ARMED SERVICES BOARD OF CONTRACT APPEALS

Appeals of --	)	
	)	
Northrop Grumman Corporation	)	ASBCA Nos. 52178, 52784,
	)	52785, 53699
	)	
Under Contract No. N00024-92-C-6300	)	

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OPINION BY ADMINISTRATIVE JUDGE DICUS

These appeals arose during performance of Contract No. N00024-92-C-6300, which was for production and delivery of 17 shipsets of AN/SQQ-89(V) Systems and related equipment. The dispute concerns the TR-343 transducers produced as part of the Transducer Array Subsystem of the Sonar Detecting-Ranging Set. ASBCA No. 52178 was taken from a contracting officer's decision denying appellant's claim of $3,282,420 for particular efforts undertaken in the remanufacture of the transducers. ASBCA No. 52784 was taken from a contracting officer's decision denying appellant's claim of $18,834,620 for efforts undertaken throughout the remanufacturing process. ASBCA No. 52785 was taken from a contracting officer's decision demanding from appellant payment of $7,742,125. ASBCA No. 53699 was taken from a stipulated *de facto* final decision denying appellant's protective consolidated claim of $18,834,620 plus repayment of $8,331,844 paid to the government under the Navy's claim. Only entitlement is at issue. We sustain portions of all four appeals.

Preliminary Matters

These appeals evolved in such a way that all four have at least some common elements. The claims overlap one another to a considerable degree, and ASBCA No.

53699 was taken from denial of an "omnibus" claim intended to cover all of appellant's bases. However, neither party moved to dismiss any of the existing appeals after that appeal was filed. Moreover, we recognize that if appeals subsumed in ASBCA No. 53699 had been dismissed, it could have affected interest. Both parties have proceeded in case presentation and briefing without any attempt to separate their positions by individual appeal. Accordingly, we will not attempt to separate the decision into individual appeal segments as we proceed, preferring to sort things out at the end.

FINDINGS OF FACT

Background

1. The AN/SQQ-89(V) System (the System) is a surface ship antisubmarine warfare combat system first delivered in 1986 which integrates various sonar and fire control subsystems and was developed by General Electric Ocean and Radar Systems Division (GE) through a series of sole source contracts. In fiscal year 1990 the first competitive procurement for the System was awarded to appellant.[1] Appellant had been developed as a second source under a Navy Leader/Follower program,[2] through which it was provided a technical data package developed by GE. GE won the competition in 1991. (Stipulation (stip.), ¶¶ 20-22) The 1990 and 1991 transducers in the System performed satisfactorily (tr. 1/110, 5/74).

The Transducer[3] and Shipboard Placement

2. The Transducer Array Subsystem is part of the sonar and incorporates the TR-343/SQS transducer, the housing for which is a tube assembly ("tube") and is principally a metal cylinder approximately 27 inches long and 8 inches in diameter (R4, tab 1/Bates 0006, tab 4/Bates 0587, tab 319, drawing no. 7344014; tr. 1/162-69). It consists of a thin walled cylinder which is welded to a thicker walled cylinder and an endcap with a hole in the middle ("chimney") and 6 bolt holes in deep counterbores around the edge which is welded to the thick cylinder (*id.;* R4, tab 234). The square base, covered with a rubber boot, is the head mass from which the acoustical signal ("ping") is sent and any return signal from the target is received (*id.*; tr. 1/163, 169-70). The interior

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[1] The original contractor in that contract and the contract at issue was Westinghouse Electric Corporation. Westinghouse was subsequently acquired by Northrop Grumman Corporation (stip., ¶¶ 21, 23).

[2] The Leader/Follower program was designed to increase competition and lower prices (tr. 6/42-43).

[3] Various photographs of transducers and elements thereof supplant the physical hearing exhibits and supplement the verbal descriptions set forth in this section. *See, e.g.*, ex. A-50.

contains the transducer assembly, consisting of a ceramic stack and other electronics, which are mounted on a metal frame (hereinafter sometimes "the stack") (R4, tab 319). During manufacture the tube is lowered over the stack with the endcap up (R4, tab 152/Bates 2601-08).

3. As installed by appellant, the cable element ("pigtail") is a rubber-encased cable with a connector at the end that rises out of the endcap to attach to the ship's power supply and signal processing equipment, and a flange designed to fit between the endcap and the metal frame of the stack. The end of the cable that terminates inside the tube is attached to the transducer assembly. (R4, tab 152/Bates 2608, tab 319/Bates 4558) The six bolt holes in the endcap counterbores are placed so as to alternate between three bolts that affix the endcap to the stack and three that pull the endcap up to the seal plate to form a watertight seal around the pigtail (R4, tab 2115). The relevant drawing gives only the torque for the bolts and requires that the counterbores be filled with a two-part epoxy "flush to .06 below surface," which was done (R4, tab 319/Bates 4561, 4564 at notes 1, 16; ex. G-26).

4. On board destroyers, the transducers are horizontally placed in 72 staves (racks), each of which holds a column of eight transducers. The staves are placed in a frame in an underwater dome on the bow of a destroyer with the head mass or "boot" ends facing outward in a circular pattern and the connector ends of the pigtails toward the center. Each destroyer has 576 transducers, which constitutes a shipset. (Tr. 1/174-78; ex. G-14)

The 1992 Contract

5. The parties understood the contract to be, and we find the contract was, a build-to-print contract, *i.e.,* a manufacturing and production contract premised upon the drawings and specifications furnished to the contractor with contractor liability for performance effectively circumscribed by the drawings and specifications (tr. 6/152, 180).

6. The Navy competitively awarded the FY 1992 contract at issue to Westinghouse (now Northrop Grumman) on 11 September 1992. The firm fixed-price contract included a base year and three one-year options. (Stip., ¶ 23)

7. The contract included contract line item numbers (CLINS) for the base and option years for various system components, including the Transducer Array Subsystem, which is a part of the Sonar Detecting-Ranging Set. The transducers that are the subject of this appeal are elements of the Transducer Array Subsystem. A Transducer Array Subsystem CLIN (except the spares set) includes one shipset (576 transducers), the staves in which the transducers are mounted in vertical rows of eight, the stave cables, and an

installation kit. Among other things, the contract required Northrop Grumman to deliver 17 shipsets of transducers, a total of 9,792 transducers. (Stip., ¶ 24)

8. The contract incorporated by reference standard FAR clauses for supply contracts including: FAR 52.243-1, CHANGES—FIXED-PRICE (AUG 1987); FAR 52.233-1, DISPUTES--ALTERNATE I (DEC 1991); FAR 53.249-8, DEFAULT (FIXED-PRICE SUPPLY AND SERVICE) (APR 1984); FAR 52.246-2, INSPECTION OF SUPPLIES—FIXED-PRICE (JULY 1985); FAR 52.215-21, CHANGES OR ADDITIONS TO MAKE-OR-BUY PROGRAM (APR 1984) (stip., ¶ 25; R4, tab 1/Bates 0120).

9. DoD-D-1000B, "Military Specification, Drawings, Engineering and Associated Lists," was incorporated into the contract by reference at Attachment 1, Appendix A (superceding DoD-STD-100) (stip., ¶ 26).

10. In its 30 June 1992 Price Proposal for the FY 1992 Contract, appellant (then Westinghouse) stated the following in its "Summary of Assumptions Used in Proposal Preparation":

> WEC will meet the requirements of Special Clause H-7, on the assumption that WEC will not be required to meet performance requirements which the design agent did not meet.

(Stip., ¶ 28)

11. Appellant included the Changes or Additions to Make-or-Buy Program clause in its proposal. The clause states in part:

> (a) The Contractor shall perform in accordance with the make-or-buy program incorporated in this contract. If the Contractor proposes to change the program, the Contractor shall, reasonably in advance of the proposed change, (1) notify the Contracting Officer in writing, and (2) submit justification in sufficient detail to permit evaluation. Changes in the place of performance of any "make" items in the program are subject to this requirement.
>
> . . . .
>
> (c) Modification of the make-or-buy program to incorporate proposed changes or additions shall be effective

> upon the Contractor’s receipt of the Contracting Officer’s written approval.

(R4, tab 2285 at C2.1) Although the proposal was not incorporated into the contract, the parties’ conduct indicates they intended to be bound by the provisions therein relating to the make-or-buy program (R4, tab 3043; tr. 6/18, 7/44, 57, 244).

12. The contract includes a modified version of FAR 52.246-18, WARRANTY OF SUPPLIES OF A COMPLEX NATURE (APR 1984) (NAVSEA VARIATION) (OCT 1990) (MODIFIED) (MAY 1992), which provides the following:

> (a) Notwithstanding inspection and/or acceptance by the Government of the supplies furnished under this contract, any term or condition of this contract concerning the conclusiveness thereof, and any other term or condition of this contract, the Contractor warrants:
>
> (1) That line items . . . [including the Transducer Array Subsystem] will conform to the design and manufacturing requirements of the contract. For the purpose of this clause, “design and manufacturing requirements” include drawings, specifications, statements of work, structural and engineering plans, and manufacturing particulars, including precise measurements, tolerances, processes, materials, and finished product tests;
>
> (2) That line items . . . [including the Transducer Array Subsystem] at the time of acceptance by the Government, will be free from all defects in design . . . materials and workmanship; and
>
> (3) That line items . . . [including the Transducer Array Subsystem] will conform to the essential performance requirements of the contract . . . .
>
> (b) The Contractor shall not be responsible under these warranties for any failure of line items . . . which is discovered more than two (2) years from the date of acceptance. In determining whether the failure was discovered prior to the expiration of the specified period, conditional acceptance shall not be considered to be acceptance. Rather, conditionally accepted supplies shall be

considered to have been accepted as of the date the Contractor is notified by the Contracting Officer, in writing, that the condition has been satisfied or waived.

(c) Notwithstanding any other term or condition contained in this contract, in the event of a failure to comply with any of the warranties provided herein, the Contractor shall, at the election of the Government:

(1) Promptly take such action as may be necessary (e.g., repair, replace and/or redesign) to correct or, if so directed by the Government, partially correct the defect responsible for the failure at no additional cost to the United States. . . .

(2) Pay costs reasonably incurred by the United States in taking such corrective action . . . .

. . . .

(e) The Contractor shall prepare and furnish to the Government data and reports applicable to any correction required under this clause (including the revision and updating of all affected data called for under this contract) at no additional cost to the United States. . . .

(f) When items covered by these warranties are returned to the Contractor pursuant to this clause, the Contractor shall pay the transportation costs and bear the risk of loss or damage from the place of delivery specified in the contract (irrespective of the f.o.b. point or point of acceptance) to the Contractor's plant and return to said place of delivery.

(g) The Contractor shall be notified in writing of any breach of the warranties set forth in paragraph (a), above within 90 days after discovery of the breach. The failure of the Contracting Officer to provide timely notice of the breach, however, shall not diminish the rights the Government would otherwise have under this clause or any other term or condition of this contract.

. . . .

> (j) For the purpose of this clause: . . . "essential performance requirements" does not include performance characteristics that are described as goals or objectives.

(R4, tab 1/Bates 0133-35; stip., ¶ 30)

13. The contract contained clause H-11, ESSENTIAL PERFORMANCE REQUIREMENTS (MAY 1992), which provides:

> Essential performance requirements delineated in Section I FAR clause 52.246-18 Warranty of Supplies of a Complex Nature (Variation) (Fixed Price Type Contract) (JUL 1990) paragraph (j) are defined as those criteria the contractor must meet in order to pass Production Testing delineated in paragraph 3.4 of Appendix C to Attachment 1 AN/SQQ-89(V) Test Requirements.

(R4, tab 1/Bates 0116)

14. Paragraph 3.4 of Appendix C to Attachment 1 AN/SQQ-89 (V) provides:

> 3.4 Production Testing--Production items require Quality Conformance Inspections to be accomplished for units, subsystems, and systems. The Contractor shall include in the MTEP a detailed plan to cover Forward-fit and Back-fit testing. This plan shall incorporate the Unit, Subsystem, and System Test levels required by Enclosure (2), Production Test Levels, and Enclosure (3), Test Procedures and Test Requirements Documents. The Specifications cited in Enclosure (1), New Supplier Qualification Test Requirements, and the drawings cited in Attachment 2 shall be the basis for the test requirements for these inspections. The Government may monitor unit level testing. Government witness and approval is required for subsystem and system level testing. Final Navy acceptance shall be based on the results of the highest level of testing required.

(R4, tab 3/Bates 0511)

15. The contract specification at drawing no. 77A104112, provided as follows at paragraph 3.2.5.4:

> (U) The interior moisture content (including the desiccant) of the transducer shall be less than the equivalent of 5 grams of water over the 5 year service life of the element. The moisture content shall be controlled by means of a desiccant . . . .

It further provided at paragraph 4.2.3.3.8:

> (U) Measure the DC resistance between the transducer element leads (tied together) and water. The resistance shall be greater than 50 megohms [sic] when measured with a 500 volt megohmmeter [sic].

(R4, tab 3037 at sheets 28, 52) This test, referred to as the insulation resistance, or IR, test, is generally used to measure the intrusion of water into the transducers and related connectors and cables (tr. 3/184-86). On shipboard, the criteria for passing the test is lowered to two megaohms (tr. 3/187). The specification at 77A104112 is specifically listed in Enclosure (3), Test Procedures and Test Requirement Documents (R4, tab 4/Bates 0536).

<u>The Tube Assembly</u>

16. Note 3 to the Tube Assembly Drawing (No. 7344010) provided as follows:

> GRIT BLAST USING NO. 40 ANGULAR STEEL GRIT OVER SURFACES INDICATED BY HEAVY LINE. GRIT BLAST OVER REMAINDER OF SURFACE OPTIONAL EXCEPT DO NOT GRIT BLAST THREADS OF FIND 4 ABOVE .40 DIMENSION.

(R4, tab 234/Bates 3442) The drawing provides that dimensions are in inches unless otherwise specified (*id*., at Bates 3443).

17. Note 4 to the drawing provides for a finish[4] that is between .015 and .030 thick with no abrupt changes. Use of an electrical detection method is prescribed to find "holidays" or paint defects. (*Id.*) Note 7 permits a maximum thickness of .06 in the chimney. Note 8 permits a taper of the coating to .005 minimum thickness in the bottom of the counterbores. (R4, tab 234/Bates 3443)

[4] The finish called for is a fusion-bonded epoxy coating, which we generally refer to as "paint."

18. Note 12 of the Tube Assembly Drawing permits repair of epoxy coating (known as "Barco Bond") as follows:

> MINOR DEFECTS IN THE EPOXY COATING MAY BE REPAIRED PER 13688-P5-GP4, INCLUDING A FILET (EPOXY BEAD) AROUND THE STUDS AT TOP OF TUBE ASSEMBLY. FILET SHALL NOT EXCEED .125R. AFTER REPAIRING SURFACE REPEAT SCANNING PER NOTE 4.

