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NONDESTRUCTIVE BORE EXAMINATION
AND
CONDITION ASSESSMENT OF
GEC ALSTROM HP ROTOR
ENRICO FERMI NUCLEAR STATION, UNIT 2
DETROIT EDISON COMPANY

June 27, 1994

Prepared By

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B/11

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1.0 SUMMARY AND CONCLUSIONS

The HP rotor of Unit #2 at the Enrico Fermi Nuclear Power Station #2 was nondestructively examined by WesDyne International Inc. (WDI) at the station during June 1994. The examinations included rotor bore diameter measurements, visual and magnetic particle inspection of the bore surfaces and ultrasonic inspection of the near bore regions.

Engineering condition assessments were made by Siemens Power Corporation (SPC). These tasks included a sizing of potential flaws from examination results, estimation of material properties, and stress and fracture mechanics analyses. The purpose of the assessment was to determine the suitability of the rotors for continued operation and recommend a future inspection schedule.

The specific results are summarized as follows.

<u>HP ROTOR</u>:

- The bore diameters before and after honing are as follows.

Axial Range, In.	Bore Diameter, in. Before Honing	Bore Diameter, in. After Honing
0 - 4"	Plug Bore	Plug Bore
4 - 226"	9.964 - 9.980	9.985 - 9.988
226 - 234"	Transition	Transition
234 - 346"	6.013 - 6.027	6.044 - 6.049

- The visual examination showed five areas of dimpled regions.

- The magnetic particle examinations did not reveal any flaw like indications including the dimpled regions.

- The ultrasonic examination using [UDRPS] system resulted 13 centroids of indications. A linkup analysis of these indications yielded 3 potentially linked up flaws.

- Engineering condition assessment analysis showed that the rotor can be returned to service but future inspections are recommended.

2.0 RECOMMENDATIONS

The HP rotor can be returned to service. It is recommended, however, that this rotor be inspected within 2000 starts or 80,000 hours which-
ever comes first.

3.0 INTRODUCTION

During June 1994, WesDyne International Inc. (WDI) performed nondestructive examinations of the subject HP rotor at the Enrico Fermi Nuclear Generating Station. Siemens Power Corporation (SPC) performed the engineering condition assessment based on WDI's inspection results.

The purpose of this study was to detect any potential flaws in or near the bore and evaluate their significance on the reliability of the rotors during future operation. These flaws could grow by fatigue and/or creep to critical sizes when a burst condition would occur. Remaining life estimates are made using fracture mechanics and a recommended future inspection interval is developed.

The unit was manufactured by GEC Alstrom and placed in service in 1975. The unit is rated at about 1200 MW, with the inlet steam at 544°F and 991 PSIG.

Section 4.0 of this r port includes a description of the inspection methodolog\ Section 5.0 includes a discussion of the condition assessment methodology. Section 6.0 includes a discussion of the specific analysis and results.

4.0 NONDESTRUCTIVE EXAMINATION METHODOLOGY

The typical procedure includes, removal of bore plug(s), bore surface preparation by power honing, bore diameter measurements, visual and magnetic particle inspections of the bore surface, ultrasonic inspection from the bore and real time data acquisition, "deworming" analysis of the ultrasonic data to determine the hypothetical flaws and final installation of the new bore plug/s (after the flaws are not found to be harmful as determined by condition assessment).

4.1 Bore Preparation and Measurements

The bore surface is power honed to obtain a finish suitable for the magnetic particle and ultrasonic examinations. The bore diameter is measured to the nearest 0.001" at every 2" axially and at transitions when more than one size bore is present.

4.2 Visual Examination

The primary purpose of the visual examination (VT) is to detect flaws that may be open to, or present at, the bore surface. The secondary purpose of the visual examination is to determine if the bore surface finish is acceptable for conducting magnetic particle and ultrasonic examinations of the rotor.

A visual examination of the entire rotor surface is performed using a borescope. This examination utilizes a conventional 2X magnification borescope that is manually rotated along the bore. Sketches and/or photographs of the indications are provided with appropriate axial and circumferential locations.

4.3 Magnetic Particle Examination

A magnetic particle examination (MT) of the bore surface is performed to locate significant surface breaking flaws. The bore surface is visually examined after proper application of a wet magnetic particle solution to the magnetized surface. Magnetization is achieved by a central conductor rod either grounded at the end of the blind bore to the rotor or run through the bore if possible. A large magnetic power supply (480 VAC, single phase) is used to deliver 200 amperes of current per inch of bore diameter. The magnetic field is checked by an independent gauge.

The magnetic particles are suspended in a solvent. Checks are made on particle concentration with care taken to prevent particle settling. The solution is sprayed onto the bore surface with the magnetic field on. Afterwards the bore is examined with a borescope with a white light source and then cleaned. Significant indications and their location are recorded by the technician.

4.4 Ultrasonic Examination

Rotorsonic System

WesDyne has developed a state-of-the-art Ultrasonic Data Recording and Processing System (UDRPS). This system is a field deployable, multi-channel, production oriented data acquisition and analysis system. The UDRPS has been successfully used at several commercial operating plants to detect, size and characterize various types of flaw indications including intergranular stress corrosion cracking.

The UDRPS has been developed to do, in real time, what a trained examiner does to discriminate flaws from other UT responses. That is, to discriminate a consistent signal moving in time (depth) relative to search unit position. This fundamental goal precipitated development of extremely fast electronics and several sophisticated mathematical processes which together form the unique technology of the UDRPS.

The UDRPS is a high-speed, ultrasonic data recording, processing and analysis system. The system is capable of performing automatic flaw detection and location and can accommodate longitudinal, shear and dual element transducers.

The UDRPS processes ultrasonic response signals in a manner that provides up to twenty-to-one improvement in signal-to-noise ratio over conventional analysis, while directly correcting for search unit characteristics such as beam spread. It generates images from the data so that the operator can "see" defects and size those defects accurately.

Although a significant increase in examination sensitivity has been demonstrated in several applications, it is also important to note that increased reliability of examination also is realized.

The location of an individual target return is calculated from time of flight (i.e., metal path) and transducer position and angle. This location is transformed and displayed in the coordinates of the material being inspected.

Sizing is performed interactively using scaled orthogonal or perspective views of sound field images displayed on a color graphics monitor.

System hardware consists of multiple, automatic detection channels. Each channel is a network of computers including an ultra high speed data stream computer, an array processor, and digital storage medium. Channels can be added or deleted from the UDRPS configuration to match the application.

Each transducer search unit is energized separately, never more than one at a time by the use of a multiplexing scheme and in a fixed sequence. Further the time separation between pulses is jittered randomly, thus eliminating any possibility of cross talk between transducers leading to false calls. All transducers used during the examination are of the non-focused, pulse/echo type.

UDRPS provides for a signal to noise ratio improvement, the objective of focused probe scanning, without the use of narrow beam profiles. This is achieved by the use of a line-SAFT (Synthetic Aperture Focusing Technique) digital signal processing calculation performed in real time by UDRPS. This technique allows wide beam transducers to be focused to smaller beam widths while maintaining the wide coverage and more rapid scan rates not generally available with focused probes.

Although 1/16" and 1/8" side drilled holes are used for calibration, a specific reference level is not used to record data. Rather all ultrasonic targets, including noise, are recorded. Since this technique is much less sensitive to the amplitude calibration, it is more repeatable for future inspections. Furthermore, the high sensitivity and the signal to noise processing employed allows surface flaws to be detected.

It should be noted that this method of inspection produces substantially more data for analysis than other single gate ultrasonic acquisition systems which record data above a certain percentage of calibration level. Therefore, the number of targets recorded is not meaningful since the majority of the targets are from insignificant point source reflectors.

Transducers/Scanning Pattern

The frequency of the transducer search units used during the examinations are 3.5 MHz for the angle beam circumferential scans, 3.5 MHz for the 0° longitudinal beam scans, and 2.25 MHz for the angle beam axial scans. The transducers are mounted in plexiglass shoes which are coupled to the bore by a continuous flow of light turbine oil force-fed to oil outlets on the bottom of the shoe. Radial shear wave search units in the clockwise and counterclockwise direction are used.

The scanning pattern used for the examination involves circumferential motion in a clockwise then counterclockwise direction with indexing in the axial direction 2down the bore. Axial index increment is .25" for a total scan section of 15". Additional lengths of the bore are examined by adding extension tubes. A dedicated, high precision computer controlled scanner has been constructed for bore inspection.

UDRPS Analysis/Output

During the examination, UDRPS provides:

- Complete recording of each entire A-scan, pulse by pulse on an optical disk.
- Target detection on a well proven, highly reliable, amplitude insensitive, signal to noise ratio and pattern recognition algorithm performed in real time as data are taken.
- A, B, C and D scan data presentations.
- Three dimensional target displays of the inspected volume of material.
- Spatial and temporal averaging of data for enhanced signal to noise.
- Multiple B scan views at near motion picture framing rates.
- Edge enhancement routines to improve signal to noise.

- Spatial correlation routines for the separation of significant from benign indications, i.e. "deworming" techniques. This technique is used to formulate potential flaw sizes. All indications that appear to be real and meet certain criteria within the UDRPS detection algorithm are centroided (flagged). These centroids are compiled in the data files and are available for further processing. Next the UDRPS uses a data processing program called "deworming". The UDRPS will go through all the raw centroids and look for consistency from one centroid to the next. It also looks for centroids that fall within the boundaries set by the operator. If centroids are found that meet the criteria, then it links them together into groups.

- All examination data are recorded in real time and reviewed for accuracy and validity at the end of each scan section. All structurally significant indications detected during the examination are documented by hard copy display, which can be found in later sections of this report.

5.0 CONDITION ASSESSMENT METHODOLOGY

The SPC condition assessment includes reviewing reported flaw sizes and/or formulating potential flaw sizes from inspection data, performing stress analyses, material data evaluation and fracture mechanics analysis to determine how detrimental the present flaws are for operation of the rotor and to establish the next inspection interval.

5.1 Crack Size Determination

If a magnetic particle inspection is conducted, it is usually assumed that the radial depth of the indication is one-half of its axial length unless proven otherwise by the boresonic inspection.

Surface and subsurface flaw sizes are provided by WesDyne from the ultrasonic examination, and when necessary they are derived by performing a "3-D Computer Linkup Analysis" of the ultrasonic data by SPC. Although the ultrasonic indications may show a relatively small amplitude, it is possible for larger flaws to be present due to reflection uncertainty associated with flaw shape and orientation. Furthermore, it is possible to have ligament yielding between indications without being detected. To reduce these uncertainties and to define the size of potential flaws a linkup analysis is conducted utilizing an ellipsoid surface criterion wherein the radial, circumferential and axial radii can be varied (Reference 1). The 3-D distance between indications is calculated and if this distance is less than a critical distance, the indications are linked together. A potential flaw is formed when sufficient indications can be linked or clustered together. This critical distance is in general a function of the size of the neighboring indications, the plastic zone size, the fracture toughness, the stress level and the yield strength of the material.

5.2 Stress Analyses

Stress analyses are normally conducted with in-house computer programs using classical formulation and in certain cases the finite element method is utilized.

For a turbine rotor, the circumferential mechanical stress profile as a function of the radial distance from the bore surface due to rotation and blade load is calculated at the potential flaw locations. An appropriate thermal stress is added to account for the start-up transient at cold starts.

For a generator rotor, the circumferential stress profile about the bore in the main body is calculated based on a solid ring of dead weight, which represents the copper coils, acting on a bored shaft with a diameter equal to the bottom of the coil slots. The distance from the bore surface to the bottom of the coil slots is measured ultrasonically.

Since the overspeed stress in addition to the running speed stress is considered in the fracture mechanics analysis, this stress profile is also calculated.

5.3 Material Evaluation

Typically fracture toughness, K_{Ic}, and crack growth data are estimated from available known mechanical properties and chemical composition for the rotor, or when data are not available the SPC database, which includes both published and unpublished in-house data for vintage rotors, are used. When possible, drilling chips are removed from the rotor for chemical analysis and correlation with fracture toughness (Reference 2).

Fracture toughness data normally used for these analyses are provided in Appendix A; Figure A-1 shows lower bound K_{Ic} data for embrittled and unembrittled rotors, and Figure A-2 shows K_{Ic} versus operating temperature minus FATT. If a need is indicated, then core samples such as radial or axial trepans, or ring samples from the bore region are removed from the rotor and actual K_{Ic} data are obtained in accordance with ASTM E-813. Fracture toughness and chemical composition correlations are also provided in Appendix A (as Attachment A) are also utilized when appropriate.

5.4 Fracture Mechanics Analyses

Since fracture mechanics deals with cracks, the visual, magnetic particle and ultrasonic indications are usually considered to be cracks unless proven otherwise; this is a conservative approach.

Critical Crack Size

The burst condition for the rotor occurs when the stress intensity factor, K_I, corresponding to the present crack size is equal to or exceeds the current fracture toughness, K_{Ic}, of the material. The crack size corresponding to this situation is said to be critical. The stress intensity factor is a function of the applied stress and crack size and increases with either of these values. The critical crack size, a_{cr}, is a function of the ratio of the fracture toughness, K_{Ic}, to the applied stress, σ. The fracture toughness is a function of the temperature and generally increases with it. If the current stress intensity factor is less than the fracture toughness, then the current crack size is subcritical. However, this subcritical crack could grow by fatigue due to start-stop cyclic operation of the rotor and/or by creep due to steady operation at high enough temperature. By performing a crack growth analysis, the remaining life to reach the burst condition is estimated.

The burst condition, depicted in Appendix A, Figure A-3, corresponds to the minimum critical crack size which occurs when the ratio of fracture toughness to stress is minimum. Therefore, the burst condition occurs sometime during a cold start when K_{Ic}/σ is minimum. Since a detailed analysis is beyond the scope of this study, the burst condition and the associated critical crack size are evaluated from minimum estimated fracture toughness and maximum estimated stress.

Fatigue Crack Growth

The NASCRAC (TM) computer program, described in Appendix B, is used to calculate the stress intensity factors for the hypothetical crack, and to determine the number of load blocks required for the crack to grow by start-stop cycling to a critical size. A load block consists of a number of normal start-stop cycles and one overspeed cycle. As a conservative estimate hot and warm starts are considered to be the same as a cold start. Upper bound fatigue crack growth rate data are used for the calculations and it is considered that the rotor will fail during an overspeed test. Crack growth rate data are provided in Appendix A, Figure A-4.

Since the NASCRAC program allows stress profiles to be input, it is especially suited to rotor bore analysis. If the circumferential stress is held constant with radial distance from the bore, the critical crack size calculated is too conservative (too small). Therefore, more realistic results can be obtained using the actual stress profile.

The NASCRAC output tabulates crack sizes, stress intensity factors based on overspeed stress, and load blocks for small increments of crack growth. To account for uncertainty in the stress analysis, fracture toughness, crack size, etc., the number of calculated load blocks is reduced by a factor of ten. Although the results may show that it would take more than 2000 start-stop cycles for the crack to reach the critical size, it is SPC policy to recommend no more than 2000 starts-stops before the next bore inspection.

Creep-Fatigue Crack Growth

An in-house computer program is used to calculate crack growth for cyclically loaded CrMoV rotors subjected to hold time at high temperature (Reference 3). Essentially, a load block consisting of one start followed by a number of steady-state running hours (usually 720 hours or one month) is used to calculate the number of starts and operating hours required for a preexisting flaw to grow to the critical size based on start-up transient and steady state stress profiles. Appropriate safety factors are then employed to determine an inspection interval.

5.5 References

1. D. R. McCann, J. Zhang, H. M. Snapp and H. R. Jhansale, "Formulating Potential Flaws From Boresonic Data", EPRI Computer Assisted Technologies For NDE and Plant Monitoring Workshop, Philadelphia, PA, August 10-13, 1992.

2. R. Viswanathan and S. Gehl, "A Method for Estimation of the Fracture Toughness of CrMoV Rotor Steels Based on Composition", Journal of Engineering Materials and Technology, April 1991, Vol. 113, P. 263-270.

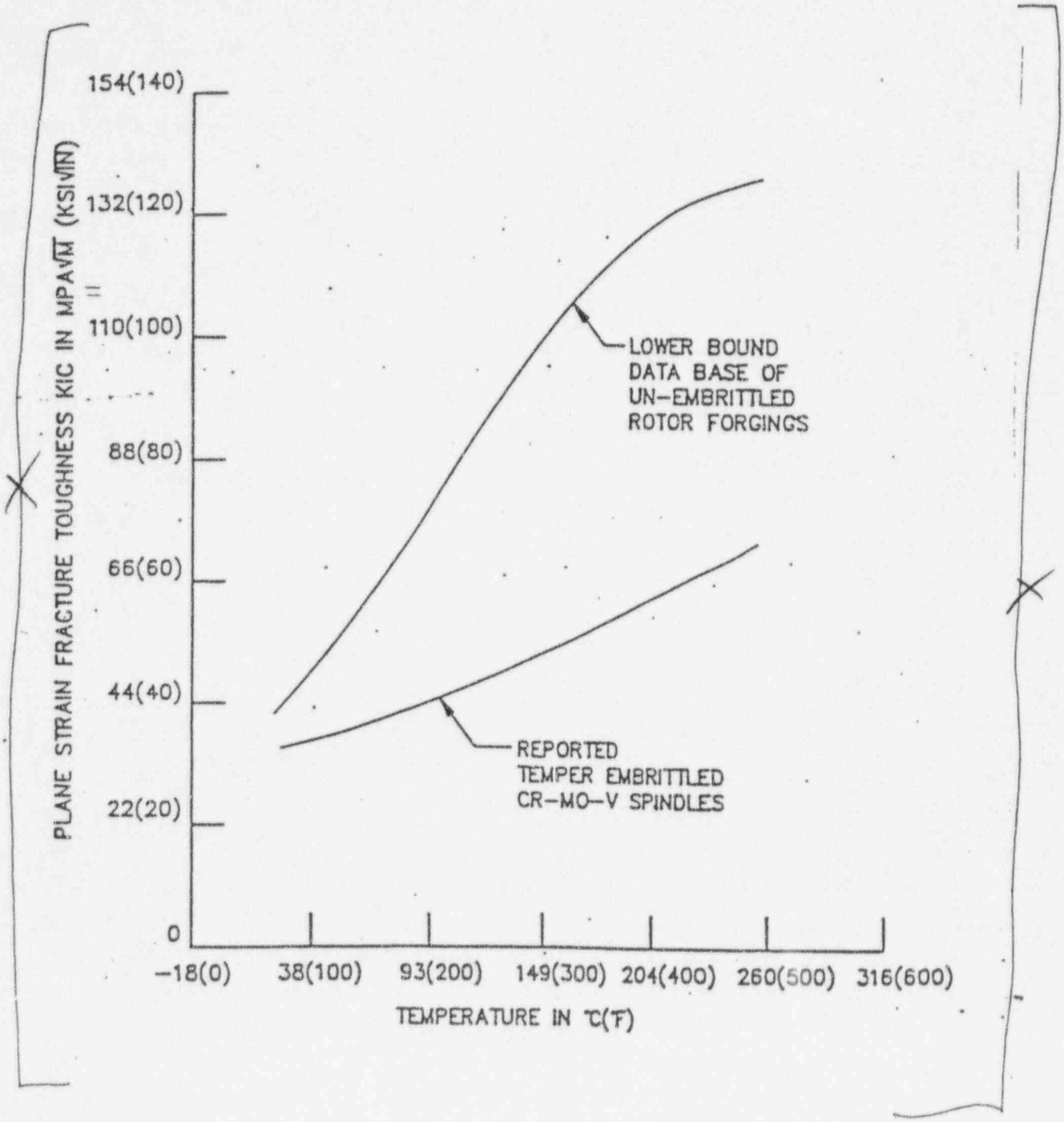
3. R. Viswanathan, "Damage Mechanism and Life Assessment of High Temperature Components", ASM International, Metals Park, OH, 1989, P. 170-172.

6.0 RESULTS

The nondestructive examination results are provided in Appendix C, and the condition assessment results are presented in Appendix D.

