

DUKE POWER COMPANY

P.O. BOX 33189  
CHARLOTTE, N.C. 28242

HAL B. TUCKER  
VICE PRESIDENT  
NUCLEAR PRODUCTION

TELEPHONE  
(704) 373-4531

July 24, 1985

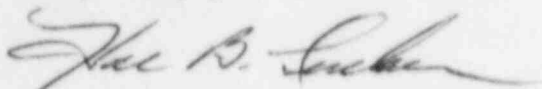
Dr. J. Nelson Grace, Regional Administrator  
U. S. Nuclear Regulatory Commission  
Region II  
101 Marietta Street, NW, Suite 2900  
Atlanta, Georgia 30323

Re: Catawba Nuclear Station, Unit 2  
Docket No. 50-414  
Significant Deficiency No. 414/85-08

Dear Dr. Grace:

Please find attached a supplement to our status report, dated July 15, 1985, which described corrective actions on the subject deficiency. This information, requested by Region II staff, consists of an engineering evaluation of over-pressurization of components of the Residual Heat Removal System, the Boron Recycle System and the Nuclear Sampling System.

Very truly yours,



Hal B. Tucker

LTP/mjf

Attachment

cc: Director  
Office of Inspection and Enforcement  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

Mr. Jesse L. Riley  
Carolina Environmental Study Group  
854 Henley Place  
Charlotte, North Carolina 28207

Robert Guild, Esq.  
P. O. Box 12097  
Charleston, South Carolina 29412

Palmetto Alliance  
2135½ Devine Street  
Columbia, South Carolina 29205

NRC Resident Inspector  
Catawba Nuclear Station

INPO Records Center  
Suite 1500  
1100 Circle 75 Parkway  
Atlanta, Georgia 30339

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Catawba Nuclear Station  
SD 414/85-08  
Supplement  
July 24, 1985

DUKE POWER COMPANY  
DESIGN ENGINEERING-SYSTEMS AND EQUIPMENT SECTION  
ENGINEERING JUSTIFICATION REPORT

Date: May 22, 1985Report No. MDS-JR-51To: E. M. CouchOriginated By: W. L. Lefler 5-22-85Station: Catawba 1-2Checked By: W. L. Bailey 5/23/85System: NB, ND, NMApproved By: R. S. Miller 5/28/85  
D.M.C. R.L.W.File: CN-1206.00-02QA Approval By: T.C. Roberts 6/3/85Variation Reported By: NCIR 19,632Description of Variation

Piping in the NB, ND, and NM systems was pressurized to 2000 Psig during testing as described by NCIR 19,632.

Engineering Evaluation(1) ND System

Flow Diagrams: CN-2561-1.0, 1.1 Line 02  
PS 601.2, Pipe SA 312 Tp 304 Smls./EFW

The allowable hydrotest pressures and the calculated stresses are tabulated by Table 1.

Evaluation for 6", 8", 12" and 14" piping:

6"

Piping was stressed to 83% of  $S_y$  based on the Minimum  $S_y$  required by the material specification. Piping is acceptable since stresses  $< S_y$ .

8"

Piping was stressed  $<$  the actual material yield strength as determined by review of the mill test reports. The lowest  $S_y$  for pipe material was found to be 41,000 psi. The lowest yield strength of any fittings was found to be 39,800 psi. Thus the pipe was stressed to 91%  $S_y$  and the fittings were stressed to 94%  $S_y$ . Pipe and fittings are acceptable since stress  $< S_y$  and based on the following conservative factors:

- (a) Evaluation is based on the material specification minimum wall thickness. Actual wall thickness of the piping is greater than the material specification minimum wall thickness. In addition fittings would be expected to have a wall thickness greater than the wall thickness of the pipe. So even though the fittings have a lower yield strength than the pipe, the stresses in the fittings would be expected to be lower than the stresses in the pipe because of the greater wall thickness of the fitting.

