NRC FORM 195 (2-76)

U.S. NUCLEAR REGULATORY COMMISSION

NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL

TO: Mr. D. L. Ziemann	FROM: FPL Miami, Fla. R.E. Uhrig	DOCKET NUMBER 50-335
		FILE NUMBER
		DATE OF DOCUMENT 6-30-76
		DATE RECEIVED 7-6-76
☒ LETTER ☒ ORIGINAL ☐ COPY ☐ NOTORIZED ☒ UNCLASSIFIED	PROP / INPUT FORM	NUMBER OF COPIES RECEIVED 1 signed

DESCRIPTION Ltr re their 6-22-76 ltr....trans the following:

ENCLOSURE Addl info on "Reactor Containment Fan Cooler Motor General Design Philosophy"..

(1 cy encl rec'd)

PLANT NAME: St. Lucie Unit 1

ACKNOWLEDGED

Do Not Remove

DHL 7-7-76

FOR ACTION/INFORMATION

SAFETY		ENVIRO
ASSIGNED AD:		ASSIGNED AD:
✓ BRANCH CHIEF:	(6) Ziemann	BRANCH CHIEF:
✓ PROJECT MANAGER:	Silver	PROJECT MANAGER:
✓ LIC. ASST.:	Diggs	LIC. ASST.:

INTERNAL DISTRIBUTION

✓ REG FILE	SYSTEMS SAFETY	PLANT SYSTEMS	SITE SAFETY &
✓ NRC PDR	HEINEMAN	TEDESCO	ENVIRO ANALYSIS
✓ I & E (2)	SCHROEDER	BENAROYA	DENTON & MULLER
✓ OELD		LAINAS	
✓ GOSSICK & STAFF	ENGINEERING	IPPOLITO	ENVIRO TECH.
MIPC	MACCARRY	KIRKWOOD	ERNST
CASE	KNIGHT		BALLARD
HANAUER	SIHWEIL	OPERATING REACTORS	SPANGLER
HARLESS	PAWLICKI	STELLO	
			SITE TECH.
PROJECT MANAGEMENT	REACTOR SAFETY	OPERATING TECH.	GAMMILL
BOYD	ROSS	✓ EISENHUT	STEPP
P. COLLINS	NOVAK	✓ SHAO	HULMAN
HOUSTON	ROSZTOCZY	✓ BAER	
PETERSON	CHECK	✓ BUTLER	SITE ANALYSIS
MELTZ		✓ GRIMES	VOLLMER
HELTEMES	AT & I		BUNCH
SKOVHOLT	SALTZMAN		✓ J. COLLINS
	RUTBERG		KREGER

EXTERNAL DISTRIBUTION

			CONTROL NUMBER
✓ LPDR: Ft. Pierce, Fla.	NAT LAB:	BROOKHAVEN NAT LAB	
✓ TIC:	REG. VIE	ULRIKSON(ORNL)	6694
✓ NSIC:	LA PDR		
ASLB:	CONSULTANTS		
✓ ACRS 16 CYS HOLDING			

NRC FORM 195 (2-76)

FLORIDA POWER & LIGHT COMPANY

June 30, 1976
L-76-243

Office of Nuclear Reactor Regulation
Attn: Mr. Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Ziemann:

Re: St. Lucie Unit No. 1 (Docket 50-335)
Conditions of License

My letter L-76-233 to you dated June 22, 1976, provided information pertaining to demonstration that the requirements of Conditions of License E.1 and E.2 have been satisfied. My letter L-76-239 to you dated June 28, 1976, provided a commitment to remove the temporary earthen construction dike associated with construction of the permanent ultimate heat sink (UHS) barrier dam required by Condition of License E.2 by July 31, 1976.

Information concerning FPL compliance with Condition of License E.3 was forwarded to you by my letter L-76-227 of June 14, 1976.

Information concerning Condition of License E.4 was forwarded to you by my letters L-76-208 and L-76-222, dated June 14, 1976, respectively. A commitment to modify the St. Lucie Plant Security Plan to address the items transmitted to FPL by Mr. R. D. Silver of your office by telecon on June 23, 1976, was provided in my letter L-76-237 to you dated June 25, 1976.

On June 29, 1976, a meeting was held between Florida Power & Light Company and the Nuclear Regulatory Commission Staff in Bethesda to review the status of St. Lucie Unit No. 1 Conditions of License, E.1, E.2 and E.3.

As indicated above, the requisite information concerning UHS erosion protection (Condition E.1) and the UHS permanent barrier dam (Condition E.2) has already been supplied which, we believe, fulfills our June 30, 1976, requirement to satisfy these two license conditions. We also agree to provide, by August 31, 1976, the additional information concerning flanking

6694

of the sheetpile groins and bulkheads requested by the Staff in the June 29, 1976 meeting. Until this supplementary information is provided and reviewed by the Staff, the following interim operational action will be established: If a hurricane or a tropical cyclone landfall is predicted for eastern and southern Florida, FPL will notify the Nuclear Regulatory Commission. The Facility Review Group will assess whether or not power operation of St. Lucie Unit No. 1 is to be continued. Continued power operation will be with the concurrence of the Company Nuclear Review Board.

The requisite information concerning the balance of plant electrical equipment QA audit (Condition E.3) has been supplied as indicated above, thus fulfilling our June 30, 1976, requirement on this condition of license. Additional information regarding containment fan cooler motor qualification presented to the Staff in the June 29, 1976, meeting at their request is also enclosed. We intend to also provide the Staff with further information regarding the analytical techniques employed in the seismic analysis of the containment fan cooler units by August 31, 1976.

On the basis of the above, FPL believes that it has satisfied all of the conditions contained in Section E of Enclosure 1 to the St. Lucie Unit No. 1 Operating License, and hereby requests that Section E be deleted and that authorization for operation beyond June 30, 1976, be granted.

Yours very truly,

J.A. De Mastry Jr.

Robert E. Uhrig
Vice President

REU/LLL/hlc

Attachment - (Responses to NRC Staff Questions 1-4 on Condition of License E.3)

cc: Norman C. Moseley, Region II
Jack R. Newman, Esq.

REACTOR CONTAINMENT FAN COOLER MOTOR

GENERAL DESIGN PHILOSOPHY

Dated 6-30-76

The design of the Reactor Containment Fan Cooler Motor results from a series of requirement and selection processes which begins with a selection of the "overall" Reactor Containment Fan Cooling System Design. Once the overall system has been identified, the main cooling coil heat exchanger requirements are established. These requirements are based on containment temperature requirements for normal, accident and/or post accident conditions, whichever is limiting.

Following the establishment of the main cooling coil requirements, a fan design is chosen to be coupled to the main coil. At this point the fan blading and fan speed are selected as part of the overall fan design. Based on the selection of fan design and containment cooling requirements, the fan horsepower motor requirements are determined for all three operating conditions (normal, accident and post accident). The motor designer then selects an adequate motor frame for the intended load application. The motor designer calculates the motor losses including the steady heat loss which must be removed to maintain normal winding temperature. This total kilowatt loss taken together with the shaft driven fan pressure-volume curve and cooling water temperature establishes the motor heat exchanger design. Electrical motor characteristics, such as efficiency, are then calculated and verified after the windings have been selected to meet specified horsepower, rise and torque valves.

In specifying the design features of the motor, the checklist provided in response to question 1 below is utilized to insure WCAP 7829 applicability. Specific motor heat exchanger requirements for St. Lucie's fan cooler motors are provided in response to question 3 below.

1. Westinghouse has stated the motors qualified by WCAP 7829 had a NEMA frame 588.5. PSL-1 has a frame size 5010L. Provide motor characteristics changes, if any, for PSL over motor qualified by Westinghouse due to frame changes.

Response:

Table 3 is a listing of the specific electrical motor characteristics associated with PSL-1 Frame 5010L and WCAP Frame 588.5. It should be noted that WCAP Frame 588.5 has an ultimate 600 HP 2 or 4 pole capability and has been used up to a 300 HP capability for containment fan coolers in various plants (see Table of FPL Submittal of 6/14/76). The PSL-1 5010L Frame has an ultimate 700 HP 2 pole capability and is used at St. Lucie to a 150 HP maximum design basis profile, thus being applied considerably more conservatively.

The PSL-1 design features shown in attached Table 1 list the motor design features required to comply with motor post accident WCAP 7829 qualification profile and are noted with references to document their conculsion in the design of the PSL-1 motor. As noted in Table 1, these design features are qualified per Table 2 of WCAP 7829. (Page 10).

Current, efficiency, power factor and other electrical characteristics (see Table 3) are calculated and verified after frame/winding/horsepower/temp. rise/torques are chosen for the specific application. Calculations are based upon commonly known motor design expression which have been specifically verified by actual complete factory tests for the PSL-1 machine. Results of these tests are shown on attached Westinghouse 9/21/73 Factory Test Data.

TABLE 1

oject ST. LUCIE File No. XARN 80010 Date June 26, 1976

CONTAINMENT MOTOR CHECKLIST
DESIGN FEATURES REQUIRED TO COMPLY WITH
MOTOR POST ACCIDENT STEAM TEST WCAP 7829

	REFERENCE DOCUMENT
. Heat exchanger supplied by others and mounted under motor.	DWG. 8223D25 Rev. 1.
. Labyrinth sealed antifriction bearings. (Bearings heat stabilized.) a. Rear bearing seal assembly similar to W̲LAC Dwg. 58C1636. b. Inner bearing seal similar to W̲LAC Dwg. 58C1636. c. Outer seal per sketch sheet signed by J. Boyd on 4-7-70.	Buffalo letter of Aug. 1, 1973 by A. F. Pierpaoli
. One bearing must be locked.	DSF 02717
. Bearing looseness - 0.0012 to 0.0023 in.	Dwg. 4198A48
. Grease drain for vertically mounted motors shall be horizontal; for horizontally mounted motors drains shall be vertical.	Dwg. 8223D25 Rev. 1
. Lubricant shall be W̲ S#773A773-G05 grease.	DSF 02717
. Thermalastic epoxy Class F insulation with one class above N.P. rating i.e. 2300 volt insulation using hand layed mica for a 460 volt motor.	DSF 02717
3. Space heaters required.	Dwg. 8232D16 Rev. 5
). Vibraswitch required.	Dwg. 8232D16 Rev. 5
). Ground pad.	Dwg. 8232D16 Rev. 5
. Oversized conduit box.	Dwg. 8232D16 Rev. 5
2. Lead length to extend to center of conduit box.	Dwg. 8232D16 Rev. 5
3. Flexible leads and #66111B lead cable silicone rubber insulated	DSF 02717
4. Lead seals and other holes in frame to be sealed with Ecobond #787	Dwg. 4198A33 Rev. 1
5. 1.15 service factor - 70°C rise by resistance - 40°C air 60°C rise by resistance - 50°C air	Dwg. 8232D16 Rev. 5
5. Spring loaded, tip grounded bearing thermocouple if required.	N/A
7. Six 10 ohm stator RTD's if required.	N/A

