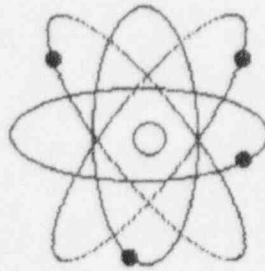


# ATTACHMENT 4

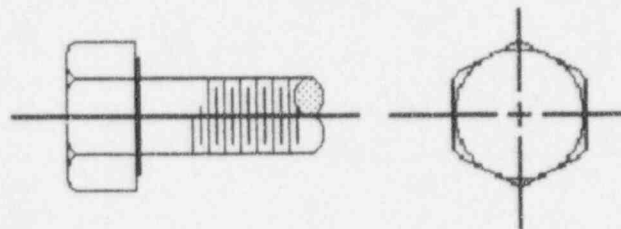
## CALLAWAY PLANT BOLTING MANUAL

A240.0079



# CALLAWAY PLANT

## BOLTING MANUAL



REVISION 2



# BOLTING MANUAL INDEX

<u>SECTION</u>	<u>PAGE NUMBER</u>	<u>REVISION NUMBER</u>
1.0 TORQUE TABLES	1	1
1.1 General Information	4	
1.2 Tolerances	5	
1.3 Pipe Flange Joints	7	
1.4 Capscrews (A-574)	14	
1.5 Metal to Metal Joints	16	
2.0 LUBRICATION	1	1
2.1 Approved Lubricants and Penetrating Oils	4	
2.2 Fel-Pro Lubricants	4	
2.3 Lubricant Application Instructions	5	
3.0 MARKINGS	1	0
3.1 Pictorial Index	4	
3.2 SAE & ASTM Equivalents	10	
3.3 SAME & ASTM Requirements	11	
4.0 STOCK NUMBERS	1	1
4.1 Disclaimer	4	
4.2 Type & Grade of Commonly Used Fasteners	5	
4.3 Type & Grade of Nut that should be used for a Given Type of Bolt/Stud	7	
4.4 Nut Material Equivalency Matrix	8	
4.5 Definitions for Notes	9	
4.6 Flanged Joint Configurations	11	
4.7 Bolts & Screws	23	
4.8 Studs	39	
4.9 Nuts	50	
4.10 Washers	61	
5.0 STRUCTURAL	1	1
5.1 Turn of the Nut Procedure	4	
5.2 Crush Washers	4	
5.3 General Information for Structural Connections	5	
6.0 WASHERS	1	1
6.1 Use of Disc Spring (Bellville) Washers	4	
6.2 Using Hardened Washers	7	
6.3 Plain, Carbon Steel Washers	7	
7.0 GENERAL FASTENER INFORMATION	1	1
7.1 Steps for the Minimization of Leaks	4	
7.2 Hardness to Tensile Strength Equivalency Chart	6	
7.3 Misc. Bolt, Stud, Nut, Washer and Cap Screw Dimensions	7	

8.0	SPECIAL TOOLS AND EQUIPMENT FOR BOLTING	1	0
8.1	Ultrasonic Extensometer	4	
9.0	PLANT POLICIES AND REFERENCES	1	0
9.1	Thread Engagement Policy	4	
9.2	Preferred References	5	

DATE: 8/11/95  
REV. 1

## DESCRIPTION OF ADDITION/REVISION

1. Add warning in Section 1.1 so that users are aware of the requirements when screwing into a tapped hole.
2. Add Figure 1-1 to Section 1.1.

## REASON/JUSTIFICATION FOR ADDITION/REVISION

1. The warning note was added to ensure that users obtain the proper information for NED evaluation when screwing into tapped holes. The intent is that users will not consider the torque tables applicable to screws in tapped holes.
2. Figure 1-1 was added to aid users in the proper bolt tightening sequence.

## SOURCES OF ADDITION/REVISION INFORMATION

1. The torque values derived in RFR# 8484A were based on known nut and bolt materials. As shown in Section 4.3, certain nut materials should be used for given bolt materials. When screwing a given bolt type and grade into a tapped hole, if the base material is not equivalent to the recommended nut material, the torque values in Section 1.0 may not be correct.
2. "Good Bolting Practices", Union Electric training course manual.

(use extra pages if necessary)

# BOLTING MANUAL

DATE: 8/11/95  
REV. 1

☒ Revision    ☐ Addition

Remove all 51 pages of Section 1.0, revision 0.

Replace with new revision 1 of Section 1.0, (51 pages total).

