



Doug Coe To: Reba Torres/D04/Caltrans/CAGov@DOT
01/27/2006 09:48 AM cc:
Subject: Contract 04-012024- DRB Recommendation, NOPC#11

----- Forwarded by Doug Coe/D04/Caltrans/CAGov on 01/27/2006 09:46 AM -----



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01/26/2006 02:23 PM cc: FGraebe@aol.com, dickLewis1@cox.net, Lee.Zink@KFMJV.com
Subject: Contract 04-012024- DRB Recommendation, NOPC#11

Gentlemen, Attached is the DRB's unanimous Recommendation to assist in the resolution of NOPC#11-Hinge Pipe Beams. It is the Board's plan to deliver the signed hard copy of the Recommendation to the parties at the DRB Meeting next Tuesday, January 31, 2006. This will then be the date when the various contract specified time periods will begin to run. Sincerely, Warren Bullock- DRB Chair



NOPC 11 Final 012606.dc

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DISPUTE REVIEW BOARD

State of California- Department of Transportation

Contract Number 04-012024 – East Span Skyway Project

Dispute No. 5 – Notice of Potential Claim #11 – Hinge Pipe Beams

Hearing Dates: November 17, 18 and December 5, 6, 2005.

Hearing Attendees: Caltrans' Representatives:

Peter Siegenthaler	Brian Maroney
Doug Coe	Dr Alan Pense- ATLSS, Lehigh University
Don Ross	Doug Williams – TY Lin/MN
Jim Merrill	Sajid Abbas – TY Lin/MN
Doug Wright	Nancy Bobb-FHWA –11/17 only
Venkatesh Iyer	
David Wu	
Mark Woods	
Patrick Treacy	

Contractor Representatives:

Lee Zink	Dr Robin Gordon-EWI MicroAlloying
Kent Boden	Matt Nousak- Middough Consulting Inc
Paul Giroux	William Kavicky- Trans Bay Steel
Kevin Rozendaal	Jay Murphy- Trans Bay Steel

BACKGROUND

The East Span Skyway Project consists of two superstructures (Eastbound and Westbound) consisting of a total of 452 precast concrete girder segments utilizing balanced cantilever construction for a total of four rigid frames including fourteen piers per superstructure. The substructure includes steel box/reinforced concrete footings supported on cast-in-shell concrete piles.

The project includes 20 hinge pipe beams (HPBs) between the frames of the superstructure to allow for thermal expansion and seismic movements. Two HPBs are installed at each hinge. The HPBs are about sixty feet long and six feet in diameter, fabricated from HPS 70W steel plate up to 4 inches thick (65mm, 85mm and 100mm plate thicknesses).

The California Department of Transportation (hereinafter referred to as the “State”, “Department”, “Engineer”, or “Caltrans”), awarded the contract for the East Span Skyway Project (Contract Number 04-012024) to Kiewit/FCI/Manson, JV, (hereinafter referred to as “KFM”, or “Contractor”), on January 17, 2002.

The Contractor initially selected Struthers Industries Inc./Irby Steel (herein after referred to as "Struthers") to fabricate the 20 HPBs. During the course of the contract Struthers filed for bankruptcy and KFM consequently awarded the fabrication contract to TransBay Steel Corporation (hereinafter referred to as "TransBay" or "TBS") on November 3, 2003.

DESCRIPTION OF DISPUTE

On September 7, 2004, TBS transmitted a letter advising KFM that during production, several of the longitudinal seam welds on the hinge pipe beams had experienced separation after re-rolling. TBS further indicated that its approved welding procedure for the longitudinal welds on the pipe beams was written in accordance with the special provisions. TBS also stated that its fabrication procedure was designed to meet the tight tolerances for roundness and curvature and that to its knowledge, the only way to meet the tight tolerances was by re-rolling each can after the longitudinal seam weld had been completed. TBS stated that it intended to request a time extension and cost increases as a result of the necessary weld repairs. KFM submitted the TBS letter to the Department on September 10, 2004.

The Department responded by letter dated September 20, 2004, advising the Contractor that the rolling equipment and methodology were part of TBS's and KFM's means and methods, and they were responsible for developing a fabrication procedure that would produce the pipe beams without damage. Since this was within TBS's and KFM's scope of work no time or cost increases to the Department could be justified.

As a result of the State's response TBS filed a Notice of Potential Claim with KFM on September 29, 2004, and this was submitted to the Department on October 1, 2004. The State advised KFM by letter dated October 15, 2004, that the Engineer had determined NOPC #11 to be without merit.

In a letter dated October 29, 2004, TBS requested KFM to forward this issue to the Dispute Review Board and at the same time offered additional information which included TBS's belief the plate material specified for the HPB's to be the wrong choice, the weld material specified for the HBP long seams to be the wrong choice and the PQR procedures in the special provisions did not represent the true stresses. KFM forwarded this TBS letter to the Department on October 29, 2004 and NOPC #11 was referred to the DRB by KFM on November 3, 2004.

Meetings between TBS/KFM and the Department occurred, to discuss concerns of the possibility that the weld filler material over-matched the base metal. TBS/KFM contended the over-matching contributed to the causation of cracks and the Department confirmed its willingness to change the welding wire in a letter dated December 22, 2004.

