

METAL ~~Flex~~ CORPORATION

CR 684

DOCUMENTATION OF COMPLIANCE

FOR

HOSE ASSEMBLY, FLEXIBLE METAL
PER ASME BOILER & PRESSURE VESSEL CODES
SECTION III, CLASS 2

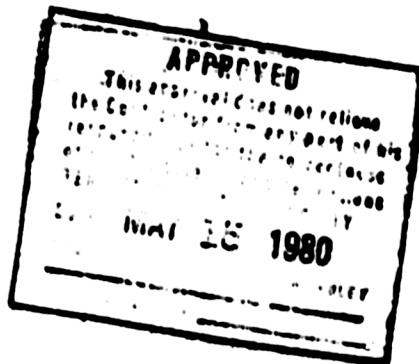
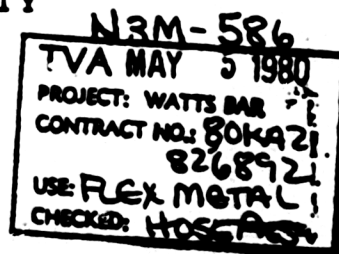
FOR

TENNESSEE VALLEY AUTHORITY
CHATTANOGA, TENNESSEE

REFERENCE:

MBC JOB NO. A14727

MBC PART NO: 77751, 77752, 77753 & 77754



No. of Pages: 40.

April 18, 1980

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Metal Bellows Corporation

CR 684
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VERIFICATION OF SPECIFICATION

Title: DOCUMENTATION OF COMPLIANCE FOR METAL BELLOWS
CORPORATION P/Ns 77751, 77752, 77753 and 77754

Revision: NC

Reference: METAL BELLOWS CORPORATION DESIGN REPORT CR 683
AND TVA SPECIFICATION 80K A2-826892

Prepared by: Frank Shen *F. Shen* **Date:** April 15, 1980

Checked by: *J. Hoffman* **Date:** *4-19-80*

Quality Assurance: *J. Ely* **Date:** *18 April 1980*

This is to certify that the above document has been reviewed by me, the undersigned, and is correct, complete, and in compliance with the 1977 Edition, including the Winter of 1979 Addenda, of ASME Code, Section III, paragraph NC-3000 and Code Case N-192.



Signature: *Ronald H. Nystrom*

Name: Ronald H. Nystrom

Number: 17261

Date: April 15, 1980

SUP-ARTICLE NUMBER	SUB-PART NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER HBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REGD	4
	(E)	FLOW DIRECTION MARKINGS	NOT REGD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF)	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATED	X	16
		CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE	X	17

REMARKS, NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END NOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY. THE PERVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 2.86 KSI
CODE ALLOWABLE STRESS IS 16.40 KSI FOR 321 CRES AT 200 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 8.26 KSI BENDING, PLUS 0.95 KSI MERIDIONAL, OR 9.21 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 13.81 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2% CHANGE. DESIGN IS ADEQUATE FOR 7% CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

(1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.

(2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (NS)(S)(SF

SF = 175 NSI FOR 10000 CYCLES

NS = (NSC)(NSS)

NSC = $2SC / (SC + SH) = 1.008$

NSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

NSS = $1.470 - (.044)(25)$

(ACTUALLY NBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

NSS = 0.37

NS = $(1.008)(.37) = .37$

NS = USE 1.25 (MIN CODE ALLOWABLE)

S = 29.56 NSI (SEE CR 683 PARA 3.6)

$(1.25)(29.56) \text{ NSI} = 36.95 \text{ NSI}$
 $36.97 \text{ NSI} < 175 \text{ NSI}$

REQUIREMENT IS MET.

12 NBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF FEMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. NBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS NET.

NBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO FEMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PER NC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 3.8

STT = 29.58 KSI (THERMAL)
STS = 62.57 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 3.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 87850000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000057

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000006 < 1.0
.000106 < 1.0

REQUIREMENT IS MET.

CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

- 16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID. BECAUSE OF SQUIRM, CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED. AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

- 17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 3.10.

$$N = F / (SA)(\cos A) = 401 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(12) = 576 \text{ WIRES}$$

REQUIREMENT IS MET.

- (B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

SUB-ARTICLE NUMBER	SUB-PAPA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF)	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
		CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE	X	17

REMARKS/NOTES

- OWNER WILL COMPLY WITH HAS STATED THE EXACT END
MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY
THE PRESSURE END LOAD. TO MINIMIZE THE NEED FOR RIGID
ANCHORS
 - 3 OWNER WILL COMPLY; THE PERVIOUS BRAID WILL ALLOW
WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS
IN HOSE.
 - 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN
PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID
PROVIDES REQUIRED RESTRAINT.
- THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION
REQUIREMENTS. FLOATING FLANGE AT EACH END WILL
MINIMIZE TWISTING THE HOSE.
- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
 - 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL
LEVELS NOTED IN STRESS REPORT CR 683
 - 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO
NC2000. THE BRAID MATERIAL SHALL MEET THE
REQUIREMENTS OF ASTM-A-580. AND MATERIAL PHYSICAL
PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III
TABLE I-7-2, PLATE MATERIAL.
 - 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS
ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT
PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 2.87 KSI
CODE ALLOWABLE STRESS IS 18.40 KSI FOR 321 FRES AT 200 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 6.25 KSI BENDING,
PLUS 0.95 KSI MERIDIONAL, OR 9.20 KSI TOTAL
BENDING STRESS AT OPERATING, TIMES 1.5 = 13.80 KSI
PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS =
1.5 X 75 = 113 KSI FOR 2X CHANGE. DESIGN IS ADEQUATE
FOR 7X CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS UN AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE). THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

- (1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.
- (2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF)

SF = 175 KSI FOR 10000 CYCLES

KS = (KSC)(KSS)

KSC = $2SC / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY HBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 40.80 KSI (SEE CR 663 PARA 4.8)

$(1.25)(40.80) \text{ KSI} < 175 \text{ KSI}$
 $51.00 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

12 MBO IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBO STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBO HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PERNC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 4.6

STT = 40.80 KSI (THERMAL)
STS = 96.77 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 4.7

N1 = 100000000 CYCLES (THERMAL)
N2 = 371830 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0013447

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .001345 < 1.0
.001445 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4900.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 4.10.

$$N = F / (S_H) (COS A) = 401 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(12) = 576 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

P/N 77751

HORIZ HOSE

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SUB-ARTICLE NUMBER	SUB-PARA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE			X	17

REMARKS/NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY; THE PERVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 8.89 KSI
CODE ALLOWABLE STRESS IS 18.55 KSI FOR 321 CRES AT 150 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 25.85 KSI BENDING, PLUS 4.01 KSI MERIDIONAL, OR 29.86 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 44.79 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2% CHANGE. DESIGN IS ADEQUATE FOR 7% CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

(1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.

(2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $25C / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 48.61 KSI (SEE CR 683 PARA 10.8)

$(1.25)(48.61) \text{ KSI} < 175 \text{ KSI}$
 $60.76 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

- 12 MBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

- 13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

- 14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PERNC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 10.8

STT = 48.61 KSI (THERMAL)
STS = 45.83 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 10.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 10.10.

$$N = F / (SA)(\cos A) = 122 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(4) = 192 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

PIN 77751
 VERT. HOSE

CR 684
 PAGE 16

SUB-ARTICLE NUMBER	SUB-PARA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE			X	17

REMARKS/NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY; THE PVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 8.92 KSI
CODE ALLOWABLE STRESS IS 18.55 KSI FOR 321 CRES AT 150 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 25.82 KSI BENDING, PLUS 4.01 KSI MERIDIONAL, OR 29.83 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 44.75 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2% CHANGE. DESIGN IS ADEQUATE FOR 7% CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