(use extra pages if necessary)

Page 3 of 51

NOTES FOR TORQUE TABLES

## 1.1 GENERAL INFORMATION:

- **WARNING:** If screwing into a tapped hole, the base material and the number of threads of engagement must be known to ensure applicability of torque tables. Consult with NED when screwing into a tapped hole.
- The torque values shown in Section 1.3 are for use with pipe flanges and are only applicable when using the following specifications and grades of bolts and/or studs: (S)A-193 Gr. B7 and (S)A-564 Gr. 630 all with (S)A-194 nuts.
- Level 1 torque values are defined as the recommended normal (minimum) torque values that are to be applied to minimize leakage. Level 2 values are the maximum values that may be used without an Engineering evaluation if Level 1 values need to be increased. Values between Level 1 and Level 2 may be selected as required.
- For the lubricated torque values shown in Section 1 of this Manual, see Section 2 for application instructions and a list of approved lubricants at Callaway.
- For critical or safety-related joints (i.e., joints in high radiation areas or pipes containing radioactive fluid, gas, etc.), the bolts should be tightened in a crossing pattern in a minimum of six passes with the third and sixth pass in the reverse direction. During each pass, tighten the bolts an even amount of their final value. Make additional passes, until all bolts have reached their final value (See Table 1-1 and Figure 1-1). For these applications, it is recommended that the torque values and any relevant comments be recorded with the work request for future reference. For convenience, Figure 1-2 has been provided to record this relevant information.

EXAMPLE: Required Final Torque = 2000 ft-lb on 8-bolt flange

Pass Number	Applied Torque	Comments
1	330	Forward
2	660	Forward
3	990	Reverse
4	1320	Forward
5	1650	Forward
6	2000	Reverse
7	2000	Forward
8	2000	Reverse

TABLE 1-1

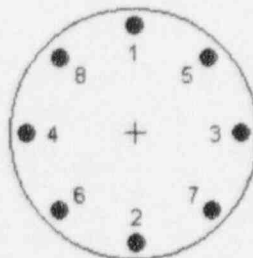


FIGURE 1-1

- Rubber Gaskets:

The torque values shown in Section 1.3 through 1.5 are not to be used on flanges with rubber gaskets. When using rubber gaskets, make sure the connection is tightened evenly. After tightening, the gasket compression should be 1/4 to 1/2 the original gasket thickness.

- Non-Metallic Flat Gaskets (i.e., Garlock, Grafoil, etc.):

The minimum torque value shown in Section 1.3 should be used on flanges with non-metallic flat gaskets. If necessary, the torque value may be increased to 90% of bolt yield as shown in Section 1.5.

## 1.2 TOLERANCES:

- The torque wrench should be set as close as practical to the required torque value.
- A nominal variation of -5% of Level 1 values up to +5% of Level 2 values is acceptable without Engineering approval if all nuts are tightened equally.
- Do not adjust the torque table values to compensate for the tolerances stated above.



DATE: 8/11/95

REV. 1

**FIGURE 1-2  
(TORQUE SHEET)**

Flange: \_\_\_\_\_

No. of Bolts/Studs \_\_\_\_\_

Valve: \_\_\_\_\_

Other: \_\_\_\_\_

Pass Number	Applied Torque (ft-lb)*	Forward/Reverse	Comments
1		Forward	
2		Forward	
3		Reverse	
4		Forward	
5		Forward	
6		Reverse	
7		Forward	
8		Reverse	

\* REQUIRED FINAL TORQUE = \_\_\_\_\_ ft-lb  $\div$  6 = \_\_\_\_\_ ft-lb.

(This is the torque for the first pass and the subsequent incremental torques).

SECTION 1.3  
TORQUE TABLE COVER PAGE  
FOR  
PIPE FLANGE JOINTS

## TORQUE TABLES FOR 150# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE SIZE I.N.	LUBED	
	LEVEL 1 TORQUE FT-LB	LEVEL 2 TORQUE FT-LB
0.50	50	65
0.75	50	65
1.00	55	70
1.25	55	75
1.50	60	80
2.00	100	140
2.50	115	145
3.00	150	175
3.50	95	120
4.00	120	160
5.00	175	250
6.00	250	300
8.00	260	310
10.00	335	450
12.00	440	500
14.00	570	700
16.00	575	710
18.00	930	1060
20.00	820	935
24.00	1180	1400

## TORQUE TABLES FOR 300# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE SIZE I.N.	LUBED	
	LEVEL 1 TORQUE FT-LB	LEVEL 2 TORQUE FT-LB
0.50	50	65
0.75	80	100
1.00	85	105
1.25	85	105
1.50	140	175
2.00	80	100
2.50	140	175
3.00	140	175
3.50	160	210
4.00	185	245
5.00	210	280
6.00	210	280
8.00	340	480
10.00	380	500
12.00	560	745
14.00	500	685
16.00	785	965
18.00	875	1135
20.00	960	1225
24.00	1565	1900

