COMBUSTION ENGINEERING

NUCLEAR POWER SYSTEMS

COMBUSTION ENGINEERING, INC.
COMPONENT SERVICES
Chattanooga, Tennessee

WATERFORD UNIT NO. 3
STEAM GENERATOR MANWAYS

CENC-1805
CALCULATION NO.

74270
CONTRACT NO.

LOUISIANA POWER AND LIGHT
CUSTOMER

STEAM GENERATOR
COMPONENT

J. E. Roberts	Structural Engineer	3-14-88	
PREPARED	TITLE	DATE	
R B Hale	Structural Engineer	3/15/88	
VERIFIED	TITLE	DATE	
P. L Anderson	Supervisor	3/15/88	
REVIEWED	TITLE	DATE	
W. J. Hall	Manager	3/15/88	
APPROVED	TITLE	DATE	

Robert 3-7-88 PREPARED DATE

Hale 3-15-88 CHECKED DATE

COMBUSTION ENGINEERING

COMPONENT ENGINEERING

SHEET 1 OF 6

CALC. NO. CENC-1805

CONTRACT NO. 74270

TITLE WATERFORD UNIT No. 3 STEAM GENERATOR MANWAYS

TABLE OF CONTENTS

EI-9

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

Roberts 7-7-88 PREPARED DATE

Hale 3-15-88 CHECKED DATE

TITLE

COMBUSTION ENGINEERING

COMPONENT ENGINEERING

SHEET 2 OF 6

CALC. NO. CENC-1865

CONTRACT NO. 74270

WATERFORD UNIT No. 3 STEAM GENERATOR MANWAYS

1. ABSTRACT

THE REQUIRED STUD THREAD ENGAGEMENT IS DETERMINED FOR THE WATERFORD III STEAM GENERATOR MANWAY CLOSURES. THE APPLICATION OF HELICOIL INSERTS FOR STUD HOLE THREAD REPAIR IS ESTABLISHED FOR EACH CLOSURE. DESIGN CONDITIONS ARE EVALUATED IN ACCORDANCE WITH THE REQUIREMENTS OF THE ASME CODE SECTION III.

2. SUMMARY OF RESULTS

THE STUD MINIMUM REQUIRED THREAD ENGAGEMENT IS 1.5" OR 12 FULL THREADS FOR THE PRIMARY MANWAY, AND 1.25" OR 10 FULL THREADS FOR THE SECONDARY MANWAY AT DESIGN CONDITIONS.

APPLICATION OF THE $1\frac{1}{8}$"-8N x $\frac{1}{8}$" HELICOIL INSERT REQUIRES A LARGER DIAMETER HOLE WHICH MEETS THE REINFORCEMENT REQUIREMENTS OF THE ASME CODE. THE SHEAR STRESS IN THE THREADED INSERT IS LESS THAN THE ALLOWABLE STRESS FOR THE MAXIMUM DESIGN STUD LOAD. IT IS CONCLUDED THAT THE HELICOIL INSERT MEETS THE ASME CODE REQUIREMENTS AND MAY BE INSTALLED IN ANY OF THE CLOSURE STUD HOLES. THERE IS NO LIMIT ON THE NUMBER OF HELICOIL INSERTS INSTALLED IN EITHER CLOSURE.

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

Roberts PREPARED	3-7-88 DATE	COMBUSTION ENGINEERING	
Hale CHECKED	3-15-88 DATE	COMPONENT ENGINEERING	SHEET I OF 5
TITLE			CALC. NO. CENC-1805
			CONTRACT NO. 74870

WATERFORD UNIT NO. 3 STEAM GENERATOR MANWAYS

3. REFERENCES

1. "ANALYTICAL REPORT FOR LOUISIANA WATERFORD UNIT NO. 3 STEAM GENERATOR", CENC-1246, DATED SEPTEMBER 1975.
2. ASME BOILER AND PRESSURE VESSEL CODE, SECTION III FOR NUCLEAR VESSELS, 1971 EDITION, AND ADDENDA THROUGH SUMMER 1971.
3. BULLETIN 913B, "HELI-COIL B-PITCH INSERT", HELI-COIL PRODUCTS, DIVISION OF MITE CORPORATION, EL MONTE, CA.
4. BULLETIN 1000, "HELI-COIL SCREW THREAD INSERTS INCH SERIES DESIGN AND PRODUCTION MANUAL", HELI-COIL PRODUCT, DIVISION OF MITE CORPORATION, EL MONTE, CA.