		REFERENCE DOCUMENT
18.	Motor lifting lugs.--	Dwg. 8232D16 Rev. 5
19.	Water drain fittings required on motors without heat exchangers-	N/A
20.	No aluminum or zinc rotors-only brazed copper rotors.-----------	E-Spec. G-677107 Rev. 2
21.	Alkyd primer removed from all brackets, frames and conduit boxes by sand or shot blasting. The first coat over bare metal to be epoxy WPDS53841FD. Normal process coatings applied to stator also to be applied to other exposed metal parts. Others will--- apply subsequent final coats. Rotor shaft shall be unpainted.--	Dwg. 8232D16 Rev. 5 D/N 005189
22.	Omit internal paint finishes. ------------------------------	-----
23.	Windings can be single or dual.----------------------------	Dwg. 8232D16 Rev. 5
24.	Insulation hot spot in steam to be 200°C.----------------------	-----
25.	Any motor mounting configuration is satisfactory---------------	-----
26.	Quality control QCS-1 is required.-----------------------------	P.O. 546-CXF-162747
27.	Parallelism between frame feet and air duct flanges to be ± 0.020 inches.--	Dwg. 8232D16 Rev. 1

ST LUCIE Table 3 & WCAP-F

TYPICAL MOTOR DESIGN PARAMETERS COMPARED TO TEST MACHINE

Operation Status	St. Lucie									Test Machine		
	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event
1. MOTOR PARAMETERS												
No. of Motors per plant	4	--	--							1	--	--
Frame Size (NEMA)	5010-L	--	--							538.5	--	--
Frame Wt. #	2620	2620	2620							3300	--	--
Bearing Rise °C	15	9	9-15							15	10	10
Inlet Air, °C	39.1	43.5	39.1-43.5							76	82	44
Rise of Ins. °C	32.3	62.3	32.3-62.3							16	40	[illegible]
Total Temp. °C	71.4	105.8	71.4-105.8							92	122	[illegible]
Voltage + 10%	460	460	460							460	460	460
Frequency + 5%	60	60	60							60	60	60
Horse Power	75	150	100							20	19.95	15.25
Poles	12	12	12							4	6	6
Full Load R.P.M.	596	592	594							1781	1193	1193
Service Factor	1.15	1.15	1.15							1.15	1.15	1.15
Full load amps.	138	203	157							26.1	25.5	25.5
Locked Rotor Amps.	1055	1055	1055							110.0	144.3	144.3
Starting Torque %	194	96	145							58	72.3	72.3
Full Load Torque ft. #	660.5	1330	884							59	88	88
Pullout Torque %	491	244	367							190	215	215
Efficiency, F.L.	90.5	91.5	91.4							80.6	87.7	[illegible]
Power Factor, F.L.	53.9	66.8	74.8							92.7	87.4	87.4
Power Factor Locked	26.1	26.1	26.1							28.5	33.6	33.6
K.P. Code letter	J	F	H							D	G	G
Number of windings	1	1	1							2	2	2
Starts/hr at amb.	4*	4*	4*							4	4	4
Starts at rated total temp.	1	1	1							2	4	4
Motor Losses	~~5.0~~ 5.9 KW	~~10.0~~ 10.FKW KW	6.7KW							3597	2116	2116
2. REQUIRED AUXILIARIES												
Heat Exchanger	X	X	X							X	X	X

AS TO NOT UPDATED

(1) Motors are idle in normal condition

Table 3 (Continued)

TYPICAL MOTOR DESIGN PARAMETERS COMPARED TO TEST MACHINE

Operation / Status	St. Lucie			Plants E, F			Plant G			Test Machine		
	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event	Normal	D.B. Event	Post Event
3. ACCESSORY EQUIPMENT												
Bearing T.C.	NO	--	--							YES	--	--
Bearing Vibraswitch	YES	--	--							YES	--	--
Stator R.T.D.	NO	--	--							YES		
4. APPLICATION	Fan Cooler			Air Recirculation			Fan Cooler			Any		

Westinghouse Electric Corporation

BUFFALO, N.Y.

5

Date 9/21/73

Purchaser WNES-Florida Power & Light　　Stock Order No. 72F90923

G.O. No. 546-CXF-162747-L7　H.P. 75　Volts 460　Phase 3　Class F Insulation

Apparatus 5010L HSW2　Poles 12　R.P.M. 596　Cycles 60

Serial	x 4	2	x	COMMENTS
HP	150	75		
Amperes Per Terminal at no load 460 Volts	112.6			
Watts Input at no load	3650			
Stator Res. (T-T) at 75° C - ohms	.0705			Heater
Starting Winding Res. at 75° C - ohms				120V - 1.99A
Rotor Res. (bet rings) at 75° C - ohms				Dielectric - 1240V - 1 min.
LOSSES IN WATTS AT FULL LOAD				
Stray Load Loss	1824	815		Stator Res. at 26°C
Stator I^2R Loss	4807	2311		
Rotor I^2R Loss	1553	378		.05935
Core Loss	2119	2119		.05935
Friction and Windage Loss 10560	257	260	5883	.05935
% Efficiency - Full Load	91.4	90.5		
- ¾ Load	91.5	88.9		
- ½ Load	90.5	85.3		Stator Bore - 16.869
% Power Factor Full Load	74	53.9		Rotor Dia. - 16.797
- ¾ Load	66.8	44.6		
- ½ Load	53.9	33.2		Vibration
RPM at Full Load	592	596		F-.0005
Amperes Per Term. at full load	207.6	143.9		R-.0004
KW input at full load	122.46	61.835		A-.0003
Amperes per Term-Rotor locked 460 V	1055			
KW input - Rotor locked	262			
Max. Sec. Volts between rings				
Sec. Amps per ring at full load				
Full Load Torque (F.L.T.) in lb. ft.	1330	660.6		
Max. Torque in % of F.L.T.	250	487		
Starting Torque in % of F.L.T.	115	232		
End Play Tested	O.K			
Balance Tested	O.K			
Stator Ins Tested 2000 V 60 Sec.	O.K			
Rotor Ins Tested V Sec.				
TEMPERATURE TESTS				
Length of Test in hours	5.5	5.5		
Volts	460	460		
% Normal Full Load Amp.	100.5	99.6		
Temp. Rise in degrees C — Stator Copper by Res.	62.3	32.3		
Temp. Rise in degrees C — Stator Iron	55	28		
Temp. Rise in degrees C — Rotor Copper				
Temp. Rise in degrees C — Rotor Iron				
Room temperature in °C	34	36		

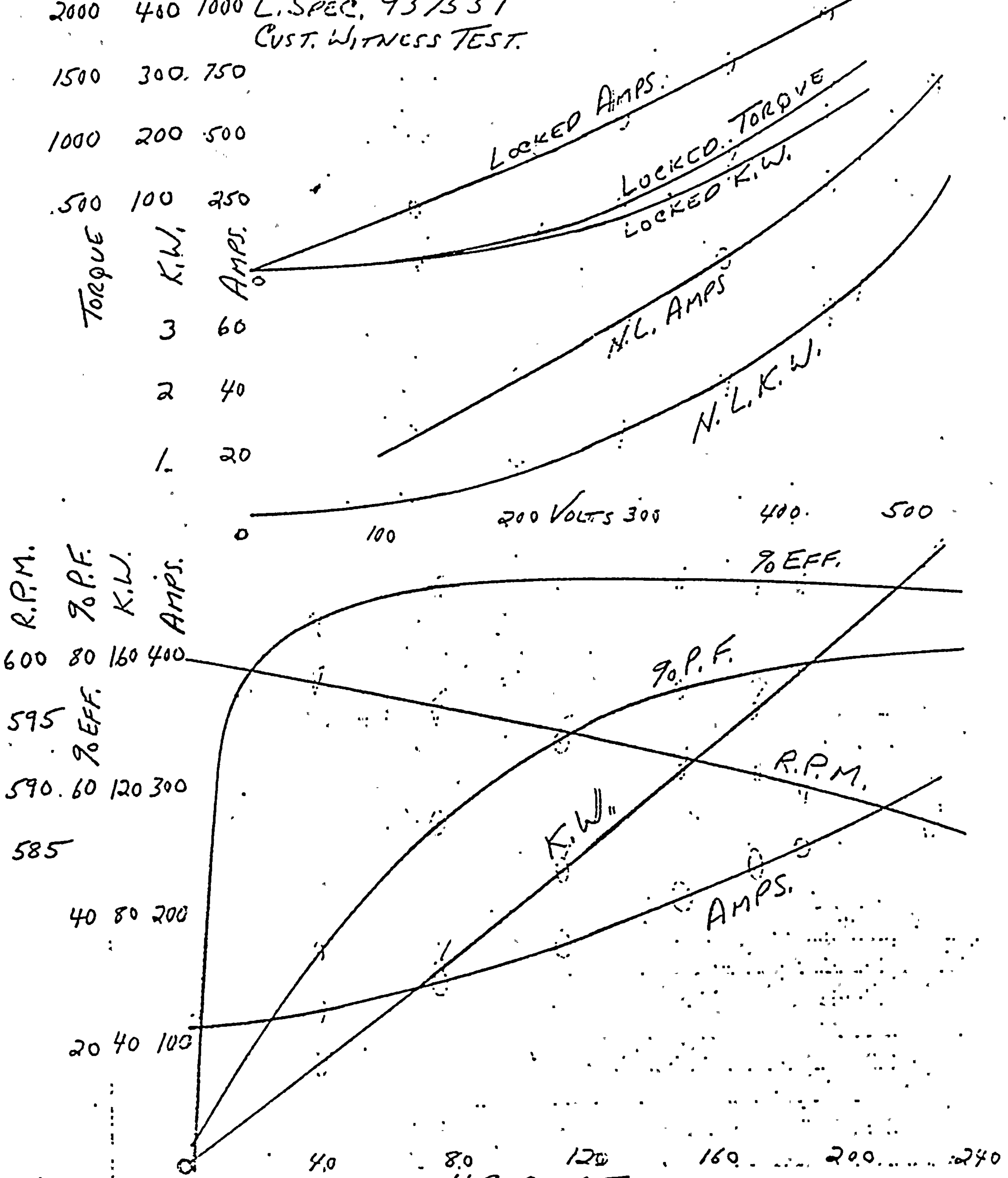
The above is a true and correct record of data obtained from tests made at the works of Westinghouse Electric Corporation.

