ARMED SERVICES BOARD OF CONTRACT APPEALS

Appeal of --	)	
	)	
Grid Construction, Inc.	)	ASBCA No. 48458
	)	
Under Contract No. DACA63-88-C-0088	)	

APPEARANCE FOR THE APPELLANT: Stephen J. Johnson, Esq.
Lyon & McManus
San Antonio, TX

APPEARANCES FOR THE GOVERNMENT: Frank Carr, Esq.
Engineer Chief Trial Attorney
Lloyd R. Crosswhite, Esq.
Engineer Trial Attorney
U. S. Army Corps of Engineers
Fort Worth District

OPINION BY ADMINISTRATIVE JUDGE VAN BROEKHOVEN

Appellant timely appealed a contracting officer's final decision denying appellant's claim for $496,668.61 and for a time extension for warranty work and an alleged constructive change. Only entitlement is before the Board for decision.

FINDINGS OF FACT

1. The Government awarded appellant a standard fixed-price construction contract in the amount of $1,993,000.00 on 17 June 1988, and with modifications, the final contract amount was approximately $2.6 to $2.7 million. (R4, tab 3; Joint Stipulation of Fact, ex. J-2) Appellant was required to construct a 55,000 barrel internal floating roof jet fuel storage tank at Kelly Air Force Base, San Antonio, Texas. The tank had an internal floating roof with an external cone roof supported by a radial truss. The trusses were supported by the tank shell. There were seven rings of steel plates for the walls of the tank shell (SR4, tab 57; tr. 1/45). In addition to the construction of this steel storage tank, the contract required appellant to perform associated site work and install pumps and piping. Upon its award of the contract, appellant awarded a tank erection subcontract to Pawnee Tank Company (Pawnee) of Pawnee, Oklahoma (tr. 1/49-50).

2. The contract contained the standard clauses for fixed-price construction contracts, including: FAR 52.233-1 DISPUTES (APR 1984), FAR 52.236-5 MATERIAL AND WORKMANSHIP (APR 1984), FAR 52.236-11 USE AND POSSESSION PRIOR TO COMPLETION (APR 1984), FAR 52.243-4 CHANGES (AUG 1987), and FAR 52.246-12 INSPECTION OF

CONSTRUCTION (JUL 1986). The USE AND POSSESSION PRIOR TO COMPLETION clause provided in pertinent part:

> (a) The Government shall have the right to take possession of or use any completed or partially completed part of the work. Before taking possession of or using any work, the Contracting Officer shall furnish the Contractor a list of items of work remaining to be performed or corrected on those portions of the work that the Government intends to take possession of or use. However, failure of the Contracting Officer to list any item of work shall not relieve the Contractor of responsibility for complying with the terms of the contract. The Government's possession or use shall not be deemed an acceptance of any work under the contract.

The INSPECTION OF CONSTRUCTION clause provided in pertinent part:

> (b) The Contractor shall maintain an adequate inspection system and perform such inspection as will ensure that the work performed under the contract conforms to the contract requirements. The Contractor shall maintain complete inspection records and make them available to the Government. All work shall be conducted under the general direction of the Contracting Officer and is subject to Government inspection and test at all places and at all reasonable times before acceptance to ensure strict compliance with the terms of the contract.
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> (c) Government inspections and tests are for the sole benefit of the Government and do not –
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> (1) Relieve the Contractor of responsibility for providing adequate quality control measures;
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> (2) Relieve the Contractor of responsibility for damage to or loss of the material before acceptance;
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> (3) Constitute or imply acceptance; or
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> (4) Affect the continuing rights of the Government after acceptance of the completed work under paragraph (i) below.
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> . . . .
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> (f) The Contractor shall, without charge, replace or correct rejected work found by the Government not to conform to contract requirements, unless in the public interest the

> Government consents to accept the work with appropriate adjustment in contract price. The Contractor shall promptly segregate and remove rejected material from the premises.
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> . . . .
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> (i) Unless otherwise specified in the contract, the Government shall accept, as promptly as practicable after completion and inspection, all work required by the contract or that portion of the work the Contracting Officer determines can be accepted separately. Acceptance shall be final and conclusive except for latent defects, fraud, gross mistakes amounting to fraud, or the Government's rights under any warranty or guarantee.

(R4, tab 3)

3. Paragraph 18 of the contract Special Clauses addressed the contractor's quality control system. (R4, tab 4; ex. J-2) Paragraph 18 required appellant to provide and maintain an effective quality control program or contractor inspection system, as required by the contract clause, INSPECTION OF CONSTRUCTION, "which will assure that all supplies and services required under the contract conform to the contract requirements whether constructed or processed by the Contractor, or procured from subcontractors or vendors." Paragraph 18(a) required appellant to "perform or have performed the inspection and tests required to substantiate that all supplies and services conform to the drawings, specifications, and contract requirements." Paragraph 18(c) specified the contractor's inspection system, which required at least three phases of inspection: preparatory inspection prior to the beginning of any work on any definable segment of the work; an initial inspection to be performed after any representative segment of work had been completed; and follow-up inspections to be performed daily or as frequently as necessary to insure continuing compliance with the contract requirements. Paragraph 18(m) specified the completion inspections to include the contractor's quality control completion inspection at least fourteen days prior to pre-final inspection, the pre-final inspection, and the final acceptance inspection with Government personnel. Paragraph 18(m)(2) further provided that: "[f]ailure of the Contracting Officer to detect and list all incomplete and/or unacceptable work during this [pre-final] inspection will not relieve the Contractor from acceptably performing the work required by the contract documents."

4. Section 01405 of the contract Technical Provisions covered the quality control inspection, sampling and testing of all supplies, services, and/or workmanship required to be performed by the contract. (R4, tab 5; ex. J-2) Paragraph 1 of § 01405 required appellant to perform such quality control inspections and testing to ensure that all supplies, services, and workmanship conformed to the contract requirements. Paragraph 2(19)

required inspection of the aboveground tank for aircraft engine fuel welded steel, with the floating internal roof and cone roof-truss support, for material and equipment conformance.

5. Paragraph 1 of § 01740 of the Technical Provisions was the FAR 52.246-21 WARRANTY OF CONSTRUCTION (APR 1984) clause (R4, tab 6; ex. J-2). This clause provided in pertinent part:

> (a) In addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph (j) of this clause, that the work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.
>
> (b) This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.
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> (c) The contractor shall remedy at the Contractor's expense any failure to conform, or any defect. . . . .

This clause further required the contracting officer to notify appellant in writing within a reasonable time after discovery of any failure, defect, or damage (paragraph (e)), and provided that if appellant failed to remedy the failure, defect, or damage within a reasonable time after receipt of the notice from the contracting officer, the Government shall have the right to remedy the failure, defect, or damage at appellant's expense.

6. The contract specifications, § 13205, incorporated the American Petroleum Institute (API) Publication 650, Standard for Welded Steel Tanks for Oil Storage, Seventh Edition, 1980 as part of the specification. (R4, tab 7; ex. J-2) Paragraph 2.1 of § 13205 of the specifications required that materials, fabrication, erection, testing, and repairs conform to the requirements of API Publication 650 and to the National Fire Protection Association (NFPA) Standard 30, which was the Flammable and Combustible Liquid Code. Section 13205, Paragraph 2.2 required appellant to erect the tank on an oil treated fine sand bed, resting on an oil resistant membrane with a concrete ring wall, "as shown on the drawings and specified in this and other sections of the specifications." Paragraph 2.3 provided:

> Design: The contract drawings indicate the diameter, height and plate thickness dimensions, and general details of design. Where details of design are not shown on the drawings or specified hereinafter, such details shall conform to

> applicable requirements of NFPA 30, or to applicable requirements of the API 650. In the event such details are not covered by the drawings, this specification, or NFPA 30 or API 650, they shall be in accordance with best established commercial practices for such work. If any departures from the contract drawings are deemed necessary by the Contractor, details of such departures and reasons therefor shall be submitted as soon as practicable to the Contracting Officer. No such departures shall be made without prior written approval of the Contracting Officer.

(R4, tab 7) Section 13205, paragraph 2.4 required shop and field fabrication to meet the requirements of API 650, unless otherwise shown on the drawings or in the specifications. Paragraph 2.4 further provided that:

> When the tank is fabricated in the field, it shall be fabricated and erected, except as modified herein or on the drawings, and field tested in accordance with applicable requirements of the API 650, and shall have the monogrammed nameplate of that institute attached to the tank shell.

In accordance with paragraph 6.1 of § 13205:

> Tightness Tests and Welding Repairs: shall be performed prior to blast cleaning and application of the protective coating, and shall be in accordance with the current edition of API Standard 650, except as specified herein. Complete radiographic inspection of all vertical joints on the tank shell shll [sic] be made. Ten percent of all horizontal joints on the tank shell shall be inspected radiographically. The contractor shall perform all radiographic testing. Radiographic testing shall be in accordance with API Standard 650. Films and test reports of all radiographic inspection shll [sic] be submitted to the Contracting Officer. All welds proven faulty by the radiographic tests shall be repaired and the Contractor shall radiographic test the repaired weld to prove to the Contracting Officer that the repair has been completed satisfactorily. . . . In addition to the above tests, the shell and floating roof shall [be] tested by filling the tank with water and maintaining it for a period of not less than 24 hours, after which the shell and the floating roof shall be inspected for leaks. The appearance of damp spots shall be considered evidence of leakage. All leaks disclosed by the tests shall be repaired by drilling, chipping, or gas gouging and rewelding, or

> by other approved methods, after which the tank shall be retested and proved tight.

Paragraph 9 of § 13205 of the specifications, FINAL EXAMINATION AND ACCEPTANCE, stated that final examination and acceptance would be as soon as practicable after the completion and testing of the tank. According to this paragraph, if the inspection revealed any defects in the work, appellant was required to repair such defects or replace the unsatisfactory work, as directed by the Contracting Officer, before the Government accepted the work. The cost of these repairs and replacements was to be borne by appellant.

7. The contract contained 27 contract drawings (R4, tab 10; ex. J-2). Drawing Sequence No. 15 provided ring wall details and tank notes. Note 1 provided:

> EXCEPT AS SHOWN OR MODIFIED HEREIN OR IN THE CONTRACT SPECIFICATIONS, THE ENTIRE TANK SHALL BE DESIGNED, FABRICATED, ERECTED, AND TESTED IN ACCORDANCE WITH WELDED STEEL TANKS FOR OIL STORAGE, API STANDARD 650, 7TH EDITION, NOV. 1980.

