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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

SAFETY MANUAL
FOR
ADMINISTRATIVE INSTRUCTIONS TO
RADIOGRAPHIC PERSONNEL

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Materials & Research Dept.

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State of California
Department of Public Works
Division of Highways
Materials and Research Department

SAFETY MANUAL

FOR

ADMINISTRATIVE INSTRUCTIONS TO

RADIOGRAPHIC PERSONNEL

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Structural Materials Section

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INTRODUCTION

The purpose of this manual is to serve as a guide for Radiographic Personnel and to be used throughout the Division of Highways for the express purpose of regulating radiographic inspection of welded structural steel for bridges and buildings.

All radiographic technicians responsible for radioactive sources shall be:

1. Thoroughly familiar with the safe handling techniques of radioactive sources.

2. Fully informed of the hazards to health that exist near radioactive sources.

3. Completely familiar and comply with the following rules and regulations:

   a. General Safety Orders, Group 6, Article 53 of the State Division of Industrial Safety.

   b. Federal Register Title 10, Chapter 1, Part 20.

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A. The only qualified personnel who will personnaly supervise the use of sealed sources and who will be in continuous attendance at the site of use are:

Paul G. Jonas
Charles B. Kendrick
Robert L. Benson
Robert G. Milliron
John Ribarchik

B. Mr. Paul G. Jonas will be directly responsible for the over-all radiation protection program. He will be assisted by Mr. Kendrick or Mr. Benson, and they will assume all of Mr. Jonas' responsibilities in his absence.

C. Mr. Ralph W. Zook and Mr. C. T. Berry, Assistant Safety Engineers, are assigned the duty of radiation protection officers. The duties of the radiation protection officers are:

1. To stop or suspend any operation which does not comply with the current Federal Register title 10 and Ammendments Part 20, and State Safety Orders.

2. Insist that only safe working conditions be practiced and maintained.

3. Inspect all safety, dosage, and medical reports for compliance.

4. To assist in emergency recovery of lost radioactive materials.

D. SUPERVISION

1. All operations involving exposure to radiation shall be under the direct supervision of qualified personnel familiar with hazards of exposure to such radiation as may be encountered.

2. In the use of radioactive materials, the radiographic technician will be responsible for monitoring the area and determining radiation intensity.

3. The radiographic technician will make a layout of the radiation field for the record. See Figure II and IIa.

4. Only those employees who are radiographic operators, directly involved in the use of such radiation, shall be permitted access to radiation of greater intensity than 6.25 mr/hr.

5. In no case shall the radiographic operator set up a radiation field which would allow persons, other than the radiographic operator, to receive a dosage greater than 5 mr.

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6. No one shall be permitted to enter a radiation field of greater intensity than 0.5 roentgens per hour.

7. No person shall be allowed to enter a radiation field without carrying a properly operating rate-indicating survey meter.

8. The maximum allowable radiation dosage to the radiographic technician is established at 100 mr per week or 20 mr per day.

9. When using buildings or property as a site for use or storage, the supervisor shall insure that persons responsible for the property are aware of the radiation hazard.

E. TRAINING COURSE OUTLINE

The technicians who will personally be working with the sealed sources shall be properly trained. This training will entail an approved A.E.C. course in Health Physics and Radiation Safety.

1. Fundamentals of Radioactivity

   a. Types of Radiation

2. Detection of Radiation

   a. Particle counters

   b. Ion chambers

   c. Electrometers

   d. Detection with film

3. Principles of Shielding

   a. Simple shielding computations

4. Health Physics of Radiation

   a. Biological effects of radiations

   b. Dose and dosage rate standards

   c. Detection and measurement instruments, principles and applications:

      1. Survey instruments

         a. Geiger-Mueller

         b. Ion Chamber

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c. Dosimeters

d. Film Badges

5. Handling of Radioactive Materials

a. Source storage and shipment

b. Health precautions in handling and storage

c. I.C.C. shipping regulations

d. Dosage rates VS cumulative dosage

e. Federal Register regulations title 10 and Ammendments Part 20, and State Division of Industrial Safety Orders Group 6, Article 53.

