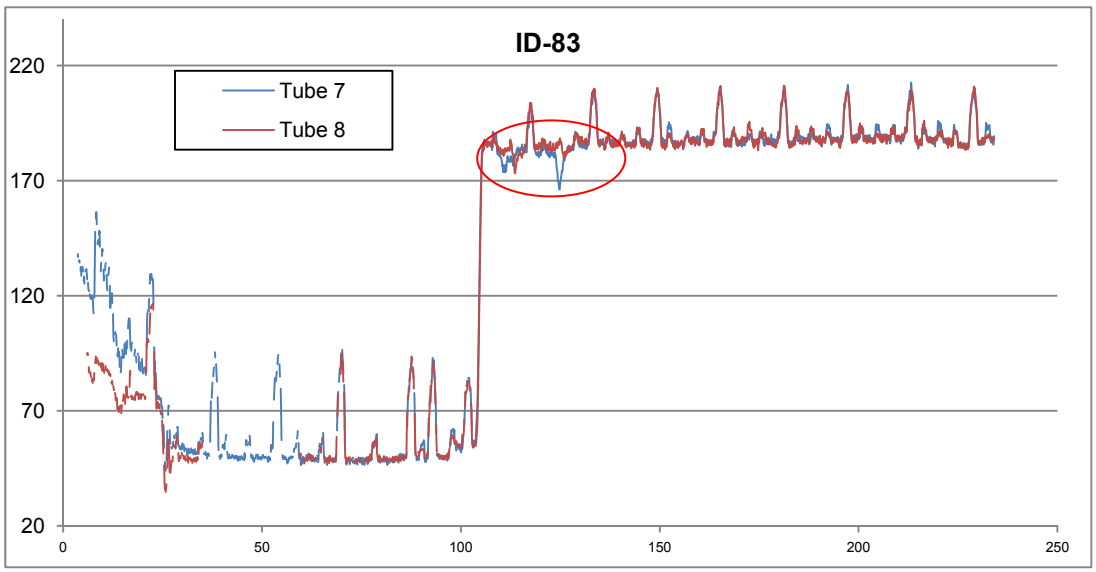
For Tubes 2, 3, and 4 the difference between the *time between file saves* and the *estimated total test time* is less than 30 seconds and determined not irregular since there is only a minor time discrepancy.

For Tubes 6, 7, and 8 the time discrepancy is on the order of 1 to 2 minutes with Tube 8 having a discrepancy of more than 4 minutes.

Discussion of Findings

The chronological discrepancy for GGL tests at Tube 6 and 7 are on the order of 1 to One possible explanation for the irregular chronology associated with Tube 8 is that Tube 8 is a rerun of Tube 7. Figure 1 below contains plotted data for both Tube 7 and 8 for the purpose of comparing data.

Figure 1: Br. 28-0153: Pier 14-Pile 6 Tube 7 and 8



There is an observable difference near the top of concrete but no conclusions about whether the data originates from the same inspection tube can be made based on the plotted data. Further analysis of the data by cross-correlation is needed.

The irregular chronology associated with Tube 8 represents an extreme case flagged by the RD-LAS chronology tool. If normal testing practices are assumed, then the 11 minutes and 46 seconds to accomplish GGL testing in Tube 8 is inadequate and requires explanation.

As shown in Figure 1 and Table 1A below, after subtracting out both the estimated time to lower the probe to the bottom of Tube 8, and the actual time to collect data in Tube 8, there is a negative 4.2 minutes left to relocate the probe from Tube 7 to Tube 8 and perform any necessary file setup prior to logging. Table 1B shows that even when non-standard probe lowering such as 'free-wheeling' is considered, there remains negative time left to relocate the probe from Tube 7 to Tube 8 and perform any necessary file setup. These results indicate there is not enough time associated with the Tube 8 test for a standard test sequence to have occurred.

Figure 1: Standard Test Sequence

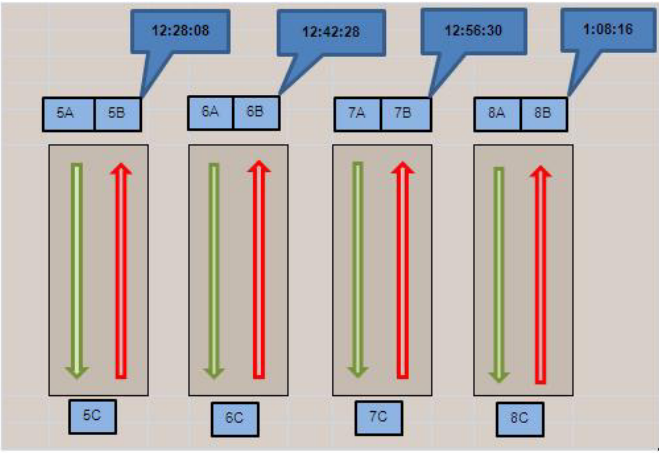


Table 1A: Standard Test Sequence with Standard Probe Lowering

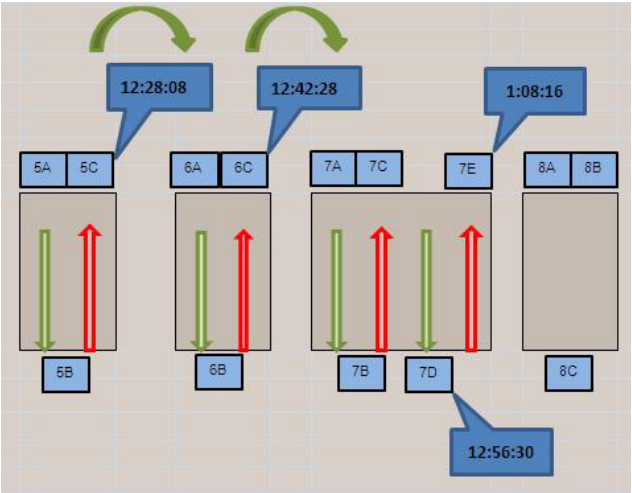
Probe Position:	5C	6A	6B	6C	7A	7B	7C	8A	8B	8C
File Time Stamp:	12:28:08			12:42:28			12:56:30			13:08:16
Elapsed Time (min.):		0:14:20			0:14:02			0:11:46		
Est. Probe Lowering Time (min.):			4.42			4.42			4.42	
Data Acquisition Time (min.):				11.19			11.59			11.56
Remaining Time For Probe Move and Setup (min.):		-1.3			-2.0			-4.2		

Table 1B: Standard Test Sequence with Non-standard Probe Lowering (Free-wheel):

Probe Position:	5C	6A	6B	6C	7A	7B	7C	8A	8B	8C
File Time Stamp:	12:28:08			12:42:28			12:56:30			13:08:16
Elapsed Time (min.):		0:14:20			0:14:02			0:11:46		
Est. Probe Lowering Time (min.):			0.42			0.42			0.42	
Data Acquisition Time (min.):				11.19			11.59			11.56
Remaining Time For Probe Move and Setup (min.):		2.7			2.0			-0.2		

One possible explanation is that the technician re-tested Tube 7 and identified the re-test data as Tube 8. This scenario is shown in Figure 2.

Figure 2: Re-Test Sequence



However, as shown in Table 2A, after subtracting out both the estimated time to lower the probe to the bottom of Tube 7, the actual time to collect data in Tube 7, and the estimated time to again lower the probe back to the bottom of Tube 7, there is a negative 5.6 minutes left to account for the initial relocation of the probe from Tube 6 to Tube 7. This would rule out the re-test scenario if standard probe lowering methods are assumed.

Table 2A: Re-test Sequence with Typical Probe Lowering

Probe Position:	5C	6A	6B	6C	7A	7B	7C	7D	7E	8A	8B	8C
File Time Stamp:	12:28:08			12:42:28				12:56:30	13:08:16			
Elapsed Time (min.):		0:14:20			0:14:02				0:11:46			
Est. Probe Lowering Time (min.):			4.42			4.42		4.42	0.00			
Data Acquisition Time (min.):				10.98			10.76		10.97			
Remaining Time For Probe Move and Setup (min.):		-1.1			-5.6				0.80			

The retest scenario is possible if a non-standard probe lowering method was used such as ‘free-wheeling’, as shown in Table 2B.

Table 2B: Re-test Sequence with Non-standard Probe Lowering (Free-wheel):

Probe Position:	5C	6A	6B	6C	7A	7B	7C	7D	7E	8A	8B	8C
File Time Stamp:	12:28:08			12:42:28				12:56:30	13:08:16			
Elapsed Time (min.):		0:14:20			0:14:02				0:11:46			
Est. Probe Lowering Time (min.):			0.42			0.42		0.42	0.00			
Data Acquisition Time (min.):				10.98			10.76		10.97			
Remaining Time For Probe Move and Setup (min.):		**2.9**			**2.4**				**0.80**			

Another possible explanation that does not include a re-test scenario is shown in Figure 3. This involves a non-standard testing sequence where the data file from an inspection tube is not saved until the probe is lowered to the bottom of the next inspection tube. This is physically possible if data is collected in the 'depth up' mode and the probe is relocated from one tube to another without requiring excess cable to be reeled in during the relocation. As shown in Table 3, the apparent lack of time to test Tube 8 can be explained by a scenario where the Tube 7 data was saved after the probe was lowered to the bottom of Tube 8 and then the Tube 8 data was saved immediately following the logging run in Tube 8. This scenario only works under the assumption that the probe was lowered to the bottom of Tube 7 via 'free-wheeling'.