Note 2 provided:

> A COMPLETE DESIGN ANALYSIS SHOWING ALL CALCULATIONS FOR THE SHELL, ROOF, STAIRS, HANDRAILS, FLOATING ROOF AND ANY OTHER MAIN APPURTENANCES SHALL BE SUBMITTED FOR APPROVAL WITH SHOP DRAWINGS. A CORROSION ALLOWANCE OF 1/16 INCH SHALL BE PROVIDED IN THE DESIGN OF THE TANK INCLUDING TOP, BOTTOM, CYLINDRICAL SHELL, AND STRUCTURAL FRAMING INSIDE THE TANK. THE SHOP DRAWINGS SHALL INCLUDE DETAILS OF ALL MAIN MEMBERS, TYPICAL CONNECTIONS, AND ERECTION DRAWINGS.

Note 7 on Drawing Sequence No. 15 provided the design loads. The design load for the roof live load was 20 psf. The tank was required to withstand a wind velocity of 100 mph.

8. Drawing Sequence Nos. 16 through 23 were the mechanical drawings for the piping system. Drawing Sequence No. 16 indicated a new 10 inch fuel unloading line to be installed through the shell of the JP4 fuel storage tank. Drawing Sequence No. 19 depicted the plan and elevation views of the storage tank. The elevation and plan views specified the tank to be 52 feet, 3 inches high with an inside diameter of 93 feet. The roof truss and purlins were shown in elevation AA on Drawing Sequence No. 19. Note 1 on this drawing sequence specified that:

> EXCEPT AS SHOWN OR MODIFIED HEREIN OR IN THE CONTRACT SPECIFICATIONS, THE ENTIRE TANK SHALL BE FABRICATED, ERECTED AND TESTED IN ACCORDANCE WITH AMERICAN PETROLEUM INSTITUTE STANDARD (API 650) FOR WELDED STEEL TANKS FOR OIL STORAGE, LATEST REVISION, INCLUDING SUPPLEMENTS, AND APPENDICES B, H, AND L.

Drawing Sequence No. 19 elevation drawing depicted vertical stiffeners along the perimeter of Rings 6 and 7. There were no views or details showing any horizontal stiffeners or "wind rings."

9. Part 5 of API 650 addressed erection of the tank. (R4, tab 9; ex. J-2) Paragraph 5.3.1 stated that the purchaser's inspector shall have, at all times, freedom to all parts of the job while work under the contract was being performed. Paragraph 5.4.1 provided that all defects found in the weld shall be called to the attention of the purchaser's inspector and his approval shall be obtained before the defects are repaired. Paragraph 5.4.5 addressed repairs and defects discovered after the tank had been filled with water and required that the repair be made with the water level at least one foot below the point being repaired or with the tank empty. Repairs were prohibited on a tank filled with oil.

10. Subpart 5.5 of API 650 provided dimensional tolerances. According to Paragraph 5.5.1, Plumbness, the maximum out-of-plumbness of the top of the shell relative to the bottom of the shell shall not exceed 1/200 of the total tank height. The out-of-plumbness in one shell plate shall not exceed the values specified for mill tolerances in Tables 14 or 15 of ASTM Specification A 6 or in Tables 10 or 13 of ASTM Specification A 20, whichever is applicable. Paragraph 5.5.2 specified that the radii for roundness measured at one foot above the bottom corner weld shall not exceed $\pm$ 3/4 inch for a tank in the diameter range of 40 to 150 feet. Paragraph 5.5.3 specified that with a horizontal sweep board 36 inches long, peaking shall not exceed 1/2 inch. Peeking is a protrusion of the weld seam and/or tank plate as measured with a horizontal sweep board. Paragraph 5.5.4 specified that with a vertical sweep board 36 inches long, banding shall not exceed 1/2 inch. Banding is a deformation of the weld seam and /or tank plate as measured with a vertical sweep board. Paragraph 5.6 required measurements to be taken prior to the water test.

11. Tank erection by appellant and Pawnee began on or about 10 October 1989 with the preparatory inspection as required by Paragraph 18 of the Special Clauses (SR4, tab 50; ex. J-2). The initial foundation was in place and had been accepted. (Tr. 2/15-17) During the assembly of the tank, the tank shell was built from pre-shaped steel plates forming and completing each ring around the circumference of the tank. Following the marking of the circle outlining the dimension of the tank, the first ring was placed and leveled. (Deposition of Hasselbring, 37-38, SR4, tab 59). The plates that composed the first ring were welded with the vertical joints welded first. After completion of the first ring and the

inspection and correction of any peaking of the welds, the second ring was constructed with plates placed on shims and key plates to hold the shell plates together. The vertical seams were welded before the horizontal seams. There was tacking between the rings that was removed as the horizontal weld was made in the space occupied by the tacking. Pawnee visually checked the vertical seams for peaking and for bands in the horizontal seams, and corrected any deformities in the welds before proceeding to the next ring. As each ring was completed, the assembly of the next ring progressed to the required height. Pawnee assembled the tank by setting each plate in place with a crane, anchoring and aligning the plate, and then welding it in place. According to appellant's Contract Quality Control Representative (CQCR), the steel plates were aligned before they were welded in place and were not forced or under stressed when welded. During daily inspections of the work, appellant's CQCR and the Government inspector visually inspected the placement of the plates and the welds to make sure that they were properly lined up and smooth. They checked the rings for firmness, roundness, peaking, and banding with a sweep board held flush against the tank plates. (Tr. 2/12-14, 21-24, 34-37)

12. During the erection of the tank, the Government's quality assurance representative (QAR) noted deficiencies not reported on appellant's CQCR daily reports. (SR4, tab 50, daily reports for 13-16, 23 October 1989) These deficiencies included problems with the welding of the bottom plate of the tank and edge plates which were not in compliance with API 650. During the tank erection, the Government's QAR noted that: the bottom bearing surface of the shell did not meet API 650 requirements for flat surfaces, there were questionable roof truss welds, there were flat areas in shell alignment, there was sloppy welding which included overwelding and undercutting, and unacceptable welds in the fifth ring of the tanks (SR4, tab 50, daily reports for 2, 3, 6, 7, and 9 November 1989, 4-5 December 1989). None of these deficiencies were identified on the CQCR daily reports for those respective dates.

13. The CQCR discovered during the CQCR's daily inspection on 21 November 1989 that the X-ray testing of welds revealed a bad section of a vertical weld. (SR4, tabs 50, 51; tr. 2/27-26-30) Later X-ray testing reports continued to reveal similar welds in which slag lines were greater than authorized by the appropriate industry standards and which required corrective work. Pawnee corrected these deficiencies, usually grinding out the weld, rewelding the joint, and retesting. There were instances in which tank shell plates developed flat spots after they had been fitted, installed, and welded in place (tr. 2/35-38). The plates with flat spots were subject to rework, which included cutting welds, repositioning the plates, and rewelding and retesting by Pawnee.

14. Appellant lifted the last four foot ring of plate steel on the tank on or about 13 December 1989, which completed the erection of the shell (SR4, tab 50, daily report for 13 December 1989). Appellant began the structure for the tank roof upon completing the welding of the seams. Appellant continued work on the seventh ring until 18 December 1989 (SR4, tab 50, daily report for 18 December 1989). On 19 December 1989, appellant began setting steel for the roof (SR4, tab 50, daily report for 19 December 1989). Work

on the tank roof continued until 22 January 1990 (SR4, tab 50, daily report for 22 January 1990). Appellant began X-raying the tank on 23 January 1990 and on 24 January 1990 began work on fitting and detail (SR4, tab 50, daily reports for 23 and 24 January 1990). This work continued through 30 January 1990 (SR4, tab 50, daily reports for 22-30 January 1990).

15. During the period of 5 February 1990 to 25 October 1990, the Government QAR, appellant's CQCR, and Pawnee representatives conducted tank inspections. (Ex. J-2) They noted conditions that needed correction which were then corrected. Corrective work on the tank shell began on 6 February 1990 and continued through 7 March 1990 (SR4, tab 50, daily reports for 6 February through 7 March 1990). After the construction and correction of the shell and roof of the tank, appellant installed the internal floating roof (SR4, tab 50, daily report for 27 August 1990; tr. 2/57-58). On 15-16 March 1990, there was a safety, walk-through inspection of the tank (SR4, tab 50, daily reports for 15 and 16 March 1990; ex. J-2). The scaffolding on the tank had been removed (SR4, tab 59 at 74). Therefore, it was impossible to perform a detailed inspection above eye level of the tank. The daily report for 27 August 1990 reported that the Government QAR performed a follow-up inspection on the floating roof, and noted that there were some joints in the panels that needed sealing.

16. Appellant began filling the tank with water on 17 September 1990 for the hydrostatic testing of the tank (SR4, tab 50, daily report for 17 September 1990; tr. 2/58-59). The purpose for this test was to determine the integrity and water-tightness of the tank and to check the operation of the floating roof to ensure that it floated up and down as the water filled the tank and was drained from the tank. Appellant was unable to completely fill the tank with water, and there was a flange leak that required repair. (SR4, tab 50, daily reports for 18, 19, 20 September 1990; tr. 2/59-62) It took several days to fill the tank for the hydrostatic test. The collapsible seal on the outside of the floating roof was compressed hard on one side of the tank and did not have contact with the walls on the other side of the tank indicating that the floating roof was not centered over the middle of the tank. The seal needed adjustment because the tank was not perfectly round in a number of areas. The Government was concerned that as the floating roof went up as the tank was filled and came down as the tank drained, the roof would be off center which would result in the floating roof hanging up and not functioning properly. If the floating roof did not stay centered as the tank was emptied, it could cause a dangerous situation when the tank was filled with jet fuel because if the roof did not stay flat on top of the jet fuel as the jet fuel was drained, it could create an area in which vapors could develop resulting in possible explosion. On 19 September 1990, the seal of the floating roof was adjusted to avoid collapsing of the seal caused by small flat spots on the tank. When the Government and appellant finished the hydrostatic test, the parties were satisfied with the floating roof and its performance.

17. On 25 October 1990, the Government's and appellant's representatives conducted a preparatory final inspection of the tank. (SR4, tab 50, daily report for

25 October 1990; ex. J-2) Although the Government's QAR noted no major problems with the tank, he did note that there were 40 to 50 deficiencies that needed correction. Since the scaffolding had been removed from the tank and appellant was required to insure that all of the contract requirements were met during the course of contract performance, the preparatory final inspection was a visual inspection only (tr. 2/106). Notwithstanding the lack of identification of all possible deficiencies, failure to do so did not relieve appellant from the responsibility for performing all the work in compliance with the contract requirements (finding 3).