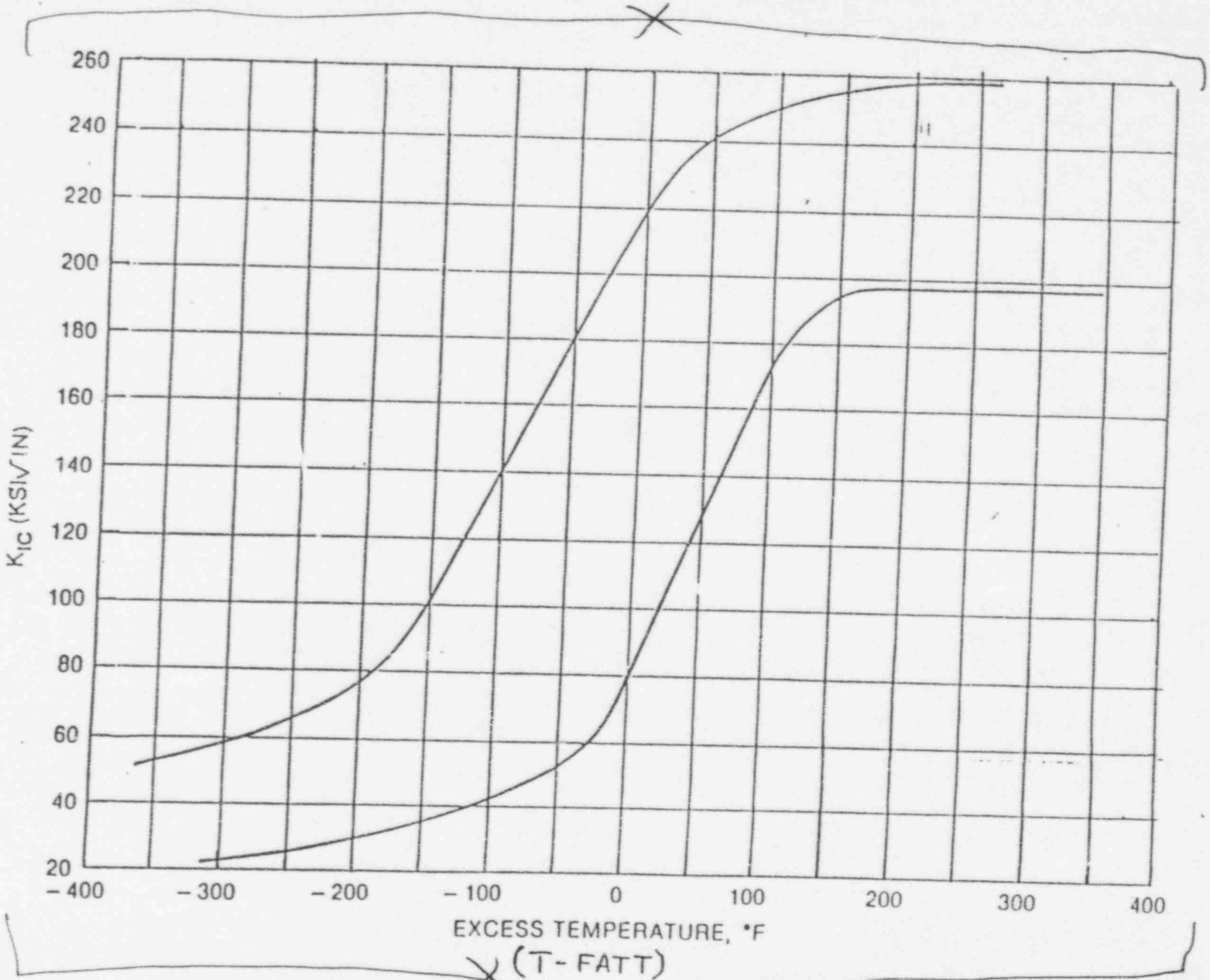
APPENDIX A

MATERIAL PROPERTIES [ATA



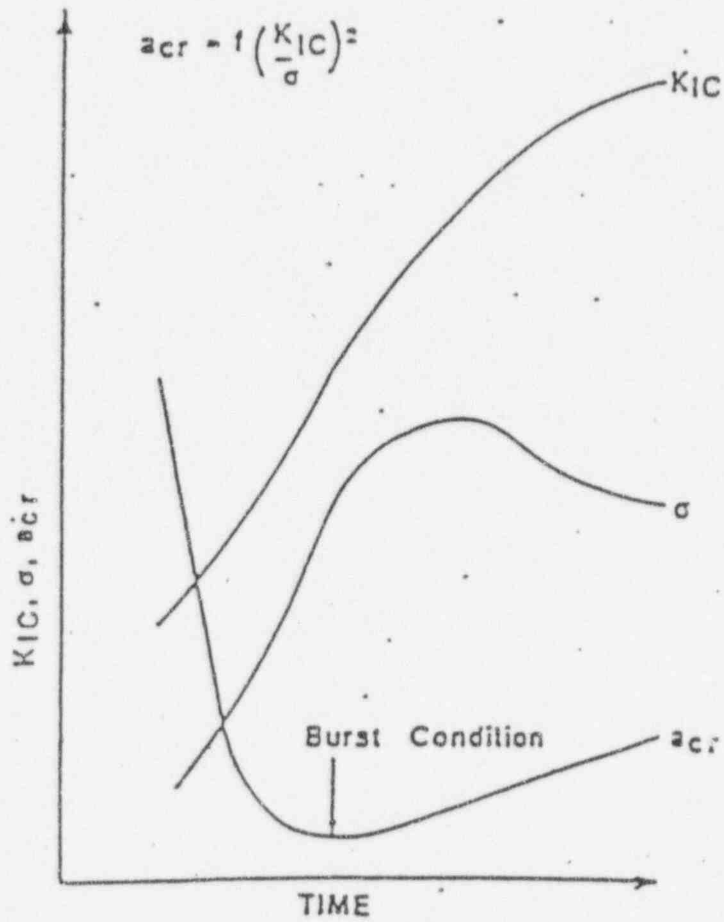
FRACTURE TOUGHNESS VERSUS TEMPERATURE

FIGURE A1



EMPIRICAL CORRELATION OF FRACTURE TOUGHNESS
WITH CHARPY FATT

FIGURE A2



K_{Ic}, σ, a_{cr} VERSUS TIME DURING A COLD START

SCHEMATIC FOR BURST CONDITION ANALYSIS

FIGURE A3

FATIGUE: TURBINE SPINDLE AND DISKS, AND GENERATOR ROTOR

$da/dN = 6.6 \times 10^{-9} (\Delta K)^{2.25}$

da/dN is in/cycle; K in ksi$\sqrt{in}$

FATIGUE: GENERATOR RETAINING RINGS

$da/dN = 1.2 \times 10^{-11} (\Delta K)^{3.655}$

da/dN is in/cycle; K is ksi$\sqrt{in}$

STRESS CORROSION: GENERATOR RETAINING RINGS

For moist H_2

$da/dt = 7.87 \times 10^{-9}$ in/sec for K = 10 to 100 ksi$\sqrt{in}$

STRESS CORROSION: L.P. SPINDLE DISKS

For Water (Westinghouse Data)

$R = EXP(-4.968 - 7302/T + 0.0278\ YS)$

where: R = Rate, in/hr

T = Saturation Temperature, °R

YS = Yield Strength, ksi

CRACK GROWTH RATE DATA

FIGURE A 4

ATTACHMENT A

=

A Method for Estimation of the Fracture Toughness of CrMoV Rotor Steels Based on Composition

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Assessment of the remaining life of steam turbine rotors in the presence of bore defects requires a knowledge of the fracture toughness (K_{IC}) of the rotors. Current procedures for estimating the K_{IC} involve two steps; as a first step, the fracture appearance transition temperature (FATT) at the critical location is determined; the FATT value is then used to estimate the K_{IC}, based on published correlations between the excess temperature (T-FATT) and K_{IC}. Some problems arise in implementing both of these steps. To determine the FATT of the material, large pieces of material have to be removed, machined into charpy specimens and tested; this procedure is often time consuming and expensive and sometimes not feasible. The excess temperatures versus the K_{IC} correlation that is used to derive the K_{IC} values from the FATT data is based on a variety of low alloy steels and is therefore characterized by a large scatter band, thus leading to considerable uncertainty in the estimated K_{IC}. In this work, FATT and K_{IC} data reported for a number of retired CrMoV rotors were gathered and analyzed and correlations specific to CrMoV rotors were developed. Based on these correlations, a method for estimating K_{IC} with greater accuracy, based on a knowledge of the steel chemistry alone, is proposed. The method offers the advantage that very small samples removed from noncritical locations in the rotor would be sufficient to get the desired data.

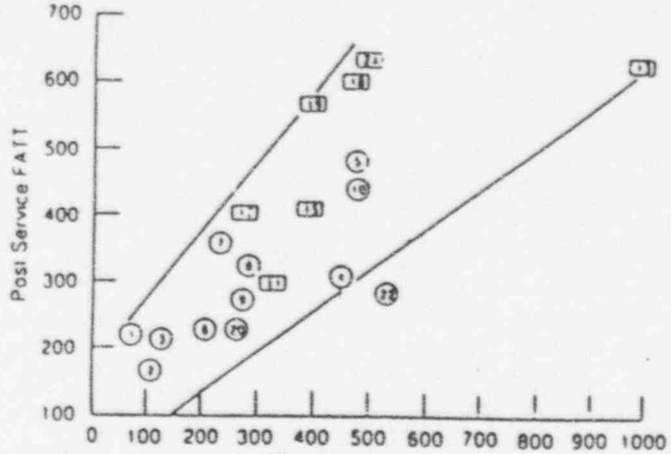


Fig. 4 Variation of post service FATT (corrected for temperature and location) with the J-Factor for CrMoV rotors

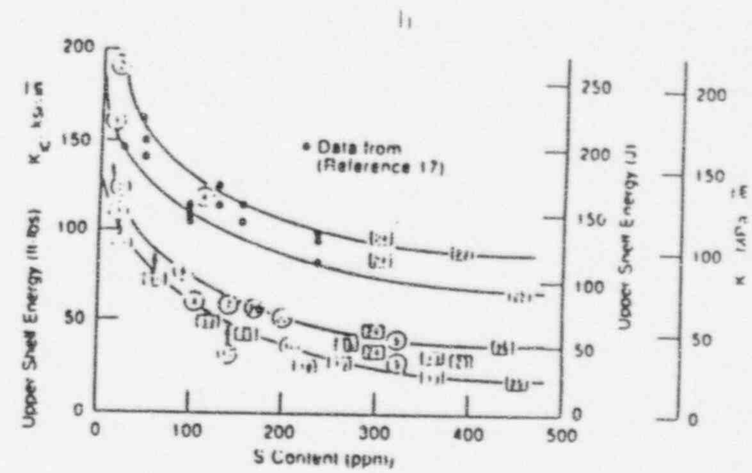


Fig. 8 Variation of upper shelf K_{IC}, and energy with sulfur content of CrMoV steel. When a pair of values are listed for the same steel, the higher value corresponds to the non-embrittled condition and the lower value corresponds to the temper embrittled condition.

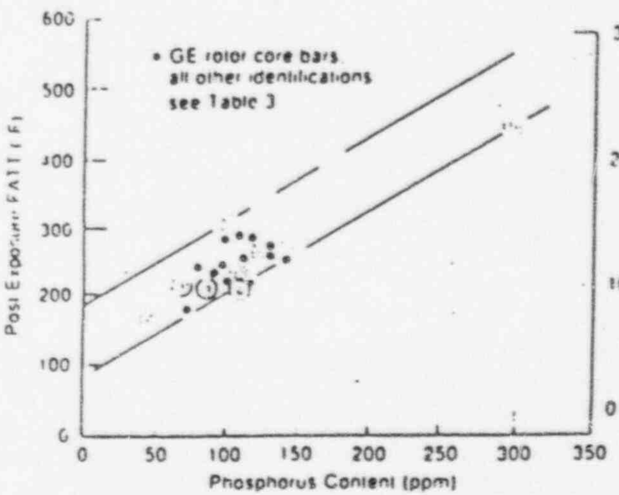


Fig. 6 Variations of post exposure FATT (corrected for temperature and location variations) with the phosphorous content for D grade rotors

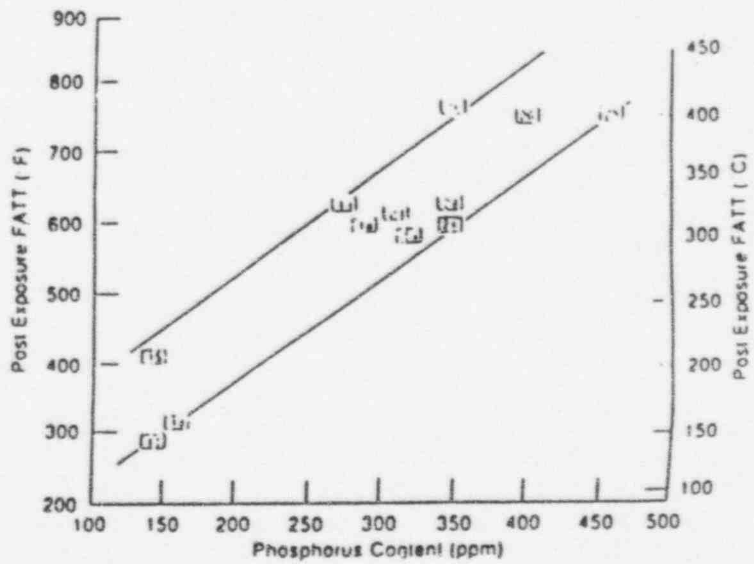


Fig. 7 Variation of FATT (corrected for exposure temperature and location variations) with phosphorous content for C grade rotors

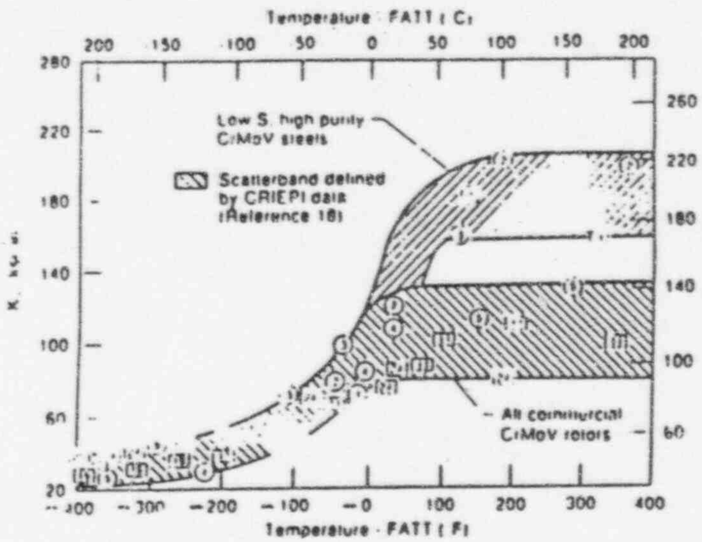


Fig. 11 Variation of K_{Ic} with excess temperature for CrMoV rotors

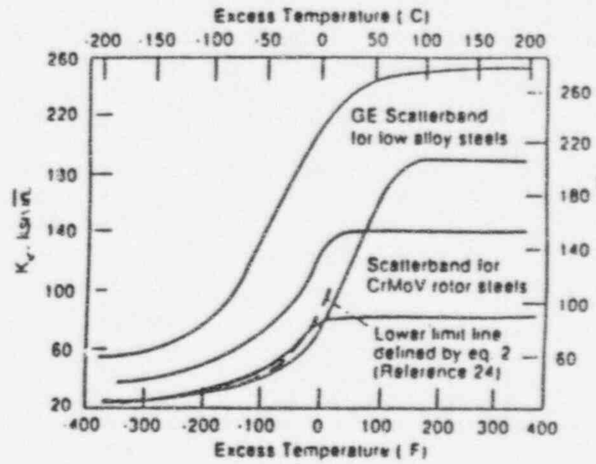


Fig. 12 Comparison of GE X's temperature correlation with the correlation specific to CrMoV rotors

APPENDIX B

NASCRAC™ FRACTURE MECHANICS COMPUTER PROGRAM

NASCRAC ™ COMPUTER CODE

The NASCRAC Code is a computer program for performing state-of-the-art fracture mechanics calculations. It utilizes influence functions, a prior stress analysis of the uncracked structure, and previously developed crack stress intensity solutions to calculate the crack-induced redistribution of the elastic stress field. The program has a library of different crack configurations for which K-solutions are provided, and has the ability to analyze a spectrum of different loads. In addition to the linear elastic fracture mechanics capabilities, the program has provisions for the evaluation of J-integrals, elastic-plastic stress redistribution, and creep crack growth.

The most common models used in the program are a semi-elliptical surface crack (702) and a buried elliptical crack (502) shown on the next pages. Both models contain correction factors to the stress intensity factor for the crack tip approaching a free surface.

NASCRAC is a trademark of THE FAILURE GROUP, INC.

Model Feature	FORTRAN Variable	Option Featured
Model Index Number	KRKTYP	702
Number of Degrees of Freedom	KRKDOF	3
Crack Front Shape	—	Semi-Elliptical
Finite Width Effects	—	Yes
Influence Function	—	Yes
Variable Thickness Effects	IVTHIC	No
J-Integral Solutions	—	No

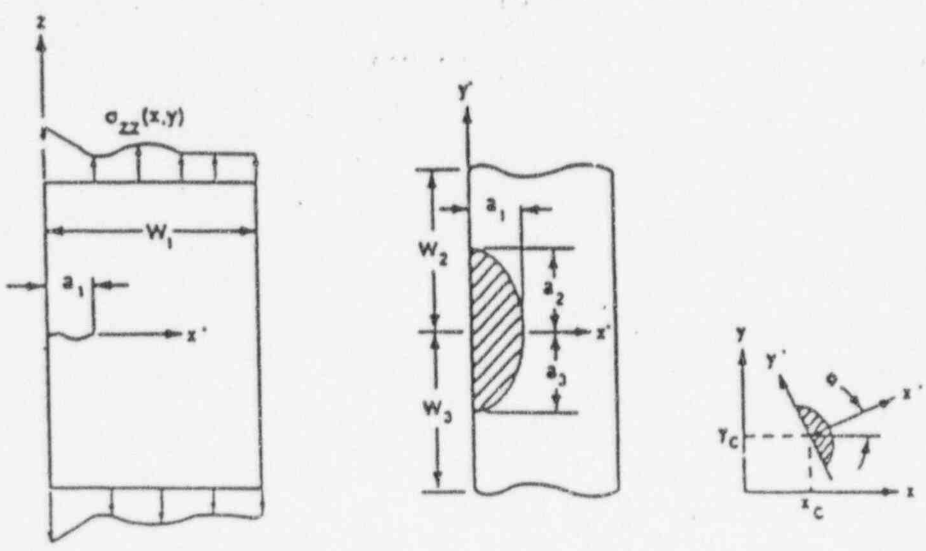
Data Input Description

Input Description		FORTRAN Variable	Input Format	Remarks
Variable Thickness		IVTHIC	Tabular	Not Available
Initial Crack Size	$a1$	AINITL(1)	Constant	
	$a2$	AINITL(2)	Constant	
	$a3$	AINITL(3)	Constant	
Body Widths	$W1$	WIDTHS(1)	Constant	
	$W2$	WIDTHS(2)	Constant	
	$W3$	WIDTHS(3)	Constant	
Crack Position	Xc	CENTER(1)	Constant	
	Yc	CENTER(2)	Constant	
Crack Orientation	ϕ	CRKANG	Constant	
Stress Input	$\sigma_{zz}(x)$		Equational Tabular	
	$\sigma_{zz}(x,y)$		Equational Tabular	

K-Solutions:

Limits : $(a_2 + a_3)/a_1 > 2$ Accuracy : Approximately 10% for $a_1/W_1 < 0.8$ and $1 \leq (a_2 + a_3)/a_1 \leq 6$;

$a_1/W_1 < 1$ Unknown outside this range.



Buried Elliptical Crack

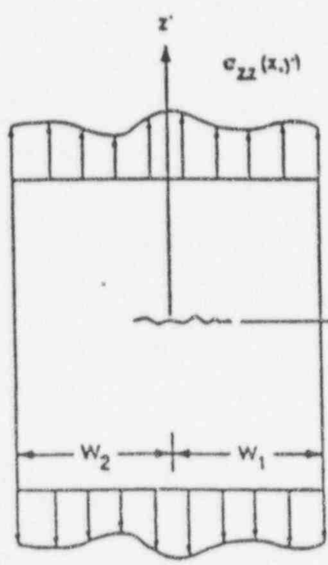
Model Feature	FORTRAN Variable	Option Featured
Model Index Number	KRKTYP	502
Number of Degrees of Freedom	KRKDOF	4
Crack Front Shape	—	Elliptical
Finite Width Effects	—	Yes
Influence Function	—	Yes
Variable Thickness Effects	IVTHIC	No
J-Integral Solutions	—	No

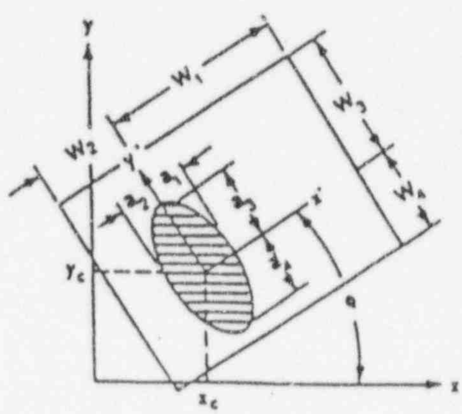
Data Input Description

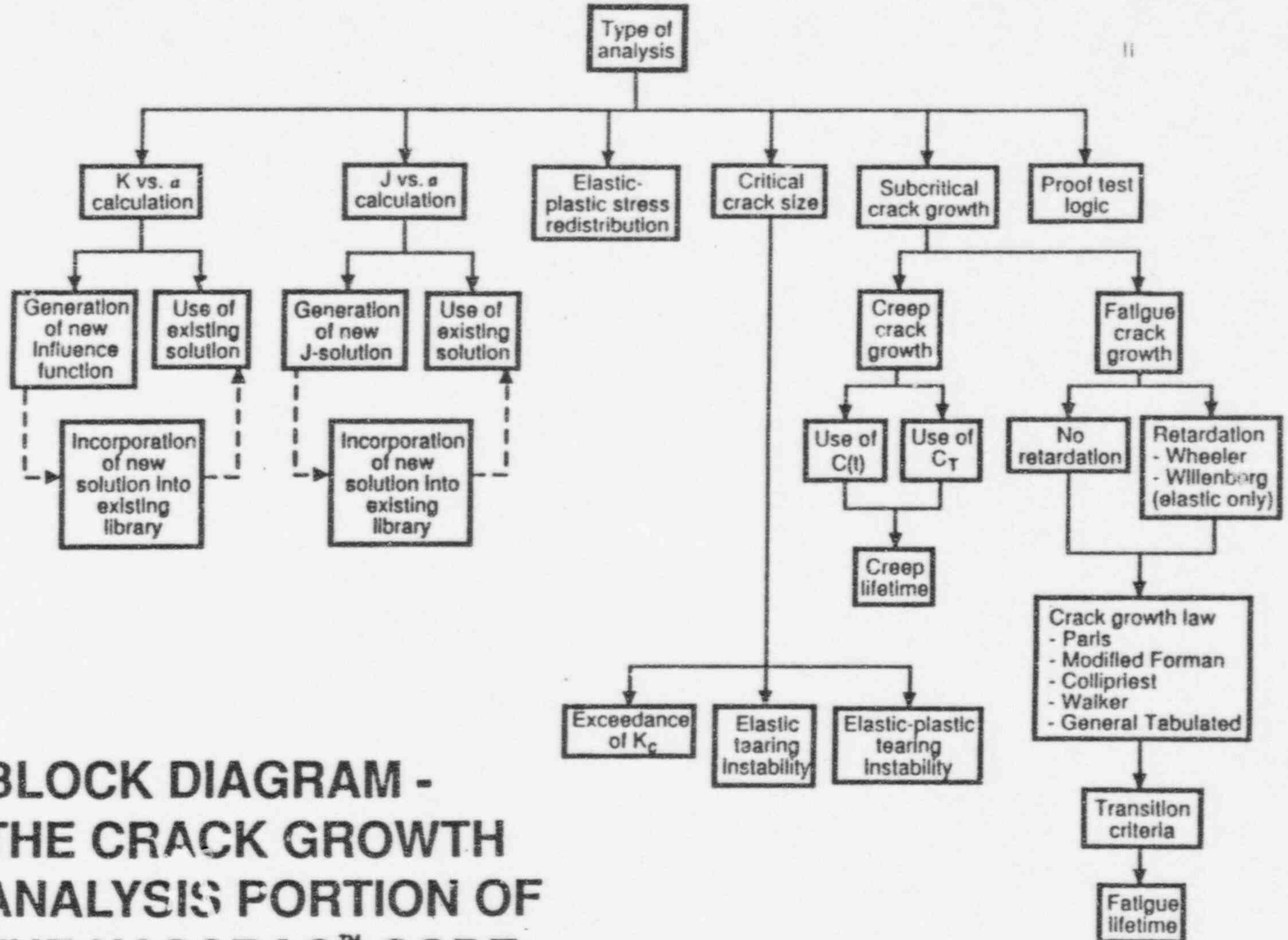
Input Description		FORTRAN Variable	Input Format	Remarks
Variable Thickness		IVTHIC	Tabular	Not Available
Initial Crack Size	$a1$	AINITL(1)	Constant	
	$a2$	AINITL(2)	Constant	
	$a3$	AINITL(3)	Constant	
	$a4$	AINITL(4)	Constant	
Body Widths	$W1$	WIDTHS(1)	Constant	
	$W2$	WIDTHS(2)	Constant	
	$W3$	WIDTHS(3)	Constant	
	$W4$	WIDTHS(4)	Constant	
Crack Position	X_c	CENTER(1)	Constant	
	Y_c	CENTER(2)	Constant	
Crack Orientation	ϕ	CRKANG	Constant	
Stress Input	$\sigma_{zz}(x)$		Equational Tabular	
	$\sigma_{zz}(x,y)$		Equational Tabular	

K-Solutions:

Limits : unknown Accuracy : unknown (better accuracy for smaller cracks)







BLOCK DIAGRAM - THE CRACK GROWTH ANALYSIS PORTION OF THE NASCRAC™ CODE

Failure Analysis Associates

00552.e.1

APPENDIX C

NONDESTRUCTIVE EXAMINATION RESULTS

DIMENSIONAL PROFILE

A bore profile was made at 2.0" Intervals down the bore after power honing. See detailed results.