(*Id*.; tr. 1/146)

19. Note 13 of the drawing provides:

> FINISH REQUIREMENT: NO EVIDENCE OF CORROSION OR DETERIORATION (WITHIN THE DESIGNATED COATED AREA) SHALL BE VISIBLE WHEN EXPOSED TO A HEATED (+95 [DEGREES] F), 5% SALT WATER ENVIRONMENT, FOR A PERIOD OF 30 DAYS.

(R4, tab 234)

20. The GE P6D-GP1 Material and Process Instruction in the technical data package provides at paragraph 2.0, "APPLICABLE DOCUMENTS," under government and industrial specifications, "NONE." Under Material Safety Data Sheets, it lists "Morton Powder Coatings – Corvel Blue 17-5002 Epoxy Powder." With regard to "Preparation of Surfaces for Coating," at paragraph 3.2, it provides:

> 3.2.1 General – In any coating application, cleaning is extremely important. The adhesion of the coating depends to a large extent on the condition of the prepared surface. Coating should take place soon after the cleaning cycle to insure thorough vetting.
>
> 3.2.2 It is important to remove all oil, grease, dirt, and other foreign matter by vapor degreasing or alkaline cleaning.

3.2.3 When specified, certain parts are to be grit blasted using #40 angular steel grit in addition to the cleaning in para. 3.2.2.

(R4, tab 68/Bates 1372-73)

21. Note 4 to the Contract's Tube Assembly Drawing directs the use of GE Process Specification P6D-GP1, "Application of Corvel Blue 17-5002 Epoxy Powder by the Fluid Bed or Electrostatic Powder Coating Process." This GE Process Specification requires the housings to be painted with Corvel Blue 17-5002 Epoxy Powder, manufactured by the Morton Powder Coatings Company. (Stip., ¶ 36) The Morton data sheets do not include any additional surface preparation requirements (ex. A-11). The National Association of Corrosion Engineers (NACE) Standard RP0394-2002, first published in 1994, calls for surface preparation of 2 to 4 mils for fusion-bonded epoxy coatings (ex. G-40, ¶ 5.1.4). The record does not contain a published industry standard in existence at the time of contract award. We find there was no published industry standard at time of contract award.

22. Morton's Corvel Blue was used as the coating for Navy transducer tubes since the late 1960's or early 1970's without problems until the contract at issue (tr. 13/25-26). Morton no longer makes Corvel Blue (tr. 2/70).

<u>The Cable Element ("Pigtail")</u>

23. Note 1 of the Cable Element drawing provides:

> FLANGE MOLDING MATERIALS TYPE WRT NEOPRENE OR EQUIVALENT TO MEET MIL-R-3065 AND ASTM D2000-2BC415A14F17Z.
>
> COMPRESSION SET MEASUREMENTS SHALL BE MADE IN ACCORDANCE WITH ASTM-D-395 WITH THE EXCEPTION THAT MEASUREMENTS SHALL BE MADE ON A COMPLETE MOLDED FLANGE USING A SPECIAL TEST FIXTURE. COMPRESSION SET SHALL BE LESS THAN 35% AFTER 70 HOURS AT 212 [DEGREES].

(R4, tab 2172 at 1)

24. First Article impulse pressure tests of the pigtail were to be performed by the Navy. The test specification further provided that seawater performance and shock tests,

also First Article, were to be performed during impulse pressure tests. (R4, tab 2165/Bates 3331-35) However, First Article tests were only required where form, fit or function changed (R4, tab 3/Bates 507). There is no probative evidence that those First Article tests were conducted or required on the 1992 contract. We are not persuaded that the memory of appellant's Jeff Lucente as to such testing is accurate given the lack of any documentation of the tests (tr. 12/95-96).

25. Note 8 of the Cable Element drawing states:

> THE CABLE ASSEMBLY SHALL PERFORM SATISFACTORILY IN SEA WATER AT ANY TEMPERATURE FROM MINUS ONE (-1º) DEGREE CENTIGRADE TO PLUS THIRTY-THREE (33º) DEGREES CENTIGRADE.

(Stip., ¶ 31)

26. Notes 9 and 10 of the Cable Element Drawing require that the cable withstand vibration, shocks, and the pressure of underwater explosions "WITHOUT PHYSICAL, ELECTRICAL OR ACOUSTICAL DAMAGE OR LEAKAGE OF SEA WATER INTO THE CABLE" (stip., ¶ 32; R4, tab 2172 at 1).

27. The Cable Element Test Specification states in part:

> 1.4.1 FIRST ARTICLE TESTS - FIRST ARTICLE TEST SHALL INCLUDE THOSE TESTS INDICATED IN COLUMN 3 OF TABLE 1. THESE TESTS WILL BE CONDUCTED ON A QUANTITY OF SIX (6) CABLE ELEMENT ASSEMBLIES.
>
> 1.4.2 QUALITY CONFORMANCE TESTS ARE THOSE TESTS INDICATED IN COLUMN 4 OF TABLE 1. QUALITY CONFORMANCE TEST SHALL BE DONE ON A SAMPLING BASIS.
>
> . . . .
>
> 2.8 TEST SPECIMEN
>
> FROM EACH NEW PRODUCTION BATCH OF MOLDING MATERIAL TEST SPECIMENS SHALL BE SUPPLIED TO BUYER. SPECIMENS SHALL

BE THOSE CALLED FOR IN NOTE 17 OF CABLE ELEMENT DRAWING NO. 7344298.

2.8.1 PROCEDURE

TESTS SHALL BE MADE ON MOLDING MATERIAL SPECIMENS TO DETERMINE IF MATERIALS MEETS REQUIREMENTS OF NOTE 1, 2 AND 3 OF CABLE ELEMENT DRAWING USING APPROPRIATE ASTM TEST CALLED FOR IN CABLE ELEMENT DRAWING AND ASTM D2000 RUBBER SPECIFICATION.

2.8.2 OBSERVATION

MATERIAL SHALL MEET ALL OF REQUIREMENTS ON NOTE 1, 2 AND 3 OF CABLE ELEMENT ASSEMBLY DRAWINGS.

2.9 TEST SPECIMENS

MOLDING MATERIALS SHALL BE SUPPLIED PER NOTE 17 OF THE ELEMENT CABLE ASSEMBLY DRAWING NO. 7344298.

(Stip., ¶ 33; R4 tab 2165/Bates 3329, 3332)

28. Table 1 lists 14 different tests, including the Rubber and Potting Compound Evaluation Cable test which was indicated as both a First Article test and a Quality Conformance test. For that test, Group D to the Chart states “FOR EACH NEW BATCH OF MOLDING MATERIAL (SEE NOTE 17 OF CABLE DWG.).” (Stip., ¶ 34) The record does not contain any documentation of performance of tests by appellant or its subcontractor during production prior to remanufacture.

29. Note 17 provides:

17. TEST SPECIMENS FROM EACH PRODUCTION BATCH OF MOLDING MATERIALS SHALL BE SUPPLIED TO PROCURING ACTIV[I]TY AS FOLLOWS: TWO BUTTONS – SIZE SPECIFIED PER ASTM D395, METHOD B; ONE MOLDED FLANGE ON 12 INCH LONG PIECE OF CABLE

AND TWO TEST SLABS 6X6X.075 INCHES PER
ASTM D395.

(R4, tab 2172/Bates 2171 at 1)

Changes from Performance of the 1990 Contract

30. Appellant had subcontracted with LaBarge Electronics (LaBarge) for pigtails under the 1990 contract. For the 1992 contract it subcontracted with Dielectric Sciences, Inc. (Dielectric), largely because of price. (tr. 7/26, 139-40) The Dielectric pigtails were made using type W neoprene while the 1990 and 1991 contracts had used type WRT (tr. 4/185). Appellant does not dispute that type WRT may perform better than type W in cold temperatures for certain applications (app. reply br. at 53). Because appellant asked the Navy for a test fixture in 1997 after problems had surfaced the Navy believed Dielectric had not tested the pigtails as set forth in Note 1 (tr. 1/97).

31. Appellant had subcontracted with Thomas Instruments for production of tubes under the 1990 contract. Tubes were produced "in-house" for the 1992 contract, with its facility in Cleveland responsible for the epoxy powder coating. Procedures called for grit blasting. (R4, tabs 2154, 3013; tr. 7/25-27, 95, 115-16) Although formal notification pursuant to the Changes or Additions to Make-or-Buy Program clause was not provided to the Navy regarding the change in the tube supplier, appellant informed the Navy of the change at a Program Management Review on 27 January 1993, the minutes of which were provided to the contracting officer on 3 February 1993 (R4, tab 3043; tr. 7/139-45).

32. After A. D. Morton Company took over the Cleveland facility in February 1996, appellant sent a quality assurance engineer, Robert Funk, to review the situation. After a visit, he withheld approval. He noted that the plant was in disarray and that the plant manager did not have a plan to perform powder coating. (R4, tab 2031) He returned in May and, while he expressed no concerns about Morton's ability to "perform acceptable coating of the tubes," he was concerned about Morton's ability to meet delivery requirements. He recommended no further business be placed with Morton. (R4, tab 2035) His September 1996 visit resulted in a recommendation that appellant get Morton under control and try to find a second source (R4, tab 2037). Concern was still being expressed in August 1997 because Morton procedures did not specify a level of grit blast or require an inspection to verify the adequacy of grit blasting (R4, tab 2062). Mr. Funk and other employees of appellant reported observing stripped tubes that, on visual inspection, appeared not to have been grit blasted during August-September 1997 inspections (R4, tab 2073/Bates 10710, tab 2074/Bates 10713, tab 2077/Bates 10706).[5]

[5] Notwithstanding Mr. Funk's concern, the problems encountered with delamination appear to have arisen from earlier manufactured tubes. *Cf.*, finding 49, *infra*.

33. Under the 1990 contract all transducers were acoustically tested at appellant's Annapolis, Maryland facility in a water tank. Under the 1992 contract, only 10 percent were tested in Annapolis because appellant had purchased a "dummy load tester" to use at its production facility in Sykesville, Maryland. (Tr. 7/29, 134) The testing process involved filling the counterbores temporarily with RTV (Room Temperature Vulcanized rubber), removing the RTV and filling them with epoxy (tr. 7/154-56). Prior to 1994, methylchloroform was used to clean the counterbores after the RTV was removed. When that product was taken off the market, isopropyl alcohol was used as the cleaning agent. (Tr. 11/79-80) The epoxy used in the counterbores was also changed because Hysol, the original material, became unavailable (tr. 7/155). Fusor 305 was used beginning in early 1992 (tr. 11/76).

Relevant Production Tests

34. The contract required appellant to "establish and implement a rigorous program of testing, for systems, subsystems, and units produced, to ensure that the system design and performance requirements of Attachment 2, Appendix C to Attachment 1, and other applicable specifications and standards are met." The implementation under Appendix C was to include a Master Test and Evaluation Program Plan (MTEP). (R4, tab 3/Bates 0331) The approved MTEP included a provision under which appellant was to test transducers in accordance with drawing 77A110688, the Test Requirement Specification (TRS) (R4, tab 247/Bates 3548, ¶ 3.1.3.3; tr. 11/35-36). The TRS sets forth the following tests for 100 percent of the transducers produced:

Test	TRS Paragraph
Maximum Current	4.1
Voltage Breakdown	4.2
Corona	4.3
Grounding of Leads	4.4
Adjustment of Mechanical Resonance	4.5
Complex Impedance	4.6
Polarity	4.7
Hydrostatic Pressure	4.8
Cable Pull	4.9

(R4, tab 134/Bates 2457) The hydrostatic pressure test was, in tandem with the IR test, intended to insure watertight integrity. If a transducer leaked, the IR test of the pigtail would show it had shorted out (tr. 11/43, 12/31). The following tests were required for 10 percent of the transducers produced:

Test	TRS Paragraph
Source Level	5.2
Receive Response	5.3
Impedance Magnitude and Phase	5.4

(R4, tab 134/Bates 2457) None of the TRS tests required cold water immersion. We find there were no cold water tests for the transducers set forth in the contract. Neither the TRS nor the contract drawings specify the WQM-8 test, which checks low impedance, high resistance, and a number of other things, as a required test. (*Id.*, at Bates 2459-71; tr. 1/72, 2/72-73)[6]

35. In addition to tests for the transducer, which is a configuration item (CI) or lowest replaceable unit (LRU) (tr. 11/25), testing the tubes for paint thickness and defects ("holidays") using electrical detection was required by Note 4 of the Tube Assembly drawing (R4, tab 234/Bates 3442).

36. Appellant required Dielectric to perform First Article testing on the pigtails, although it was not required to do so, and the pigtails passed the tests (tr. 12/104; R4, tab 3052). During performance of the Dielectric subcontract, Dielectric submitted Certificates of Conformance that certified that the pigtails delivered were manufactured to all applicable contract requirements (R4, tab 3055; tr. 12/61-62). Dielectric had received similar certificates from its neoprene rubber supplier for each batch of rubber (R4, tab 3267/Bates 24209; tr. 12/69-70).

Discovery of Transducer Problems

37. It is undisputed that appellant had delivered and the Navy had accepted 16 shipsets of the System prior to January 1997 (tr. 1/17-18).

a. When the government inspector responsible for accepting transducers found problems, he issued a corrective action request (tr. 4/9-10). He did not accept any transducers with defects. The inspection practice was geared toward assuring that processes were proper and working correctly (tr. 4/10-11). During the first observation of transducers and at time of acceptance, the government inspector, who was stationed at appellant's Sykesville, Maryland

[6] We have not articulated the full and rather convoluted path the contract takes to fully inform this finding by resort to many supporting citations to the record which lead to the TRS. In this regard, we are content that the testimony of Mr. Erickson on this score is credible, substantially accurate, and supported by our review of the contract documents referred to during his testimony. (Tr. vol. 11 *passim*, ex. A-18)

plant, saw painted transducer tubes. He had no opportunity to observe the condition of the tubes under the paint. Pigtails were observed at times before installation and dimensional checks were performed. (Tr. 4/7, 11-12)

b. The wet megger test is a means of testing IR (tr. 1/72). In December 1996 transducer systems being installed in a destroyer, DDG-70, were put through a wet megger test (48 hours in the water) in Portland, Maine, which all but three passed. The three were replaced and the ship put in the water. Upon return to Bath, Maine, testing continued until shipyard holiday shutdown. On 3 January 1997 testing resumed and 52 transducers failed the megger test, meaning a short circuit was detected. On 6 January 1997 after the shipyard reopened, more than 60 transducers failed the continued megger testing. On 16 January 1997, 83 transducers failed the IR test. Thereafter, DDG-68, previously tested, was subjected again to megger tests. Fifty-eight transducers failed. On 23 January 1997, 92 transducers failed IR tests. The number of failures meant the ships could not operate (tr.1/82). At that point, Michael Dennehy, the group manager, felt it necessary to obtain Navy help. The Navy sent engineer Bernard Strozeski. (R4, tab 371/Bates 5162, 5166, tabs 3070; 2305 at 43, tab 2317; tr. 1/50-55, 71-72, 160) As water was subsequently discovered in some of the transducers and the IR test is to ascertain whether a transducer has leaked (tr. 1/85-86, 194, 3/118, 11/43), we conclude the failures were caused by leakage.[7]

c. All of the 1992 transducers with serial numbers lower than 11115 on DDG-68 and DDG-70 had been accepted on DD250s on or before 29 November 1994, more than two years before the discovery of the problems. In this regard, we note that, while serial number 10741 cannot be located in the record, serial number 10744 appears twice on the DD250s and all other transducers beginning with 1074 (10740, 10742-49) are accounted for. (R4, tabs 2290-95) Accordingly, we infer that one of the entries for serial number 10744 should have been for 10741 and that all transducers with serial numbers lower than 11115 were accepted no later than 29 November 1994. None of the transducers between serial numbers 11115 and 13270 that are listed on the array maps for DDG-68 and DDG-70 appear on DD250s issued between 23 February 1995 and 19 December 1995 (R4, tabs 310, 2297-98, 2300, -02, -04, -06). The record contains no DD250s between 29 November 1994 and 23 February 1995. We find, therefore, that it has not been shown that the higher numbers on DDG-68 and DDG-70 were accepted two years or less before discovery of the transducer problems. However, approximately 135

[7] The parties' conduct throughout leaves little doubt that they believed the problem to be leakage.

transducers with serial numbers between 11115 and 13665, both lower and higher than 13270, and which are not on the array maps for DDG-68 and DDG-70 were accepted after 23 February 1995 and were therefore covered by the warranty. (R4, tabs 2298, 2300, -02, -04, -06)

38. On 9 January 1997 the dome of the ship had been entered and testing confirmed that the stave cable to one of the failed transducers was not the problem. The transducer was removed and replaced. It had an inflated boot. Also on 9 January 1997, the Navy informally told appellant of the low insulation resistance readings. That transducer and two others were transported to the Naval Undersea Warfare Center facility (NUWC), then in New London, Connecticut, for diagnostic testing. (Stip., ¶ 40; R4, tab 3070; tr. 1/56-57)

39. The dome of the ship where the transducers are installed is confined and nicks or "dings"[8] to the transducers are unavoidable (tr. 1/58). Transducers would not be initially installed in that condition (tr. 1/72-73). The original installation is done before the dome is installed under conditions where it is unlikely there will be damage (tr. 1/48-49).