18. Drawing Sequence No. 16 contained a plan view of the site showing the location of the fuel storage tank. (R4, tab 10) On the left side of the fuel storage tank was a 10-inch fuel line extending from the tank. Detail 5/M1/M5 referred to an expanded view of the connection between the 10-inch line and the tank and depicted the 10-inch line extending from the tank with 10-inch ball valve installed on the line, a 10-inch high liquid shutoff or control valve, and a 10-inch check valve. The function of the high level shutoff valve, which was a mechanical valve, was to prevent the tank from overflowing when fuel reached a preset level. A float valve was activated within the tank which directed fluid to the bonnet of the valve activating the valve to prevent overflowing (tr. 2/168-69).

19. Paragraph 2.4.8.a of § 15485 of the contract Technical Provisions required that the high liquid level shutoff valve be of an aluminum body (R4, tab 8). The 10-inch line was designed by the Government with a 20-foot straight run from the tank which included a ball valve, a control valve, a check valve, and swing joints with two ball and knuckle joints (tr. 2/170). These were designed to alleviate stress on the piping in the event of tank settlement (tr. 2/171). If tank floor plate settlement occurred, the ball and knuckle joints would rotate, alleviating the stress on the 10-inch line.

20. Shortly after appellant completed the hydrostatic test and a punchlist inspection of the tank, appellant began filling the tank with jet fuel (tr. 2/66-69). During the filling of the tank, appellant's project manager discovered that a 10-inch control valve on the inlet to the tank had split at its flange and the 10-inch pipe going into the valve was raised two to three inches out of the pipe support (R4, tab 20 at ex. 1; SR4, tab 50, daily reports for 13 and 14 December 1990, SR4, tab 58; ex. J-2; tr. 1/124-27, 2/66-68).

21. During an investigation of the cracked 10-inch control valve, the Government's mechanical engineer in the Quality Assurance Department of the Corps of Engineers Construction Division, determined that the tank floor had settled resulting in a moment being placed on the line (ex. G-1; tr. 2/172-73, 176). The tank was constructed with a sand floor underneath the steel bottom of the tank. This sand base was sloped to the center with a sump in the middle of the tank. Because there was a flat grade beam on which the tank wall rested, the floor plate of the tank was flat around the ring wall grade beam which created a built-in gap between the floor plate and the sand. However, there is a construction method in which seasoned tank construction contractors will bend and deform the floor

plate so that it does not crest above the sand base and create a gap between the tank floor plate and the sand bed. With a gap between the floor plate and the sand bed, the filling of the tank would force the floor plate down into the sand bed. The Corps of Engineers had anticipated this and designed the piping system with a double set of swing joints to compensate for the possible sinking of the floor into the gap between the floor plate and the sand bed instead of causing a deflection of the entire 12-foot length of 10-inch pipe. (Ex. G-1; tr. 2/175-77)

22. The swing joints were not acting as flexible swing joints as designed. Rather, they were rigid and operated as a fixed straight lever arm through the wall of the tank. When the fuel was loaded into the tank, the steel floor plate of the tank deformed until it reached the sand bed and the welded nozzle support of the 10-inch pipe followed the floor down to the sand bed and exerted a force on the 10-inch line. The paint drips or beads across the joints had not been disturbed indicating that the ball and knuckle joints had not flexed. There was evidence that the bolts holding the mechanical gland that was tightened in to seal the ball and knuckle part of the swing joint had been over-torqued. (Tr. 2/176-79) Drawing Sequence No. 20 depicted a pipe support that required two large structural angles with a horizontal angle between them that would cradle the 10-inch pipe allowing the pipe to rest on the horizontal steel beam across the two steel C-channels (R4, tab 10; tr. 2/183). Appellant did not install the type of pipe support specified on Drawing Sequence No. 20. Rather, it installed a simple saddle type support with a curved saddle on which the pipe was to rest (SR4, tab 58; tr. 2/182-83). Had the swing joints been installed properly, the control valve would not have cracked when the tank floor plate deformed to reach the sand bed as the tank was filled with fuel (tr. 2/180).

23. Following discussions between representatives of the Corps of Engineers, the Air Force, appellant, and the valve manufacturer, the parties attributed a possible cause to be tank wall movement resulting from out-of-roundness of the tank (R4, tab 20 at ex. 1; ex. J-2). By letter, dated 27 December 1990, Bay Associates, the supplier of the control valve, recommended that: (1) the pipe supports be spring supports allowing side-to-side unrestricted movement; (2) the control valve be steel bodied rather than aluminum bodied; (3) the ball joints be reinstalled in cold set to accommodate present deflection and allow for movement back when the tank was emptied; (4) the seal gland fasteners be loosened and retightened to 40 ft. lbs (R4, tab 20 at ex. 2). Bay Associates further noted that the loop had no impact other than adding flexibility.

24. The Government reviewed the Bay Associates letter and concluded that there was no need for spring pipe support since the sliding type of support depicted on Drawing Sequence No. 20 was sufficient with working swing joints (tr. 2/182). Since the swing joints had been over-torqued, the Government did not know whether they were in usable condition and did not object to appellant installing a stronger bodied control valve but did not advise appellant to furnish the stronger bodied control valve (tr. 2/184). The Government did not have any objections to the other Bay Associates recommendations. Although the Government did not object to these Bay Associates recommendations, there is

no evidence that the 10-inch fuel line system and valve designs as set forth in the contract specifications and drawings were defective.

25. Representatives of the Government and appellant conducted the final inspection on 8 February 1991 (SR4, tab 50, daily report for 4-8 February 1991; ex. J-2; tr. 2/51). According to the daily report for 8 February 1991, "PRIME – FINAL INSPECTION HELD. ATTENDANTS LIST ATTACHED. BENEFICIAL OCCUPANCY TAKEN BY KELLY AFB." Attached to this daily report were several pages of punch list items dated 7 and 8 February 1991. There was nothing in this punch list regarding any outstanding issues relating to weld corrections, alignment, or plumbness. This inspection was a visual inspection of the facility to verify that appellant's quality control organization had performed its responsibilities to insure that all of the requirements of the contract had been met (tr. 2/106-07). There was no scaffolding on the tank so that the Government's project engineer was unable to inspect the upper reaches of the tank. By letter dated 6 March 1991, the Government's Authorized Representative of the Contracting Officer informed appellant that the Warranty of Construction period "for all work, materials, and equipment in the referenced contract extends from 8 February 1991 through 7 February 1992," indicating the Government's taking possession of the work or its beneficial occupancy of the tank (R4, tab 20 at ex. 3). There was nothing in this letter, however, that expressly stated that the contract was complete and that the work was accepted. Moreover, we have not found anything in the record that established that the contracting officer, acting on behalf of the Government, accepted the tank at this time, or that the Government made final payment shortly thereafter indicating its acceptance of the work. Accordingly, we are unable to make any finding that the Government accepted the tank and related site work in accordance with the FAR 52.246-12 INSPECTION OF CONSTRUCTION clause and Paragraph 9 of § 13205, FINAL EXAMINATION AND ACCEPTANCE provision of the contract.

26. On 6 May 1991, the Government contacted appellant and informed it that there were indentations (buckling) in the tank, that these indentations had increased in size, and requested appellant to be at the site to evaluate the problems with the tank (ex. J-2). Appellant notified Pawnee of the increasing buckling in the tank and requested that a representative of Pawnee also attend the investigation of the problem of buckling (R4, tab 20 at ex. 9; ex. J-2).

27. The buckling occurred at the bottom of the sixth ring and into the fifth ring directly above the 18-inch withdrawal nozzle of the tank (tr. 3/6-7). This large deformation was approximately ten feet by ten feet with an inward warp of nine inches deep (ex. J-2; tr. 3/6-7). Just below the fifth ring, the tank wall then buckled outward approximately three inches causing a sinusoidal collapsed configuration which gave the appearance that the roof was collapsing down on the tank. Symmetric to that on the left side of the tank, there was a diagonal buckle in the wall plate that was limited by the helical stairwell that wrapped around that part of the tank. The floating roof was just below the crest of the most inward buckle (tr. 3/35). Additionally, there were 1/4 inch to 1/2 inch cracks in the weld at the top

of some of the tank stiffeners (ex. J-2). The buckling occurred at the time the Air Force was withdrawing fuel from the tank (tr. 3/6-7).

28. By letter dated 16 May 1991, the Authorized Representative of the Contracting Officer (ARCO) confirmed discussions it had with appellant, both telephonically and during a meeting at the site, concerning the deformations and weld cracks, and informed appellant that it considered these to be warranty defects in the jet fuel tank (R4, tab 20 at ex. 12; ex. J-2). The ARCO stated in his letter:

> On May 2, 1991, the Kelly Air Force Base Civil Engineer notified Major Bleakley of suspected warranty defects in the 55,000 barrel Jet Fuel Storage Tanks constructed under this contract. The defects include two areas, approximately 10' x 10', which have warped inward approximately 6" to 8"; and cracks ranging from 1/4" to 1/2" in the weld at the top of some stiffeners.
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> . . . .
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> As discussed during the site visit and by phone between Mr. Flockart and Major Bleakley, our intention is for you to document the extent of the problem, determine the cause, and determine a solution.

The Government requested appellant to submit documentation of the extent of the problem and supporting data by 24 May 1991 and to provide preliminary findings on the cause of the defects and recommendations for fixing the problem, including a proposed schedule, by 31 May 1991.

29. Appellant submitted to the Government a report prepared by Pipeline Consulting Services for Pawnee as a preliminary report concerning the tank damage (R4, tab 20 at ex. 14, tab 21 at ex. 105; ex. J-2). This report was based on a review of drawings submitted by Pawnee to Pipeline Consulting Services and on Pawnee's description of the tank damage and piping connections. There is no evidence that it was prepared on the basis of a site visit and examination of the tank. Pipeline Consulting stated that no differential settlement of tank shell was found and that this could be a major contributing factor to the shell distortion. According to Pipeline Consulting, it appeared that the design criteria for the 18-inch line did take into account the transfer of forces to the tank shell since all forces generated by the expansion loop of the 18-inch line were transferred to the tank shell. As the plate shell thickness became smaller, its resistance to distortion became less. Moreover, Pipeline Consulting opined that since the distortion and buckling of the tank occurred near the top at the 32-foot level of liquid, the distortion from an external load would tend to occur at that point where the internal loading by liquid was minimal.

