INEL
Idaho National Engineering Laboratory

May 18, 1988

Ms. C. M. Abbate
Vendor Inspection Branch
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

TRANSMITTAL OF FINAL REPORT ON TEST OF SAFETY/RELATED THREADED FASTENERS - TASK ORDER 88-4 (FIN A6181) - BLB-56-88

Ref: (a) R. D. Folker ltr to S. B. Milan, RFD-224-87, Transmittal of Revision 2 of the NRC Form 189 for Technical Assistance for Vendor Program Inspections (FIN A6181), October 1987
(b) Task Order 88-4 Project 1, "Test of Safety Related Threaded Fasteners", December 17, 1987

Dear Ms. Abbate:

In accordance with FIN A6181, Reference (a), EG&G Idaho, Inc. is providing technical assistance to the Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation. This assistance involves the evaluation of vendor-related problems with hardware supplied to the nuclear industry. Task Order 88-4, Reference (b), required technical assistance on testing 18 threaded fasteners from the Calvert Cliffs (16) and Rancho Seco (2) nuclear power plants.

The enclosed report satisfies the work scope requirements of Task Order 88-4 and EG&G Milestone Chart Node 144-52.

Results indicate that all fasteners tested were within the bounds of applicable specifications. Though the minor thread diameters for all Calvert Cliffs cap screws were less than specified, these cap screws were not rejectable because the specifications list this as a reference dimension and not a direct requirement.

EG&G Idaho, Inc. P.O. Box 1625 Idaho Falls, ID 83415

A/R

Note that not all of the requirements defined in the applicable ASTM Standards were evaluated. For example, process requirements for the fasteners were defined but not evaluated. The tests defined in the NRC Task Order were the tests that were accomplished.

Very truly yours,

B. L. Barnes, Manager
Reactor Inspections & Safeguards

jm

Enclosure:
As Stated

cc: H. E. Polk, NRC/NRR
J. O. Zane, EG&G Idaho (w/o Encl.)

TESTS OF SAFETY-RELATED THREADED FASTENERS FROM RANCHO SECO AND CALVERT CLIFFS NUCLEAR POWER PLANTS

1. INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, Vendor Inspection Branch submitted two (2) cap screws from Rancho Seco Nuclear Power Plant, and fourteen (14) cap screws and two (2) nuts from Calvert Cliffs Nuclear Power Plants to EG&G Idaho, Inc., for testing. This assignment was authorized and funded by Task Order 88-4, FIN A6181, Project 1. Previously submitted individual test reports for threaded fasteners are included as an attachment.

2. TESTING AND ANALYSIS

In order to determine the acceptance standards for each threaded fastener, the identification grade marks on each fastener (Figures 1 through 16) were correlated with the grade marks and related specifications identified in the Industrial Fastener Institute's Fastener Standards. The results of this correlation are presented in Table 1. The tests defined in the NRC Task Order were the only tests that were accomplished.

2.1 Mechanical Tests

Tensile and hardness tests were conducted in accordance with ASTM A-370, Mechanical Testing of Steel Products, or ASTM F606, Method for Conducting Tests to Determine the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers and Rivets, which are the standards for mechanical testing of steel fasteners. The specific tests required and the accept-reject criteria for each fastener were determined by reviewing the standard applicable to each grade of fastener.

2.1.1 Hardness Tests

Hardness tests were performed using a standard Rockwell hardness tester. Acceptable hardness machine performance was verified by performing hardness tests on certified test blocks prior to testing each fastener. A total of four hardness tests were performed on each fastener. The results are reported in either Rockwell C or Rockwell B scale units.

2.1.2 Tensile Tests

Tensile tests were accomplished at Detroit Testing Laboratories, Inc., in accordance with ASTM A-370 using a 125,000 pound load capacity, Tinius-Olsen tensile test machine. Extensometer load versus deflection values were automatically recorded and retained for each tensile test. Full-size specimens were tested in accordance with ASTM F-606. Proof and ultimate loads were determined and reported.