40. Mr. Strozeski was concerned that more water would get into the transducers and do damage to the ceramic stack. As a result, he ordered the purchase of "dummy plugs" for both ships. Thereafter, all the transducers were removed from both ships. (Tr. 1/207-08)

41. Commander Carl Carlson was appointed to head the investigation into the transducer failures. It was reported to him that 400 failures[9] had occurred on DDG-68 and 200 on DDG-70 during the January 1997 WQM-8 testing (tr. 1/81-82). While WQM-8 tests are not contractually required (finding 34), the failures from contractually required IR testing experienced on DDG-68 and DDG-70 exceeded the ten percent standard (58 failures) for removing a ship from antisubmarine service (finding 37; R4, tab 595 at 6806; tr. 2/138-39). The failures were the result of leaks (tr. 1/85-86). He was directed by Admiral Huchting to get the matter fixed quickly, in large measure because otherwise the period of time during which the shipbuilding funds could be used ("the SCN envelope") might pass before delivery of "operating fleet ships that work." Admiral Huchting told CDR Carlson a number of times that "we're to deliver brand new systems and that's what we paid for. And [Admiral Huchting] expected that to happen before the

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[8] The parties regularly used this term, which we interpret as a missing chip of paint caused by contact and no larger than ½ inch.

[9] The actual number was 407 that failed the WQM-8 test as of 23 January 1997 as follows: 68 shorts; 43 high impedance; 54 high resistance and low phase; and 242 low phase (R4, tab 1644).

ship left the SCN envelope." (Tr. 82-84) CDR Carlson, who was being strongly pressured not to allow ships to be delivered with inoperative sonar, essentially started out trying to recreate what he believed were the leaks causing the failures (tr. 1/86). He understood there to be three leak paths: the pigtails, the counterbores, and the boots (stip., ¶ 41; tr. 1/87-88).

42. In February 1997 the Defense Contract Management Command representative was instructed by the Navy not to sign the DD-250 for the last shipset even though he felt he did not "have a legitimate reason to not accept the CLIN" (R4, tab 368/Bates 4992-93). The Board finds the government did not accept the last shipset.

43. By letter of 24 February 1997 appellant was formally apprised of the transducer failures and directed to take corrective action pursuant to the warranty clause. The letter also directed corrective action for transducers outside the warranty period. (R4, tab 412) The Navy thus met the 90-day notice requirement of the warranty clause (finding 12).

44. On 24 February 1997, the Navy ordered work (Technical Instruction No. TI97-0016AD-002) under Northrop Grumman's design agent contract (Contract No. N00024-92-C-6312). The Technical Instruction authorized 95 man days plus $5,000 of support for Northrop Grumman to "support[] Navy efforts for investigation of leakage failures attributable [to] the TR-343 transducers." (Stip., ¶ 42; R4, tab 411/Bates 5434, 5436)

45. One focus of the Navy's investigation was whether Northrop Grumman's cable element vendor used the appropriate type of flange material. Note 1 of the Cable Element drawing requires the flange material to be "WRT NEOPRENE OR EQUIVALENT." Northrop Grumman's supplier Dielectric did not use type WRT neoprene but instead used type W neoprene. (Stip., ¶ 43)

<u>Testing for Leaks</u>

46. The Navy undertook a concentrated effort to ascertain the cause of transducer leaks. At NUWC failure analysis was carried out by a team that included Phillip Watrous, a retired NUWC employee (tr. 3/114-16). The areas looked at were the counterbores, pigtails and paint failures (tr. 3/117).[10] Mr. Watrous devised a system for injecting pressurized dye into the transducers to determine whether the counterbores and

[10] Review of the videotapes of the failure analysis efforts indicates that the transducer boot was also analyzed. *See, e.g.,* ex. G-20. The Navy has not argued that the boot was one of the leak paths at issue.

pigtails were leaking (*id*.). After review of the videotaped NUWC examinations, the Board finds as follows:

a. The transducers were subjected to exterior and interior visual inspection, a holiday test, measurement of paint thickness, measurement of the pigtails, inspection of the boot, measurement of counterbore breakaway torque of up to 200 inch/pounds and swabbing of the counterbores with a Q-tip for evidence of RTV.

b. Many transducers were subjected to electrical testing.

c. The testing was carried out in an objective and workman-like fashion.

(Exs. G-17, -20; R4, tabs 2332, 2335-36, 2348-54, 2361-90) Our review of the videotapes persuades us that disassembly of the transducers requires destructive removal of the boot, and drilling of the epoxy in the counterbores (which covers the bolts fastening the endcap to the tube and ceramic stack). It further persuades us that reassembly would require replacing the bolts, epoxy, boot and pigtail. (*Id*.)

47. The testing involved transducers from sources other than DDG-68 and DDG-70. Of 24 transducers shown on two of the NUWC tapes, two came from DDG-68 and one from DDG-70, and 12 fell within the range of serial numbers 11115 to 13665. (R4, tab 310; exs. G-17, -20)[11] The array map for DDG-68 and DDG-70 shows transducers with serial numbers (s/ns) ranging from 1511 to 13270 (R4, tab 310). Based on the tapes, the Board finds that, while there were minimal holiday test failures, except for the transducers repainted with gray epoxy at Naval Surface Warfare Center (NSWC), which did poorly in holiday tests, one of the transducers in the tapes reviewed (ex. G-17, s/n 11868) showed significant paint problems not attributable to handling, including peeling in dollar-bill sized segments and paint coming off with the boot.[12] Two of the tested transducers (s/ns 11868, 12625) leaked through the counterbores, the pigtail, or

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[11] As ex. G-17 was admitted with respect only to one transducer and a total of 18 transducers appear on the tape (one, s/n 12625 is included in ex. G-20), there were a total of 40 transducers tested. This explains the disparity between the number of transducers referred to in the testimony of Mr. Strozeski and Mr. Watrous and the number of transducers referenced in finding 47. Moreover, some of the transducers had been rebuilt (suffix "R").

[12] Board review of the videotapes (including the NSWC videotapes) and transducers produced at the hearing (*e.g.*, ex. G-21) leads us to observe that delamination of the paint is marked by the appearance of brittleness of the paint, separation from the substrate, and the paint's rigidity as it may appear to lift away from its point of attachment to the tube for an inch or more in the worst cases.

both, and demonstrated weak bonding of the epoxy in the counterbores (inadequate breakaway torque), foreign substances (thought to be RTV) in the counterbores, and substantial interior and exterior rust (*id*.). Moreover, during testing Mr. Watrous found that water got under the paint even though not pressurized. He experienced water squirting out from under the paint when drilling through the paint barrier. Water between the paint and metal was the third most frequent leak path. (Tr. 3/118-91) However, there are also examples of transducers with weak breakaway torque and foreign substances in the counterbores that did not leak or malfunction (*e.g.*, ex. G-20, s/n 11456), as well as transducers that appeared to be problem-free (*e.g.*, ex. G-20, s/n 13262). Others showed no signs of leakage from the counterbores or pigtails and only paint chips which could be from handling (ex. G-20, s/ns 14306, 14339, 14554).

48. The record also includes videotapes of tests that were performed on another 40 transducers (R4, tabs 2332, 2335-36, 2348-54, 2361-70, 2372-90).[13] Twenty-four of the transducers came from DDG-68 (s/ns 11612, 11674, 11870, 11499, 11523, 11862, 11310, 11402, 11390, 11618, 11726, 11288, 11645, 11710, 11885, 11875, 11855, 11853, 11792, 11798, 11588, 11582, 11554, 11187) and 37 fell within the range of 11115 to 13665 (*id.*, R4, tab 310). We find that 16 of the 40 transducers showed substantial paint problems not attributable to handling (paint delaminating in 2 to 3-inch pieces or larger, sticking to the boot, or both). Ten of the transducers with paint problems were from DDG-68. The serial numbers of the transducers with delaminating paint ranged from 11260 to 11875. Inadequate breakaway torque was the norm. (*Id.*) As nearly all had substantial rust problems inside the tube, leakage was indicated. However, it was difficult to ascertain the source of the leak in seven of the transducers with paint issues, except that leakage occurred through the endcap and thus could have found its source in the counterbores or pigtail as well as the paint. Of the 40 transducers observed, at least four of the transducers leaked through both the counterbores and pigtail. Nine leaked through the counterbores and six (s/ns 11260, 11402, 11499, 11523, 11870, 13643) leaked through the pigtail.[14] (*Id.*) It was Mr. Watrous' testimony, and we find, that the most frequent area for the leaks observed in testing was through the counterbores, with the pigtails the second most prominent cause, and leakage under the paint third (tr. 3/119). In this regard, Mr. Strozeski testified that 12 transducers leaked only in the counterbores, 11 transducers in both the pigtail and the counterbores, 4 leaked only in the pigtail, and 1 leaked in the boot (tr. 2/147-48). We find the tapes and Mr. Watrous more persuasive.

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[13] One of the tests is of s/n 11868 (R4, tab 2371), which is also on ex. G-17. It is not included in finding 48.

[14] We confined our observations to the video portion only, making it difficult to tell if leakage may have occurred in both places.

49. The Navy also sent a substantial number of transducers to its NSWC in Crane, Indiana (tr. 1/92). Ultimately, three shipsets (approximately 1800 transducers) were sent to NSWC for evaluation and remanufacture (tr. 3/13, 66-67). David Bartlett of NSWC was involved in the transducer problem from January 1997 to July 1998 (tr. 3/10). He saw approximately 40 transducers with peeling paint and 20 to 25 with paint peeling off in sheets of 3 inches by 4 inches (tr. 3/72, 75). He also saw about 150-160 "puffy boots" that were sent to NUWC or appellant. He did not know where they came from. (Tr. 3/43, 73) Neither did he know where the three shipsets at NSWC came from (tr. 3/73-74). During the Board's review of the NSWC videotapes, which includes roughly 650 transducers with discernible and relevant serial numbers ranging from 10415 to 14420,[15] approximately 76 transducers with paint delaminating in sheets of 2 inches to 3 inches or larger were observed. These transducers all fell between serial numbers 11115 and 12565. We further observed, and we find, the delamination on those transducers was not attributable to "dings" or scratches suffered in handling. (R4, tabs 2289, 2325-29; ex. G-16) We have eliminated double-counting, as some transducers appear in more than one tape (*id*., R4, tabs 2332, 2335-36, 2348-54, 2361-90; exs. G-17, -20). As with the NUWC videotapes and other exhibits, the serial numbers of the transducers represent chronological, as well as numerical, order, although some were accepted on DD250's out of sequence. Therefore, serial number 10007 from the 1990 contract shows a manufacturing date of November 1993, serial number 10712 from the 1992 contract shows a manufacturing date of March 1994, serial number 14007 shows a manufacturing date of February 1995, etc. (R4, tabs 2298, 2329). The NSWC tapes include approximately 325 transducers between 11115 and 13665 (R4, tabs 2325-29). The earliest 1992 serial number in the NSWC and NUWC tapes is 10415 (R4, tabs 2289, 2325).

50. NSWC did various engineering analyses, manufacturing process evaluation, failure analysis and remanufacturing (tr. 3/11). NSWC attempted to find a test for paint adherence and used the cross-hatch test where the paint is scored in an X-pattern and tape is applied to attempt de-bonding the paint (tr. 3/15-16). The test provided a means to determine, on a "pass-fail" basis, if the paint adhered to the tube, but the Navy felt the test did not quantify, or provide the degree of, adherence (tr. 3/61-65).

51. NSWC stripped the paint from one shipset. According to Commander Carlson, half showed inadequate surface preparation. He asked NSWC to document this. (Tr. 1/136-37) There is no evidence of documentation. Commander Carlson suggested

[15] Several low numbers appear to be from another contract and there are 2 high numbers (19075 and 19078) with a gap of over 4,000 numbers from the next highest serial number (R4, tab 2327). We have not considered those in our analysis. Neither have we considered any of the rebuilt transducers (which have an "R" suffix), of which there are several with serial numbers above 15000 (*e.g.*, ex. G-20).

statistical sampling such as 50 to 100 randomly selected transducers in July 1997 to test the paint, but the Navy's and appellant's experts could not agree on a test (tr. 1/143-45, 7/196).

52. It is unclear where the shipsets of transducers sent to NSWC came from. Mr. Bartlett did not know (tr. 3/73-74). He testified, and we have found, there were three shipsets (finding 49). Commander Carlson testified there were two shipsets (tr. 1/136), that one shipset was from a warehouse and he thought the other shipset had been on "one of those two ships," which we interpret as DDG-68 and DDG-70, the only ships mentioned by number in his testimony (tr. 1/92-93, *passim*). Mr. Strozeski believed that NSWC also remanufactured transducers from DDG-69, and that the paint on those transducers stuck to the boots when the boots were removed (tr. 1/253-54). However, record documents indicate that appellant performed the remanufacturing work on DDG-69's transducers (R4, tabs 574, 618). The record is, at best, ambiguous as to whether NSWC received transducers from DDG-69. The NSWC videotapes include five transducers from DDG-68 (s/ns 11042, 11115, 11220, 11380, 11454) and three transducers from DDG-70 (s/ns 12433, 12509, 12565) (R4, tabs 2325-29; ex. G-16). Thus, some of the transducers at NSWC came from DDG-68 and DDG-70. We find that some of the transducers came from a warehouse, some came from DDG-68 and DDG-70, and the rest had unknown origins.