In addition to the daily contact of TBS, Caltrans' inspectors and QC/QA personnel, numerous summit meetings to discuss the can fabrication problems were held with Caltrans, KFM, TBS, QC/QA personnel and various consultants. Summit meetings to discuss the issues and develop alternative methods and procedures to resolve the problems occurred on October 4, 2004, November 1, 2004, January 4, 2005, February 11, 2005, March 9, 2005, March 11, 2005 and April 13, 2005. TBS's letter of March 11, 2005 summarized the various alternative procedures that were proposed to mitigate the cracking and also included a summary of the toe crack data. Caltrans' letter of March 25,

2005 noted that “hot” (warm) rolling at temperatures between 425 degrees C and 590 degrees C would require that the PQR plate be similarly treated and its mechanical properties tested before being used in production. This letter also expressed Caltrans’ concerns about TBS’s ability to maintain the specified temperature range given its logistical and equipment resources. During the period from the filing of NOPC #11, TBS continued to attempt to fabricate and perform repair on cans for the hinge pipe beams with limited success. Also, destructive test samples were taken from the rolled cans and tested extensively by KFM’s consultants.

On February 25, 2005 and March 2, 2005, TBS successfully met the tolerance requirements and delivered the eastbound D pipe beams.

On April 15, 2005, TBS informed KFM that it had ceased all rolling and long seam welding operations on April 13, 2005, following a meeting with Caltrans, METS and KFM to discuss the issues surrounding the long seam welds. TBS indicated that at the meeting all parties acknowledged there was a material problem with the HPBs and agreed to work towards a solution. TBS’s letter was forwarded to the State the same day.

The Department responded on April 21, 2005, advising KFM that the State believed TBS had not exhausted all of its options regarding changes to its fabrication methods and requested TBS to return to work. Further, since TBS had not exhausted all its options to resolve its fabrication problems the State did not agree with its actions nor its interpretation of the April 13, 2005 meeting.

In a follow-up letter on April 27, 2005, the Department urged TBS to return to work, and offered additional suggestions to help correct the TBS fabrication issues, primarily the crack repairs to the B and C series HPBs.

TBS responded to the State’s letter of April 21, 2005, in its letter to KFM dated April 27, 2005. TBS sought to clarify specific items in the Department’s letter, as well as confirming its belief that the root cause of the cracking problem was in the choice of base material and filler material.

On May 6, 2005, the Department directed TBS to return to work and to incorporate certain specific directions into its fabrication procedures. A Contract Change Order would be issued for the specifically directed work. The directions were to apply only to the work on the longitudinal seams of the 100mm thick cans. The Department also stated that since all the fabrication options had not been exhausted before ceasing work, the related costs of stopped production for the previous two weeks would not be the responsibility of the State.

At a May 12, 2005 summit meeting, KFM indicated to Caltrans that the proposed solutions to the fabrication process may very likely not work and could in fact ultimately delay the project. The Engineer responded that “this was part of the due diligence that Caltrans was required to make in order to try everything to get the original design to work.”

On June 17, 2005, the Department, in accepting KFM’s April 2005, revision schedule also requested responses to Department comments, including details of the “critical” portion of the “Pipe Beams:Fabrication” work activity. In a separate letter, also June 17, 2005, the Department responded to KFM’s June 14, 2005, request for a time extension for delays experienced in the pipe beam fabrication, advising KFM that contract time extensions could only be granted when the delay was beyond the control and without the fault of the Contractor. Since NOPC #11 dealt specifically with this issue

time extensions would only be considered pending its resolution and analysis of possible mitigation measures.

In describing certain extra work to be included in CCO #160 in a letter dated June 20, 2005, the Department also directed TBS to accelerate the work to be able to deliver the two pipe beams for Eastbound Hinge C as quickly as possible. TBS acknowledged receipt of this letter the same day and confirmed it would proceed with the additional work and its acceleration.

On August 1, 2005, the Department advised the Contractor that despite its prior directions to work longer and additional shifts, TBS, as of that date, was continuing to work only two shifts of eight hours and the second shift had typically only two or three workers. The Department further advised KFM that the then current rate of progress at TBS was not acceptable and reminded KFM of its responsibilities under Sections 5-1.01, 8-1.07, and 8-1.09 of the Standard Specifications. TBS was to proceed with the ordered work without delay and if it did not any resulting schedule delay from lack of acceptable progress would be the sole responsibility of the Contractor. The Department finally directed that work be performed 24 hours per day 6 days per week and requested KFM to submit a CPM schedule demonstrating what steps had been taken to mitigate delays.

The same day, August 1, 2005, KFM's letter advised the State that TBS continued to increase personnel to provide the acceleration to mitigate the ongoing project delay and to react to the changing requirements and that TBS and Caltrans had added QC and QA UT inspectors to stay ahead of the welders.

KFM responded to the Department's letter of August 1, 2005 on August 11, 2005, advising it had agreed to provide the requested schedule and further advised that KFM had provided preliminary project recovery schedules that might mitigate the delay from -142 to -59 days. The recovery schedules were based on the implementation of certain changes to other project activities and KFM sought the Department's direction as to selection of the appropriate recovery schedule.

On August 12, 2005, the State advised KFM that according to the Department's observations KFM and TBS had not been working actively over the previous few weeks to mitigate delays and that TBS was working very little on the delivery of pipe beams for Eastbound Hinge B, Westbound Hinge D and all other future pipe beams. The critical operation for delivery of the future pipe beams was rolling and re-rolling yet the TBS rolls had been idle for nine of the previous ten days. Further the Department had not yet been provided with the requested resource loaded CPM schedule.

On August 17, 2005, KFM responded to the Department's August 12, 2005 letter advising that the BE beam had been re-rolled and that the critical activity was in fact clearing the long-seam weld repairs and the DW beam was on hold awaiting the State's decision on the type of weld wire to be used, following testing of alternative weld wires.