- (1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.
- (2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $2SC / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})^1$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 42.64 KSI (SEE CR 683 PARA 2.8)

$(1.25)(42.64) \text{ KSI} < 175 \text{ KSI}$
 $53.30 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

12 MBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PER NC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 12.8

STT = 42.64 KSI (THERMAL)
STS = 49.67 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 12.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 12.10.

$$N = F / (SA)(\cos A) = 122 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(4) = 192 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

PH-77754

HORIZ HOSE

CR 684
PAGE 21

SUB-ARTICLE NUMBER	SUB-PARA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE			X	17

REMARKS/NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY; THE PERVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 10.14 KSI
CODE ALLOWABLE STRESS IS 18.70 KSI FOR 321 CRES AT 70 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 29.42 KSI BENDING, PLUS 4.57 KSI MERIDIONAL, OR 33.99 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 50.98 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2X CHANGE. DESIGN IS ADEQUATE FOR 7X CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

- (1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.
- (2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $2SC / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 47.28 KSI (SEE CR 683 PARA 15.8)

$(1.25)(47.28)$ KSI < 175 KSI
59.10 KSI < 175 KSI

REQUIREMENT IS MET.

12 MBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PERNC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 18.8

STT = 47.28 KSI (THERMAL)
STS = 53.06 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 18.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 4.10.

$$N = F / (SA)(\cos A) = 138 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(4) = 192 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

PN 77754
VERT HOSE

CR 684
PAGE 26

SUB-ARTICLE NUMBER	SUB-PARA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
		CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE	X	17

REMARKS/NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY; THE PERVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 10.15 KSI
CODE ALLOWABLE STRESS IS 18.70 KSI FOR 321 CRES AT 70 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 29.40 KSI BENDING, PLUS 4.57 KSI MERIDIONAL, OR 33.97 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 50.95 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2X CHANGE. DESIGN IS ADEQUATE FOR 7X CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

(1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.

(2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $25C / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 47.99 KSI (SEE CR 683 PARA 7.8)

$(1.25)(47.99) \text{ KSI} < 175 \text{ KSI}$
 $59.99 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

12 MBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT PER NC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 7.8

STT = 47.99 KSI (THERMAL)
STS = 55.16 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 7.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 7.10.

$$N = F / (SA)(\cos A) = 138 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (48)(4) = 192 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

P/W 77752

HORIZ HOSE

CR 684
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SUB-ARTICLE NUMBER	SUB-PARA NO.	ASME SECTION III SUBSECTION NC 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING BARS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL SLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
	(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT
	(I)	CYLINDRICAL BELLOWS COLLARS	X	15
	(J)	EXPANSION JOINT SPRING RATES	X	16
		CODE CASE NUMBER D-192 USE OF FLEXIBLE HOSE	X	17

REMARKS NOTED

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE MAJAL RESTRAINT CAUSED BY THE PRESSURE END LOAD. TO MINIMIZE THE NEED FOR RIGID ANCHORS

THE OWNER WILL COMPLY. THE PEEVIOUS BRAID WILL ALLOW NO LEAK, SEEP OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.
- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 1.52 KSI
CODE ALLOWABLE STRESS IS 16.55 KSI FOR 321 CRES AT 150 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 5.85 KSI BENDING, PLUS 0.79 KSI MERIDIONAL, OR 6.64 KSI TOTAL BENDING STRESS AT OPERATING. TIMES 1.5 = 9.96 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 2% CHANGE. DESIGN IS ADEQUATE FOR 7% CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE FITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

- (1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.
- (2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $250 / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 21.86 KSI (SEE CR 683 PARA 2.9)

$(1.008)(21.86) \text{ KSI} < 175 \text{ KSI}$

$27.32 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

12 MBO IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF ASME TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBO STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBO HAS CONDUCTED MANY TESTS OF ITS CWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME B & PV CODE REQUIREMENT FERNC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 583 PARA 3.8

STT = 21.86 KSI (THERMAL)
STS = 24.24 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 3.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 3.10.

$$N = F / (SA) (\cos A) = 60 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (36)(8) = 288 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.