2.2 Chemical Analysis

Samples for chemical analysis were machined from each threaded fastener and the analysis was accomplished at National Spectrographics Laboratories. The specific elements required for product analysis are defined in the ASTM standard that is specified for each fastener, and only the results obtained for the required elements are reported in the individual fastener reports. The reproducibility of the chemical analyses results reported by National Spectrographics Laboratories were within ±5%.

2.3 Dimensional Inspection

Dimensional inspections were accomplished by EG&G Idaho, Inc., using a Kodak 20 magnification comparator. The results of the dimensional inspections are reported in Table 2. The procedures and acceptance criteria that are defined in ANSI B1.1, 1982 and ANSI B18.2.1, 1981 were used. Pitch diameters were determined by using wire gauges, and ring gauges were used to verify the class of the thread of the cap screws. Plug gauges were used to determine the class of threads for nuts.

The minimum minor diameters were less than the defined reference minor diameters for all Calvert Cliffs cap screws. Since the defined minimum minor diameters are reference dimensions, the cap screws are not rejectable. Examination of the thread root of the Calvert Cliffs cap screws at 20 magnifications, revealed comparatively small root truncations (radii) which explains the reason why acceptable pitch diameters were determined and the minimum minor diameters were less than the defined reference dimensions.

3. SUMMARY OF RESULTS

- Threaded Fasteners RS-A and RS-B meet the minimum evaluated requirements defined in ASTM A-193, Grade B-7.

- Threaded fasteners CC-C through CC-P meet the minimum evaluated requirements defined in ASTM A-449, Type 1.

- Threaded fasteners CC-Q and CC-R meet the minimum evaluated requirements defined in ASTM A-149, Grade 2H.

Table 1. Grade Marks and Required ASTM Standards for Fasteners Submitted for Evaluation

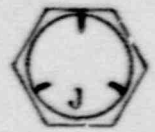
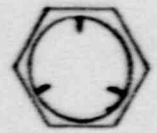
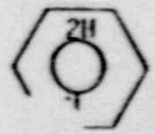
Sample Identification	Type	NRC Identification	Head Mark	Description Diameter-Threads Per Inch - Length	ASTM Standard
RS-A	Capscrew	RS-21		1 x 8 x 12	ASTM A-193 Grade B-7
RS-B	Capscrew	RS-22		1 x 8 x 12	ASTM A-193 Grade B-7
CC-C	Capscrew	CC-72-226		3/8 x 16 x 1	ASTM A-449 Type 1
CC-D	Capscrew	CC-72-226		3/8 x 16 x 1	ASTM A-449 Type 1
CC-E	Capscrew	CC-72-226		3/8 x 16 x 1	ASTM A-449 Type 1
CC-F	Capscrew	CC-72-226		3/8 x 16 x 1	ASTM A-449 Type 1
CC-G	Capscrew	CC-72-175		3/8 x 24 x 3	ASTM A-449 Type 1
CC-H	Capscrew	CC-72-175		3/8 x 24 x 3	ASTM A-449 Type 1
CC-I	Capscrew	CC-72-165		9/16 x 18 x 3	ASTM A-449 Type 1
CC-J	Capscrew	CC-72-218		5/16 x 18 x 1 1/4	ASTM A-449 Type 1
CC-K	Capscrew	CC-72-218		5/16 x 18 x 1 1/4	ASTM A-449 Type 1
CC-L	Capscrew	CC-72-218		5/16 x 18 x 1 1/4	ASTM A-449 Type 1
CC-M	Capscrew	CC-72-279		1/2 x 13 x 3	ASTM A-449 Type 1
CC-N	Capscrew	CC-72-279		1/2 x 13 x 3	ASTM A-449 Type 1
CC-P	Capscrew	CC-72-155/A		5/8 x 18 x 1	ASTM A-449 Type 1
CC-O	Capscrew	CC-72-155		5/8 x 18 x 1	ASTM A-449 Type 1
CC-Q	Nut	CC-SRI-445767		1 x 8	ASTM A-194 Grade 2H
CC-R	Nut	CC-SRI-445767		1 x 8	ASTM A-194 Grade 2H

Table 2. Dimensional Inspection (inch)