## TORQUE TABLES FOR 600# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE  SIZE I.N.	LUBED	
	LEVEL 1	LEVEL 2
	TORQUE FT-LB	TORQUE FT-LB
0.50	50	65
0.75	80	105
1.00	85	110
1.25	85	105
1.50	140	175
2.00	80	110
2.50	140	180
3.00	160	210
3.50	310	370
4.00	340	400
5.00	465	595
6.00	465	595
8.00	685	870
10.00	790	1050
12.00	875	1050
14.00	950	1190
16.00	1400	1725
18.00	1810	2220
20.00	1620	2020
24.00	2535	3170

## TORQUE TABLES FOR 900# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

## BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE SIZE I.N.	LUBED	
	LEVEL 1 TORQUE FT-LB	LEVEL 2 TORQUE FT-LB
0.50	140	175
0.75	140	175
1.00	225	285
1.25	225	285
1.50	335	425
2.00	225	285
2.50	335	425
3.00	280	340
3.50	315	400
4.00	500	620
5.00	700	875
6.00	560	685
8.00	950	1185
10.00	950	1185
12.00	1065	1300
14.00	1250	1565
16.00	1615	2020
18.00	2535	3170
20.00	3100	3880
24.00	6220	7770

TORQUE TABLES FOR 1500# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE SIZE I.N.	LEVEL 1 TORQUE FT-LB	LUBED LEVEL 2 TORQUE FT-LB
0.50	140	175
0.75	140	175
1.00	225	285
1.25	225	285
1.50	335	425
2.00	225	285
2.50	335	425
3.00	500	620
3.50	500	620
4.00	700	875
5.00	1250	1565
6.00	950	1185
8.00	1615	2020
10.00	2535	3170
12.00	3100	3880
14.00	4480	5600
16.00	6220	7770

## TORQUE TABLES FOR 2500# RAISED FACE FLANGES USING

(S)A-193 GR.B7 and (S)A-564 GR.630

BOLTS/STUDS WITH SPIRAL WOUND TYPE CG GASKET

NOMINAL PIPE SIZE I.N.	LUBED	
	LEVEL 1 TORQUE FT-LB	LEVEL 2 TORQUE FT-LB
0.50	150	175
0.75	150	175
1.00	225	285
1.25	335	425
1.50	500	620
2.00	335	425
2.50	500	620
3.00	700	875
3.50	700	875
4.00	1250	1565
5.00	2040	2550
6.00	3100	3880
8.00	3100	3880
10.00	6220	7770
12.00	8000	10000



TORQUE TABLE COVER PAGE  
FOR  
METAL TO METAL JOINTS  
(S)A-453

DATA FOR (S)A-453 GR 660 BOLTS OR STUDS  
FOR METAL TO METAL JOINTS.PERCENT YIELD = 40 %  
BOLT STRESS = 34000 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	4.5	3.6
0.375	17.2	13.7
0.500	40.2	32.2
0.625	80.0	64.0
0.750	142.1	113.7
0.875	228.9	183.2
1.000	343.3	274.6
1.125	503.9	403.1
1.250	708.1	566.5
1.375	961.1	768.9
1.500	1268.1	1014.5
1.625	1634.2	1307.4
1.750	2064.8	1651.8
1.875	2565.0	2052.0
2.000	3140.1	2512.0
2.125	3795.2	3036.1
2.250	4535.6	3628.4
2.375	5366.4	4293.2
2.500	6293.0	5034.4

PERCENT YIELD = 45 %  
BOLT STRESS = 38250 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	5.1	4.1
0.375	19.3	15.5
0.500	45.2	36.2
0.625	90.0	72.0
0.750	159.9	127.9
0.875	257.6	206.0
1.000	386.2	308.9
1.125	566.9	453.5
1.250	796.6	637.3
1.375	1081.2	865.0
1.500	1426.6	1141.3
1.625	1838.5	1470.8
1.750	2322.9	1858.3
1.875	2885.6	2308.5
2.000	3532.6	2826.1
2.125	4269.6	3415.7
2.250	5102.5	4082.0
2.375	6037.2	4829.8
2.500	7079.7	5663.7

DATE: 8/11/95Rev. 1

PERCENT YIELD = 50 %  
 BOLT STRESS = 42500 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	5.6	4.5
0.375	21.5	17.2
0.500	50.3	40.2
0.625	100.1	80.0
0.750	177.7	142.1
0.875	286.2	228.9
1.000	429.1	343.3
1.125	629.9	503.9
1.250	885.2	708.1
1.375	1201.4	961.1
1.500	1585.1	1268.1
1.625	2042.8	1634.2
1.750	2581.0	2064.8
1.875	3206.3	2565.0
2.000	3925.1	3140.1
2.125	4744.0	3795.2
2.250	5669.5	4535.6
2.375	6708.1	5366.4
2.500	7866.3	6293.0