F. Instruction to Personnel Concerning the Safe Operation of Radiographic Exposure Devices

1. Cobalt 60 one curie source, open air radiography.

2. Kel-Ray Projector Model C-B, with 20 curie cesium 137 source.

3. Curtiss-Wright Puff Camera Model 10-5A with 30 curie iridium 192 source.

4. The personnel working with the foregoing radiographic exposure devices will not receive in excess of 100 mr per week. Our experience has shown in the past the 100 mr per week standard is well within our exposure limit.

G. Cobalt 60 Source Safe Handling Procedure

1. The cobalt source is the standard CR-1000 Tracerlab model. The source is equipped with a permanent identification tag attached to the handling chain.

2. The storage container for the one curie cobalt 60 source is the type E-33 container Tracerlab model. The container has a 5 inch wall-thickness of lead encompassing the source cavity and weighs 270 pounds. This container will be bracketed into the truck and locked with a key for transportation and storage. The container is also labelled showing the type and amount of radiation.

3. The handling of the cobalt 60 source will be limited and employed only as a last resort. Every effort must be exerted to use the iridium 192 or the Kel-Ray cesium 137 projector.

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4. The handling of the one curie cobalt 60 source will be the standard open air fish-pole technique. (Two methods used.)

First Method - The fish-pole is a 10-foot handler equipped with mechanical fingers for positive handling between storage container and radiographic set-up or from the storage container to a safety carrying pot for work done at great heights above the ground.

Second Method- A fish-pole handler 10 foot in length is fashioned with a hook and the source is hooked by the handling chain and lifted from the storage container to the radiographic set-up, or as above, from a safety carrying pot.

The methods of handling must be determined in advance in accordance with the rules and regulations of the Federal Register.

Note: For both fish-pole technique handling methods, there shall be a safety cord with one end attached to the source handling chain and the other end of the safety cord secured to the grip-end of the fish-pole. This is to insure immediate recovery in case source is dropped. The safety cord end, which is attached to the grip-end of the fish-pole, shall be fastened with a versatile hook which will enable the radiographic technician to secure the end of the safety cord to a magnet placed near the radiographic exposure set-up.

5. Identification tags or other attachments relating to the source capsule to be used outside the source holder will be secured by licensed laboratories equipped to handle such sources at close range; and likewise, all repairs or replacements of such tags or similar attachments will be handled by such laboratories through a contracted service agreement.

H. Characteristics and Methods of Operation of Kel-Ray Projector Model C-B with 20 Curie Cesium 137 Source

1. Prior to actual operation of the Kel-Ray Projector, the technician shall study the Kel-Ray handbook whereby he shall acquire a thorough knowledge of the projector operation and become familiar with nomenclature of parts.

I. Curtiss-Wright Model 10-5A Iridium Puff Camera with 30 Curie Iridium 192 Source, Characteristics and Methods of Operation

Here also the technician shall study the Curtiss-Wright operation manual for the 10-5A puff camera and become thoroughly versed in the operation, parts, and their designated names.

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J. Radiation Survey Instrumentation

1. The radiographic technician shall make a physical radiation survey at the jobsite where radiographic exposures are to be made to determine the level of radiation.

2. The types of survey instruments which are at the radiographic technician's disposal are as follows:

(Type of Survey Meters)	(Sensitivity Range-mr/hr)		
(1) Victoreen Gamma Survey Meter #592	(0-10)	(0-100)	(0-1000)
(2) Tracerlab SU-1H Survey Meter	(0-15)	(0-150)	(0-1500)
(3) Tracerlab SU-14 Survey Meter	(0.25)	(2.5)	(25.0)

3. All of the Survey Meters #1, #2, and #3 must be calibrated and checked at regular intervals and kept in good operating condition.

4. The calibration and checking of the survey meters shall be done by the manufacturer or qualified laboratories and the date recorded on the meter.

5. It is required that an actual physical radiation survey be made to determine compliance with Section 20.102 and 20.203 of Federal Register title 10, Part 20.

   Also - See Figure II for Radiation Survey Record.

6. It is mandatory that a physical radiation survey be made immediately after each radiographic exposure is completed. This is to determine that all sources have been returned to their storage containers or retracted into the safe position into the camera projector.