Figure 3: Non-standard Sequence (Saving File With Probe at Bottom of Next Tube)

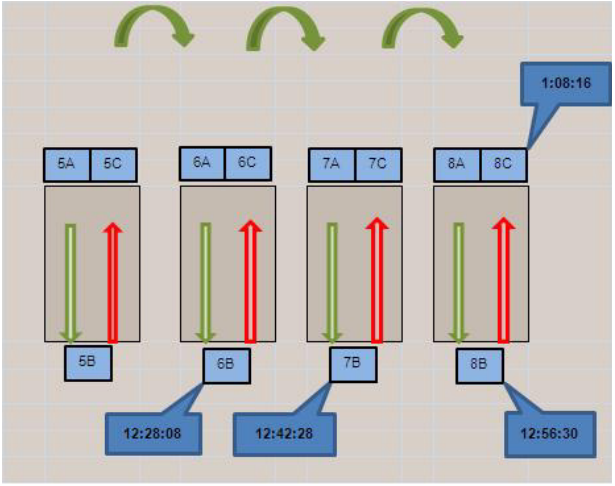


Table 3: Non-standard Sequence (Saving File With Probe at Bottom of Next Tube) with Non-standard Probe Lowering (Free-wheel):

Probe Position:	6B	6C	7A	7B	7C	8A	8B	8C
File Time Stamp:	12:28:08			12:42:28			12:56:30	13:08:16
Elapsed Time (min.):		0:14:20			0:14:02			0:11:46
Est. Probe Lowering Time (min.):				0.42			0.42	0.00
Data Acquisition Time (min.):		10.98			10.76			10.97
Remaining Time For Probe Move and Setup (min.):			**3.2**			**2.6**		**0.78**

Conclusions from considering the above scenarios include:

- The chronological discrepancy between Tube 7 and 8 'File Save Times' cannot be explained if standard test sequences were used.
- The chronological discrepancy between Tube 7 and 8 'File Save Times' can only be explained if Non-standard probe lowering practices ('free-wheeling" the probe) combined with a non-standard test sequence were used. Non-standard test sequences would include either re-testing the same tube twice or saving data files after relocating the probe to the next tube location.
- The only scenario that includes intentional action resulting in consequential impacts is the re-test scenario. However, based on the observable difference in the Tube 7 and 8 plots, and the likelihood that a non-standard test sequence combined with non-standard probe lowering explains the chronology discrepancy, the irregularity is determined to be likely inconsequential and the result of inadvertent actions.

Summary of Empirical Sigma-Delta Analysis

Manual Analysis ID: 83

Name: RD Chronology at 28-0153, Pier 14, Pile 6

Analyzed by: L. Turner **Date:** 10/24/12

Calculation of Sigma-Delta

Sigma-Delta values were calculated for all tube-pair combinations for Pile 6. The calculated sigma-delta results were then evaluated using the Empirical Sigma-Delta Method. Results are summarized in the table below.

	T1	T2	T3	T4	T5	T6	T7	T8
T1		1.65	2.10	2.02	1.41	1.35	2.39	1.25
T2			2.07	2.12	1.80	2.04	2.90	1.91
T3				2.09	2.32	2.41	3.36	2.40
T4					2.08	2.23	2.89	2.18
T5						**1.19**	**2.29**	**1.48**
T6							2.13	1.32
T7								2.19
T8								

Are Tubes 6, 7, and 8 a rerun of Tube 5?

The chronology analysis suggests that one possible explanation for the irregular chronology associated with Tubes 6, 7, and 8 is that all three tubes are a rerun of Tube 5. The sigma-delta value for these tube-pair combinations were calculated to be between 1.19 and 2.29. When compared against the distribution of sigma-delta values derived from a reference data set of known rerun and independent tests, two of the three calculated sigma-delta values fall in a range where only independent tests were observed, and the remaining one falls in a range where a mixture of rerun and independent tests were observed.

The retest scenario of the three tubes being reruns of Tube 5 does not appear to be likely, since two-thirds of the sigma-delta values fall in a range where only independent tests were observed.

Limitations

Correlation methods are considered prototype, as significant uncertainty remains in confidently applying and interpreting results. Results are presented here as additional information.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 84

Name: RD Chronology at 28-0153, Pier 14, Pile 4

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/8/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 1 of Pile 4 was flagged by the Time Stamp chronology analysis. The elapsed time between saving the test file at Tube 1, and the test file for the preceding test, is 13.10 minutes, as shown below in Table 1. This elapsed time was interpreted by the GamDat program to represent the *time between file saves* for Tube 1. In normal test cases this is true however at Pile 4 the test preceding the Tube 1 test file is an empty file. This empty file indicates the probe was at the bottom of Tube 1 when this empty file, which precedes T1, was saved. Therefore the *time between file saves* for Tube 1 does not include the time to move the probe from Tube 8 to Tube 1 and does not include the time to lower the probe to the bottom of Tube 1. This explanation explains the fact that the *actual test time*, 13.1 minutes, for Tube 1 is slightly greater than the *Data Acquisition Time,* 12.19 minutes. Because the probe was already in position for logging, the Tube 1 *time between file saves* represents the time to raise and record the data in Tube 1.

Table 1: Br. 28-0153: Bent 14, Pile 4

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5478	P14P4T8.rd	12.4	230.33	8:42:20	0.00	17.33
5470	P14P4T.rd	0	0.00	8:50:22	8.03	0.50
5471	P14P4T1.rd	12.19	230.43	9:03:28	13.10	17.12
5472	P14P4T2.rd	12.04	229.43	9:23:08	19.67	16.95
5473	P14P4T3.rd	11.67	230.53	9:44:00	20.87	16.60
5474	P14P4T4.rd	11.75	230.53	10:02:44	18.73	16.68
5475	P14P4T5.rd	11.58	230.63	10:22:04	19.33	16.52
5476	P14P4T6.rd	11.52	230.73	10:40:56	18.87	16.46
5477	P14P4T7.rd	11.35	230.33	10:59:34	18.63	16.28

Discussion of Findings
The significance of ID-84 is that it demonstrates the chronology tool is effective in finding cases where the *time between file saves* is insufficient to account for moving the tube from one location to the next and lowering the probe to the bottom of the tube. In the case of ID-84, these findings do not indicate a re-run since the file preceding the Tube 1 file is an empty file. The time to move from Tube 8 to Tube 1 and lower the probe to the bottom of Tube 1 is included in the empty file's *actual test time.* These findings support the possible explanation of reruns at ID-77 and ID-83.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **85**

Name: **RD Chronology at 28-0153, Pier 12, Pile 1**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/8/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 6 of Pier 12 Pile 1 was flagged by the Time Stamp chronology analysis. The *time between file saves* for Tube 6 is less than the *estimated total test time* which is calculated using the actual data acquisition time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and probe lowering rate of 52 feet per minute.

The chronology at Pile 1 is shown below in Table 1.

Table 1: Br. 28-0153: Bent 12, Pile 1

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5445	P12P1T1.rd	11.04	207.79	12:15:12	0.00	15.54
5446	P12P1T2.rd	11.41	208.09	12:35:04	19.87	15.91
5447	P12P1T3.rd	11.93	208.19	13:06:34	31.50	16.43
5448	P12P1T4.rd	13.66	208.69	13:33:38	27.07	18.17
5449	P12P1T5.rd	11.16	209.19	13:56:08	22.50	15.68
5450	P12P1T6.rd	11.36	207.79	14:10:18	14.17	15.86
5451	P12P1T7.rd	11.07	207.59	14:28:32	18.23	15.56
5452	P12P1T8.rd	12.46	207.99	14:46:04	17.53	16.96

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is ~1.7 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 86

Name: 28-0153, Pier 16, Pile 6

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

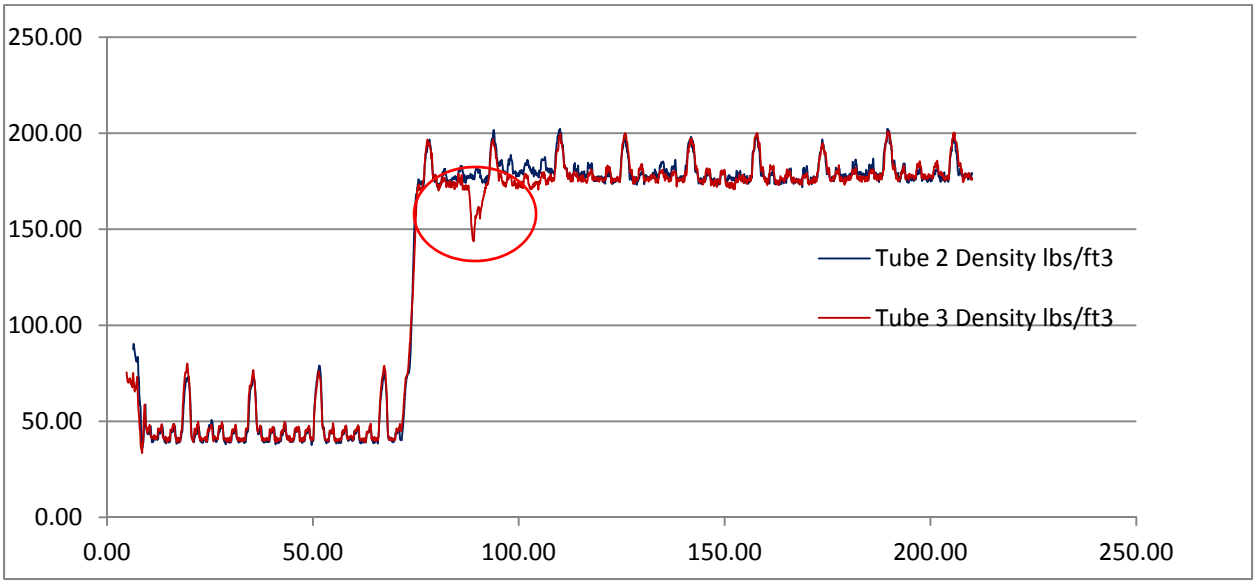
The GGL test performed on Tube 3 of Pile 6 on 12/8/2003 was flagged by the Time Stamp Chronology analysis. The time between file saves at Tube 3 is 14.93 minutes and is less than the estimated minimum test time which was calculated to be 16.27 minutes. The estimated minimum time required to test is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Pier 16, Pile 6