PERCENT YIELD = 55 %  
 BOLT STRESS = 46750 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	6.2	5.0
0.375	23.6	18.9
0.500	55.3	44.2
0.625	110.1	88.0
0.750	195.5	156.4
0.875	314.8	251.8
1.000	472.0	377.6
1.125	692.9	554.3
1.250	973.7	778.9
1.375	1321.5	1057.2
1.500	1743.6	1394.9
1.625	2247.1	1797.7
1.750	2839.1	2271.3
1.875	3526.9	2821.5
2.000	4317.6	3454.1
2.125	5218.4	4174.7
2.250	6236.4	4989.1
2.375	7378.9	5903.1
2.500	8652.9	6922.3

PERCENT YIELD = 60 %  
BOLT STRESS = 51000 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	6.8	5.4
0.375	25.8	20.6
0.500	60.3	48.2
0.625	120.1	96.1
0.750	213.2	170.6
0.875	343.4	274.7
1.000	514.9	411.9
1.125	755.9	604.7
1.250	1062.2	849.8
1.375	1441.7	1153.3
1.500	1902.1	1521.7
1.625	2451.3	1961.1
1.750	3097.2	2477.8
1.875	3847.5	3078.0
2.000	4710.1	3768.1
2.125	5692.8	4554.2
2.250	6803.3	5442.7
2.375	8049.7	6439.7
2.500	9439.5	7551.6

PERCENT YIELD = 65 %  
BOLT STRESS = 55250 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	7.3	5.9
0.375	27.9	22.3
0.500	65.3	52.3
0.625	130.1	104.1
0.750	231.0	184.8
0.875	372.0	297.6
1.000	557.8	446.2
1.125	818.9	655.1
1.250	1150.7	920.6
1.375	1561.8	1249.4
1.500	2060.6	1648.5
1.625	2655.6	2124.5
1.750	3355.3	2684.2
1.875	4168.1	3334.5
2.000	5102.6	4082.1
2.125	6167.2	4933.7
2.250	7370.3	5896.2
2.375	8720.5	6976.4
2.500	10226.2	8180.9

PERCENT YIELD = 70 %  
BOLT STRESS = 59500 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	7.9	6.3
0.375	30.1	24.1
0.500	70.4	56.3
0.625	140.1	112.1
0.750	248.8	199.0
0.875	400.7	320.5
1.000	600.7	480.6
1.125	881.9	705.5
1.250	1239.2	991.4
1.375	1681.9	1345.5
1.500	2219.1	1775.3
1.625	2859.9	2287.9
1.750	3613.4	2890.7
1.875	4488.8	3591.0
2.000	5495.1	4396.1
2.125	6641.6	5313.2
2.250	7937.2	6349.8
2.375	9391.3	7513.0
2.500	11012.8	8810.2

PERCENT YIELD = 75 %  
BOLT STRESS = 63750 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	8.5	6.8
0.375	32.2	25.8
0.500	75.4	60.3
0.625	150.1	120.1
0.750	266.5	213.2
0.875	429.3	343.4
1.000	643.6	514.9
1.125	944.8	755.9
1.250	1327.7	1062.2
1.375	1802.1	1441.7
1.500	2377.6	1902.1
1.625	3064.2	2451.3
1.750	3871.5	3097.2
1.875	4809.4	3847.5
2.000	5887.6	4710.1
2.125	7115.9	5692.8
2.250	8504.2	6803.3
2.375	10062.1	8049.7
2.500	11799.4	9439.5

DATE: 8/11/95Rev. 1

PERCENT YIELD = 80 %  
 BOLT STRESS = 68000 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	9.0	7.2
0.375	34.4	27.5
0.500	80.4	64.3
0.625	160.1	128.1
0.750	284.3	227.4
0.875	457.9	366.3
1.000	686.5	549.2
1.125	1007.8	806.3
1.250	1416.3	1133.0
1.375	1922.2	1537.8
1.500	2536.1	2028.9
1.625	3268.5	2614.8
1.750	4129.6	3303.7
1.875	5130.0	4104.0
2.000	6280.1	5024.1
2.125	7590.3	6072.3
2.250	9071.1	7256.9
2.375	10732.9	8586.3
2.500	12586.1	10068.8