7. The Tracerlab SU-14 survey meter will be used for the wipe testing of the cesium 137 source. This is to be done only by Mr. P. G. Jonas or C. B. Kendrick and/or an authorized laboratory at 6 month intervals. The wipe test results must be recorded and kept on file for A.E.C. and safety inspection.

K. Instructions for Restricting Radiographic Areas

1. The state radiography program does not currently provide a permanent established radiographic area. The majority of the radiographic inspection is done on structural steel bridges at jobsite locations.

2. The security measures observed at jobsite location must conform to the Federal Register title 10 and Amendments Part 20, 20.201, 20.202, 20.203.

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3. All radiographic exposures must be personally under the radiographic technician's surveillance including roped off and signed areas. See Figure II and IIa for Radiation Survey Record.

L. Personal Monitoring

1. The radiographic technician, when handling radioactive materials or subjected to radiation, must wear a film badge which records the total dosage received. Separate badges are to be used for X and gamma radiation. Film badges are to be developed weekly.

2. The film badge service is handled under a contracted service agreement through a private laboratory. The film badge service is the twin-film type, which reveals a weekly and a 13-week cumulative exposure for personal monitoring of radiation received from X or gamma rays.

   The evaluation is made by the service lab and reports sent in triplicate each week, and at the end of 13-weeks the cumulative report is evaluated and the results are reported in triplicate.

3. The radiographic technician must also wear two dosimeters, of the Victoreen Direct reading Model 541/A 200 mr full scale type.

4. Daily dosimeter readings shall be posted on the personal radiation exposure record (Form T-646). See Figure I, Page 10 for comparison with the weekly badge exposure report.

5. Each employee as listed herein shall be under the supervision of, or in consultation with, a competent medical expert experienced in the diagnosis of harmful effects of ionized radiation. Prior to starting ionizing radiation and again at intervals not less than once annually while so employed for radiographic inspection, a physical examination shall be performed by the M.D. Periodic blood tests every three months shall also be included under the above policy. Reports of the medical examination and blood tests shall be kept current and on file with the employee's radiation exposure records.

M. Transporting of Sources to Field Locations

Radioactive sources shall be transported and stored in a state owned truck adapted especially for this purpose. The containers are secured by a bracket and locked with a separate lock other than the lock that is on the source container.

The source containers and brackets shall be locked at all times except when sources are being removed from the containers or the container is being used as a projector.

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The keys to the containers, bracket-locks, and projector locks, are placed in the custody of the radiographic technician to whom the sources have been entrusted.

The source projectors and cobalt 60 container are so shielded that there shall not be any radiation in excess of 2 mr/hr at the surface of the radiographic truck.

The radiation level in the driving compartment shall be less than 2 mr/hr. This shall be physically surveyed continuously for assurance.

1. The Kel-Ray Projector Model C-B for the cesium 137, 20 curie source, will be shielded, bracketed, and locked within the radiographic truck for transporting and storage.

2. The Iridium Projector Curtiss-Wright Model 10-5A, accommodated with the 30 curie iridium source, will be shielded, bracketed, and locked within the radiographic truck for transporting and storage.

3. In addition to locked source containers, the radiographic truck has locked doors, and the technician shall keep these radiographic truck doors locked at all times except when sources are being removed or returned to their containers or brackets.

4. When the sources or containers are being removed from the radiographic truck, the truck shall be posted according to the Federal Register Title 10, Part 20, Section 20.203.

5. The radiographic truck, when not in use, shall be locked and preferably backed up to a concrete wall or barrier, so a thief would not be tempted to break open the locked door.

   The keys to the radiographic truck shall be entrusted to no one but the radiographic technician to whom the keys have been issued.

6. In case of a road accident when transporting the sources and (resulting in radiation danger), the local Civil Authorities and the California Division of Highways, Materials and Research Department, shall be notified. Telephone number is Sacramento, Gladstone 2-5481. Ask for Mr. Paul Jonas. If Mr. Jonas cannot be reached, then ask for Mr. Victor Sayers. He will then notify the proper authorities to take action.

   Specific instructions to this effect will be printed on the dashboard of the radiographic truck on the driver's side. Also refer to Emergency Procedures (Q).