REPORT OF TESTS ON INDUCTION MOTORS　　Signed R. H. Knoller　Engineer

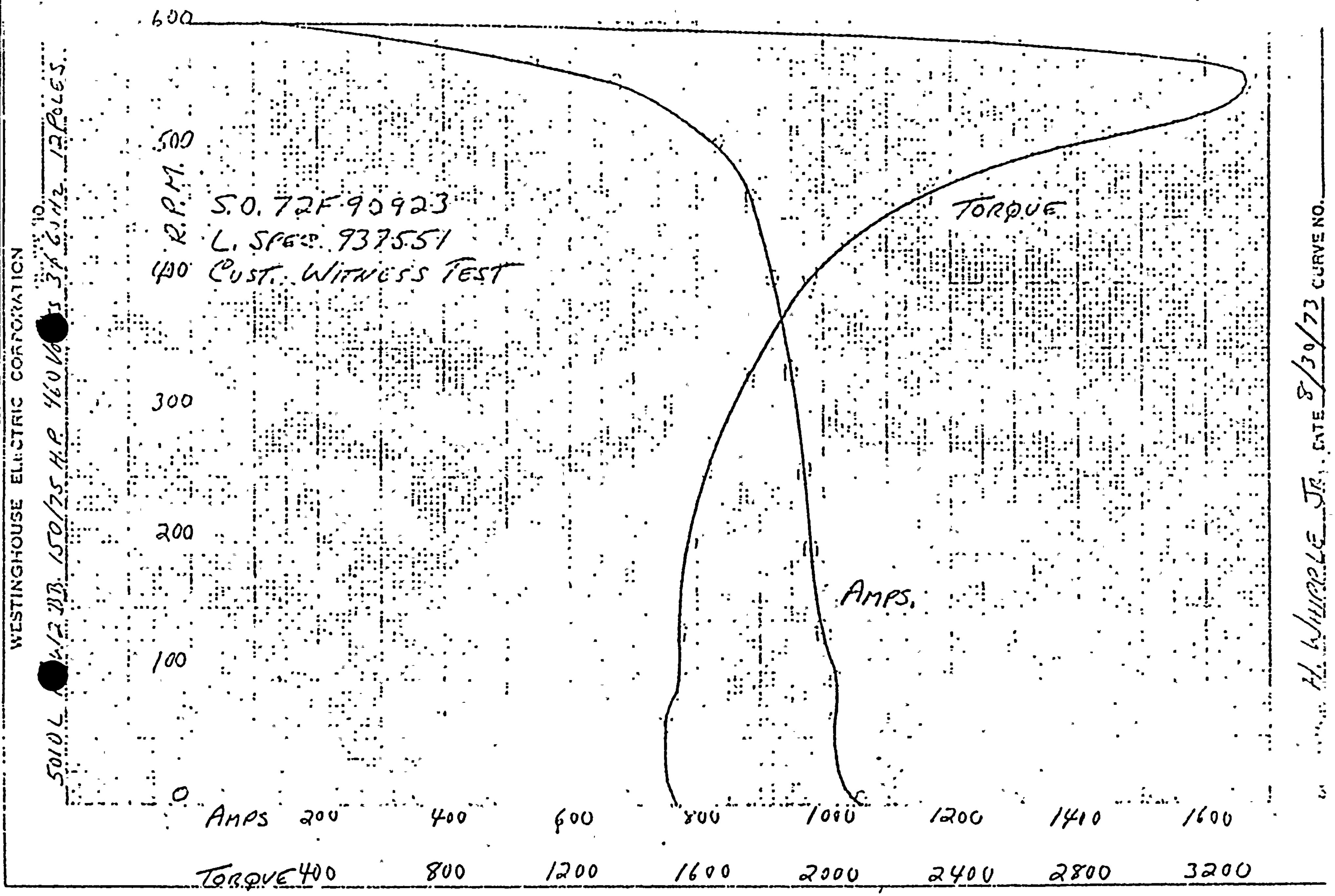
FORM 2958K

[illegible]

5010L 150/75 H.P. 460 Volts 3φ 60 Hz 10 Poles
S.O. 2F 90923
L. Spec. 937551
Cust. Witness Test.



H. Whipple Jr 8/19/73



WESTINGHOUSE ELECTRIC CORPORATION
5010L 1/2 BB 150/75 H.P. 460V 3Ø 60Hz 12 POLES
R.P.M.
S.O. 72F 90923
L. SPEC. 937551
CUST. WITNESS TEST
TORQUE
AMPS.
600
500
400
300
200
100
0
AMPS 200 400 600 800 1000 1200 1400 1600
TORQUE 400 800 1200 1600 2000 2400 2800 3200
H. WHIPPLE JR.
DATE 5/30/73
CURVE NO.

WESTINGHOUSE ELECTRIC CORPORATION
MOTOR DIVISION, BUFFALO, N.Y.

REPORT OF COMMERCIAL TESTS — INDUCTION MOTOR

DATE	STYLE NO.	S.O.NO.	G.O.NO.	PURCHASER'S ORDER NO.
9/18/73		72F90923	546-CXF-162747-L7	

PURCHASER
WNES - Florida Power & Light

NAME PLATE DATA

H.P.	SPEED	PHASE	FREQ.	VOLTS	AMPS.	TYPE	FRAME	TEMP. RISE	TIME RATING	DESIGN (LETTER)	LOCKED KVA CODE LETTER
75	596	3	60	460	138	HSW2	5010L	60°C	Cont.		M

TEST CHARACTERISTICS

SERIAL NO.	NO LOAD					1 Phase LOCKED ROTOR				OPEN CIRCUIT VOLTAGE (WOUND ROTOR)	DIELECTRIC TEST
	VOLTS	FREQ.	SPEED	AMPS.	Watts	VOLTS	FREQ.	AMPS.	Vibration		
1	460	60	600	110.6	3680	452	60	850	F-.0001		2000
				112					R-.00006		
				113					A-.00005		
			Stator Res. at 26.5°C - .0603 - .0603 - .0603								
Heater	120			2.03							1240
2	460	60	600	112.4	3920	452	60	850	F-.00015		2000
				113.6					R-.00017		
				113.6					A-.0001		
			Stator Res. at 31.5°C - .0608 - .0608 - .0608								
Heater	120			2.05							1240
3	460	60	600	114	3600	460	60	890	F-.00022		2000
				116					R-.00012		
				114					A-.00006		
			Stator Res. at 29°C - .0605 - .0605 - .0605								
Heater	120			2.05							1240

TESTS ON THIS MOTOR
DUPLICATE

APPROVED BY [illegible] DATE 9/18/73
ENGINEER

WESTINGHOUSE ELECTRIC CORPORATION
MOTOR DIVISION, BUFFALO, N.Y.

REPORT OF COMMERCIAL TESTS – INDUCTION MOTOR

DATE	STYLE NO.	S.O.NO.	G.O.NO.	PURCHASER'S ORDER NO.
9/25/73		73F56688	546-CXF-162747-L7	

PURCHASER
WNES

NAME PLATE DATA

H.P.	SPEED	PHASE	FREQ.	VOLTS	AMPS.	TYPE	FRAME	TEMP. RISE	TIME RATING	DESIGN (LETTER)	LOCKED KVA CODE LETTER
75	596	3	60	460	138	HSW2	5010L	60°C	Cont.		M

TEST CHARACTERISTICS

SERIAL NO.	NO LOAD VOLTS	NO LOAD FREQ.	NO LOAD SPEED	NO LOAD AMPS.	Watts	1 Phase LOCKED ROTOR VOLTS	LOCKED ROTOR FREQ.	LOCKED ROTOR AMPS.	Vibration	OPEN CIRCUIT VOLTAGE (WOUND ROTOR)	DIELECTRIC TEST
1	460	60	600	118	4000	400	60	747	F-.0005		2000
				118					R-.00045		
				116.2					A-.00027		
		Stator Res. at 26.5°C - .05975 - .05985 - .05985									
Heater	120			2.09							1240

Water Test

Water Temp. - °C - 25.6

Insul. Res. in Air - 1 Min. - 5000 megohms

Insul. Res. in Water - 1 Min. - 3000 megohms

Dielectric Test in Water - 500V - 1 Min. - O.K.

Insul. Res. in Water - 1 Min. - 3000 megohms

Insul. Res. in Air - 1 min. - 10000 megohms

TESTS ON THIS DUPLICATE MOTOR

APPROVED BY [signature] ENGINEER DATE 9/21/73

G.O. #546-CXF-162747-L7 S:O.# 72F90923

WATER TEST

SERIAL #	1	2	3	4
Water Temp. °C	21.1	25	25	25.6
Insul. Res. in Air - 1 Min.	6000	2500	2500	5000
Insul. Res. in Water - 1 Min.	5000	2000	1800	3000
Dielectric test in water				
500V - 1 Min.	O.K.	O.K.	O.K.	O.K.
Insul. Res. in Water - 1 Min.	5000	2000	1700	4000
Insul. Res. in Air - 1 Min.	10000	5000	5000	10000

A. C. MOTOR INSPECTION TAG

WESTINGHOUSE FORM 30333

Mead Lead Leads

ASSEMBLY

S. O. 72F90923 Serial #1

	Name
Outline Dwg. 8232D16	
Eyebolt tight and correct length ✓	
Winding neat and free from damage ✓	
Inside of frame clean and free from cuttings	
Stator bore 16.867	
Rotor bore 16.796	
Bearing S# Front 144 9546	
Bearing S# Rear 385 D261 4216	
Rotor fan for correct rotation	
Assembly std. ✓ Opp. std. ✓	
Oil or grease pipe fittings ok ✓	
Oil rings Oil Level ✓	173
End play ✓	
Shaft Clearance ✓	
Shaft extension per outline	
Shaft run out 12.484	
Face run out	
Fit run out	
Collector rings eccentricity	
Brushes S#	
Brushes line up with rings	
Revolving and bearing seal ok	
Insulation test 1600V [illegible] 3000V	[illegible]
Lubrication ok	
Explosion proof, leads spaced and sealed	
Does information call for thermoguard. brake adapter, speed switch, etc.	
Remarks:	

[illegible] = 1407 [illegible] = 570

[illegible signature]

Res = .061 Ω

7ZF-7C-[illegible] - W 1

SHIPPING

Following items as per information:

Nameplate	Nameplate stamping
Frame	Covers
Shaft Ext.	Conduit Box
Connectors	Eye Bolt
Lead Ext.	Assembly
Keys	Nuts and Washers
Finish	Conn. Plate
Grease pipes and fittings	
Customer mounting dimensions	

Does information call for:

Coupling	Shims
Fan	Thermometers
Dowel pins	Air shield
Shunts	Shaft guard
Rotation plate	Thermoguard
Brake adapter	Exp. proof plate

Is inside of machine free from cuttings and foreign material?

Are machined parts slushed?