ID	Size	Overall Length	Threaded Length	Major Diameter	Minor Diameter	Minimum Reference* Minor Diameter	Class	Pitch Diameter By Wire Gauge Measurement
Cap screws								
RS-A	1 x 8 x 12	12.065	2.230	0.992	0.856	0.8446	II	0.9112
RS-B	1 x 8 x 12	12.000	2.30	0.992	0.830	0.8446	I	0.9072
CC-C	3/8 x 16 x 1	0.985	Fully threaded	0.3682-0.3685	0.2923	0.297	I	0.3281
CC-D	3/8 x 16 x 1	0.980	Fully threaded	0.3680-0.3685	0.2917	0.297	II	0.3293
CC-E	3/8 x 16 x 1	0.978	Fully threaded	0.3685-0.3688	0.2923	0.297	II	0.3295
CC-F	3/8 x 16 x 1	0.985	Fully threaded	0.3682-0.3688	0.2933	0.297	II	0.3292
CC-G	3/8 x 24 x 3	3.007	1.044	0.3692	0.3203	0.322	II	0.3435
CC-H	3/8 x 24 x 3	3.005	1.085	0.3698	0.3115	0.3228	I	0.3416
CC-I	9/16 x 18 x 3	2.950	1.440	0.559	0.488	0.4929	II	0.5220
CC-J	5/16 x 18 x 1-1/4	1.260	Fully threaded	0.3038-0.3052	0.2378	0.2431	I	0.2706
CC-K	5/16 x 18 x 1-1/4	1.250	Fully threaded	0.3048-0.3052	0.2372	0.2431	I	0.2709
CC-L	5/16 x 18 x 1-1/4	1.250	Fully threaded	0.3040-0.3048	0.2370	0.2431	I	0.2709
CC-M	1/2 x 13 x 3	3.006	1.2745	0.4825-0.4837	0.403	0.4041	II	0.4479
CC-N	1/2 x 13 x 3	3.014	1.310	0.494	0.402	0.4041	II	0.4466
CC-O	5/8 x 18 x 1	0.960	Fully threaded	0.618	0.549	0.5554	I	0.5816
CC-P	5/8 x 18 x 1	0.982	0.90	0.616	0.5475	0.5554	II	0.5844
Nuts								
CC-Q	1 x 8	(Class II fit determined with plug gauges)						
CC-R	1 x 8	(Class II fit determined with plug gauges)						

* ANSI B1.1.

Sample Identification: RS-A
Source: Rancho Seco
Sample Type: Bolt
Size: 1 x 8 x 12
Identification Grade Mark: B7
ASTM Standard: A-193 Grade B-7

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.37 - 0.49	0.41
Chromium - 0.75 - 1.20	0.91
Manganese - 0.65 - 1.10	0.79
Molybdenum - 0.15 - 0.25	0.22
Silicon - 0.15 - 0.35	0.23
Phosphorus - less than 0.035	0.008
Sulfur - less than 0.040	0.021
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile strength - 125 ksi	149.8 ksi
0.2% Offset yield strength - 105 ksi	138.8 ksi
Elongation - 16%	18%
Reduction in area - 50%	59%
Hardness	Rc 28-32

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-193 M86 Grade B7.

Sample Identification: RS-B
Source: Rancho Seco
Sample Type: Bolt
Size: 1 x 8 x 12
Identification Grade Mark: B7
ASTM Standard: A-193 Grade B-7

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.37 - 0.49	0.44
Chromium - 0.75 - 1.20	0.91
Manganese - 0.65 - 1.10	0.79
Molybdenum - 0.15 - 0.25	0.22
Silicon - 0.15 - 0.35	0.23
Phosphorus - less than 0.035	0.008
Sulfur - less than 0.040	0.022
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile strength - 125 ksi	148.1 ksi
0.2% Offset yield strength - 105 ksi	137.0 ksi
Elongation - 16%	18%
Reduction in area - 50%	59%
Hardness	Rc 28-30

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-193 M86 Grade B7.