SUB-ARTICLE NUMBER	SUB-SECTION NO.	NAME SECTION III SUBSECTION NO 3649 REQUIREMENTS	COMPLIANCE BY OWNER MBC	REMARKS /NOTES
3649.2	(A)	PIPING SYSTEM LAYOUT, ANCHORAGE, GUIDING AND MOTIONS	X	1
	(B)	RIGID ANCHORS	X	2
	(C)	INSTALLATION LOCATIONS AND INSPECTION ACCESSIBILITY	X	3
	(D)	SHIPPING SFRS	NOT REQD	4
	(H)	FLOW DIRECTION MARKINGS	NOT REQD	5
	(F)	INTERNAL CLEEVES	NOT USED	6
3649.3		ALL PRESSURE BOUNDARY MATERIAL PER NC 2000	X	7
3649.4	(A)	ALLOWABLE CIRCUMFERENTIAL BELLOWS MEMBRANE STRESS	X	8
	(B)	ALLOWABLE MERIDIONAL MEMBRANE AND BENDING STRESS AT 1-1/2 DESIGN PRESSURE FOR NO PERMANENT DEFORMATION	X	9
	(C)	MINIMUM ALLOWED SQUIRM PRESSURE	X	10
	(D)	STRESS MULTIPLICATION FACTOR FOR DESIGN LIFE (KS)(S)(SF	X	11
	(E)	COMPLIANCE DEMONSTRATED BY (1), (2) OR (3)		
		(1) CALCULATED STRESSES VS STD LIFE VERIFIED BY TESTS	X	12
		(2) INDIVIDUAL TEST TO VERIFY SINGLE DESIGN	NOT APPLICABLE	
		(3) DESIGN ANALYSIS PER NC 3200	NOT APPLICABLE	
	(F)	PROCEDURES USED BY CERTIFICATE HOLDER TO VERIFY DESIGN	X	13
	(G)	TYPES OF SIGNIFICANT STRESSES FOR LIFE CALCULATIONS	X	14
(H)	CERTIFICATE HOLDERS COMPLIANCE REPORT TO NC 3649	X	THIS REPORT	
(I)	CYLINDRICAL BELLOWS COLLARS	X	15	
(J)	EXPANSION JOINT SPRING RATES	X	16	
	CODE CASE NUMBER N-192 USE OF FLEXIBLE HOSE	X	17	

REMARKS/NOTES

- 1 OWNER WILL COMPLY AND HAS STATED THE EXACT END MOTIONS REQUIRED OF THE HOSE.
- 2 THE BRAID PROVIDES THE AXIAL RESTRAINT CAUSED BY THE PRESSURE END LOAD, TO MINIMIZE THE NEED FOR RIGID ANCHORS
- 3 OWNER WILL COMPLY; THE PERVIOUS BRAID WILL ALLOW WATER TO LEAK, SEEP, OR FLOW THROUGH IF LEAK DEVELOPS IN HOSE.
- 4 EXTRA SHIPPING BARS ARE NOT REQUIRED TO MAINTAIN PROPER FACE-TO-FACE LENGTH BECAUSE THE HOSE BRAID PROVIDES REQUIRED RESTRAINT.

THE OWNER MUST COMPLY WITH ALIGNMENT INSTALLATION REQUIREMENTS. FLOATING FLANGE AT EACH END WILL MINIMIZE TWISTING THE HOSE.