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
2731	p16p6t1.rd	12.94	206.60	11:02:50	0.00	17.41
2732	p16p6t2.rd	11.69	203.81	11:19:10	16.33	16.11
2733	p16p6t3.rd	11.82	205.40	11:34:06	**14.93**	16.27
2734	p16p6t4.rd	10.87	197.32	11:49:48	15.70	15.16
2735	p16p6t5.rd	11.45	204.50	12:05:45	15.95	15.88
2736	p16p6t6.rd	10.67	190.84	12:20:54	15.15	14.84
2737	p16p6t7.rd	13.37	204.60	12:40:02	19.13	17.80
2738	p16p6t8.rd	11.61	206.40	12:55:12	**15.17**	16.08

Discussion of Findings

One possible explanation for the irregular test time for Tube 3 is that Tube 3 is a rerun of Tube 2. Raw data from the LAS file for Tube 3 was plotted against Tube 2 to determine if any qualitative observations could rule out the possibility of a rerun in Tube 3. As shown below, there is a clear difference in the two plots and a rerun of Tube 2 can be ruled out.



GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 87

Name: RD Chronology at 28-0153, Pier 8, Pile 5

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 8/8/12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The many of the GGL tests performed at Pier 8 Pile 5 were flagged by the Time Stamp chronology analysis. In these cases the *time between file saves* is slightly less than the *estimated total test time* which is calculated using the actual data collection time and the following assumptions: 15 seconds to move from tube to tube, 15 seconds to setup the computer, and probe lowering rate of 52 feet per minute. The chronology at Pile 5 is shown below in Table 1.

Table 1: Br. 28-0153: Pier 8, Pile 5

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
2567	p8p5t1.rd	16.24	256.55	12:33:28	0.00	21.67
2568	p8p5t2.rd	13.81	256.15	12:52:32	19.07	19.24
2569	P8P5T3.rd	15.14	250.27	13:13:16	20.73	20.45
2570	P8P5T4.rd	13.49	254.96	13:31:42	18.43	18.89
2571	P8P5T5.rd	13.71	254.26	13:48:54	17.20	19.10
2572	P8P5T6.rd	13.96	256.15	14:06:50	17.93	19.39
2573	P8P5T7.rd	13.83	256.65	14:23:36	16.77	19.27
2574	P8P5T8.rd	13.53	253.76	14:40:46	17.17	18.91

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 0.2 to 2.5 minutes for the flagged tubes given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 88

Name: 34-0006, SFOBB, T1 Pile 5

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/24/12

Summarized by: Wahleithner **Date:** 7/24/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tube 3, 4, 5, and 6 of Pile 5 at Pier T1 on 1/17/2007 were flagged by the Time Stamp Chronology analysis. The *time between file saves* at these four tubes are less than the *estimated total test time* as shown below in Table 1. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Pier T1, Pile 5

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
7263	T1.rd	12.82	214.87	10:44:47	0.00	17.45
7264	T2.rd	12.64	216.07	11:02:39	17.87	17.30
7265	T3.rd	11.98	215.37	11:17:52	**15.22**	16.62
7266	T4.rd	12.24	215.07	11:32:15	**14.38**	16.88
7267	T5.rd	12.08	215.17	11:46:45	**14.50**	16.72
7268	T6.rd	11.98	214.67	12:01:58	**15.22**	16.61

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 1.4 to 2.5 minutes for the flagged tubes given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 89

Name: 34-0006, SFOBB, T1 Pile 3

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 8/2/12

Summarized by: Wahleithner **Date:** 8/2/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tube 2, 3, 4, and 5 of Pile 3 at Pier T1 on 1/12/2007 were flagged by the Time Stamp Chronology analysis. The *time between file saves* at these four tubes are less than the *estimated total test time* as shown below in Table 1. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Pier T1, Pile 3

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
7251	T1.rd	13.04	214.67	11:16:44		17.67
7256	T6.rd	12.48	215.37	11:36:39	19.92	17.12
7252	T2.rd	12.07	215.37	11:52:31	**15.87**	16.71
7253	T3.rd	12.74	215.47	12:07:07	**14.60**	17.38
7254	T4.rd	11.98	215.87	12:21:54	**14.78**	16.63
7255	T5.rd	12.16	215.57	12:36:57	**15.05**	16.81

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is 0.8 to 2.5 minutes for the flagged tubes given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **90**

Name: **28-0153, Pier 11, Pile 8**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL tests performed on Tube 6, 7, and 8 of Pile 8 at Pier 11 on 10/16/2004 were flagged by the Time Stamp Chronology analysis. The *time between file saves* at these three tubes are less than the *estimated total test time* as shown below in Table 1. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 30 seconds each for moving to the tube and setting up the computer file.

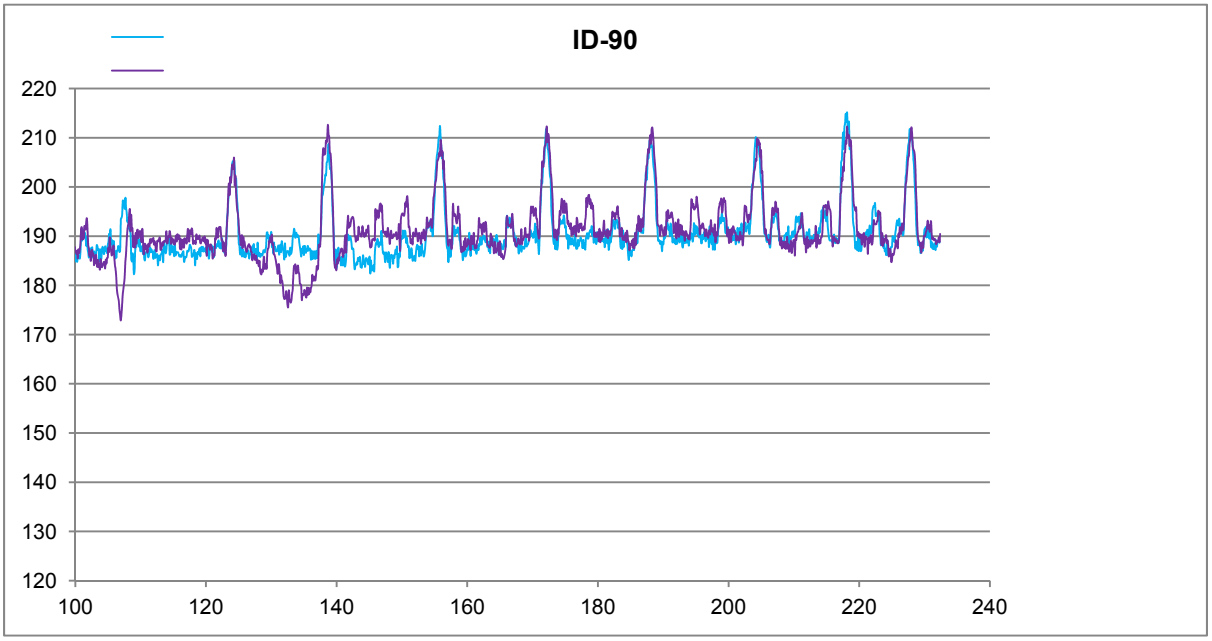
Table 1: Test Chronology at Pier 11, Pile 8

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5060	P11P8T1.rd	12.01	229.63	11:45:32	0.00	16.93
5061	P11P8T2.rd	11.55	230.43	12:05:46	20.23	16.48
5062	P11P8T3.rd	12.09	229.73	12:24:36	18.83	17.01
5063	P11P8T4.rd	11.52	230.13	12:42:22	17.77	16.45
5064	P11P8T5.rd	12.23	230.33	13:05:02	22.67	17.16
5065	P11P8T6.rd	11.28	230.33	13:21:12	**16.17**	16.21
5066	P11P8T7.rd	10.98	230.43	13:36:42	**15.50**	15.91
5067	P11P8T8.rd	11.15	230.33	13:52:28	**15.77**	16.08

Discussion of Findings

One possible explanation for the irregular test time for Tubes 6, 7, and 8 is that these tests are reruns of Tube 5. Raw data from the LAS files were plotted against Tube 5 to determine if any qualitative observations could rule out the possibility of a rerun in Tube 5. As shown below, there is a distinct difference in the plotted data for Tube 5 and 8, and a rerun of Tube 5 can be ruled out based on observing the plotted data.

Figure 1: Pier 11, Pile 8 Raw Data Plot For Tube 5 and 8



The differences between the *time between file saves* at these three tubes and the *estimated total test time* are on the order of 25 seconds or less. This slight difference can be explained in the uncertainty of estimating the time to move from tube to tube, the time to setup the computer file, and the time to lower the probe to the bottom of the tube. The fact that the plotted data from Tube 8 is distinctly different supports a conclusion that the minor chronological discrepancies are the result of the uncertainties in estimating the minimum test time.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **91**

Name: **28-0153, Pier 10, Piles 3 and 6**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 7 of Pile 3 on 9/16/2004 was flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 7 is 19.37 minutes and is less than the minimum *estimated total test time* which was calculated to be 19.56 minutes. The minimum *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Pier 10, Pile 3

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5439	p10p3t5.rd	14.54	257.847937	14:57:10	36.30	20.00
5440	p10p3t6.rd	14.58	257.748224	15:19:42	22.53	20.04
5441	p10p3t7.rd	14.09	258.246784	15:39:04	19.37	19.56

The GGL test performed on Tube 7 of Pile 6 on 9/16/2004 was flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 7 is 16.43 minutes and is less than the minimum *estimated total test time* which was calculated to be 18.38 minutes. The minimum *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the

computer file.