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N. Shipment of Radioactive Sources

In case of shipment by commercial carriers becomes necessary, prior authority will be secured from headquarters and the appropriate interstate commerce commission regulations will be complied with.

O. Security of Sources When Stored in Areas Other Than The Radiographic Truck

1. When the radiographic truck is at the headquarters office, the sources shall be stored in the subterranean concrete vault. This vault is equipped with steel doors and locked. The keys to this vault are in Mr. Paul Jonas' possession.

2. The standard warning signs are posted on the steel doors of the concrete vault.

3. There is no radiation level from the sources at the external surfaces of the concrete vault or the steel doors.

4. When sources are being removed from or returned to the storage vault, a physical survey shall be made in each case.

P. Removal and Exchange of Sealed Sources

1. For the Model 10-5A Curtiss-Wright Iridium 192 camera, the annual contract calls for an original and five replacements of one 30 curie iridium 192 source, especially encapsulated as per Curtiss-Wright drawing 30-5. Shipments are based on the half life of the iridium 192.

2. The removal and exchange of the iridium 192 capsule from the special shipping container to the 10-5A camera will be as follows:

   The Curtiss-Wright special shipping container for the iridium source is equipped with two compartments especially fitted to take the iridium camera source cable. The half-spent iridium source is then blown into the shipping container.

   The source cable is then fitted to the new iridium source compartment and the new source blown back into the iridium camera.

   The Curtiss-Wright iridium source 192 shipping container is then locked and shipped back to the Curtiss-Wright Company via air express, according to appropriate shipping regulations.

Note: A physical radiation survey is always maintained to assure the radiographic technician that the sources are in their proper places.

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Q. Emergency Procedures

For emergency such as listed below, immediately call the local Civil authorities and California Division of Highways, Materials and Research Department, Sacramento, California, phone GLadstone 2-5481 and ask for Mr. Paul G. Jonas. If unable to contact Mr. Jonas, ask for Mr. Victor Sayers.

1. In the event of an accident involving the radiographic truck and sources, the technician shall rope off the area until the Civil authorities and/or the Disaster Squad arrive.

2. In case of theft or loss of radioactive materials, the technician shall immediately notify the above.

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The radiation exposure record Figure I shall be filled out completely in triplicate by the radiographic technician for the type of radiation he receives. The dosage reported shall be that as recorded by the pocket dosimeter.

The radiation exposure record shall be turned in once a month with the technicians' time sheets or as requested by the department or safety section.

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Figure I

MATERIALS & RESEARCH DEPARTMENT

RADIATION EXPOSURE RECORD

(Recorded by Pocket Dosimeter)

FORM T-646 (ORIG. 1-58)

Signature: _____

Month: _____ 19____

SHOW DATE BELOW EACH DAY

Source	Total Radiation To Date:	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	Mr							
X-Ray	Mr							
Iridium 192	Mr							
Cesium 137	Mr							
Cobalt 60	Mr							
Radiation Received This Week								

Source	Total Radiation To Date:	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	Mr							
X-Ray	Mr							
Iridium 192	Mr							
Cesium 137	Mr							
Cobalt 60	Mr							
Radiation Received This Week								

Source	Total Radiation To Date:	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	Mr							
X-Ray	Mr							
Iridium 192	Mr							
Cesium 137	Mr							
Cobalt 60	Mr							
Radiation Received This Week								

Source	Total Radiation To Date:	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	Mr							
X-Ray	Mr							
Iridium 192	Mr							
Cesium 137	Mr							
Cobalt 60	Mr							
Radiation Received This Week								

Source	Total Radiation To Date:	Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
	Mr							
X-Ray	Mr							
Iridium 192	Mr							
Cesium 137	Mr							
Cobalt 60	Mr							
Radiation Received This Week								

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The radiation survey record Figure II or IIa, whichever is appropriate to the job, shall be made out in triplicate for each radiographic exposure. The sign stations and sign location should show the mr/hr and the distance in feet from the source used or set-up location.

The radiation survey records should be turned in as follows: one should stay with the radiograph exposed, one should go into the contract file, and one should stay in the technician's file until the job is completed.