Then on August 18, 2005, the Contractor advised that Department, that as the Department was aware, KFM had assembled a group of experts from across the country with expertise in materials engineering, welding and metallurgy. The group's mission was to evaluate and provide guidance regarding the ultrasonic indications found in the longitudinal weld of the HPB's after re-rolling. The experts started a materials testing program on January 20, 2005 and the results were forwarded in a report to Caltrans on April 13, 2005. KFM's experts performed a second test program, witnessed by Caltrans, May 17 through May 20, 2005. KFM's panel of experts made a presentation of its

findings to the Department on June 24, 2005 and a formal report was transmitted on July 6, 2005. Consistent with its experts' recommendation, KFM tested additional materials, also witnessed by Caltrans, during the week of August 1, 2005, and on August 12, 2005, KFM's panel of experts presented its updated findings to Caltrans.

KFM's "approximate order of magnitude" claim under NOPC # 11 ranges from \$50.284M to \$88.288M, including TBS's direct and delay costs, based on delays of 48 to 140 days to the project critical path.

CONTRACTOR'S POSITION

The following is a summary of the basis of entitlement. Full details of KFM's position are included in its Position and Supplemental Position Papers.

The dispute is whether the State provided directions for fabrication of the hinge pipe beams that would allow a competent mechanic to perform the work.

Special Provisions section 10-1.44 requires that "The Contractor shall fabricate pipe beams in accordance with the approved fabrication procedure conforming to the requirements of these special provisions." TBS's plan was reasonable and prudent. The State approved TBS's fabrication plan that detailed all equipment and methods including re-rolling the pipe sections after longitudinal seam welding. TBS's facility was approved by Caltrans during the steel Audit. TBS is also AISC approved for fracture critical members.

The State and the State's Designer worked with KFM from August 2002 until September of 2003 to conform plan sheet section G-G to the governing Special Provision tolerances. After considering many options, CCO #30 was issued by the State ordering two additional restrictions to pipe tolerances. Effectively, CCO #30 reduced the out-of-round tolerance by 50%. Re-rolling pipe sections was necessary both before and after the change.

Beginning in August of 2004, the longitudinal seam UT test results showed excessive indications requiring excavation and re-welding. The added work to date has caused a 28 week job delay that was mitigated to a 12 week job delay.

TBS worked with the State, State's Designers, KFM and its experts between October 2004 and now, (October 2005) brainstorming solutions to the excessive UT indication issues. Late April 2005, the State ordered many CCO #160 experiments that varied the work plans exhausting the final viable options for resolving the issues. Finally, Caltrans ordered changes relaxing the longitudinal weld UT requirements and eliminated the RT requirements allowing the project to move forward.

Since October 2004, KFM has employed the assistance of experts in the fields of metallurgy, fracture mechanics and welding. Exhaustive testing has been employed to understand the base metal properties such that KFM's experts are now referred to as "world experts" regarding the thru-thickness properties of 100mm HPS 70W steel. Both PW Marshall (primary author of AWS – D1.1 Tubular) and Allen Sindel (Co-chair AWS – D1) have requested KFM's experts to author a paper for the ISOPE 2006 and AWS on the HPS 70W through-thickness properties. The experts are in complete agreement that the specified fabrication process exhausts the ductility of the HPS 70W base metal and UT indications are to be expected after re-rolling.

Per Caltrans Plans, Specifications and Estimates guide, “The fundamental requirement for Caltrans to provide quality PS&E’s is found in Section 10120 of the State Contract Act. It states, “Before entering into any contract for a project, the department shall prepare full, complete and accurate plans and specifications and estimates of cost, giving such directions as will enable any competent mechanic or other builder to carry them out.”

TBS followed the directions given in the plans and specifications and the directions did not produce a satisfactory result. The landmark case of *United States v Spearin*, 24B U.S.132 (1918), and later cases hold that an owner furnishing contract documents to prospective bidders impliedly warrants the accuracy of any factual representations and the adequacy of the specified design, materials and methods.

The awarding authority providing plans and specifications for a project impliedly represents that the design, materials, and methods prescribed in the plans and specifications will yield a satisfactory result. In other words, the awarding authority should be held responsible if the plan was not workable or produced a poor result. A breach of the implied warranty occurs when a project, although constructed in accordance with the plans and specifications, contains material defects or cannot be completed without using a more expensive design or method than specified. For a breach of the implied warranty of suitability, KFM/TBS can recover cost for remedial work performed on the project and the additional delays or impacts caused by the breach.

KFM and TBS are entitled to compensation for the additional costs caused by the inadequate directions to perform the work.

DEPARTMENT’S POSITION

The following is a summary of the Department’s position. Full details are included in its Position and Supplemental Position Papers.

The Department has determined that there is no merit to KFM’s claim for additional compensation for the required repairs because the specifications primarily set forth the performance standard the finished product is required to meet. The Contractor made its own business decisions in choosing fabricators, equipment, and processes in an attempt to comply with the contract requirements. These decisions affected the Contractor’s ability to meet their schedule, caused equipment breakdowns, and caused an excessive amount of repairs. The Department cannot be held responsible for the delays and costs associated with the chosen means and methods.

The Davi rolls have had two major breakdowns lasting two months each totaling sixteen weeks of delay. Because of the fabrication methods chosen, the Department has allowed modifications to the specifications to accommodate the Contractor and to keep the project moving. As a result, the Department’s actions have minimized the damages incurred by KFM and TBS.