Table 2: Test Chronology at Pier 10, Pile 6

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
5444	p10p6t8.rd	13.16	256.85084	13:41:16		18.60
5443	p10p6t7.rd	12.94	256.950552	13:57:42	16.43	18.38
5442	p10p6t1.rd	14.01	256.950565	14:20:52	23.17	19.45

Discussion of Findings

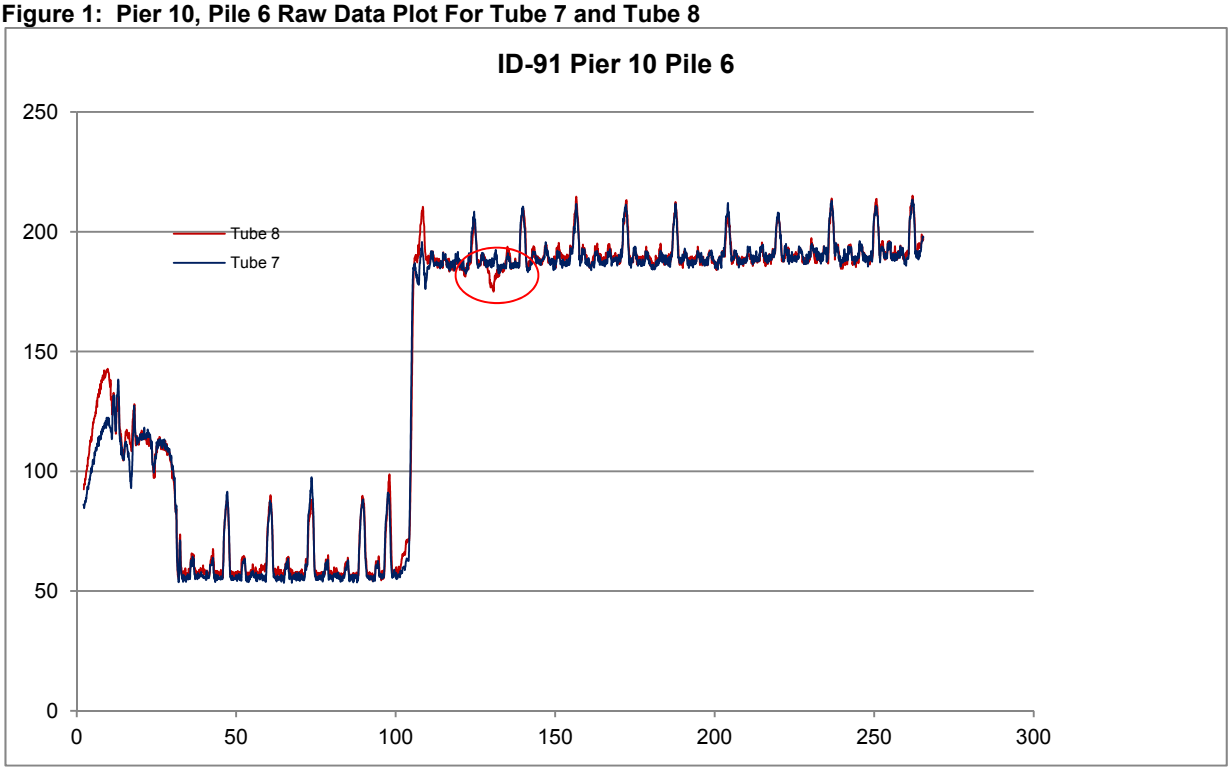
Pier 10 Pile 3

The chronology check fails in this case by only a 12 second difference between the actual and estimated test time. This small difference can be accounted for in the estimate of the time to move from Tube 6 to Tube 7, the time to lower the probe to the bottom of Tube 7, and/or the time to setup the computer.

Pier 10 Pile 6

One possible explanation for the irregular test time for Pile 6 Tube 7 is that Tube 7 is a rerun of Tube 8. Raw data from the LAS files for Tube 7 was plotted against Tube 8 to determine if any qualitative observations could rule out the possibility of a rerun in Tube 8. As shown below, there is a distinct difference in the two plots and a rerun of Tube 8 can be ruled out based on observing the plotted data alone.

Figure 1: Pier 10, Pile 6 Raw Data Plot For Tube 7 and Tube 8



The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is ~2 minutes for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 92

Name: 28-0212, Bent 18, Pile 6

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 11/2/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☒Intentional Action ☐ Inadvertent Action	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 5 of Pile 6 on 11/26/2003 was flagged by the Time Stamp Chronology analysis. The *time between file saves* is 14.57 minutes and is less than the minimum *estimated total test time* which was calculated to be 15.58 minutes. The minimum *estimated total test time* is calculated as the sum of the following: estimated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Bent 18, Pile 6

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
855	B18P6T1.rd	11.87	178.678859	10:07:58	0.00	15.81
856	B18P6T2.rd	11.74	180.473615	10:24:18	16.33	15.71
857	B18P6T3.rd	11.68	177.18322	10:40:46	16.47	15.59
858	B18P6T4.rd	11.88	176.684666	10:57:34	16.80	15.78
859	B18P6T5.rd	11.71	175.189036	11:12:08	14.57	15.58

Discussion of Findings

The following observations are made from the available data:

- The test data was collected in depth-up mode.
- The data acquisition times are known from the RD files.
- The calculated time deficiency (the difference between *Estimated Total Time* and *Time between File Saves*) is ~1 minute for the flagged tube given a probe lowering speed of 52 fpm.

Although, the GamDat Team could not produce evidence to confirm the actual probe lowering method used by the technician, the only reasonable explanation that accounts for the timing deficiency is that the probe was lowered using a method resulting in a shortened time. A retest of one more tubes in these piles was not specifically considered, as a retest alone would not account for the amount of time in question. The time that would have been saved by not repositioning the probe does not offset the significantly larger time deficiencies estimated using the parameters and assumptions from the analysis.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 93

Name: RD Chronology at Br. 28-0212, Bent 18, Pile 2

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The GGL test performed on Tube 4 of Pile 2 on 12/5/2003 was flagged by the Time Stamp Chronology analysis. The *time between file saves* at Tube 4 is 16.13 minutes and is less than the *estimated total test time* which was calculated to be 16.24 minutes. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 30 seconds each for moving to the tube and setting up the computer file.

Table 1: Test Chronology at Bent 18, Pile 2

Unique File ID	File Name	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
840	B18P2T1.rd	12.52	178.78	10:50:48		16.46
841	B18P2T2.rd	12.27	178.78	11:13:44	22.93	16.21
842	B18P2T3.rd	13.87	179.28	11:33:34	19.83	17.82
843	B18P2T4.rd	12.29	179.18	11:49:42	16.13	16.24
844	B18P2T5.rd	12.18	177.78	12:06:08	16.43	16.10

Discussion of Findings
The chronology check fails in this case by only a 7 second difference between the actual and estimated test time. This small difference can be accounted for in the estimate of the time to move from Tube 3 to Tube 4, the time to lower the probe to the bottom of Tube 4, and/or the time to setup the computer.

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **94**

Name: **RD Chronology at Br. 28-0153, Benicia-Martinez, Various**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Cross Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 11/12/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Modification ☐ Inadvertent Modification	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

These 20 RD files were flagged for Chronology irregularities. These files were flagged because the time between file saves, derived from a chronology analysis of file save times for a specific test location, was less than the estimated test time.

The estimated test time was calculated using an assumed probe lowering rate of 52 feet per minute, the actual acquisition time derived from logging speed data within the RD file, and an assumed duration of 15 seconds for moving the probe from one inspection tube to the next and 15 seconds to prepare the data file.

Table 1: ID-94 RD Files Flagged for Chronology Irregularities

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2621	PIER10PILE8TUBE6.rd	07/02/2004 12:52:18	13.94	264.33	12:52:18	19.33	19.52
2622	PIER10PILE8TUBE7.rd	07/02/2004 13:14:10	16.36	265.03	13:14:10	21.87	21.96
2562	P8P3T4.rd	01/15/2004 13:18:24	15.38	282.28	13:18:24	**20.40**	21.31
2563	P8P3T5.rd	01/15/2004 13:38:32	15.31	282.38	13:38:32	**20.13**	21.24
2564	P8P3T6.rd	01/15/2004 13:57:58	15.14	279.39	13:57:58	**19.43**	21.01
2565	P8P3T7.rd	01/15/2004 14:17:30	15.85	282.28	14:17:30	**19.53**	21.78
2566	P8P3T8.rd	01/15/2004 14:38:30	15.11	282.48	14:38:30	**21.00**	21.04
2586	P8P7T4.rd	11/11/2003 10:18:04	14.85	248.28	10:18:04	**19.87**	20.12
2595	P8P9T5.rd	11/18/2003 12:39:30	13.35	251.77	12:39:30	**18.00**	18.69
2596	P8P9T6.rd	11/18/2003 12:56:26	13.46	251.27	12:56:26	**16.93**	18.79

2597	P8P9T7.rd	11/18/2003 13:13:02	13.73	247.78	13:13:02	**16.60**	18.99
2598	P8P9T8.rd	11/18/2003 13:30:18	13.21	250.67	13:30:18	**17.27**	18.53
5465	P14P2T5.rd	08/01/2004 09:46:26	10.97	230.73	9:46:26	**15.23**	15.91
5466	P14P2T6.rd	08/01/2004 10:02:16	11	230.93	10:02:16	**15.83**	15.94
5468	P14P2T8.rd	08/01/2004 10:34:12	10.37	231.03	10:34:12	**15.23**	15.31
5483	p14p5t5.rd	07/30/2004 13:22:34	10.65	230.63	13:22:34	**15.47**	15.59
5513	P7P6T4.rd	06/04/2004 11:45:58	11.14	240.20	11:45:58	**15.73**	16.26
5514	P7P6T5.rd	06/04/2004 12:02:38	12.08	241.50	12:02:38	**16.67**	17.22
5516	P7P6T7.rd	06/04/2004 12:39:12	11.59	236.51	12:39:12	**16.03**	16.64
5458	p12p4t6.rd	07/30/2004 09:20:34	14.73	209.89	9:20:34	**19.17**	19.27

Discussion of Findings

For 28-0153, Pier 10, Pile 8, the two flagged files shown in Table 2 have a chronological discrepancy of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular.