- 5 FLOW DIRECTION NOT REQUIRED FOR A HOSE.
- 6 NOT REQUIRED. FLOW VELOCITIES ARE BELOW CRITICAL LEVELS NOTED IN STRESS REPORT CR 683
- 7 ALL PRESSURE BOUNDARY MATERIAL SHALL CONFORM TO NC2000. THE BRAID MATERIAL SHALL MEET THE REQUIREMENTS OF ASTM-A-580, AND MATERIAL PHYSICAL PROPERTIES SHALL MEET THE REQUIREMENTS OF SECTION III TABLE I-7-2, PLATE MATERIAL.
- 8 THE STRESS ANALYSIS IS PERFORMED ON THE BELLOWS ONLY AND IGNORES THE COMPRESSIVE HOOP SUPPORT PROVIDED BY THE BRAID.

CALCULATED HOOP STRESS PER CR 683 IS 1.52 KSI
CODE ALLOWABLE STRESS IS 16.55 KSI FOR 321 CRES AT 150 F

REQUIREMENT IS MET.

- 9 THE CALCULATED BENDING STRESS IS 5.85 KSI BENDING, PLUS 0.79 KSI MERIDIONAL, OR 6.64 KSI TOTAL BENDING STRESS AT OPERATING, TIMES 1.5 = 9.96 KSI PROOF PRESSURE STRESS. ALLOWABLE BENDING STRESS = $1.5 \times 75 = 113$ KSI FOR 7% CHANGE. DESIGN IS ADEQUATE FOR 7% CHANGE PERMITTED BY THE CODE.

10 THE BRAID PROVIDES THE EXTERNAL RESTRAINT TO THE HOSE BELLOWS AND REMAINS ON AT ALL TIMES.

NOTE: EXTERNAL RESTRAINT IS PERMITTED FOR SQUIRM TESTS PER LAST SENTENCE OF PARAGRAPH.

THE HOOP EXTERNAL RESTRAINT FORCE FAR EXCEEDS THE LOW OFFSET LOADS CAUSED BY THE HOSE SQUIRMING.

IN BURST TESTS TO FAILURE (4 TIMES MIN OPERATING PRESSURE), THE HOSE DOES NOT SQUIRM AT ANY TIME, EVEN THOUGH THE BELLOWS DEFORMS DRASTICALLY WITHIN THE BRAID. IN SEVERAL TESTS (AFTER FAILURE) THE BELLOWS HOSE APPEARED TO LOOK LIKE A TUBE INSIDE THE BRAID WITH INTERNAL STIFFENING RINGS. THE OUTSIDE RADIUS OF THE BELLOWS INCREASES TO LOOK LIKE A TUBE WHILE THE INSIDE BELLOWS RADIUS BECOMES VERY SMALL. THIS BURST TEST TO FOUR TIMES MINIMUM OPERATING EXCEEDS THE 2.25 TIMES SQUIRM REQUIREMENT BY THIS PARAGRAPH.

THE HOSE PITCH DOES NOT CHANGE BECAUSE OF THE FRICTION LOAD CAUSED BY THE HOOP SQUEEZE OF THE BRAID

- (1) HOSES ARE NORMALLY HELD ONLY AT ONE END BY THE EQUIPMENT WHICH APPLIES THE TEST PRESSURE. THE OPPOSITE END IS ALLOWED TO MOVE AS REQUIRED TO FIT PRESSURE TEST TANK.
- (2) PROOF TEST PRESSURE WAS INCREASED TO ACCOUNT FOR DESIGN TEMPERATURES.

11 (KS)(S)(SF

SF = 175 KSI FOR 10000 CYCLES

KS = (KCS)(KSS)

KSC = $2SC / (SC + SH) = 1.008$

KSS = $1.470 - (.044)(\text{NUMBER OF TESTS})$

KSS = $1.470 - (.044)(25)$

(ACTUALLY MBC HAS MORE THAN 25 TESTS PERFORMED TO REAFFIRM S-N CURVE)

KSS = 0.37

KS = $(1.008)(0.37) = .37$

KS = USE 1.25 (MIN CODE ALLOWABLE)

S = 16.83 KSI (SEE CR 663 PART 2.5)

$(1.25)(16.83) \text{ KSI} < 170 \text{ KSI}$

$21.04 \text{ KSI} < 175 \text{ KSI}$

REQUIREMENT IS MET.