Tested by:

5501 correctly filled out and signed

Remarks:

Inspector__________________ Date 9/17/77

S.O. 72F50923 Ser. 1 Size 5010

473754-755 Flex lead-cut stringers

Prebake	Heater & Therm.	1st Vac.	turn 2nd Vac.	turn 3rd Vac.	turn 4t
3 hrs at 150° or 4 hrs at 135°		4 hrs at 150	4 hrs at 150°	4 hrs at 150°	4 hrs a
Oven 1 Date 8/7/73 Out 10:00PM	Heater H [illegible] 5/8	Tank # 3 Oven # 7 Date 8/11 Out 11:50AM	Tank # 3 Oven # 7 Date 8/12 Out 8:30PM	Tank # 3 Oven # 5 Date 8/13 Out 8:30PM	Tank # 1 Oven #6 Date 8/14 Out 11:00PM

Send to WT	Passed-Dry Out	Open Epoxy 8 Hr	Notes	Paint
10/12 BU-910-A	3 hrs. at 150° or 4 hrs. at 135° Oven # 5 10/5/73 Out 6:30PM	at 150° Oven #5 12440-2 1:00AM 2692-6 10/17/73		

A. C. MOTOR INSPECTION TAG

WESTINGHOUSE FORM 30333

Seal Leak [illegible]

ASSEMBLY

S. O. 72F 90923 Serial #2	
	Name
Outline Dwg. 8232I216	
Eyebolt tight and correct length	
Winding neat and free from damage	
Inside of frame clean and free from cuttings	
Stator bore 16.865	
Rotor bore 16.795	
Bearing S# Front 1449546	
Bearing S# Rear 38510261826	
Rotor fan for correct rotation	
Assembly std. Opp. std.	
Oil or grease pipe fittings ok	
Oil rings Oil Level	
End play —	
Shaft Clearance —	
Shaft extension per outline 6.5 3.375 x 7/8 x 45	
Shaft run out ℄ 12.190	
Face run out	
Fit run out	
Collector rings eccentricity	
Brushes S#	
Brushes line up with rings	
Revolving and bearing seal ok	
Insulation test Meter Range 3000V	∞ 8/1/73
Lubrication ok	
Explosion proof, leads spaced and sealed	
Does information call for thermoguard. brake adapter, speed switch, etc.	

Remarks: [illegible]

[illegible]

Heater = 467 [illegible] = 57 Ω

Rez = .061 Ω

72F99773-#2

SHIPPING

Following items as per information:

Nameplate

Frame

Shaft Ext.

Connectors

Lead Ext.

Keys

Finish

Grease pipes and fittings

Customer mounting dimensions

Nameplate stamping

Covers

Conduit Box

Eye Bolt

Assembly

Nuts and Washers

Conn. Plate

Does information call for:

Coupling

Fan

Dowel pins

Shunts

Rotation plate

Brake adapter

Shims

Thermometers

Air shield

Shaft guard

Thermoguard

Exp. proof plate

Is inside of machine free from cuttings and foreign material?

Are machined parts slushed?

Tested by:

5501 correctly filled out and signed

Remarks:

Inspector________________ Date 9/17/73

S.O. 72P90923 Ser. 2 Size 5/10

472754-755 Flex lead-out st[illegible]gers

Prebake	Heater & Therm.	1st Vac.	turn 2nd Vac.	turn 3rd Vac.	turn 4th
3 hrs at 150° or 4 hrs at 135°		4 hrs at 150	4 hrs at 150°	4 hrs at 150°	4 hrs a
Oven 5 Date 8/9/73 Out 7:00pm	Heater [illegible] [illegible] 57[illegible]	Tank # 3 Oven # 7 Date 8/11/73 Out 7:30am	Tank # 3 Oven # 7 Date 8/12 Out 8:30pm	Tank # 3 Oven # 5 Date 8/13 Out 5:30pm	Tank #3 Oven #6 Date 8/15 Out 10:30am

Send to WT	Passed-Dry Out	Open Epoxy 8 Hr at 150°	Notes	Paint
8/15/73 BU-910-A	3 hrs. at 150° or 4 hrs. at 135° Oven # 4 8/16/73 Out 4:00pm	[illegible] 1:00pm 12440-2 2692-6 8/17/73		

A. C. MOTOR INSPECTION TAG

WESTINGHOUSE FORM 30333

ASSEMBLY

S. O. 72F90923 Serial #3

		Name
Outline Dwg.	823D16	
Eyebolt tight and correct length	—	
Winding neat and free from damage	—	
Inside of frame clean and free from cuttings	—	
Stator bore	16.867	
Rotor bore	16.795	
Bearing S# Front	1449546	
Bearing S# Rear	354 D 261826	
Rotor fan for correct rotation		
Assembly std. Opp. std.	—	
Oil or grease pipe fittings ok	—	
Oil rings Oil Level		
End play		
Shaft Clearance		
Shaft extension per outline		
Shaft run out	[illegible] - 17.480	
Face run out		
Fit run out		
Collector rings eccentricity		
Brushes S#		
Brushes line up with rings		
Revolving and bearing seal ok		
Insulation test	1000 [illegible] 3000 [illegible]	[illegible] 8873
Lubrication ok		
Explosion proof, leads spaced and sealed		
Does information call for thermoguard, brake adapter, speed switch, etc.	—	

Remarks: [illegible]

[illegible] = 1407 [illegible] = 510

Rz = .061 5

72F 92923 - 7/-3

SHIPPING

Following items as per information:

Nameplate	Nameplate stamping
Frame	Covers
Shaft Ext.	Conduit Box
Connectors	Eye Bolt
Lead Ext.	Assembly
Keys	Nuts and Washers
Finish	Conn. Plate
Grease pipes and fittings	
Customer mounting dimensions	

Does information call for:

Coupling	Shims
Fan	Thermometers
Dowel pins	Air shield
Shunts	Shaft guard
Rotation plate	Thermoguard
Brake adapter	Exp. proof plate

Is inside of machine free from cuttings and foreign material?

Are machined parts slushed?

Tested by:

5501 correctly filled out and signed

Remarks:

Inspector____________________ Date 9/17/73

S.O. 72E90 923 Ser. 3 [illegible] 5010

472754-755 Flex lead-cut stringers

Prebake	Heater & Therm.	1st Vac.	turn 2nd Vac.	turn 3rd Vac.	turn 4t
3 hrs at 150° or 4 hrs at 135°		4 hrs at 150	4 hrs at 150°	4 hrs at 150°	4 hrs a
Oven 1 Date 8/8/73 Out 10:00PM	Heeter [illegible] 57	Tank # 3 Oven # 7 Date 8/11/73 Out 8:30 Am	Tank # 3 Oven # 7 Date 8/12 Out 8/50 PM	Tank # 3 Oven # 5 Date 8/13/73 Out 8:30 PM	Tank #3 Oven #6 Date 8/15/73 Out 10:30 AM

Send to WT	Passed-Dry Out 3 hrs. at 150° or 4 hrs. at 135°	Open Epoxy 8 Hr at 150°	Notes	Paint
8/16/73 BU-910-A	Oven # 4 8/16/73 Out 4:00PM	12440-2 [illegible] #2 2692-6 11:00Am 8/17/73		

A. C. MOTOR INSPECTION TAG
WESTINGHOUSE FORM 30333

Hold for Conversion Painted Rotors

ASSEMBLY

S. O. 72F 90923 Serial #57 #4

		Name
Outline Dwg	8232D16	
Eyebolt tight and correct length	✓	
Winding neat and free from damage		
Inside of frame clean and free from cuttings	✓	
Stator bore	16.869	
Rotor bore	16.797	
Bearing S# Front		
Bearing S# Rear		
Rotor fan for correct rotation		
Assembly std. ✓ Opp. std.		
Oil or grease pipe fittings ok		
Oil rings / Oil Level		
End play	✓	
Shaft Clearance	✓	
Shaft extension per outline	6.9 7/8 x 5 Ky.	
Shaft run out	⊄ 12.487	
Face run out		
Fit run out		
Collector rings eccentricity		
Brushes S#		
Brushes line up with rings		
Revolving and bearing seal ok		
Insulation test	10000 Surge 3000	2/4/73
Lubrication ok		
Explosion proof, leads spaced and sealed		
Does information call for thermoguard, brake adapter, speed switch, etc.		
Remarks:		

Heatless = .407 Pan = .575

Res = .0600

[illegible signature]

772F9C92 3 — #4

SHIPPING

Following items as per information:

Nameplate	Nameplate stamping
Frame	Covers
Shaft Ext.	Conduit Box
Connectors	Eye Bolt
Lead Ext.	Assembly
Keys	Nuts and Washers
Finish	Conn. Plate
Grease pipes and fittings	
Customer mounting dimensions	

Does information call for:

Coupling	Shims
Fan	Thermometers
Dowel pins	Air shield
Shunts	Shaft guard
Rotation plate	Thermoguard
Brake adapter	Exp. proof plate

Is inside of machine free from cuttings and foreign material?

Are machined parts slushed?

Tested by:

5501 correctly filled out and signed

Remarks:

Inspector____________________ Date 9/12/72.

S.O. 72P90923 Ser. 54 Size 5010

4/2754-755 Flex lead-out stringers

Prebake	Heater & Therm.	1st Vac.	turn 2nd Vac.	turn 3rd V...	turn 4t...
3 hrs at 150° or 4 hrs at 135°	4 hrs at 150	4 hrs at 150°	4 hrs at 15..	4 hrs a...	
Oven 2 Date 8/13 Out 5:30pm.	Heater Heat ... 570	Tank # 3 Oven # 6 Date 8/14/73 Out 5:30am	Tank # 3 Oven # 7 Date 8/15/73 Out 9:30pm	Tank # 1 Oven # 6 Date 8/16/73 Out 2:30am	Tank #3 Oven #7 Date 8/18/73 Out 5:30am

Send to WT	Passed-Dry Out	Open Epoxy 8 Hr	Notes	Paint
8/18/73	3 hrs. at 150° or 4 hrs. at 135°	at 150°		
BU-910-A	Oven #8 8/18/73 Out 10:30pm	12440-2 oven 5 2692-6 3:30am 8/22/73		

A. C. MOTOR INSPECTION TAG

WESTINGHOUSE FORM 30333

F4 11 M 73 F 5 6 6 9 8

ASSEMBLY

S. O. [illegible] Serial # 1

	Name
Outline Dwg. 8311 D16	
Eyebolt tight and correct length	
Winding neat and free from damage	
Inside of frame clean and free from cuttings	
Stator bore 16.871	
Rotor bore 16.795	
Bearing S# Front 1402546	
Bearing S# Rear [illegible]	
Rotor fan for correct rotation	
Assembly std. Opp. std.	
Oil or grease pipe fittings ok	
Oil rings Oil Level	
End play	
Shaft Clearance	
Shaft extension per outline 3.375 = 1/2 [illegible] 25.00 - 6.50	
Shaft run out 0	
Face run out	
Fit run out	
Collector rings eccentricity	
Brushes S#	
Brushes line up with rings	
Revolving and bearing seal ok	
Insulation test Meggar Surge 3000v	[illegible] 9/14/73
Lubrication ok	
Explosion proof, leads spaced and sealed	
Does information call for thermoguard, brake adapter, speed switch, etc.	
Remarks:	

[illegible] = [illegible] = 57 0 [illegible]

[illegible] = .0005

7 35 56655

SHIPPING

Following items as per information:

Nameplate ✓	Nameplate stamping ✓
Frame ✓	Covers ✓
Shaft Ext.	Conduit Box ✓
Connectors	Eye Bolt
Lead Ext.	Assembly ✓
Keys ✓	Nuts and Washers
Finish	Conn. Plate ✓
Grease pipes and fittings	
Customer mounting dimensions	

Does information call for:

Coupling	Shims
Fan	Thermometers
Dowel pins	Air shield
Shunts	Shaft guard
Rotation plate	Thermoguard
Brake adapter	Exp. proof plate

Is inside of machine free from cuttings and foreign material?

