Lab. No. 79.123
Revision A
May 9, 1980

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S&W Stress Report No - 12177 N SR 802 0

DESIGN REPORT FOR
24"-900# CARBON STEEL SWING CHECK VALVE
WITH & WITHOUT AIR CYLINDER ACTUATOR
NINE MILE POINT NUCLEAR STATION UNIT 2
STONE & WEBSTER ENGINEERING CORP.
P.O. NMP2-P303W
SPECIFICATION NO. NMP2-P303W

For
Anchor/Darling Valve Company
24747 Clawiter Road
Hayward, California 94545

Stone & Webster
Engineering Corporation
☒ APPROVED AS DEFINED IN THE SPECIFICATION
☐ UNACCEPTABLE
☐ APPROVED AS NOTED AS DEFINED IN THE SPEC.
☐ REVIEWED
J.O. No. 12177
SPEC. No. P303W
DATE 5/28/80
BY P Mitchell

By
Anamet Laboratories, Inc.
100 Industrial Way
San Carlos, California 94070

ANAMET LABORATORIES, INC.
BERKELEY, CALIF. SAN CARLOS, CALIF.

Lab. No. 79.123
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Revision A of the report incorporates the editorial comments and calculations transmitted in Stone & Webster Engineering Corp. letter T31, 211, dated May 6, 1980. This work is authorized by Anchor/Darling Valve Co. Purchase Order B0750.

I, the undersigned Registered Professional Engineer, certify to my best belief and knowledge that the calculations for the 24"-900# carbon steel swing check valves with 5" bore air cylinder actuator (Assy. Nos. 4020-3 & 4021-3) and 24"-900# carbon swing check valve (Assy. No. 4022-3) are complete and correct. This certification assures the structural integrity and operability of the identified valve assemblies to the applicable requirements of the ASME B&PV Code, Section III, Nuclear Power Plant Components, Division 1, Subsection NB, 1977, without addenda, and the project specification. Design requirements for this project are outlined in Stone and Webster Engineering Corporation Specification No. NMP2-P303W, Addendum 4, titled "Special Check Valves," which pertain to the Nine Mile Point Nuclear Station, Unit 2, of the Niagara Mohawk Power Corporation.

VALVE IDENTIFICATION

Anchor/Darling Valve S.J.O.	Anchor/Darling Valve Assembly Drwg. No.	Stone and Webster Identification No.
6308-01	4020-3	2FWS*AOV23A
6308-02	4021-3	2FWS*AOV23B
6308-03	4022-3	2FWS*V12A,B

REGISTERED PROFESSIONAL ENGINEER
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Prepared & Certified by:

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Reviewed by:

E. B. Flora

E. B. Flora

TABULATION OF VALVE COMPONENTS

Description	Part No. (Drawing No.)	Material Specification
Assembly Drwg. No. 4020-3 and 4021-3		
Body	6342-7-5	SA216-WCB
Bonnet	6342-7-5	SA105
Disc	6342-7-5	SA105
Hinge	6342-7-2	A216-WCB
Seat Ring	6342-10-1	SA516-70
Gasket Retainer	6342-9-2	SA516-70
Actuator Shaft	6342-4-2	Nitronic 60
Gland (Actuator)	6342-1-2	A479-410
Stud (Stuffing box)		SA193-B7
Capscrews		A574
Air Cylinder		Parker-Hannifin
Actuator Frame		A36
Stuffing Box (Actuator)	6342-11-2	SA105
Assembly Drwg. No. 4022-3		
Body	6342-8-5	SA216-WCB
Bonnet	6342-8-5	SA105
Disc	6342-8-5	SA105
Hinge	6342-8-2	A216-WCB
Seat Ring	6342-10-1	SA516-70
Gasket Retainer	6342-9-2	SA516-70
Hinge Pin	6342-7-1	A479-410
Cover (Hinge pin)	6342-6-1	SA105
Stud (Cover)		SA193-B7