12 MBC IS USING THE STANDARD PUBLISHED AND MODIFIED BY TEST EQUATIONS OF EJMA TO DEMONSTRATE COMPLIANCE WITH THIS LIFE REQUIREMENT. MBC STRESS REPORT, CR683 PROVIDES THE CALCULATIONS TO SHOW LIFE IS MET.

MBC HAS CONDUCTED MANY TESTS OF ITS OWN AND HAS FOUND RESULTS TO BE VERY SIMILAR TO EJMA RESULTS.

13 SEE DESIGN STRESS REPORT CR683 USED FOR DESIGN VERIFICATION. SEISMIC TEST REPORTS CR427 AND CR439 ARE AVAILABLE FOR TEST VERIFICATION.

14 ALL TYPES OF STRESS CYCLES WERE CONSIDERED WITH PRESSURE STRESS AND MOTION STRESS OCCURRING SIMULTANEOUSLY TO PRODUCE THE SIGNIFICANT STRESS FOR LIFE CALCULATIONS.

CUMULATIVE STRESSES FOR SEISMIC AND THERMAL MOTION MEET ASME 8 & PV CODE REQUIREMENT PER NC 3649.4(G) AS FOLLOWS

TYPE

T1 = 10000 THERMAL LIFE CYCLES
T2 = 500 SEISMIC LIFE CYCLES

CYCLES STRESS PER CR 683 PARA 2.8

STT = 16.83 KSI (THERMAL)
STS = 25.85 KSI (SEISMIC)

CALCULATED CYCLIC LIFE PER CR 683 PARA 2.9

N1 = 100000000 CYCLES (THERMAL)
N2 = 100000000 CYCLES (SEISMIC)

USAGE FACTORS

U1 = T1/N1 = .0001000
U2 = T2/N2 = .0000050

CUMULATIVE USAGE FACTORS SHALL NOT EXCEED 1.0

U1 + U2 + ETC < 1.0
.000100 + .000005 < 1.0
.000105 < 1.0

REQUIREMENT IS MET.

15 CYLINDRICAL COLLARS ARE USED AND ARE ACCOUNTED FOR, SINCE THE COLLARS PROVIDE AN EXCELLENT LOCATION TO ATTACH THE LIGHT WALL BELLOWS MATERIAL TO HEAVIER RING WHERE THE BRAID AND TUBE STUB ARE ATTACHED. ATTACHMENT OF THE HOSE (OR BELLOWS) JOINTS MEETS THE REQUIREMENTS OF THE ASME B & PV CODE SECTION III PARA. NC4800.

16 THE SPRING RATE FOR A LONG HOSE IS USUALLY SO LOW THAT IT IS DIFFICULT TO MEASURE WITHOUT THE BRAID BECAUSE OF SQUIRM. CALCULATED SPRING RATES ARE PROVIDED IN CR683. FRICTION FORCES PROVIDE A LARGER PORTION OF THE LOADING THAN SPRING RATE LOADS AND ARE ALSO CONSIDERED, AND A FACTOR IS APPLIED TO SHOW THAT THE IMPOSED LOADS WILL BE LESS THAN THE ALLOWABLE REQUIRED BY THE CUSTOMER.

NO INDIVIDUAL SPRING RATE TESTS WILL BE PERFORMED ON PRODUCTION HOSE.

17 (A) REQUIRED NUMBER OF WIRES FOR HOSE - REF. CR683 PARA 24.10.

$$N = F / (SA)(\cos A) = 60 \text{ WIRES}$$

$$\text{ACTUAL CONSTRUCTION} = (36)(8) = 288 \text{ WIRES}$$

REQUIREMENT IS MET.

(B) ALL OTHER REQUIREMENTS OF THIS CODE CASE HAVE BEEN MET AS NOTED IN OTHER PORTIONS OF THIS CHECK LIST.