Sample Identification: CC-C
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 16 x 1
Identification Grade Mark:
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.36
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.020
Sulfur - not more than 0.058	0.12
Boron - not controlled	less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 33-34

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-D
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 16 x 1
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.36
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.022
Sulfur - not more than 0.058	0.012
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 33-34

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-E
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 16 x 1
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.36
Manganese - not less than 0.57	0.74
Phosphorus - not more than 0.048	0.019
Sulfur - not more than 0.058	0.008
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 31-34

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-F
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 16 x 1
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.35
Manganese - not less than 0.57	0 75
Phosphorus - not more than 0.048	0.022
Sulfur - not more than 0.058	0.009
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specification	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 33-34

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-G
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 24 x 3
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.40
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.020
Sulfur - not more than 0.058	0.017
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 10,550 lbs	13,250 lbs
Proof load - 7,450 lbs	Acceptable
Hardness	Rc 32-34

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-H
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 3/8 x 24 x 3
Identification Grade Mark:

ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.38
Manganese - not less than 0.57	0.69
Phosphorus - not more than 0.048	0.028
Sulfur - not more than 0.058	0.018
Boron - not controlled	0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 10,550 lbs	12,250 lbs
Proof load - 7,450 lbs	Acceptable
Hardness	Rc 29-33

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-I
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 9/16 x 18 x 3
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.34
Manganese - not less than 0.57	0.74
Phosphorus - not more than 0.048	0.014
Sulfur - not more than 0.058	0.015
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 24,350 lbs	27,650 lbs
Proof load - 17,250 lbs	Acceptable
Hardness	Rc 30-31

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-J
Source. Calvert Cliff
Sample Type: Cap Screw
Size: 5/16 x 18 x 1-1/4
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.35
Manganese - not less than 0.57	0.72
Phosphorus - not more than 0.048	0.024
Sulfur - not more than 0.058	0.018
Boron - not controlled	less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 6,300 lbs	7,250 lbs
Proof load - 4,450 lbs	Acceptable
Hardness	Rc 26-29

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-K
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 5/16 x 18 x 1-1/4
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.34
Manganese - not less than 0.57	0.74
Phosphorus - not more than 0.048	0.026
Sulfur - not more than 0.058	0.018
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 6,300 lbs	7,250 lbs
Proof load - 4,450 lbs	Acceptable
Hardness	Rc 30-31

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-L
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 5/16 x 18 x 1-1/4
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.33
Manganese - not less than 0.57	0.77
Phosphorus - not more than 0.048	0.019
Sulfur - not more than 0.058	0.014
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 6,300 lbs	7,250 lbs
Proof load - 4,450 lbs	Acceptable
Hardness	Rc 29-31

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-M
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 1/2 x 13 x 3
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.35
Manganese - not less than 0.57	0.73
Phosphorus - not more than 0.048	0.016
Sulfur - not more than 0.058	0.019
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 17,050 lbs	22,000 lbs
Proof load - 12,050	Acceptable
Hardness	Rc 29-32

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-P
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 1/2 x 13 x 3
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.35
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.010
Sulfur - not more than 0.058	0.014
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Ultimate tensile load - 17,050 lbs	22,350 lbs
Proof load - 12,050 lbs	Acceptable
Hardness	Rc 32

Remarks:

Fastener meets the minimum evaluated requirements oefined in ASTM A-449-86 Type 1.

Sample Identification: CC-0
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 5/8 x 18 x 1
Identification Grade Mark: 
ASTM Standard: A-449 Type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.34
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.012
Sulfur - not more than 0.058	0.014
Boron - not controlled	0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 30-33

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-P
Source: Calvert Cliff
Sample Type: Cap Screw
Size: 5/8 x 18 x 1
Identification Grade Mark: 
ASTM Standard: A-449 type 1

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.25 - 0.58	0.43
Manganese - not less than 0.57	0.75
Phosphorus - not more than 0.048	0.030
Sulfur - not more than 0.058	0.024
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness Rockwell C 25-34	Rc 30-31

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-449-86 Type 1.

Sample Identification: CC-Q
Source: Calvert Cliffs
Sample Type: Nut
Size: 1 x 8
Identification Grade Mark: 
ASTM Standard: A-194 Grade 2H

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.40 minimum	0.43
Manganese - not controlled	0.70
Phosphorus - less than 0.040	0.028
Sulfur - less than 0.050	0.022
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness - Rockwell C 24-38	Rc 29-32

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-194-87.