Are machined parts slushed? ✓

Tested by:

5501 correctly filled out and signed ✓

Remarks:

Inspector________________ Date 9/27/73

S.O. ~~[illegible]~~ 6M-73F56688 Scr. ~~4~~ 1 Size 5010

472754-755 Flex lead-cut stringers

Prebake	Heater & Therm.	1st Vac.	turn 2nd Vac.	turn 3rd Vac.	turn 4t
3 hrs at 150° or 4 hrs at 135° Oven 2 Date 8/13 Out 5:30pm	Heating [illegible] [illegible] 8/13	4 hrs at 150 Tank # 3 Oven # 6 Date 8/14 Out 5:00P.M.	4 hrs at 150° Tank # 3 Oven # 7 Date 8/15 Out 9:30 P.M.	4 hrs at 150° Tank # 1 Oven # 6 Date 8/16 Out 2:30AM	4 hrs a Tank # 3 Oven # 7 Date 8/18 Out 5:30AM
Send to WT 8/28 73 BU-910-A	Passed-Dry Out 3 hrs. at 150° or 4 hrs. at 135° Oven # 1 8/20/73 Out 10:00pm	Open Epoxy 8 Hr at 150° # oven 6 12440-2 9:00pm 2692-6 8/21/73	Notes	Paint	

2. Westinghouse has stated in WCAP 7829, the intent of report is to show environmental qualifications. IEEE-334-71 requires seismic qualifications. Provide seismic test qualification program.

Response

In response to NRC Question 14 contained in D. B. Vassallo's letter of June 11, 1975, concerning WCAP 7829, Westinghouse indicated that the "....report is intended to address only the environmental qualification of the motors...." The seismic qualification of the fan cooler unit supplied to St. Lucie is attached. The qualification was performed by analysis as allowed by IEEE 344-1971, Section 3.1 (IEEE 344-1971 is referenced by IEEE 334-1971 in Section 4.3.2)

SEISMIC ANALYSIS

REACTOR CONTAINMENT FAN COOLERS

ST. LUCIE #1

HUTCHINSON ISLAND, FLA.

WESTINGHOUSE NUCLEAR ENERGY SYSTEMS

ORDER NO. 546-GXF-175641-BM

(W) STURTEVANT ORDER NO. PHY-2063

DATE: 5-16-74

PREPARED BY:

G. A. Balciunas
Engineer

CHECKED BY:

B. W. Shaw
Engineer

APPROVED:

R. L. Carlson, Manager
Industrial & Comm. Prod.
Registered Professional Engr. #10422
Comm. of Mass.

CERTIFICATE OF COMPLIANCE

In accordance with WNES purchase order #546-GXF-175641-BM, I certify that the Reactor Containment Fan Cooler System, except Enclosure, is designed to conform to the "Seismic Criteria" portions of the applicable specifications and that the calculations presented in the Seismic Analysis PHY-2063 adequately verify this compliance.

R. C. Carlson
R. C. Carlson
Registered Professional Engineer
Commonwealth of Massachusetts

PHY-2063 SEISMIC ANALYSIS OF REACTOR CONTAINMENT FAN COOLERS

OBJECT

The purpose of this analysis is to verify the structural integrity of the reactor fan coolers when subjected to seismic loads.

METHOD

The fan motor system spring constants and natural frequencies were calculated (see Table 1). All frequencies except fan rotor are above the rigid range (33 cps). The rotor (24.6 cps) is close to rigid range and its second natural frequency (153.5 cps) is very high. Therefore its response in characteristics is one made dominant. From the acceleration spectra curves for period .041 sec it is seen that the rotor assembly has the same frequency as in the rigid zone. Because all frequencies are in the region of zero amplification the fan motor system was analyzed using seismic equivalent static loads. The coils and coil banks are also rigid and were analyzed as such.

The seismic load levels were established using the defined seismic criteria for Hutchinson Island. The following DBE acceleration values were used:

Vertical Seismic	Horizontal Seismic Elev. 44'	Horizontal Seismic Elev. 60'
0.8 g	1.2 g	1.2 g

The vertical and horizontal seismic loads were applied simultaneously in the worst possible manner. In addition the coils were subjected to a differential pressure of 2 psi to represent the blowdown transient pressure difference.

Stresses and deflections were calculated using elastic relations for the worst combination of operating loads, horizontal seismic (DBE), vertical seismic (DBE), and accident pressure (coils and coil banks).

Limit values used were in accordance with the elastic provisions in the AISC-69 and ASME Sec. VIII Pressure Vessels Specifications (latter primarily for coil tube and fin material).

RESULTS

The calculated and limit behavior along with factor of safety values for different modes of failure are given in Table 2. DBE seismic loads were used for calculated values in Table 2. Since the elastic limits, associates with an OBE event, were not exceeded when DBE seismic levels were used is not necessary to perform an OBE seismic analysis.

CONCLUSIONS

Based upon the seismic analysis the fan system, cooling coils and coil banks can more than support the maximum earthquake (DBE) loads in combination with operating and accident loads called for in the specifications. The above will remain elastic under specified maximum loads. The design, therefore, is adequate.

The enclosure seismic analysis was prepared by Shaffer Engineering and is given in a separate report.

TABLE 1 NATURAL FREQUENCIES

ITEM	DESCRIPTION		FREQUENCY (CPS)	BEHAVIOR
1.	Bearing Base	Horizontal	106	Rigid
2.	Bearing Base	Vertical	426	Rigid
3.	Motor Base and Motor Coil	Horizontal	86.09	Rigid
4.	Motor Base with Motor & Coil	Horizontal	67.80	Rigid
5.	Rotor Assy on Brg Base & Bearings	1st	24.6	Near Rigid Region
6.	Rotor Assy on Brg Base & Bearings	2nd	153.5*	Rigid
7.	Motor Shaft on Motor Brg. Brackets		54.65	Rigid

*Approximate - Cantilever Beam Ref.

Den Hartog, Mechanical Vibrations 4th Ed.

P. 432, McGraw-Hill Book Co.

TABLE 2 - SEISMIC ANALYSIS OF REACTOR CONTAINMENT FAN COOLER

ITEM	POSTULATED FAILURE MODE DESCRIPTION	UNITS	CALCULATED BEHAVIOR	LIMIT BEHAVIOUR	MARGIN OF STRENGTH*
1	Deflection of fan wheel & housing to cause rubbing	in.	.0239	.125	5.23
2.	Wheel - Shaft Attachment	lb.	1755.	2600	1.48
3.	Max fan shaft stress - combined	psi	5844	24,800	4.28
4.	Motor coil hold down bolts (shear)	psi	5865	10000	1.70
5.	Motor coil support stress	psi	1534	22000	14.30
6.	Motor - Motor Base Bolts (tension-2 bolts)	psi	2785	20000	7.18
7.	Motor - Motor base bolts (shear-4 bolts)	psi	2228	10000	4.49
8	Motor base - Sub base bolts (tension-10 bolts)	psi	2148	20000	9.31
9.	Motor base - Sub base bolts (shear-20bolts)	psi	1300	10000	7.69
10.	Bearing bolts fxd brg (shear)	psi	868	10000	11.51
11.	Bearing bolts fxd brg (tension)	psi	736	20000	27.16
12.	Bearing bolts fltg brg. (shear)	psi	1152	10000	8.67
13.	Motor coil tube stress	psi	3001	6000	2.00
14.	Motor coil end frame stress	psi	230	22000	96.0
15.	Motor coil nozzle stress	psi	1029	6000	5.83
16.	Motor rotor deflection (air gap)	in.	.00745	.0395	5.30
17.	Motor shaft stress combined	psi	4443	22000	4.95

... of limit behavior.

ITEM	POSTULATED FAILURE MODE DESCRIPTION	UNITS	CALCULATED BEHAVIOUR	LIMIT BEHAVIOUR	FACTOR OF SAFETY
18.	Motor shaft stress shear	psi	4236	14500	3.42
19.	Motor Bearings fxd brg B_{10}	Hr	188000**	-	-
20.	Motor Bearings fltg brg B_{10}	Hr	293000**	-	-
21.	Fan Bearings fxd & fltg B_{10} (See FMC registered brg anal. 73618)	Hr	200,000+**	-	-
22.	Coupling	BHP	154	405	2.63
23.	Coil Bank coil tube end (shear)	psi	51.6	3406	65.97
24.	Coil Bank coil tube stress	psi	3899	5900	1.51
25.	Coil Bank coil fin stress (vert.-load)	psi	97.4	1345	13.8
26.	Coil Bank coil top & bottom plt stress	psi	1353	13200	9.75
27.	Coil Bank coil fin stress @ fin suppt	psi	598	1952	3.26
28.	Fin Support Bolts @ center (Shear)	psi	6906	10000	1.45
29.	Fin Support Bolts @ center (Shear)	psi	4577	10000	2.18
30.	Coil Top & Bottom end bolts (Shear)	psi	1433	10000	6.98
31.	Coil Header Nozzle Stress	psi	419	5900	14.05
32.	Coil - Coil Bank Frame Bolts (Shear)	psi	1298	10000	7.7

TABLE 2 - SEISMIC ANALYSIS OF REACTOR CONTAINMENT FAN COOLER-Page Three

ITEM	POSTULATED FAILURE MODE DESCRIPTION	UNITS	CALCULATED BEHAVIOUR	LIMIT BEHAVIOUR	RATIO OF LIMIT TO CALCULATED BEHAVIOR
33.	Coil Trough - Coil Bank Frame Bolts (Shear)	psi	6637	10000	1.50
34.	Coil Bank Frame - Top Bolts (Shear)	psi	5842	10000	1.71
35.	Coil Bank Frame - Bottom Bolts (Tension)	psi	10384	20000	1.93
36.	Coil Bank - Enclosure Attachment (Tension)	psi	6443	20000	3.10
37.	Coil Bank - Enclosure Attachment (shear)	psi	1326	10000	7.53
38.	Coil Bank Base - Enclosure Attachment (shear)	psi	776	10000	12.87
39.	Coil Bank Base - Enclosure Attachment (tension)	psi	1054	20000	18.97
40.	Motor Base Piping Brace	psi	4838	22000	4.55
41.	Fan Housing Ass'y Piping Brace	psi	726	22000	30.29
42.	Bearing Base Piping Brace	psi	611	22000	36.01
43.	RCFC Roof Ass'y Piping Brace	psi	3900	22000	5.64
44.	RCFC Manifold Pipe Support	psi	4892	22000	4.50
45.	RCFC Manifold "U" Clamp Stress (Shear)	psi	1770	10000	5.65
46.	RCFC Manifold Lower Pipe Support	psi	16764	22000	1.31
	** Seismic Effect has No Effect on BRG Life				

SKETCH SHEET
WESTINGHOUSE FORM

WESTINGHOUSE ELECTRIC CORPORATION

3. A letter from J. Irons of June 14, 1976, states that the table "Typical Motor Design Parameters Compared to Test Machine" shows an insulation peak temperature of 105.8°C for worst case DBA conditions. Heat which must be removed from PSL-1 fan cooler motor windings is 1.) added heat from outside DBA conditions 2) added heat generated internal to winding due to fan cooler load. The motor in WCAP 7829 demonstrates only that the heat from outside DBA conditions plus the heat resulting from current of 26.1 Amps can be removed by the heat exchanger. Provide results of heat exchanger analysis to demonstrate the PSL-1 motor insulation temperature W.71 remain within 105.8°C for worst case DBA conditions plus full load current of 200 amperes.