BORE PROFILE SHEET

CUSTOMER DECO STATION/UNIT FERMI #2 JOB NO. DEHY200

HP ✓ IP ____ LP ____ GEN ____ ROTOR

MEASURED FROM Gen End

Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing
0	NA	NA	44	9.964	9.985	88	9.965	9.986
2	NA	NA	46	9.964	9.985	90	9.966	9.986
4	9.980	9.986	48	9.965	9.985	92	9.967	9.986
6	9.980	9.986	50	9.963	9.985	94	9.967	9.986
8	9.965	9.985	52	9.964	9.985	96	9.966	9.986
10	9.966	9.985	54	9.964	9.986	98	9.967	9.986
12	9.967	9.985	56	9.965	9.986	100	9.967	9.986
14	9.967	9.985	58	9.966	9.986	102	9.967	9.986
16	9.960	9.985	60	9.966	9.986	104	9.967	9.986
18	9.965	9.985	62	9.966	9.986	106	9.967	9.986
20	9.965	9.985	64	9.966	9.986	108	9.967	9.986
22	9.965	9.985	66	9.966	9.985	110	9.967	9.986
24	9.965	9.985	68	9.965	9.986	112	9.967	9.986
26	9.965	9.985	70	9.965	9.986	114	9.967	9.986
28	9.966	9.985	72	9.965	9.986	116	9.967	9.985
30	9.966	9.985	74	9.966	9.986	118	9.967	9.987
32	9.967	9.985	76	9.967	9.986	120	9.966	9.986
34	9.965	9.986	78	9.965	9.986	122	9.966	9.986
36	9.965	9.986	80	9.967	9.986	124	9.965	9.986
38	9.965	9.986	82	9.967	9.986	126	9.965	9.986
40	9.965	9.985	84	9.967	9.986	128	9.965	9.986
42	9.964	9.985	86	9.965	9.986	130	9.965	9.986

DIMENSIONS TAKEN BY D. Morgan DATE 6-11-94

BORE PROFILE CONTINUATION SHEET

CUSTOMER DECO STATION/UNIT FERMI #2 JOB NO. DEHY200

HP ✓ IP ____ LP ____ GEN ____ ROTOR

MEASURED FROM GEN END

Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing
132	9.966	9.986	176	9.967	9.988	220	9.971	9.980
134	9.966	↑	178	9.965	↑	222	9.974	9.974
136	9.966		180	9.965		224	9.971	9.974
138	9.966		182	9.966		225	9.966	9.968
140	9.966		184	9.969		228	TRANSITION AREA	TRANSITION AREA
142	9.966		186	9.972		230	TRANSITION AREA	TRANSITION AREA
144	9.966		188	9.969		232	TRANSITION AREA	TRANSITION AREA
146	9.966		190	9.968		234	6.013	6.046
148	9.966		192	9.965		236	6.014	6.044
150	9.965		194	9.966		238	6.015	↑
152	9.965		196	9.966		240	6.015	
154	9.966		198	9.968		242	6.015	
156	9.965		200	9.968		244	6.014	
158	9.965		202	9.971		246	6.015	
160	9.966	↓	204	9.969		248	6.015	
162	9.965	9.987	206	9.968		250	6.015	
164	9.964	↑	208	9.967		252	6.015	
166	9.964		210	9.965	↓	254	6.015	
168	9.965		212	9.967	9.986	256	6.015	
170	9.967		214	9.966	9.985	258	6.015	
172	9.967	↓	216	9.967	9.984	260	6.015	
174	9.967	9.988	218	9.969	9.984	262	6.015	↓

DIMENSIONS TAKEN BY D. Morgan DATE 6-11-9

BORE PROFILE CONTINUATION SHEET

CUSTOMER DECO STATION/UNIT Fermi #2 JOB NO. DEHY200

HP ✓ IP ___ LP ___ GEN ___ ROTOR

MEASURED FROM Gen End

Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing	Bore Depth	Before Honing	After Honing
264	6.015	6.044	308	6.014	6.044	352		
266	6.015	↑	310	6.014	↑	354		
268	6.015		312	6.014		356		
270	6.015		314	6.014		358		
272	6.015		316	6.014		360		
274	6.015		318	6.013		362		
276	6.015		320	6.014		364		
278	6.015		322	6.014		366		
280	6.015		324	6.014		368		
282	6.015		326	6.014		370		
284	6.015		328	6.013		372		
286	6.015		330	6.015		374		
288	6.015		332	6.015	↓	376		
290	6.015		334	6.015	6.045	378		
292	6.015		336	6.015	6.046	380		
294	6.015		338	6.015	6.047	382		
296	6.015		340	6.015	6.047	384		
298	6.015		342	6.017	6.047	386		
300	6.015		344	6.020	6.048	390		
302	6.015		346	6.027	6.049	392		
304	6.014		348			394		
306	6.015	↓	350			396		

DIMENSIONS TAKEN BY W. Morgan DATE 6-11-9

VISUAL INSPECTION

The visual examination was conducted using a borescopic probe. The borescope allowed for the complete viewing of the visual examination. See detailed results.

INDICATION DATA SHEET

CUSTOMER FERMI STATION/UNIT 2 JOB NO. DEHY

H.P. ROTOR ✓ I.P. ROTOR N/A L.P. ROTOR N/A GENERATOR N/A

MAGNETIC PARTICLE N/A VISUAL ✓ PRELIMINARY ✓ FINAL N/A

BORE DIA. 9.984/60 ZERO DEG.REF. 1 BOLT HOLE FIELD OF VIEW 5.25/30

Ind.# 1 Deg. 1° to 360° Axial Start FULL LENGTH Length N/A Description MEDIUM CORROSION	N/A Ind.# Deg. Axial Start Length Description	N/A Ind.# Deg. Axial Start Length Description
N/A Ind.# Deg. Axial Start Length Description	N/A Ind.# Deg. Axial Start Length Description	N/A Ind.# Deg. Axial Start Length Description

REMARKS:

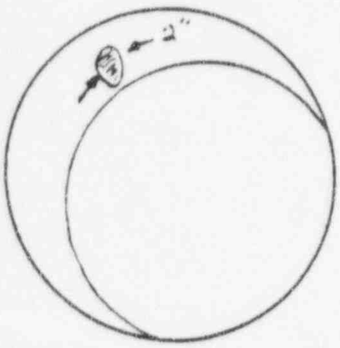
DATA SHEET

CUSTOMER FERMI 2 STATION/UNIT 2 JOB NO. DEHY

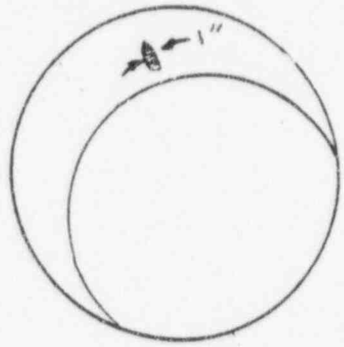
H.P. ROTOR ✓ I.P. ROTOR N/A L.P. ROTOR N/A GENERATOR N/A

MAGNETIC PARTICLE N/A VISUAL ✓ PRELIMINARY N/A FINAL ✓

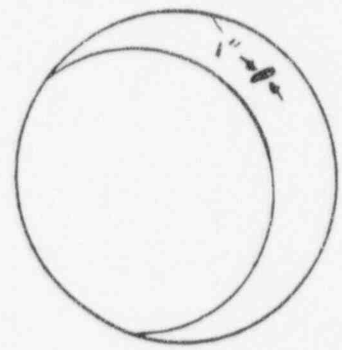
BORE DIA. 9.984"/6.0" ZERO DEG.REF. BOLT HOLE #1 FIELD OF VIEW 5.25"/3.0



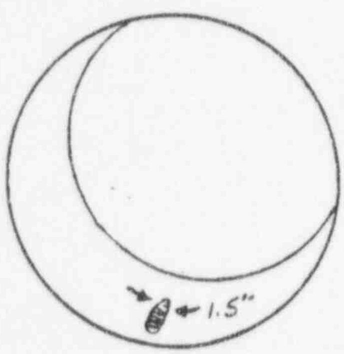
Ind.# 1 Deg. 345°
Axial Start 148"
Length 4"x2"
Description DIMPLE



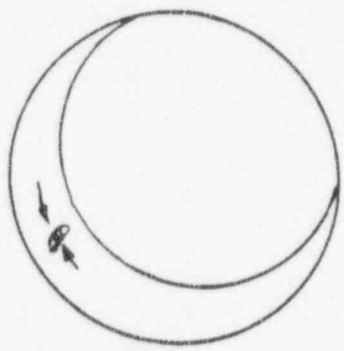
Ind.# 2 Deg. 345°
Axial Start 183.5"
Length 3"x1"
Description DIMPLE



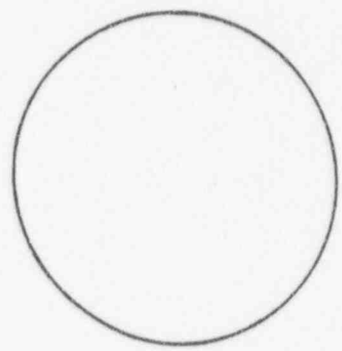
Ind.# 3 Deg. 60°
Axial Start 190.5
Length 1.5"x1"
Description DIMPLE



Ind.# 4 Deg. 200°
Axial Start 196.5
Length 3x1.5"
Description DIMPLE



Ind.# 5 Deg. 240°
Axial Start 199.0"
Length 2.5x1.0"
Description DIMPLE



Ind.# Deg.
Axial Start
Length
Description

REMARKS:

EXAMINER LEVEL DATE 6-8-94

MAGNETIC PARTICLE EXAMINATION

A magnetic particle examination was performed. A borescopic probe was utilized to allow complete viewing of the examination. See detailed results.

CUSTOMER FERMI STATION/UNIT 2 JOB NO. DEHY

H.P. ROTOR ✓ I.P. ROTOR N/A L.P. ROTOR N/A GENERATOR N/A

MAGNETIC PARTICLE ✓ VISUAL N/A PRELIMINARY N/A FINAL ✓

BORE DIA. 9.984"/6.0" ZERO DEG.REF. #1 BOLT HOLE FIELD OF VIEW 5.25/3.0

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

N/A

Ind.# ____ Deg. ____
Axial Start ____
Length ____
Description ____

REMARKS: NO RELEVANT INDICATIONS FOUND

EXAMINER [signature] LEVEL II DATE 6-9-94

ULTRASONIC EXAMINATION

Calibrations

A dynamic calibration designed to establish udrps detection parameters was performed. This sensitivity reference standard is made from a block of material acoustically similar to the rotor forging material. The block contains a bore with a radius similar to the radius of the forging. Each block contains small diameter reference reflectors at different depths radially outward from the bore surface. Results of the dynamic calibrations and examination parameters are permanently stored on optical disk for future reference.

Figure 1 is a view of the 12" Calibration block with the clockwise radial search unit.
Figure 2 is a counterclockwise view of the 12" Calibration block with the other radial search unit.
Figure 3 is a clockwise view of the 6.25" Calibration block with the clockwise radial search unit.
Figure 4 is a counterclockwise veiw of the 6.25" Calibration block with the other radial search unit.

WESDYNE INTERNATIONAL

BORE UT CALIBRATION DATA SHEET 'A'

CUSTOMER: DETROIT EDISON STATION/UNIT: FERMI / 2 JOB NO.: DEHY-200

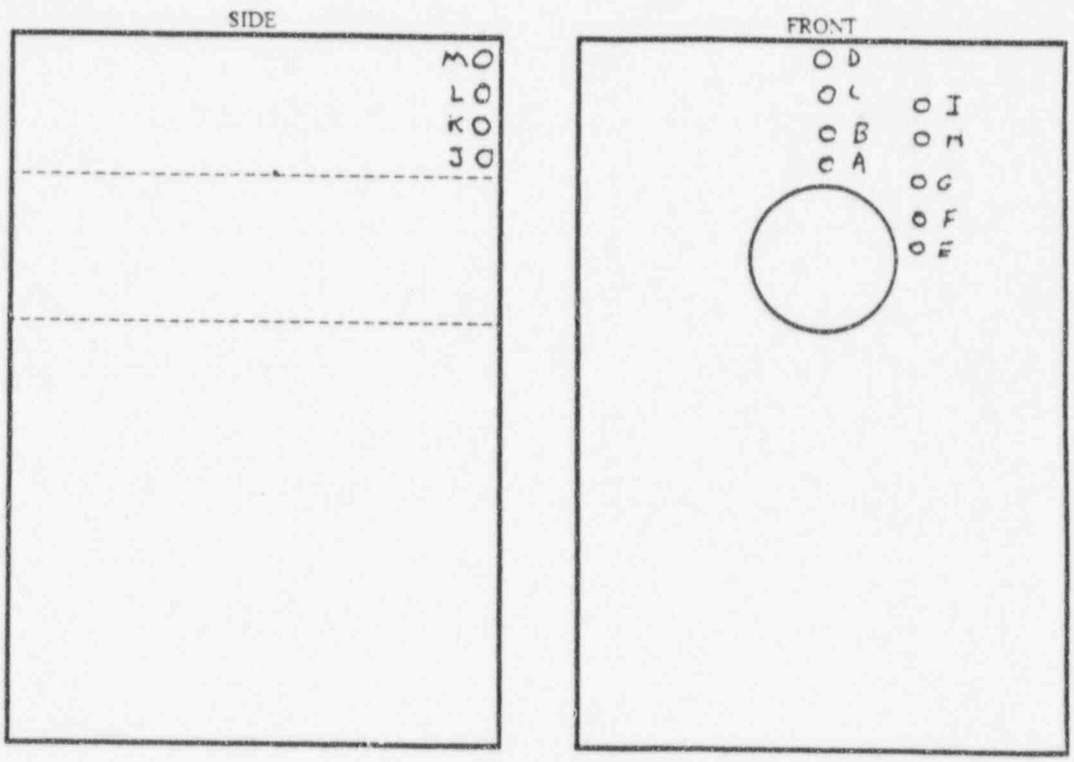
HP ROTOR SN: EERF12133 BORE DIAMETER: 9.984 CAL. BLOCK DIA.: 12.0 TRANSDUCER SHOE SIZE: 9.980

	CIRC. SHEAR		AXIAL SHEAR		ZERO DEGREE	
	CW	CCW	OUT	IN	NS	FS
TRANSDUCER S/N	C111L5	C111L4	D03972	D03972	G07929	G07927
UT INSTRUMENT MODEL NO. / SERIAL NO.	DYNAPULSER CH 1 WEM 10792		DYNAPULSER CH 2 WEM 10792		DYNAPULSER CH 3 WEM 10792	
SENSITIVITY	35		30		30	

SKETCH OF CALIBRATION BLOCK AND HOLES USED

HOLE/DEPTH

A .25
B 1.0
C 2.0
D 3.5
E .25
F .50
G 1.0
H 2.0
I 3.0
J .25
K 1.0
L 2.0
M 3.0
N ____
O ____
P ____
Q ____



O-DISK NO. 94-3-72-A

CCW OFF-SET 3 DEGREES

NOTES:

EXAMINER ____ LEVEL II DATE 6-9-94 Page 1 of 2

WESDYNE INTERNATIONAL

BORE UT CALIBRATION DATA SHEET 'A'

CUSTOMER: DETROIT EDISON STATION/UNIT: FERMI 2 JOB NO.: DEHY-200

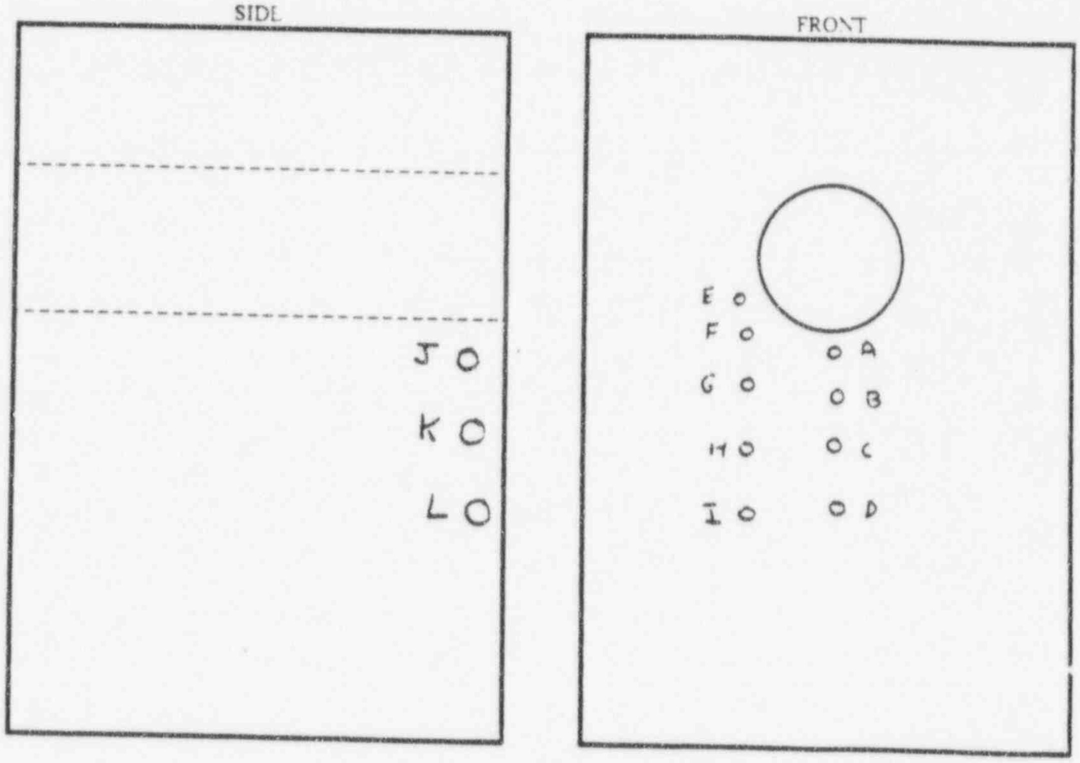
HP ROTOR SN: EERF12133 BORE DIAMETER: 6.01 CAL. BLOCK DIA.: 6.25 TRANSDUCER SHOE SIZE: 6.0"

	CIRC. SHEAR		AXIAL SHEAR		ZERO DEGREE	
	CW	CCW	OUT	IN	NS	FS
TRANSDUCER S/N	C11165	C11164	D03972	D03972	607929	607927
UT INSTRUMENT MODEL NO. / SERIAL NO.	DYNAPULSER CH 1 WEM 10792		DYNAPULSER CH 2 WEM 10772		DYNAPULSER CH 3 WEM 10792	
SENSITIVITY	35		26		32	

SKETCH OF CALIBRATION BLOCK AND HOLES USED

HOLE/DEPTH

A .25"
B 1.00"
C 2.00"
D 3.00"
E .25"
F .50"
G 1.00"
H 2.00"
I 3.00
J .25"
K 1.00"
L 2.00"
M
N
O
P
Q



O-DISK NO. 94-73-B

CCW OFF-SET 4

NOTES:

[signature]
EXAMINER

II
LEVEL

6-11-94
DATE

Page 2 of 2


FIGURE 1

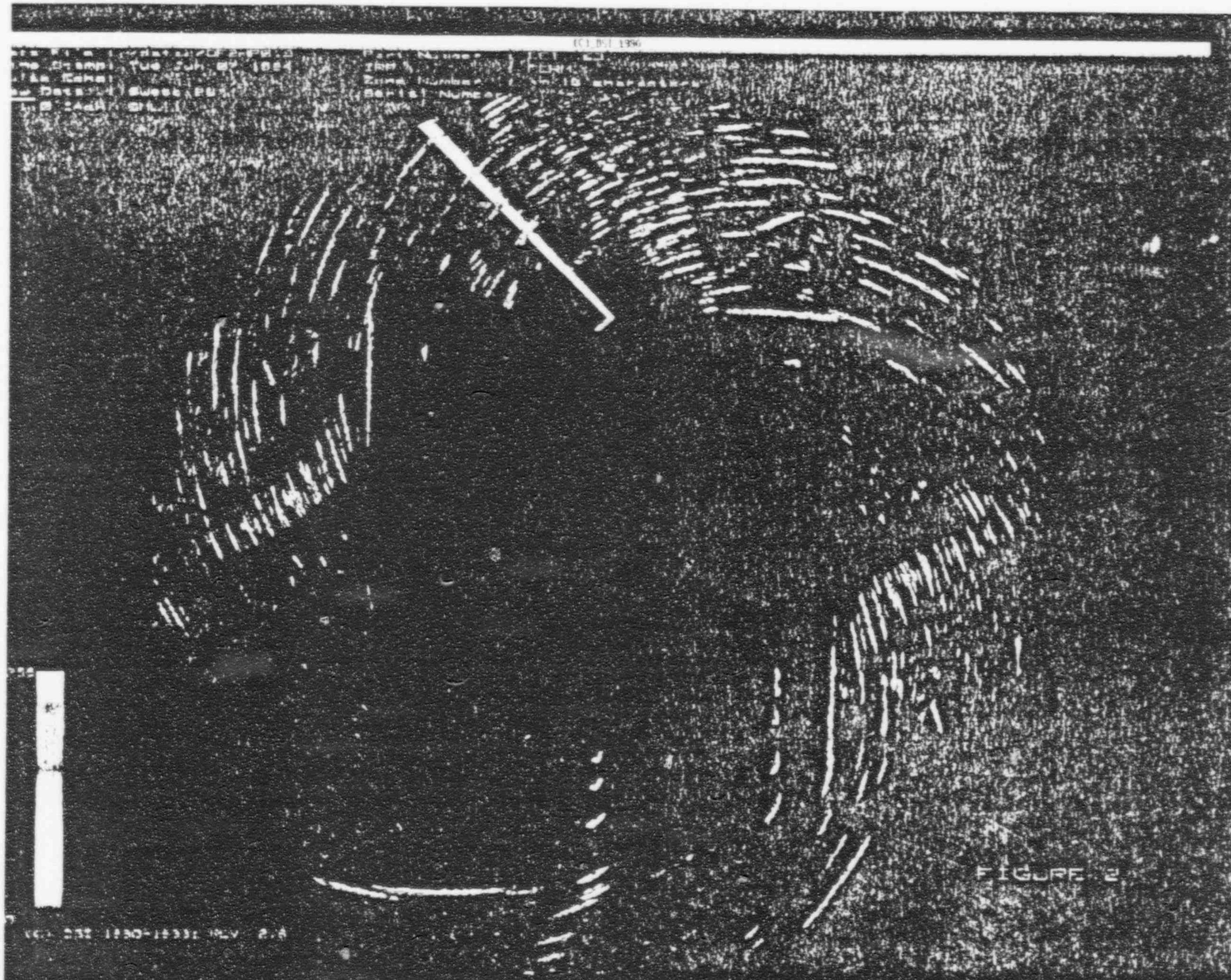


FIGURE 2

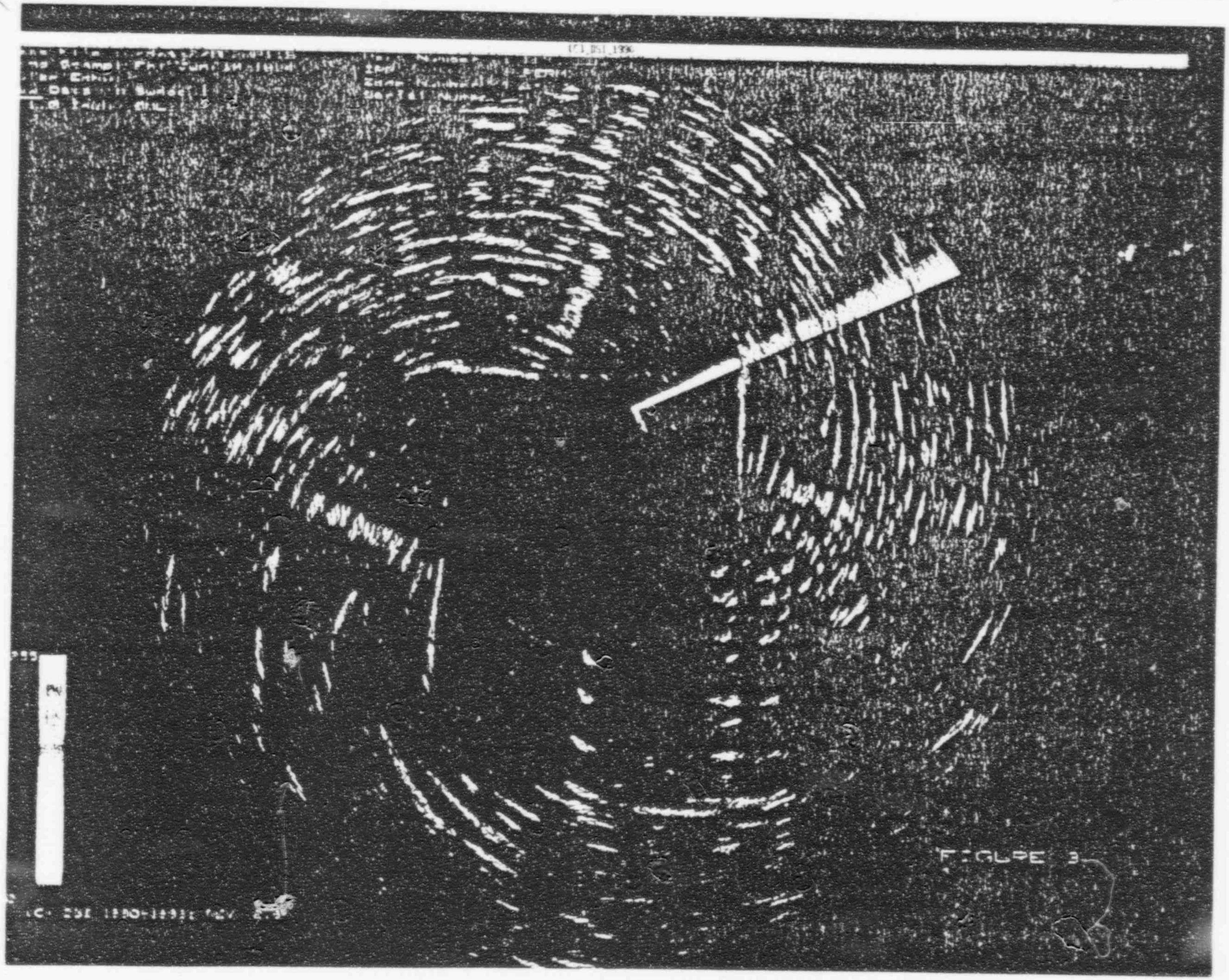
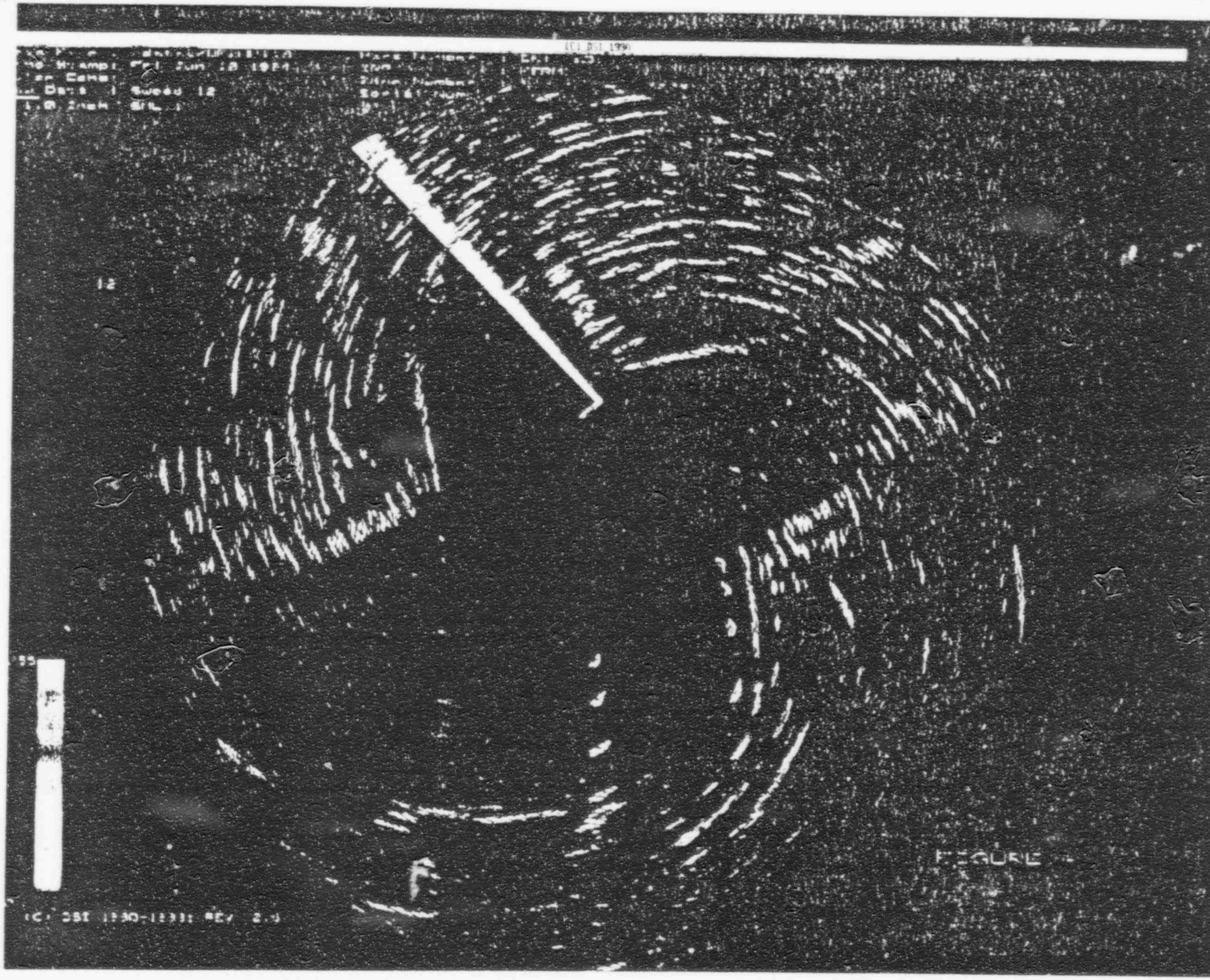


FIGURE 3



FIGURE

DATA ANALYSIS

The data files were dewormed and analyzed for real targets that correlated perpendicular to the principal stress direction (radial axial near bore).

The following tables provide a listing of the indications found in the HP rotor. The contents of the tables (c file) are as follows:

Column 1	Rmin	Minimum distance that the indication is located below the bore's inner surface.
Column 2	Delta-R	Total through-wall dimension of the indication.
Column 3	Zmin	Minimum axial distance the indication is located from the coupling face.
Column 4	Delta-Z	Total axial length of the indication.
Column 5	Tmin	Minimum circumferential location of the indication measured in degrees from a fixed datum point. Typically bolt hole one.
Column 6	Delta-R	Total circumferential length of the indication.
Column 7	AMPmin	Minimum amplitude of the indication. Amplitude ranges are from 0-255.
Column 8	AMPmax	Maximum amplitude of the indication.

PERCY FILE

AXIAL LENGTH RANGE FROM 2.750" TO 0.250"

Rmin	Delta-R	Zmin	Delta-Z	Tmin	Delta-T	AMPmin	AMPmax
1.930	0.420	320.5	2.75	12.780	3.280	19.0	255.0*
2.140	0.260	321.4	0.50	12.640	1.150	30.0	108.0**

NOTE: only indications of lengths > .25" are listed.

* = CW INDICATION ** = CCW INDICATION

SUMMARY OF INFORMATION

FILE NAME LIST : CF17CW + CF17CCW

TURBINE NAME.................. FERMI-#2-HP

COORDINATE ZERO LOCATION...... #1-BOLT-HOLE

DELTA Z PER SWEEP............. 0.25"
TRANSDUCER DIAMETER........... 0.50"
TRANSDUCER TYPE............... RADIAL SHEAR
BORE DIAMETER................. 6.01"

APPENDIX D

CONDITION ASSESSMENT RESULTS

CONDITION ASSESSMENT RESULTS:

1. HP ROTOR:

Figure D1 shows a cross-section of the HP rotor. The axial zero reference was from the generator end. The angular measurements were referenced from the No. 1 bolt hole on the coupling.

Bore Measurements:

Bore diameter measurements were made at 2" intervals axially and are included in Appendix C. The bore diameters before and after honing were respectively as follows.

Axial Range, In.	Bore Diameter, In. Before Honing	After Honing
0 - 4"	Plug Bore	Plug Bore
4 - 226"	9.964 - 9.980	9.985 - 9.988
226 - 234"	Transition	Transition
234 - 346"	6.013 - 6.027	6.044 - 6.049

Visual and Magnetic Particle Examinations:

The visual and magnetic particle examinations did not reveal any reportable flaw like indications, except for five dimpled areas.

Ultrasonic Examination:

The ultrasonic examination of the near bore region using the [UDRPS] system revealed 13 centroids of indications. Figures D2-D6 show two dimensional plots of these indications in three views. Figures D2-D3 show plots over the entire length of the rotor, while Figures D4-D5 show a closer view of the same plots over a shorter section of the rotor. A 3D linkup analysis of these indications resulted in 3 potentially linked flaws. Figure D7 includes a listing of these linkup flaws.

Crack Sizes Analyzed:

All three linkup flaws are located outside the last stage blade row on the governor side, which is a low stressed region. However, Linkup #2 which is the worst is considered for analysis. Also, a default surface flaw 0.25" long and 0.125" deep is assumed to be present in the highest stressed section and analyzed.

Stress Analysis:

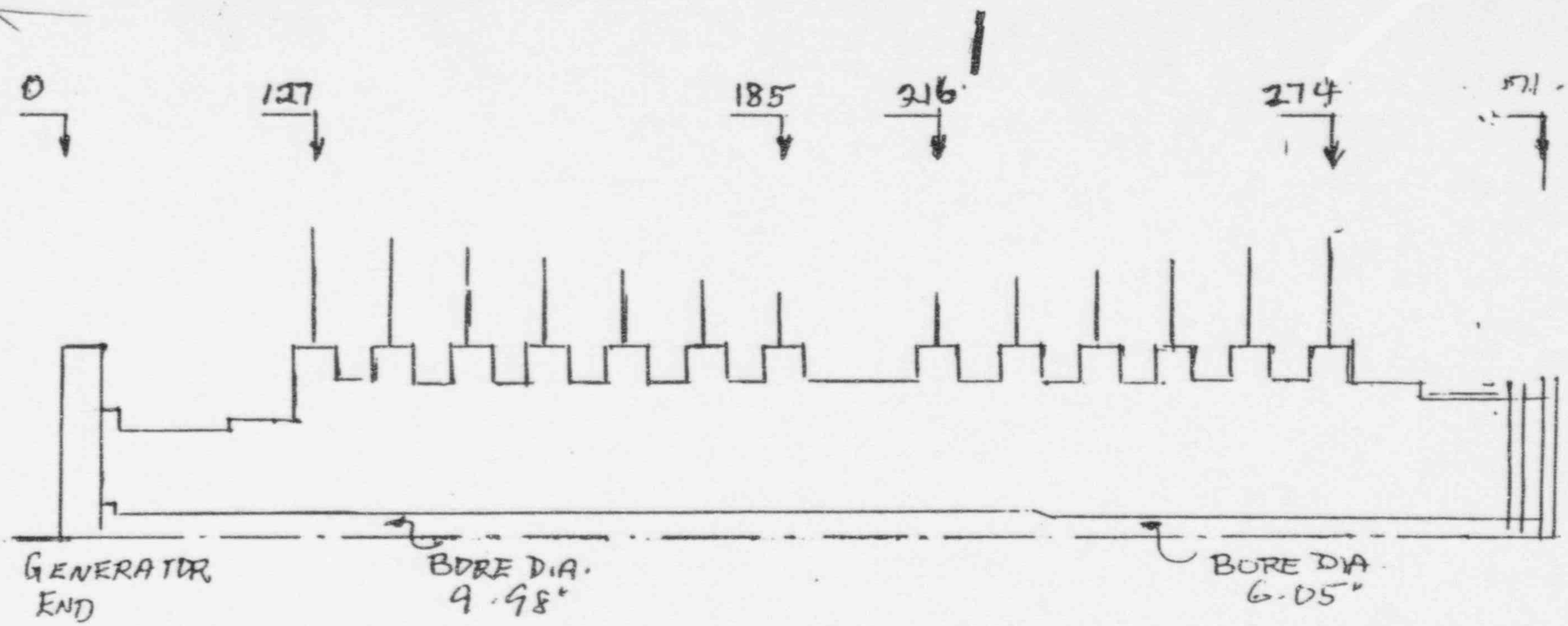
Circumferential mechanical stresses were calculated at the inlet and exhaust stages. Appropriate thermal stresses based on previous analyses data were added to these values to develop total stresses corresponding to running and 10% overspeed conditions. Figure D8 shows these stresses under the last stage.

Material Properties:

No material properties were available. Typically, nuclear HP turbine rotors are made of NiCrMoV steel which has good fracture toughness properties. However, for the purpose of the present analysis a fracture toughness of 35 ksi$\sqrt{in}$ will be assumed.

Fracture Mechanics Analysis:

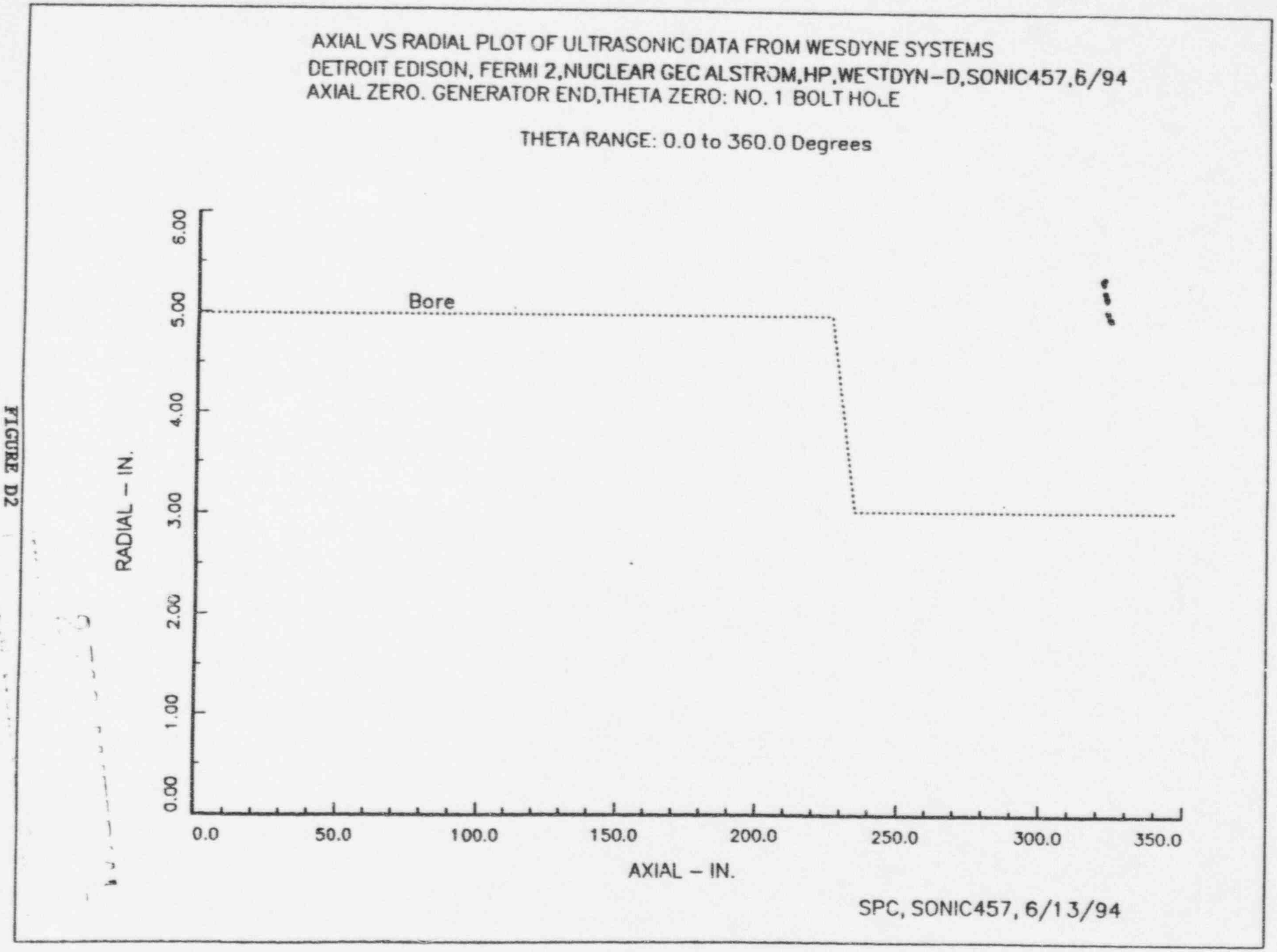
Figures D8 and D9 show the fatigue crack growth analysis results for the default flaw and linkup #2 respectively. The number of blocks to reach the critical fracture toughness of 35 ksi$\sqrt{in}$ for the two cracks analyzed are 2767 and 2050 respectively. However, it is SPC policy to limit the number of starts and the hours before the next inspection to 2000 and 70,000 hours. Creep crack growth damage is not a problem since the operating temperature is well below 800°F.