Sample Identification: CC-R
Source: Calvert Cliffs
Sample Type: Nut
Size: 1 x 8
Identification Grade Mark: 
ASTM Standard: A 194 Grade 2H

CHEMICAL COMPOSITION (wt%)

ASTM Chemical Specifications	Actual Chemical Analysis Results
Carbon - 0.40 minimum	0.43
Manganese - not controlled	0.70
Phosphorus - less than 0.040	0.030
Sulfur - less than 0.050	0.020
Boron - not controlled	Less than 0.0005

MECHANICAL PROPERTIES

Minimum ASTM Mechanical Specifications	Actual Mechanical Measurements
Hardness - Rockwell C 24-38	Rc 29

Remarks:

Fastener meets the minimum evaluated requirements defined in ASTM A-194-87.

Figure 1. Photograph of Bolts RS-A and RS-B

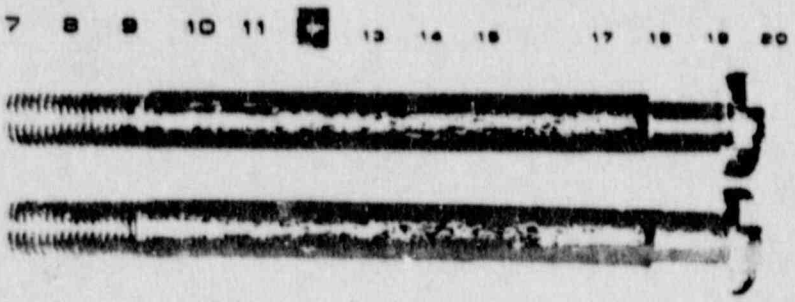


Figure 2. Photograph of Bolts RS-A and RS-B

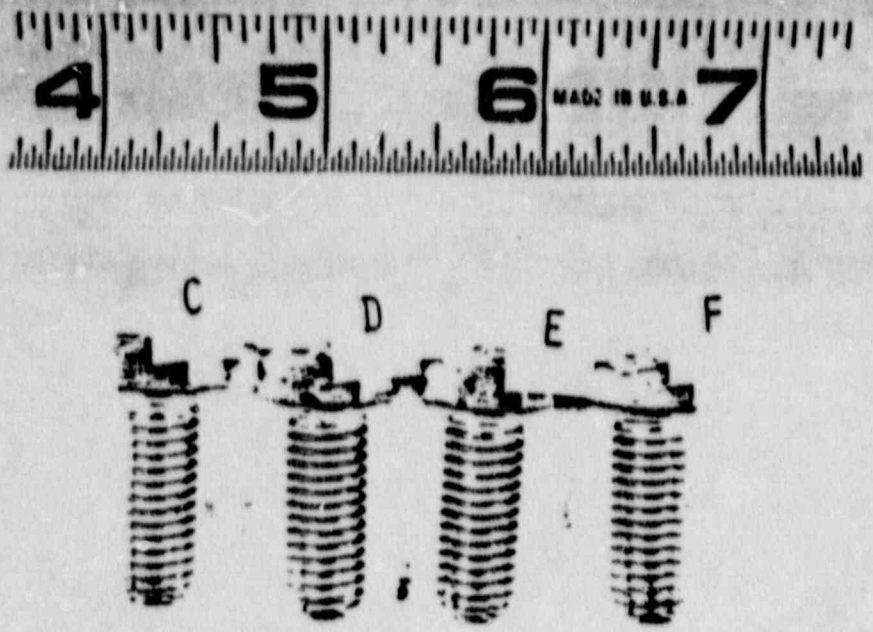


Figure 3. Photograph of capscrews CC-C through CC-F

Figure 4. Photograph of capscrews CC-C through CC-F