30. Government technical personnel reviewed the Pipeline Consulting Services' evaluation report and found it to be inadequate (R4, tab 20 at ex. 15; ex. J-2). Contrary to the statement in the Pipeline report concerning the lack of settlement differential, and the inference that there should be a settlement differential, a settlement differential would have resulted in buckling (R4, tab 20 at ex. 15; tr. 3/11). Pipeline's assertion that the force due to thermal expansion of the 18-inch line caused buckling in the upper shells, failed to acknowledge the presence of four ball and knuckle swing joints in the line which were part of the design, and the additional elbow in the expansion loop in the line as a "work-around" feature added by appellant when it failed to coordinate the dike penetration with the final tank location (R4, tab 20 at ex. 15; tr. 3/12). Moreover, the plate above the connection to the 18-inch line was examined and found not to be in tension, with no distortions or stresses found in the plates adjacent to the 18-inch line (tr. 3/10). In its response to appellant's report, the Government cited unspecified violations of API 650 which were not addressed in the Pipeline Consulting Services' report.

31. By letter dated 11 June 1991, appellant submitted a further report from Pipeline Consulting on the possible cause of the buckling (R4, tab 21 at ex. 106; ex. J-2). Although affirming its prior preliminary evaluation, this report was based on a visual inspection of the tank and the configuration of the connected piping and associated distortion. Pipeline clarified its earlier statement concerning the differential settlement, stating that there was no differential settlement of the tank that could have contributed to the shell deformation. Once again, it attributed the buckling of the upper plates in the tank shell to the 18-inch pipe installation; Pipeline opined that the joints were mis-aligned, and that when they were tightened to prevent leakage of liquids or gas, they became essentially rigid. Pipeline Consulting also noted that there were some minor distortions in the tank shell on the northeast side, which were unrelated to the major distortions above the 18-inch piping and appeared to be normal distortions resulting during the tank construction.

32. The Government responded to this additional report from Pipeline Consulting Services and noted its disagreements with Pipeline Consulting Services' conclusions regarding the role of the 18-inch line as the cause for the deformation in the tank shell (R4, tab 20 at ex. 18; ex. J-2). The Government requested appellant to submit a plan for measuring the actual strain in the tank before and after a section was removed from the 18-inch line to empirically test the hypothesis that the 18-inch outlet line could have caused the tank deformations, and to submit a plan for the safe withdrawal of the remaining fuel from the tank and for the commencement of repairs on the tank.

33. On 19 July 1991, Raba-Kistner Consultants, Inc. submitted a report of its investigation of the structural distortions of the jet fuel storage tank to Maryland Casualty Company (R4, tab 21 at ex. 107; ex. J-2). The report noted the two distortions above the 18-inch discharge line identified in the Government's 16 May 1991 notice to appellant, as well as other distortions, including a local flattening present as a result of the fabrication irregularities, and the weld failures at the top of the vertical stiffeners. The report concluded that based on observations and preliminary discussions, the tank distortions

could have resulted from one or more of the following: (i) "as-built irregularities" that could make the shell susceptible to local buckling and some of the current distortions, but not the major ones; (ii) although API 650 required approximately twice as much open vent as actually provided, inadequate venting in the roof and excess vacuum could possibly be sufficiently small to create small dents or depressions; (iii) transmission of loads from the pipe to the tank should be minimal; (iv) although API 650 apparently would require wind girders for the tank, lack of wind girders may be a significant contributing cause for tank distortions; (v) the floating roof did not appear to be sufficiently rigid to allow significant vacuum to develop and tank was rewelded in places so that it met API 650 requirements for roundness, although the data on tank roundness was not reviewed; (vi) impingement on trusses would not appear to be able to cause the distortions noted; and (vii) the deadweight of the roof, trusses, and other support members was supported primarily at only eight points on the tank rim with concentrated forces from improper roof design transmitted down the vertical stiffeners into the tank wall, which may have been sufficient to cause buckling at the bottom of the stiffeners in the steel plate and to be the main contributing cause for tank distortions. Raba-Kistner made a number of recommendations in its report, including that the tank not be drained further without strengthening the walls and reducing the load on the vertical stiffeners, and that stiffener rings be added below the current liquid level. Additionally, because welding of stiffener rings to the tank while the tank was full of jet fuel could represent a hazard, Raba-Kistner recommended displacing the jet fuel with water before installing stiffeners.

34. The Government's technical personnel understood Raba-Kistner's reference to the "as-built irregularities" to refer to the small, flat, spots visible around the tank. Some of the plates were flat and not uniformly curved, as well. Additionally, there was a large flat area on the northeast side of the tank in the fifth and sixth rings. (Tr. 3/15-16) With respect to the roof venting, Raba-Kistner did not measure the vents and calculate the size of the venting. Nevertheless, in a tank the size of this tank, there would be some vacuum. However, any vacuum would be throughout the entire tank and would not be localized in one place to produce the kind of deformation observed in the instant tank. Moreover, the highest flow rate of approximately 5,400 gallons per minute would not require a venting area in excess of the 16 square feet for the roof of this tank. (Tr. 3/16-17)

35. Appellant submitted to the Government for review and approval its plan for removal of jet fuel from the tank, tank design drawings, and reconstruction of the tank (R4, tab 20 at ex. 19; ex. J-2; tr. 3/18). Appellant's reconstruction plan for the fuel tank was prepared and submitted by Raba-Kistner on 29 August 1991 (R4, tab 21 at ex. 108; ex. J-2). Raba-Kistner prepared an additional report and reconstruction plan and submitted this plan on 13 September 1991 (R4, tab 21 at ex. 109; ex. J-2). In its 29 August 1991 reconstruction plan, Raba-Kistner recommended replacement of the jet fuel with water so that the stiffener rings could be safely welded to the tank shell, the placement of strain gauges on the tank to monitor changes that may occur during the reconstruction process and to see what effect the piping had on tank shell stresses, installation of standard stiffener rings meeting API 650 requirements for intermediate wind girders, installation of wind

girders, draining the tank, designing the final tank reconstruction to achieve a structurally sound tank system, and correction of the tank deformations.

36. By letter dated 10 September 1991, the Government informed appellant that because of an additive present in the jet fuel, the displacement of the fuel with water was cost prohibitive and not acceptable to the Government (R4, tab 20 at ex. 20; ex. J-2; tr. 3/22). Doing so would result in stripping the fuel of its dewatering agent. As a result, the fuel would not be useful for aircraft. Nevertheless, the Government reiterated the importance of researching and resubmitting an alternative proposal without delay.

37. Appellant submitted a 13 September 1991 revision to the Raba-Kistner 29 August 1991 reconstruction plan that included a plan of action for the removal of the jet fuel, new tank shop drawings, and a plan for the reconstruction of the tank (R4, tab 20 at ex. 20; tab 21 at ex. 109; ex. J-2). The revised report continued to assert that the primary factor that contributed to the distortions in the tank plates was the excess stress on the tank shell due to the dead weight load of the roof and truss acting only on eight primary support points, and that the secondary factors were inadequate venting capacity and inadequate wind girders. The main difference between this revision and the prior report of 29 August 1991 was that the revised report recommendation stated that "the shell should be strengthened or the load on the shell relieved sufficiently to allow safe removal of all fuel." Therefore, this recommendation amended the prior recommendation from a specific method of strengthening the shell to a general statement that supplemented the recommendation that the tank should not be drained without further strengthening of the tank shell (tr. 3/22). The report further stated that Kelly Air Force Base "would not allow water displacement of fuel from the tank, because fuel would be contaminated with water." Moreover, in its revised report, Raba-Kistner recommended that external columns be attached to each of the eight truss-loaded vertical stiffeners to insure that the design of the final tank reconstruction would achieve a structurally sound tank system. The plan called for the correction of tank distortions during the final tank reconstruction phase. The Government approved appellant's proposed plans for the repair of the fuel tank on 19 September 1991 and directed appellant to submit its final design of the external columns immediately (R4, tab 20 at ex. 22; ex. J-2).

38. Appellant provided drawings and calculations for the external columns to the Government on 4 October 1991 (ex. J-2). The parties discussed the tank repair during the period of 15-17 October 1991 (R4, tab 20 at ex. 24; ex. J-2). The parties agreed that the external support concept presented by appellant was acceptable and that the time extension requested by Pawnee for submitting a design of the approved external support column concept was granted. Appellant submitted its proposal for a design of a temporary structure to support the tank during the downloading of the fuel on 29 October 1991 (R4, tab 20 at ex. 25; ex. J-2). The proposal consisted of design calculations for the vertical members and the WF beams. Construction details and erection sequences were to be submitted no later than 8 December 1991. The Government approved the concept and calculations for the tank

support contingent upon further development of horizontal frame bracing, guy wire connections, and full construction detail development (R4, tab 20 at ex. 26; ex. J-2).

39. Neither the Government's engineer or its project manager had discussed with appellant the installation or design of the exterior columns except as part of the Raba-Kistner recommendations, nor did they direct appellant to provide external support columns to the tank (tr. 2/112, 3/23-24). Rather than installing the previously proposed eight exterior support columns, appellant proposed utilizing a four column tower designed to be placed above the withdrawal line to provide lateral stability if the tank were to move and to catch the load of the roof if it continued to drop (tr. 2/112-13, 3/24).

40. Pawnee obtained the expert consultant services of Dean K. McKibbin Contracting and Consulting Services (McKibbin) to investigate the tank and to submit an opinion concerning the cause of the deformation of the tank plates and a recommendation for reconstruction and correction of the deformations (R4, tab 20 at ex. 30; ex. J-2). According to McKibbin, if the tank shell required a support tower, which it did not believe was the case, one such tower would be sufficient for this purpose, and stated that since the helical stairway offered limited resistance to shell distortions, it should not be cut. Pawnee forwarded this report to appellant and requested written directions as to how it should proceed. On 20 November 1991, appellant submitted to the Government a modification of its tank support plan based on a proposal received from Pawnee (R4, tab 20 at exs. 29, 30; ex. J-2). Appellant proposed only one support tower located at the truss point above the 18-inch discharge line. The tower was not to be attached to the WT member of the tank, and the helical stairs should not be cut. The Government accepted appellant's proposal to use only one support tower at the truss point above the 18-inch discharge line and to not attach the tower to the stiffener member (R4, tab 20 at ex. 31; ex. J-2). The support tower was constructed in December 1991 (ex. J-2). Appellant never told the Government prior to the construction of the tower that the tower was not necessary and it was not until several months later that McKibben also told the Government that more highly deformed tanks had been successfully drained without a support tower (tr. 3/25).