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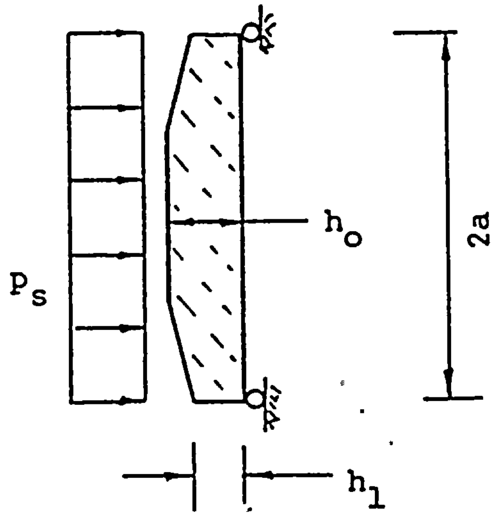
2. Valve Disc (NB-3546.2)

a. Effect of Internal Pressure

The valve disc is schematically represented by the following geometry:



h_o (in.) = 3.75

h_1 (in.) = 2.69

a (in.) = 10.00 (max)

p_s (psi.) = 2,250

An approximate solution is obtained by using the circular plate equations for linearly varying thickness. (Ref: Timoshenko, "Theory of Plates & Shells," 2nd Edition, pg. 307.) From Table 72 of the referenced text, the bending moments at the center of the disc are expressed as

$$M_r^c = M_t^c = \beta_c \, p_s \, a^2$$

and the corresponding bending stresses are

For the two locations, the maximum primary membrane plus primary bending stress intensities satisfy the material stress limit of 1.5 S_m at 500°F per NB-3546.2.

c. Stellite Facing

For the closed position, the swing check disc will have a maximum seating force F, where

$$F = \frac{\pi}{4} (S_o)^2 \cdot P_s$$

Thus, the maximum bearing stress against the stellite facing can be expressed as

$$\sigma_{stellite} = \frac{F}{\frac{\pi}{4}[(S_o)^2 - (S_i)^2]}$$

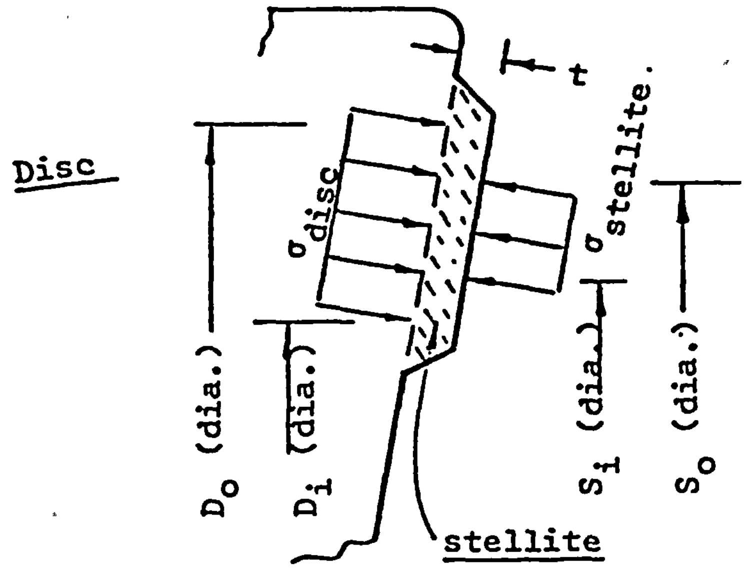
where S_o and S_i denotes the outer and inner diameters of the stellite seating surfaces, respectively.

S_o	(in.)	=	19.50
S_i	(in.)	=	19.00
F	(kip)	=	671.96
$\sigma_{stellite}$	(ksi.)	=	44.44

which satisfies the minimum allowable bearing stress of the stellite. Based upon data available in Cabot Stellite Division technical data "Stellite Wear-Resistant Alloys," the ultimate compressive strength and yield strength are specified as 220 ksi. for sand-cast conditions.

The bearing surface against the disc material is increased in proportion to the stellite facing thickness (t). Assuming the load path diverges at a 45° angle, the net effective bearing area will have an outer diameter D_o and inner diameter D_i.