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FIGURE II

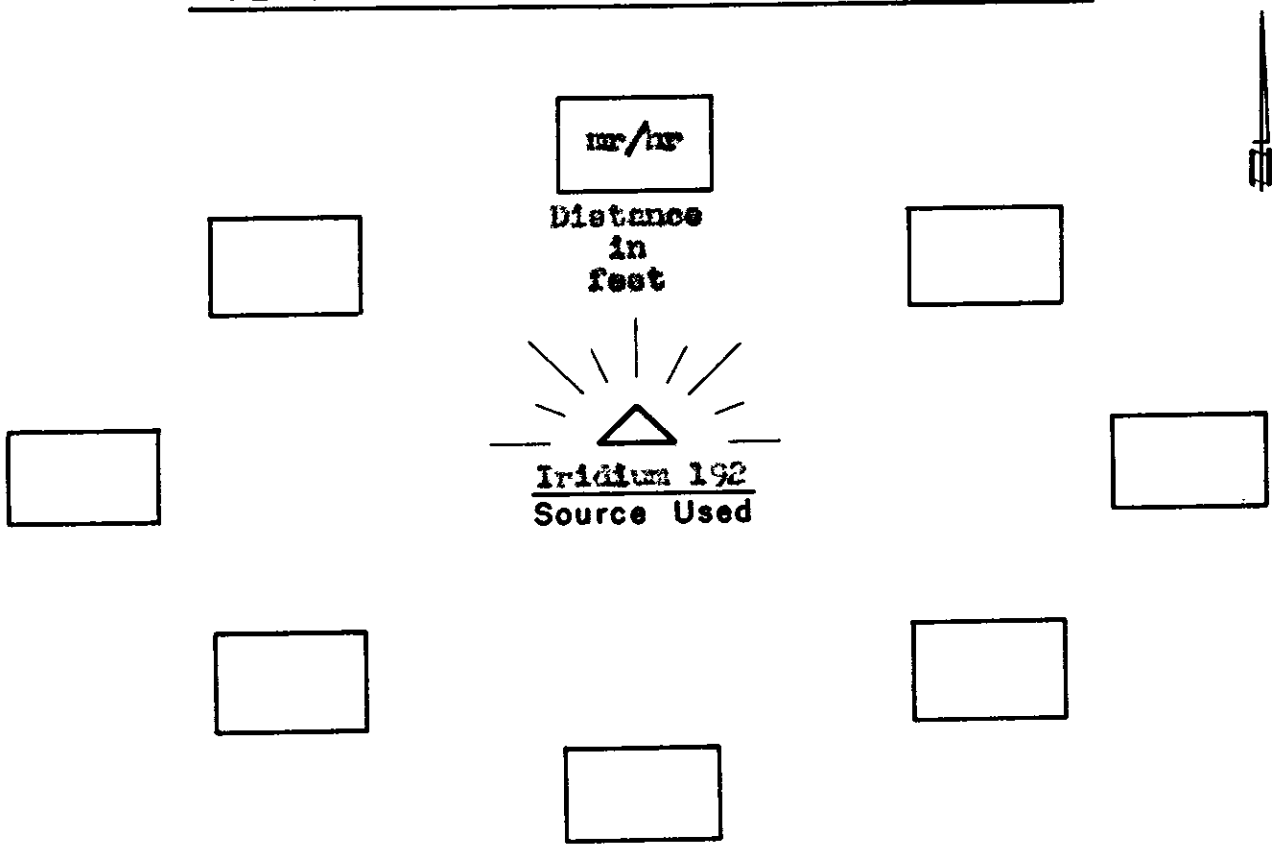
RADIATION SURVEY RECORD

Contract No._____ Co._____ Rt._____ Sec._____

Technician_____ Structure_____

Date_____ Structural Shape_____

PLAN VIEW OF SET-UP & SIGN LOCATION



Exposure No.	Exposure Time	Structural Unit	Remarks

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FIGURE IIa

RADIATION SURVEY RECORD

Contract No._____ Co._____ Rt._____ Sec._____

Technician _____ Structure _____

Date_____ Structural Shape _____

Set-up	Set-up Location	Sign Sta. No.	Sign Location	mr / hr
			IN FEET	

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MODEL FORM

State of California
Department of Public Works
Division of Highways
Materials and Research Department

Responsibilities of a Radiographic Technician for

Handling of Radioactive Sources

You are one of the men in the Materials and Research Department assigned to radiographic work. This is a highly responsible function for which you have been carefully selected and trained.