41. By letter of 9 March 1992, appellant forwarded to the Government reports submitted by McKibbin and Southwest Research Institute to Pawnee. (R4, tab 20 at exs. 30, 35; ex. J-2) McKibben, in its report, recommended the installation of a circumferential ring stiffener to the outside of the shell at the bottom of the vertical stiffeners to distribute possible shell distortions more uniformly. Based on its understanding of the reports, appellant opined that the causes for the distortions in the tank wall were the support design for the 18-inch discharge pipe and the placing of the 10-foot vertical members at the top of the tank structure which created hard points in the tank shell. According to appellant, these elements were required by the Government's contract design and specifications. Therefore, appellant concluded that it had constructed the tank in compliance with the contract and within the constraints of API 650. Moreover, appellant contended that the Government had inspected the tank and its appurtenances demonstrating that appellant had fulfilled its contractual warranty obligations and that it had no responsibility to perform any remedial

measures on the tank. Accordingly, appellant asserted that it was entitled to an equitable adjustment to compensate it for its costs incurred in determining the causes of the tank deformations and reserved its rights for additional compensation for any additional work required to put the tank back into operation.

42. Appellant notified the contracting officer on 18 March 1992 that the Government's inspector and representatives of appellant and Pawnee had visually inspected the inside, outside, and top of the fuel tank on 17 March 1992 and that it appeared that there was no damage to either the tank or the roof structure as a result of the distortions which developed during the fuel discharge procedures of May 1991 (R4, tab 20 at ex. 38; ex. J-2). The parties agreed to defer any final determination on the cause of the deformations in the tank until it could be inspected by an engineer representing Pawnee. After the tank had been drained, the tank was inspected in order to determine mechanisms which caused the buckling, with particular attention given to the roof structure, the seal of the floating roof, the vertical gauging well within the tank, and the anti-rotational cable (tr. 3/33-34). Unlike the severe inward and outward buckling found in May 1991 (findings 26 and 27), the parties' representatives found a nominally benign tank that did not have considerable deformation in it after it was emptied. There was no sign of catastrophic failure in the tank wall and no sign of buckling, roof structural problems, damage to the seal of the floating roof, or distress within the tank (tr. 2/34-35).

43. Pawnee submitted to appellant a revision to the prior McKibbin and Southwest Research Institute reports and asserted that the problem of the tank deformation appeared to be uniquely caused by the 18-inch discharge pipe (R4, tab 20 at ex. 39, tab 21 at ex. 110). McKibbin reported that with the tank empty, the severity of the shell distortions was gone. Although McKibbin admitted that it was impossible to assign the total cause of the shell distortions to one item, all indications were that the 18-inch discharge pipe was a major contributor. McKibbin reported that to correct such severe distortions by cutting the tank shell plates would create more distortions. However, McKibben recommended that adding ring stiffeners to the outside of the shell at the bottom of the vertical stiffeners would minimize the severity of the deformations by uniformly distributing them. Pawnee asserted to appellant that it had built the tank as shown in the contract drawings and in compliance with the contract. According to Pawnee, it had fulfilled its contractual obligations and had met all the requests for safely emptying the tank. Pawnee, therefore, requested final payment for the tank construction, release of its bond, and all expenses incurred since the tank deformation problem became evident. Appellant, in its 9 March 1992 letter to the Government, submitted by facsimile transmission on 9 April 1992, stated that it was enclosing the reports submitted by McKibbin and Southwest Research Institute to Pawnee.

44. The contracting officer, by letter dated 28 April 1992, rejected appellant's 9 March 1992 letter reporting the findings of its tank investigation and its conclusion that it had constructed the tank in compliance with the contract and API 650. (Finding 41; R4, tab 20 at exs. 35, 40; ex. J-1) The contracting officer stated that there were four specific tank features that he found to be in violation of the contract drawings, appellant's shop drawings,

and the contract specifications. These included: a wind girder had not been provided as required in API 650; the 18-inch withdrawal pipe was not supported two feet from the inside of the tank as shown on appellant's shop drawing and on contract drawing, Sequence No. 20 (which would have decreased the moment the withdrawal pipe applied to the tank shell); the radial load of the 18-inch withdrawal pipe was not considered in appellant's design as required by API 650; and several of the vertical WT members' welds were cracked and needed repair. According to the contracting officer, the vertical WT members had been analyzed along with the entire tank using a finite element analysis, and the first three elements identified contributed directly to the moment loading of the tank wall and the wall displacements observed. Accordingly, appellant was directed to repair these deficiencies in accordance with the contract WARRANTY OF CONSTRUCTION provision in the Technical Provisions, § 01740.

45. At the time the contracting officer wrote this letter, the Government believed that the wind girder was required by API 650. (Tr. 3/37-38) A wind girder was a feasible method to address the wind load requirements of the contract. On further review of the issue, the Government determined that the particular version of API 650 referenced in the contract did not explicitly required a wind girder. However, the major concern in this regard was how appellant addressed the 100-mile per hour wind load requirement in the contract design. The tank had an unstable wall. Had there been a wind girder, it would have given the tank requisite stability similar to the two four-inch angles that were later provided on the tank. Moreover, as of 28 April 1992, appellant had not established that the shell of the tank met the 100 mile per hour wind load requirement of the contract as provided in Note 7 of Drawing Sequence No. 20 (finding 7). Appellant never installed a wind girder.

46. By letter dated 1 May 1992, appellant directed Pawnee to provide a response to the contracting officer's letter of 28 April 1992, with a detailed corrective plan of action and schedule not later than 4 May 1992 (R4, tab 20 at ex. 41; ex. J-2). Pawnee responded to appellant on 4 May 1992, addressing the issues raised by the contracting officer in his letter of 28 April 1992, and attaching a further report from McKibbin (finding 44; R4, tab 20 at ex. 42). Pawnee first asserted that the Government had not requested wind girders pursuant to API 650, and that the tank distortions were not a result of wind loading; rather that they resulted from the mechanical design, particularly, the rigidity of the 18-inch discharge pipe and to a lesser degree, the fixation of the 10-inch line. In this regard, Pawnee asserted that the tank was designed with vertical stiffeners, and that without vertical stiffeners, the tank was specified at a minimum wind load of 70 m.p.h. when empty. Second, Pawnee asserted that it was not responsible for the design of the 18-inch discharge pipe, but that it would interlineate the 18-inch line with corrugated flexible hose and install a flexible joint to remove the rigidity of the line inside the tank and accommodate the natural tank wall movement. Pawnee also stated that it would disconnect the 10-inch support which was fixed to the tank floor, and that it would notch out the cracks in the vertical WT members to reduce any interference with coating. Nevertheless, it claimed that $33,179.00 remained unpaid on its original contract, requested payment of an additional

$46.800.00 for the tower, and reserved its right to claim additional compensation for the corrective work.

47. In its letter of 4 May 1992 to the contracting officer, appellant disputed the Government's assertion that the items addressed in the Government's 28 April 1992 letter were violations of the contract that resulted in the deformations to the fuel tank shell (R4, tab 20 at ex. 44; ex. J-2). Appellant forwarded the most recent McKibbin report submitted by Pawnee and acknowledged responsibility only for the cracks in the welding of the WT girders, which according to appellant, had no relation to the deformations in the tank shell. Appellant recommended installing a 6" x 4" x 1/2" angle stiffener to the tank shell at the bottom of the vertical WTs for distortion distribution, and proposed a schedule for repairing the welding of the WT girders, and installing a flexible expansion joint on the 18-inch discharge line. In conclusion, appellant contended that its performance was in compliance with the contract and that it was entitled to an equitable adjustment for all its costs incurred in determining the causes for the tank deformations and for any costs incurred in making additional repairs. The Government accepted appellant's proposed corrections and schedule by letter dated 20 May 1992 (R4, tab 20 at ex. 45; ex. J-2). On 1 June 1992, appellant submitted a more detailed schedule for performing the work under which all work was to be completed in September 1992 (R4, tab 20 at ex. 48; ex. J-2).

48. In its effort to establish that the shell of the tank could withstand a 100 mph wind load, appellant submitted to the Government correspondence from Pawnee, Pipeline Consulting Services, and Thomas D. Jordan, P.E., Ph.D (R4, tab 20 at ex. 54; ex. J-1). According to the Pipeline Consulting Services report, "Deformation of the tank shell may occur as sustained wind velocity approaches 100 MPH. Should shell deformation occur failure due to sheet distortion would not be predicted." (R4. tab 20 at ex. 54) In his report, Thomas Jordan opined that "stiffeners were capable of withstanding a design wind velocity of over 65 mph," based on certain assumptions with respect to the place and method of attaching stiffeners. Neither the Pipeline Consulting Services report nor the Thomas Jordan report contained supporting calculations (R4, tab 20 at ex. 54; tr. 3/39-41). By letter dated 2 November 1992, appellant submitted to the Government, Pawnee calculations that purported to show that the tank could withstand 100 mph wind loading (R4, tab 20 at ex. 61; ex. J-1). Pawnee, also by letter dated 3 November 1992, continued to assert that the 18-inch withdrawal line was installed in accordance with the specifications and that the design specifications for this pipe presented a significant problem with respect to the tank shell, and was related to the deformation in the upper rings of the tank shell (R4, tab 20 at ex. 63). Appellant supplemented this submission with further correspondence from Pawnee with additional calculations in which Pawnee attempted to establish that the tank could withstand wind loads of 100 mph (R4, tab 20 at ex. 67; ex. J-2).

49. Appellant's corrective work stopped on 4 August 1992 due to Government failure to remove fuel from the tank (R4, tab 20 at exs. 52, 53; ex. J-2). During the period of 26 October 1992 to 10 November 1992, appellant installed an 18-inch flex joint on the 18-inch discharge line inside the tank shell (ex. J-2). Appellant had previously proposed

adding a 6-inch by 4-inch by 1/2-inch angle stiffener to the tank shell at the bottom of the vertical WTs for distortion distribution (finding 47; R4, tab 20 at ex. 44). This angle stiffener was not installed during the October/November 1992 time period (ex. J-2). On 6 November 1992, appellant reported to the contracting officer that it had begun filling the tank with water on 3 November 1992, but that the Air Force had requested that it stop filling the tank until the Air Force could obtain approval from the State of Texas (R4, tab 20 at ex. 64; ex. J-2). Appellant also complained in that letter and in a letter dated 10 November 1992 that it had been delayed since 3 November 1992 in testing the tank because of the Air Force's action in stopping the filling of the tank with water (R4, tab 20 at ex. 65; ex. J-2). Appellant contended therein that upon review of further calculations submitted by the Government and appellant's original calculations at the time appellant constructed the tank that the tank met the 100 mph wind loading requirement, and that the tank developed the deformations as a result of the design of the piping system. Therefore, according to appellant, the deformations were not due to the nature of the construction of the tank, but were due to poor design.