$$D_o = S_o + 2\,t \quad , \quad D_i = S_i - 2\,t$$



Hence, the maximum disc bearing stress is expressed as

$$\sigma_{disc} = \frac{F}{\frac{\pi}{4}[(D_o)^2 - (D_i)^2]}$$

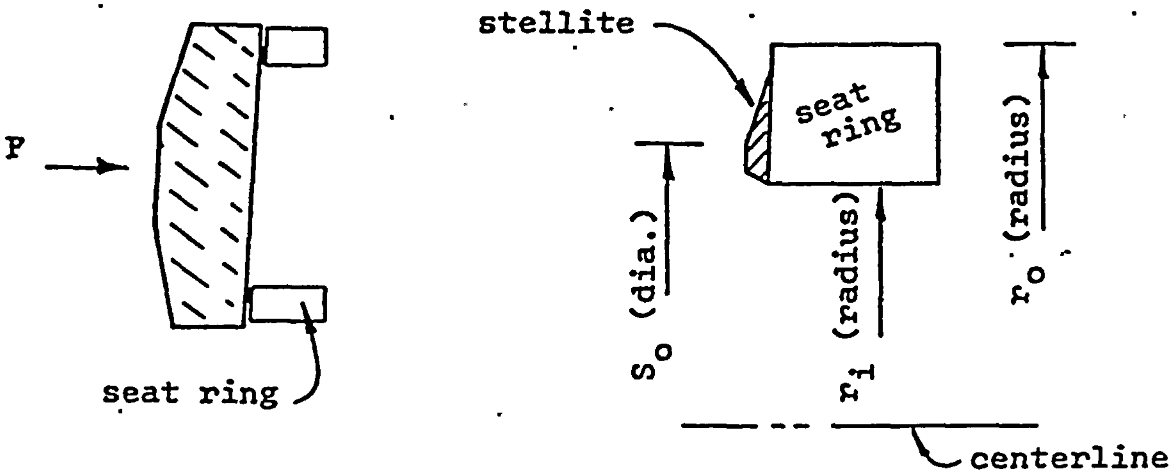
D_o	(in.)	=	19.75
D_i	(in.)	=	18.75
t	(in.)	=	0.125
σ_{disc}	(ksi.)	=	22.22
S_y	(ksi.)	=	29.1 (SA105)

The above bearing stress satisfies the minimum yield strength S_y at 500°F as prescribed in NB-3227.1.

6. Seat Ring

Referring to the valve disc analysis, the maximum force (F) imposed upon the seat ring stellite facing is expressed as

$$F = \frac{\pi}{4}(S_o)^2\ p_s$$



Thus, the meridional stress (σ_s) in the seat ring is

$$\sigma_s = \frac{-F}{\pi[(r_o)^2 - (r_i)^2]}$$

and the circumferential stress (σ_t) is conservatively approximated to be

$$\sigma_t = \frac{-p_s\ r_o}{(r_o - r_i)}$$

which neglects the restraint at the seal weld and stellite facing.