PERCENT YIELD = 85 %  
 BOLT STRESS = 72250 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	9.6	7.7
0.375	36.5	29.2
0.500	85.4	68.3
0.625	170.1	136.1
0.750	302.1	241.6
0.875	486.5	389.2
1.000	729.4	583.5
1.125	1070.8	856.7
1.250	1504.8	1203.8
1.375	2042.3	1633.9
1.500	2694.6	2155.7
1.625	3472.7	2778.2
1.750	4387.7	3510.2
1.875	5450.6	4360.5
2.000	6672.6	5338.1
2.125	8064.7	6451.8
2.250	9638.1	7710.5
2.375	11403.7	9123.0
2.500	13372.7	10698.2

DATE: 8/11/95Rev. 1

PERCENT YIELD = 90 %  
 BOLT STRESS = 76500 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	10.1	8.1
0.375	38.7	30.9
0.500	90.5	72.4
0.625	180.1	144.1
0.750	319.8	255.9
0.875	515.1	412.1
1.000	772.3	617.9
1.125	1133.8	907.0
1.250	1593.3	1274.6
1.375	2162.5	1730.0
1.500	2853.2	2282.5
1.625	3677.0	2941.6
1.750	4645.8	3716.6
1.875	5771.3	4617.0
2.000	7065.1	5652.1
2.125	8539.1	6831.3
2.250	10205.0	8164.0
2.375	12074.5	9659.6
2.500	14159.3	11327.5

PERCENT YIELD = 95 %  
 BOLT STRESS = 80750 PSI

(S)A-453 GR 660

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	10.7	8.6
0.375	40.8	32.6
0.500	95.5	76.4
0.625	190.1	152.1
0.750	337.6	270.1
0.875	543.7	435.0
1.000	815.2	652.2
1.125	1196.8	957.4
1.250	1681.8	1345.4
1.375	2282.6	1826.1
1.500	3011.7	2409.3
1.625	3881.3	3105.0
1.750	4903.9	3923.1
1.875	6091.9	4873.5
2.000	7457.6	5966.1
2.125	9013.5	7210.8
2.250	10772.0	8617.6
2.375	12745.3	10196.2
2.500	14945.9	11956.8



TORQUE TABLE COVER PAGE  
FOR  
METAL TO METAL JOINTS  
(S)A-564



DATA FOR (S)A-564 GR 630 BOLTS OR STUDS  
 FOR METAL TO METAL JOINTS.

PERCENT YIELD = 40 %  
 BOLT STRESS = 46000 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	6.1	4.9
0.375	23.2	18.6
0.500	54.4	43.5
0.625	108.3	86.6
0.750	192.3	153.9
0.875	309.7	247.8
1.000	464.4	371.5
1.125	681.8	545.4
1.250	958.1	766.4
1.375	1300.3	1040.3
1.500	1715.6	1372.5
1.625	2211.0	1768.8
1.750	2793.6	2234.8
1.875	3470.3	2776.2
2.000	4248.3	3398.7
2.125	5134.6	4107.7
2.250	6136.3	4909.1
2.375	7260.5	5808.4
2.500	8514.1	6811.3

PERCENT YIELD = 45 %  
 BOLT STRESS = 51750 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	6.9	5.5
0.375	26.2	20.9
0.500	61.2	49.0
0.625	121.8	97.5
0.750	216.4	173.1
0.875	348.5	278.8
1.000	522.5	418.0
1.125	767.0	613.6
1.250	1077.8	862.2
1.375	1462.9	1170.3
1.500	1930.1	1544.1
1.625	2487.4	1989.9
1.750	3142.8	2514.2
1.875	3904.1	3123.3
2.000	4779.4	3823.5
2.125	5776.5	4621.2
2.250	6903.4	5522.7
2.375	8168.0	6534.4
2.500	9578.4	7662.7

PERCENT YIELD = 50 %  
 BOLT STRESS = 57500 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	7.6	6.1
0.375	29.1	23.2
0.500	68.0	54.4
0.625	135.4	108.3
0.750	240.4	192.3
0.875	387.2	309.7
1.000	580.5	464.4
1.125	852.2	681.8
1.250	1197.6	958.1
1.375	1625.4	1300.3
1.500	2144.5	1715.6
1.625	2763.8	2211.0
1.750	3491.9	2793.6
1.875	4337.9	3470.3
2.000	5310.4	4248.3
2.125	6418.3	5134.6
2.250	7670.4	6136.3
2.375	9075.6	7260.5
2.500	10642.6	8514.1

PERCENT YIELD = 55 %  
 BOLT STRESS = 63250 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	8.4	6.7
0.375	32.0	25.6
0.500	74.8	59.8
0.625	148.9	119.1
0.750	264.4	211.5
0.875	425.9	340.7
1.000	638.6	510.8
1.125	937.4	749.9
1.250	1317.3	1053.9
1.375	1787.9	1430.3
1.500	2359.0	1887.2
1.625	3040.1	2432.1
1.750	3841.1	3072.9
1.875	4771.7	3817.3
2.000	5841.4	4673.1
2.125	7060.1	5648.1
2.250	8437.5	6750.0
2.375	9983.2	7986.5
2.500	11706.9	9365.5