CROSS SECTION SKETCH OF THE HP ROTOR

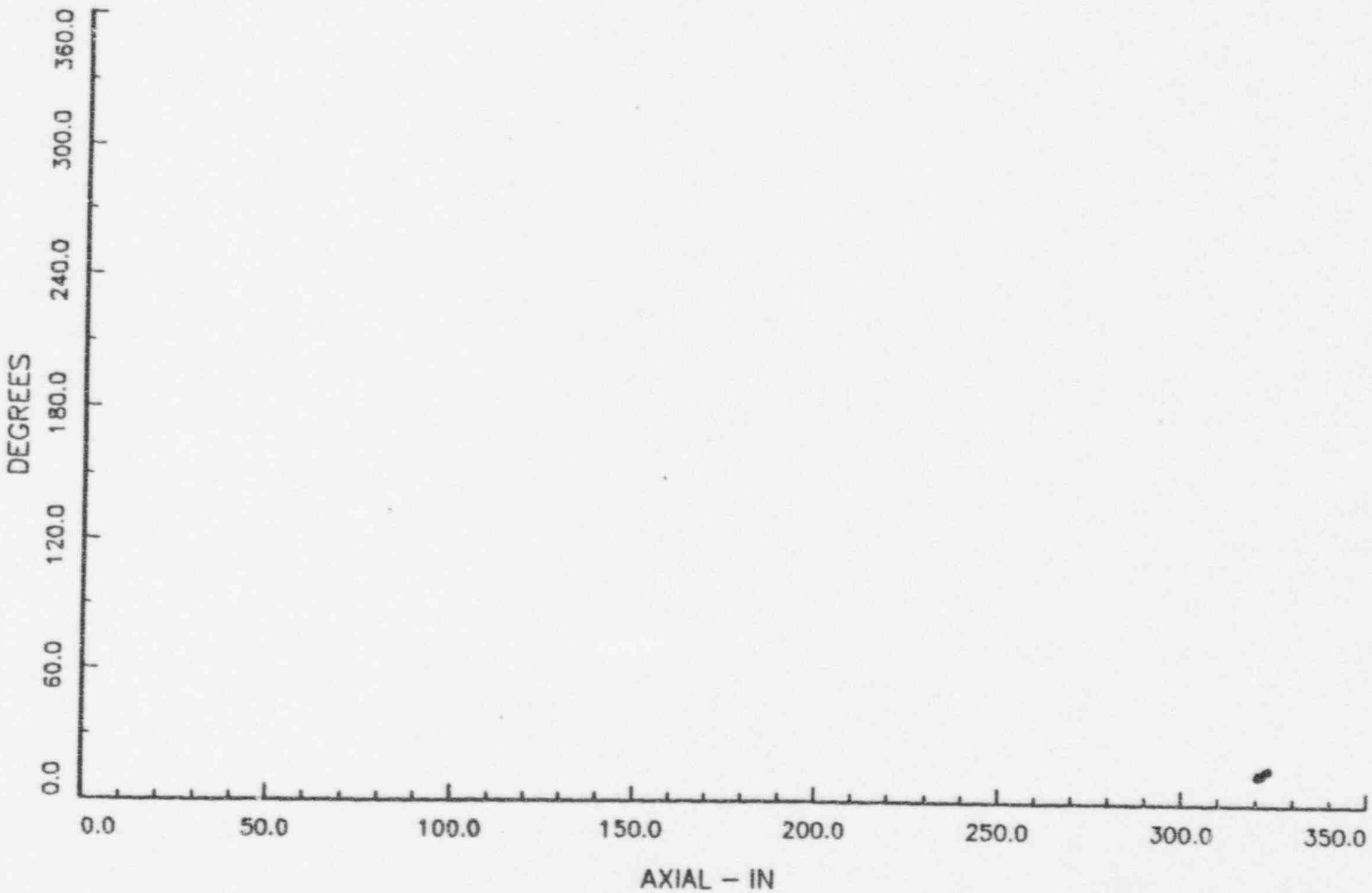
FIGURE D1

FIGURE D2



AXIAL VS RADIAL PLOT OF ULTRASONIC DATA FROM WESDYNE SYSTEMS
DETROIT EDISON, FERMI 2,NUCLEAR GEC ALSTROM,HP,WESTDYN-D,SONIC457,6/94
AXIAL ZERO. GENERATOR END,THETA ZERO: NO. 1 BOLT HOLE
THETA RANGE: 0.0 to 360.0 Degrees
Bore
RADIAL - IN.
0.00
1.00
2.00
3.00
4.00
5.00
6.00
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
AXIAL - IN.
SPC, SONIC457, 6/13/94

AXIAL VS CIRCUMFERENTIAL PLOT OF ULTRASONIC DATA FROM WESDYNE SYSTEMS
DETROIT EDISON, FERMI 2,NUCLEAR GEC ALSTROM,HP,WESTDYN-D,SONIC457,6/94
AXIAL ZERO: GENERATOR END, THETA ZERO: NO. 1 BOLT HOLE
DEPTH RANGE: 0 to 10"

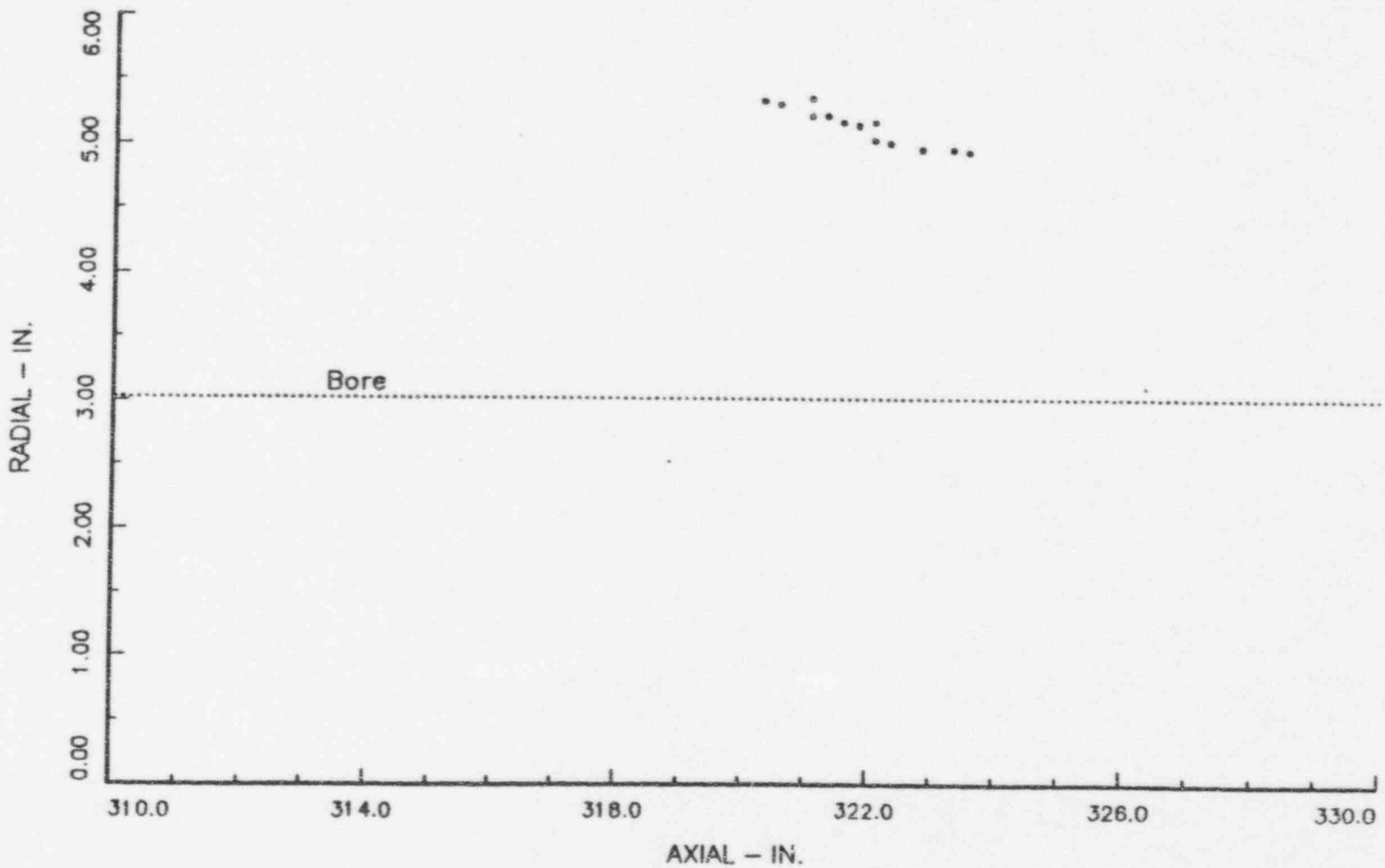


SPC, SONIC457, 6/13/94

FIGURE D3

AXIAL VS RADIAL PLOT OF ULTRASONIC DATA FROM WESDYNE SYSTEMS
DETROIT EDISON, FERMI 2,NUCLEAR GEC ALSTROM,HP,WESTDYN-D,SONIC457,6/94
AXIAL ZERO: GENERATOR END,THETA ZERO: NO. 1 BOLT HOLE

THETA RANGE: 0.0 to 60.0 Degrees



SPC, SONIC457, 6/13/94

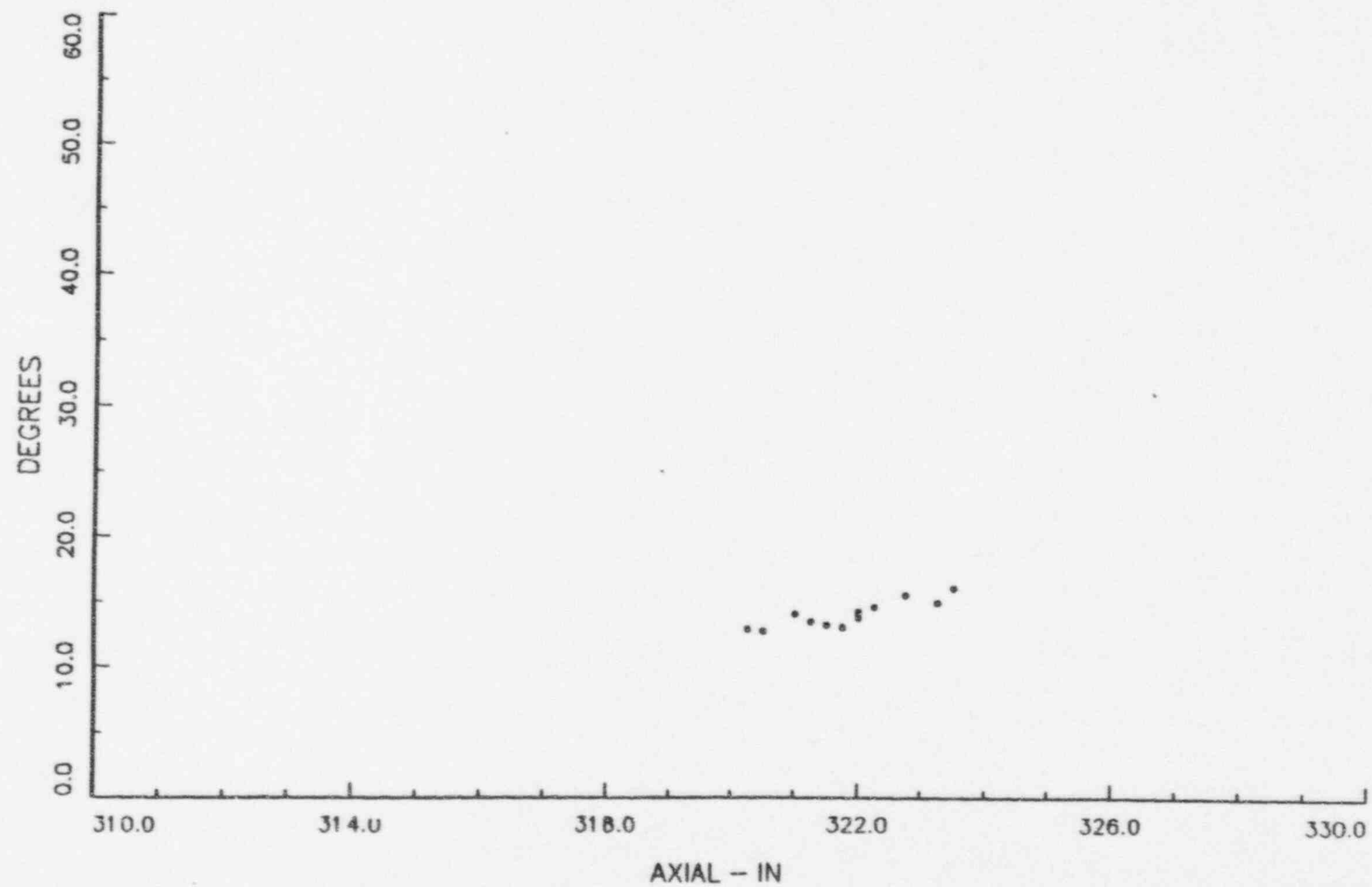
FIGURE D4

AXIAL VS CIRCUMFERENTIAL PLOT OF ULTRASONIC DATA FROM WESDYNE SYSTEMS

DETROIT EDISON, FERMI 2,NUCLEAR GEC ALSTROM,HP WESTDYN-D,SONIC457,6/94

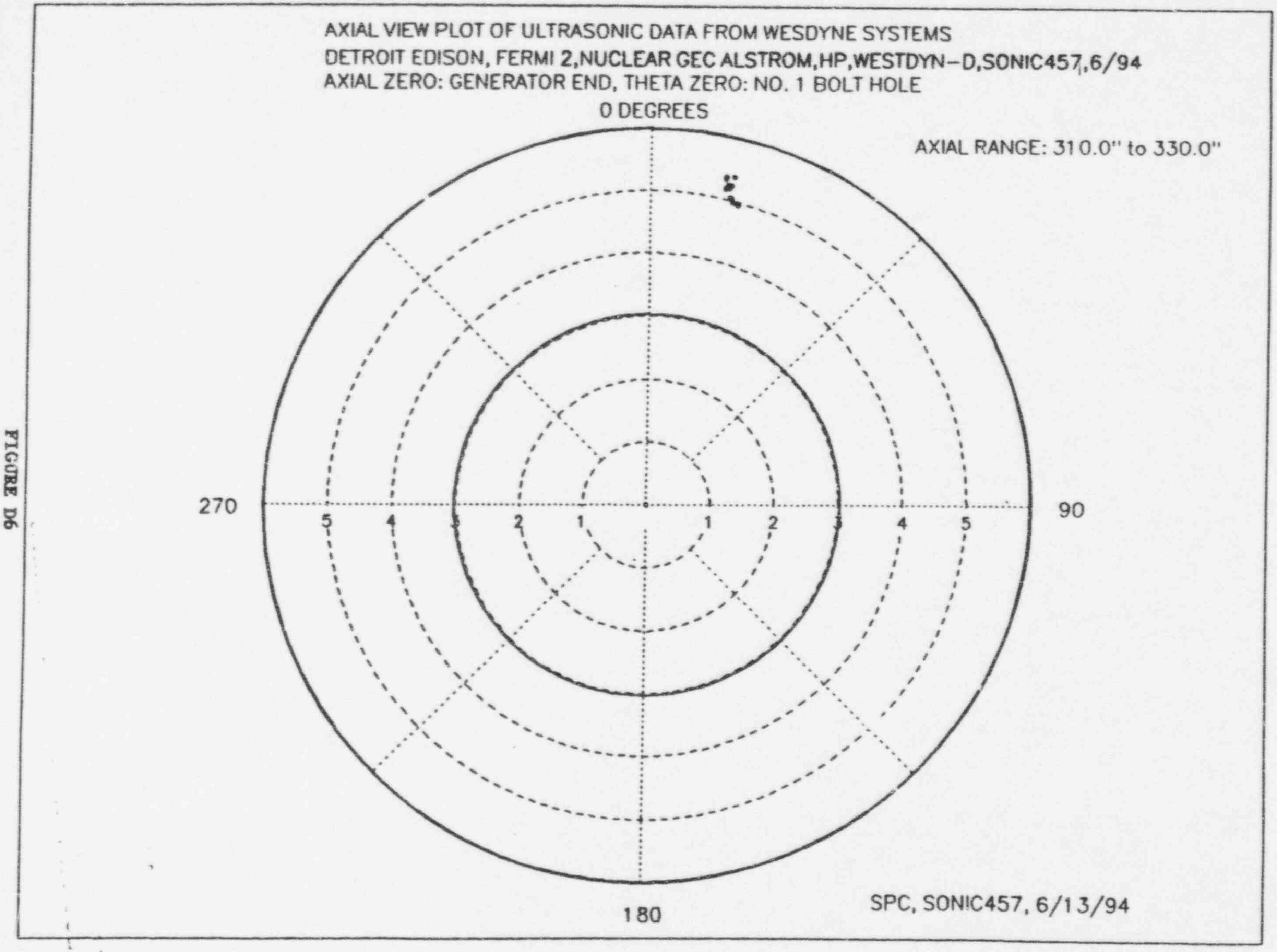
AXIAL ZERO: GENERATOR END, THETA ZERO: NO. 1 BOLT HOLE

DEPTH RANGE: 0 to 10 "



SPC, SONIC457, 6/13/94

FIGURE D5



AXIAL VIEW PLOT OF ULTRASONIC DATA FROM WESDYNE SYSTEMS
DETROIT EDISON, FERMI 2,NUCLEAR GEC ALSTROM,HP,WESTDYN-D,SONIC457,6/94
AXIAL ZERO: GENERATOR END, THETA ZERO: NO. 1 BOLT HOLE
0 DEGREES
AXIAL RANGE: 310.0" to 330.0"
270
90
180
5 4 3 2 1 1 2 3 4 5
SPC, SONIC457, 6/13/94

FIGURE D6

DETROIT EDISON, FERMI #2, NUCLEAR GEC ALSTROM, HP, WESTDYN-D, SONIC457, 6/94

bore diameter = 9.976 from 0.000 to 225.000
6.047 from 234.000 to 346.000

Entered Ellipse Parameters

- Zone #	Depth	a	b	c
1	2.000	.100	.100	.150
2	2.000	.100	.100	.150
3	2.000	.100	.100	.150
4	2.000	.100	.100	.150
5	2.000	.100	.100	.150

** dynacon threshold = 0

** no. of data points = 13

** search units selected: 1

		position						
linkup	no.	axial, in.		circum. deg.		in.	radial, in.	
no.	pts.	x	dx	theta	dtheta	mean	r	dr
		start	diff	start	diff	width	start	diff
1	2	320.25	.25	12.78	.11	.010	2.30	.03
2	8	321.00	1.25	13.13	1.58	.140	2.00	.35
3	2	323.25	.25	15.03	1.03	.089	1.93	.02

total no. of linkups = 3

RESULTS OF LINKUP ANALYSIS

FIGURE D7

DETROIT EDISON, FERMI #2, GEC HP, DEFAULT FLAW, 6/94

Stress distribution used for calculating K1 values

Distance-in	OVERSPEED Transient Stress-ksi	RUNNING Steady State Stress-ksi
.00	45.900	40.500
1.00	41.200	36.600
2.00	38.400	34.300
3.00	36.600	32.900
5.00	34.600	31.200

Entered fracture toughness = 60.0

Flaw Dim: dx= .250; dr= .125; r= .000

ELLIPTIC SURFACE CRACK GROWTH ANALYSIS
FOR LINKUP NO. default

No. of cold starts/overspeed run = 10

a1	a3	SIF1	SIF3	NO. BLOCKS
.1250	.1250	19.1298	20.1586	.0000E+00
.1361	.1375	20.0379	21.0550	.2452E+03
.1483	.1511	20.9786	21.9910	.4874E+03
.1616	.1659	21.9537	22.9681	.7265E+03
.1762	.1821	22.9653	23.9881	.9630E+03
.1922	.1997	24.0154	25.0527	.1197E+04
.2097	.2190	25.1057	26.1636	.1428E+04
.2288	.2399	26.2380	27.3226	.1657E+04
.2498	.2628	27.4142	28.5314	.1883E+04
.2726	.2878	28.6361	29.7919	.2107E+04
.2976	.3150	29.9053	31.1061	.2329E+04
.3248	.3448	31.2237	32.4759	.2549E+04
.3546	.3773	32.5930	33.9034	.2767E+04 ←
.3871	.4127	34.0152	35.3910	.2982E+04
.4225	.4514	35.4921	36.9408	.3196E+04
.4612	.4937	37.0257	38.5555	.3408E+04
.5033	.5398	38.6181	40.2377	.3618E+04
.5493	.5901	40.2715	41.9904	.3826E+04
.5994	.6451	41.9883	43.8170	.4033E+04
.6539	.7050	43.7712	45.7210	.4237E+04
.7133	.7704	45.6232	47.7066	.4440E+04
.7780	.8417	47.5478	49.7786	.4641E+04
.8483	.9195	49.5490	51.9424	.4840E+04
.9248	1.0044	51.6312	54.2042	.5037E+04

FATIGUE CRACK GROWTH ANALYSIS RESULTS FOR THE DEFAULT FLAW

FIGURE D8

Stress distribution used for calculating K1 values

Distance-in	OVERSPEED Transient Stress-ksi	RUNNING Steady State Stress-ksi
.00	45.900	40.500
1.00	41.200	36.600
2.00	38.400	34.300
3.00	36.600	32.900
5.00	34.600	31.200

Entered fracture toughness = 60.0

Flaw Dim: dx= 1.250; dr= .350; r= 2.000

BURIED ELLIPTIC CRACK GROWTH ANALYSIS
FOR LINKUP NO. 2

no. cold starts/overspeed run = 10

a1	a2	a3	SIF1	SIF2	SIF3	NO. BLOCKS
.1750	.1750	.6250	24.0119	24.1802	18.5627	.0000E+00
.1923	.1925	.6347	24.9455	25.1978	19.4727	.2220E+03
.2112	.2118	.6455	25.8886	26.2399	20.4203	.4447E+03
.2318	.2329	.6575	26.8391	27.3067	21.4059	.6683E+03
.2543	.2562	.6710	27.7947	28.3983	22.4299	.8933E+03
.2788	.2818	.6862	28.7536	29.5158	23.4923	.1120E+04
.3055	.3100	.7031	29.7144	30.6608	24.5932	.1349E+04
.3346	.3410	.7220	30.6765	31.8360	25.7323	.1580E+04
.3662	.3751	.7433	31.6399	33.0450	26.9094	.1814E+04
.4005	.4126	.7670	32.6057	34.2930	28.1240	.2050E+04 ←
.4376	.4539	.7936	33.5757	35.5861	29.3760	.2290E+04
.4779	.4993	.8233	34.5528	36.9324	30.6651	.2533E+04
.5214	.5492	.8564	35.5405	38.3416	31.9911	.2779E+04
.5683	.6041	.8933	36.5428	39.8259	33.3540	.3028E+04
.6188	.6646	.9343	37.5636	41.4004	34.7539	.3280E+04
.6732	.7310	.9797	38.6064	43.0845	36.1908	.3534E+04
.7314	.8041	1.0298	39.6734	44.9043	37.6641	.3790E+04
.7936	.8845	1.0849	40.7647	46.8957	39.1725	.4048E+04
.8598	.9730	1.1450	41.8778	49.1100	40.7131	.4305E+04
.9297	1.0703	1.2102	43.0055	51.6218	42.2799	.4561E+04
1.0030	1.1773	1.2801	44.1349	54.5422	43.8633	.4814E+04
1.0787	1.2950	1.3542	45.2454	58.0385	45.4473	.5060E+04

FATIGUE CRACK GROWTH ANALYSIS RESULTS FOR LINKUP #2

FIGURE D9

WESTH ELECT. DOC

~~CONFIDENTIAL~~ No longer considered confidential by DECo
R C [signature]
8/22/94

0801.21

Date: July 21, 1994
TMTB-94-0011

To: W. D. Romberg
Assistant Vice President
and Manager, Technical

From: L. C. Fron
Director, Turbine & Special Projects

Subject: **LP Turbines Operated With 7th and 8th Stage Pressure Plates**

This memo is being written to assemble, organize and summarize documents applicable to the above subject. The EF2 Main Turbine Generator has experienced problems with the LP 7th and 8th stages of rotating blades. Due to this fact, reviews were performed to determine the safety and reliability of operating the Main Turbine Generator with the airfoils removed from the 7th and 8th stages of rotating blades and pressure plates installed in place of the 7th and 8th stage diaphragms. Results of these reviews show that the turbine can be operated safely and reliably in this modified configuration. The plan is to run for one cycle in this modified configuration and then to install new LP rotors and diaphragms.