Whenever you are working with radioactive materials the reputation and confidence of the State of California rests with you, especially insofar as the safety to yourself and others is concerned.

This responsibility includes the use of x-ray equipment, a one-curie cobalt 60 source, Tracerlab Model CR-1000, a Kel-Ray Projector C-B with a 20 curie cesium 137 source, and a Curtiss-Wright camera Model 10-5A with a 30 curie iridium 192 source.

When this equipment is used by competent personnel, it is completely safe.

It is the policy of this department that any employee working with radioactive materials does not absorb any more radiation than 100 mr per week, instead of the 300 mr per week standard.

The personal monitoring equipment with which you will be equipped includes pocket dosimeters, film badges, and radiation survey meters for your personal protection and for the protection of others. You have been especially trained by a formal course dealing with the safety and handling of radioactive sources.

In addition to the above safety equipment and training, you are required at state expense to take periodic blood tests and physical examinations.

Under the safety policy and precautions there is no reason other than personal carelessness for you to be in any danger insofar as present knowledge of handling radioactive sources is concerned. Therefore, the responsibilities listed in the following statement are expected of you.

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Statement by Radiographic Technician

1. I accept responsibility for physical security, safe handling, and transporting of all radioactive sources entrusted to my care.

2. I have read, familiarized myself with, and understand the Federal Register Title 10, Part 20 and the General Industry Safety Orders Group 6, Article 53.

3. I have read, familiarized myself with, and understand the California Division of Highways, Materials and Research Safety Manual and Administrative Instructions to radiographic personnel.

4. I will comply with the requirements of the Federal Register Title 10, Part 20 and this manual. I understand that failure to do so will result in disciplinary action and/or dismissal.

5. I will insure that all persons including observers comply with the listed safety rules and regulations.

6. I will not delegate custody of any state supplied radioactive source to any individual not qualified under this department.

Unauthorized source transfer will not be tolerated.

_____ Date

_____ Signed by radiographic technician

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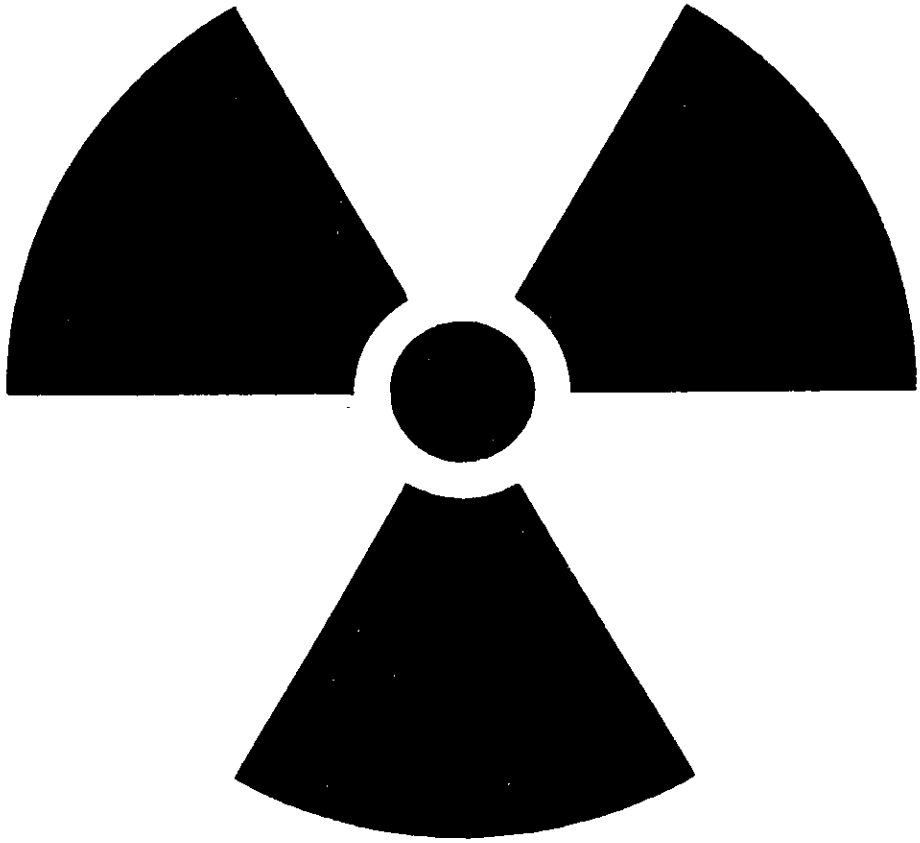
STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