The Contractor has claimed that their means and methods should have worked without delay, without modification and without repairs. The Contractor has cited the public contract code claiming that any competent mechanic should be able to carry out directions if the plans and specifications are complete, and accurate. However, the contract does not provide directions on how to perform the work or what equipment to

use; this choice is left to the Contractor's discretion as long as he attains the necessary performance standard.

In summary,

- Contractor is responsible for equipment selection and equipment breakdowns.
- The contractor has requested compensation for weld repairs required by contract.
- Initial start-up contributed to delays and cost over-runs.
- The weld procedure qualification requirements in the Special Provisions did not cause the longitudinal seam cracking.
- Contractor's fabrication methods caused welding and HAZ failures, and equipment breakdowns, which have created project delays.
 - The long seam cracking is caused by low cycle/plastic fatigue due to excessive re-rolling after welding.
 - Weld repairs have been required to correct slag inclusions, cracks and other defects caused by the welders. KFM has not itemized these for exclusion from this claim.
 - The delays experienced with the long seam cracking were intensified by a lack of production and quality controls. All of the earliest cans with longitudinal seam cracking did not have the weld reinforcement removed prior to re-rolling even though this significantly reduced the number of cracks.
- The weld material meets the classification requirements of the contract, but was selected by the Contractor in contradiction to the recommendations in the "Guide for Welding HPS70W."
- The results of all testing of the HPS70W steel to date, including KFM's weld procedure qualification and their extensive testing program, meet all code and specification property requirements.
- Cracking has occurred after re-rolling in the weld itself or in the HAZ. Cracking at the weld toe and within the weld can be attributed to low cycle/plastic fatigue caused by excessive plastic forming cycles that greatly exceed the industry norm for rolling heavy plate. The remaining weld repairs are to correct workmanship problems, such as slag etc. The facts indicate that the cracks are a direct result of the fabrication means and methods used by the Contractor, not the choice of the plate material for the pipe beams.
- Other options have not been fully explored by the Contractor, including:
 - Cutting plate width in half and rolling more cans would require less rolling force and decrease the amount of cold working of the material.
 - "Warm" forming was selected by Struthers to form the cans. The location of the TBS's oven causes logistical difficulties in maintaining the temperature; although temporary furnaces could be constructed.

- Development of better heat management systems for production welding. (e.g. resistance strip heaters)
- Appropriate placement of welding beads avoiding vertical stacking.
- Avoid placing cap passes outside the weld joint.

DRB FINDINGS & CONCLUSIONS

PLANS & SPECIFICATIONS

1. Government Code Section 10120

The Contractor's position is that the Department did not comply with Public Contract Code 10120, which states, "Before entering into any contract for a project, the Department shall prepare full, complete and accurate plans and specifications and estimates of cost, giving such directions as will enable any competent mechanic or other builder to carry them out". KFM argued that the contract documents were not full, complete and accurate and since TBS was a competent mechanic the Department was liable for the extra costs of performing the contract work.

The Department maintains that PCC 10120 is not applicable since this contract is a seismic retrofit project and as a result the Streets and Highway Code Section 180 et seq applies which waives PCC section 10120 for seismic retrofit projects. As KFM's claim relies solely on the PCC there is no legal basis for its claim.

The DRB finds and concludes that the Department had an obligation to furnish complete and accurate plans and specifications for this project. The Department has not shown, and the DRB has not found, any reference in the contract documents to this project being a "seismic retrofit" project. Besides, there is no portion of the project that requires "retrofitting" any existing construction. Last but not least, absent a clear expression in the contract documents that this project is a seismic retrofit project, governed by the provisions of Streets and Highways Code sections 180 et seq., the Department impliedly warranted the adequacy of the plans and specifications.

It is the finding and conclusion of the Board that the contract documents, at time of contract award, were incomplete and due to the contingency of unknown conditions of completing the work, the Contractor is entitled to be compensated for any additional work required to complete the project.

2. Specification of HPS 70W Steel

The difficulties in performing the contract work appears to arise from the Department's choice of the specified material (HPS 70W) to be used in an unusual and apparently first-time application - taking 100mm (4 inch) thick plate and rolling (forming) it into 1900mm (6.23 feet) diameter cans, welding the longitudinal seam and then re-rolling the cans to form a circular shape to meet the extremely tight circularity

tolerances specified. The tolerances dictate the amount of re-rolling required - around 4 passes to obtain 9mm out of round and about a further 13 passes to obtain 2mm (maximum diameter less minimum diameter) as performed by TBS for the Department's rolling expert on November 10, 2005.

The DRB heard testimony that this was apparently the first time this high performance steel (HPS 70W), in plates of 65mm, 85mm and 100mm thickness, had been used in this type of application at the design radii indicated on the plans.

The DRB further finds and concludes that the plans and specifications pertaining to the fabrication of the HPS 70W hinge beams were defective in that they did not alert the Contractor that the HPS 70W steel had never been rolled into cans of 1900 mm diameter in the specified thicknesses and that the actual properties of this quenched and tempered steel would pose severe problems in the fabrication of the hinge pipe beams.

One consultant experienced in the design of tubular members for offshore oil platforms testified that normal practice before a new type of steel was used in tubular fabrication would be to have it "prequalified" as appropriate for that application before being specified. Such prequalification was not performed in this instance.

U.S. Steel, the supplier of the steel plate, in a letter to KFM on April 9, 2005, opined "that the cracking found is related to the amount of cold work induced into the steel plate and weld. The U.S. Steel properties card for the steel provided recommends that cold forming be restricted to a maximum thickness of 50mm."