50. The Government, by letter dated 3 December 1992, informed appellant that it had been notified on 25 November 1992 that the Air Force had allowed the continued filling of the tank with water, and directed appellant to immediately resume its work activity (R4, tab 20 at ex. 66; ex. J-2). The Government further rejected appellant's assertions with regard to the wind load calculations, stating that:

> the calculations submitted by you demonstrates [sic] the adequacy of the tank to resist overturning. However, they do not address tank buckling. Based on the API 650 code, 7th Edition (1980), paragraph 3.9.7, the maximum wind velocity the tank, as constructed, is capable of resisting is 86 MPH (see enclosed calculations). This fails to meet the contract requirement of 100 MPH.

(R4, tab 20 at ex. 66) The Government again directed appellant to provide the previously directed proper fix which would provide the additional stiffening to meet the wind velocity requirement. On 15 December 1992, appellant informed the Government that the filling of the tank had been completed and that there did not appear to be any damage to the tank during the filling process (R4, tab 20 at ex. 68; ex. J-2).

51. By letter dated 24 December 1992, the contracting officer informed appellant that based on the Government's further review of appellant's wind calculations submitted with its 9 and 15 December 1992 letters, he was satisfied that appellant had reasonably met the contract requirements and that no additional stiffening of the tank wall was required (R4, tab 20 at ex. 71; ex. J-2). Appellant could, therefore, remove the water from the tank, remove the tower support and other items provided to do the work and demobilize from the site. At that time, The Government was aware that appellant had not installed either a wind

girder or the angle at the bottom of the vertical stiffeners (R4, tab 20 at exs. 68, 71, 74; tr. 1/108-09).

52. On 4 January 1993, appellant wrote the Government in response to the Government's letter of 24 December 1992, stating that it would comply with the Government's direction to begin operations for the removal of water from the tank and dismantling the support tower (R4, tab 20 at ex. 74). In its letter, appellant stated:

> We would like to go on record as stating that the recommendations for the corrections to the tank as given by Mr. Dean McKibbon, Engineer for Pawnee Tank, be considered as the solution for putting this tank back into service. These corrections, previously communicated to you both verbally and in writing, were for the placement of an angle iron at the base of the vertical stiffeners, the cutting loose of the 10" support from the tank floor and the isolation of that line from the tank wall, and the installation of another flex-joint on the 18" line just outside the tank. Also, please note that the existing deformations will continue to be present in the tank shell now and in the future.

53. Sometime between 6 January 1993 and 8 January 1993, deformations once again appeared in the shell of the tank (R4, tab 20 at exs. 76, 78; ex. J-2). The deformations or buckles in the tank wall that appeared in January 1993 were at the same locations, of the same general sizes, and same general patterns as the deformations that appeared in May/June 1991 (tr. 2/114, 3/51-52). As of 8 January 1993, appellant and Pawnee were still considering possible causes to the deformations and possible corrections to the tank (R4, tab 20 at ex. 79). They identified possible causes as the tank was not round, that appellant did not using curved sheets, and the fact that the 1/4-inch sheets were not in compliance with the API and were not thick enough for the load weight of the roof structure. Once again appellant identified possible corrections, including the use of angles to support the shell at the bottom of the WT members and between the WT members and 5/16-inch sheet, use of thicker plates or sheets, and reworking existing sheets to remove distortions and round out the flat sheets. The tank, when either empty or full did not contain any buckles. However, during withdrawal of either water or product from the tank, the buckles would reappear. As a result, the Government retained the services of Tank Consultants, Inc., an independent tank consultant and member of the tank design subgroup of API to evaluate the tank, determine the cause or causes for the buckling, and recommend a method for repairing the tank (R4, tab 20 at ex. 80; ex. J-2; tr. 3/52-53, 4/5-7, 20).

54. After it reviewed the contract drawings and other contract documents, Tank Consultants, Inc. performed a visual inspection of the tank and all nozzles in the lower shell, took detailed measurements of the condition of the tank, including shell thickness readings with an ultrasonic thickness meter, performed a visual inspection of the fixed roof, and

inspected the inside of the tank on top of the floating roof (tr. 4/20-23). Tank Consultants, Inc. representatives met with representatives of the Government, appellant, and its subcontractor, Pawnee, for this inspection and the evaluation of the conditions of the tank (R4, tab 20 at ex. 80). Tank Consultants, Inc. found the following conditions: The foundation flatness was 0.1 inch above the API 650 tolerance and the out-of-plane deflection of the foundation was in accordance with API 650 and in good condition and acceptable. There was peaking in the 5th and 6th shell rings which exceeded the API 650 authorized tolerance and required corrective repair. The banding of the 5th and 6th shell rings was at the maximum allowed tolerance of API 650, and did not require corrective action. Improper construction practices were found in the repad for the manway in shell ring number 2, which overlapped a vertical shell seam, and the weld spacing to the corner weld on five of the shell nozzles was less than required by API 650. There were two large buckles in the upper shell, one measured 6.9 inches deep and the other was 7.14 inches deep. This buckling was a continued manifestation of a previous buckling (tr. 4/144). Once a tank has buckled, it is more likely to buckle again. The tank shell was measured for tilt and roundness. Of the 30 stations measured for plumb, five did not meet the requirements of API 650 for new construction. Two of the stations were at the location of the large buckles, and did not meet the requirements of API 653 for reconstructed tanks. Although not referenced in the instant contract, this API 653 was a new standard developed by the API dealing with the inspection, maintenance, and reconstruction of tanks after they have been put in service, whereas API 650 addressed new tank construction (tr. 4/27, 50). API 653 was a more lenient standard than API 650. The rim space of the floating roof varied from 2 1/2 inches to 6 3/4 inches; and API 650 required that the floating roof seals be designed to accommodate a plus or minus 4-inch deviation between the floating roof and the shell. The horizontal deviations of the tank shell at ring 5 and ring 6 were greater that the four inches authorized by the API and could cause the roof to bind or damage the seals. The horizontal seam of the 5th and 6th shell rings was misaligned in places exceeding the maximum misalignment allowed in API 650 and API 653. The overall appearance of the workmanship was poor, as evidenced by areas of weld undercut and pinholes evident through the paint on the inside of the shell on the upper shell rings, the many scars on the shell plates, welds were low in some areas, and the many areas where the weld was wider than the adjacent weld. (R4, tab 20 at ex. 80)

55. Tank Consultants, Inc. concluded that appellant had a problem with welding in the upper shell because the welds exceeded the allowable tolerances as reflected by the number of seams that did not meet the API standard or that were at the limits of the standard tolerances (tr. 4/37-38). Moreover, Tank Consultants, Inc. concluded that the peaking occurred at the time of the welding and was caused by improper fabrication or welding with the distortion of the shell out of the true circle (tr. 4/38-39). In addition to the two large buckles in shell rings 5 and 6, there were flat spots in the tank shell approximately halfway around the tank shell from the large buckles. Indeed, Certified Tank Calibrators, the calibration and measurement subcontractor for Tank Consultants, Inc., measured the flat spots and found a large number of deviations in and out from the correct round shape. These flat spots were caused by welding or fabrication problems, or both, where there was

too much heat put into the weld and where the joints were not properly restrained. The tank was not close to a true cylindrical plumb and round shape. Buckles of the depth found in the tank could easily damage the seals on the floating roof causing premature wear of the seal, cutting the seal, and causing the roof to bind on the shell as it traveled up and down resting on the fuel product as the tank was filled or emptied. (Tr. 4/43-48) In its report, however, Tank Consultants, Inc., reported that the floating roof appearance was good and that there was no distress evident in the roof at the level on which the inspection was performed notwithstanding the fact that the floating roof seals had deviations that exceeded the API authorized local deviations (R4, tab 20 at ex. 80). Nevertheless, based on both the visual inspection and the detailed measurement performed by Certified Tank Calibrators, Tank Consultants, Inc. concluded that the tank did not meet the requirements of API 650 for roundness, plumbness, peaking, and banding prior to appellant's performance of the hydrostatic tests and the conclusion of its construction. (Tr. 4/43-48)

56. The shell of the tank was a large flexible membrane with the upper shell being 1/4 inch thick on a 93-foot diameter tank (tr. 4/62). It was designed primarily to operate in tensile stress from the liquid load that is imposed on it (tr. 4/40-41, 57). Peaking in weld seams and misalignment placed stress risers in the tank shell that could not travel from one plate to another thereby giving high local stresses in a particular area. If the sequence of welding was done properly and weld seams did not have peaking and banding, the tank would maintain a round shape (tr. 4/62-63). Once stress risers are created in the joints of the tank from peaking, banding, wide welds, and misalignments, residual stresses are induced in different locations throughout the tank. Where weld sequences have not been controlled, and stress risers are created putting loads on the thin membrane shell, buckling will occur in different locations in the tank shell. There were so many construction deficiencies in the tank that Tank Consultants, Inc. could not isolate any particular problem or location as a cause for the buckling, rather it concluded that all of these deficiencies in combination caused the buckling (tr. 4/182-83). According to Tank Consultants, Inc., none of these conditions could have been caused by the hydrostatic test (R4, tab 20 at ex. 80; tr. 4/48-50).

57. On 8 February 1993, the Government furnished appellant a copy of the Tank Consultants, Inc. report concerning its inspection and evaluation of the condition of the tank (R4, tab 20 at ex. 80). In its letter of 10 February 1993, the Government referenced this inspection and the Tank Consultants, Inc. report, and identified specific deficiencies in the construction of the tank. These included: inadequate tank wall radius control; the peaking of the vertical seams which exceed 1/2-inch needing repair, particularly four locations in the fifth and sixth rings of the tank; the 1/4-inch misalignment between the fifth and sixth rings of the tank which occurred on the Northwest to Southwest sector of the tank; and noncompliance of the handrail height on the stairway. According to the Government, all of these conditions existed prior to hydrostatic testing, a conclusion consistent with the findings and conclusion of Tank Consultants, Inc. that they would not have been caused by the hydrostatic test (findings 54 and 55). The Government further stated in this letter that:

> Based on Mr. Devlin's report [Tank Consultants, Inc.], the Government agrees with Mr. McKibbon's [*sic*] concept of placing angle iron(s) to round the tank wall. Since your letter did not provide specific details for this type of fix, we are not able to evaluate the sufficiency of your proposal at this time. I remind you that the design of the tank and any design fix continues to be your responsibility. However, if you choose to follow our consultant's recommendation for wall stiffening through radius control, that will be acceptable to the Government. In either event, adequate wall stiffening must be achieved to ensure that buckling will not recur.