Table 2:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2616	PIER10PILE8TUBE1.rd	07/02/2004 11:01:38	15.25	264.53	11:01:38	0.00	20.84
2617	PIER10PILE8TUBE2.rd	07/02/2004 11:25:42	14.85	264.33	11:25:42	24.07	20.43
2618	PIER10PILE8TUBE3.rd	07/02/2004 11:52:28	15.12	263.93	11:52:28	26.77	20.70
2619	PIER10PILE8TUBE4.rd	07/02/2004 12:13:22	14.01	264.33	12:13:22	20.90	19.59
2620	PIER10PILE8TUBE5.rd	07/02/2004 12:32:58	13.82	264.33	12:32:58	19.60	19.40
2621	PIER10PILE8TUBE6.rd	07/02/2004 12:52:18	13.94	264.33	12:52:18	**19.33**	19.52
2622	PIER10PILE8TUBE7.rd	07/02/2004 13:14:10	16.36	265.03	13:14:10	**21.87**	21.96
2623	PIER10PILE8TUBE8.rd	07/02/2004 13:37:32	14.63	264.93	13:37:32	23.37	20.22

For 28-0153, Pier 8, Pile 3, one of the flagged files shown in Table 3 has a chronological discrepancy of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular. There are five additional files flagged for a chronological discrepancy of approximately two minutes however none of the *Time Between File Save*s is not unusual relative to each other. The likely explanation is that the actual method of probe lowering (e.g. free-wheeling) was outside the normal practice for which the analysis assumptions are based.

Table 3:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2559	P8P3T1.rd	01/15/2004 11:28:28	16.74	282.48	11:28:28	0.00	22.67
2560	P8P3T2.rd	01/15/2004 12:09:36	17.79	283.27	12:09:36	41.13	23.74
2561	P8P3T3.rd	01/15/2004 12:58:00	15.33	283.07	12:58:00	48.40	21.27
2562	P8P3T4.rd	01/15/2004 13:18:24	15.38	282.28	13:18:24	**20.40**	21.31
2563	P8P3T5.rd	01/15/2004 13:38:32	15.31	282.38	13:38:32	**20.13**	21.24
2564	P8P3T6.rd	01/15/2004 13:57:58	15.14	279.39	13:57:58	**19.43**	21.01
2565	P8P3T7.rd	01/15/2004 14:17:30	15.85	282.28	14:17:30	**19.53**	21.78
2566	P8P3T8.rd	01/15/2004 14:38:30	15.11	282.48	14:38:30	**21.00**	21.04

For 28-0153, Pier 8, Pile 7, the flagged file shown in Table 4 has a chronological discrepancy of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular.

Table 4:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2590	P8P7T8.rd	11/11/2003 09:01:48	13.71	239.70	9:01:48	0.00	18.82
2589	P8P7T7.rd	11/11/2003 09:20:44	13.42	251.77	9:20:44	18.93	18.76
2588	P8P7T6.rd	11/11/2003 09:39:54	13.29	247.38	9:39:54	19.17	18.55
2587	P8P7T5.rd	11/11/2003 09:58:12	10.91	214.97	9:58:12	18.30	15.54
2586	P8P7T4.rd	11/11/2003 10:18:04	14.85	248.28	10:18:04	**19.87**	20.12
2585	P8P7T3.rd	11/11/2003 10:43:30	12.84	228.83	10:43:30	25.43	17.74
2584	P8P7T2.rd	11/11/2003 11:01:50	12.68	238.90	11:01:50	18.33	17.77
2583	P8P7T1.rd	11/11/2003 11:29:06	13.36	250.27	11:29:06	27.27	18.67

For 28-0153, Pier 8, Pile 9, there are four files flagged for a chronological discrepancy of approximately two minutes however none of the *Time Between File Save*s is not unusual relative to each other. The likely explanation is that the actual method of probe lowering (e.g. free-wheeling) was outside the normal practice for which the analysis assumptions are based.

Table 5:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2591	P8P9T1.rd	11/18/2003 11:23:14	14.53	248.18	11:23:14	0.00	19.80
2592	P8P9T2.rd	11/18/2003 11:40:04	11.53	176.49	11:40:04	16.83	15.42
2593	P8P9T3.rd	11/18/2003 11:59:28	13.39	247.28	11:59:28	19.40	18.65
2594	P8P9T4.rd	11/18/2003 12:21:30	13.9	250.57	12:21:30	22.03	19.22
2595	P8P9T5.rd	11/18/2003 12:39:30	13.35	251.77	12:39:30	**18.00**	18.69
2596	P8P9T6.rd	11/18/2003 12:56:26	13.46	251.27	12:56:26	**16.93**	18.79
2597	P8P9T7.rd	11/18/2003 13:13:02	13.73	247.78	13:13:02	**16.60**	18.99
2598	P8P9T8.rd	11/18/2003 13:30:18	13.21	250.67	13:30:18	**17.27**	18.53

For 28-0153, Pier 14, Pile 2, two of the flagged files shown in Table 6 have chronological discrepancies of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined not to be chronologically irregular. There is one additional file flagged for a chronological discrepancy of approximately two minutes however none of the *Time Between File Save*s is not unusual relative to each other. The likely explanation is that the actual method of probe lowering (e.g. free-wheeling) was outside the normal practice for which the analysis assumptions are based.

Table 6:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
5461	P14P2T1.rd	08/01/2004 08:36:24	11.56	231.52	8:36:24	0.00	16.51
5462	P14P2T2.rd	08/01/2004 08:55:02	13.22	231.52	8:55:02	18.63	18.17
5463	P14P2T3.rd	08/01/2004 09:15:06	10.82	230.83	9:15:06	20.07	15.76
5464	P14P2T4.rd	08/01/2004 09:31:12	10.81	230.73	9:31:12	16.10	15.75
5465	P14P2T5.rd	08/01/2004 09:46:26	10.97	230.73	9:46:26	**15.23**	15.91
5466	P14P2T6.rd	08/01/2004 10:02:16	11	230.93	10:02:16	**15.83**	15.94
5467	P14P2T7.rd	08/01/2004 10:18:58	11.59	231.23	10:18:58	16.70	16.54
5468	P14P2T8.rd	08/01/2004 10:34:12	10.37	231.03	10:34:12	**15.23**	15.31

For 28-0153, Pier 14, Pile 5, the flagged file shown in Table 7 has a chronological discrepancy of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular.

Table 7:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
5479	p14p5t1.rd	07/30/2004 12:13:38	13.35	231.72	12:13:38	0.00	18.31
5480	p14p5t2.rd	07/30/2004 12:31:08	11.35	234.62	12:31:08	17.50	16.36
5481	p14p5t3.rd	07/30/2004 12:51:26	10.53	231.03	12:51:26	20.30	15.47
5482	p14p5t4.rd	07/30/2004 13:07:06	10.45	230.23	13:07:06	15.67	15.38
5483	p14p5t5.rd	07/30/2004 13:22:34	10.65	230.63	13:22:34	**15.47**	15.59
5484	p14p5t7.rd	07/30/2004 13:40:40	11.58	231.33	13:40:40	18.10	16.53
5485	p14p5t8.rd	07/30/2004 13:56:26	10.54	231.03	13:56:26	15.77	15.48
5479	p14p5t1.rd	07/30/2004 12:13:38	13.35	231.72	12:13:38	0.00	18.31

For 28-0153, Pier 7, Pile 6, the flagged file shown in Table 8 has a chronological discrepancy of approximately 30 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular.

Table 8:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
5510	P7P6T1.rd	06/04/2004 10:45:46	12.96	241.50	10:45:46	0.00	18.10
5511	P7P6T2.rd	06/04/2004 11:09:24	12.35	241.30	11:09:24	23.63	17.49
5512	P7P6T3.rd	06/04/2004 11:30:14	11.95	241.20	11:30:14	20.83	17.09
5513	P7P6T4.rd	06/04/2004 11:45:58	11.14	240.20	11:45:58	**15.73**	16.26
5514	P7P6T5.rd	06/04/2004 12:02:38	12.08	241.50	12:02:38	**16.67**	17.22
5515	P7P6T6.rd	06/04/2004 12:23:10	11.73	235.71	12:23:10	20.53	16.76
5516	P7P6T7.rd	06/04/2004 12:39:12	11.59	236.51	12:39:12	**16.03**	16.64
5517	P7P6T8.rd	06/04/2004 12:55:58	11.15	236.31	12:55:58	16.77	16.19

For 28-0153, Pier 12, Pile 4, the flagged file shown in Table 9 has a chronological discrepancy of less than 15 seconds. Due to the small difference between the *Time Between File Save*s and the *Estimated Total Time* this was determined to not be chronologically irregular.