PERCENT YIELD = 60 %  
 BOLT STRESS = 69000 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	9.1	7.3
0.375	34.9	27.9
0.500	81.6	65.3
0.625	162.4	130.0
0.750	288.5	230.8
0.875	464.6	371.7
1.000	696.6	557.3
1.125	1022.7	818.1
1.250	1437.1	1149.7
1.375	1950.5	1560.4
1.500	2573.4	2058.7
1.625	3316.5	2653.2
1.750	4190.3	3352.3
1.875	5205.5	4164.4
2.000	6372.5	5098.0
2.125	7702.0	6161.6
2.250	9204.5	7363.6
2.375	10890.7	8712.6
2.500	12771.2	10216.9

PERCENT YIELD = 65 %  
 BOLT STRESS = 74750 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	9.9	7.9
0.375	37.8	30.2
0.500	88.4	70.7
0.625	176.0	140.8
0.750	312.5	250.0
0.875	503.3	402.7
1.000	754.7	603.7
1.125	1107.9	886.3
1.250	1556.8	1245.5
1.375	2113.0	1690.4
1.500	2787.9	2230.3
1.625	3592.9	2874.3
1.750	4539.5	3631.6
1.875	5639.2	4511.4
2.000	6903.5	5522.8
2.125	8343.8	6675.0
2.250	9971.6	7977.3
2.375	11798.3	9438.6
2.500	13835.4	11068.3

DATE: 8/11/95Rev. 1

PERCENT YIELD = 70 %  
 BOLT STRESS = 80500 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	10.7	8.5
0.375	40.7	32.5
0.500	95.2	76.2
0.625	189.5	151.6
0.750	336.6	269.2
0.875	542.1	433.6
1.000	812.7	650.2
1.125	1193.1	954.5
1.250	1676.6	1341.3
1.375	2275.6	1820.4
1.500	3002.3	2401.9
1.625	3869.3	3095.4
1.750	4888.7	3911.0
1.875	6073.0	4858.4
2.000	7434.6	5947.6
2.125	8985.6	7188.5
2.250	10738.6	8590.9
2.375	12705.8	10164.7
2.500	14899.7	11919.7

PERCENT YIELD = 75 %  
 BOLT STRESS = 86250 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	11.4	9.1
0.375	43.6	34.9
0.500	102.0	81.6
0.625	203.0	162.4
0.750	360.6	288.5
0.875	580.8	464.6
1.000	870.8	696.6
1.125	1278.3	1022.6
1.250	1796.3	1437.1
1.375	2438.1	1950.5
1.500	3216.8	2573.4
1.625	4145.7	3316.5
1.750	5237.9	4190.3
1.875	6506.8	5205.5
2.000	7965.6	6372.5
2.125	9627.5	7702.0
2.250	11505.7	9204.5
2.375	13613.4	10890.7
2.500	15963.9	12771.1

## BOLTING MANUAL

DATE: 8/11/95Rev. 1

PERCENT YIELD = 80 %  
 BOLT STRESS = 92000 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	12.2	9.8
0.375	46.5	37.2
0.500	108.8	87.0
0.625	216.6	173.3
0.750	384.6	307.7
0.875	619.5	495.6
1.000	928.8	743.0
1.125	1363.5	1090.8
1.250	1916.1	1532.9
1.375	2600.6	2080.5
1.500	3431.2	2745.0
1.625	4422.0	3537.6
1.750	5587.1	4469.7
1.875	6940.6	5552.5
2.000	8496.6	6797.3
2.125	10269.3	8215.4
2.250	12272.7	9818.2
2.375	14521.0	11616.8
2.500	17028.2	13622.6

PERCENT YIELD = 85 %  
 BOLT STRESS = 97750 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	13.0	10.4
0.375	49.4	39.5
0.500	115.6	92.5
0.625	230.1	184.1
0.750	408.7	326.9
0.875	658.2	526.6
1.000	986.9	789.5
1.125	1448.8	1159.0
1.250	2035.9	1628.7
1.375	2763.2	2210.5
1.500	3645.7	2916.6
1.625	4698.4	3758.7
1.750	5936.3	4749.0
1.875	7374.4	5899.5
2.000	9027.7	7222.1
2.125	10911.1	8728.9
2.250	13039.7	10431.8
2.375	15428.5	12342.8
2.500	18092.5	14474.0