53. The Navy came to believe during the investigation that cold temperatures were a significant factor in transducer failure (R4, tab 2334 at 10, 11). Appellant's analysis similarly concluded that cold water could cause the leak, and that the pigtail flange could be affected, although appellant maintained that it had complied with the drawings (tr. 7/167-68). Appellant's analysis also raised concern in February 1997 that use of Type W was "a very bad choice" with respect to crystallization and would cause a compression set at low temperatures (R4, tabs 2205, 2208). It also had concerns about the use of RTV in the counterbores during testing and the rebound characteristics of the 1992 contract pigtail flange (tr. 1/217-19). Unnamed "engineering experts" told Mr. Strozeski that it is very hard to get all of the RTV out of the counterbores (tr. 1/100-01).

54. Dielectric provided certificates of conformance for its pigtails, as did its rubber supplier (R4, tabs 3055, 3267). However, there is no specific evidence that the Note 1 compression test was performed or of a special test fixture during original manufacture (tr. 12/90-91). Dielectric flanges did not pass the 35 percent compression set test in tests performed after the leaking problem developed (R4, tabs 2250, 3450). However, a sample of neoprene reconstructed by a laboratory at the Navy's request using the Dielectric composition did pass the compression set test (R4, tab 3133). Similarly, material from pigtails passed the compression set test (R4, tab 3276).

The 944 Repair

55. Use of a polyurethane patch on the pigtail end of the transducer was considered and rejected (tr. 1/227). In February 1997 NSWC came up with the idea of using a sealant, PR-944 ("944") to seal the pigtail assembly to the cap of the tube. The 944 "fix" involved opening the transducer, taking the cap off, removing the pigtail, placing the 944 between the flange of the pigtail and its mounting, and reassembling. (Tr. 1/230, 7/163-64)

56. The 944 process came into being because the Navy wanted to get units to the fleet as quickly as possible because there were ship schedules to meet and they could not timely qualify a source for pigtails. Later NSWC replaced the pigtails instead of using the 944 repair. (Tr. 3/35, 46-47)

57. NSWC tested the 944 repair successfully. The tests involved 36 transducers, which were totally submerged in water horizontally with the pigtail outside the chamber to test insulation resistance for two weeks. Half were tested in cold temperatures and half in hot temperatures. Water was pumped under pressure to simulate "worst case" conditions, trying to pump water into the transducers. None of the transducers failed. (Tr. 1/234-35) However, during the disassembly of the 36 units NSWC discovered paint delamination due to a lack of surface preparation in some endcaps. Later, delaminations were observed in other areas. (Tr. 3/37-40) NSWC believed there was a potential leak path between the paint and the metal substrate (tr. 3/41). After the first shipset was repaired, NSWC brought on a new pigtail manufacturer (LaBarge) (tr. 3/44, 46-47, 59-61). It also repainted the later transducers with gray paint because it could not find a source for Corvel Blue (tr. 3/44-45).

58. In mid-March 1997 meetings were held to turn the 944 process over to appellant. The parties ended up with a process that would be workable at appellant's Sykesville facility. (Tr. 1/239-41) The Navy also imposed an additional test. It modified the hydrostatic pressure test required by the drawing by directing it to be performed on one transducer from each manufacturing batch per day at 36 degrees Fahrenheit for 30 days (hereinafter "cold testing") (tr. 1/243).

59. By letter dated 15 April 1997, the Navy directed Northrop Grumman to prepare a waiver to engineering drawings, technical manuals and provisioning documentation reflecting the Navy directed 944 remanufacturing process. The Navy further directed Northrop Grumman to submit the waiver to the AN/SQQ-89(V) configuration manager. (Stip., ¶ 44)

60. By letter dated 30 April 1997, Northrop Grumman objected to the Navy's direction to submit a waiver for the Navy directed 944 remanufacturing process.

Northrop Grumman stated in its letter that a waiver was inappropriate unless the transducers were nonconforming to the build-to-print drawing package. (Stip., ¶ 45)

61. The Navy sent some problem transducers to the Logistics Support Facility (LSF) in Chesapeake, Virginia (tr. 1/69, 2/15). In June 1997 appellant's L. S. DeVilbiss and the Navy's Mr. Strozeski visited the LSF. They authored a trip report, which compared the condition of 1988 and 1991 GE, and 1990 appellant transducers with 1992 transducers. Twelve 1990 and 1991 transducers, which had been in salt water for several months, were examined. All had "dings." The three 1990 transducers had more rust in the "dings" than did the nine 1988 and 1991 transducers. Thirty 1992 transducers had been in fresh water only a short time. Six showed some paint loss and rust. Five had "dings" and one had a small patch of paint missing. Thirty of the problem 1992 transducers from DDG-68 were examined. Twenty-four showed some rust and some loss of paint. Most were "dings," an undefined number had patches of missing paint larger than "dings," and two had larger patches of paint missing from the sides. (R4, tab 2149) Mr. Strozeski "knew [after the LSF visit] . . . that the 944 [repair] was not going to be effective" because the 944 repair depended on bonding of the paint and housing to prevent another leak path. He reported this to Commander Carlson. (Tr. 2/41)

62. Commander Carlson had come to believe that a variety of problems existed with the 944 repair. During the first six months of 1997 he came to believe that Dielectric had not performed the compression set test required by the drawings on the pigtail, in part because Dielectric had asked for a test fixture from the Navy when questioned about testing. The Navy had also learned that Dielectric had used Type W instead of WRT neoprene in the pigtail flanges. The Navy also "had issues" with the way the band on the boots was torqued, the epoxy mix for and adherence to the counterbores, and the use of RTV. (Tr. 1/95-101) Of particular significance was the adherence of the paint to the tubes. The Navy believed the 944 repair was dependent on good paint adherence. (Tr. 1/101-04) In this regard, Mr. Strozeski had caused failure analysis to be done after cracks began appearing around the Hysol epoxy in the counterbores after cold testing. This was determined to have been caused by the paint adhering to the Hysol epoxy rather than the tube. Contemporaneously with this, NSWC began to report paint peeling with boot removal. (Tr. 1/249-56) The parties tried, but could not agree upon, a means of statistically sampling and testing the transducers for the adequacy of the paint (tr. 1/144).

63. Commander Carlson testified as follows regarding the decision to abandon the 944 repair:

> So when I reported to my superiors in PMS 400, Admiral Hucting [sic], and then again Mr. Douglas and Captain Goldsby that I was installing a fix that depended on

> paint that we had physical examples of was not adhering properly to the can, they were quite upset and essentially, you know, order all stop. And we began to look at this more specifically.
>
> Then what we came up with was that if you don't have good paint to begin with, any fix that you come up with, or any assembly of the transducer is going to be faulty. If you don't have the paint sticking to the can before you squeeze a transducer pigtail against it, before you pour epoxy on it, before you squeeze an Inconel band against it, you don't have anything. And that sets aside the other issue that was equally important to the shipbuilder, again going back to their issue about not passing defective products onto the fleet, was strictly the long-term life of the transducer. If you had paint failures like that, whether or not they could conclusively be shown to be affecting the leak path, you weren't going to get the kind of life out [of] a transducer that you hoped to get, and so that was another issue.
>
> The decision was made by the Admiral and by the head of PMS 411 and PEO USW to follow the recommendations and to remanufacture these transducers essentially from the paint on.

(Tr. 1/104-05)

Remanufacturing All Transducers

64. Once the decision was made by the Navy to remanufacture all 1992 transducers "from the paint on," a 2 July 1997 letter was sent to appellant that outlined various observed problems and directed appellant to:

> A. Remove all TR-343 transducer tube assemblies and arrange to have the paint stripped and reapplied in accordance to the specifications of DWG#7344010 Rev. K, Tube Assembly. Transducers already reworked which have a 48 hr. cure cycle on the hysol epoxy in their counterbores, and are currently ready for shipment, shall be the last transducers disassembled for tube assembly repainting.

> B. Upon receipt of properly repainted tube assemblies, NG shall install new pigtails vice applying 944 to old pigtails. Begin pigtail installation using the 576 pigtails provided by the Navy and manufactured by LaBarge.
>
> C. Using guidance to be provided by the Navy, order 17 ship sets of new pigtails for use in reassembling the transducers after repainting the tube assemblies.
>
> D. Tube assemblies will no longer require chamfer and O-ring installation. A copper washer will be substituted for the steel washer called out in the current specifications. The Navy will provide this washer specification. Tube assemblies already chamfered will also be reassembled using this copper washer vice an O-ring.

(R4, tab 593/Bates 6798)

65. There were physical exhibits at the hearing (now images on a CD) and videotapes that demonstrated the existence of severe paint delamination in numerous transducers (R4, tabs 2325-28, 2350, 2352, 2385, 2371-73, 2378-79, 2382, 2385; exs. G-16, -17, -20, -21, -23). James Watts, the contracting officer who signed the 2 July 1997 letter, testified that the paint was "an issue in that we had no idea as to whether or not that--what the limits to that problem were in terms of the numbers of the transducers affected" (tr. 6/132).

66. The Navy followed-up with a second letter on 21 July 1997 that revised the post-944 remanufacturing process by requiring pigtail testing, compression set testing, chamfering and bolt installation. Also imposed was a requirement for First Article testing on six pigtails, to be jointly witnessed by the parties. (R4, tab 606)

67. Appellant sent a 25 July 1997 letter to the Navy stating it would repair or repaint any transducers identified as having defective paint that were within the two-year warranty. Appellant also informed the Navy of its position that the direction to repaint all transducers exceeded appellant's responsibility under the Warranty clause. (R4, tab 616)

68. By letter of 11 August 1997 the Navy again revised its direction to appellant, this time stating that only transducers that failed an American Society for Testing and Materials (ASTM) test for paint adherence were to be stripped and repainted (R4, tab 629). Appellant and the Navy considered various tests. Appellant favored an ASTM test requiring the paint to be crosshatched in an "X" pattern. Transducers that passed the test would be repaired with the contractually approved Barco Bond method at appellant's

expense. (Tr. 1/146-47; R4, tab 3220) However, Commander Carlson insisted on nondestructive tests (tr. 1/145-47, 2/161-62). The Navy wanted to "get back a new transducer . . . . [Although] [t]he insides weren't all redone. . . . we were redoing the can and putting it back together" (tr. 1/107). We find that the Navy's decision not to allow testing that necessitated a Barco Bond repair was partly driven by the way it wanted the repaired transducers to look.

69. When the parties could not agree on a test procedure, Commander Carlson asked appellant to provide information to narrow the process. He had in mind such things as a change in the paint and preparation process, which, we infer, would have isolated a particular group or groups of transducers. Appellant did not provide such information. (Tr. 1/144-45)

70. By letter of 2 September 1997 the Navy set forth the procedures for remanufacturing, as follows:

- Remove all TR-343 transducer tube assemblies and have the paint stripped and reapplied in accordance with the specifications of DWG#7344010 Rev K. Tube Assembly. However, do not proceed with reapplication of the paint until the Government witnesses that the tube assemblies have proper surface preparation in accordance with DWG#7344010 Rev K, Tube Assembly, Note 3[.]

- Replace pigtails that have flanges made of Type W Neoprene with either new or remanufactured pigtails which have a flange that conforms to the specifications in DWG#7344298 Rev. D "Cable Element and DWG#77A102840 Rev. A "Cable Element Test Specification"), [sic] both of which are contained in the TR-343 Transducer Drawing Package.

- Testing shall be performed in accordance with DWG#7344298 Rev D "Cable Element" and DWG#77A102840 Rev A "Cable Element Test Specification". This includes first article testing on six (6) assemblies, quality conformance inspections on sample assemblies selected at random from an inspection lot, and testing of each new batch of molding material in accordance with paragraph 2.8 and 2.9 of DWG#77A102840. These tests include the required compression set measurements on the completed molded flange using the special test fixture called out in Note 1 of DWG#7344298. The Government will witness these tests, and also perform additional testing on random samples.

- Tube assemblies will no longer require chamfer and o-ring installation.

- On tube assemblies that have not been chamfered, use the original bolts and washers called out in DWG #7344014. For tube assemblies that have been chamfered, NG should use the bolt specified in "TR-343 Remanufacturing Process and Test Procedure", PN 5A37113H04, Cage 2S209. The recommended washer for chamfered assemblies is McMaster Carr Catalog Part Number 90107A030 or its equivalent. The washer is of 316 Stainless. 0.343" I.D., 0.750" O.D. and 0.050" thick.

- Continue to apply Hysol epoxy, resin part number EE4183, hardener part number HD3561 will continue to be applied in accordance with the Transducer Remanufacturing and Test Procedure provided under NAVSEA letter Ser 2017.

- Continue to band boots using the single 3/4" wide, double wrapped Inconel band.

(R4, tab 659)

71. By letter dated 26 September 1997, Northrop Grumman notified the Navy that a significant amount of the Navy directed remanufacturing work was out of scope of the Contract's Warranty clause, but Northrop Grumman would proceed with the remanufacturing effort as directed, while reserving its right to an equitable adjustment for all work accomplished that was outside the warranty obligations. (Stip., ¶ 46)

72. Appellant contracted with Automatic Coatings Limited (ACL) to strip, prepare the surface, and repaint the transducers. The president of ACL, Brad Bamford, also testified as an expert in surface preparation and application of powder coatings on behalf of the Navy in these appeals. (Tr. 5/8, 14-15, 19-21)

73. It is undisputed that appellant remanufactured all but four shipsets of transducers, of which three were remanufactured by NSWC. As to the fourth, it was decided to decommission the USS Thorn. (ASBCA No. 53699, complaint and answer, ¶ 117) There is no evidence that the transducers on the USS Thorn, which was still in service in 2002, failed in excessive numbers (exs. A-4 to -7; tr. 1/138).

"Science Projects" and Over-Inspection

74. Appellant complained of what it called "science projects" (tr. 8/55). These were various efforts undertaken by appellant at Navy direction during the course of remanufacturing that appellant considered unnecessary (*id.*). Appellant lists the "SCIENCE PROJECTS" in a 15-page table (Table 2) in its claim (R4, tab 2340 at 98-111). In its brief, appellant relies on the testimony of Bruce Ballantyne and Margaret Solomon to support its position (app. br. at 79-80).

75. Mr. Ballantyne was a vice president and program manager who was assigned to attempt resolution of technical problems with the transducers in September 1997 (tr. 8/26-27). During his involvement he encountered several instances where he believed the Navy had been responsible for appellant undertaking the following efforts that were not fruitful:

a. The Navy challenged the number of rubber layers on the pigtail provided by appellant (tr. 69-70);

b. The Navy directed efforts to ascertain the cause and treatment of raised metal on the studs, which resulted in a solution that was a departure from the drawing (tr. 8/80-83);

c. A problem with boot banding, the resolution of which Mr. Ballantyne did not recall (tr. 8/86-87);

d. Getting an answer as to whether the "protective goop" used on tubes for shipment was meant to stay or be removed (tr. 8/88);

e. An effort to assure that tightening the transducer bolts was being done properly (tr. 8/96-97).