Response

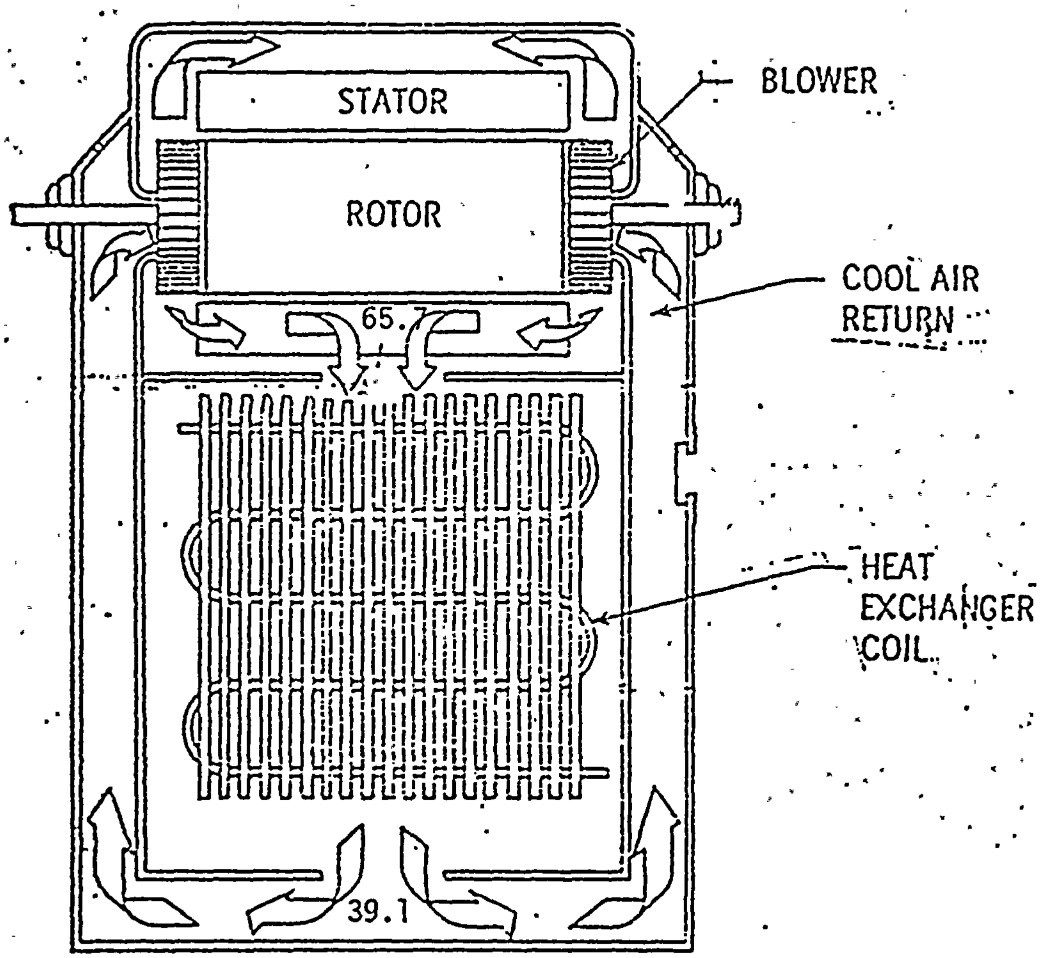
Due to the number of variables for each plant (i.e. cooling water temperatures, containment temperatures, motor losses, etc.) the heat exchanger must be specifically sized for its particular application. This is accomplished by use of a computer code developed for this purpose.

Copies of the computer print out for the heat exchangers used in the St. Lucie motors are listed as Item 1 thru 6. Items 1 and 2 are for normal operation, 3 and 4 for DBE operation and 5 and 6 for post DBE operation.

Additionally, Figures 1, 2, and 3 show the air flow pattern through the motor and heat exchanger indicating the heat exchanger inlet and exhaust temperatures for normal (Figure 1), DBE (Figure 2), and Post DBE (Figure 3) operation.

Performance of the heat exchanger is predicted by a computer program. It has been verified by standard ARI coil certification tests. Heat and mass transfer occuring on the surface of base enclosure and motor are based on standard correlation for free convection heat transfer and "COLBURN ANALOGY" between heat and mass transfer. Heat transfer of the interior of base enclosure is based on the standard "COLBURN RELATIONSHIP" for turbulent forced convection in an enclosed space.

Heat transfer between the outside of the motor frame and air passing through the motor is based on a computer program developed to predict the heat transfer performance for electric motors of this type. The attached print outs are computer out put for normal and POST LOCA operation of heat exchanger for PSL-1. It should be noted that the heat exchanger is suitable for the worst environment of DBA condition, (Items 3 and 4), which includes the maximum heat losses of the motor associated with its increased horsepower requirements during DBA operation. Under normal and POST DBA operation, performance of the heat exchanger greatly exceeds the heat removal requirements.



.Figure 1 - Air Flow Temperature Distribution Schematic
Normal Operation
(Temperature in °C).

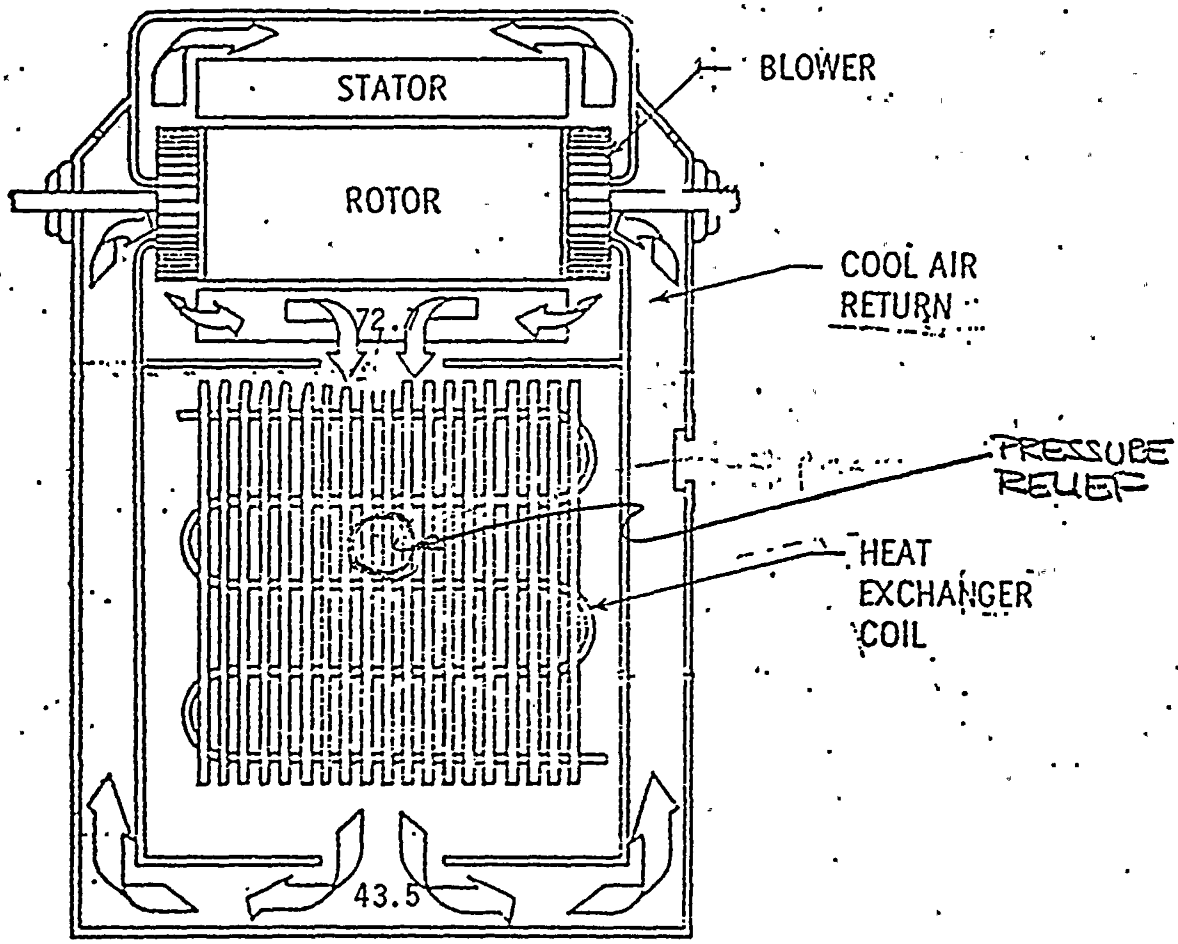


Figure 2 - Air Flow Temperature Distribution Schematic
Design Basis Event Operation
(Temperature in °C)

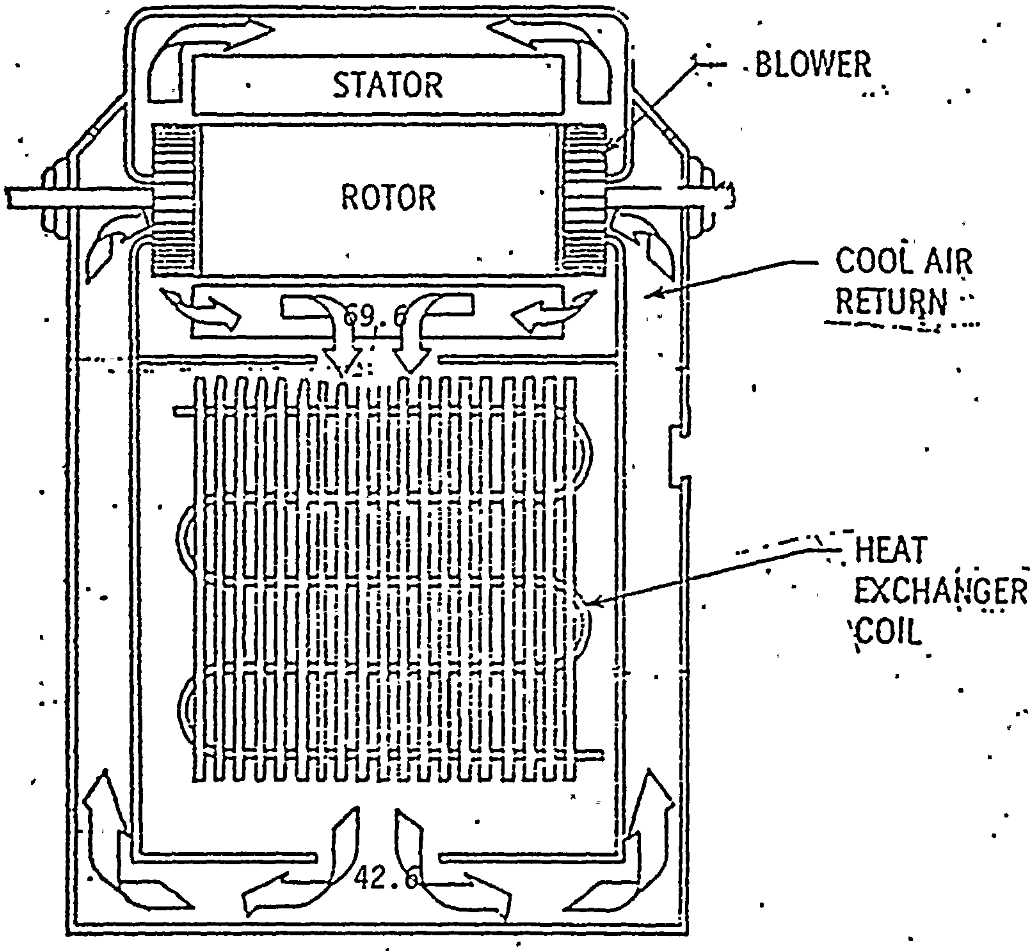


Figure 3 - Air Flow Temperature Distribution Schematic
Post Design Basis Event Operation
(Temperature in °C)