Table 9:

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
5457	p12p4t5.rd	07/30/2004 09:01:24	12.26	210.49	9:01:24	0.00	16.81
5458	p12p4t6.rd	07/30/2004 09:20:34	14.73	209.89	9:20:34	**19.17**	19.27
5459	p12p4t7.rd	07/30/2004 09:38:46	11.45	209.69	9:38:46	18.20	15.98
5460	p12p4t8.rd	07/30/2004 09:55:04	10.82	209.49	9:55:04	16.30	15.35
5453	p12p4t1.rd	07/30/2004 10:11:26	10.31	209.69	10:11:26	16.37	14.84
5454	p12p4t2.rd	07/30/2004 10:28:28	10.86	208.99	10:28:28	17.03	15.38
5455	p12p4t3.rd	07/30/2004 10:46:00	11.77	209.09	10:46:00	17.53	16.29
5456	p12p4t4.rd	07/30/2004 11:03:00	10.55	209.29	11:03:00	17.00	15.07

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 95

Name: LS Chronology for Various Sound Wall Piles

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 7/30/12

Summarized by: Wahleithner **Date:** 7/30/12

Reviewed by: Hannenian **Date:** 10/19/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

49 LS test files were flagged because the elapsed time between consecutive file save times was less than the estimated testing time for a given pile (15 seconds of setup, lowering the probe at 52 fpm, 15 seconds of computer setup, and data acquisition calculated from speed records embedded in LS file.)

Discussion of Findings

Two probes were working the same site. Multiple files were flagged because the calculation of elapsed time between tests used the file save times for two different probes. The chronology analysis is intended to look at the consecutive file save times of a single probe to determine if the elapsed time between consecutive tests agrees with the estimated testing time for a given pile.

Review of these 49 LS files determined that the elapsed time is incorrectly calculated as a result of two probes being used to collect data at the same site. Therefore, the chronology analysis should not have flagged these files and no further review based on file (test) chronology is required.

List of Files:

File ID	Unique File ID	Group ID	File Name	Date-Time	Data Acq Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Flag if Est Total Time > Time Between File Saves
3818	3214	201	Sw250p31.ta	12/11/2003 10:58:02	5.63	53.4	10:58:02	2.47	1
13978	3234	201	Sw250p31.tb	12/11/2003 11:10:36	5.29	53.2	11:10:36	3.23	1
13754	3206	201	SW250P22.TA	12/11/2003 11:41:40	4.24	53.2	11:41:40	4.03	1
13826	3215	201	Sw250p32.ta	12/11/2003 11:47:32	4.63	53.6	11:47:32	5.87	1
13914	3226	201	SW250P23.TB	12/11/2003 12:04:16	5.2	53.7	12:04:16	1.63	1
13842	3217	201	Sw250p34.ta	12/11/2003 12:34:14	4.61	54.1	12:34:14	1.97	1
14002	3237	201	Sw250p34.tb	12/11/2003 12:58:56	4.59	53.5	12:58:56	3.10	1
14018	3239	201	Sw250p36.tb	12/11/2003 14:04:40	4.76	53.7	14:04:40	2.77	1
14520	3298	204	Sw250p71.ta	12/17/2003 09:02:44	4.52	52.9	9:02:44	1.90	1
14608	3310	204	Copy of SW250P53.TB	12/17/2003 09:16:28	4.42	52.6	9:16:28	3.67	1
14621	3311	204	Copy of SW250P54.TB	12/17/2003 09:52:46	4.52	52.8	9:52:46	3.23	1
15243	3383	215	SW25P108.TB	12/18/2003 13:31:24	5.12	53.9	13:31:24	4.60	1
15347	3395	218	Copy of SW25P114.TA	12/19/2003 09:16:26	4.68	55.2	9:16:26	3.47	1
15338	3394	218	Copy of SW25P113.TA	12/19/2003 09:50:18	4.95	56.3	9:50:18	4.67	1
15500	3412	218	SW25P116.TB	12/19/2003 09:56:00	7.89	55.4	9:56:00	5.70	1
15455	3407	218	Copy of SW25P113.TB	12/19/2003 10:00:18	4.7	56.6	10:00:18	4.30	1
15383	3399	218	SW25P115.TA	12/19/2003 10:15:58	5.38	55.3	10:15:58	4.60	1
15446	3406	218	Copy of SW25P112.TB	12/19/2003 10:21:08	4.82	55.4	10:21:08	5.17	1
15491	3411	218	SW25P115.TB	12/19/2003 10:26:26	5.35	55.5	10:26:26	5.30	1
15482	3410	218	Copy of SW25P122.TB	12/19/2003 11:51:34	4.81	55.4	11:51:34	4.67	1
15527	3415	218	SW25P120.TB	12/19/2003 11:57:38	5.01	55.3	11:57:38	6.07	1
15550	3418	221	101P135.TA	12/22/2003 10:35:42	5.35	56.6	10:35:42	4.30	1
15722	3444	221	101P135.TB	12/22/2003 10:44:48	5.26	56.5	10:44:48	1.27	1
15629	3430	221	SW25P131.TA	12/22/2003 11:01:00	5.2	56.7	11:01:00	3.47	1
15728	3445	221	101P136.TB	12/22/2003 11:05:28	5.32	56.7	11:05:28	4.47	1
15734	3446	221	101P137.TB	12/22/2003 11:26:02	5.3	56.6	11:26:02	2.77	1
15568	3421	221	101P138.TA	12/22/2003 11:37:34	5.17	56.6	11:37:34	1.33	1
15815	3458	221	SW25P133.TB	12/22/2003 12:16:18	5.12	56.9	12:16:18	5.17	1
15580	3423	221	101P140.TA	12/22/2003 12:21:22	5.25	56.8	12:21:22	5.07	1
15864	3465	224	SW25P146.TB	12/22/2003 14:46:54	5.16	56.8	14:46:54	3.23	1
15857	3464	224	101P151.TB	12/22/2003 14:50:54	5.02	56.7	14:50:54	4.00	1
15871	3466	224	SW25P147.TB	12/22/2003 15:31:18	5.22	56.7	15:31:18	1.37	1
15713	3442	224	SW25P148.TA	12/22/2003 15:42:18	5.12	56.6	15:42:18	1.33	1
15843	3462	224	101P149.TB	12/22/2003 15:48:16	5.03	56.7	15:48:16	5.97	1
15878	3467	224	SW25P148.TB	12/22/2003 15:53:06	5.36	56.8	15:53:06	4.83	1

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 96

Name: RD Chronology: Minor Discrepancy in Timing

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/30/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

These 28 files are part of the 130 total files flagged for RD Chronology issues. These files were flagged because the *time between file saves*, or elapsed time between consecutive file save times, was less than the *estimated total test time*. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube assuming a lowering speed of 52 feet per minute, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Discussion of Findings

As shown in Table 1 below, the difference between *time between file saves* and *estimated total test time* test time is very small and is likely the result of one of the parameters being slightly off.

Table 1: ID-96 RD Files With Minor Chronology Irregularity

Unique File ID	File Name	Date	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
1465	P93T2.rd	07/25/2008 10:40:04	2.18	24.03	10:40:04	3.13	3.14
9506	B7LP4T4.rd	06/25/2007 11:50:06	5.52	74.08	11:50:06	7.42	7.44
5181	B17T14.rd	04/06/2005 12:08:30	8.28	117.86	12:08:30	11.00	11.05
879	B18P8T1.rd	11/14/2003 10:13:58	13.78	198.42	10:13:58	17.90	18.10
883	B18P8T5.rd	11/14/2003 11:10:14	13.04	200.02	11:10:14	16.13	17.39
1516	T3.rd	12/10/2003 12:50:20	7.83	100.51	12:50:20	9.80	10.26
1518	T5.rd	12/10/2003 12:09:09	7.14	101.11	12:09:09	9.20	9.58
1519	T6.rd	12/10/2003 13:18:28	7.13	101.11	13:18:28	9.30	9.57
5806	bent18pile6t2.rd	12/18/2003 10:13:49	10.89	171.20	10:13:49	13.98	14.68
6913	T3.rd	12/19/2006 08:54:55	6.87	97.22	8:54:55	8.45	9.24
6916	T6.rd	12/19/2006 09:23:22	6.86	99.81	9:23:22	8.98	9.28
6917	T7.rd	12/19/2006 09:32:14	6.58	99.31	9:32:14	8.87	8.99
6918	T8.rd	12/19/2006 09:40:52	6.53	99.61	9:40:52	8.63	8.95
7154	P2P13t2.rd	10/14/2005 08:43:49	5.61	59.33	8:43:49	7.15	7.25
7213	P2.rd	07/28/2006 19:19:20	5.8	84.55	19:19:20	7.87	7.93
7277	T3.rd	11/15/2006 11:43:56	11.92	214.97	11:43:56	16.47	16.55
7279	T5.rd	11/15/2006 12:21:10	11.91	214.57	12:21:10	15.52	16.54
7280	T6.rd	11/15/2006 12:37:37	11.93	215.17	12:37:37	16.45	16.57
10950	T7.rd	10/03/2007 12:32:47	6.38	96.82	12:32:47	8.55	8.74
10955	T4.rd	10/03/2007 11:29:32	5.77	90.14	11:29:32	7.53	8.00
10956	T5.rd	10/03/2007 11:37:28	5.89	91.23	11:37:28	7.93	8.14
10959	T8.rd	10/03/2007 12:03:52	5.91	92.83	12:03:52	7.80	8.20
11492	T5.rd	10/03/2007 20:16:24	6	94.52	20:16:24	7.57	8.32
11493	T6.rd	10/03/2007 20:24:14	6.34	94.62	20:24:14	7.83	8.66
1485	t2.rd	01/31/2007 12:03:58	12.41	215.07	12:03:58	16.87	17.05
1486	t3.rd	01/31/2007 12:21:18	13.35	215.07	12:21:18	17.33	17.99
1487	t4.rd	01/31/2007 12:37:34	12.26	214.97	12:37:34	16.27	16.89
1488	t5.rd	01/31/2007 12:53:22	12.13	215.07	12:53:22	15.80	16.77

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 97

Name: RD and LS Acquisition Times Overestimated From Speed Data

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/30/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

11 LS files and 17 RD files were flagged because the *time between file saves*, or elapsed time between consecutive file save times, was less than the *estimated total test time*. The *estimated total test time* is calculated as the sum of the following: calculated time to lower the probe to the bottom of the inspection tube, the actual data acquisition time derived from the data file, and assumed durations of 15 seconds each for moving to the tube and setting up the computer file.