76. Ms. Solomon was a manufacturing engineer for appellant (tr. 11/72). She testified that Table 2 was a "summary of the investigations that [appellant] worked on that, once again, were above and beyond what was required by the contract" (tr. 11/121-22).

77. Beginning around March 1997, government inspection activity increased (tr. 4/51). If government inspectors saw something amiss, they would issue a Deficiency Corrective Action Report (DCAR) (tr. 8/107-08). According to Mr. Ballantyne, DCARs were often issued for non-functional reasons (tr. 8/105-11). According to Ms. Solomon, the inspections process interfered with appellant's manufacturing efforts (tr. 11/118-20). Ms. Solomon testified that appellant's lunch period was 11:00 a.m. to 11:30 a.m. and that "it was pretty standard that it was at least 11:45 before we could begin assembling" because government inspectors were not available (tr. 11/119). Joseph Reoli, a government inspector, conceded that inspectors were occasionally late returning from lunch but that it was not a regular occurrence (tr. 14/6). Appellant never filed a written complaint about inspection during remanufacturing although the process was contentious (tr. 4/58).

The Experts on the Three Leak Paths

The Counterbores

78. As the precise leak path for two of the transducers could have been either the pigtail or the counterbore (finding 47), we have found that 15 of the transducers tested at NUWC may have leaked through the counterbores. As many as 11 may have leaked in the counterbores only. (Findings 47, 48) In this finding and in finding 79, *infra*, we do not include the 7 transducers that leaked through the endcaps (finding 48) in our analysis. James Paschal offered expert reports (exs. G-7, -29) and expert testimony on the counterbore leak path for the Navy. He focused on the epoxy in the counterbores. He ultimately concluded that the design was not a contributing factor and his review supported only contamination in the counterbores (RTV or Tectal) as a viable cause of leakage. (Tr. 4/98, 115-16, 122, 126, 128-29, 147-48) The videotapes show drilled-out counterbores that have a white substance remaining, and which would appear to be contamination (R4, tab 2329). However, the samples taken of the substance or substances in the counterbores did not conclusively confirm the presence of RTV or Tectal (tr. 4/165-66). We find that contamination in the counterbores as a cause of leakage has not been demonstrated, and that the specific cause of leakage through the counterbores remains unresolved.

The Pigtail

79. We have found that, including the two transducers that could also have been leaking through the counterbore, as many as 12 of the transducers tested by NUWC may have leaked through the pigtail, of which 4 leaked in the pigtail only (findings 47, 48). At the outset, we note that the parties have not provided the Board with calculations as to how much thermal expansion would be experienced by the metals in the tubes, and what minimum compression set would consistently prevent leaks with that amount of

expansion. Thus, we have no way of knowing whether or not the 35 percent compression set in Note 1 of the drawing (finding 23) represents “over-engineering.” Robert Megill offered an expert report (ex. G-6) and expert testimony on the pigtail leakpath for the Navy. He reviewed relevant contract documents and test results provided by the Navy (*id.*; tr. 4/198). He concluded as follows:

> 1. A possible pathway for water intrusion into the TR-343 transducer assembly is a faulty seal caused by the use of an improper rubber material for the sealing flange of the Cable Element. Lower cost [FN omitted] Neoprene Type W rubber was used instead of Neoprene Type WRT. Records exist that indicate that the flanges manufactured from Neoprene W under Contract N00024-C-6300 [sic] did not meet the compression set and hardness requirements of the Cable Element Drawing [FN omitted]. There appears to be an absence of quality control test records on the Cable Element flange that would verify that it was in compliance with the specifications of the Cable Element Drawing.
>
> 2. When “equivalent” materials are allowed by a drawing package these equivalent materials are to be chemically equivalent. This fact is understood by Rubber Chemists, Purchasing agents, Quality control personnel, and manufacturing supervision familiar with the manufacture of rubber materials. Chemically equivalent materials are allowed in order to encourage competition between rubber suppliers and to provide for alternates to trade-named materials in the event of product unavailability. Neoprene W and Neoprene WRT are not equivalent.
>
> 3. The Cable Element Drawing and Test Specification for the transducer is totally sufficient to call-out a rubber material that will perform the required function as a sealing flange in the TR-343 Transducer assembly. The flange material that was provided under contract number N00024-92-C-6300 did not provide the properties needed to perform over the test conditions specified.

(Ex. G-6 at 4-5)

80. Mr. Megill could offer no industry standard, literature, or other support for his conclusion that in the chemical discipline, equivalent materials are understood to mean chemical equivalents. Rather, he testified that “it’s been accepted for a long time,” and that, while others may have a different view, “they’d be wrong.” His experience was that problems resulted when substitutes were not chemical equivalents. (Tr. 4/190, 202) Dupont makes a neoprene product, WD, which is chemically equivalent. Dupont does not publish the composition of WRT but a manufacturer could determine the composition by analytical methods. (Tr. 4/204-05) He testified that appellant’s substitute for WRT, Type W, hardens over time. Contrasting Type W neoprene with WRT, he testified that because WRT retains more of its softness, it is better able to conform to the metal shapes around it during thermal expansion and contraction. (Tr. 4/187-88)

81. Mr. Megill opined that passing the hot compression test in the pigtail drawing would not predict how Type W neoprene would perform in cold temperatures (tr. 4/217). He stated that it would be error to replace the hot compression set test with a cold compression set test because the latter test would be inferior as an indication of the completeness of the vulcanization. Moreover, “[s]ince Neoprene WRT is specified as the base rubber it is unnecessary to add a cold compression set test to define the material to be formulated.” (Ex. G-6 at 24)

82. Note 1 of the pigtail drawing (finding 23) refers to MIL-R-3065 and ASTM D2000-2BC415A14F17Z. Mr. Megill’s report states that each of the numbers and letters (or specific combinations thereof) in the latter hyphenated grouping can be translated pursuant to ASTM D-2000 reference material, as follows:

2BC--This designates the grade, type and class of the rubber material specified. Grade 2 means it is not a standard formulation and must meet additional requirements in the drawing. Type B means that heat resistance must be measured at 100 degrees Celsius (C). Type C designates the oil resistance of the material, to wit, a maximum volume swell of less than 120 percent after 70 hours of immersion in ASTM No. 3 oil at 100 degrees centigrade when tested pursuant to ASTM-D-471. According to Mr. Megill, under ASTM-D-2000 protocol neoprene is the most common material used for BC applications, although other materials meeting BC conditions may be used. Mr. Megill further states that because of the Z notation only WRT can be used as the base rubber.

415--This determines hardness and minimum tensile strength. The 4 means 40 on the Shore A hardness scale, + or – 5 points, and is at the low end of the hardness scale. The 15 means tensile strength of 15 megapascals with an ultimate elongation minimum of 500 percent.

A14--This deals with heat resistance. The A means heat resistance requirements follow. The 1 means the testing procedure to use is ASTM-D-573. The 4 sets the temperature at 100 degrees C and exposure time as 70 hours. A maximum change of + or – 30 percent of tensile strength, minus 50 percent in elongation, and a hardness change of + or - 15 Shore A points is permissible.

F17--This deals with low temperature requirements. F means low temperature resistance requirements follow. The 1 identifies the applicable procedure as ASTM-D-2137, Method A, 9.3.2. The 7 signifies that the material shall be non-brittle after being exposed to a temperature of -40 degrees C for 3 minutes. Mr. Megill considers this important because it accentuates the need to consider material performance at low temperatures and, when considered in combination with the requirement for WRT, "a competent rubber technologist would not consider substituting Neoprene W for Neoprene WRT in this application."

Z--This designates a special requirement, here the second part of Note 1 detailing the compression set test. He also states the type of testing is clarified by Note 17 of the drawing,[16] MIL-R-3065, section 4.3.3.1, ¶¶ a, b, and c, and the ASTM D-395 test procedure. (Ex. G-6 at 6-9)

83. Mr. Megill reviewed certain tests made by appellant (ex. G-6, app. H). He considered the test results to be invalid because they were performed after additional vulcanization (ex. G-6 at 23).

84. Richard F. Grossman, Ph.D., offered an expert report (R4, tab 3502) and expert testimony on the pigtail for appellant. He reviewed the contract and drawing as well as various test procedures and results (*id.*). He concluded as follows:

> My conclusions based on my review of General Electric Cable Element Drawing No. 7344298, Rev. D, and Cable Element Test Specification No. 77A102840, Rev. A, are fully stated in the following discussion. In summary, the most salient conclusions are as follows:
>
> 1. The equivalence delineated in Note 1 of the Drawing: Type WRT Neoprene or equivalent, cannot be taken reasonably to mean anything other than an equivalent per ASTM D2000, 2BC415 A14 F17 Z. This is significant because the BC designation does not specify polychloroprene (Neoprene). ASTM D2000 callouts require only conformance to specified tests; they do not identify specific elastomers or grades.

[16] See finding 29.

2. Performance in sea water beyond conformance to the above ASTM designation is clearly the responsibility of the procuring activity, per Paragraphs 2.6.1 and 2.7.1 of the Test Specification, and Note 17 of the Drawing, requiring test specimens to be sent for acceptance testing.

3. There are a number of compounds that could be formulated that would pass the entire ASTM D2000 callout, but still may be unserviceable in practice.

4. Compression set testing as specified in the Drawing yields little information on elastic recovery over a range of temperature, and almost no information related to cold temperature performance.

5. Failure to meet the specification for compression set as specified in the Drawing does not preclude good sealing performance at –1 to 33 C. On the other hand, meeting the compression set requirement does not ensure good sealing performance at low temperatures.

6. There are inherent difficulties as in this case in describing fitness for service for the cable element flange by the specification alone. A number of other approaches would have increased the likelihood of producing a product that would be successful in service.

7. The requirements of the Drawing and Test Specification are deficient in that they do not adequately describe the properties that are needed for successful service in the field.

(R4, tab 3502/Bates 29062-63)

85. Dr. Grossman also offered an expert report and expert testimony on his review of testing and analysis on the pigtail materials (R4, tab 3502/Bates 29085-99, tabs 1-20). He concluded as follows:

1. The most salient feature of the testing and analysis presented in the attached documents is that the modified compression set procedure given in Note 1 of Drawing No. 7344298, Rev. D is unacceptable as a qualification test. Testing carried out on the molded flange lacks:

    a) A history of round robin testing to establish precision.

    b) A standard test fixture manufactured by an established supplier of instruments to closely controlled dimensions.

    c) Establishment of correlation with ASTM D395 standard samples.

2. The reconstructed compounds were close in properties, with the Dielectric Sciences formulation producing superior results based on the low temperature tolerance required by the ASTM D2000 callout.

3. The test data provided is confusing, conflicting, and the scatter of data is so great that it cannot be stated with any certainty that the Dielectric Sciences samples failed to meet the requirements of the Drawing. Further, as described below, in most tests the Dielectric Sciences samples performed equal to or better than the LaBarge samples.

(R4, tab 3052/Bates 29085-86) The class of MIL-R-3065 is not specified but inferred to correspond with the ASTM reference (*id.*/Bates 29088).

86. Except as noted, we perceive Dr. Grossman's testimony on the ASTM designations to be generally consistent with that of Mr. Megill (*cf.* finding 82). He did, however, testify that 2BC signifies the lowest grade of BC material, and his discussion of the Z notation made no mention of whether, in combination with BC, the Z notation mandates use of WRT as the base rubber (tr. 9/14-18; *cf.* finding 82). We find, based on other parts of his testimony and report, that he does not believe WRT is mandated by the drawing note (R4, tab 3502/Bates 29064-65; tr. 9/37). Moreover, his testimony that the lowest grade of BC material is called for by 2BC appears to, and we find it does, directly

contradict Mr. Megill's statement that WRT is mandated by the BC and Z notations, and that neoprene is the most common BC material used under the ASTM protocol.

87. Dr. Grossman stated that the design of the flange is "an excellent example of . . . [a design that], has been thought out such that you're not overly dependent on the rubbery nature of the compound" (tr. 9/21). He points out that the design is such that in the field it takes advantage of hydrostatic pressure to push down on the metal in contact with the flange and tighten the seal (tr. 9/22; ex. A-27). He believes that the hot compression set test is a quality assurance test and not a basis for predicting field performance (tr. 9/23). He also testified that as neoprene ages it gets harder, making the seal tighter. At a hardness level of Shore A 45 to 55 instead of the 40 called for in the contract "it's probably a better seal than the original material" because of the static application (tr. 9/15, 36-37). He sees this as further support for his testimony that the design is excellent (tr. 9/24).

88. Dr. Grossman also believes that "Type W [neoprene] could be compounded to meet the ASTM call-out" (tr. 9/29). He further testified that if a chemical equivalent to WRT is required, the specifications must state it specifically (tr. 9/28). It is his opinion that the cold test in the drawing, which requires exposure to –40 degrees C for three minutes, "has little bearing on extended low temperature performance." To be meaningful for performance, the test must require longer exposure, such as 7 days at –10 degrees C. (R4, tab 3502/Bates 29066; *cf*. finding 82) Dr. Grossman concluded that it could not be concluded with scientific certainty based on the tests performed by both parties whether the Dielectric pigtails did or did not meet contract requirements (tr. 9/84). Moreover, the age of the pigtails tested was such that it could not be determined whether they would have met all contract requirements when tested (tr. 9/84-85). His report states "[b]ased on the data at hand, this question [of the equivalency with WRT] cannot be answered because of the unreliability of the unorthodox compression set procedure." He felt, however, that Dielectric's sample would be "equivalent" per the drawing since it passed the ASTM D2000 callout. (R4, tab 3502/Bates 29088)

<u>The Paint</u>

89. We have found that 76 transducers of the three shipsets sent to NSWC showed delamination in sheets of 2-3 inches or larger and that the condition was not attributable to handling. We have also found that 17 of the 64 transducers tested at NUWC also showed significant delamination. (Findings 47-49) Subhash Kapoor and Brad Bamford offered an expert report (ex. G-5) and expert testimony on behalf of the Navy on the contract-required paint, which is a fusion-bonded epoxy powder (finding 17, n.6). Mr. Bamford was presented as an expert in surface preparation and application of functional powder coatings (tr. 5/8, 19-21). Mr. Kapoor was presented as an expert in corrosion science and failure analysis of functional powder coatings (tr. 5/144).

90. Both Navy experts agreed that the requirement for use of No. 40 angular steel grit gave the bidder sufficient information to know that SP10, "near white metal," was the required level of surface preparation for application of the paint (tr. 5/65-66; ex. G-5 at 4). This equates to surface preparation measurable as a range of 2-4 mils (tr. 5/24, 161). However, Mr. Bamford testified that there are standards calling for a range of 1.5 to 4 mils (tr. 13/82). Both Navy experts agreed that Note 3 of the drawing, which does not specify the level of surface preparation, gives adequate information in that its requirement of No. 40 angular steel grit would tell a competent applicator that 2-4 mil surface preparation is necessary (tr. 5/33-37, 164). Their rationale was that a competent applicator had enough information to seek out from the Navy the required level of surface preparation (*id.*). However, they also agreed that, had they drafted the specification, they would have spelled out the requirement for 2-4 mil surface preparation (tr. 5/67, 183).