EI-11

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

Roberts PREPARED	3-7-88 DATE	COMBUSTION ENGINEERING	SHEET 4 OF 6
Harker CHECKED	3-15-88 DATE	COMPONENT ENGINEERING	CALC. NO. CENC-1805
TITLE			CONTRACT NO. 74270

WATERFORD UNIT NO 3 STEAM GENERATOR MANWAYS

4. ANALYSIS

	STEAM GENERATOR	
	PRI. MANWAY	SEC. MANWAY
NO. OF STUDS	20	16
THREAD SPEC.	1½-8N-2A	1½-8N-2A
STUD MAT.	SA-540 B-24	SA-540 B-24
BASE MAT.	SA-533 GR.B CL.1	SA-508-CL.2
Sm (STUD) KSI	34.8	36.6
Sm (BASE) KSI	26.7	26.7
d PITCH IN	1.4188	1.4188
PRELOAD/BOLT KIPS	48.75	36.5
DESIGN TEMP	650°F	560°F

A. STUD THREAD ENGAGEMENT

THE AVERAGE SHEAR IS DETERMINED BY THE FOLLOWING FORMULA:

$$\tau = \frac{2F}{\pi d h} \longrightarrow h = \frac{2F}{\pi d \tau}$$

WHERE: d = PITCH DIAMETER
h = THREAD ENGAGEMENT
F = PRELOAD
τ = .6 Sm (ALLOWABLE)

$$h = \frac{2(48.75)}{\pi(1.4188)(16.02)} = 1.37 \text{ in.}$$

FOR PRIMARY MANWAY STUDS USE 1.5" MINIMUM OR 12 FULL THREADS

$$h = \frac{2(36.5)}{\pi(1.4188)(16.02)} = 1.02 \text{ in.}$$

FOR SECONDARY MANWAY STUDS USE 1.25" MINIMUM OR 10 FULL THREADS

EI-12

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

WATERFORD UNIT No. 3 STEAM GENERATOR MANWAYS

4. ANALYSIS

B. PRIMARY MANWAY REINFORCEMENT (REF. 1 SHEET A-42)

$A_1 = 89.769\ in^2$

$A_2 = 8.387\ in^2$

$A_{BOLT\ HOLE} = 3.125(1.625) = 5.078\ in^2$

$A_{AVAILABLE} = A_1 + A_2 - A_{BOLT\ HOLE} = 43.013\ in^2 > A_{REQD} = 31.906\ in^2$

THE REINFORCEMENT REQUIREMENT IS MET BASED ON USING A 1 1/2" HELICOIL INSERT.

C. SECONDARY MANWAY REINFORCEMENT (REF. 1 SHEET A-48)

$A_1 = 1.596\ in.^2$

$A_2 = 10.370\ in.^2$

$A_3 = 4.346\ in.^2$

$A_4 = (4.24)(t_N - t_{RN}) - 1.625(3) - (1.032 - t_{RN})(.375)$

$A_4 = (4.24)(8.561) - 4.875 - (.630)(.375) = 31.187\ in^2$

AVAILABLE $A = A_1 + A_2 + A_3 + A_4 = 47.499\ in^2 > A_{REQD} = 43.452\ in.^2$

THE REINFORCEMENT REQUIREMENT IS MET BASED ON USING A 1 1/2" HELICOIL INSERT.

D. SHEAR STRENGTH OF HELICOIL / STUD - PRIMARY MANWAY

HELICOIL SPECIFICATIONS

MATERIAL : SA-479 TYPE 304 REF. 4

S_m : 16.2 KSI @ 650 REF. 2

SIZE : 1 1/2" - 8N x 2 1/2" REF. 3

STRENGTH OF THE STUD

TENSILE STRESS AREA OF STUD BASED ON SHANK DIAMETER d=1.31"

$$A = \frac{\pi d^2}{4} = \frac{\pi (1.31)^2}{4} = 1.348\ in.^2$$

MAXIMUM DESIGN STUD LOAD AT 650°F

$F = AS_m = 1.348\ (34.8) = 46.91$ KIPS

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

EI 13

Roberts 3-7-88 DATE
PREPARED

Hale 3-15-88 DATE
CHECKED

TITLE

COMBUSTION ENGINEERING
COMPONENT ENGINEERING

SHEET 5 OF 6
CALC NO. CENC-1805
CONTRACT NO 74370

WATERFORD UNIT No 3 STEAM GENERATOR MANWAYS

4. ANALYSIS

D. SHEAR STRENGTH OF HELICOIL / STUD - PRIMARY MANWAY SEAT'D

SHEAR AREA OF HELICOIL

$A_H = \frac{\pi d_s h}{2}$ WHERE d_s = MINIMUM PITCH DIAMETER = 1.4188"

h = THREAD ENGAGEMENT OF HELICOIL = 2.20"
BASED ON 1⅛-8 x 2.5 LONG
INSERT WITH 17.5/8 FREE COILS.
REF. 3.