Discussion of Findings

The LS files listed below in Table 1 were flagged for a chronology irregularity because the *time between file saves* is less than the *estimated total test time*. Visual inspection of the table finds the *estimated total test time* is incorrectly calculated. For some files shown in Table 1 it is apparent the miscalculation is caused by incorrect acquisition times and total depths. (Example Unique File ID 1777). For other files the miscalculation appears to be caused by an incorrect acquisition time. (Example Unique File ID 1892).

Therefore the chronology irregularities for LS Files addressed in ID-97 do not exist.

Table 1: ID-97 LS Files Flagged For Chronology Irregularity

Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
1777	805B5PR1.T3	06/21/2002 15:03:58	**2885.15**	**578.6**	15:03:58	14.20	**2896.78**
1892	B13T08.SA1	07/24/2002 20:19:48	**43.03**	60.8	20:19:48	12.37	**44.70**
1241	B2rP31T3.saj	01/22/2002 14:53:16	7902.2	606.5	14:53:16	14.07	7914.36
1846	BENMART.T3	07/03/2002 14:36:16	3674.05	469.2	14:36:16	16.40	3683.57
2319	BMPR9PI3.T4	12/30/2002 12:38:42	4642.79	860	12:38:42	11.43	4659.83
2052	BP9P4.T9	09/19/2002 15:03:26	5877.77	837.8	15:03:26	22.00	5894.38
1502	Hbn3p21.t1.t1	03/19/2002 15:20:52	21.65	70.7	15:20:52	15.87	23.51
2828	NBB19P6.T2	07/08/2003 11:27:04	13198.5	1453.3	11:27:04	15.57	13226.95
2545	RSRP38PW.T6	03/20/2003 15:35:56	45.27	191.3	15:35:56	28.53	49.45
2548	RSRP38PW.T9	03/20/2003 17:18:16	41.31	191.7	17:18:16	29.30	45.50
2959	RSU1B19P.T3	09/17/2003 02:39:56	870.52	209.1	2:39:56	15.67	875.04

The RD files listed below in Table 2 were flagged for a chronology irregularity because the *time between file saves* is less than the *estimated total test time*. Visual inspection of the table finds the *estimated total test time* is incorrectly calculated.

Table 2: ID-97 RD Files Flagged For Chronology Irregularity

Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
8893	HRW92P103T2.rd	02/20/2008 15:42:06	3.37	30.3	15:42:06	4.30	4.45
7728	sawp119t2.rd	05/29/2007 14:02:43	3.3	28.9	14:02:43	4.23	4.36
1463	P92T2.rd	07/25/2008 10:33:08	3.03	24.7	10:33:08	3.23	4.01
5436	B5RT6.rd	05/04/2005 12:37:24	7.45	84.2	12:37:24	9.50	9.57
1507	T6.rd	12/11/2003 11:26:40	6.28	65.2	11:26:40	7.97	8.03
5072	B2LP3T1.rd	04/19/2005 09:40:12	3.86	36.4	9:40:12	4.70	5.06
5544	P58T1.rd	02/08/2005 10:52:45	3.82	34.3	10:52:45	4.63	4.98
5549	P60T2.rd	02/08/2005 19:17:44	4.19	35.0	19:17:44	4.73	5.36
6024	P7T1.rd	01/16/2007 14:26:33	3.71	25.0	14:26:33	4.08	4.69
7213	P2.rd	07/28/2006 11:19:20	5.8	84.6	11:19:20	7.88	7.93
8326	P112T1.rd	08/12/2008 09:55:58	3.28	25.3	9:55:58	4.27	4.27
8342	P120T1.rd	08/13/2008 08:51:34	3.24	23.3	8:51:34	3.97	4.19
8348	P122T3.rd	08/13/2008 09:19:16	3.33	26.3	9:19:16	3.57	4.34
616	P10T2.rd	04/06/2007 12:14:22	4.25	42.7	12:14:22	5.43	5.57
619	P12T1.rd	04/06/2007 12:30:24	4.23	43.2	12:30:24	5.50	5.56
624	P14T2.rd	04/06/2007 13:01:08	3.89	43.3	13:01:08	4.93	5.22

When each file is examined in the context of the group of RD files for that test location, it becomes apparent that the flagged file has a significantly higher data acquisition time compared to the other RD files in the group. The erroneous data acquisition time is causing a miscalculation of the *estimated total test time* which becomes apparent when comparing other files in the group that have a similar tested length.

An example of this error is shown below in Table 3. The files all have a similar tested length of approximately 24 feet and a data acquisition of approximately 1.7 to 2.2 minutes with one exception. File P92T2.rd (Unique File ID 1463) has a data acquisition of over 3 minutes. This results in an *estimated total test time* of 4.01 minutes. The *time between file saves* for P92T2.rd is 3.23 minutes which is consistent with the other files of the group. However when compared to the *estimated total test time* of 4.01 minutes, it appears P92T2.rd was tested more than a minute

faster than the estimated time required.

Table 3: ID-97 RD Files Flagged For Chronology Irregularity

Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
1461	P91T2.rd	07/25/2008 10:26:14	1.71	24.23	10:26:14	3.27	2.68
1462	P92T1.rd	07/25/2008 10:29:54	1.85	24.13	10:29:54	3.67	2.81
1463	P92T2.rd	07/25/2008 10:33:08	**3.03**	**24.73**	10:33:08	3.23	**4.01**
1464	P93T1.rd	07/25/2008 10:36:56	1.65	23.83	10:36:56	3.80	2.61
1465	P93T2.rd	07/25/2008 10:40:04	2.18	24.03	10:40:04	3.13	3.14

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 98

Name: LS Chronology: Files Flagged Due To Incorrect File Save Date and/or Time

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by:
☐ Pattern Matching ☐ File Rename
☐ Calibration Constant ☐ Correlation
☐ Depth Consistency ☐ Time Stamp (RD-LAS)
☐ Fidelity (RD-LAS) ☒ Chronology

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12
Summarized by: Wahleithner **Date:** 6/26/12
Reviewed by: Hannenian **Date:** 10/29/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☐ Inconsequential	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

The following eight LS test files were flagged because the elapsed time between consecutive file save times was less than the estimated testing time for setup, lowering the probe, and data acquisition.

Table 1: ID-98 LS Files

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
8	4	04pr8.t2	12/23/1998 07:39:42	14.24	222.3	7:39:42	1.63	19.02
9	5	04pr8.t3	12/23/1998 07:41:20	12.02	218.9	7:41:20	1.63	16.73
10	6	04pr8.t4	12/23/1998 07:43:00	13.53	219.5	7:43:00	1.67	18.25
3962	1352	B2lp1bt2.sa1	02/08/2002 13:14:50	5.68	64.7	13:14:50	1.17	7.42
3127	1225	b2lp4at1.sa1.sa1	01/23/2002 06:40:22	5.93	62.4	6:40:22	3.57	7.63
3134	1226	b2lp5at1.sa1.sa1	01/23/2002 06:42:06	5.66	65.3	6:42:06	1.73	7.42
3934	1348	Smb4lp6a.t3	02/07/2002 12:30:28	5.8	56.3	12:30:28	1.80	7.38
3927	1347	Smb4rp3a.t2	02/07/2002 12:31:54	5.04	55.7	12:31:54	1.43	7.61

Discussion of Findings

The eight LS files shown in Table 1 were each examined in the context of the group of LS files pertaining to the actual pile location, as shown below in Tables 2 through 6. The flagged file is shown in bold. This analysis determined that the file save date and time are approximately the same for all LS files for each pile location. This may occur when the file date and time were inadvertently modified by a post-test file transfer operation or a post-test review by the technician or engineer in order to verify file completeness. It is further noted that these eight files were not flagged for other irregularities such as pattern match, calibration, or depth.

Therefore, the apparent chronology irregularity was determined <u>not</u> to exist.

The date and time chronology for each file, with respect to the pile location or file group, is shown in the tables below.