Figure 5. Photograph of capscrews CC-G and CC-H

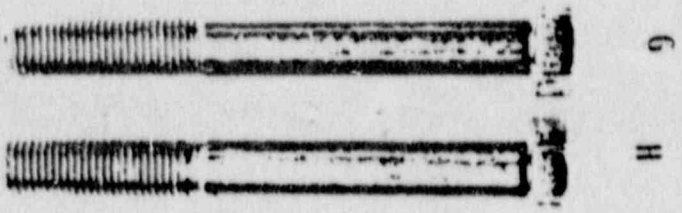


Figure 6. Photograph of capscrews CC-G and CC-H

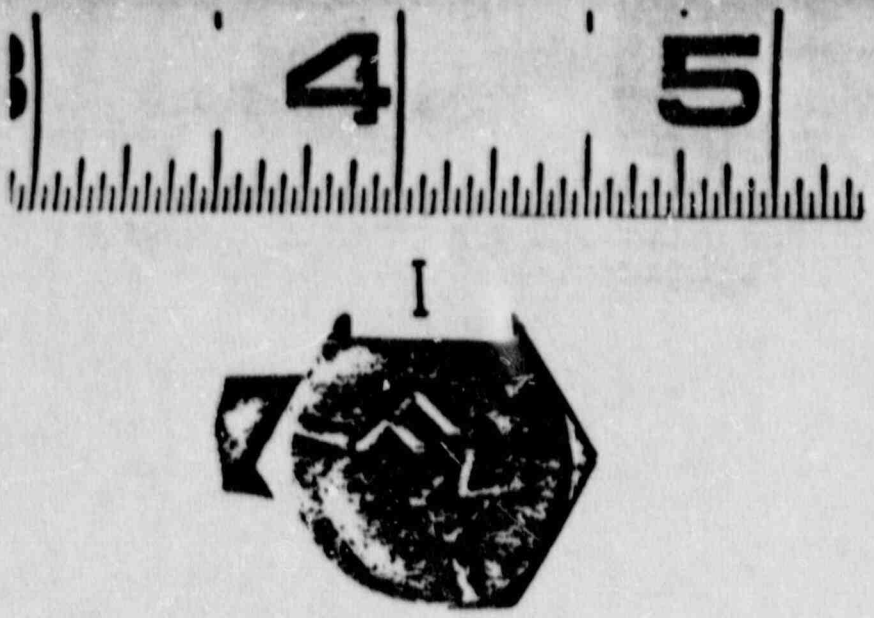


Figure 7. Photograph of capscrew CC-I

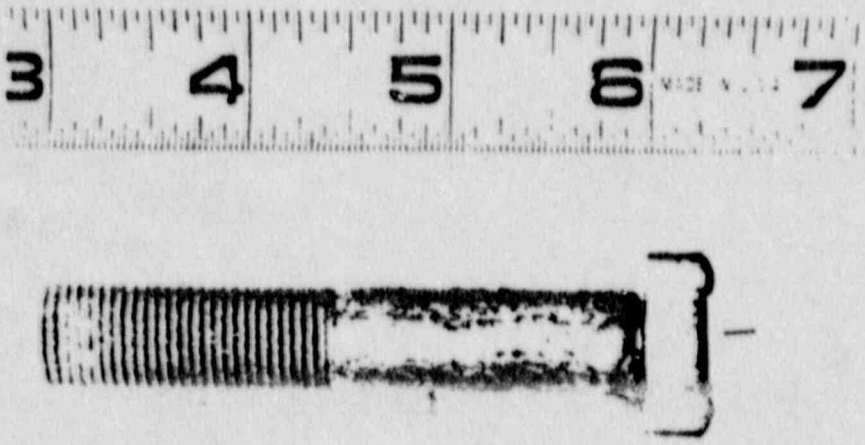


Figure 8. Photograph of capscrew CC-I

Figure 9. Photograph of capscrew CC-J through CC-L

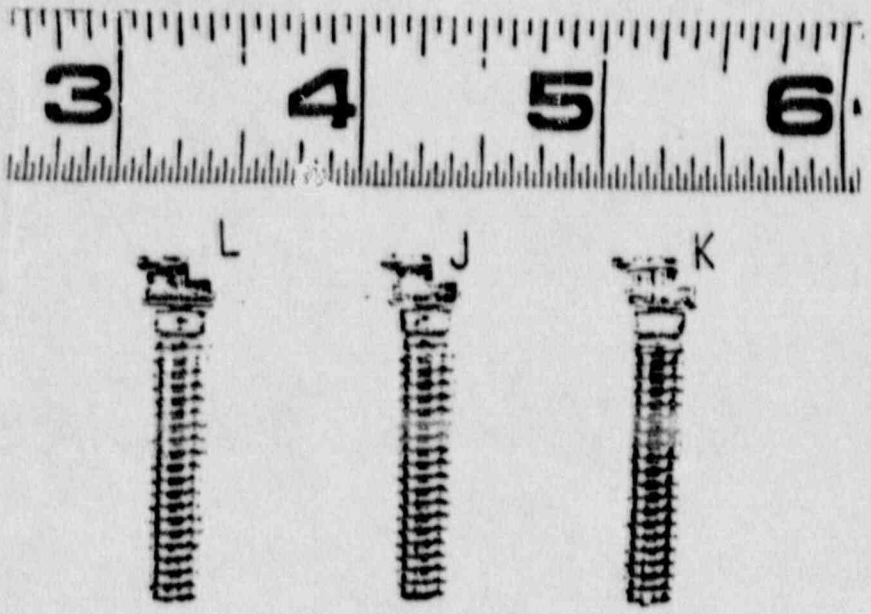


Figure 10. Photograph of capscrew CC-J through CC-L