The Government also approved Mr. McKibbin's recommendation concerning cutting loose the 10-inch support from the tank floor.

58. By letter dated 17 February 1993, appellant requested Pawnee to provide a corrective plan of action and schedule for making the necessary repairs to the tank as required by the Government in its letter of 10 February 1993 to appellant (R4, tab 21 at ex. 82; ex. J-2). On 8 March 1993, appellant informed the Government that it had directed Pawnee to effect the repairs to the tank in accordance with the contract and the report prepared by Tank Consultants, Inc. (R4, tab 21 at ex. 88; ex. J-2). Appellant also stated therein that although it was effecting repairs as directed by the Government, it did not acknowledge that the repairs were appellant's responsibility under the contract, and, therefore, that it reserved its rights under the contract and the DISPUTES clause to contest the liability and claim additional costs incurred.

59. Installation of the support angles started on or about 26 March 1993 (R4, tab 21 at ex. 98; ex. J-2). Pawnee completed the work and demobilized on or about 3 May 1993 (R4, tab 21 at exs. 100-102; ex. J-2). However, the only work Pawnee performed in March-May 1993 was to install two stiffeners (tr. 1/167-68). It did not correct the peaking and did not correct the misalignment. Nevertheless, by letter dated 22 June 1993, the Government confirmed that the repair work had been completed and that Pawnee had demobilized (R4, tab 21 at ex. 103).

60. Tank Consultants, Inc. performed further examination of the tank in March 1996 (SR4, tab 52). During this examination, it performed a finite element analysis which was a mathematical analysis done by modeling the tank and then using a computer to calculate a solution to the problems (tr. 4/76). This particular analysis was performed to determine if the tank was constructed in accordance with API 650 and to determine potential causes for the buckling of the tank. These included the nozzle load of the 18-inch withdrawal line and 10-inch pipe, the roof load, and a possible vacuum. Tank Consultants, Inc. and its consulting engineer determined that when high stresses were induced locally on the 18-inch pipe, any deformation was local, and that the stresses rapidly diminished away from the nozzle and were very low in the upper shell rings. There was no

buckling at any point. (SR4, tab 52; tr. 4/76-77, 105) Actual roof loads were calculated and then in the computer model, the actual roof load on the tank rim was doubled to determine if the roof load could have caused the buckling (tr. 4/78). Based on this analysis, Tank Consultants, Inc. concluded that the roof load could not cause the buckling. Tank Consultants, Inc. also concluded, based on its inspection, that the vents in the cone roof at the center of the tank, the circulation vents at the edge of the roof, and the overflow nozzles on the tank provided more than adequate venting capacity to prevent the forming of a vacuum above the floating roof, and were put in the tank in accordance with API 650 (tr. 4/79-83, 86).

61. Appellant submitted to the contracting officer a properly certified claim in the amount of $496,668.61 for Government directed warranty work to repair the tank, including repair of the 10-inch control valve on the inlet 10-inch pipe to the tank (R4, tab 19; ex. J-2). The claim included costs incurred in documenting the extent of all the problems, determining the causes and proposing solutions, submitting plans of action, and performing the repair work. According to appellant, the directed work was due to the Government's defective design. However, appellant stipulated that it does not allege a design defect in the Government's design of the tank piping, in particular, the location and support for the 18-inch withdrawal pipe as the source of the shell loading causing distortions in the shell of the tank as concluded by Pipeline Consulting Services in its report of 6 June 1991, McKibben in its reports of 15 November 1991 and 1 May 1992, and Pawnee in its letter dated 3 November 1992 (ex. J-2; findings 29, 30, 40, 46, 49). We have found no basis in the record for finding that the Government's specifications and drawings for tank design were deficient.

62. The contracting officer denied appellant's claim (R4, tab 2). Appellant timely appealed the contracting officer's final decision denying its claim (R4, tab 1; ex. J-2). Appellant stipulated that its primary defense to the Government's claim under the WARRANTY OF CONSTRUCTION clause is premised on the finality of acceptance under the contract's INSPECTION OF CONSTRUCTION clause, and appellant's compliance of its workmanship with the contract standards at the time of acceptance, namely, that there was no defective work (ex. J-1).

DECISION

The thrust of appellant's arguments is that the record conclusively established that appellant's construction of the tank met the contract requirements on 7 February 1991 "when the Corps accepted the work" (app. br. at 19). The dispositive issue in this appeal is the finality of the Government's acceptance, if any, of the tank under the contract's INSPECTION OF CONSTRUCTION clause. If, as asserted by the Government, the buckling in the fuel storage tank in May 1992 and in January 1993 was covered by the contract's WARRANTY OF CONSTRUCTION clause, the questions arise as to whether there were defects in appellant's workmanship, and if so whether there was a causal connection between the alleged defects in workmanship and the buckling. Appellant also questions whether the

Government's warranty notice was sufficient to survive the expiration of the warranty period. Although contesting the Government's contention that appellant's poor workmanship resulted in the buckling of the tank, appellant contends that the Government did not specifically identify the defective aspects of appellant's performance at any time prior to February 1993, after expiration of the warranty period. Rather, according to appellant, the Government set forth general and then specific aspects of the design which were contended by the Government to be appellant's responsibility as a basis for the Government directives to appellant. Appellant simply asserts that the Government's warranty notice of buckling in the upper rings of the tanks was issued to task appellant with investigation and remedial work, and "did not specify any of the 'classes' of breaches set forth under the warranty clause."

The WARRANTY OF CONSTRUCTION clause provides in paragraph (e) that "[t]he Contracting Officer shall notify the Contractor in writing, within a reasonable time after the discovery of any failure, defect, or damage." In order to recover under the warranty clause, the Government must show that the contractor was given notice of the defect and prove the existence of a defect within the contractor's control. *Kordick and Son, Inc. v. United States*, 12 Cl. Ct. 662, 668 (1987). Buckling in the fifth and sixth rings of the tank, further deformation in the wall plate that was limited by the helical stairway, and cracks in the welds at the top of some of the vertical stiffeners were discovered in early May 1991 as the Air Force was withdrawing fuel from the tank. The Government notified appellant on 6 May 1991 that there was buckling in the tank and that these indentations had increased in size and requested appellant to attend an investigation of the problem at the site. The ARCO confirmed this information in writing on 16 May 1991 after the parties had discussed the problem both telephonically and at the tank site during the preliminary investigation of the buckling (finding 28). Appellant has not directed our attention to any language in the warranty clause or to any other authority requiring the Government in its notice of failure, defect, or damage to more specifically identify in its warranty notice the work the Government believed to be defective or to further "specify any of the 'classes' of breaches set forth under the warranty clause." Both the joint site visit by appellant, Pawnee, and Government representatives, and the ARCO's written notice of 16 May 1991 were sufficient to put appellant on notice of the failure, defect, or damage.

Ed Dickson Contracting Co. Inc., ASBCA No. 27205, 84-1 BCA ¶ 16,950 and *Great Valley Construction Company, Inc.*, ASBCA No. 24449, 81-2 BCA ¶15,308 cited by appellant are inapposite. *Ed Dickson Contracting Co.* simply stands for the propositions that failure of materials within the guarantee period does not create a presumption of improper workmanship, and that the determination of the precise cause of failure cannot be based on suspicion, speculation, or surmise. *Great Valley Construction Company, Inc.* stands for the proposition that the existence of a failure, standing alone, does not satisfy the Government's burden of proof to show by a preponderance of the evidence the failure of the contractor's compliance under the warranty clause, which burden of proof does not require the Government to establish the cause of the defects with absolute certainty.

When the Government asserts its rights under the WARRANTY OF CONSTRUCTION clause, it must prove: (1) that the material or workmanship was defective; and (2) the most probable cause of the failure was the deficiency. *Earth Tech Industries, Ltd*., ASBCA No. 46450, 99-1 BCA ¶ 30,341 at 150,045; *Hogan Construction, Inc.*, ASBCA No. 38801, 95-1 BCA ¶ 27,396 at 136,575, *aff'd on recons*., 95-2 BCA ¶ 27,688. However, as we said in *Airport Construction & Materials, Inc.*, ASBCA No. 32583, 87-1 BCA ¶ 19,361 at 97,927:

> The Government is not required to prove the cause of the failures with absolute certainty. The standard of proof is not that stringent. To establish such causation, it is sufficient for the Government to show that the defective material or improper workmanship ordered to be corrected was "the most probable cause . . . of the failures, when considered with reference to other possible causes." *Abney Construction Co.*, ASBCA No. 23686, 80-2 BCA ¶ 14,506 at 71,514.

The evidence here established deficient workmanship in the construction of the tank. During the erection of the tank, deficiencies included: problems with welding the bottom plate of the tank and edge plates which were not in compliance with API 650; bottom bearing surfaces that did not meet API 650 requirements for flat surfaces; questionable roof truss welds; flat areas in shell alignment; sloppy welding which included over-welding and undercutting; and unacceptable welds in the fifth ring of the tank. There were X-ray testing reports that revealed a bad section of a vertical weld, and welds in which slag lines were greater than authorized by the appropriate industry standards. Although the evidence showed that Pawnee attempted to correct these weld deficiencies, usually grinding out the weld and rewelding the joint, there were instances in which tank shell plates had developed flat spots after they had been fitted, installed, and welded in place. During the filling of the tank with water for the hydrostatic testing, appellant was unable to completely fill the tank with water and there was a flange leak that required repair. The collapsible seal on the outside of the floating roof was compressed hard on one side of the tank and did not have contact with the walls on the other side, indicating that the floating roof had not been centered over the middle of the tank. Moreover, the seal needed adjustment because the tank was not perfectly round in a number of areas.