3. Cold Rolling versus Warm Rolling

The Special Provisions at Section 10-1.44 STEEL STRUCTURES, Pipe Beams require forming to be performed at ambient temperature unless approved and qualified at elevated temperature, yet, AASHTO/NSBA, Steel Bridge Collaboration S 2.1 – 2002, at Section 4 -Workmanship, Para 4.3.1 states: "Do not cold-bend fracture-critical materials".

The Hinge Pipe Beams are specified to be fracture critical members yet the Board heard testimony that technically they are not but were specified as such by the Department in order to guarantee a quality product.

As stated above, U.S. Steel, the supplier of the steel plate, in its letter to KFM on April 9, 2005, opined "that the cracking found is related to the amount of cold work induced into the steel plate and weld. The U.S. Steel properties card for the steel provided recommends that cold forming be restricted to a maximum thickness of 50mm." AASHTO/ NSBA S 2.1-2002 "Steel Bridge Fabrication Guide Specification" does not permit cold bending of fracture critical materials.

The weight of evidence (and the benefits of hindsight) is perhaps that the 100mm (and 85mm) plates should have been warm rolled but since the specifications clearly preferred cold rolling to be performed (the specifications used the mandatory “shall”), and the Contractor, in complying with the specifications, had the right to rely on the indications given in the contract documents that cold forming would produce satisfactory and acceptable results. The Board heard evidence that warm forming the steel within the narrow band allowed in the specifications would increase the yield strength by only 12%. The Board heard considerable consultant testimony that warm rolling would have minimal, if any, beneficial effect to the rolling of the cans.

The supplier of the rolls, Davi, indicated that the bearings were designed for only cold rolling, implying that different bearings would be required if warm rolling was subsequently used in the fabrication process.

The Board finds and concludes that any adverse effects produced by cold-rolling were precipitated by the Department’s direction to form this material by cold-rolling.

INVESTIGATION OF THE METALLURGY & CRACKING MECHANISM

KFM, following extensive testing of samples taken from the HPS 70W product by Matthew Nousak of Middough Consulting Inc., concluded that the weld toe-cracking in the cans of 85mm and 100mm plate thickness was a combination of:

- (1) The presence of a relatively hard shallow strain-sensitive layer at the plate surfaces that results from the quenching and tempering of the steel during the manufacturing process.
- (2) The presence of an overmatching weld deposit.
- (3) Significant strain hardening and aging resulting from cold forming, and thermal processing (welding, gouging, preheat) fabrication requirements of the cans.

KFM’s consultants concluded that consequences of these phenomena were an increase in hardness, yield strength and tensile strength, a decrease in elongation and reduction of area, and an increase in the temperature of transition from ductile to brittle fracture at the surface and HAZ of the plate, resulting in cracking during and after re-rolling.

The Department’s consultant (Dr Alan Pense) on the other hand concluded that the primary cause for cracking of the cans was low cycle plastic fatigue induced by fabrication processing due to the extensive rolling during forming.

Although believing them not to be primary causes the Department also found that toe cracking may have resulted from:

- (1) Higher hardness zones at the plate surfaces.
- (2) Weld/HAZ Hydrogen induced.
- (3) Exhaustion of available toughness and ductility of the HPS 70W steel.
- (4) Differential strengths of plate and weld metal.

Another KFM expert, Dr Robin Gordon agreed that low cycle fatigue may be a contributing factor but was not the primary cause. He concluded that although the 85 mm and 100mm thick plates received from U.S. Steel meet the tensile and Charpy properties of base material for the HPS 70W specifications they show variations in through-thickness tensile properties of 20% and higher yield strength at the surface. After rolling and aging the 100mm plate outer surface yield strength increases up to approximately 106ksi and the Y/T ratio increases to approximately 1.0. Initial rolling and welding exhausts the ductility of the base material and creates a low toughness HAZ microstructure. Local strains produced during final rolling in the low ductility HAZ microstructure are the primary causes of the cracking.

The DRB remains unclear as to whether the primary cause of the cracking is due to Low Cycle Plastic Fatigue or Exhaustion of Ductility. The DRB suspects that it is not entirely due to one or the other, but a combination of both with instances of some of the other potential causes, such as hydrogen induced cracking, all as discussed by the experts in their reports and testimony. However, the consultants for the most part concluded that the hydrogen induced cracking was not the likely culprit when considering the welding process, the welding material and the type of steel utilized.

Professor Peter Marshall, a consultant retained by the Department, indicated in his report, dated August 1, 2005, that while the HPB's have thicknesses in the typical range for warm forming (at stress relieving temperatures), the choice of material raises legitimate concerns over doing this. Further in his report in discussing tests to establish a precedent for re-rolling a seam weld up to 2.35 inches thick, 60ksi steel, and about 4% forming strain he indicated that the HPB's go beyond these parameters and that "with extrapolation comes surprises".

The Board finds that the fabrication problems were essentially the result of unanticipated material behavior actually encountered which could not have been reasonably anticipated by an experienced fabricator at time of bid.

As stated above, the DRB finds the contract documents to be defective, and that they, in addition to the findings made under "Plans and Specifications" above, did not limit the number of roll passes of the steel plates to achieve the required tolerances for roundness, did not require warm rolling to decrease cracking potential, did not deal with high hardness values induced by rolling and aging at the surfaces of the HPS 70 W steel plates and did not provide for alternative use of steel plate thicker than 4 inches.