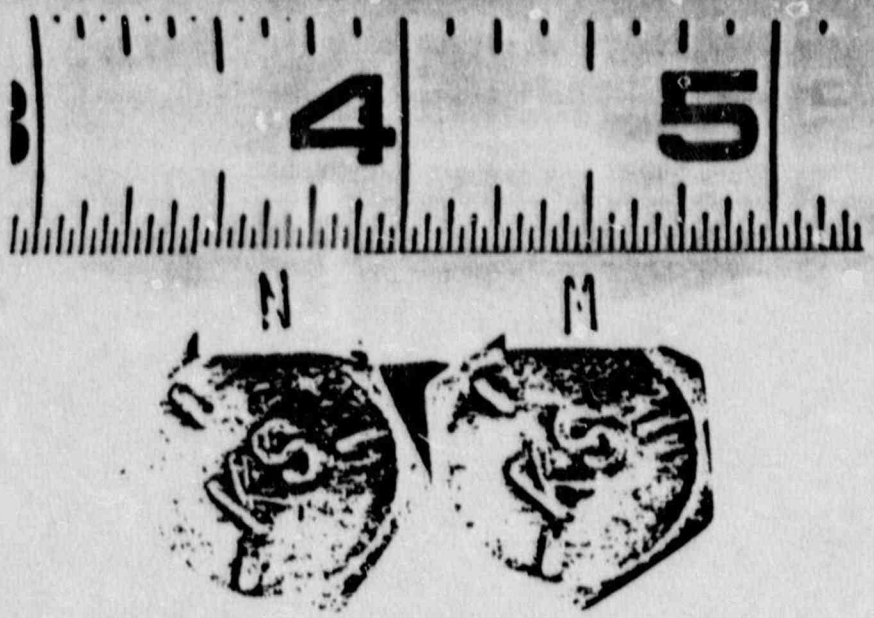


Figure 11. Photograph of capscrews CC-M and CC-N

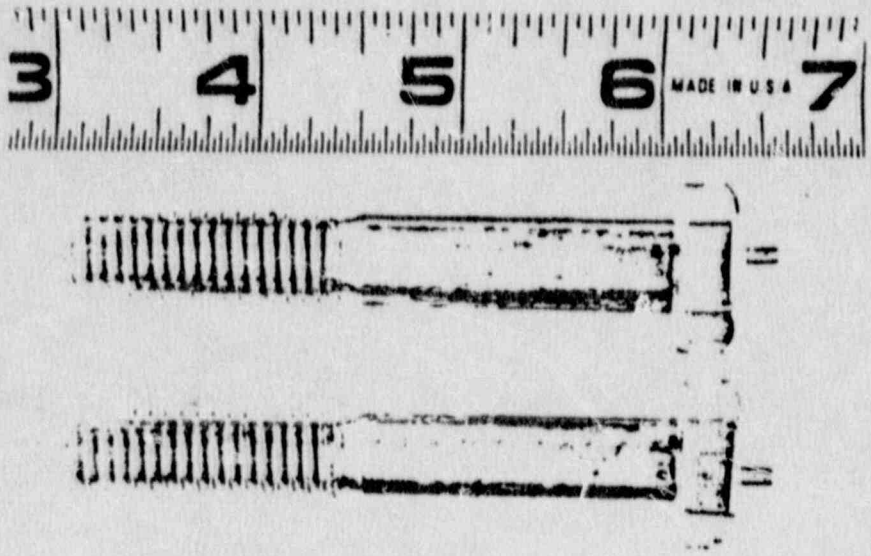


Figure 12. Photograph of capscrews CC-M and CC-N

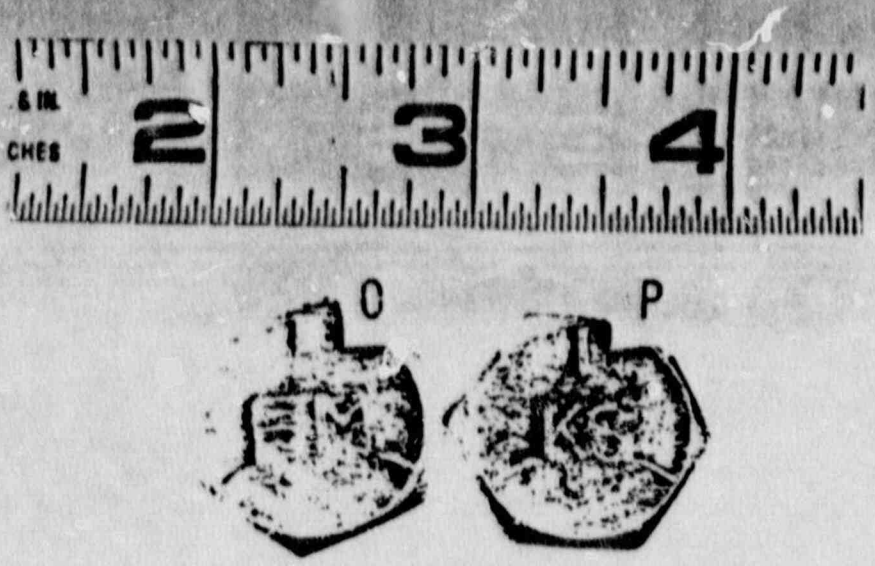


Figure 13. Photograph of capscrews CC-O and CC-P

Figure 14. Photograph of capscrews CC-O and CC-P

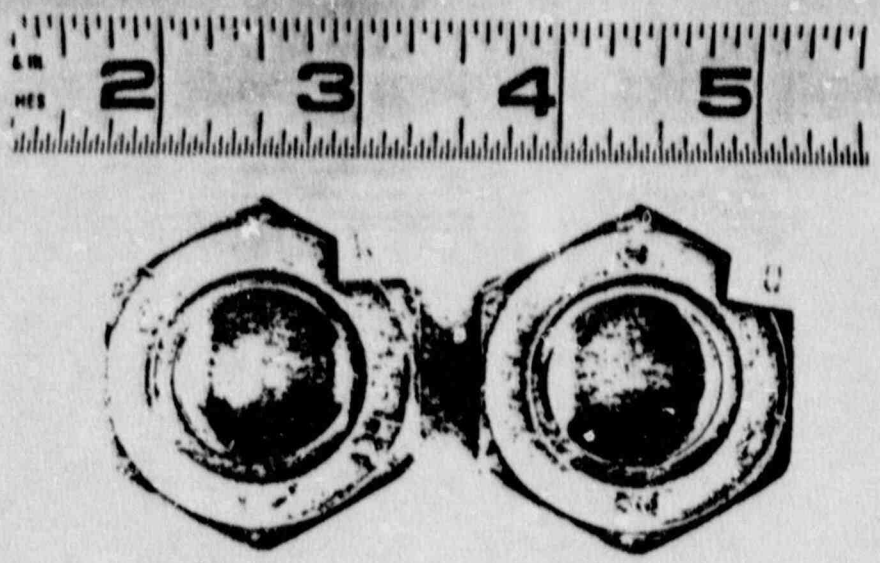


Figure 15. Photograph of nuts CC-Q and CC-R

Figure 16. Photograph of nuts CC-Q and CC-R