ITEM 1

11:38:49 OCTOBER 31, 1973

HEAT EXCHANGER DESIGN PROGRAM
T. J. FAGAN 501-2Y29 EXT 7306

OPTIMIZING FIN BLOCK ONLY

STURTEVANT WATER CIRCUITING

1.00 VELOCITY WATER CIRCUITING

NEW FIN PATTERN ALL COPPER

MOTOR COOLING SYSTEM PARAMETERS
MOTOR DIAMETER 34.00INCHES LENGTH 41.00INCHES A 56.00 INCHES
B 24.00 INCHES C 60.75 INCHES D 53.00 INCHES E 30.00 INCHES

LOSSES 5.50 KILOWATTS
CONTAINMENT
TEMPERATURE 120.00 DEG F PRESSURE 14.700 PSIA
PARTIAL PRESSURES AIR 13.008 PSIA WATER VAPOR 1.692 PSIA

DENSITIES AIR 0.06057 LBM/CU FT WATER VAPOR 0.00492 LBM/CU FT
MOTOR CASE
TEMPERATURE 113.83DEG F SURFACE AREA 31.62 SQ FT
PARTIAL PRESSURES AIR 13.277PSIA WATER VAPOR 1.423PSIA
DENSITIES AIR 0.06249 LBM/CU FT WATER VAPOR 0.00419 LBM/CU FT
CONVECTIONCOEFFICIENT 0.2555 BTU/HR-SQ FT-DEGF QCONV 49.98TU/HR
MASS TRANSPORT COEFFICIENT 38.0351 FT/HR QMASS 1004.1 BTU/HR
CONDENSATION RATE 0.98 LBM/HR

INSIDE CONVECTION COEFFICIENT 6.0000 BTU/HR-SQ FT-DEG F
BASE ENCLOSURE
TEMPERATURE 118.91 DEG F SURFACE AREA 78.75 SQ FT
PARTIAL PRESSURES AIR 13.058 PSIA WATERVAPOR 1.642 PSIA
DENSITIES AIR 0.06092 LBM/CU FT WATER VAPOR 0.00480 LBM/CU FT
CONVECTION COEFFICIENT 0.1513 BTU/HR-SQ FT-DEG F QCONV 13.0 BTU/HR
MASS TRANSPORT COEFFICIENT 22.0249 FT/HR QMASS 248.8BTU/HR
CONDENSATION RATE 0.24 LBM/HR
INSIDE CONVECTIONCOEFFICIENT 0.2057 BTU/HR-SQ FT-DEG F

EXIT TEMPERATURE 103.10 DEG F
COIL DESIGN PARAMETERS
F= 8.50 FINS/INCH TF= 0.0080 INCHES DB= 0.6250 INCHES DTO= 0.6437 INCHES
DTI= 0.5491 INCHES TT= 0.0490 INCHES PT= 1.5000 INCHES PL= 1.2990 INCHES
W= 30.00 INCHES H= 24.00 INCHES 4 ROWS VCF= 69.43 FPM VW= 4.303 FPS

AIR AND WATER INLET AND EXIT CONDITIONS
TAI= 150.24 DEG F PAIR= 14.700 PSI WAIR= 1.4180.+03 LB/HR (319.56 SCFM)