Table 1  
ND System

Pipe Allowable Pressures and Theoretical Stresses for 2000 Psig							
NPS	Sch.	Min. Wall (In.)	Pa (Psig) (1)	Max. Hydro Press. (Psig) (2)	Theo. Hoop Stress (Psi) (3)	% of Min Spec. Yield Strength (4)	% of Actual Yield Strength(s)
1/2	40	.095	3991	6346			
3/4	40	.099	3255	5175	Piping is acceptable since allowable hydrotest pressure > 2000 Psi.		
1	40	.116	3044	4840			
2	40	.135	1900	3021			
3	40	.189	1804	2868			
4	40	.207	1529	2431			
6	40	.245	1218	1937	25041	83%	---
8	20	.219	827	1315	37384	125%	94%
12	Std	.328	839	1334	36872	123%	85%
14	40	.383	894	1421	34554	115%	71%

Notes: (1) From CNC-1232.00-00-0010 Table S using  $E = 0.85$  at  $100^{\circ}\text{F}$

(2) Max. Hydro Press = (Pa) (1.5) (1.06)

(3) Theo. Hoop Stress =  $(2000) (D - 2 \times t_M) / 2 t_M$

(4) Min.  $S_y = 30,000$  Psi per material specification.

(5) Actual  $S_y$  determined by review of Mill Test Reports.

- (b) The actual yield strengths used in this evaluation are the worst case. Most materials have actual yield strengths greater than the yield strengths used in this evaluation.

#### 12"

Piping was stressed to 85% of  $S_y$  based on review of mill test reports which found the lowest  $S_y = 43,300$  psig. The 12" pipe and fittings are acceptable since stress  $< S_y$  and based on the conservative wall thickness values used in this evaluation.

#### 14"

The 14" piping consists only of 14" x 8" reducers. The reducer was stressed to 71% of  $S_y$  based on review of mill test reports which found the actual  $S_y = 48,800$  psi. The 14" reducer is acceptable since stress  $< S_y$  and the actual wall thickness value used in this evaluation is conservative.

#### Evaluation of Flanges:

Flanges are 600 lb, A182 F304 B16.5 Rating @ 100°F = 1140 Psig  
 Max. Hydrotest Pressure = (1.5) (1.06) (1140)  
 = 2290 Psig

The flanges are acceptable since maximum hydrotest pressure allowed, 2290 Psig > 2000 Psig test pressure.

#### (2) NB System

Flow Diagram: CN-1556-1.1  
 PS 151.3 Pipe SA 312 TP 30½ EFW.

The allowable hydrotest pressures and the calculated stresses are tabulated by Table 2.

#### Evaluation for Flanges :

Flanges are 150 lb, A182 F304 (Reference Notes 1 and 2 on page 5)  
 B16.5 (1977) rating at 100°F = 275 Psig  
 Allowable Hydrotest Pressure = (1.5) (1.06) (275)  
 = 437 Psig

Flanges are not acceptable for 2000 Psig pressure.

#### (3) NM System

Flow Diagram: CN-2572-1.0 & 1.5  
 PS 1501.8, PS 2501.4, TS 2701.4

<u>PS No.</u>	<u>Pa at 100°F, (PSIG) (1)</u>	<u>Maximum Hydrotest Pressure (Psig) (2)</u>
1501.8	1420	2258
2501.4	3209	5102
2701.4	2900	4611

- Notes: (1) Pa = Design pressure parameter from piping subtable  
 (2) Max. Hydro. Press - (1.5) (1.06) (Pa)

Piping is acceptable since maximum hydrotest pressure > 2000 Psig.

Table 2  
NB System

Pipe Allowable Pressures and Theoretical Stresses for 2000 Psig						
NPS	Sch.	tMin. (In.)	Pa (Psig) (1)	Max. Hydro Press. (Psig) (2)	Theo. Hoop Stress (Psi) (3)	% of Min. Spec. Yield Strength (4)
1	40	.116	2865	4555	Piping is acceptable since allowable hydrotest pressure > 2000 Psi	
2	40	.135	1788	2843		
3	40	.189	1698	2699		
6	40	.245	1146	1822	25,041	83%

(1) From CNC-1232.00-00-0010 Table H

(2) Maximum Hydro Pressure = (Pa) (1.5) (1.06)

(3) Theo. Hoop Stress =  $(2000) (D - 2 \times t_M) / 2 t_M$

(4) Min.  $S_y = 30,000$  Psi per material specification

Engineering Conclusions:

All piping subjected to the 2000 Psi pressure was found to be acceptable except for the 150 lb. flanges. The 8", 12" and 14" piping was qualified by using the yield strength values from the material test reports.