The following actions were taken to investigate and determine the safety and reliability of operating in this modified configuration.

1. The pressure plates were designed by the original equipment manufacturer (O.E.M.), GEC. The basis for the GEC design is documented in a memo from A. Holmes to L. R. Gobbett, dated 7/26/94, which is included as Attachment 1. The pressure plates were designed to replicate the pressure drops exhibited by the stationary and rotating blades they are replacing. GEC provided a review of their experience in designing pressure plates and the operating experience with those installations. The applicability of this experience to the proposed design and installation at Fermi 2 was also documented. This document is included as Attachment 2.

2. Westinghouse provided a summary of their design experience for pressure plates, and the operating experience with those plates. They presented this experience and its applicability to their review of the GEC design to site personnel. This is included as Attachment 3. As can be seen from this attachment, Westinghouse has a significant amount of experience in designing and operating with pressure plates.

B/12

3. Westinghouse performed a detailed review of the GEC proposed pressure plate design using their own design methodology and verification process (Attachment 4). They have concluded that the GEC design is adequate and, indeed, conservative.

4. Technical and Engineering Services (DECo) provided detailed review of the operational experience with pressure plates designed by GEC at Fermi 2. No adverse operational or vibration effects were identified. This review is included as Attachment 5.

5. MPR Associates performed a survey (Attachment 6) of domestic Westinghouse and GE turbines that have operated with pressure plates installed. This survey specifically requested operational limitations and adverse operational effects experienced. The period covered begins in 1970, with more than twelve nuclear plants identified. Experience supports the installation of pressure plates at Fermi, with several plants identified that also installed pressure plates in the last two stages of the LP turbine(s).

6. Failure Prevention International (FPI) performed:

   a. an independent study utilizing their own experience,
   b. a review of the GEC and Westinghouse identified relevant experience summaries,
   c. a review of the Westinghouse conclusions of the GEC design review, and
   d. a review of the MPR industry experience survey.

   FPI concluded that their experience, the Westinghouse design review of GEC design (in light of Westinghouse's experience), and the identified operational experience supports the prudency and viability of installing pressure plates. Their report is included as Attachment 7.

7. A Safety Evaluation (SE) was performed in accordance with 10CFR50.59 and site procedures and it determined that there would be no unreviewed safety question and that operation in this modified configuration would reduce the probability of a turbine missile accident. For additional details, see Attachment 8 (SE 94-0073).

8. An Engineering Design Package (EDP) has been prepared in accordance with site procedures to document the design and installation of these pressure plates. EDP 26726 is included as Attachment 9.

9. GEC has revised the heat balance for EF2 (Drawing TS 24122) with these pressure plates installed and it is included as Attachment 10.

10. Westinghouse has reviewed the GEC revised heat balance as it affects operability of the pressure plates and found there are no significant differences from their initial evaluation. Attachment 11 documents this review.

11. The fabrication drawing for the pressure plates, Drawings TI-3687, are included as Attachment 12.

12. Heat Exchanger Systems, Inc. performed an analysis of the effects on the condenser from operating the turbine with these pressure plates installed and determined that the condenser will operate satisfactorily. This review is included as Attachment 13.

In summary, these reviews clearly show that the EF2 Main Turbine Generator can be safely and reliably operated with these pressure plates installed.

BCW
LCF/klb

Attachments

GEC ALSTHOM

ELECTROMECHANICAL

MEMORANDUM

To: Mr L.R.Gobbett.
Construction & Service.
Rugby

From: Mr A.Holmes.
P.C.D.G.
Rugby

Date: 26 July, 1994

Tel: 531(4)946

Copy To: File

Fax:

Ref:

Enrico Fermi Pressure Plates for Stages LP7 & 8

With regard to the request by Mr L.Fron for design considerations for the design of Enrico LP7 & 8 pressure plates we would reply as follows :-

The Design Considerations for the design of drilled pressure plates to replace a turbine stage are :-

1. To provide a flow area that will maintain the design pressure distribution in the turbine. This will ensure that the turbine cycle remains close to design and in the case of replacing Enrico LP7 & 8 that stage loadings on stage LP 6 remain as design.

2. To size the holes so that the jet issuing from the plate will decay sufficiently before reaching the next stage, (normally a diaphragm) in the case of Enrico LP7 the drilled plate for LP8 and in the case of Enrico LP8 the cone of the exhaust hood.

3. To arrange the holes within the annulus of the removed stage.

4. To size the thickness of the plate so that it is adequately strong and deflections are kept within acceptable limits (this is done by use of an in house computer program).

Using the above design considerations we have provided and fitted drilled pressure plates on a number of occasions which have enabled a machine to remain satisfactorily in service

Large Steam Turbines

Mr L.C. Fron
Section Head - Turbine
Fermi 2

10th June 1994

OPERATION OF FERMI 2 WITH PRESSURE PLATES

Following telephone conversations with George Trahey and Brian Stone, please find attached a statement regarding GEC ALSTHOM experience of operating with pressure plates.

Regards

P.M. McGuire

P.M. McGUIRE

Copy: Mr G. Trahey, Fermi 2

Newbold Road, Rugby, Warwickshire CV21 2NH, England
Telephone: 0788 577111 Telex: 31463 GALTG G Fax: 0788 531700

GEC ALSTHOM TURBINE GENERATORS LIMITED
Registered Office: Newbold Road, Rugby, Warwickshire. Registered in England No. 561851

In certain circumstances it may e necessary to operate turbines for limited periods with a complete stage of fixed and moving blades removed. In such cases pressure plates are often installed to avoid overloading other stages, particularly the immediate upstream stage. The pressure plate has a large number of small holes of sufficient area to ensure that the normal stage pressure drop and flow rate are maintained. The holes are distributed uniformly to minimise flow perturbations and are sized to allow sufficient jet mixing and velocity reduction before inlet to the next stage.

The first significant use of pressure plates was in the early 1970's when a major rehabilitation exercise was carried out on LP rotors of 60MW turbines. Since that time pressure plates have been fitted to a number of turbines [redacted]

Normally the time of operation with pressure plates has been for periods of 6 - 24 months until permanent remedial action could be carried out. In most cases the turbines have been operated without restriction after the installation of the pressure plate and we have no experience of any consequential problems with pressure plates of this type. There is therefore no reason which would have prevented operation for longer periods.

At Fermi 2 DECO have decided to remove the last two stages of LP blading and to instal pressure plates, for which relevant design details have already been provided. [redacted] present any [redacted] In some respects the absence of any stage downstream of the pressure plates represents a less onerous condition. With the pressure plates installed the turbine can be operated in accordance with normal procedures and there are no additional restrictions. The enthalpy of the exhaust steam to the condenser will be greater than under normal conditions and as a consequence there will be a slight increase in condenser back pressure but there should be no adverse effect on the safe operation of the turbine.

P.M.M.
10.6.94

WESTINGHOUSE NUCLEAR AND FOSSIL BAFFLE EXPERIENCE

BB	STAGE	GENERAL COMMENTS
81 Nuclear	L-0	Used at [Indian Point #3] LP3 in 8/86, removal date unknown.
	L-1	Not used yet
	L-2	Used at [Palisades] in 2/80, removal date unknown.
	L-3	Used at [Surry #1] LP#1 and LP#2 from 3/80 to 4/81. Used at [Salem #1] in LP #3 in 4/81, removal date unknown. Used at [Main Yankee] 10/81, removal date unknown. Used at [Palisades] in 1/80, removal date unknown. Used at [Indian Point #3] 11/79, removal date unknown. Used at [Indian Point #2] from 2/80 to 2/81. Used at [Cooper] in 6/80, removal date unknown.
	L-4	Used at [Surry #1] LP#1 from 7/78 to 4/81. Used at [Salem, Cooper, and Indian Point] the same dates as above. Used at [Palisades] in 1/80, removal date unknown.
	L-5	Used at [Indian Point] from 3/80 to 3/82.
	L-6	Used at [Salem] from 6/81 to 12/81.
	L-7	Used at [Palisades] in 1/80, removal date unknown. Used at [Haddem Neck] in 3/86, removal date unknown.
	L-8	Ran with [Cooper] from 3/80 to 4/81. Removed in early '82.
	L-9	
80 Nuclear	L-0	Used at [Prairie Island] in '74, removal date unknown.
	L,L-1	Designed for [San Onofore.] Used at [Prairie Island #1] from '74 to '78. Used at [Ginna] from '76 to '78.
	L-1	Not used yet.
	L-2	Used at [Prairie Island] [No. 2] from '74 to '78. Used at [Ginna] from '76 to '78. Used at [ChinShan #1 and #2] in 5/80, removal date unknown.

See attachment 6

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MPR associates

WESTINGHOUSE NUCLEAR AND FOSSIL BAFFLE EXPERIENCE

	L-3	Not used yet.
	L-4	Not used yet.
281 Nuclear	L-0	Not used yet.
	L-1	Not used yet.
	L-2	Used at SMUD in 7/75, removal date unknown.
	L-5	Used at Zion from 12/79 to 3/81.
	L-6	Used at Russlesville from 1/80 to 1/81.
	L-7	Used at SMUD in 5/81, removal date unknown.
280 Nuclear	L-0	Not used yet.
	L-1	Not used yet.
	L-2	Not used yet.
73 Fossil	L-0	Not used yet.
	L-1	Used at Sutton from 8/74 to '76. Installed in Summer - Spring '82.
	L-2	Wagner 4 running with L-2. Stage Baffle from 4/79 to '85. Used at Deely # 2 in 4/79, removal date unknown. Used at Manatee in 1/85, removal date unknown.
	L-3	Used at Horseshoe Lake from 1979 to 1972. Used at Lake Hubbard from 1970 to 1972. Used at Wagner 4 from 8/79 to 3/81.
72 Fossil	L-0	Used in CFE Mexico in 7/78, removal date unknown.
	L-1	Used at Harrison 3 from 9/82 to 12/84. Four ends Harrison 1 removed in mid '84.
	L-1C & 2C	Not used yet.

WESTINGHOUSE NUCLEAR AND FOSSIL BAFFLE EXPERIENCE

BB111-126	L-1	Not used yet.
RT-2566	L-1	Not used yet. Special Design must be redesigned.
	L-2	Used at Lake Creed in 1977, removal date unknown. Used at Avon 8 in 4/85, removal date unknown.
	1st IP Row	Used at TVA, removal date unknown.
57	L-3, L-4	Used at LaCygne from 7/79 to 1/80.
RST-2566	L-2, L-3	Used at Avon 8 in 8/80, removal date unknown.
44	L-2, L-3 (HP)	Used at Boardman from 6/81 to 5/82.
	IP-13th	Used at Boardman from 6/81 to 5/82.
	L-0, L-1 (HP)	
AB-240	L-2	Used at Somisa in 10/79, removal date unknown.
BB46	HP 11C	Used at Canal 1, Commonwealth Electric.
RT-1606G	IP, 1, 2, 3	Used on VEPCO's 10A9242 unit from 1972 to 1974. Replaced 3 stages at Indian Point.
BB72	L-2	Used at Hudson 1, PSE&G of N.J. 11/30/83, removal date unknown.
BB51	R-3	Used at Kincaid #2 in 2/84, removal date unknown.

Date: June 10, 1994

To: G. Trahey
Fermi 2 Power Plant

From: L. G. Fron
Technical and Engineering Services

Subject: Fermi 2 Main Turbine - Generator Vibration During Operation with Blades Removed and Pressure Plates Installed

This memorandum is written in response to our telephone conversation on June 10, 1994; the subject of which was Main Turbine - Generator (MTG) shaft lateral vibration during operation with pressure plates in place of Low Pressure (LP) Turbine blade rows.

During Fermi 2 refueling outage RF01, the fifth stage rotating blades from both flows of each LP Turbine rotor were removed. The MTG operated in this condition from late December 1989 to late November 1990.

In late November 1990, an outage was required to disassemble LP Turbine 3 to confirm fourth stage blade failures predicted by vibration analysis. During this forced outage the LP Turbine 3 fourth stage rotating blades were removed and pressure plates were installed in both flows of LP Turbine 3. The MTG was returned to service on January 1, 1991. The plant operated at 80% power from January 1991 to March 1991 (to refueling outage RF02) with fifth stage blades removed from all LP Turbine flows, fourth stage blades removed from both flows of LP Turbine 3, and pressure plates installed in both flows of LP Turbine 3 between the third and sixth stage blades. During this time of operation with pressure plates in LP Turbine 3, no abnormal shaft lateral vibration was observed. MTG shaft vibration amplitudes were less than 6.5 mils P-P at each bearing at approximately 800 Mw.

As we discussed, if uniform axisymmetric flow is maintained by the pressure plates, shaft lateral excitation should not result. I am not aware of a situation where two pressure plates were utilized in one flow of a turbine. My experience of pressure plates effect on shaft vibration is limited to that described above for the Fermi 2 LP Turbine 3.

Rotordynamic characteristics of a rotor will change as a result of removing blades (mass) from the rotor. Reduction in rotor mass results in increasing the critical speeds (shaft lateral vibration natural frequencies) of the rotor.

Removing the eighth and seventh stage blades from both flows of an LP Turbine rotor results in an approximate 7% reduction in rotor weight. Simple rotating beam model calculations predict a less than 5% increase in critical speed due to a 7% decrease in weight. The LP Turbine rotors operate very close to their second critical speeds which complicates field balancing. However, balancing characteristics have been established from experience and successful balancing has been performed. Therefore, it is anticipated that an increase in the critical speeds on the order of less than 5% will not result in amplified shaft lateral vibration that cannot be dealt with by field balancing.

Not confidential BWS

MPR Associates, Inc.

320 King Street
Alexandria, VA 22314-3238
(703) 519-0200

(703) 519-0224 Fax Number

FAX TRANSMITTAL COVER SHEET

DATE: June 13, 1994

TO: Brian Stone FROM: L. Demick

COMPANY: Detroit Edison LOCATION: ______

FAX NUMBER: 313-586-1772

VERIFICATION NO.: ______

NO. OF PAGES: 8 INCLUDING COVER

MACHINE: OMNIFAX G93

MESSAGES

MPR Associates, Inc.

320 King Street
Alexandria, VA 22314-3238
(703) 519-0200

(703) 519-0224 Fax Number

Not confidential

FAX TRANSMITTAL COVER SHEET

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COMPANY: Detroit Edison LOCATION:

FAX NUMBER: 313-586-1772

VERIFICATION NO.:

NO. OF PAGES: 8 INCLUDING COVER

MACHINE: OMNIFAX G93

MESSAGES

Table 1
Plants With Operating Experience with
Pressure Plates Installed in Place of LP Turbine Stages

GENERAL ELECTIC PLANTS

Plant	Affected Stage(s)	Power Loss (MW)	Discussion
Brunswick 2	4TA	15	Installed pressure plate in 1993. Have not inspected since installation. Intend to operate until outage in 1996. Have no operating restrictions and have not noted any change in vibration or feed system operation.
Nine Mile Point 2	N/A	22	Installed in the Fall of 1993. No adverse impact of installation other than loss of power noted. Will be replacing the rotors with monoblocks the next refueling outage.
Oyster Creek	5GB	10	Installed in 1993. Will inspect in September 1994 when long shank buckets will be installed. No vibration problems noted and there are no operating restrictions.
Monticello	5TA	N/A	Operated for a couple of years in the early 1980's with a pressure plate in 5TA stage. No problems encountered except loss of MW (Actual loss not remenbered but is indicated by GE to be "minimal"). No damage was found to downstream stages when rotor was replaced. Stage temperatures at the pressure plate were monitored to ensure the startup transients did not exceed design ramp rates for the plates and that the plates produced the desired pressure ratios. The pressure ratios were satisfactory. This is believed to be the first GE installation of pressure plates in a nuclear turbine.
Millstone 1	N/A	N/A	We were not able to contact Millstone, however they are reported to have operated with pressure plates.

Table 2

WESTINGHOUSE TURBINES

Plant	Affected Stage(s)	Power Loss (MW)	Discussion
Prairie Island	L-1/L-2	100	The pressure plates were installed in the 1970s. The 17% power loss was attributed to reduced reactor power (80%) stemming from flow restrictions across the pressure plates. Specifically, the design pressure drop was not achieved resulting in significant stress on the pressure plates. It was reported that the holes in the pressure plates were not large enough to achieve the desired pressure drop. The station tried to increase back pressure but this had no significant effect. The heater drain temperature increased slightly.
Surry	N/A	N/A	We were not able to contact personnel familiar with operation with removed stages. We were informed that operating experience from a decade ago would be unretrievable. However, they are reported to have operated with removed stage(s).
Salem 1	2nd	N/A	We were not able to contact personnel familiar with operation with removed stages. However, they are reported to have operated with removed stage(s).
Ginna 1	L-0/L-1/L-2	40	The unit is rated at 470 MW but generally runs at ~490MW (less in summer months). The plates were installed in 1974 in one of the LP turbines (both barrels) and ran with this configuration for about two years until reblading. The crossover line between condenser zones was blanked out during this operation period. No significant deviation was observed in the feedwater train. There were no limiting conditions for operation and, as such, reactor power was not reduced.
Maine Yankee 1	L-2 L-2/L-3	30 60	The unit operated at two separate times with pressure plates installed. The original Westinghouse steam path was replaced after the second period ('88) with an ABB design. The pressure plates were approximately 1 inch thick. The blades were cut off such that the roots remained. There is no recollection of torsional vibration analyses being performed or of any torsional problems during operation with stages removed.

Table 2 (continued)

WESTINGHOUSE TURBINES

Plant	Affected Stage(s)	Power Loss (MW)	Discussion
Indian Point 3	L-2	15	The pressure plates were used in the mid 1980s while procuring a new steam path. The actual unit derate was close to that predicted by Westinghouse. No significant deviation was observed in the feedwater train. There were no limiting conditions for operation and, as such, reactor power was not reduced. The blades were cut off such that the roots remained.

June 13, 1994
021-004

TF.:ECON MEMORANDUM

Date: June 13, 1994

Subject: Turbine Pressure I :ate - Operating Experience

Person Called: Carl Jacobs [India: Point 3] (914) 681-6262

Person Calling: D. Lutchenkov

The unit has three LP turbines and was operated with pressure plate(s) installed in the L-2 stage (both barrels of one LP turbine only) in the early 1980s. The L-0 was also removed. The unit lost about 7½MW per stage removed (15MW total) which was the predicted value by Westinghouse. No significant deviation was observed in the feedwater train. There were no limiting conditions for operation and, as such, reactor power was not reduced. However, the blades were cut off just above the root which, due to SCC in some locations, broke apart sending damaging fragments into the condenser tube bundle.

No problems were reported with pressure plate operation. The plates were about an inch thick.

The original Westinghouse steam path has been replaced with an ABB design. The steam path replacement took 76 days. Significant effort (~$300K) was expended in covering the condenser tube bundles with platforms to preclude tube damage from above. Herculized, fire retardant wood was used.

Mr. Jacobs wrote the procurement specification (~60 pages) for the replacement steam path. The specification required numerous documentation regarding material composition reports, vibration test results and stress analyses. The specification also included the following:

- replacement of expansion bellows (the inner cylinder was replaced)
- expansion bellows couplings
- hydraulic bolting
- replacement of all asbestos gaskets with graphite filled

June 13, 1994
021-004

TELECON MEMORANDUM

Date: June 10, 1994

Subject: Turbine Pressure Plate - Operating Experience

Person Called: Hunter Gilpatrick [Maine Yankee] (207) 882-6321

Person Calling: D. Lutchenkov

The unit has two LP turbines and was operated with pressure plate(s) installed in the LP turbine twice with the Westinghouse steam path as follows:

- Early in the 1980s the L-3 stage was removed in both barrels (for balancing) with a total of 30 MW derate. The blades were cut off but the root was retained.

- In 1987 the L-2 and L-3 stages were removed in both barrels resulting in a derate of 60 MW. Operation was maintained in this configuration for a bout a year until the steam path was replaced in 1988 with an ABB design. The blades were cut off but the root was retained. The steam path replacement took 55 days.

No problems were reported with pressure plate operation. The plates were about an inch thick.

Mr. Gilpatrick recommended calling Clayton Giggey (performance, x5604) to discuss detailed impact on operation while pressure plates were installed. Talked to Mr. Giggey on 6/13/94. He only has experience with the 1987 pressure plate operation. He indicated that Westinghouse predicted 58 MW derate with the L-2 and L-3 stages removed. They could not monitor the pressure drop across the plates but did monitor extraction pressures to verify satisfactory operation. No significant deviation was observed in the feedwater train. There were no limiting conditions for operation and, as such, reactor power was not reduced. Mr. Giggey will forward any operating data available which spanned this period of operation.

June 13, 1994
021-004

TELECON MEMORANDUM

Date: June 9, 1994

Subject: Turbine Pressure Plate - Operating Experience

Person Called: Joe Eastwood [Surrey] (804) 273-2730

Person Calling: D. Lutchenkov

Mr. Eastwood does not recall operation with pressure plates installed. In addition, any information concerning this operation would be unretrievable. He could not offer any additional help or leads.

June 13, 1994
021-004

TELECON MEMORANDUM

Date: June 13, 1994

Subject: Turbine Pressure Plate - Operating Experience

Person Called: Paul Detwiler [GINNA] (315) 524-4446 x8306
Dennis Grandjean [Rochester gas & Electric] (716) 724-8062

Person Calling: D. Lutchenkov

The unit is rated at 470 MW but generally runs at ~490MW (less in summer months). The plates were installed in 1974 in one of the LP turbines (both barrels) and ran with this configuration for about two years until reblading. The stages were removed from LP2 due to failure of a blade in the L-2 stage. The crossover line between condenser zones was blanked out during this operation period. There were no limiting conditions for operation and, as such, reactor power was not reduced.

No problems were reported with pressure plate operation. The plates were about an inch thick.

Note: Originally called Jeff Wayland (Rochester Gas & Electric) who referred me to Barry Ketchmaryk (x215) who is a performance engineer at the station. Mr. Ketchmaryk referred me to Paul Detwiler who a maintenance engineer at the station. Mr. Detwiler referred me to his supervisor Mr. Dennis Grandjean at the main office for more detailed information.