DATE: 8/11/95Rev. 1

PERCENT YIELD = 90 %  
 BOLT STRESS = 103500 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	13.7	11.0
0.375	52.3	41.8
0.500	122.4	97.9
0.625	243.7	194.9
0.750	432.7	346.2
0.875	696.9	557.5
1.000	1044.9	835.9
1.125	1534.0	1227.2
1.250	2155.6	1724.5
1.375	2925.7	2340.6
1.500	3860.1	3088.1
1.625	4974.8	3979.8
1.750	6285.5	5028.4
1.875	7808.2	6246.6
2.000	9558.7	7647.0
2.125	11553.0	9242.4
2.250	13806.8	11045.4
2.375	16336.1	13068.9
2.500	19156.7	15325.4

PERCENT YIELD = 95 %  
 BOLT STRESS = 109250 PSI

(S)A-564 GR 630

NOMINAL DIAMETER IN.	UNLUBED TORQUE FT-LB	LUBED TORQUE FT-LB
0.250	14.5	11.6
0.375	55.2	44.2
0.500	129.2	103.3
0.625	257.2	205.8
0.750	456.7	365.4
0.875	735.6	588.5
1.000	1103.0	882.4
1.125	1619.2	1295.4
1.250	2275.4	1820.3
1.375	3088.3	2470.6
1.500	4074.6	3259.7
1.625	5251.2	4200.9
1.750	6634.7	5307.8
1.875	8242.0	6593.6
2.000	10089.8	8071.8
2.125	12194.8	9755.8
2.250	14573.8	11659.1
2.375	17243.6	13794.9
2.500	20221.0	16176.8

## ATTACHMENT 5

### TABLE 1 ISI-07B



Table 1  
Alternative Examination Request ISI-07B

Class 1 Bolted Connections that are insulated on systems bated for the purpose of controlling reactivity.					
Component	Stud Material	Bolt/Stud Processing and Testing Results		Nut Material	Nut Processing and Testing Results
BB8010A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/321, RC 27		SA-194 Gr 6	1100 °F Tempering, RC 27
BB8010B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/321, RC 27		SA-194 Gr 6	1100 °F Tempering, RC 27
BB8010C	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/321, RC 27		SA-194 Gr 6	1100 °F Tempering, RC 27
BB8085	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 288/306		SA-194 Gr 6	1050 °F Tempering, 30/32 RC
BB8948A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 306		SA-453 Gr 660	1650 °F Oil Quench, 1325 °F Hardening Treatment, BHN 311/331
BB8948B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/321		SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302
BB8948C	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 278/311		SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment
BB8948D	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/311		SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment
BB8949A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 277/321		SA-194 Gr 6	1125 °F Tempering, RC 29/31
BB8949B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 309/329		SA-193 Gr B6	1100 °F Tempering, RC 41
BB8949C	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 309/329		SA-193 Gr B6	1100 °F Tempering, RC 41
BB8949D	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 309/329		SA-193 Gr B6	1100 °F Tempering, RC 41
BBPCV0455B	SA-453 Gr 660	1650 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 321		SA-194 Gr 6	1075 °F Tempering, RC 25/26
BBPCV0455C	SA-453 Gr 660	1650 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 321		SA-194 Gr 6	1075 °F Tempering, RC 25/26
BBV0008	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0009	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0028	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0029	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0047	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0048	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0065	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0066	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
BBV0067	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment		SA-194 Gr 6	1100 °F Tempering
EJHV8701A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 278/291		SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment
EJHV8701B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302/311		SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment
EM8815	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 313		SA-194 Gr 6	1100 °F Tempering, RC 31-35
EMFE0924	SA-564 Gr 630	1100 °F Tempering, RC 33/34		SA-194 Gr 6	1100 °F Tempering
EMFE0925	SA-564 Gr 630	1100 °F Tempering, RC 33/34		SA-194 Gr 6	1100 °F Tempering
EMFE0926	SA-564 Gr 630	1100 °F Tempering, RC 33/34		SA-194 Gr 6	1100 °F Tempering
EMFEC927	SA-564 Gr 630	1100 °F Tempering, RC 33/34		SA-194 Gr 6	1100 °F Tempering

Note: SA-193 Grade B6 meets the requirements of SA-194 Grade 6 when used as a nut. Both are 410 Stainless Steels.

\* = Component is currently being evaluated for permanent removal of insulation.



Table 1  
Alternative Examination Request ISI-07B

Class 2 Bolted Connections that are insulated on systems boroed for the purpose of controlling reactivity and are located **outside** of containment.