Engineering Disposition of Variation:

The 150 lb. flanges require replacement. All other piping is acceptable. This disposition is addressed by Attachment No. 2 to NCIR 19632.

T. F. Wyke, Chief Engineer  
Mechanical & Nuclear Division

*R. L. Williams*

for S. S. Lefler, Jr., Design Engineer I

SSL:mmg

Attachments: Copy of NCIR 19632, Attachment Nos. 1 and 2

cc:	D. R. Ingle	w/o attachments
	R. C. Gamberg	"
	T. E. Goodson	"
	T. C. Roberts	"
	T. D. Crom	"
	R. E. Miller	"
	R. L. Williams	"
	J. E. Cavender	"

Note 1: Review by the Stress Analysis Group found the 150 lb. flanges to be unacceptable following the 2000 psi test pressure. Reference Attachments No. 1 and No. 2.

Note 2: Review of NB flanges covered under PS 151.3 found that 300 lb. flanges were furnished with relief valves 2N1161, 2N1151 and 2N1119. The B16.5 rating for SA 182 F304 flanges at 100°F is 720 psig corresponding to a allowable hydrotest pressure of 1145 psig. This value is less than 2000 psig test pressure however the Stress Analysis Group was able to qualify the flanges to be acceptable as stated by Attachment No. 2. Therefore the 300 lb. flanges are acceptable as installed.

FORM Q-1A REVISION 15 4-25-85

Requestion No.		Vendor/Location	Documents Violated	FORM Q-1A	REVISION 15
N/A		N/A	Flow Diagrams	DUKE POWER COMPANY	
MPS PO NO.		Mech/Elec System	CN-2561-1.0, 2561-1.1,	Project CATAWBA Unit 2	
N/A		NB, ND, NM	2572-1.0, 2572-1.5 and	NONCONFORMING ITEM REPORT	
Condition		Class	Identification Method	Serial No. 19632	
1 & 2		E & B	<input type="checkbox"/> Q-1B's <input type="checkbox"/> Other Areas to numerous to tag	<input type="checkbox"/> NCI Tape <input checked="" type="checkbox"/> Not Practical	

Location of Item \_\_\_\_\_

Description of Nonconformance Various piping, valves and equipment were overpressurized by H.P.D. while operating the centrifugal charging pump "2B" during cold hydro. This problem was discovered when H.P.D. found water spraying from flanges on relief valves 2ND031 and 2NM296. Subsequent review of testing procedures then discovered the over-pressurization had occurred. See attached page #1 for additional information. This incident occurred during the a.m. hours of 4/19/85.

No physical damage is evident and Design Engineering (Sam Alexander) has authorized N.P.D. to continue testing, therefore, no tagging is necessary.

Responsibility for Nonconformance Disposition ☐ Const. ☒ Design ☐ QA ☐ Nuclear Production ☐ Group DM  
Reportability Evaluation, Q-ID, Requested from DESIGN MECH (Provide Department or N/A)

Originated By <u>Bill Greene</u> <sup>with</sup> Date <u>4/23/85</u>		QA Review <u>HLH</u>	Date <u>4/23/85</u>
Disposition of Nonconformance		DNC (PR-202) Application	

Disposition of Nonconformance	DNC (PR-202) Applicable (Design Eng. Only)	
	<input type="checkbox"/> Yes <input type="checkbox"/> No	
	Spec/Calc/Dwg Revised	Rev No.
	_____	_____
_____	R-6A Assigned to _____ Dept.	
_____	For 10CFR 50 App. B Criterion XVI Evaluation	
_____		
_____		
_____		
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_____		

Resolved By	Date	Technical Approval	Date	QA Approval	Date
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[illegible]

by		Date	QA Approval			
Signature/Inspection Remarks			Date			

Distribution		Const Mgr	Eng Mgr	Can Eng	Can Eng	Project QA Mgr	QA Vendors	QA	QA	Whse Supv	Design	ANI	NRC	NCI Orig		
Number of Copies	Initial	2	1	MECH							MECH					
	Final															
Trend Info. NAPP		Final QA Review													Date	





NCI  
REQUEST FOR REVIEW

The attached NCI is being sent to you for your review and comments. Please respond by completing this form and returning it to the Materials Group.