Table 2: 28-0153 Benicia

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
7	3	04pr8.t1	12/23/1998 07:38:04	14.16	223.1	7:38:04	0.00	18.95
8	**4**	**04pr8.t2**	**12/23/1998 07:39:42**	**14.24**	**222.3**	**7:39:42**	**1.63**	**19.02**
9	**5**	**04pr8.t3**	**12/23/1998 07:41:20**	**12.02**	**218.9**	**7:41:20**	**1.63**	**16.73**
10	**6**	**04pr8.t4**	**12/23/1998 07:43:00**	**13.53**	**219.5**	**7:43:00**	**1.67**	**18.25**

Table 3: 57-001RL San Mateo Creek Emergency Repair

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
3955	1351	B2lP1bT1.sa1	02/08/2002 13:13:40	6.05	64.5	13:13:40	0.00	7.79
3969	1354	B2lP1bT3.sa6	02/08/2002 13:13:40	5.69	64.5	13:13:40	0.00	7.43
3962	**1352**	**B2lp1bt2.sa1**	**02/08/2002 13:14:50**	**5.68**	**64.7**	**13:14:50**	**1.17**	**7.42**
3976	1355	B2lP4bT1.sa9	02/08/2002 13:14:50	5.73	64.6	13:14:50	0.00	7.47
3990	1357	B2lP4bT2.sad	02/08/2002 13:15:54	5.76	64.4	13:15:54	1.07	7.50
3983	1356	B2lP4bT3.sab	02/08/2002 13:15:54	6.01	64.7	13:15:54	0.00	7.75
3997	1358	B2lP6bT1.saf	02/08/2002 13:16:46	5.62	65.2	13:16:46	0.87	7.37
4004	1359	B2lP6bT2.sah	02/08/2002 13:16:46	5.59	64.9	13:16:46	0.00	7.34
4011	1360	B2lP6bT3.saj	02/08/2002 13:17:24	6.07	65	13:17:24	0.63	7.82

Table 4: 57-001RL San Mateo Creek Emergency Repair

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
3120	1224	b2lp2at1.sa1.sa1	01/23/2002 06:36:48	6	65.2	6:36:48	0.00	7.75
3148	1228	b2lp2at2.sa3.sa3	01/23/2002 06:36:48	5.9	64.9	6:36:48	0.00	7.65
3169	1231	b2lp2at3.sa5	01/23/2002 06:36:48	5.91	64.9	6:36:48	0.00	7.66
3127	**1225**	**b2lp4at1.sa1.sa1**	**01/23/2002 06:40:22**	**5.93**	**62.4**	**6:40:22**	**3.57**	**7.63**
3155	1229	b2lp4at2.sa3.sa3	01/23/2002 06:40:22	5.79	64.6	6:40:22	0.00	7.53
3176	1232	b2lp4at3.sa5	01/23/2002 06:40:22	5.53	61.6	6:40:22	0.00	7.21
3134	**1226**	**b2lp5at1.sa1.sa1**	**01/23/2002 06:42:06**	**5.66**	**65.3**	**6:42:06**	**1.73**	**7.42**
3162	1230	b2lp5at2.sa3.sa3	01/23/2002 06:42:06	5.93	65.1	6:42:06	0.00	7.68
3183	1233	b2lp5at3.sa5	01/23/2002 06:42:06	5.69	65	6:42:06	0.00	7.44

Table 5: 57-001RL San Mateo Creek Emergency Repair

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
3904	1344	Smb4lp6a.t1	02/07/2002 12:28:40	5.23	57.4	12:28:40	0.00	6.83
3919	1346	Smb4lp6a.t2	02/07/2002 12:28:40	5.21	57.4	12:28:40	0.00	6.81
3934	**1348**	**Smb4lp6a.t3**	**02/07/2002 12:30:28**	**5.8**	**56.3**	**12:30:28**	**1.80**	**7.38**

Table 6: 57-001RL San Mateo Creek Emergency Repair

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
3912	1345	Smb4rp3a.t1	02/07/2002 12:30:28	5.13	56.1	12:30:28	0.00	6.71
3927	**1347**	**Smb4rp3a.t2**	**02/07/2002 12:31:54**	**5.04**	**55.7**	**12:31:54**	**1.43**	**6.61**
3942	1349	Smb4rp3a.t3	02/07/2002 12:31:54	5.02	56	12:31:54	0.00	6.60

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: 99

Name: LS Chronology: Minor Discrepancy in Timing Benicia-Mar Retrofit 28-0153 P 9

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 10/29/12

Conclusions		Confidence
Existence of Irregularity	☒ Exists ☐ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☐ Certain ☒ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☐ Inadvertent Action	☐ Certain ☐ Likely ☐ Plausible
	☒ Undetermined	

Irregularity Description

The following two LS files were flagged for chronology issues. These files were flagged because the *time between file saves*, derived from a chronology analysis of file save times, was less than the *estimated test time*.

Table 1: ID-99 LS Files

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
2517	1047	T3NWW3.T5	02/21/2001 12:07:48	16.52	205.4	12:07:48	20.53	20.97
9094	2324	BMPR9PI1.T7	12/30/2002 10:30:06	18.51	190.4	10:30:06	22.53	22.67

Discussion of Findings

The estimated test time was calculated with the following assumptions:

Tube to Tube movement of 15 seconds, a lowering speed of 52 feet per minute, and computer setup of 15 seconds. The estimated test time is the sum of the above assumed durations plus the data acquisition time calculated from the recorded speed information.

For the cases shown above in Table 1, the difference between the actual and estimated test time is less than 30 seconds and consistent with other tests from the same pile location. Therefore the two cases were determined not to be chronologically irregular and no additional analysis is necessary. Minor variations in the above assumptions, such as lowering slightly faster than 52 feet per minute, could account for the time between file saves being slightly less than the estimated test time.

Table 2: 28-0153 - Benicia Martinez

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time (min)
9102	2328	BMPR9PI1.SA0	12/30/2002 09:35:38	20.59	211.3	9:35:38	0.00	25.15
9086	2320	BMPR9PI1.T5	12/30/2002 09:47:40	8.04	84.2	9:47:40	12.03	10.16
9090	2322	BMPR9PI1.T6	12/30/2002 10:07:34	16.17	163.6	10:07:34	19.90	19.82
9094	**2324**	**BMPR9PI1.T7**	**12/30/2002 10:30:06**	**18.51**	**190.4**	**10:30:06**	**22.53**	**22.67**
9104	2329	BMPR9PI1.T10	12/30/2002 10:56:02	20.58	211.7	10:56:02	25.93	25.15
9108	2331	BMPR9PI1.T11	12/30/2002 11:13:44	13.36	135.7	11:13:44	17.70	16.47

Table 3: 28-0352L - New Carquinez

File ID	Unique File ID	File Name	Date-Time	Data Acquisition Time (min)	Total Depth (ft)	File Save Time	Time Between File Saves (min)	Est Total Time (min)
2489	1043	T3NWW3.T1	02/21/2001 10:38:14	15.5	205.1	10:38:14	0.00	19.94
2496	1044	T3NWW3.T2	02/21/2001 11:02:24	14.69	203.3	11:02:24	24.17	19.10
2503	1045	T3NWW3.T3	02/21/2001 11:24:26	14.39	203.7	11:24:26	22.03	18.81
2510	1046	T3NWW3.T4	02/21/2001 11:47:16	15.53	204.1	11:47:16	22.83	19.96
2517	**1047**	**T3NWW3.T5**	**02/21/2001 12:07:48**	**16.52**	**205.4**	**12:07:48**	**20.53**	**20.97**
2524	1048	T3NWW3.T7	02/21/2001 12:50:36	14.77	204.8	12:50:36	42.80	19.21
2531	1049	T3NWW3.T8	02/21/2001 13:13:52	14.8	203.6	13:13:52	23.27	19.22
2538	1050	T3NWW3.T9	02/21/2001 13:36:08	14.45	200.3	13:36:08	22.27	18.80

GamDat Manual Analysis of Potential GGL Data File Irregularity

Analysis Summary

Manual Analysis ID: **100**

Name: **LS Chronology: Minor Discrepancy in Timing Various Piles**

Status: ☐ Inactive ☐ Active ☒ Closed

Assigned to Case: ☐ Yes ☒ No

Flagged by: ☐ Pattern Matching ☐ File Rename ☐ Calibration Constant ☐ Correlation ☐ Depth Consistency ☒ Time Stamp ☐ Fidelity (RD-LAS)

Code Version: V3

Analyzed by: Wahleithner **Date:** 6/26/12

Summarized by: Wahleithner **Date:** 6/26/12

Reviewed by: Hannenian **Date:** 11/6/12

Conclusions		Confidence
Existence of Irregularity	☐ Exists ☒ Does not exist	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Impact of Irregularity	☐ Consequential ☒ Inconsequential	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	
Cause of Irregularity	☐ Intentional Action ☒ Inadvertent Action	☒ Certain ☐ Likely ☐ Plausible
	☐ Undetermined	

Irregularity Description

These 6 LS files flagged for LS Chronology issues. These files were flagged because the time between file saves, derived from a chronology analysis of file save times, was less than the estimated test time.

Discussion of Findings

The estimated test time was calculated with the following assumptions:

Tube to Tube movement of 15 seconds, a lowering speed of 52 feet per minute, and computer setup of 15 seconds. The estimated test time is the sum of the above assumed durations plus the data acquisition time calculated from the recorded speed information.

For the cases shown in Table 1, the difference between the actual and estimated test time is less than 30 seconds and consistent with other tests from the same pile location. Therefore these were determined not to be chronologically irregular and no additional analysis is necessary. Minor variations in the above assumptions, such as lowering slightly faster than 52 feet per minute, could account for the time between file saves being slightly less than the estimated test time.

Table 1:

File ID	Unique File ID	Group ID	File Name	Date-Time	Data Acq Time (min)	Total Depth (ft)	File Save Time	Time between File Saves (min)	Est Total Time, move + setup + lower + acquire (min)
8990	2283	337	NOYOB2E1.T3	12/06/2002 12:37:36	12.53	127.3	12:37:36	15.43	15.48
5315	1578	1208	OKLBM5R.T5	03/25/2002 12:04:56	8.14	79.6	12:04:56	10.10	10.17
6103	1747	1219	OKLCB16L.T6	05/15/2002 13:55:54	8.74	84.1	13:55:54	10.73	10.86
17011	3679	1590	SF101P8L.T2	02/11/2004 13:05:04	8.28	76	13:05:04	9.80	10.24
17232	3729	1706	SF80P5U2.T3	02/23/2004 14:34:06	13.49	141	14:34:06	16.27	16.70
11035	2693	493	TRCKPR2P.T3	05/09/2003 11:07:18	5.74	58	11:07:18	7.33	7.36