The radial stress (σ_r) is

$$\sigma_r = \frac{1}{2}(-p_s)$$

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S_o (in.) = 19.500

r_o (in.) = 10.873

r_i (in.) = 9.375

F (kip) = 671.96

$\sigma_s = \sigma_1$ (ksi.) = -7.05

$\sigma_t = \sigma_2$ (ksi.) = -16.33

$\sigma_r = \sigma_3$ (ksi.) = -1.13

Thus, the primary membrane stress intensities are

S_{12} (ksi.) = 9.28

S_{23} (ksi.) = -15.20

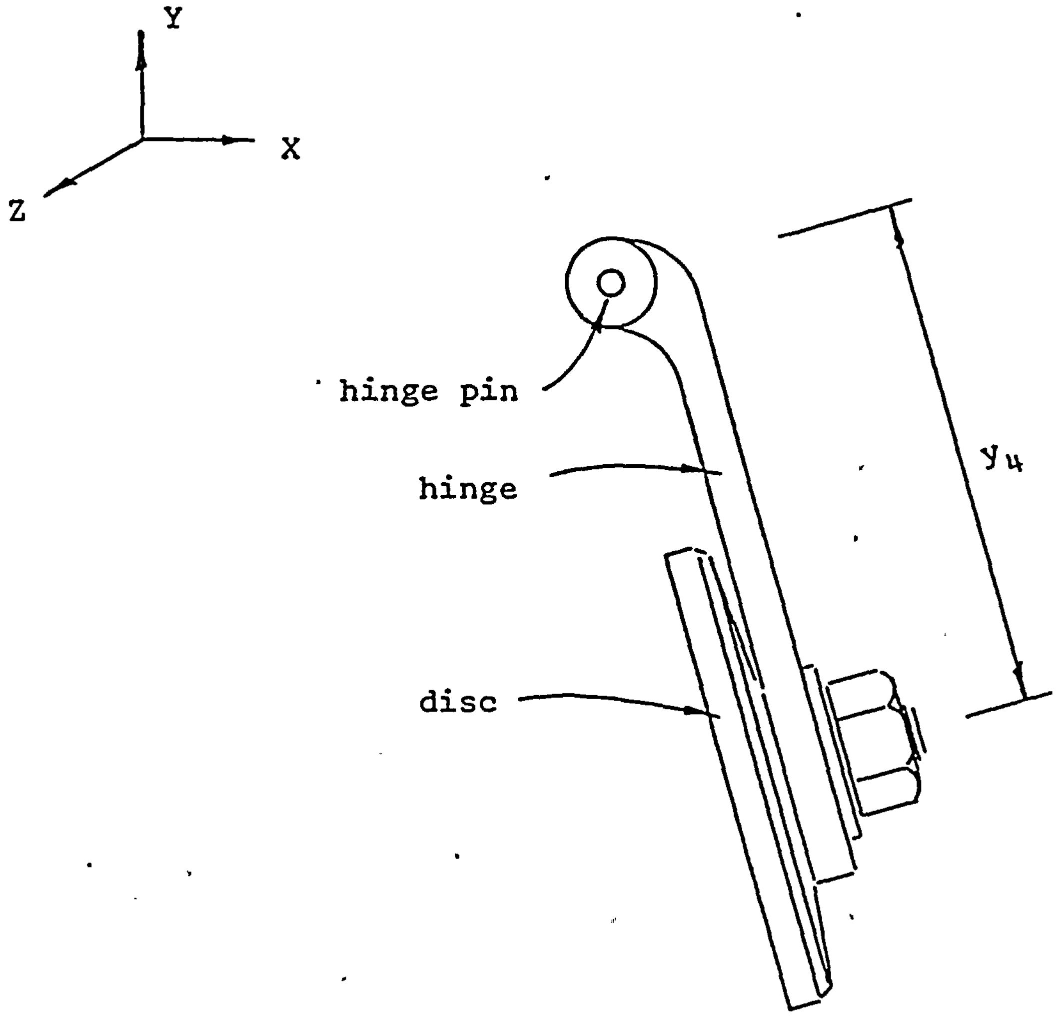
S_{31} (ksi.) = 5.92

S_m (ksi.) = 20.5 (SA516 Gr. 70)

which satisfy the allowable stress limit of S_m at 500°F.

C. DISC AND HINGE ASSEMBLY

As required in the Specification, the disc and hinge assembly are analyzed for the maximum seismic acceleration g_{max}.



1. Loading

Gross stresses in the assembly shall be investigated for the individual parts on the above sketch. For these components, the maximum force resultants are conservatively estimated to be:

Thrust = $w_3\ g_{max}$

Shear = $w_3\ g_{max}$

Moment = $w_3\ (y_4)\ g_{max}$ $\equiv$ M_x

Torque = negligible

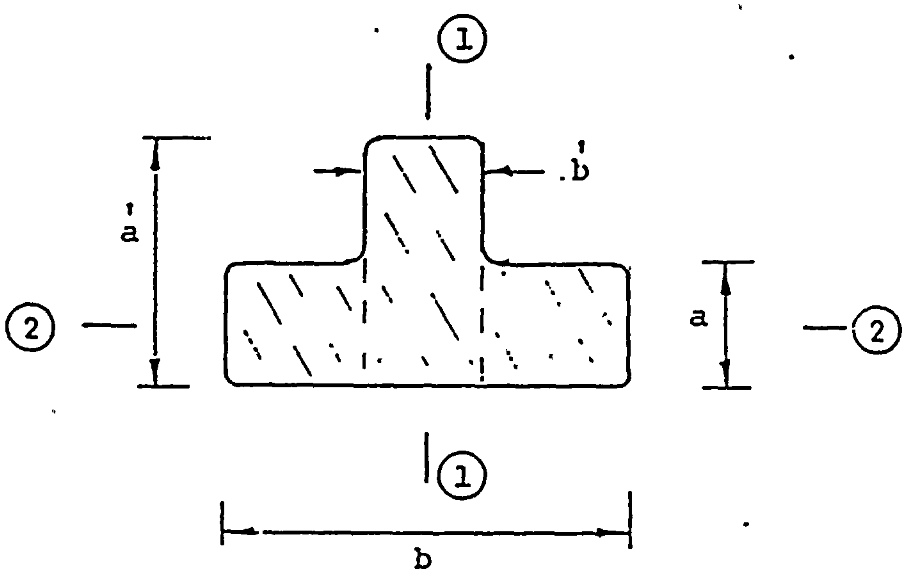
TABLE III-C-1

FORCE RESULTANTS ON DISC-HINGE ASSEMBLY

Thrust	(kip)	=	2.38
Shear	(kip)	=	2.38
Moment	(in-kip)	=	35.77
Torque	(in-kip)	=	0