ITEM 2

```
TAI= 100.00 DEG F WWATER= 2.5110,+04 LB/HR (  50.82 GPM)
TAE= 102.35 DEG F TWE= 100.66 DEG F QAIR= 1.6565,+04 BTU/HR
QWATER= 1.6582,+04 BTU/HR QHTF= 1.6584,+04 BTU/HR RHOA= 0.06991 LB/CU FT

                    AIR SIDE PRESSURE DROP

ARF= 0.932 ART= 0.560 PDA= 0.011 INCHES OF WATER  PDR=10.000 INCHES OF WATER

                    WATER SIDE PRESSURE DROP

        WATER TEMPERATURE  100 DEG F

NRE= 3.236,+04 PDW= 1.775,+00 PSI

                HEAT TRANSFER PARAMETERS

ATI=   23.00 SQ FT  ATO=    26.97 SQ FT  ACOL=    25.76 SQ FT
      AFIN=  364.85 SQ FT  AAIR=  390.61 SQ FT
HI= 1166.56 BTU/HR-SQ FT-DEG F  FI= 0.00050 HR-SQ FT-DEG F/BTU
KT=  215.00 BTU/HR-FT-DEG F      HC= 1500.00 BTU/HR-SQ FT-DEG F
KF=  215.00 BTU/HR-FT-DEG F      HA=    3.113 BTU/HR-SQ FT-DEG F
                U=   2.74 BTU/HR-SQ FT-DEG F
                K=   53.56 BTU/HR-SQ FT FACE-DEG-MED-ROW
       HA AUGMENTED BY   5.00 PERCENT  ETAF= 0.967

       THERMAL IMPEDANCES BASED ON TOTAL AIR SIDE AREA
                    Q=(AAIR/RTOT)*LMTD

TUBE SIDE CONVECTION  0.01456 HR-SQ FT-DEG F/BTU    3.99 PERCENT
TUBE SIDE FOULING     0.00849 HR-SQ FT-DEG F/BTU    2.33 PERCENT
TUBE METAL CONDUCTION 0.00029 HR-SQ FT-DEG F/BTU    0.08 PERCENT
CONTACT IMPEDANCE     0.00966 HR-SQ FT-DEG F/BTU    2.65 PERCENT
COLLAR CONDUCTION     0.00004 HR-SQ FT-DEG F/BTU    0.01 PERCENT
AIR SIDE CONVECTION   0.33162 HR-SQ FT-DEG F/BTU   90.94 PERCENT
 AND FIN EFFICIENCY
TOTAL                 0.36466 HR-SQ FT-DEG F/BTU

          SPOILER HEIGHT  0.0000 INCHES
          CORRUGATIONS PER PITCH  3
          HA AUGMENTED BY     0.00 PERCENT
          PDA AUGMENTED BY   45.75 PERCENT
              GRATZ NUMBER     0.00

                    COST PARAMETERS

      COSTAL=  0.394 $/LB  COSTCU  0.651 $/LB
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08:55:59      OCTOBER 30, 1973

        HEAT EXCHANGER DESIGN PROGRAM
        T. J. FAGAN 501-2Y29 EXT 7306

         OPTIMIZING FIN BLOCK ONLY

        STURTEVANT WATER CIRCUITING

          1.00 VELOCITY WATER CIRCUITING

     NEW FIN PATTERN ALL COPPER

               MOTOR COOLING SYSTEM PARAMETERS
    MOTOR DIAMETER 34.00INCHES LENGTH 41.00INCHES A 56.00 INCHES
    B 24.00 INCHES C 60.75 INCHES D 53.00 INCHES E 30.00 INCHES
                   LOSSES 10.56 KILOWATTS
                       CONTAINMENT
    TEMPERATURE 264.00 DEG F PRESSURE  53.700 PSIA
    PARTIAL PRESSURES AIR  15.804 PSIA WATER VAPOR  37.896 PSIA

    DENSITIES AIR 0.05894 LBM/CU FT WATER VAPOR 0.09035 LBM/CU FT
                        MOTOR CASE
    TEMPERATURE 257.05DEG F  SURFACE AREA  31.62 SQ FT
    PARTIAL PRESSURES  AIR  20.004PSIA WATER VAPOR  33.696PSIA
    DENSITIES AIR 0.07533 LBM/CU FT WATER VAPOR 0.03095 LBM/CU FT
    CONVECTIONCOEFFICIENT  1.0194 BTU/HR-SQ FT-DEG F QCONV    223.9BTU/HR
    MASS TRANSPORT COEFFICIENT 26.2574 FT/HR  QMASS  22120.5 BTU/HR
                   CONDENSATION RATE   23.50 LBM/HR

          INSIDE CONVECTION COEFFICIENT  6.0000 BTU/HR-SQ FT-DEG F
                      BASE ENCLOSURE
    TEMPERATURE 262.71 DEG F  SURFACE AREA  78.75 SQ FT
    PARTIAL PRESSURES AIR  16.613 PSIA WATERVAPOR  37.087 PSIA
    DENSITIES AIR 0.06207 LBM/CU FT  WATER VAPOR 0.08855 LBM/CU FT
    CONVECTION COEFFICIENT  0.5899 BTU/HR-SQ FT-DEG F QCONV     59.8 BTU/HR
    MASS TRANSPORT COEFFICIENT 15.1294 FT/HR  QMASS   6679.3BTU/HR
                      CONDENSATION RATE    7.13 LBM/HR
          INSIDE CONVECTIONCOEFFICIENT  0.5713 BTU/HR-SQ FT-DEG F

                      EXIT TEMPERATURE 115.73 DEG F
                          COIL DESIGN PARAMETERS
    F=  8.50 FINS/INCH TF= 0.0080 INCHES DB= 0.6250 INCHES DTO= 0.6437 INCHES
    DTI= 0.5491 INCHES TT= 0.0490 INCHES PT= 1.5000 INCHES PL= 1.2990 INCHES
    W=  30.00 INCHES H=  24.00 INCHES   4 ROWS VCF=  73.23 FPM VW= 4.303 FPS

                 AIR AND WATER INLET AND EXIT CONDITIONS
    TAI= 162.37 DEG F  PAIR= 53.700 PSI WAIR= 5.1388,+03 LB/HR (  1141.96 SCFM)
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ITEM 4

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TWI= 100.00 DEG F WWATER= 2.5110,+04 LB/HR (  50.82 GPM)
TAE= 110.29 DEG F TWE= 102.59 DEG F QAIR= 6.4976,+04 BTU/HR
QWATER= 6.5046,+04 BTU/HR QHTF= 6.5052,+04 BTU/HR RHOA= 0.24377 LB/CU FT

                          AIR SIDE PRESSURE DROP

ARF= 0.932 ART= 0.560 PDA= 0.040 INCHES OF WATER  PDR=10.000 INCHES OF WATER

                          WATER SIDE PRESSURE DROP

     WATER TEMPERATURE  101 DEG F

NRE= 3.236,+04 PDW= 1.775,+00 PSI

                      HEAT TRANSFER PARAMETERS

ATI=   23.00 SQ FT  ATO=   26.97 SQ FT  ACOL=   25.76 SQ FT
     AFIN=  364.85 SQ FT  AAIR=  390.61 SQ FT
HI= 1166.56 BTU/HR-SQ FT-DEG F  FI= 0.00050 HR-SQ FT-DEG F/BTU
KT=  215.00 BTU/HR-FT-DEG F      HC= 1500.00 BTU/HR-SQ FT-DEG F
KF=  215.00 BTU/HR-FT-DEG F      HA=   7.884 BTU/HR-SQ FT-DEG F
                U=   5.89 BTU/HR-SQ FT-DEG F
                K= 115.01 BTU/HR-SQ FT FACE-DEG MED-ROW
       HA AUGMENTED BY   0.00 PERCENT  ETAF= 0.922

       THERMAL IMPEDANCES BASED ON TOTAL AIR SIDE AREA
                     Q=(AAIR/RTOT)*LMTD

TUBE SIDE CONVECTION  0.01456 HR-SQ FT-DEG F/BTU    8.57 PERCENT

TUBE SIDE FOULING     0.00849 HR-SQ FT-DEG F/BTU    5.00 PERCENT

TUBE METAL CONDUCTION 0.00029 HR-SQ FT-DEG F/BTU    0.17 PERCENT

CONTACT IMPEDANCE     0.00966 HR-SQ FT-DEG F/BTU    5.69 PERCENT

COLLAR CONDUCTION     0.00004 HR-SQ FT-DEG F/BTU    0.03 PERCENT

AIR SIDE CONVECTION   0.13677 HR-SQ FT-DEG F/BTU   80.54 PERCENT
 AND FIN EFFICIENCY
TOTAL                 0.16981 HR-SQ FT-DEG F/BTU

           SPOILER HEIGHT  0.0425 INCHES
           CORRUGATIONS PER PITCH  3
           HA AUGMENTED BY   17.71 PERCENT
           PDA AUGMENTED BY   45.75 PERCENT
              GRATZ NUMBER   12.95

                       COST PARAMETERS

       COSTAL=  0.394 $/LB  COSTCU  0.651 $/LB
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11:13:13      OCTOBER 31, 1973

HEAT EXCHANGER DESIGN PROGRAM
T. J. FAGAN 501-2Y29 EXT 7306

OPTIMIZING FIN BLOCK ONLY

STURTEVANT WATER CIRCUITING

1.00 VELOCITY WATER CIRCUITING

NEW FIN PATTERN ALL COPPER

MOTOR COOLING SYSTEM PARAMETERS
MOTOR DIAMETER 34.00INCHES LENGTH 41.00INCHES A 56.00 INCHES
B 24.00 INCHES C 60.75 INCHES D 53.00 INCHES E 30.00 INCHES

LOSSES  6.70 KILOWATTS
CONTAINMENT
TEMPERATURE 240.00 DEG F PRESSURE  40.700 PSIA
PARTIAL PRESSURES AIR  15.731 PSIA WATER VAPOR  24.969 PSIA
DENSITIES AIR 0.06069 LBM/CU FT WATER VAPOR 0.06119 LBM/CU FT
MOTOR CASE
TEMPERATURE 231.89DEG F  SURFACE AREA  31.62 SQ FT
PARTIAL PRESSURES  AIR  19.175PSIA WATER VAPOR  21.525PSIA
DENSITIES AIR 0.07489 LBM/CU FT WATER VAPOR 0.05327 LBM/CU FT
CONVECTIONCOEFFICIENT  0.9369 BTU/HR-SQ FT-DEGF QCONV    240.1BTU/HR
MASS TRANSPORT COEFFICIENT 32.1705 FT/HR  QMASS  18047.4 BTU/HR
CONDENSATION RATE   18.84 LBM/HR

INSIDE CONVECTION COEFFICIENT  6.0000 BTU/HR-SQ FT-DEG F
BASE ENCLOSURE
TEMPERATURE 238.69 DEG F  SURFACE AREA  78.75 SQ FT
PARTIAL PRESSURES AIR  16.316 PSIA WATERVAPOR  24.384 PSIA
DENSITIES AIR 0.06306 LBM/CU FT  WATER VAPOR 0.05985 LBM/CU FT
CONVECTION COEFFICIENT  0.5250 BTU/HR-SQ FT-DEG F QCONV    54.1 BTU/HR
MASS TRANSPORT COEFFICIENT 17.3351 FT/HR  QMASS   4553.1BTU/HR
CONDENSATION RATE    4.78 LBM/HR
INSIDE CONVECTIONCOEFFICIENT  0.4589 BTU/HR-SQ FT-DEG F

EXIT TEMPERATURE 113.60 DEG F
COIL DESIGN PARAMETERS
F=  8.50 FINS/INCH TF= 0.0080 INCHES DB= 0.6250 INCHES DTC= 0.6437 INCHES
DTI= 0.5491 INCHES TT= 0.0490 INCHES PT= 1.5000 INCHES PL= 1.2990 INCHES
W=  30.00 INCHES H=  24.00 INCHES   4 ROWS VCF=  73.52 FPM VW= 4.303 FPS

AIR AND WATER INLET AND EXIT CONDITIONS
TAI= 157.33 DEG F  PAIR= 40.700 PSI WAIR= 3.9100+03 LB/HR (   868.89 SCFM)
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ITEM 6

TWI= 100.00 DEG F WWATER= 2.5110,+04 LB/HR (50.82 GPM)
TAE= 103.71 DEG F TWE= 101.82 DEG F QAIR= 4.5712,+04 BTU/HR
QWATER= 4.5761,+04 BTU/HR QHTF= 4.5769,+04 BTU/HR RHOA= 0.18487 LB/CU FT

AIR SIDE PRESSURE DROP

ARF= 0.932 ART= 0.560 PDA= 0.030 INCHES OF WATER PDR=10.000 INCHES OF WATER

WATER SIDE PRESSURE DROP

WATER TEMPERATURE 101 DEG F

NRE= 3.236,+04 PDW= 1.775,+00 PSI

HEAT TRANSFER PARAMETERS

ATI= 23.00 SQ FT ATO= 26.97 SQ FT ACOL= 25.76 SQ FT
AFIN= 364.85 SQ FT AAIR= 390.61 SQ FT
HI= 1166.56 BTU/HR-SQ FT-DEG F FI= 0.00050 HR-SQ FT-DEG F/BTU
KT= 215.00 BTU/HR-FT-DEG F HC= 1500.00 BTU/HR-SQ FT-DEG F
KF= 215.00 BTU/HR-FT-DEG F HA= 5.796 BTU/HR-SQ FT-DEG F
U= 4.64 BTU/HR-SQ FT-DEG F
K= 90.56 BTU/HR-SQ FT FACE-DEG MED-ROW
HA AUGMENTED BY 0.00 PERCENT ETAF= 0.941

THERMAL IMPEDANCES BASED ON TOTAL AIR SIDE AREA
Q=(AAIR/RTOT)*LMTD

TUBE SIDE CONVECTION	0.01456 HR-SQ FT-DEG F/BTU	6.75 PERCENT
TUBE SIDE FOULING	0.00849 HR-SQ FT-DEG F/BTU	3.94 PERCENT
TUBE METAL CONDUCTION	0.00029 HR-SQ FT-DEG F/BTU	0.13 PERCENT
CONTACT IMPEDANCE	0.00966 HR-SQ FT-DEG F/BTU	4.48 PERCENT
COLLAR CONDUCTION	0.00004 HR-SQ FT-DEG F/BTU	0.02 PERCENT
AIR SIDE CONVECTION AND FIN EFFICIENCY	0.18263 HR-SQ FT-DEG F/BTU	84.68 PERCENT
TOTAL	0.21567 HR-SQ FT-DEG F/BTU	

SPOILER HEIGHT 0.0425 INCHES
CORRUGATIONS PER PITCH 3
HA AUGMENTED BY 3.08 PERCENT
PDA AUGMENTED BY 45.75 PERCENT
GRATZ NUMBER 9.86

COST PARAMETERS

COSTAL= 0.334 $/LB COSTCU 0.651 $/LB

4. From data given in table "Typical Motor Design Parameters Compared to Test Machine" explain apparent discrepancy of inlet air temperature to insulation (°F) under item 5 for the test machine, and the inlet air (°C) under item #1, motor parameters (e.g., 100°F ≠ 76°C).

In addition please justify variation between motor parameters:

- inlet air °C
- rise of insulation °C
- total temperature
- horsepower
- full load amperes
- starting torque

<u>Response</u>

During normal plant operation the heat exchanger output to the fan cooler motor unit is in the order of 100°F (~38°C). However, the test plan for the motor called for producing realistic total temperature rise (inlet air + insulation rise) by varying inlet air temperature to the motor and/or varying motor loading. Since the test machine had a fixed blading (loading) configuration inlet air temperature to the motor insulation was increased. This was performed by circulating heated water through the heat exchanger. For example, in a test under normal room conditions the fan load raised the winding temperature only 16°C; consequently, the heat exchanger water temperature was increased until the heat exchanger output (motor intake) was 76°C giving a total temperature rise of 92°C, i.e. inlet air (76°C) plus loading (16°C). As previously mentioned in normal applications the heat exchanger output (air inlet to the motor) is of the order of 100°F (~ 38°C). This allows for a motor temperature (winding) rise on the order of 60°C during normal operation (Class A application of Class F insulation).

The variation in motor parameters as shown in the previously submitted Table, "Typical Motor Design Parameters Compared to Test Machine" result from the individual motor design application requirements. However, as indicated in response to Question 1 above, specific conditions, requirements which the motor design must provide in order to have WCAP 7829 applicability have been included in the fan cooler motors supplied to St. Lucie. More specifically the motor thermal design for the individual application is first established then the electrical characteristics follow.

Motor design requires calculation of 5 separate losses which account for internal rise of the motor and a steady heat loss which must be removed. This total kilowatt loss taken together with the shaft driven fan P-V curve and cooling water temperature permit the heat exchanger designer to arrive at an air outlet (motor inlet) temperature. The motor internal rise plus the inlet air gives the total temperature at any horsepower.

Current, efficiency, power factor and other electrical characteristics can be calculated and verified as soon as windings have been selected to meet specified horsepower, rise and torque values.