NCI Number: 19632

Materials Group Responsible Engineer SS Lefler Jr.

Materials Group Need Date 5-22-85

150 lb. flanges for relief valves ZNV 273, ZNS 19, ZNS 2, ZNV 989, ZND 35, ZNI 161, ZNI 151, ZNI 119, ZNI 102, ZND 31, ZND 64 (CN 1556-1.1) and relief valve ZNM 296 (CN 2572-1.5) were subjected to 2000 psi pressure as described by NCIR 19,632. Please advise as to acceptability of 150 lb. Flanges and bolting materials following overpressurization.

Date sent: 5-8-85

Comments:

- ☐ NCI is acceptable  
☒ NCI is not acceptable  
☐ No Comments

Reason: Flange stresses exceeded yield and flanges should be replaced.

But material did not exceed yield stress, therefore, bolts are still acceptable.

These comments address only valves ZND 31 & 64. The other valves are alternate analysis scope.

Specification/Calculation/Drawing Revised by

Catawba Stress Analysis: N/A

Specification/Calculation/Drawing to be revised

by other groups: N/A

By: D.R. Inf

Technical Approval: R. Sales

NCI  
REQUEST FOR REVIEW

The attached NCI is being sent to you for your review and comments. Please respond by completing this form and returning it to the Materials Group.

NCI Number: 19632

Materials Group Responsible Engineer SS Lefler Jr.

Materials Group Need Date 5-22-85

150 lb. flanges for relief valves ZNV 273, ZNS 19, ZNS 2, ZNV 989, ZND 35, ZNI 161, ZNI 151, ZNI 119, ZNI 102, ZND 31, ZND 64 (CN 1556-1.1) and relief valve ZNM 296 (CN 2572-1.5) were subjected to 2000 psi pressure as described by NCIR 19,632. Please advise as to acceptability of 150 lb. Flanges and bolting materials following overpressurization.

Date sent: 5-8-85

Comments:

- ☐ NCI is acceptable
- ☒ NCI is not acceptable, Except as noted below.
- ☐ No Comments

Reason: The 1" + 2" - 150 lb Flanges have been permanently deformed from the 2000 psi pressure. These flanges need to be replaced. The bolt material can be reused since the pressure did not permanently deform the bolts. (see attached calculations). The 2 1/2" - 300 lb flanges are still acceptable and can remain. (see attached calculations)

Specification/Calculation/Drawing Revised by

Catawba Stress Analysis: \_\_\_\_\_

Specification/Calculation/Drawing to be revised by other groups: \_\_\_\_\_

By: J. H. Crom

Technical Approval: FE SR 5/15/85

Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 - Over Pressurization of FlangesBy TDC Date 5-10-85Sheet No. 1 of 7 Problem No. \_\_\_\_\_Checked By APB Date 5-15-85

Problem: NCI 19632 states that the NB relief valve discharge line was overpressurized to 2000 PSIG. Check if 2 1/2" - 300 lb flanges need to be replaced. Calculations show that the flange material for 1" and 2" - 150 lb flanges were overstressed into deformation. Check if bolts are still acceptable.

### References:

- 1) Catawba Piping Analysis Handbook - CNSA - DOC-80-002. Section 10.12
- 2) ASME Boiler & Pressure Vessel Code Section III, 1977 Edition, Appendices
- 3) ITT Grinnell Welding Fittings & Flanges Catalog WFF-79

### Body:

2 1/2" Raised Face 300# Flange, Method 2A of ref. 1, SA182 F304

Gasket Code G-5, Bolt Code B-5

Gravity will be considered negligible

$$N = \frac{37/8 - 31/4}{2} = 0.3125"$$

Gasket Dimensions Control

$$b = b_0 = \frac{0.3125}{2} = 0.1563"$$

$$G = \frac{37/8 + 31/4}{2} = 3.563"$$

$$m = 3.0$$

$$W_{m1} = 0.785 (3.563)^2 2000 + 6.79 (0.1563) (3.563) (3.0 \sqrt{2000}) = 40915 \text{ lb}$$

Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 - OVER Pressurization of FlangesBy TDCDate 5-10-85Sheet No. 2 of 7 Problem No. \_\_\_\_\_Checked By APDDate 5-15-85

$$S_y = 105,000 \text{ PSI}$$

Yield Stress will be used to ensure that there is no permanent deformation or damage.

$$\text{Required Bolt Area} = \frac{40915}{105000} = 0.3897 \text{ IN}^2$$

$$\text{Actual Bolt Area} = 8(0.302) = 2.420 \text{ IN}^2$$

Bolts are OK since they were not taken beyond yield stress.

$$W_{H1} = 40915 \text{ lb}$$

$$C = 5\frac{7}{8}'' , 5.875''$$

$$G = 3.563''$$

$$B = 2.47''$$

$$g_1 = 0.734''$$

$$g_0 = 0.205''$$

$$R = \frac{5.875 - 2.47}{2} - 0.734 = 0.9685''$$

$$h = 2''$$

$$H = 0.785(3.563)^2 2000 = 19931 \text{ lb}$$

$$H_G = 40915 - 19931 = 20984 \text{ lb}$$

$$h_g = \frac{5.875 - 3.563}{2} = 1.156''$$

$$M_G = 20984(1.156) = 24250 \text{ IN-LB}$$



Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 - Over Pressurization of FlangesBy TDCDate 5-10-85Sheet No. 3 of 7 Problem No. \_\_\_\_\_Checked By OP DailyDate 5-15-85

$$H_D = 0.785(2.47)^2 2000 = 9578 \text{ lb}$$

$$h_D = 0.9685 + 0.5(.734) = 1.336''$$

$$M_D = 9578(1.336) = 12796 \text{ IN-LB}$$

$$H_T = 19931 - 9578 = 10353 \text{ lb}$$

$$h_T = \frac{0.9685 + .734 + 1.156}{2} = 1.429''$$

$$M_T = 10353(1.429) = 14794 \text{ IN-LB}$$

$$h = 2''$$

$$h_o = \sqrt{2.47(.205)} = 0.712''$$

$$h/h_o = 2.8 \quad g/g_o = 3.6$$

$$f = 1.0 \quad \text{Conservative}$$

$$A = 7\frac{1}{2}''$$

$$B = 2.47''$$

$$V = 0.0216$$

$$K = 3.036$$

$$U = \frac{(3.036)^2 (1 + 8.55246 \log_{10} 3.036) - 1}{1.36136 (3.036^2 - 1)(3.036 - 1)} = 2.03$$

Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 - Over Pressurization of FlangesBy TPLDate 5-10-85Sheet No. 4 of 7 Problem No. \_\_\_\_\_Checked By DPBDate 5-15-85

$$d = \frac{2.03}{0.0216} (0.712)(.205)^2 = 2.812$$

$$F = 0.4934$$

$$C = \frac{0.4934}{0.712} = 0.6930$$

$$T = \frac{(3.036)^2 (1 + 8.55246 \log_{10} 3.036) - 1}{(1.04720 + 1.9448(3.036)^2)(3.036 - 1)} = 1.197$$

$$I = 1 - \frac{1}{16} = \frac{15}{16}$$

$$L = \frac{\frac{15}{16} (0.6930) + 1}{1.197} + \frac{(\frac{15}{16})^3}{2.812} = 1.671$$

$$Y = \frac{1}{3.036 - 1} \left[ 0.66945 + 5.71690 \frac{(3.036)^2 \log_{10} 3.036}{3.036^2 - 1} \right] = 1.847$$

$$Z = \frac{3.036^2 + 1}{3.036^2 - 1} = 1.24$$

$$M_0 = 14794 + 12796 + 24258 = 51848 \text{ IN-LB}$$

Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 over Pressurization of FlangesBy TBCDate 5-10-85Sheet No. 5 of 7 Problem No. \_\_\_\_\_Checked By OPR Date 5-15-85

$$S_H = \frac{1.0 (51848)}{(1.671)(.734)^2 (2.47)} + \frac{2000(2.47)}{4 (.205)} = 29341 \text{ PSI}$$

$$S_R = \frac{(1.33(15/16)(.6930) + 1) 51848}{(1.671)(15/16)^2 (2.47)} = 26643 \text{ PSI}$$

$$S_T = \frac{1.847(51848)}{(15/16)^2 (2.47)} - 1.24(26643) = 11075 \text{ PSI}$$