2. <u>Cross-Sectional Properties</u>

Hinge



$$(\text{Area})_{\text{hinge}} = a\,b + (a' - a)(b')$$

$$(I_1)_{\text{hinge}} = \frac{a\,b^3}{12} + \frac{(a'-a)(b')^3}{12}$$

$$(I_2)_{\text{hinge}} = \frac{b'\,(a')^3}{12} + \frac{(b-b')\,a^3}{12}$$

<u>TABLE III-C-2</u>

<u>CROSS-SECTIONAL PROPERTIES OF HINGE</u>

a	(in.)	= 1.125
a'	(in.)	= 2.750
b	(in.)	= 4.125
b'	(in.)	= 1.250
$(\text{Area})_{\text{hinge}}$	(in.^{2})	= 6.67
$(I_1)_{\text{hinge}}$	(in.^{4})	= 6.84
$(I_2)_{\text{hinge}}$	(in.^{4})	= 2.507

3. Stresses

Considering the disc-hinge assembly as a cantilever beam, the maximum stresses are derived by using the basic equations for combined stress

$$\sigma = \frac{P}{A} \pm \frac{M\,c}{I}$$

$$\tau = \frac{V}{A} \pm \frac{T\,c}{J}$$

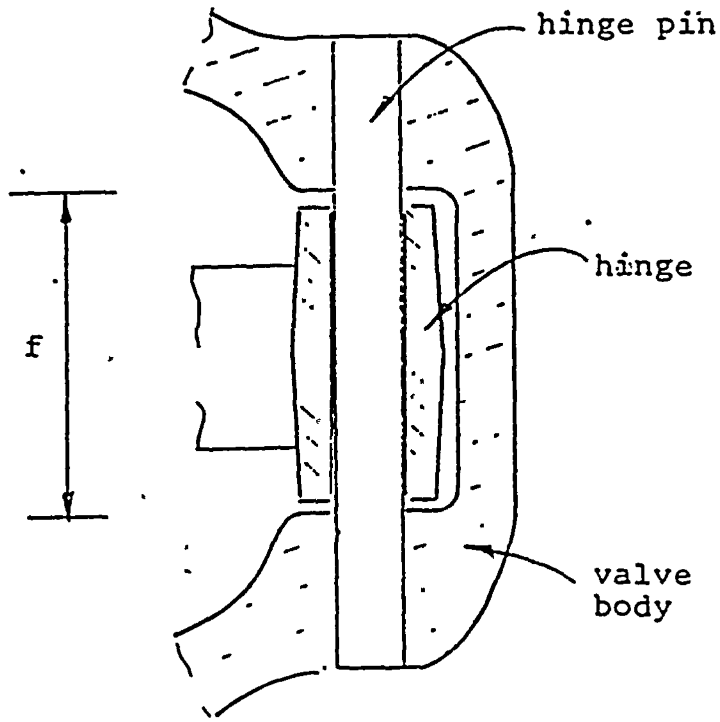
Thus, the maximum stresses in the hinge are expressed as the greater of

$$\sigma_{hinge} = \frac{\text{Thrust}}{(\text{Area})_{hinge}} \pm \frac{\text{Moment}\,(\frac{a}{2})}{(I_2)_{hinge}}$$

or

$$\sigma_{hinge} = \frac{\text{Thrust}}{(\text{Area})_{hinge}} \pm \frac{\text{Moment}\,(\frac{b}{2})}{(I_1)_{hinge}}$$

$$\tau_{hinge} = \frac{\text{Shear}}{(\text{Area})_{hinge}}$$



Also, the maximum shear stress in the hinge pin is derived by

$$\tau_{shaft} = \left(\frac{\text{Shear}}{2} + \frac{\text{Moment}}{f}\right)\left(\frac{1}{\pi(r_p)^2}\right)$$

where r_p = hinge pin radius.

TABLE III-C-3

HINGE ASSEMBLY DIMENSIONS AND STRESSES

σ_{hinge}	(ksi.)	=	19.98
τ_{hinge}	(ksi.)	=	0.36
f	(in.)	=	12.0
r_p	(in.)	=	~~0.3125~~ 1.0" (min. for hinge pin) Telecon 4/23 (Ref. 12)
τ_{pin}	(ksi.)	=	13.60

In the above detailed analysis, the maximum tensile and shear stresses are noted to satisfy 0.9 σ_{yield} and 0.6 σ_{yield}, respectively, for each corresponding material. These mechanical properties are considered at the 450°F design temperature.

A216-WCB σ_{yield} = 29.95 ksi.

Nitronic-60 σ_{yield} = 35.0 ksi. (minimum)

Stone and Webster Engineering Corporation
CALCULATION SHEET

Calculation Identification Number				PAGE
J.O./W.O. NO. 12177	DIVISION & GROUP NM(C)	CALCULATION NO. 1948	OPTIONAL CODE SQE	A-16

REFERENCE 10