FABRICATION

1. Rolling

Essentially, the Department believes that the toe cracking is due to low cycle plastic fatigue occurring during fabrication of the cans performed in accordance with the Contractor's means and methods. These means and methods included the election to "cold" form and not "warm" form the plate material, as optionally provided for in the

specification and as proposed by Struthers, the fabricator originally contracted by KFM. The cold forming required multiple passes to be performed in the re-rolling process, exacerbated – according to the Department - by the Contractor’s purchase of Rolling Equipment which had insufficient capacity to perform the work without excessive rolling. The number of passes required in the re-rolling process were greater for the cold formed steel than would have been necessary for warm formed, thereby causing low cycle plastic fatigue in the HAZ.

Initially, TBS did not grind the seam weld completely flush to the base metal prior to re-rolling and the Department believes the rollers encountering this “speed bump” contributed to the development of the cracking. Following a meeting between the parties to address Weld Seam issues on March 9, 2005, a preliminary finding was to “remove additional reinforcement – grind weld smooth and flush prior to re-roll”. The benefit of this would be to reduce uneven loading during re-roll. According to testimony this practice did not appear to reduce the amount of cracking and weld repair.

The DRB finds and concludes that, while many of the means and methods of fabrication are the responsibility of the Contractor (such as all steps of proper weld preparation, welding heat input management, good workmanship of welding, grinding of welds to proper smoothness, and good workmanship of weld repair), the nonexistence of any prior experience of rolling the HPS 70W steel in the specified thicknesses into round cans to tight tolerances as well as the extensive testing of the steel and the fabrication parameters, including the various suggestions and directives by the Department to change fabrication parameters, turned the fabrication of the hinge pipe beams into a “research and development project”. This resulted in the Contractor performing work above and beyond the requirements of the contract. Such R & D activity, aided by numerous experts, is not the obligation of the Contractor but rather is the responsibility of the Department which specified steel that had not previously been used in the instant application. The Board also finds that the extensive testing and experimentation caused delays to the project that are the responsibility of the Department.

The State claims that the re-rolling of the cans after welding the longitudinal seam was a significant contributor to the cracking problem. The Board noted that not only was Struthers going to re-roll the cans after welding, but all the potential fabricators anticipated that re-rolling would be necessary after completion of the longitudinal seam welding in order to meet the tolerances specified.

Publications addressing forming of steel by rolling emphasize the importance that operators of the equipment have adequate experience in successfully fabricating tubular members. The Board finds that TBS provided personnel adequately experienced in rolling steel plates.

2. Rolling Equipment

TBS purchased a new set of forming rolls for the contract from an Italian manufacturer (Davi) –also known as Prom Au. The rolls were specifically designed to

roll 100mm thick HPS 70W steel to the required diameter (1900mm). This specialized rolling equipment was submitted to and approved by the Department.

During production there were some mechanical problems with hydraulic components and additionally some modifications were made to the equipment. Since the repairs and modifications were made to the rolling equipment the machine's performance appears to be satisfactory. Information provided at the hearing indicated that these repairs and modifications were extraordinary and above that anticipated by TBS and Davi from its historical experience.

The Department argued that the mechanical failures were due to overloading of the machine and that heavier and more powerful equipment should have been provided in the beginning. This would have resulted in a reduction in the amount of re-rolling required and low cycle plastic fatigue would not have occurred.

The steel plate as received from U.S. Steel satisfied HPS 70W property requirements. However, in the cold forming process, the I.D. and O.D. surface properties changed due to work hardening. For example, the Yield Strength of the surface material increased by as much as 23% so that the 70 Grade material behaved more like 100 Grade.

This sort of change in material properties, not anticipated by Davi or TBS, would presumably tax the equipment and at least result in additional re-roll effort. TBS claims (KFM letter 001393 of October 12, 2005) that much of the repair and/or modifications to the Davi equipment was necessitated by the unexpected behavior and characteristics of the HPS 70W steel such as the extremely high yield strength.

The Department asserted that TBS did not let State inspectors view the rolling operations and have access to the various rolling parameters. TBS responded that the rolling operation was proprietary.

The Board believes that the rolling equipment provided by TBS and approved by the Department should have been adequate to satisfactorily perform the work indicated in the contract documents.

The cost of parts, their installation, the costs of any modifications made to the equipment, as well as any delays to the fabrication of cans resulting from downtime to the rolling equipment would be to TBS's account, except to the extent any repairs and modifications were necessitated as a consequence of the unexpected characteristics of the HPS 70W steel.

Also, TBS should have granted the Department full access to the rolling operations and the rolling pressures and other data; the Department had a right to inspect the work in progress at an time, and TBS's contention of "proprietary rolling" was not appropriate and did not contribute to the resolution of the rolling problems.

3 Welding, Weld Metal

From the evidence and testimony, absent the cracking, the overall quality of longitudinal seam welds from a workmanship point of view was very good. There appears to be a paucity of Non Conformance Reports issued given the huge amount of weld metal put in place. However, the costs of repair of all defective welds resulting from poor workmanship should be the responsibility of the Contractor.

Initially, overmatching of the weld material with the base metal was thought to be a major issue although subsequently it was determined not to be. Nevertheless changes were made to the welding wire/flux combinations for both the longitudinal seam welds and weld repairs. The matter of welding/wire flux combinations does not appear to be an issue between the parties since the changes made were approved by the Department.