Failure will be taken at the point the material yields and takes permanent deformation

$$S_y = 30000 \text{ PSI}$$

Using the distortion energy theory for ductile failure

$$\sigma_1 = 29341 \text{ PSI}, \sigma_2 = 26643 \text{ PSI}, \sigma_3 = 11075 \text{ PSI}$$

$$\frac{1}{2} \left[ (29341 - 26643)^2 + (26643 - 11075)^2 + (11075 - 29341)^2 \right] \leq 30000^2$$

$$291644292 \leq 9 \times 10^8$$

Flange material was not permanently deformed.



Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 - Over Pressurization of FlangesSheet No. 6 of 7 Problem No. \_\_\_\_\_By TRDate 5-10-85Checked By DPHDate 5-15-851" Raised Face 150# Flange, Method 2A, SA182 F304Gasket Code G-5, Bolt Code B-5

Gravity Will be considered negligible.

$$N = \frac{1\frac{7}{8} - 1.25}{2} = 0.31" \quad \text{Gasket dimensions Control}$$

$$b = b_0 = \frac{0.31}{2} = 0.155"$$

$$G = \frac{1\frac{7}{8} + 1.25}{2} = 1.56"$$

$$m = 3.0$$

$$W_{HT} = .785(1.56)^2 2000 + 6.28(0.155)(1.56)(3.0) 2000 = 12932 \text{ lb}$$

$$S_y = 105,000 \text{ PSI}$$

$$\text{Required Bolt Area} = \frac{12932}{105000} = 0.123 \text{ IN}^2$$

$$\text{Actual Bolt Area} = 4(.1257) = 0.502 \text{ IN}^2$$

Bolts Are OK since They Were not Taken Beyond Yield Stress.

Dev./Station CatawbaUnit 2 File No. \_\_\_\_\_Subject NCI 19632 Over Pressurization of FlangesBy TDC Date 5-10-85Sheet No. 7 of 7 Problem No. \_\_\_\_\_Checked By APD/Inley Date 5-15-852" Raised Face 150# Flange, Method 2A, SA182 F304Gasket Code G-5, Bolt Code B-5

Gravity will be considered negligible.

$$N = \frac{3\frac{3}{8} - 2\frac{3}{4}}{2} = 0.3125" \quad \text{Gasket dimensions Control}$$

$$b = b_0 = \frac{0.3125}{2} = 0.156"$$

$$G = \frac{3\frac{3}{8} + 2\frac{3}{4}}{2} = 3.06"$$

$$m = 3.0$$

$$W_{M1} = .785 (3.06)^2 (2000) + 6.28 (.156) (3.06) (3.0) 2000 = 32688 \text{ lb}$$

$$S_y = 105000 \text{ PSI}$$

$$\text{Required Bolt Area} = \frac{32688}{105000} = 0.3113 \text{ IN}^2$$

$$\text{Actual Area} = 4(.202) = 0.808 \text{ IN}^2$$

Bolts are OK since they were not taken beyond yield stress.

Conclusion: The 2 1/2" 300 lb flanges + bolts were not permanently deformed or damaged. Therefore they do not need to be replaced. Previous calculations show that the 1" + 2" 150 lb flanges were deformed and shall be replaced. Bolt material can be reused since no permanent deformation occurred.

Dev./Station CatawbUnit 2 File No. \_\_\_\_\_Subject NCI 19631By TDLDate 6-3-85Sheet No. 27 of 27 Problem No. \_\_\_\_\_Checked By EKRDate 6-5-85Conclusion

Since the flanges listed in the problem were not permanently yielded, deformed, or damaged, they will still have their same pressure and load carrying capability even though they were pressurized beyond their rated pressure. The original flanges and bolts can remain.