While the record established that Pawnee performed some corrective work on the tank during its performance of the construction, and that the Government inspected the tank, both in a preparatory final inspection and a final inspection, these were visual inspections of the facility to verify that appellant's quality control organization had performed its responsibilities to ensure that all the requirements of the contract had been met. There was no scaffolding on the tank so the Government inspectors and project engineer were unable to inspect the upper reaches of the tank. Notwithstanding this, deficiencies were noted and a punch list provided appellant. As stated in the INSPECTION OF CONSTRUCTION clause, the

"Government inspections and tests are for the sole benefit of the Government and do not" relieve the contractor of responsibility for providing adequate control measures, or affect the continuing rights of the Government after acceptance to require the appellant to replace or correct work, without charge to the Government, found by the Government not to conform to the contract requirements. The law is well established that inspections are for the benefit of the Government, not the contractor, and that failure of the Government to provide for an inspection does not relieve the contractor of compliance with its responsibilities under the contract. *Russell R. Gannon Co. v. United States*, 189 Ct. Cl. 328, 417 F.2d 1356 (1969); *Red Circle Corp. v. United States*, 185 Ct. Cl. 1, 398 F.2d 836 (1968); *Rosendin Electric, Inc.* ASBCA No. 22996, 81-1 BCA ¶ 14,827.

Following the final inspection and Government acceptance of beneficial occupancy on 8 February 1991, the Government discovered substantial buckling in the fifth and sixth rings of the tank shell. In addition to the major buckling in the fifth and sixth rings of the tank shell wall, there were other minor distortions in the tank shell that were unrelated to the major buckles in the fifth and sixth rings. Some of the plates were flat and not uniformly curved. There was a large flat area on the northeast side of the tank in the fifth and sixth rings. Additionally, there were cracks in the weld at the top of some of the tank stiffeners. Although the particular version of API 650 incorporated in the contract did not have a specific requirement for a wind girder, the contract did require that the tank withstand a 100 mph wind load. Appellant never installed a wind girder either during its performance of the contract or following the corrective work on the tank after the Government asserted its rights under the WARRANTY OF CONSTRUCTION clause.

Expert engineering testimony and reports conflict as to the most probable cause or causes for the buckling of the tank. Appellant's consulting engineers' reports point to the design of the 18-inch withdrawal line system as the most probable cause of the deformations in the fifth and sixth ring. Their conclusions were disputed by Government engineers on the basis of the engineering evaluation of the data and analysis submitted by appellant. Following the second failure of the tank shell in January 1993, consultant engineering services retained by the Government reviewed contract drawings and documents, performed visual inspection of the tank and nozzles, took detailed measurements of the condition of the tank, including shell thickness readings with ultrasonic meters, and inspected both the inside and outside of the tank. This inspection and testing revealed a number of conditions which were out of the tolerances specified in API 650 or at the maximum authorized tolerance, improper construction practices, and the renewed large buckles in the upper rings of the tank that were continuing manifestations of the previous buckling. Based on its findings, Tank Consultants, Inc. concluded that the tank did not meet the requirements of API 650 for roundness, plumbness, peaking, and banding prior to appellant's performance of the hydrostatic testing and conclusion of its construction.

We hold that the Government has carried its burden, in part though its expert testimony, of proving that Pawnee's workmanship was defective and that the defective

workmanship was the most probable cause of the deformations in the tank shell wall. In battles between experts, we must choose between expert opinions and theories, and we are justified in our evaluation of conflicting conclusions unless the testimony is inherently improbable or discredited by uncontrovertible evidence. *Maitland Bros. Co. v. United States*, 20 Cl. Ct. 53, 64 (1990), *aff'g Maitland Brothers Co*., ASBCA No. 24476, 86-3 BCA ¶ 19,172, *mot. for recons. denied*, 87-3 BCA ¶ 20,194. The evidentiary record of the condition of the tank, both during its construction and following the buckling and deformations in the tank shell, support the conclusions of both the Government's project engineer and its expert.

Once the Government has established a prima facie case that there were failures, defects, or damages to the tank and that the most probable cause of the failure was appellant's deficient workmanship, appellant must come forward with proof that such defects did not exist, or if they did, that it was not responsible for them under the contract. *Great Valley Construction Company, Inc.*, *supra* at 75,801. Similarly, if appellant alleges the defects are the result of a Government fault, it bears the burden of establishing that assertion by a preponderance of evidence. Here, the Government has met its burden and appellant has not.

We further hold that the buckling of the tank that occurred in January 1993 was not a second and new failure, defect, or damage to the tank after the expiration of the warranty period and after the Government had accepted the remedial work, as alleged by appellant, but was a continuation of the buckling that first occurred in May 1991. As we found above, the deformations and buckles appearing in the tank in January 1993 were at the same locations, of the same general size, and same general pattern as the deformations that appeared in May 1991. Although appellant performed some corrective repair of the tank, including the installation of an 18-inch flex joint on the 18-inch discharge line inside the tank shell, it did not install the previously proposed angle stiffener to the tank shell at the bottom of the vertical WT's for distortion distribution and had not satisfied the 100 mph wind loading requirement in the contract. As of 4 January 1993, appellant was still working on the tank corrections and discussing with the Government the need to install angle irons at the base of the vertical stiffeners, cutting loose the 10-inch support from the tank floor and isolating that line from the tank wall, and the installation of another flex-joint on the 18-inch line outside the tank. Appellant also noted to the Government that the existing deformation would continue to be present in the tank shell both "now and in the future." At the time of the buckling in January 1993, appellant and Pawnee were still considering the possible causes to be that the tank was out of round and the fact that the 1/4-inch sheets were not in compliance with the API. Corrections still under consideration included the use of the angles at the base of the WT members, use of thicker plates or sheets, and working existing sheets to remove distortions and round out the flat sheets.

There is no evidence that the Government had finally accepted the tank or the warranty corrections to the tank when the tank failed in January 1993. Although the Government took possession of the tank in February 1991, the contract expressly stated in

the USE AND POSSESSION PRIOR TO COMPLETION clause that the "Government's possession or use shall not be deemed acceptance of the work under the contract." One "reason for this standard 'use and possession' provision is to enable the government to examine and test substantially completed work before accepting it to make sure that it meets the contractual requirements." *M.C. & D. Capital Corporation v. United States*, 948 F.2d 1251, 1255 (Fed. Cir. 1991). The Government's use and possession do not constitute final acceptance where no contractually required steps for final acceptance took place, and where the Government's beneficial use of work is for work that was completed in accordance with the contract requirements. Moreover, the contract had a one-year warranty which became effective when the Government took possession. As we found above, during that one-year period, the tank shell developed large deformations which appellant had failed to completely correct, notwithstanding its repeated studies of the cause for the buckling in the tank shell and its recommendations for corrections during the warranty period. The WARRANTY OF CONSTRUCTION clause provides, in pertinent part, that "If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of notice," the Government has the right to replace, repair, or otherwise remedy the failure, defect, or damage at the contractor's expense. Here, the Government informed appellant in writing of the failures in the tank shell on 16 May 1991 and as of 4 January 1993, shortly before the reappearance of the deformations, appellant had not completed the corrections and repairs to the tank which it had recommended to the Government. This was more than a reasonable time in which to accomplish the work. *Gavco Corporation*, ASBCA Nos. 29763, 30935, 32708, 88-3 BCA ¶ 21,095, at 106,502. Appellant's responsibility did not expire with the expiration of the warranty period, rather it continued until all the failures, defects, or damages were repaired or corrected.

Additionally, there were other defects, such as, other distortions and local flattening as a result of fabrication irregularities, cracks in the welds at the top of some of the tank stiffeners, and questions about whether the tank could withstand a 100 mph wind load as required in the contract As stated by the Court in *M.C. & D. Capital Corporation v. United States*, *supra*, at 1256, "a contractor whose work contained so many uncorrected deficiencies did not substantially perform the contract." Indeed, as reported by Tank Consultants, Inc. following its inspection of the tank after the reappearance of the buckling in the tank shell wall occurred in January 1993, there were a number of conditions, failures, defects, and damages to the tank that indicated non-compliance with API 650, improper construction practices, and poor workmanship (findings 53-55). Therefore, in accordance with the warranty clause, appellant is required to remedy at its expense the failure, defects, and damages to the tank caused by appellant's deficient workmanship and its failure to comply with the contract specifications and drawings.

In addition to these issues arising out of the buckling of the fuel tank and its attempted repair, appellant also claims entitlement to an equitable adjustment for the replacement of the 10-inch control valve, alleging defective specifications in the design of the 10-inch line and fixtures to be anchored to the floor of the tank. According to appellant, the Government specification called for the lines and related fixtures to be anchored to the

floor. Without that feature, the valve would not have broken. The implication of this was, according to appellant, found in the fact that in 1993 the Government directed that the internal anchoring be cut loose. Rather than focusing on the anchoring of the support for the 10-inch line to the floor, the Government focused its argument on the change resulting from the replacement of the aluminum control valve body to a steel body valve, and simply refers briefly to the reason for the design of the ball and knuckle joints that would rotate when the pipe was lifted relieving the strain off the control valve.

In this claim, appellant has the burden of establishing the fundamental facts of liability, causation, and resultant injury. *Electronic and Missile Facilities, Inc. v. United States*, 189 Ct. Cl. 237, 416 F.2d 1345 (1969). Appellant has not done so. We believe that the weight of the evidence points to the improper torquing of the bolts that held the mechanical gland tightened to seal the ball and knuckle part of the swing joint, and the installation of an improper saddle type support rather than the type of pipe support specified on Drawing Sequence No. 20 as the cause for the crack in the 10-inch control valve. There was no evidence that the specification or drawings were defective either with respect to the body of the control valve or the anchoring of the support to the floor. The valve was cracked and needed to be replaced, and appellant proposed a steel valve rather than an aluminum valve. That appellant proposed and the Government accepted a substitution of a steel body valve rather than the specified aluminum valve does not render the specification or drawing defective. Moreover, we are not persuaded that the control valve would not have cracked had the 10-inch line support not been anchored to the floor of the fuel tank. We, therefore, hold that appellant is not entitled to an equitable adjustment for the replacement of the control valve on the 10-inch inlet line to the tank.

Accordingly, we deny the appeal.

Dated: 29 June 2001

ROLLIN A. VAN BROEKHOVEN
Administrative Judge
Armed Services Board
of Contract Appeals

(Signatures continued)

I concur

I concur

MARK N. STEMPLER
Administrative Judge
Acting Chairman
Armed Services Board
of Contract Appeals

EUNICE W. THOMAS
Administrative Judge
Vice Chairman
Armed Services Board
of Contract Appeals

I certify that the foregoing is a true copy of the Opinion and Decision of the Armed Services Board of Contract Appeals in ASBCA No. 48458, Appeal of Grid Construction, Inc., rendered in conformance with the Board's Charter.

Dated:

EDWARD S. ADAMKEWICZ
Recorder, Armed Services
Board of Contract Appeals