$A_H = 4.90$ IN²

SHEAR STRESS IN HELICOIL

$\tau_H = \frac{46.91 \text{ KIPS}}{4.90 \text{ IN}^2} = 9.57 \text{ KSI} < 9.72 \text{ KSI} = .6S_m$ ALLOWABLE

THE SHEAR STRESS ALLOWABLE IS SATISFIED FOR THE MAXIMUM DESIGN STUD LOAD.

E. SHEAR STRENGTH OF HELICOL / STUD - SECONDARY MANWAY

HELICOIL SPECIFICATIONS

MATERIAL : SA-479 TYPE 304 REF. 4
S_m : 16.8 KSI @ 560°F REF. 2
SIZE : 1⅛"-8N x 2½" REF. 3

STRENGTH OF THE STUD

TENSILE STRESS AREA OF STUD BASED ON SHANK DIAMETER $d = 1.31$"

$A = \frac{\pi d^2}{4} = \frac{\pi (1.31)^2}{4} = 1.348 \text{ IN}^2$

MAXIMUM DESIGN LOAD AT 560°F

$F = A S_m = 1.348 (36.6) = 49.34$ KIPS

SHEAR AREA OF HELICOIL

$A_N = 4.90 \text{ IN}^2$

SHEAR STRESS IN HELICOIL

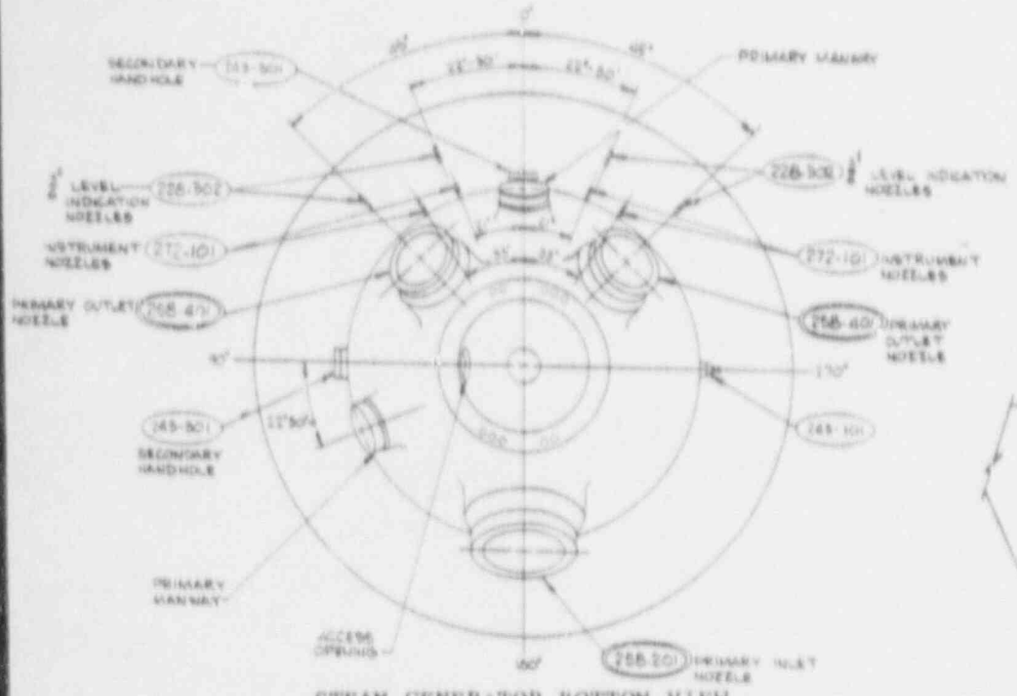
$\tau = \frac{49.34 \text{ KIPS}}{4.90 \text{ IN}^2} = 10.07 \text{ KSI} < 10.08 \text{ KSI} = .6S_m$ ALLOWABLE

THE SHEAR STRESS ALLOWABLE IS SATISFIED FOR THE MAXIMUM DESIGN STUD LOAD.