4 Trans Bay Steel – A Competent Mechanic or Builder

It was reasonable and appropriate for KFM to select and award the initial subcontract for supply of the hinge pipe beams to Struthers at the start of the contract. The selection of TBS as the substitute supplier with the bankruptcy of Struthers was also reasonable and appropriate under the circumstances. The Board finds that TBS with its management and employees qualifies as “a competent mechanic or other builder” with extensive experience in fabrication of steel products including tubular members. However, KFM bears the burden for any increased costs due to the difference in quotation/subcontract dollar amounts that may have occurred as a consequence of the Struthers default, as well as any delays which may have resulted from the substitution.

5 Tolerances

The roundness and alignment tolerances specified in Section 10-1.44 of the Special Provisions and various plan notes for the hinge pipe beams were extremely tight, necessitating a significant number of rolling and re-rolling passes to form the pipe beams within these tolerances. The tolerances were not acknowledged or conformed in the typical Section G-G on the various plan sheets for the hinge pipe beams. The specifications provided no minimum dimensions or thickness tolerances (i.e., plus or minus values) for either the HPS 70W base metal or the stainless steel cladding.

The specifications indicated, “Steel designated as Pipe Beam Grade 70 on the plans shall conform to the requirements in ASTM Designation A709, Grade HPS 70W...” which designates a maximum plate thickness of 4” (100mm).

Pre-bid question no. 204 asked various questions to clarify how these tolerances would be accommodated to conform to the fixed dimensions shown for the hinge pipe beams. Caltrans responded, “The base material (carbon steel) shall conform to Pipe Beam Grade 70 as specified in the Special Provisions. With proper equipment, tolerances can be met without machining the base material.”

KFM's RFI 231, dated August 6, 2002, suggested using thicker HPS 70W plate to allow some excess steel to assist in achieving the tolerances including particularly the sections requiring stainless steel cladding. Caltrans' letter (428) of September 10, 2002 was not responsive in explaining how to reconcile or conform the tolerances with Section G-G dimensions. Caltrans chose to not authorize use of HPS 70W steel plate thicker than 4" which would have required a change order to approve the use of "HPS 70W Modified" steel.

A memorandum, dated September 19, 2002, by email from the State's Design Consultant and Steel Consultant to the Department explained the reasons for selecting HPS 70W steel and indicated that these plates could be produced up to 4-1/4" to 4-1/2" thick, although it would be called "HPS 70W Modified." "This mill designation should be acceptable."

The information in this memorandum was not shared with the Contractor until early 2004. The State's response to bidder question no. 204 and its failure to share the information in the September 19, 2002 memorandum in a timely manner resulted in denying the Contractor a viable option to assist it in meeting the required tolerances by incorporating the opportunity for additional machining as a part of the fabrication process. This could have potentially reduced the amount of rolling and re-rolling necessary to meet the specified tolerances.

TBS has asserted that Caltrans' interpretation that the maximum gap between the stiffeners and the cans cannot exceed 5mm and that this required the cans to be re-rolled to a greater extent than would have otherwise been necessary. TBS argued that the Department's interpretation exceeded the requirements of AWS D 1.5 - 96, paragraph 3.3.1 and the contract Special Provisions. However, the Board understood during the TBS shop tour that the stiffeners could be "match cut" to accommodate the roundness conditions at the location of each stiffener with its sophisticated computerized control system and this would appear to mitigate the TBS claim.

Contract Change Order No. 30 authorized payment for machining the base metal up to minus 5mm in order to assist the fabricator in retaining a minimum of 5mm of stainless steel cladding and meet the specified tolerances for these sections of the hinge pipe beams. This Change Order addressed the tolerance problem in the stainless steel cladding areas of the pipe beams, which in effect forced the base material to be formed by rolling to a tolerance 3 - 4mm out of roundness as a consequence of the restrictions it provided. Change Order No. 30 was accepted and executed by the parties. However, CCO #30 was executed in September 2003, before the first pipe section was rolled on June 28, 2004, well before the HPB fabrication problems manifested themselves. The Board concludes that, due to the unexpected HPS 70W steel behavior, any impacts arising from rolling or re-rolling with respect to the requirements of CCO #30 should be the Department's responsibility.

REVISION OF NOPC #11.

The State has objected to KFM's failure to provide a revised NOPC to reflect its concerns regarding 1) the increased tolerance restrictions due to CCO No. 30, and 2) expansion of issues beyond the specification PQR requirements due to overmatched and undermatched weld material and allegations that "The HPS 70W material as supplied and fabricated in accordance with Caltrans's Special Provisions does not appear suitable for the fabrication of the hinge pipe beams."

The original NOPC #11 dated September 30, 2004 was submitted to the State by letter of October 1, 2004. Extensive discussions, meetings, correspondence, testing and investigations have occurred between the Contractor, TBS, the Department and the parties' various consultants, regarding the problems of the fabrication of the cans for the pipe beams during the interim period. All these exchanges and efforts have developed extensive additional information about these problems which in the most part have been shared between the parties in a cooperative and timely manner. In light of the extensive involvement of all the parties in attempting to understand, mitigate and resolve the issues, the Board finds the original NOPC #11 was timely and adequate and that the State has not been prejudiced by a failure of NOPC 11 to be revised with regard to the pipe beam fabrication problems and their potential impact.

ACCEPTANCE CRITERIA

The fact that the Hinge Pipe Beams are not fracture-critical members and the longitudinal welded seams would be primarily subject to shear forces enabled the Department to ultimately reduce its acceptance criteria when TBS was at a point of virtually being unable to perform the contract work and meet the original quality requirements.

As a result of a modification to the acceptance criteria (compression and not tension) at the end of June 2005, acceptable product was able to be delivered. The Department testified that HPB cans have recently been produced that comply with the original acceptance criteria and that the TBS problems were a result of an extended learning curve and inadequate rolling equipment now performing since modifications have been made. KFM disputes this assertion by the Department and maintains that the fabrication quality problems would have continued if the acceptance criteria and various procedures had not been changed.