June 13, 1994
021-004

TELECON MEMORANDUM

Date: June 9, 1994

Subject: Turbine Pressure Plate - Operating Experience

Person Called: Bernie Haug [SALEM] (609) 339-1790
Mark Moncourtois (609) 935-6000 (x2065)

Person Calling: D. Lutchenkov

Mr. Haug recalls that Salem 1 operated with pressure plates installed in the 2nd stage (from front) in the early 1980s. He does not have any specific details about operation with this configuration.

MPR
ASSOCIATES INC.
ENGINEERS

June 14, 1994
021004-03

Brian Stone
Fermi Unit 2
Detroit Edison Company
6400 North Dixie Highway
Newport, MI 48166

Subject: Pressure Plate Installations at Prairie Island and Ginna

Dear Mr. Stone:

As a follow up to our telephone conversation June 14, 1994, the following summarizes the results of our review to-date on the use of pressure plates at Prairie Island and Ginna. This summary is based on review of the "Grey Books" (Nureg 0020, "Operating Units Status Report for Licensed Generating Reactors" for the period January 1974 through November 1978. The grey books were not published prior to January 1974.

Prairie Island 1

- Prairie Island 1 went critical in December 1973. On 3/9/74 a turbine blade failure was reported. The plant was operated to ≈91% reactor power. The report does not indicate the status of the failed turbine stage. Possibly a pressure plate was installed. On 4/27/94 another turbine blade failure was reported. Three stages of LP blading were replaced with pressure plates (called baffles in the grey books). The unit was then restricted to 85% power.

- On September 5, 1974 the unit was shutdown to repair the turbine, i.e., replace the blading. The unit was returned to full power in October 1974. Maximum dependable power rating was 520 Mwe. The electrical rating was 530 MWe.

- ASME turbine cycle heat rate tests were performed in November 1974.

- No other problems with the turbine or derates due to turbine problems are reported through November 1978. In early 1977 the maximum dependable capacity (MDC) of the unit was decreased to 507 MWe. I don't believe that was related to turbine problems because the electrical rating was still 530 MWe.

Prairie Island 2

- The first records for Prairie Island 2 begin in May 1975. Turbine bearing problems required a shutdown of the unit that month.
- An L-1 blade failed in the No. 2 LP turbine in December 1975. The last three rows of blading in LP2 were replaced with baffles. The unit was restricted to 445 MWe at 100% power.
- New LP turbine rotors were installed in December 1976 and the 100% power rating was returned to 520 MWe.
- The MDC for this unit was also reduced to 507 MWe with an electrical rating of 530 MWe in early 1977. No turbine problems were reported through November 1978.

Ginna

- Ginna began commercial operation in March 1970. A turbine blade failure in the No. 2 LP turbine is reported in the February 1974 status report. The unit was in an outage for turbine repair. The nature of the repair was not described. The plant was returned to 70% power in April 1974 "to evaluate turbine blade failures in similar turbine units". In August and September 1974 power was increased to 91%. In October power was increased to 100%.
- On January 19, 1976 another blade failure occurred in the No. 2 LP turbine. Apparently pressure plates were installed, because the 100% power rating of the unit was reduced from 470 MWe (MDC) to 415 MWe. The electrical rating of the plant was 490 MWe.
- Another blade failure in the No. 2 LP turbine was reported on August 7, 1976. No details on the repair to return to service are provided.
- The plant remained at 415 MWe 100% power rating until May 1978 when a new rotor was installed in the No. 2 LP turbine. The 100% power rating was returned to 470 MWe. No turbine problems were noted through November 1978.

We have enclosed copies of those pages of the grey books for the pertinent events in each plant. If you have any questions please give me a call.

Sincerely,

L. E. Demick

PRAIRIE ISLAND 1

FACILITY DATA

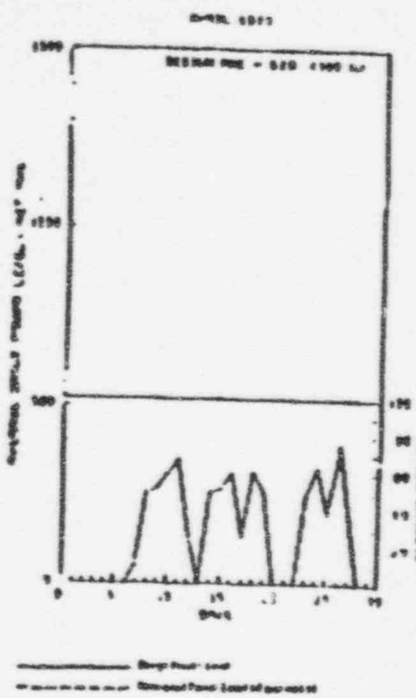
INSPECTION STATUS

ENFORCEMENT STATUS

REPORTS RECEIVED FROM LICENSEE

PRAIRIE ISLAND 1

DAILY REACTOR POWER



OPERATING STATUS

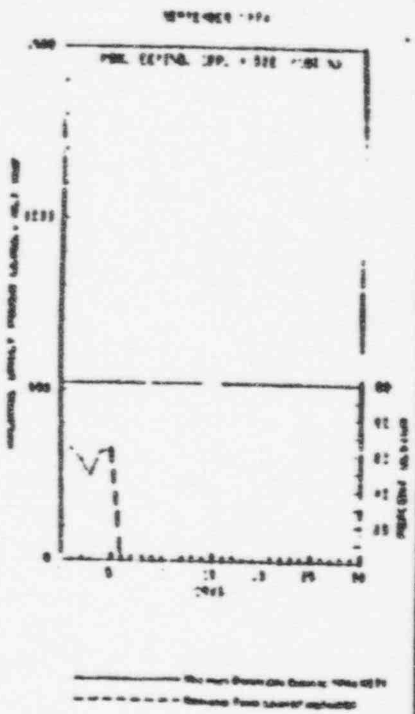
PLANT SHUTDOWNS

261

PRAIRIE ISLAND 1

REACTOR AVAILABILITY (%)	24.0	UNIT AVAILABILITY (%)	16.5	UNIT CAPACITY (%)	8.6	FORCED OUTAGE RATE (%)	0

AVERAGE DAILY POWER LEVEL (MWe)



OPERATING STATUS

[illegible]

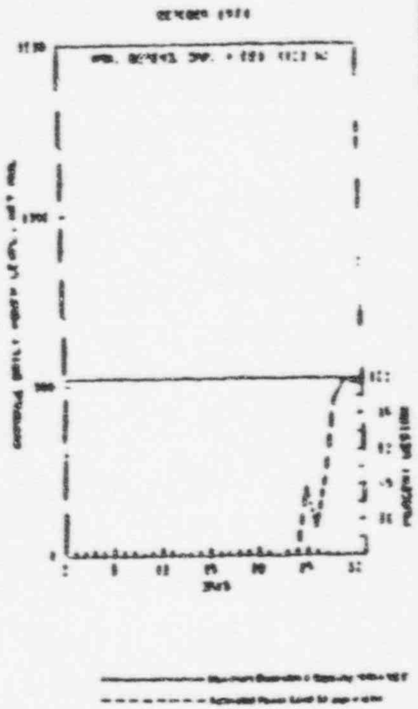
UNIT SHUTDOWNS/REDUCTIONS

[illegible]

PRAIRIE ISLAND 1

REACTOR AVAILABILITY (%)	26.6	UNIT AVAILABILITY (%)	18.5	UNIT CAPACITY (%)	14.4	FORCED OUTAGE RATE (%)	6.9

AVERAGE DAILY POWER LEVEL (MWe)

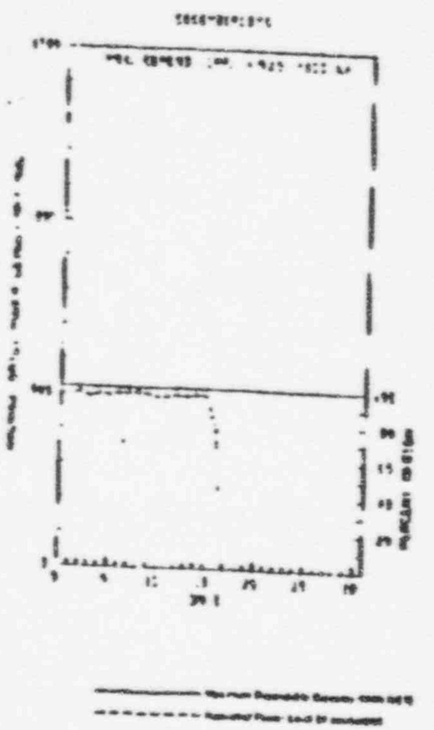


OPERATING STATUS

UNIT SHUTDOWNS/REDUCTIONS

PRAIRIE ISLAND 2

AVERAGE DAILY POWER LEVEL (MWe)



OPERATING STATUS

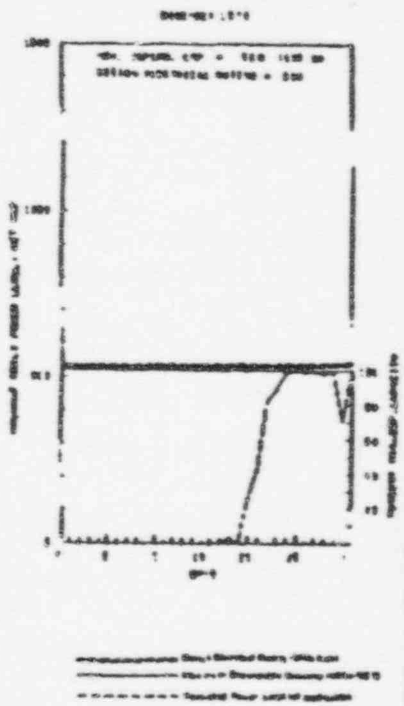
[illegible]

UNIT SHUTDOWNS/REDUCTIONS

[illegible]

PRAIRIE ISLAND 2

AVERAGE DAILY POWER LEVEL (MWe)



OPERATING STATUS

UNIT SHUTDOWNS/REDUCTIONS

2.93

FACILITY DATA

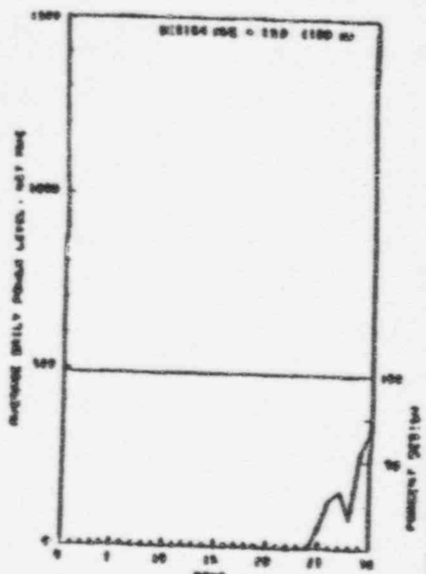
INSPECTION STATUS

ENFORCEMENT STATUS

REPORTS RECEIVED FROM LICENSEE

GINNA

DAILY REACTOR POWER



OPERATING STATUS

PLANT SHUTDOWNS

2-23

GINNA

FACILITY DATA

[illegible]

INSPECTION STATUS

ENFORCEMENT STATUS

- A. [illegible]
- B. [illegible]

OTHER SIGNIFICANT ITEMS [illegible]

A – [illegible]

- [illegible]

B – [illegible]

- [illegible]

C – [illegible]

None

LAST IE SITE INSPECTION DATE: [illegible]

INSPECTION REPORT NO: [illegible]

* [illegible]

REPORTS RECEIVED FROM LICENSEE

NUMBER	DATE OF EVENT	DATE OF REPORT	TYPE OF REPORT	SUBJECT	PUBLIC DOCUMENT ROOM
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

GINNA

FACILITY DATA

INSPECTION STATUS

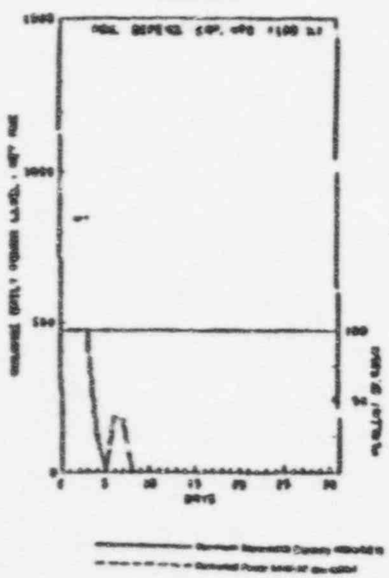
ENFORCEMENT STATUS

OTHER SIGNIFICANT ITEMS

REPORTS RECEIVED FROM LICENSEE

GINNA

AVERAGE DAILY POWER LEVEL (MWe)



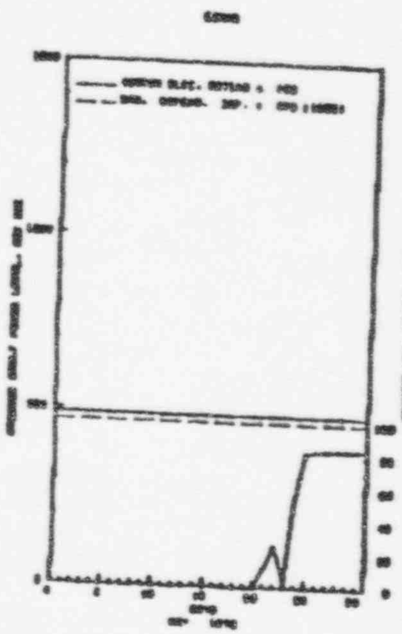
OPERATING STATUS

UNIT SHUTDOWNS/REDUCTIONS

2-41

GINNA

AVERAGE DAILY POWER LEVEL (MWe)



OPERATING STATUS

UNIT SHUTDOWNS/REDUCTIONS

CONFIDENTIAL

Westinghouse
Electric Corporation

Power Generation
Business Unit

The Quadrangle
4400 Alafaya Trail
Orlando, Fl 32826-2399

July 13, 1994

Detroit Edison Company
Enrico Fermi 2
6400 Dixie Highway
Newport, Michigan 48166

Attention: Len C. Fron, Sr.

Subject: Pressure Plating Evaluation Report

Dear Mr. Fron:

Attached is the final report for the Westinghouse evaluation of the pressure plates. I hope that we have provided all of the information that you need.

If you have any questions, please call me at (407) 281-5640.

not personal info

Thank you.

Sincerely,

Phillip R. Ratliff

Phillip R. Ratliff
Manager, Turbine Service Programs

Westinghouse Evaluation of GEC Pressure Plates for DECO Fermi 2

Prepared by:
Brad A. Steinebronn
Matthew Tremmel
Larry Fowles
Phil R. Ratliff

I. Introduction

In certain instances, it may be necessary to operate turbines with a complete stage of blades removed. [redacted] This plate is designed with a large number of small holes to ensure that the pressure drop is maintained at the same level, thus allows for temporary operation.

In order to provide safe and reliable operation, the pressure plates must: [redacted]

II. Statement of Mission

When blades in the Fermi 2 Low Pressure turbines failed, the utilization of pressure plates in lieu of the last two stages of blading was considered as a temporary method for return to service. DECO decided that OEM should be responsible for any modifications to the turbine, and thus GEC's pressure plate design was conducted. At the request of Detroit Edison, Westinghouse reviewed the GEC design of the L-0 and L-1 stage pressure plates. This review focused on the capability of the pressure plate designs to duplicate the turbine thermodynamic conditions and the mechanical adequacy of the pressure plate structure. This review was prudent to assure that the plates operate with complete reliability and safety.

III. Pressure Plate Experience

Westinghouse has utilized pressure plates in many different steam turbines in the 1970's and 1980's in fossil and nuclear low pressure steam turbines. During this time span, many improvements were made on the specific designs and design methodology. Westinghouse's most relevant experience, however, is with Northern States Power and Rochester Gas and Electric.

In 1974, Northern States Prairie Island #1 encountered a forced outage because of blade failure in the L and L-1 stages. Pressure plates were used across the blading gaps, and, after setting the allowable pressure drop to [redacted] the unit ran at 100% MWt.

In 1976, pressure plates were installed in Rochester Gas and Electric Ginna Station. After testing, the allowable pressure drop was raised [redacted] This advancement was significant [redacted] These tests have shown that the turbine can operate at 100% MWt, while staying well below the critical operating conditions.

This most relevant experience base has lead to the creation and use of analytical and empirical tools for the design of pressure plates. These tools have been compared to actual unit operation to ensure the performance of the pressure plates. Specifically, there is experience in the design of pressure plates for wet steam applications in nuclear low pressure steam turbines as exists in Fermi 2.

IV. Design Evaluation

Utilizing the above mentioned knowledge base, Westinghouse has evaluated the GEC design for the Fermi 2 low pressure turbine pressure plates. Although there are construction differences in design of the pressure plates between GEC and Westinghouse, the application of our tools and experience was judged to be relevant.

1. Thermodynamic Evaluation

1.1 Westinghouse Estimate of Flow Area

The majority of Westinghouse pressure plates were designed with the aid of an in-house developed computer code. This code has been extensively verified through field and laboratory tests. [redacted]

Table 1 shows the flow conditions used for the Westinghouse evaluation as supplied by GEC (Attachment 1). Because this is not a Westinghouse unit, accuracy of these numbers was not verifiable.

[redacted]

Table 2 shows the results of the Westinghouse computer program. All areas include the designed leakage area.

[redacted]

While there is some difference in the flow areas, the first pressure plate (which is the most critical) is sized adequately [redacted]

1.2 Estimate of Inlet Total Pressure

Because the pressure ratio across both pressure plates is greater than the critical pressure ratio, the flow is choked through the holes. The critical flow equation was applied to estimate the inlet total pressure to each pressure plate. Table 3 presents the Westinghouse estimate of inlet total pressures.

[redacted]

1.3 Discussion of Results

The hole area and subsequent inlet pressure to the plates, as determined by Westinghouse, considers the GEC design to be a conservative design. [redacted]

An estimate of the loss in power from the last rotating row due to the increase in total pressure was made. Based on the DECO supplied expansion line data (Attachment 2), Table 4 shows the resulting loss in power from stage 6. The additional loss in power is 2.7 MW per end for a total loss of 16.2 MW from the LP due to the change in stage 6 exit conditions only.

[redacted]

2. Mechanical Evaluation

Th[redacted] design used by GEC differs from the [redacted] design used by Westinghouse. The differences includ[redacted]

The GEC method of pressure baffle design seems to be sound, although somewhat more conservative than that used by Westinghouse. One concern is the fact that the GEC design requires adequate axial clearance between the rotor disc's and the baffle plate for operation. These axial clearance concerns would not be present in the Westinghouse design. This design type requires the axial clearances should be opened up enough to provide extra margin due to the deflection of the pressure baffles. GEC has stated that the axial clearances as established are sufficient. However, Westinghouse deflection calculations indicate that smaller deflections than the GEC axial clearances should be adequate.

The methods for calculating maximum stresses and deflections in uniformly loaded, semicircular plates was developed by Ara O. Karamanian and reported in Westinghouse Engineering Report EM-1167. The formulas and curves found in the report were developed based on [redacted] Karamanian's report the methods were checked by finite element processes available to verify that all assumptions were valid. This method has been used by Westinghouse since the early 70's for pressure baffle design. Considering the calculation methods used, a minimum safety factor of 2 based on yield strength is used. [redacted]

The operating stresses determined in the evaluation were within our design allowables for the materials used. The following table shows approximations determined using our design techniques and their value relative to allowables.

Stage 7 Pressure Plate

	VALUE	COMMENTS
[redacted]	[redacted]	

Stage 8 Pressure Plate

	VALUE	COMMENTS
[redacted]		

V. Design Review

The design review was held on 6/14/94 (following Westinghouse Design Assurance Policy) to review the Westinghouse effort of the GEC-Alsthom design of [redacted] which would replace the damaged seventh and eight stages in the GEC-Alsthom machine at the Detroit Edison Company's Fermi Plant.

In general, the review panel felt that the flow areas of the [redacted] were slightly lower than what was required for Westinghouse's design which had generated good field experience at Ginna and Prairie Island. However, the difference in area was not great enough to reject the design, as some assumptions had to be made within the calculation procedure. However it was thought prudent to inform Detroit Edison of this fact and note to them that the effect on the unit cycle could be a higher minimum extraction pressure and might unload the sixth stage. These effects were not considered critical to the accomplishment of the overall task.

Other concerns recorded for this review involved the impact on the condenser of an increase heat load imposed by dumping 200 MW into the condenser and subsequently into the environment and the fact that the higher energy last extraction would reduce the heater steam requirements and subsequently increase flow through the last stage [redacted] Also a manufacturability concern was recorded.

The following concerns were recorded for the review:

Concern #1: Can the condenser handle the increased heat load (approximately 200 MW) without any detrimental effects including the environmental impact.

Response: This is a concern to be addressed by DECO, however initial customer feedback is that the condenser has the capacity to handle the additional heat load.

Concern #2: Consider monitoring the last stage extraction pressure to assure ourselves of proper operational impact of th[redacted]

Response: The conclusion that th[redacted] will cause a higher than designed pressure at the stage seven and eight inlets is a conservative approach relative to blade loading. Based on this conservatism, monitoring of the last stage extraction pressure is not necessary.

Concern #3: Consider running a GPHB to assess the cycle effects of higher energy steam being extracted to the lowest pressure heater.

Response: The scope of work to perform a GPHB model was outside the realm of the pressure plate evaluation study purchased by DECO. Considering the conservatism of the GEC design, it was not necessary to perform this analysis to form conclusions on the GEC pressure plate designs.

Concern #4: [redacted] The program documentation is better than most but the recorded limitations can be subject to interpretation.

Response: Although the limitations of the subject computer analysis are not well documented, the engineer performed other calculation methods in addition to the computer program to assure the validity of the results.

Concern #5: Attempting to dril[redacted] could prove to be a difficult manufacturing challenge. The need to prevent drill drift could make this a costly design from a manufacturing point of view[redacted] would be the preferred method if it can be accommodated.

Response: Review of the manufacturability of the GEC pressure plate design with the Pensacola factory revealed that drill drift would not be a problem. Pensacola has successfully drilled smaller diameter holes through thicker steel plate without occurrence of drill drift.

Concern #6: As Westinghouse would prefer to use larger diameter holes in their design, we should check to see what size holes they have used in the 4th and 5th stage baffle plate.

Response: The concern is irrelevant, as the GEC specific hole diameter was accepted by DECO.

Concern #7: As a check on our results we should check the stage flows and enthalpies and see if we approximate the stated 200 MW loss. This would be a quick look check.