RADIATION AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL2-5481-NIGHT PHONE GI 2-2846

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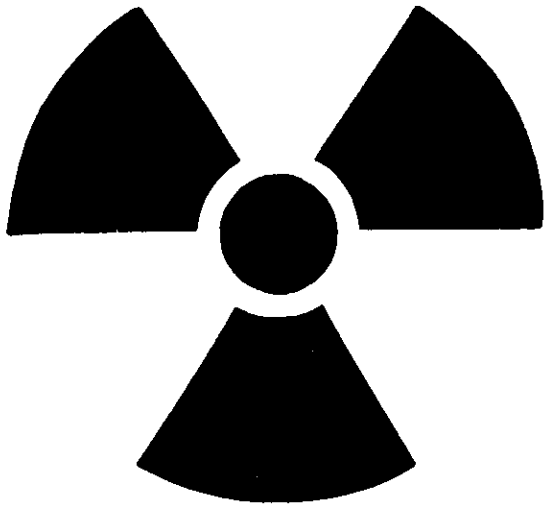
STATE OF CALIFORNIA DIVISION OF HIGHWAYS
MATERIALS & RESEARCH DEPARTMENT
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



RADIATION AREA

DO NOT ENTER THIS AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL 2-5481 - NIGHT PHONE GI 2-2846

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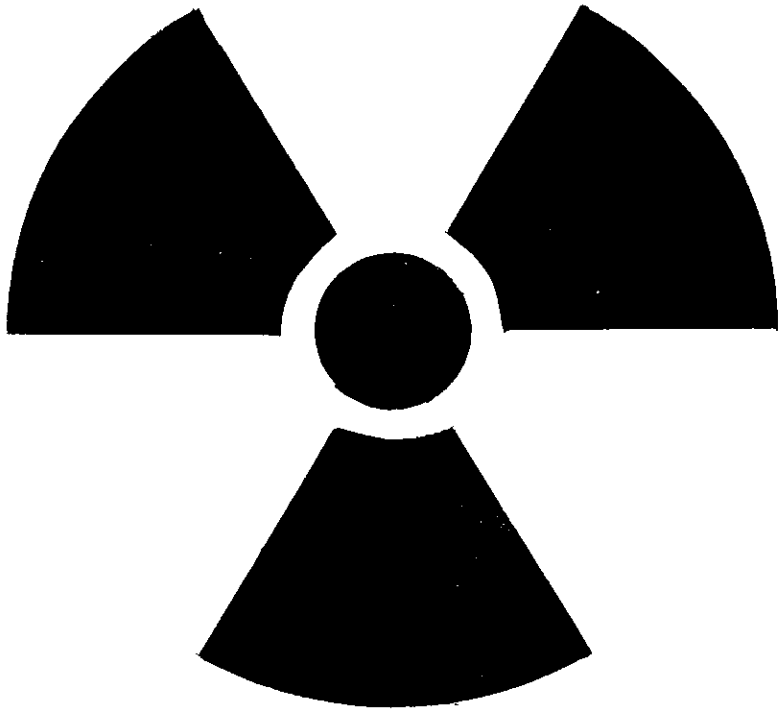
5900 FOLSOM BLVD. SACRAMENTO

CAUTION



HIGH RADIATION AREA

IN EMERGENCY CALL LOCAL CIVIL AUTHORITIES AND
PAUL JONAS SACRAMENTO GL 2-5481 - NIGHT PHONE IV 9-1701
VIC SAYERS SACRAMENTO GL2-5481-NIGHT PHONE GI 2-2846

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