The Board is not persuaded by the Department's claim. The fact that this was a first time use of HPS 70W steel in this sort of application the Board finds that the material behavior problems could not have been anticipated by TBS at time of bid. TBS should have expected there to be a learning curve, however, what TBS has experienced goes well beyond any reasonable measure of a learning curve.

MITIGATING CHANGE ORDERS

The Department's issuance of contract change orders to aid in the resolution and mitigation of the pipe beam fabrication problems was proactive and well intended. They also indicate the Department's acknowledgement that many of the fabrication problems were reasonably beyond the Contractor's control.

Change Order No. 160 was issued to pay for certain repairs and modifications to the TBS fabrication procedures that the Engineer directed to be incorporated into the fabrication process for the hinge pipe beams. These modifications include "fabrication options (that) were not exhausted before stopping work." Much of this work was referred to in the hearing by KFM as "experiments" and included repair work procedures for cans previously fabricated, but not accepted as satisfactory by the Department. With reference to KFM's exhibit entitled "LIST OF EXPERIMENTS/SOLUTIONS," the Board notes that various modifications and alternatives to the TBS fabrication process of the hinge pipe beams were considered and implemented whenever practical from September 2004 to the present. The Board has concluded that limited improvement to the quality problems was realized from most of the proposed changes that could be implemented.

Contract Change Order No. 164 (per Caltrans' letter 5.03.01-8064) was issued to provide payment for premium pay due to Engineer-directed overtime in the fabrication of the pipe beams. Subsequently, this directive has been confirmed by Caltrans (letter 5.03.01-008381) to be a full acceleration directive for the TBS pipe beam fabrication work, directing TBS to work 24 hours, 6 days a week, on the fabrication of the hinge pipe beams.

Contract Change Order No. 165 was issued to confirm the changes in inspection and welding requirements for the longitudinal seam welds of the pipe beam cans (except for the fuse section). This change order eliminates the RT testing requirements and revised the UT test evaluation criteria to a compression standard, except for cans in the fuse section. Apparently, the relaxation of these requirements has had a significant and positive effect on the production of acceptable cans for use in the hinge pipe beams.

TBS FABRICATION, SCHEDULE INFORMATION

The State has requested additional schedule information from the Contractor to assist in its evaluation of the dispute. The Board concurs that the Contractor is obliged to fully cooperate in developing this information to the best of its ability. While it is recognized this information is important to the administration of the contract, particularly with regard to the acceleration directive and evaluation of quantum in this dispute, the Board believes the Contractor is attempting to fully cooperate to provide available schedule information and data and that these concerns do not directly affect determination of merit on this dispute.

DRB RECOMMENDATION

The DRB unanimously recommends the following:

- (1) That the Department compensates the Contractor for all hinge pipe beam fabrication work, including weld metal experimentation and any delays occasioned by such fabrication work that were unexpected and unforeseeable due to the unknown and unanticipated behavior of the HPS 70W steel which had never previously been rolled into cans of the specified diameters using 65mm, 85mm and 100mm plate thicknesses.
- (2) That the Department compensates the Contractor for repair of welds deemed defective under the “tension criteria” but acceptable under the “compression criteria”. That the Department compensates the Contractor for the repair of ALL defective welds OTHER than those attributable to poor workmanship.
- (3) That the Contractor be compensated for the testing and investigation of the steel in order to achieve the contract-specified results – such testing and investigation should have been performed prior to advertising of the contract.
- (4) That the Contractor be responsible for the costs of repair of defective welds and any delays resulting from the repair of defective welds resulting from poor workmanship.
- (5) That the Contractor be responsible for the grinding of longitudinal seam welds to appropriate smoothness in accordance with the specifications and code. Any additional grinding beyond these requirements would be the responsibility of the Department.
- (6) Since difficulties in obtaining the specified tight tolerances were to be expected, the Contractor is to be responsible for all fabrication work required to meet such tolerances, except for additional work occasioned by the unexpected behavior of the steel and tighter tolerances resulting from CCO #30 and possibly from achieving the Department’s required stiffener gap dimensions.
- (7) That the Contractor be responsible for an appropriate learning curve absent the unexpected behavior of the HPS 70W steel.
- (8) That the cost and expenses of work and delays caused by equipment breakdowns, and equipment modifications be the responsibility of the Contractor, except to the extent such breakdowns and modifications can be shown to have been necessitated as a consequence of the unexpected characteristics of the HPS 70W steel. In that regard the Board recommends that any delays in determining fabrication mitigation measures caused by the Contractor’s refusal to share what it deemed to be “proprietary” rolling practices be the responsibility of TBS.

- (9) That the Contractor be responsible for any increased costs due to differences in the dollar amounts between the Struthers and TBS subcontracts for the same scope of work, as well as any delays resulting from the substitution.
- (10) That unless the Contractor can establish that the work stoppage by TBS was justified due to mixed directions, sample test results or other similar considerations at the fabrication site, the Department will not be responsible for the cost or time lost specifically due to the work suspension.

The Board makes no recommendations on quantum or extensions of contract time believing these are best determined and agreed to by the parties. However, in the event agreement cannot be reached these matters can be referred back to the Board under this dispute.

Respectfully submitted:

Warren M. Bullock
DRB Member

Frederick Graebe
DRB Member

Richard A. Lewis
DRB Member

Dated: January 26, 2006