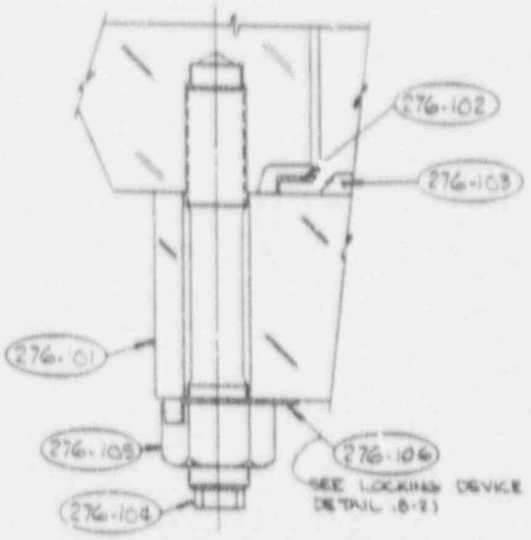
EI-14

REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK	REV.	DATE	BY	CHECK

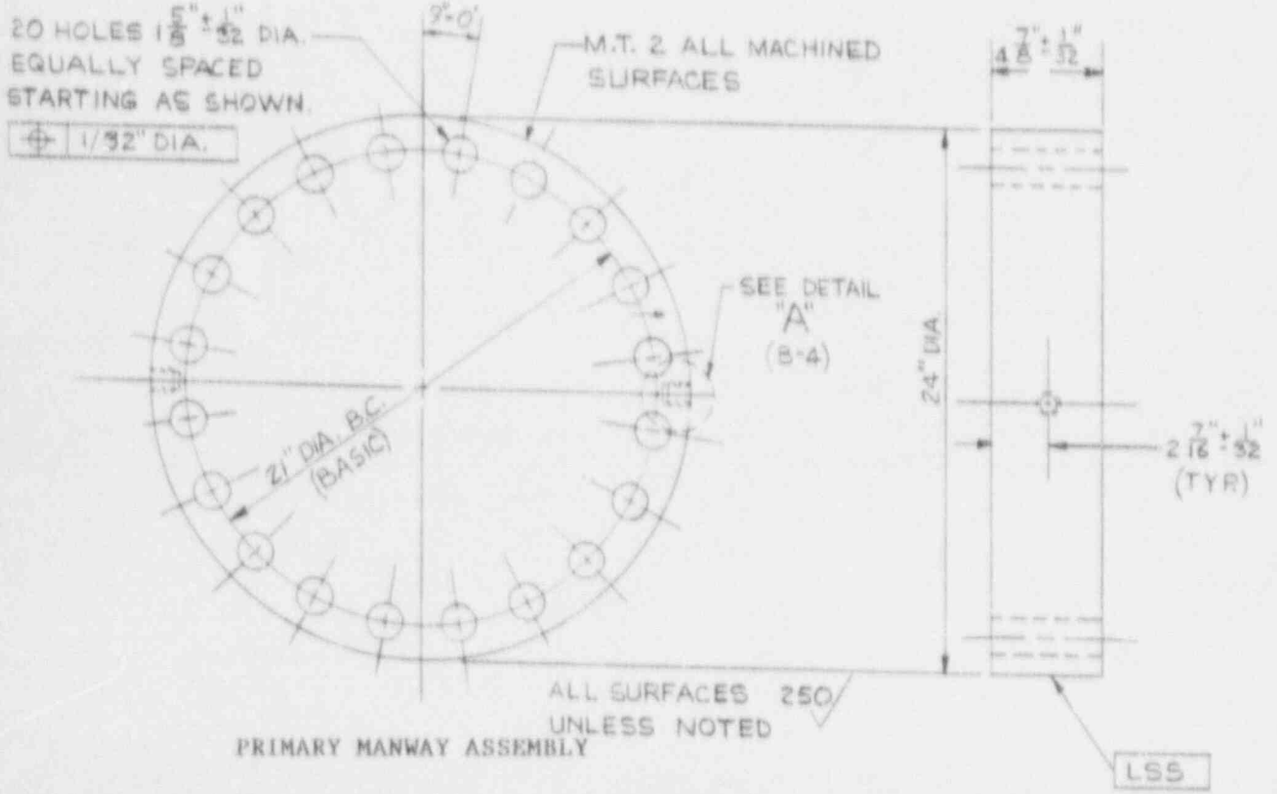
STEAM GENERATOR PRIMARY MANWAY CLOSURE DETAILS



STEAM GENERATOR BOTTOM VIEW



PRIMARY MANWAY CLOSURE



PRIMARY MANWAY ASSEMBLY

Waterford 3
Steam Generator Design Data

Application:	Steam Generator Primary Manway Closure, 20 Studs per Closure
Oper. Pressure/Temperature:	2250 psia/611°F (hot leg)/553°F (cold leg)
Design Pressure/Temperature:	2500 psia/650°F
Stud Size:	1-1/2" - 8N - 2A
Stud Material:	SA-540, Grade B24, Class 3 (Sy) min. yield 130 ksi
Manway Material:	SA-533, Class 2 (Sy) min. yield 50 ksi
Helical Material:	SA-479, Type 304 stainless (Sy) min. yield 150 ksi (after cold working)
Max. Stud Service Stress Intensity, Sm: (from preload, pressure, and operating transients)	36.7 ksi @ 611°F operating temperature 36.7 ksi is less than 71.4 ksi NOTE: ASME Section III allowable at 611°F is 71.4 ksi from 2 x Sm = 71.4 ksi(Sm Design Value = 35.7)

Sy = Yield Stress
Sm = Stress intensity
KSI = Kips per in^{2}