Component	Stud Material	Bolt Heat Treatment	Nut Material	Nut Heat Treatment
EJ8724A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 285/306	SA-194 Gr 6	1800 °F 1 hr. Oil Quench, 575 °F 2 hr. Tempering, 41/42 RC
EJ8724B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 291/306	SA-194 Gr 6	1100 °F Tempering, RC 32/34
EJ8730A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302	SA-193 Gr B6	1100 °F Tempering, BHN 248/352
EJ8730B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302	SA-193 Gr B6	1100 °F Tempering, RC 27/32
EJ8856A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment	SA-194 Gr 6	1100 °F Tempering
EJ8856B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment	SA-194 Gr 6	1100 °F Tempering
EJ8958A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 285/298	SA-193 Gr B6	1100 °F Tempering, RC 41
EJ8958B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 285/298	SA-193 Gr B6	1100 °F Tempering, RC 41
EJFCV0610	SA-564 Gr 630	1100 °F Tempering, RC 34/35	SA-194 Gr 6	1050 °F Tempering, RC 24/25
EJFCV0611	SA-564 Gr 630	1100 °F Tempering, RC 34/35	SA-194 Gr 6	1050 °F Tempering, RC 24/25
EJFCV0618	SA-564 Gr 630	1100 °F Tempering, RC 35.2	SA-194 Gr 6	1100 °F Tempering, RC 26/27
EJFCV0619	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment	SA-194 Gr 6	1100 °F Tempering
EJFE0610	SA-564 Gr 630	1100 °F Tempering, BHN 341	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EJFE0618	SA-564 Gr 630	1100 °F Tempering, BHN 341	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EJFE0619	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EJFE0988	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EJFE0611	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EJFO0007	SA-564 Gr 630	1100 °F Tempering, BHN 341/352	SA-194 Gr 6	1100 °F Tempering, RC 27/28
EJFO0008	SA-564 Gr 630	1100 °F Tempering, BHN 341/352	SA-194 Gr 6	1100 °F Tempering, RC 27/28
EJHCV0606	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment	SA-194 Gr 6	1100 °F Tempering
EJHCV0607	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment	SA-194 Gr 6	1100 °F Tempering
EJHV8716A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 311/321	SA-194 Gr 6	1100 °F Tempering, RC 43
EJHV8716B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 311/321	SA-194 Gr 6	1100 °F Tempering, RC 32/34
EJHV8804A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 311/332	SA-194 Gr 6	1100 °F Tempering, RC 40/41
EJHV8804B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 306/329	SA-194 Gr 6	1100 °F Tempering, RC 43
EJHV8809A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 278	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302
EJHV8809B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 291/338	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 302
EMFE0917A	SA-564 Gr 630	1100 °F Tempering, RC 39	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EMFE0917B	SA-564 Gr 630	1100 °F Tempering, RC 39	SA-194 Gr 6	1105 °F Tempering, RC 27/28
EMHV8801A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 288/306	SA-194 Gr 6	1100 °F Tempering, RC 30/32
EMHV8801B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 288/306	SA-193 Gr B6	1100 °F Tempering, BHN 248/352
EMHV8803A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 288/306	SA-193 Gr B6	1100 °F Tempering, BHN 248/352
EMHV8803B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 288/306	SA-193 Gr B6	1100 °F Tempering, BHN 248/352
PEJ01A	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 269/302	SA-193 Gr B6	1100 °F Tempering, BHN 269/277
*EJSS0002	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28
PEJ01B	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 321/332	SA-193 Gr B6	1100 °F Tempering, BHN 262/269
*EJSS0001	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28

Note: SA-193 Grade B6 meets the requirements of SA-194 Grade 6 when used as a nut. Both are 410 Stainless Steels.

\* = Component is currently being evaluated for permanent removal of insulation.

Table 1  
Alternative Examination Request ISI-07B

Class 2 Bolted Connections that are insulated on systems bolated for the purpose of controlling reactivity and are located <b>inside</b> containment.				
Component	Stud Material	Bolt Heat Treatment	Nut Material	Nut Heat Treatment
BGHV8146	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 311/332	SA-194 Gr 6	1100 °F Tempering, RC 27/33
BGHV8147	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 311/332	SA-194 Gr 6	1100 °F Tempering, RC 27/33
BGHV8145	SA-453 Gr 660	1800 °F Liquid Quench, 1325 °F Hardening Treatment, BHN 341	SA-194 Gr 8	1100 °F Tempering, RC 27/28
EJF01	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28
EJF02	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28
EJF03	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28
EJF04	SA-564 Gr 630	1100 °F Tempering, BHN 331/341	SA-194 Gr 6	1100 °F Tempering, RC 27/28

Note: SA-193 Grade B6 meets the requirements of SA-194 Grade 6 when used as a nut. Both are 410 Stainless Steels.

\* = Component is currently being evaluated for permanent removal of insulation.