91. Mr. Kapoor designed and monitored the testing of the paint (tr. 5/145). Testing was carried out at ACL (ex. G-5, app. E). Tests were performed on 39 transducers produced under three separate contracts from fiscal years 1990, 1991, and 1992 (ex. G-5 at 11). The following tests were performed: Cathodic Disbondment Resistance (CDR); Differential Scanning Calorimetry (DSC) (performed on 3 endcaps); Salt Spray Resistance; Adhesion Tests; Impact Resistance; Coating Thickness; Holiday Tests; and Cure Tests. Tests for Surface Profile were performed on 30 tubes, which were stripped alternately by chemical and mechanical means. (Ex. G-5 at 11-20) Tubes and endcaps from tubes of nine transducers from the 1992 contract were tested for adequacy of surface profile (*id.* at 21-22). A scoring system of 0-10 was devised under which the 1990 tubes were satisfactory overall (8.1) and 1991 (4.1) and 1992 (3.0) were unsatisfactory overall (ex. G-5 at 8-9).

92. Measurements with a profilometer of the surface profiles of the three sets of tubes were taken at the thick and thin tube sections, and at the interior and exterior of the endcaps. The transducers from the 1992 contract were serial numbers 11325, 11327, 11795, 13235, 13260, 13375, 13426, 13469 and 13665. Measurements for those that were mechanically stripped and those that were chemically stripped were reported separately. The average measurements[17] in mils are set forth below:

[17] The report states that, with regard to the 1992 endcaps, all but the measurements for exterior, mechanically stripped endcaps are misleading. The report states there was no surface preparation on chemically stripped endcaps and mechanically stripped endcap interiors. (Ex. G-5 at 21)

	Endcaps- Interior	Endcaps- Exterior	Tube-Thick Section	Tube-Thin Section
1990				
Chemical	1.26	1.86	1.19	1.23
Mechanical	1.01	1.68	0.91	0.79
1991				
Chemical	0.69	1.10	1.07	1.11
Mechanical	0.56	1.00	0.81	0.75
1992				
Chemical	0.48	0.80	0.71	0.35
Mechanical	0.32	0.71	0.60	0.32

(Ex. G-5 at 21-22; tr. 5/153) We find there was less than 2 mils and therefore inadequate surface preparation on all the 1992 tubes and endcaps tested (finding 106, *infra*).

93. Mr. Bamford testified that the chemical stripping process would have had no effect on the surface profiles. Mechanical stripping would have had a "negligible" effect. However, no baseline measurements were taken prior to stripping. (Tr. 5/94-96) Mr. Kapoor believed mechanical stripping caused some reduction in the profile. He believed that chemical stripping affected the profile "very little," but since he did not know whether an inhibitor was used, he could not be certain of the effect. (Tr. 5/148-49, 172)

94. Mr. Bamford and Mr. Kapoor disagreed as to what is adequate strength for the adhesion pull test. Mr. Kapoor believed 2000 pounds per square inch (psi) was adequate (tr. 5/174). Mr. Bamford believed that 4000 psi was adequate (tr. 13/83). Similarly, Mr. Bamford believed a fusion-bonded epoxy coating could last for 40 years (tr. 13/98), while Mr. Kapoor believed it should last "20-plus" years (tr. 5/192).

95. Both Mr. Bamford and Mr. Kapoor observed mill scale and yellow stenciled markings on some 1992 tubes that strongly indicated there had been virtually no surface preparation (ex. G-5 at 3-4; tr. 5/153-56, 13/59-61).

96. Mr. Kapoor considered the cathodic disbondment test to be the most important test (tr. 5/175). The cathodic disbondment test attempts to measure the effects of a corrosive atmosphere on the paint (tr. 5/47-50). All 10 of the 1991 tubes failed totally. Of the 9 considered in the assessment of the 1992 tubes, 4 failed totally and 5 received an average score of 1.8. Thus, while both the 1991 and 1992 tubes were rated unacceptable, the 1991 tubes failed absolutely. (Ex. G-5, app. B; tr. 5/175-76). Mr. Kapoor attributes the failures of the 1991 and 1992 tubes to inadequate surface preparation (tr. 5/176).

97. Mr. Bamford testified, and we find, the term "fusion-bonded epoxy" is not a trademark of Minnesota Mining and Manufacturing Corporation (3M) (tr. 13/52-53; *cf.* finding 101). We also find based on his testimony the Morton formulation had not changed since the early 1980s (tr. 5/126).

98. The Navy's experts concluded that a lack of surface preparation was the primary cause of the paint failure (ex. G-5 at 9; tr. 5/153).

99. Wayne B. LeGrande offered an expert report (R4, tab 3503) and expert testimony on the paint for appellant. He was accepted as an expert in marine and underwater painting and powder coating (tr. 10/18). His report consists of a preliminary report and a second report, with 40 tabs.

100. Mr. LeGrande did not believe that the requirement for No. 40 angular steel grit in Note 3 provided any particular duty regarding surface preparation. In his opinion, a reasonably competent powder coater would "basically do the bare minimum as far as blasting." (Tr. 10/32)

101. Mr. LeGrande testified "My experience with fusion-bonded epoxy is that fusion-bonded epoxy is a trade name of 3M" (tr. 10/18; *cf.* finding 97).

102. Mr. LeGrande was very critical of the testing done by or on behalf of the Navy because he believed only standardized, repeatable tests are reliable. His observation was that the testing was flawed because of the adjustments that were made to standard tests. He also testified there was no way of telling the effects of chemical and mechanical stripping. (Tr. 10/62-69, 75-77, 86-89, 94-98) We have observed the testing process on videotape (ex. G-15) and weighed the testimony of Mr. LeGrande and the Navy's experts. We find the testing and the test results sufficiently trustworthy to warrant consideration in the resolution of these appeals.

103. In Mr. LeGrande's opinion 1200 psi was adequate for the measurement of adhesion under the pull test (tr. 10/65-66).

104. In his preliminary report, Mr. LeGrande reached the following conclusion:

> In my years of experience with paint and coatings used in a saltwater or undersea environments, the lack of any acceptance testing in the Drawing or Instruction is extremely unusual. If this tube assembly is a critical item in the SQQ-89 System, I would expect to see either industry or federal standards and specifications incorporated by reference. The

> lack of any such federal or industry standards, along with the imprecise, vague and generalized language in the Drawing and Instruction, introduces a wide range in tolerances that potentially could result in contractors that comply with the Drawing and Instruction obtaining significant differences in product performance.

(R4, tab 3503/Bates 29320)

105. In his second report, Mr. LeGrande made the following observations and conclusion:

> - 99% of the coating failures I observed were from apparent mechanical damage. The failures were not consistent with problems with the powder coating process or surface preparation.
>
> - Many of the damaged areas on the top and the cap of the tubes were repaired apparently using the Barco Bond repair allowed by the drawings.
>
> - I saw no blistering, general delamination, or stress cracking on flat areas except where apparent impact and mechanical damage occurred.
>
> - A blasted surface profile was observed under magnification in the damaged areas where the coating had been chipped away.
>
> - In areas that were damaged and the coating breached, it appeared that the rust that had occurred was after the impact that caused the damage.
>
> - The salt fog testing produced some undercutting in the scribed areas, but even with salt fog testing there appeared to be no significant adhesion problems.
>
> - Based on visual inspection there was no significant difference among the 1990, 1991 and 1992 tubes that had been subjected to salt fog testing in the scribed areas.

- The impact testing apparently using a method of cutting around the impact area could have fractured or damaged the film and reduced the film integrity.

- Even after the 1992 tubes were stripped, I observed with magnification paint residue embedded in the metal indicating a strong mechanical adhesion had occurred when originally powder coated.

- In tubes that were chemically stripped, I observed darker areas in the metal where the stripper apparently reacted with the steel. In addition, the mechanically stripped tubes showed abrasion and damage to the metal surface.

- Based on the results of the stripping process I observed, any profile readings or measurements taken on stripped tubes would be questionable.

V. <u>Conclusion</u>.

Based on the above, my opinion is that Northrop Grumman complied with the Drawing and GESD Instruction related to powder coating the transducers. In addition, I saw no evidence demonstrating to me that there was a massive coating failure as alleged by the Navy.

(R4, tab 3503/Bates 29333-34)

106. We find, based on our review of the experts' reports and testimony, that there was a general lack of surface preparation in the 1992 tubes and endcaps on which surface profiles were measured. We further find, based on the experts' reports and testimony and the Note 3 requirement for use of No. 40 angular steel grit, that 2 mils was the minimum acceptable surface profile for fusion-bonded epoxy at the time of the contract. In addition, based on the experts' reports and testimony and particularly on our review and comparison of the surface profile data from the measurements of the 15 mechanically stripped and 15 chemically stripped tubes and endcaps (finding 91), we find that the average reduction in surface profile attributable to mechanical stripping is .2 mil. This is derived from adding the 12 average measurements for mechanical stripping (9.46) and subtracting that total from the sum of the 12 average measurements for chemical stripping (11.85), and dividing the result (2.39) by 12. Our finding is also based upon the premise that the logical reason for the consistently lower numbers for mechanically

stripped tubes is due to the effect of the mechanical stripping process. Finally, on balance, we find that chemical stripping had no quantifiable effect on surface profiles (findings 93, 102). We find, therefore, that the effects of the mechanical and chemical stripping do not alter our finding that the surface preparation on the 1992 tubes and endcaps tested was inadequate.

The Claims and Contracting Officers' Decisions

107. On 22 July 1998, appellant submitted to the contracting officer a written, certified claim under the CDA (the "944 Claim") in the amount of $3,282,420, claiming additional work was directed by the Navy to remanufacture certain of the elements, the transducers of the TR-343 Transducer Array Assembly Subsystem (stip., ¶ 4).

108. In an 11 February 1999 contracting officer's decision, appellant's claim was denied. The decision cited the Warranty clause, *inter alia*, as the basis for denial. The appeal was docketed as ASBCA No. 52178. (R4, tab 2337; stip., ¶¶ 5, 6)

109. On 28 October 1999 the contracting officer issued a notice of indebtedness to appellant in the amount of $7,880,583.12, claiming damages were incurred as a result of appellant's performance. The 28 October 1999 letter set forth specific bases for the alleged damages, namely: (a) removing defective transducers from ships; (b) investigation of the defects and in-house processing; (c) failure analysis in 1997; (d) onsite support at appellant's plant in 1997 through 1999; (e) follow-on failure analysis in 1998 and 1999; (f) test and evaluation of fully remanufactured pigtails; (g) engineering support and development of the 944 process and painting with gray paint; (h) remanufacture of shipsets not performed by appellant; (i) data and reports; and (j) shipping costs. (R4, tab 2338; stip.,¶ 7) Appellant denied any indebtedness in a 15 December 1999 letter (stip., ¶ 8).

110. On 15 December 1999, Northrop Grumman submitted to the contracting officer a written, certified claim under the CDA (the "Remanufacturing Claim") in the amount of $18,834,620, claiming additional work was directed by the Navy to remanufacture the transducers from the beginning of the "944" related effort through completion of the effort to totally remanufacture all transducers produced under the contract (stip., ¶ 12).

111. By decision dated 31 March 2000 the contracting officer denied the remanufacturing claim in its entirety (stip., ¶ 13).

112. In a 26 April 2000 contracting officer's decision the Navy demanded from appellant payment for the matters addressed in its 28 October 1999 letter in the revised amount of $7,742,125. Appellant filed a timely appeal on 22 May 2000 that was

docketed as ASBCA No. 52785. In June 2001 appellant made two payments to the government pursuant to the Navy's demand in the total amount of $8,331,844.02 representing full payment plus interest. (Stip., ¶¶ 9-11)

113. On 22 May 2000, Northrop Grumman timely appealed the 31 March 2000 final decision regarding the remanufacturing claim by filing a notice of appeal with the Board. The appeal was thereafter docketed as ASBCA No. 52784 (stip., ¶ 14).

114. On 31 August 2001, Northrop Grumman filed with the Board Appellant's Motion Requesting Leave to Amend Its Complaint and Appellant's First Amended Complaint for the Remanufacturing Claim. Through its First Amended Complaint, Northrop Grumman sought to increase the amount of damages to include the amount already collected by the Navy pursuant to the government claim. (Stip., ¶ 15)

115. On 26 October 2001, the Navy filed with the Board Respondent's Opposition to Northrop Grumman's Motion Requesting Leave to Amend its Complaint (stip., ¶ 16).

116. On 23 January 2002, Northrop Grumman submitted to the contracting officer a duly certified "Protective" consolidated claim in the amount of $27,166,464, which includes $18,834,620 sought under the Remanufacturing Claim, plus $8,331,844 already paid to the Navy under the government's claim (stip., ¶ 17).

117. On 20 February 2002, Northrop Grumman timely appealed the *de facto* final decision regarding the consolidated claim by filing a notice of appeal with the Board. The appeal was thereafter docketed as ASBCA No. 53699 (stip., ¶ 18).

DECISION

As stated *supra*, we deal first with entitlement issues common to all appeals and address application to the individual appeals, *infra*. In ASBCA No. 52785, which is a Navy claim, the Navy bears the burden of proof. *Roberts v. United States*, 357 F.2d 938, 949 (Ct. Cl. 1966). It attempts to meet that burden by arguing that appellant delivered transducers with latent defects. It also argues that appellant is liable under the Warranty clause. Appellant argues, *inter alia*, that the elements of a successful latent defects claim are missing, and that the Warranty clause only applies to the CLIN level, and the transducers are not contract line items. In ASBCA Nos. 52178, 52784 and 53699, which arise from appellant's equitable adjustment claims for its effort in complying with the Navy's direction, appellant's arguments include the contention that it met all the contract requirements, that the Navy overreached both when it directed the 944 repair and when it directed appellant to remanufacture all the transducers, and that no cause for the leaks has ever been established. Appellant also seeks costs allegedly arising from the Navy's overzealous inspection and "science projects." The Navy argues that it has established the existence of three leak paths and that appellant's claims should be denied for the same reasons that its claim should be sustained.

At the outset we note that appellant would have us hold the Navy to a standard of near-scientific certainty in proving the cause of the transducer problems. It would also have us hold that a single cause must be shown. Conversely, the Navy would have us apply the results of the testing of a relatively small number of transducers to the nearly 10,000 transducers manufactured and delivered by appellant. As we deal in probabilities, we cannot subscribe to either position. We also note that the seventeenth shipset was never accepted (finding 42), so the Navy's remedies are not confined to latent defect and warranty with respect to that shipset.

Latent Defect

For the purposes of these appeals, the principal difference between a latent defect claim and a claim under the contract's Warranty clause is that the former survives the two-year time limitation of the latter. We have found that transducers on DDG-68 and DDG-70 failed IR tests because of leaks (findings 37, 41). We have also found that Navy tests established three leak paths – the counterbores, the pigtail and the paint (finding 48). The Navy first argues that the transducers failed because of latent defects.[18] The defects alleged were failure to grit blast the tubes and failure to meet contract requirements for the pigtail and the counterbores. Under the Inspection of Supplies clause (FAR 52.246-2) the Navy's acceptance of the systems was not conclusive if there were latent defects:

> (k) Inspections and tests by the Government do not relieve the Contractor of responsibility for defects or other failures to meet contract requirements discovered before acceptance. Acceptance shall be conclusive, except for latent defects, fraud, gross mistakes amounting to fraud, or as otherwise provided in the contract.

See also Roberts v. United States, 357 F.2d at 948.

A government inspector accepted transducers on a DD250 (finding 37). To establish a latent defect the party alleging the defect must show that it was not discoverable "by observation or inspection made with ordinary care." *Kaminer Construction Corp. v. United States,* 488 F.2d 980, 984 (Ct. Cl. 1973). Of major

[18] Although the boot was identified as a leak path earlier in the dispute, the Navy has not argued that the boot was a leak path in its briefs. We have proceeded, therefore, on the assumption that the Navy does not seek relief based on defects in the boot.

significance here, where the contract contains a warranty clause, is that contractor liability for a latent defect survives the time limit in the warranty clause, which in this case is two years. *Keco Industries, Inc.*, ASBCA No. 13271, 71-1 BCA ¶ 8727 at 40,539. As proponent of the claim, the Navy must show liability, causation and resultant injury. *Roberts, supra,* at 949. It must also show that the defect existed at the time of acceptance. *Herley Industries, Inc.*, ASBCA No. 13727, 71-1 BCA ¶ 8888 at 41,309. The specifications are the touchstone of a latent defect claim and a testing procedure or standard for demonstrating compliance more stringent than that set forth in the contract generally may not be used to establish a defect. *United Technologies Corp. v. United States,* 27 Fed. Cl. 393, 397 (1992); *Stewart & Stevenson Services, Inc.*, ASBCA No. 52140, 00-2 BCA ¶ 31,041.

The Counterbores

As to the counterbores, the record is perplexing. Navy testing showed the counterbores to be the dominant leak source (finding 48). The videotapes show frequent occasions of inadequate breakaway torque in the counterbore epoxy (findings 47, 48). However, the Navy has simply failed to prove that appellant did not comply with the specifications. The Navy's expert could not explain what the alleged defect in the counterbores was (finding 78). Indeed, his testimony and report provided little of value to the Navy's case and fell far short of establishing a latent defect. Accordingly, we hold the Navy has not met its burden of proving the existence of a latent defect. *Roberts, supra.* Moreover, as we hold below that the surface profile was latently defective and correction of that defect necessarily involved removal and replacement of the counterbores, the issue is moot for practical purposes.

The Paint

With respect to the paint, we have found that a minimum surface profile of 2 mils was a required level of grit blasting with No. 40 angular steel grit. Use of No. 40 angular steel grit was a contract requirement. (Findings 16, 106) Appellant argues strenuously that there is no surface profile inherent in the requirement for use of No. 40 angular steel grit. We disagree. Appellant's painting subcontractor's procedures called for grit blasting (finding 31), thereby offering strong support for a contemporaneous interpretation that surface preparation was required. It is reasonable that the level of grit blasting should be compatible with the coating to be applied. While appellant's expert, Mr. LeGrande, did not believe any particular standard was called for (finding 100), we find this "intrinsically unpersuasive" and reject it. *Sternberger v. United States,* 401 F.2d 1012, 1016 (Ct. Cl. 1968). Mr. LeGrande also believed, incorrectly, that fusion-bonded epoxy was a trade name of 3M (findings 97, 101). We found this particularly disquieting, as it demonstrated a lack of familiarity with the powder coating called for by the contract. In weighing his testimony on surface preparation for fusion-bonded epoxy, our willingness to rely on his opinion was diminished by this apparent lack of familiarity. We found Mr. Kapoor and Mr. Bamford considerably more persuasive on the issue of surface profile and, as a result, are persuaded to adopt the 2 mils minimum articulated by Mr. Bamford and Mr. Kapoor (finding 90).

We have found there were approximately 76 tubes with substantial[19] paint delamination observed at NSWC, and substantial delamination in 17 of 64 tubes tested at NUWC (findings 47-49). There were also 9 examined by Mr. Kapoor (finding 92). We have observed these transducers as physical exhibits, photographs or on videotape. There is nothing subtle or nuanced about the delaminations in the group we have identified. Indeed, we observed numerous suspicious transducers with paint missing in dime to quarter sized areas (*e.g.*, R4, tab 2325, s/n 12243) that we have not included in the number we considered to fall within our definition of substantial delamination. We believe we have given appellant the benefit of the doubt on suspicious transducers. The 102 tubes with substantial delamination are not transducers with "pings" or chips attributable to handling (findings 47-49). While we may resort to experts to help us understand evidence or determine facts, the visual evidence needs little explanation and is certainly comprehensible without expert evidence. *Carlsen v. Javurek,* 526 F.2d 202 (8th Cir. 1975) (error to instruct jury that expert opinion was necessary when the matter was within the comprehension of lay jurors).

The cause of the delamination is a matter calling for expert testimony. There was little or no surface preparation on the 9 tubes[20] from the 1992 contract measured by the Navy's experts (finding 92). The range in serial numbers was 11325 through 13665. The Navy's experts testified, and we have found, that the substantial paint delamination observed is attributable to inadequate surface preparation (finding 106). The Navy thus meets the causation standard, and the injury—delaminating paint, leaking and rusting transducers—is also established (findings 47, 48). We are persuaded the delaminating paint was a leak path (findings 47, 48, 57, 61). We think the condition meets the criteria for a latent defect for the delaminated tubes, as the tubes were painted when inspected (finding 37), making the inadequate surface preparation not discoverable by observation or inspection made with ordinary care. Further, the defect of inadequate surface preparation must have existed at the time of acceptance. We have been shown no proof to the contrary, we have quantified the effect of mechanical stripping, found chemical stripping to be without effect (finding 106) and we think it would be illogical in the extreme to conclude in the absence of evidence that a surface protected by an epoxy coating would return to its non-treated state in the course of residing in a warehouse or

[19] We use the term "substantial" to refer to delamination not attributable to handling where 2-3 inch sheets of paint, or larger, no longer adhere.

[20] Exhibit G-5 at page 19, section 4.9.3 refers to 30, 1992 transducers. We can only identify results on 9 (*id.* at 21-22; ex. A-38).

stave. As there was no test in the contract to determine what the surface profile was, we think the method employed (profilometer, finding 92) was reasonable and did not exceed any test or standard to be inferred from the contract. *Cf. United Technologies Corp. v. United States*; *Stewart & Stevenson Services, Inc., supra.*

We do not infer, however, that all the nearly 10,000 tubes were inadequately prepared based upon the testimony, videotapes and exhibits. This is because the paint delamination and inadequate surface preparation observed were confined to specimens from a group of 2,550 transducers within a range of serial numbers from 11115 to 13665 (findings 47, 48, 49, 92). The Navy has thus failed to prove that all or substantially all of the transducers were defectively coated. *Baifield Industries, Inc.*, ASBCA Nos. 14582, 14583, 72-2 BCA ¶ 9676 at 45,187-88 (recovery for only one of 222 containers where the defect was proved with respect to that one container).[21] It has, however, established to our satisfaction that it was entitled to have the group of 2,550 transducers stripped, prepared to a minimum 2 mil surface profile and recoated.

The record contains tapes and expert testimony on roughly 711 1992 transducers that had not been rebuilt or whose serial numbers do not break continuity by several thousand numbers and that we consider material (findings 47 (12), 48 (40), 49 (650), 92 (9), n.15). The serial numbers for those transducers range from 10415 to 14554, a range of 4,139 (*id.*). The 711 transducers thus constitute a sample of over 17 percent of that range. We hold that the size of the sample is sufficient to be representative of the 4,139 within the range, particularly since the parties would apparently have been willing to live with a sample of 50 to 100 of the total produced in July 1997 if they could have agreed on a test, and 10 percent acoustical testing was done by appellant on transducers in production (findings 33, 51). We have found that 102 transducers had inadequate surface preparation resulting in substantial paint delamination (findings 47 (1), 48 (16), 49 (76), 92 (9)). If one considers these specimens across the full range of 4,139 serial numbers from which the 711 observed transducers were taken, it constitutes a failure rate of over 14 percent (102 divided by 711), which is a failure rate in excess of the 10 percent that would render a ship unusable for antisubmarine warfare (finding 41). If the analysis stopped there, we would consider the 14 percent failure rate to be material and high enough to justify the Navy's direction to remanufacture. However, a more detailed analysis reveals that the distribution of the 102 substantially delaminating transducers did

[21] Similarly, the adhesion, cathodic disbondment and other testing done by the Navy's experts involved only 39 transducers from three contract years (findings 91, 96). Based on this sample, with little or no information as to the background of the transducers tested, the argument that a comparison emerges which establishes latent defects in the paint sufficient to warrant remanufacture of all 1992 transducers is not compelling. *Baifield Industries, supra.*

not occur over the full range of 4,139 transducers and that the Navy was therefore not entitled to have the group of 4,139 remanufactured. The delaminations are clumped within a range of 2,550 transducers with serial numbers from 11115 to 13665 (findings 47-49, 92). The record contains tapes and expert testimony as to 383 transducers within the range of 2,550 transducers, or 15 percent of the group (findings 47 (12), 48 (37), 49 (325), 92 (9)). We find the 15 percent sample to also be of sufficient size to constitute a representative sample. More than 26 percent of the sample (102 divided by 383) had inadequate surface preparation that we believe resulted in substantial paint delamination. The failure rate for rendering a ship unusable for antisubmarine warfare is 10 percent (finding 41). The rate of failure within the 2,550 transducers was thus 2.6 times that necessary to take a ship off the line and prevent it from performing its essential function. Accordingly, we hold the Navy was entitled to require appellant to remanufacture transducers within that range of 2,550.

We have observed the destructive process necessary to disassemble the transducers so that the tubes can be prepared and coated. In the restoration process after disassembly and recoating, new bolts would be needed, the counterbores, which would have been drilled out, would require installation of new epoxy, a new cable element would be required (*see also* ASBCA No. 52784, *infra*), as would a new boot, and any other work necessary to make the transducers functional would be required. In this regard we have observed rust damage to the stack in the videotapes. The Navy's claim is sustained and appellant's appeal is denied to that extent.

<u>The Pigtail</u>

Dielectric and its rubber supplier both provided certificates of conformance (finding 36). While hardly adequate to conclusively establish that all tests were conducted successfully, the Navy has the burden of proof. We cannot agree that the Navy has proved the required tests were not done, based on a lack of documentation of specific test results and appellant's request for a test fixture in 1997 (findings 28, 30). Moreover, as addressed below, since the contract did not require a cold water test and the problem was performance in cold water, it has not been proved that the required testing (hot compression set) was material to the leakage issue (findings 84, 87, 88). The Navy also argues that appellant failed to meet the specifications when it supplied pigtail flanges made with Type W neoprene instead of WRT (finding 30). Since use of Type W was a condition that existed in all the pigtails prior to remanufacture, the Navy's argument does not suffer from the problem of an unrepresentative sample if we conclude that use of Type W constituted a failure to meet the specifications.

There is evidence that there was leakage through the pigtails, and we so find (finding 48).[22] Evidence of record led the parties to contemporaneously deduce that cold temperatures were the trigger (finding 53). We agree with the parties and hold that it is most probable that cold temperatures activated the leaks.

The contract required the transducers to perform in cold water (finding 25). It placed the burden for seawater testing on the Navy (finding 24), but those were First Article tests not required for the 1992 contract and the contract did not require cold water immersion testing (findings 24, 34). The one cold temperature test was for -40 degrees for three minutes (finding 82). We agree with appellant's expert, Dr. Grossman, that the test is not a reliable measure of extended cold water performance (finding 88). The contract thus provided no reliable means to assess the ability of the pigtail to function in a cold-water environment, particularly over time. Nor would testing of test specimens pursuant to Note 17 (finding 29) have revealed cold water leaks, assuming, *arguendo,* that appellant provided the specimens to the Navy and that government testing was inferred by Note 17. The pigtails could have passed the tests and still been a source of leaks. Nevertheless, the contract required satisfactory performance in seawater at minus 1 degree C (finding 25). Further, the only seawater testing was the Navy's responsibility for a First Article test (finding 24), but the 1992 contract did not require the test (*id*.). Moreover, failure to meet a performance specification has been held sufficient to sustain a latent defect claim under the Inspection clause. *Keco Industries, Inc., supra*, 71-1 BCA at 40,538 (failure to perform for 500 hours). As we see it, the key latent defect issue is whether the use of Type W did not conform to the specifications and created a latent defect that caused the leakage and performance failure.

The first part of the issue is whether only WRT complied with the specifications. The drawing note provided "FLANGE MOLDING MATERIALS TYPE WRT NEOPRENE OR EQUIVALENT TO MEET MIL-R-3065 AND ASTM D2000-2BC415A14F17Z" (finding 23). Notwithstanding Mr. Megill's testimony for the Navy that the quoted language means chemically equivalent to WRT, we think the language is ambiguous at best. In the first place, the note is unequivocal in its articulation that equivalency is acceptable. We are not persuaded that the equivalency sought must be chemical, in part because it doesn't specifically say so, in part because Mr. Megill and the Navy offered no support through technical literature or otherwise for his testimony vis-à-vis chemical equivalency, and in part because Dr. Grossman credibly disagreed. We are persuaded that the specific language used, the placement of key words and their plain meaning lead to a reasonable interpretation that means an acceptable equivalent is one that meets the requirements of MIL-R-3065 and ASTM D2000-

[22] While appellant argues there is no proof the transducers leaked, we think, in addition to the tests, etc., there is no other credible explanation for the interior rust observed (findings 47, 48).

2BC415A14F17Z, the meaning of which is explained in finding 82. Thus, the note, reasonably interpreted, does not require chemical equivalency with WRT.

Assuming, *arguendo*, the note is ambiguous, we must determine where it stands on the patent/latent continuum. *Cf. Triax Pacific, Inc. v. West*, 130 F.3d 1469 (Fed. Cir. 1997); *Hills Materials Co. v. Rice*, 982 F.2d 514 (Fed. Cir. 1992). We find it is latent. "Because the doctrine has the effect of relieving the government from the consequences of its own poorly drafted contracts, the doctrine has been applied only to contract ambiguities that are judged so 'patent and glaring' that it is unreasonable for a contractor not to discover and inquire about them." *Triax Pacific, supra*, at 1475. Where, as here, the contract does not include a qualifier such as the word "chemical," but does spell out a detailed industry standard as the basis for equivalency, we cannot impose a duty to inquire.

The experts disagreed as to the effect of the greater hardness of Type W. The Navy's expert believed the softer WRT would better conform to the metal parts during thermal expansion and contraction and thereby form a more effective seal (finding 80). The question, however, is not whether WRT would have provided a more effective seal. The question is whether Type W provided an adequate seal, *i.e.*, one that did not leak in seawater between minus 1 degree C and 33 degrees C. Appellant's expert testified that greater hardness, up to about Shore A 45 to 55, as opposed to the contract requirement of 40, would "probably [be] a better seal" (finding 87). He did not, however, assert that the design was deficient in that respect. Appellant's expert also was laudatory in his testimony on the shape of the flange. He believed that the shape would contribute significantly to preventing leaks. (Finding 87) Given that the only motion involved would be that caused by thermal expansion and contraction, we found this unrebutted testimony logical and supportive of appellant's position. However, Dr. Grossman's testimony that a harder flange would provide better protection from leakage was less persuasive. Without calculations to determine the extent of thermal expansion and the compression set and resilience necessary to accommodate the thermal expansion, we are persuaded by Mr. Megill's testimony that the softer WRT was preferable, although we cannot find that Type W could not have been formulated to work (finding 88).

The principal flaw in Dr. Grossman's testimony for appellant is that he stopped short of testifying that the pigtail flange met contract specifications. He pointedly testified only that it could not be determined "with scientific certainty" whether the Dielectric pigtails did or did not meet contract requirements (finding 88). We agree that it cannot be determined whether the composition of the pigtail was defective. We cannot agree with regard to compliance with the contract performance requirements. There is evidence and we have found that some transducers leaked through the pigtail (finding 48). However, the leakage was confined to a relatively small number of tested pigtails and the size of the sample was not sufficiently large to warrant replacement of all pigtails.

Baifield Industries, Inc., supra, 72-2 BCA at 45,187-88. We have held, *supra,* that replacement of pigtails is a necessary part of the remanufacture to which the Navy is entitled for inadequate surface preparation. The Navy's remedy for defective pigtails is thus subsumed within the remedy for defective paint.

Warranty

The warranty clause extends coverage for two years beyond acceptance (finding 12). Thus, transducer failures discovered more than two years after acceptance are not covered. Here, transducer failures were discovered between December 1996 and 23 January 1997 (finding 37). It is well-established on this record that substantial numbers of transducers on DDG-68 and DDG-70 failed the IR test, meaning they leaked and shorted out. The range of serial numbers for transducers on the two destroyers is from 1511[23] to 13270 (finding 47). Thus, it appears that some of the 1992 transducers fall outside the range of serial numbers for which we have held there was a latent defect of inadequate surface preparation. Our review of the record leads us to conclude that the transducers on DDG-68 and DDG-70 which are at the center of this dispute were not covered by the two-year warranty. This is based on either verifiable acceptance on DD250's or the fact that the relevant transducers do not appear on DD250's after November 1994. There are, however, transducers between serial numbers 11115 and 13665 covered by warranty for which the Navy proved latent defects. (Finding 37) Accordingly, and assuming that the Navy has the right to seek a remedy for those defects under the warranty clause as well as under the Inspection clause, the question is whether the Navy acted reasonably in ordering remanufacture of all transducers.

We have found there were approximately 135 transducers still under warranty among the range of serial numbers from which the Navy selected specimens and among which we held the Navy had proved defects (finding 37). That small number is not sufficiently representative in size to persuade us that the contract permitted the Navy to direct the correction of nearly 10,000 transducers (or of any transducers with serial numbers above 13665 which may still have been under warranty). We consider the applicable principle to mirror the principle set forth under the Latent Defect portion of this opinion, *supra*. We could not infer that all transducers were defective, even including the number shown to be latently defective. *Cf. Gavco Corp.,* ASBCA Nos. 29763 *et al*., 88-3 BCA ¶ 21,095.

The Navy argues that the Warranty clause's provision allowing it to order appellant "to correct or, if so directed by the Government, partially correct the defect responsible for the failure" (finding 12) gives it the option of having all or part of the

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[23] We recognize that this would not be a 1992 transducer. However, all others but 4636 are 1992 transducers (R4, tabs 2391-2306).

transducers corrected. According to the Navy, it chose to have all transducers corrected. Carried to absurdity, under the Navy's interpretation a defect in only one transducer could require a massive and expensive correction in all the nearly 10,000 transducers delivered here. We find that argument unpersuasive. We think a standard of reason, based on the facts, must be applied to determine whether the Navy went too far in ordering the remanufacture of all transducers.

We are not persuaded that the Navy acted reasonably in ordering remanufacture of *all* 1992 transducers. Among our reasons is the performance of the USS Thorn, which did not suffer excessive transducer failures and was still in service in 2002 (finding 73). Further, although the specific serial number of the earliest transducer produced under the 1992 contract is not ascertainable, we know that 10007 was a 1990 transducer and 10415 was a 1992 transducer (finding 49). We also know that 9,792 transducers (17 shipsets of 576) were produced. Even if the first serial number from the 1992 contract was 10008, the serial numbers ran at least through 19800. However, no transducers above serial number 13665 are shown in the videotapes or elsewhere in the record with a substantial paint or leakage problem.[24] We cannot ascertain on this record the serial numbers of the 17th shipset. In any event, the effect of non-acceptance of that shipset, if any, should have no practical effect on the resolution set forth herein.

The 944 Repair and Other Specific Cost Elements

Appellant argues that the Navy is not entitled to the costs attributable to the 944 repair, in part because that activity required effort beyond the contract requirements. We agree that the 944 repair did not involve simply replacing parts. It added a completely new procedure that entailed partial disassembly and, among other things, the placement of a sealant—PR-944—not previously called for by the specifications and drawings. Appellant also argues that the effort was wasted by the direction to remanufacture the transducers. The Navy offers little on the 944 repair.

The difficulty for the Navy with recovering for the 944 procedure is that the Navy has proved that defects existed from inadequate surface preparation which led to paint delamination and leaks associated with the paint (findings 47, 48, 92, 106). The 944 procedure had little to do with the proven defects and the remedial effect of the 944 procedure was in fact thwarted by the proven defects (findings 61, 62). Indeed, delaminating paint was observed after an initial successful test of the process and NSWC believed the delaminating paint described a leak path between the paint and the metal substrate (finding 57). Moreover, the use of the 944 process was schedule driven and

[24] R4, tab 2327, shows several transducers with s/ns above 19000. Although the videotape is of little probative value with respect to those transducers, there are no apparent paint or leakage issues.

effected in large measure because a new pigtail manufacturer could not be timely qualified (finding 56). In this regard, we believe the Navy has some obligation to establish that the 944 repair was in accordance with good industry practice. *Webb Electric Co. of Florida, Inc.*, ASBCA No. 23116, 79-1 BCA ¶ 13,742. The process described (findings 55-57) leaves the distinct impression of an improvised procedure that was continued in spite of the discovery of a leak path it could not cure. We hold the Navy has not proved that the 944 procedure constituted good industry practice. This failure of proof with respect to the 944 remedy applies whether the remedy is pursued as an exercise of warranty rights or under the Inspection clause and the Navy is not entitled to recover those costs.

ASBCA No. 52785

The Navy's claim includes costs of testing,[25] removal and transport of transducers, and failure analyses in 1997 (finding 109). Remanufacture was directed on 2 July 1997 (finding 64). As to 135 or so transducers in the range of serial numbers between 11115 and 13665 which were under warranty, the warranty clause covers the cost of relevant data and reports, and "costs reasonably incurred by the United States in taking such corrective action" (finding 12). We think the costs of testing, removal and transport and failure analysis up to the date of direction to remanufacture, 2 July 1997 were "reasonably incurred" (*id.*). We are not persuaded that the Navy is entitled to compensation for test and evaluation of fully remanufactured pigtails. We also consider any tests and failure analyses that continued after remanufacture was ordered in July 1997 to be extra-contractual. At the point when such tests and analyses were conducted the direction for repair had been given and was being implemented. We do not consider the Warranty clause, absent a specific provision (and there is none), to inferentially confer upon the government the right to continue testing at contractor expense after it has ordered a specific correction and the contractor has put that correction into practice. As the number of affected transducers is small and comment on other particulars could prove to be speculative, we think further cost issues under the Warranty clause are best left to the quantum phase.

As to the remainder of the 2,550 transducers covered only by the Inspection clause (hereinafter Inspection transducers), the Navy's remedies are to be found in that clause. As stated above, our holding with respect to the fundamental unsoundness of the 944 procedure applies equally to Inspection transducers. The 944 costs are not recoverable under the Inspection clause. Whether recovery for relevant data and reports is covered by (e)(2) of the Inspection clause is best left as a quantum issue. Transportation costs, including removal of Inspection transducers from ships, are allowable under the clause's

[25] The contracting officer's notice of indebtedness also refers to "investigation" (finding 109). We include that effort under testing.

provision for transportation costs in paragraph (l) ("[w]hen supplies are returned to the Contractor, the Contractor shall bear the transportation cost from the original point of delivery to the contractor's plant and return to the original point . . . .") Also recoverable under paragraph (e)(2) are costs of retesting ("the Contractor [may be charged] for any additional cost of inspection or test when prior rejection makes reinspection or test necessary"). Investigation of defects and related failure analysis not performed at appellant's plant are not recoverable pursuant to paragraph (d) ("the Government shall bear the expense of Government inspections or tests made at other than the Contractor's or subcontractor's premises").

While the Navy's claim includes costs incurred by the Navy for the remanufacture of some transducers that it remanufactured, we cannot conclude on this record whether any of those transducers fell within the 2,550 with latent surface preparation defects. If so, the Navy would be entitled to recover those costs, if reasonable, pursuant to paragraph (h) of the Inspection clause. *Costello Industries, Inc.*, ASBCA No. 28731, 89-3 BCA ¶ 22,090 at 111,088 ("since [these] were latent defects, the Government's post-acceptance rights . . . continued under the INSPECTION AND ACCEPTANCE clause of the contract."); *Jo-Bar Mfg. Corporation,* ASBCA No. 17774, 73-2 BCA ¶ 10,311 at 48,685.

To summarize, we hold that the Navy has established a latent defect in 2,550 transducers between serial numbers 11115 and 13665, specifically inadequate surface preparation of the transducer tubes leading to delamination and causing a leak path, entitling the Navy to remedies under the Inspection clause. Roughly 135 of that number are also covered by the Warranty clause. ASBCA No. 52785 is denied and the Navy's claim upheld, as applicable, to the extent indicated. ASBCA No. 52785 is otherwise sustained.

<u>ASBCA No. 52178 – The 944 Claim</u>

We understand appellant's 944 claim to include costs attributable to testing, removal and transport of transducers up to 2 July 1997, and relevant data and reports. To the extent we have upheld the Navy's affirmative claim in ASBCA No. 52785 with respect to testing, removal and transport of transducers up to 2 July 1997, and relevant data and reports, we deny ASBCA No. 52178. As to the remaining elements of the 944 claim, we hold for appellant for the reasons stated under the <u>Latent Defects</u> and <u>Warranty</u> sections *supra*. In so holding, we note that it will be incumbent upon appellant to prove that any costs claimed are the result of the Navy's direction to implement the 944 repair.

ASBCA No. 52784 – The Remanufacturing Claim

The underlying claim seeks recovery for remanufacturing transducers at the Navy's direction "from the paint on," and includes the 944 claim (findings 64, 110). We have held there was a latent defect (inadequate surface preparation) affecting 2,550 transducers, serial numbers 11115 through 13665. The claim is denied as to remanufacture of those 2,550 transducers. It is also denied with respect to the related costs (testing, etc.) included in the Navy claim and allowed as recoverable by the Navy in ASBCA No. 52785. To the extent the underlying claim includes the 944 claim, it is moot, as that claim is resolved by our holding in ASBCA No. 52178.

Appellant seeks recovery for so-called "science projects" and over-inspection as part of its claim. *See* findings 74-77. We view the allegations as principally setting forth the contention that manufacturing processes were disrupted and rendered inefficient by the government's actions. The problem with appellant's evidence is that it is largely anecdotal. There is no expert testimony to support this portion of the claim. There are no standards established against which the effects, if any, of the alleged interferences can be measured:

> It is a rare case where loss of productivity can be proven by books and records; almost always it has to be proven by the opinions of expert witnesses. However, the mere expression of an estimate as to the amount of productivity loss by an expert witness with nothing to support it will not establish the fundamental fact of resultant injury nor provide a sufficient basis for making a reasonably correct approximation of damages. See Wunderlich Contracting Co. v. United States, 351 F.2d 956, 968, 173 Ct.Cl. 180, 199 (1965).

Luria Brothers & Co. v. United States, 369 F.2d 701, 713 (Ct. Cl. 1966). Here, we do even have books and records. Moreover, the principal witnesses offered testimony not free of the pique which was a legacy of this rather drawn-out process. Appellant's claim for "science projects" and over-inspection fails for a lack of proof.

The appeal is moot with respect to the 944 claim and denied to the extent indicated above. ASBCA No. 52784 is otherwise sustained.

ASBCA No. 53699 – The Omnibus Claim

The claim underlying ASBCA No. 53699 is comprised of the claim in ASBCA No. 52784 (the Remanufacturing Claim) and appellant's claim for return of the payment of $8,331,844 (findings 116, 117). As we have already resolved the Remanufacturing Claim, that portion of ASBCA No. 53699 is moot. With respect to the rest of the claim for return of the payment underlying ASBCA No. 53699, the appeal is sustained except for amounts attributable to that portion of the Navy claim to which we have found the Navy entitled in our holding in ASBCA No. 52785, *supra*.

SUMMARY

ASBCA No. 52178 (the 944 claim) is sustained except to the extent, if any (*e.g.* failure analysis), it is affected by our holding on the Navy's claim in ASBCA No. 52785.

ASBCA No. 52784 is moot with respect to the 944 claim. It is denied as to the 2,550 transducers for which the Navy proved inadequate surface preparation. It is also denied to the extent we have upheld the Navy's claim in ASBCA No. 52785. It is also denied with respect to the "science projects" and over-inspection portions of the claim. It is otherwise sustained.

ASBCA No. 52785 is resolved as follows: we uphold the Navy's claim and deny the appeal with respect to the remanufacture of any of the 2,550 transducers from the 1992 contract between serial numbers 11115 and 13665 and certain related costs of testing, removal and transport of transducers up to 2 July 1997, and certain relevant data and reports in accordance with our discussion, *supra*. ASBCA No. 52875 is otherwise sustained and the Navy's claim denied.

ASBCA No. 53699 is moot in all respects save that portion arising from appellant's demand for return of payment made to the Navy, plus CDA interest. It is sustained in regard to that payment except for costs attributable to the part of the Navy's claim that we have upheld in our resolution of ASBCA No. 52785.

Dated: 8 November 2004

CARROLL C. DICUS, JR.
Administrative Judge
Armed Services Board
of Contract Appeals

(Signature continued)

I concur

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

I concur

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 Nos. 52178, 52784, 52785 and 53699, Appeals of Northrop Grumman Corporation, rendered in conformance with the Board's Charter.

Dated:

CATHERINE A STANTON
Recorder, Armed Services
Board of Contract Appeals