Response: Based on expansion line data provided by DECO/Fermi the 200 MW estimated loss is correct for the loss of stages seven and eight.

Concern #8: If we knew the seventh stage stationary gaging, we could get a better feel for the accuracy of ou[redacted] calculation and verify some of the assumption we made.

Response: GEC would not provide the seventh stage stationary gaging, so the validity of the assumption could not be checked.

Concern #9: Westinghouse would be concerned if we designed a baffle application that changed an extraction pressur[redacted]

Response: Westinghouse has identified the deviation in extraction pressure that is caused by the GEC thermal design.

Concern #10: We should calculate th[redacted] bottoms out in the mounting groove. I don't think we have a concern here but we should check.
Response: The data was checked, and this does not seem to be a concern.

Concern #11: We should ask GEC if they have checked the ability of the cylinder to pick up th[redacted] We don't have enough dimensional information to do this ourselves with any accuracy. Right now this doesn't look like a problem but we should ask.
Response: A bounding calculation of the cylinder loads imposed by the pressure plates was performed by Westinghouse. These results were found to be within allowable values.

Concern #12: The plate support pockets have been damaged (especially in LP3). Will they be cleaned up and if they are, will they be restored to drawing. Any differences will have to be picked up in the design of the support keys.
Response: This concern will be identified in the final report to DECO Fermi for identification and attention during unit restoration

No open concerns exist from the design review.

VI. Conclusion

The technical review of the pressure plates does not identify any significant deficiencies in the design. The application of the Westinghouse knowledge base to the evaluation of the GEC pressure plates shows that the design satisfies the basic thermodynamic and mechanical strength requirements with ample conservatism. The turbine should perform safely without operating restrictions.

Withhold from

Dryness Fraction x

[redacted]

Withho[illegible]
[illegible]

Attachment #1

Westinghouse Electric Corporation

Power Generation Business Unit

Technology Division

The Quadrangle
4400 Alafaya Trail
Orlando Florida 32826 2399

August 4, 1994

Detroit Edison Company
Enrico Fermi 2
6400 Dixie Highway
Newport, Michigan 48166

Attention: Brian Stone

Dear Mr. Stone:

In reference to questions of today, table for Stage 7 Pressure Plate Steam Analysis indicated calculated axial load forces [redacted] This was an increased by 10% to a value of [redacted] in analysis to add conservatism to the calculation. The calculation considered the load to be a steady load situation, no impact loading considered.

Sincerely,

Phillip R. Ratliff

Phillip R. Ratliff

PRRlk271.doc

FPI International

The Leading Experts in Failure Prevention & Investigation

N.A ... per B. Wilk...

June 15, 1994

Mr. Len Fron
Turbine Supervisor
Detroit Edison Company
Fermi-2
6400 N. Dixie Highway
Newport, MI 48166

Subject: **FPI Review of Pressure Plate Use on Fermi-2**

Dear Mr. Fron

Per your verbal request of June 11, 1994, FPI has conducted a review of various subjects regarding use of pressure plates in large steam turbines. This review is organized based on discussions with Mr. Brian Stone into the following areas.

1. Experience / perspective on operation with pressure plates / baffles.
2. Review of industry experience as provided by Westinghouse.
3. Review of Westinghouse evaluation for Fermi-2 pressure plates.

This review does not attempt to provide an in-depth evaluation of whether FPI would recommend pressure plates versus other turbine repair possibilities such as reblading. It is understood that this analysis has been conducted and the determination has been made to use pressure plates in all three LP rotors for all L-0 and L-1 rows provided the technical analysis of this installation does not jeopardize turbine operation. The primary purpose of this assessment therefore, is to provide an independent review of current industry experience using pressure plates and review the evaluations conducted by Westinghouse and others for Detroit Edison. This is to support the Detroit Edison Company in ensuring all consideration is given to arrive at the best overall decision regarding the return to service of the Fermi - 2 turbine.

112 W. Canada • San Clemente, California 92672
Phone / Fax: (714) 361-5479 • Messages: (714) 361-5474

1. Experience / perspective on operation with pressure plates / baffles.

The primary purpose for installing pressure plates is to prevent overloading upstream and downstream stages when it becomes necessary to operate a turbine with rotor blade stage(s) removed. The theory is that the pressure drop through the installed pressure plate is designed to replicate the expected pressure drop exhibited by the stage diaphragm and rotating blading it is replacing. Therefore, surrounding stages continue to have the same pressure forces exerted on them as if the rotating blades were installed. The typical industry use for pressure plates has been in reaction stages, usually L.P. exhaust stages for example L-4, L-3, L-2, L-1, and L-0 stages. The industry experience has been good with respect to pressure plate applications.

Problems which might occur due to improperly designed or installed pressure plates are: rotor vibration, excessive blade vibration upstream or downstream, excessive noise emissions, overheating of exhaust, casing distortion (not expected in diaphragm type construction), overheating of condenser expansion joint, excessive rotor thrust (not expected in double flow design), failure or distortion of pressure plates, unacceptable changes in rotor torsional frequency to name a few. Certain operating limitations could be experienced with pressure plates installed such as: reduced generator output, rotor vibration limits, reduced steam flow, additional exhaust temperature control requirements, for example: capacity of exhaust sprays, capacity of exhaust cooling water system, condenser heat removal capacity, cooling water system capacity. The above must be considered when installing pressure plates.

However, pertinent experience in the use of pressure plates occurred at the Southern California Edison Mohave Generating Station. Mohave Generating Station is a 790 megawatt coal fired supercritical unit using General Electric double flow L.P. steam turbines. These are 1800 RPM turbines with L-0 blades of 52", L-1 = 34", and L-2 = 22.5". Both units have experienced problems on different stages resulting from disc cracking and both required the use of pressure plates. Unit 1, L-2 stage cracks were in the rotor dovetail. Unit 2, L-1 stage had a disc bore crack at a keyway. These units are similar to the Fermi - 2 turbine in that they both employ diaphragms. No operational problems were experienced with either Mohave unit which were operated with pressure plates for over 1 year.

Therefore, based on the above discussion and knowledge that pressure plates have been used throughout the industry on numerous occasions without adverse consequences, it is our conclusion that pressure plates are a suitable alternative for the Fermi - 2 turbine. This similar question was posed to FPI personnel during a recent presentation to the Detroit Edison Board of Directors. When asked if FPI personnel thought pressure plates were a viable alternative it was stated that after hearing the entire presentation by Fermi personnel we would concur with the decision to install pressure plates for one operating cycle.

2. Review of industry experience as provided by Westinghouse.

FPI reviewed a series of documents that were prepared for Detroit Edison personnel by GEC Alstrom and MPR Associates. These documents provide the results of industry use by the three major turbine vendors: GEC, G.E., and Westinghouse, of pressure plates. FPI's conclusion based on the review of this industry data compilation is that it supports our conclusion expressed in item 1 above that the industry experience concerning use of pressure plates has been successful. Therefore, this reinforces FPI's overall conclusion that use of pressure plates for the Fermi 2 turbine is a suitable alternative solution.

3. Review of Westinghouse evaluation for Fermi-2 pressure plates.

FPI reviewed a draft memo Phillip R. Ratliff, Mgr. Turbine Service Programs of Westinghouse Electric Corporation to Len Fron, Sr. of Detroit Edison Company, Subject: Westinghouse Evaluation of GEC Design Pressure Plates for Fermi 2, dated June 14, 1994. This document presents Westinghouse Electric Corporations technical assessment of the GEC design for Fermi 2 turbine pressure plates. This points to the facts that Westinghouse has utilized pressure plates successfully in many applications in the past 20 years which is important from a practical industry experience standpoint. In addition they have developed tools which have provided them both analytical and empirical design basis for reviewing pressure plate designs. They express confidence in their capability of reviewing the GEC design using their tools and have done this through their design review process. The Westinghouse review process concludes that the thermodynamic design of the GEC pressure plates closely matches the Westinghouse predictions. The memo also goes on to describe other evaluations that were performed to validate the adequacy of the GEC design for the pressure plates. Thus, the FPI review of the Westinghouse analysis concludes that the Westinghouse review and validation process adequately considers those parameters necessary for pressure plate design and that the GEC design meets those requirements.

In conclusion, FPI conducted an independent review based on the decision by Detroit Edison to install pressure plates for L-0 and L-1 turbine blades. This review determined that although there are certain special considerations as described above which should be considered prior to installing pressure plates it was demonstrated that Detroit Edison took the necessary prudent steps to examine those considerations to allow installation of pressure plates for the Fermi-2 turbine. In fact, multiple independent analysis were conducted to provide assurance that this is a prudent and intelligent decision based on facts available at this time.

Please feel free to contact me regarding any questions you might have regarding the above subject.

Sincerely,

Jeffrey S. Summy
Director,

Ralph J. Ortolano
Concurrence:
Mr. Ralph Ortolano

cc: Dr. Chung Chiu

ENGINEERING DESIGN PACKAGE COVER SHEET

CONFIDENTIAL

EDP - 26726	Type [X] I [] II
Index Item No. 1	
Rev 0	
Page 1 of 1	

PART 1: IDENTIFICATION (Preparer)

A) Title ELIMINATION OF THE 7TH AND 8TH STAGE LP TURBINE BLADES AND PRESSURE PLATES INSTALLATION		
B) System PIS Number(s) N3011C001		
C) Commitment References		
D) Responsible Group MECHANICAL	E) Responsible Engineer R. TASSELL	F) QA Level [] 1 [] 1M [X] Non-Q
G) Seismic Category [] I [] II/I [X] None	H) Piping Groups [] A [] B [] C [] D [] D+ [X] NA	I) Simulator Impact [X] Yes [] No
J) Training Impact [X] Yes [] No	K) Change Paper CECO [X] Yes [] No	L) EQ Central File/EQ M&S Requirements Impact [] Yes [X] No
M) DVRP Required [] Yes [X] No	N) Spare Parts Impact [X] Yes [] No	O) SE Required [] No [X] Yes, SE Number: 94-0073

PART 2: ENGINEERING OPERABILITY CONSTRAINTS (EOCs) (Preparer) [X] NA

A) Issued with EOC [] No [] If Yes, EOC No.:	B) Revised to Remove EOC [] Yes [] No
C) EOC Description/Removal Explanation [] NA	

PART 3: SIGNATURES

A) Prepared By R. L. TASSELL Print & Sign R L Tassell	Date 8-1-94
B) Checked By Print & Sign H. Ackerman [signature]	Date 8/2/94
C) Approved By Project Engineer (Support Organization only) Print & Sign	[X] NA Date LES 8-2-94
D) Concurred By PMRG (PMRG Leader) Print & Sign	[X] NA Date LES 8-2-94
E) Approved By LARRY E. SCHUERMAN Print & Sign Larry E. Schuerman FOR K. E. HOWARD	Date 8-2-94
F) Approved By OSRO (OSRO Chairman) Print & Sign J. H. PLONA Joseph H. Plona	[] NA Date 8/2/94

ARMS - INFORMATION

DSN 26726.001	Rev 0	Date 8-3-94	
DTC: TCEDP	File: 1801	DECOM Related: [X] Yes	Recipient 362

EDP -26726	
Index Item No. 2	
Rev 0	
Page 1 of 1	

PART 1: CONTENT

Item No.	Item Description	Item Rev.	Remarks
1	EDP COVER SHEET	Ø	
2	EDP INDEX SHEET	Ø	
3	LIST OF BCDD'S TO BE REVISED	Ø	
4	SCOPE OF EDP	Ø	
	A) PURPOSE/OBJECTIVE		
	B) GENERAL DESCRIPTION		
	C) FUNCTIONAL DESCRIPTION		
	D) JUSTIFICATION		
	E) DESIGN INPUT		
	1) DESIGN BASIS		
	2) ALARA		
	3) FIRE PROTECTION		
	4) SECURITY		
	5) HUMAN FACTORS		
	F) NUCLEAR TRAINING/ SIMULATOR IMPACT		
	G) UFSAR IMPACT		
5	PRELIMINARY EVALUATION	Ø	
6	REFERENCES	Ø	
7	LIST OF MATERIAL	Ø	
8	INSTALLATION INSTRUCTIONS	Ø	
9	PMT/DESIGN CHANGE	Ø	
	ACCEPTANCE TEST (DCAT)	Ø	
10	Pressure Plate Modifications to Drawings R LA 94 04766 (T1-3687), R200 A1 5462 (T1-3688) & R265 A3 3077 (T1-3689)	Ø	
11	TURBINE DESCRIPTION CHAPTER 7/ L.P. TURBINE (VMT1-1.1.7)	Ø	
12	Misc. Vendor Drawings	Ø	

PART 2: SIGNATURES

A) Prepared By R. L. TASSELL [ ] NA	B) Checked By [ ] NA
Sign R L Tassell Date 8-1-94	Sign [signature] Date 8/2/94

ARMS – INFORMATION SERVICES
DTC: TCEDP DSN: 26726.002 REV: Ø
DATE: 8-3-94 RECIPIENT NO: 362

ARMS – INFORMATION SERVICES
DTC: TCEDP DSN: 26726.003 REV: 0
DATE: 8-3-94 RECIPIENT NO: 362

EDP -26726
Index Item No. 3
Rev 0

PART 1: CONTENTS

ARMS DTC	ARMS DSN	ARMS Rev	Description or Other Identification	Description of Change/ Affected CECO PIS No.
TMINSL	VMT1-1.1.7	B	TURBINE DESCRIPTION CHAPTER 7/ L.P. TURBINE	See Index Item 11
DDVEND	LA 146X69	K	LP 3 SHAFT AND BODY GROOVING (T1-569)	See Index Item 12
DDVEND	LA 231X69	M	LP 2 SHAFT AND BODY GROOVING (T1-568)	See Index Item 12
DDVEND	LA 230X69	L	LP 1 SHAFT AND BODY GROOVING (T1-567)	See Index Item 12
DDVEND	R277A874 PG. 1	H	LP 1 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1187)	See Index Item 12
DDVEND	R277A874 PG. 2	J	LP 1 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1187)	See Index Item 12
DDVEND	R277A875 PG. 1	H	LP 2 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1264)	See Index Item 12
DDVEND	R277A875 PG. 2	L	LP 2 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1264)	See Index Item 12
DDVEND	R277A876 PG. 1	H	LP 3 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1265)	See Index Item 12
DDVEND	R277A876 PG. 2	J	LP 3 CYLINDER ARRGT. & RECORD OF CLEARANCE (T1-1265)	See Index Item 12
DDVEND	TS 17280	B	DIAGRAM SHOWING OPERATING CONDITION (T1-1598)	See Index Item 12 UFSAR FIG. 10.1-1 LCR-94-149-UFS
8-3-94 ADD PER LL DDVEND	R LA 94 04766	A	LP STAGE 7 & 8 PRESSURE PLATES (T1-3687) PG. 1, 2, 3	See Index Item 10
DDVEND	R200 A1 5462	G	SPECIAL SOCKET HEADED SCREWS (WAISTED) B.S. FINE (T1-3688)	See Index Item 10
DDVEND	R265 A3 3077	M	LOCATING PEG FOR DIAPHRAGM (T1-3689)	See Index Item 10

PART 2: SIGNATURES

A) Prepared By R. L. TASSELL	[ ] NA	B) Checked By	[ ] NA
Sign R L Tassell	Date 8-1-94	Sign [signature]	Date 8/2/94

BCDDs TO BE POSTED/REVISED

EDP -26726	
Index Item No. 3	
Rev 0	
Page 2 of 3	

PART 1: CONTENT

ARMS DTC	ARMS DSN	ARMS Rev	Description or Other Identification	Description of Change/ Affected CECO PIS No.
TLEQIP	CECO	Ø	CENTRAL COMPONENT (CECO) DATABASE	PIS # N3011C001 (Electronic CECO)

PART 2: SIGNATURES

A) Prepared By R. L. TASSELL [X] NA Sign Date	B) Checked By [X] NA Sign Date

LIST OF OTHER AFFECTED DOCUMENTS
(References on ARMS)

EDP -26726
Index Item No. 3
Rev 0
Page 3 of 3

PART 1: CONTENT

ARMS DTC	ARMS DSN	ARMS Rev	Document Description	Description of Change
VSSERC	SE-94-0073		SAFETY EVALUATION FOR EDP-26726	ISSUED TO SUPPORT THIS EDP
TDLCR	94-149-UFS		LICENSING CHANGE REQUEST	ISSUED TO SUPPORT THIS EDP
TDFSAR	UFSAR	6A	UPDATED FINAL SAFETY ANALYSIS REPORT	SEE LCR-94-149-UFS FOR CHANGES
DDVEND	R LA 94 04766	A	LP STAGE 7 & 8 PRESSURE PLATES (T1-3687)	ISSUED TO SUPPORT THIS EDP
DDVEND	R200 A1 5462	G	SPECIAL SOCKET HEADED SCREWS (WAISTED) B.S. FINE (T1-3688)	ISSUED TO SUPPORT THIS EDP
DDVEND	R265 A3 3077	M	LOCATING PEG FOR DIAPHRAGM (T1-3689)	ISSUED TO SUPPORT THIS EDP
DDVEND	TS 24122	A	DIAGRAM SHOWING OPERATING CONDITIONS AT 105% REACTOR FLOW - LP STAGES 7 & 8 REPLACED WITH DRILLED PLATES	ISSUED TO SUPPORT THIS EDP

PART 2: SIGNATURES

A) Prepared By R. L. TASSELL [X] NA Sign Date	B) Checked By [X] NA Sign Date

EDP -26726
Index Item No. 4
Rev 0
Page 1 of 2

SCOPE OF WORK

A. PURPOSE / OBJECTIVE:

Due to the failure on December 25, 1993 of an eighth stage blade on the number three Low Pressure Turbine (LP3) and the resulting damage found during investigation, this EDP allows the operation of all three LPs without their seventh and eighth stage blades for one fuel cycle or until new LP Turbine sections are available for installation. The new LP sections are expected to be delivered in early 1996 and installed during RFO5.

B. GENERAL DESCRIPTION:

This EDP includes removal of all the seventh and eighth stage blades on three LP's. The disc blade serrations will be protected by root blocks, which are fabricated by cutting the blades at the bottom of the airfoil. For those 7th & 8th stage blades, which had destructive testing done or an unacceptable NDE of the roots, a root block will be fabricated and installed by Westinghouse during straightening and balancing of the rotors at the factory. To account for the removal of the blades, the 7th and 8th stage diaphragms will be removed and pressure plates will be installed.

C. FUNCTIONAL DESCRIPTION:

With this modification installed, the turbine / generator output will be reduced by approximately 200 megawatts during the next fuel cycle, per discussions with the Turbine manufacturer, GEC/Alsthom.

Feedwater heaters 1 and 2, located in the neck of the condenser under each LP , receive their steam from extraction points before stage 8 and stage 7 blades respectively and the steam after the 8th stage is exhausted directly into the condenser.

The pressure plates are designed to restore the pressure drops across stages 7 & 8 to values similar to having the blades and diaphragms installed. Thus, stage 6 blades will not be overstressed and the thermodynamic effects on the feedwater heaters and the condenser will be minimal.

D. JUSTIFICATION:

Removal of the LP 8th stage blades eliminates the potential of on 8th stage blade penetrating an LP hood which is what occurred in the December 25th incident. The LP 7th stage blades are being removed due to indications found during inspection of some of their roots. Management's decision is to remove these blades and replace them with pressure plates until RFO5, at which time newly designed LP rotors and blade sections will be installed.

The pressure plates have been designed by the turbine manufacturer, GEC/Alsthom, with an independent review performed by Westinghouse Electric Corporation Turbine Services group and found to be acceptable as an interim measure until the newly designed rotors and blades can be installed.

SIGNATURES	
A) Prepared By R. L. TASSELL	B) Checked By
Sign R L Tassell Date 8-1-94	Sign [signature] Date 8/2/94

EDP -26726
Index Item No. 4
Rev 0
Page 2 of 2

SCOPE OF WORK (Continued)

E. DESIGN INPUT:

1) DESIGN BASIS

Per GEC/Alsthom, the plates are designed to provide a similar pressure drop for the blades and diaphragms they are replacing. The revised heat balance provided by GEC/Alsthom (Edison File # T1-3690) indicates approximately 17% reduction in megawatts, approx. 10% increase in condenser heat load and only minor changes in the balance of the thermal cycle conditions. See SE 94-0073 for a detail evaluation of the changes.

2) ALARA

The turbine is typically a low radiation, contaminated area during outages. All work should be in accordance with normal radiation protection requirements.

Removing the LP's 7th & 8th stage blades and replacing them with pressure plates results in an insignificant change in the steam conditions (pressure & temperature) to the feedwater heaters or condenser. Therefore, this change does not affect any radiation assessment calculations or exposure doses.

3) FIRE PROTECTION

This design change conforms with, and does not adversely affect, the plant Fire Protection Program. The modification is all within the LP turbine casings. There are no additional combustibles being added or any fire barrier penetrations being breached as the result of this EDP.

4) SECURITY

This EDP does not involve any safeguard information, nor does it impact any Physical Security Plans, Systems or Facilities.

5) HUMAN FACTORS

The modifications in this EDP replaces the LP's 7th & 8th stage blades and diaphragms. There is no impact on any control center components or local controls. Therefore, human factors are not affected.

F. NUCLEAR TRAINING / SIMULATOR IMPACT

The training material should be reviewed and changed as required to address the removal of the LP 7th & 8th stage blades & diaphragms and the replacement with pressure plates. The only change to the simulator, if any, would be the slight change in the operating conditions of the condenser, heater drains and number 1& 2 heaters. as well as MW Output. These changes can be seen by reviewing the new heat balance provided by GEC/Alsthom (Edison File # T1-3690) against the previous one shown in UFSAR fig 10.1-1 (Edision File # T1-1598).

G. UFSAR IMPACT

1) Fig. 10.1-1 - Heat Balance at 100 Percent Reactor Flow, temporarily replaced with a new heat balance.
2) Sections 10.1, 10.2, 10.3, and 10.4 will also require changes.

SIGNATURES	
A) Prepared By R. L. TASSELL Sign R L Tassell Date 8-1-94	B) Checked By Sign [signature] Date 8/2/94

PRELIMINARY EVALUATION

PART 1: DESCRIPTION OF CHANGE (Preparer)

A) Document Identification	B) Revision If Approved	C) PIS Number
EDP-26726	0	N3011C001

D) Description of Change Replace all three LPs 7^{th} & 8^{th} stage blades and diaphragms with pressure plates.

PART 2: PRELIMINARY EVALUATION (Preparer, Approver)

A) Review of Commitments

[ ] No commitments
[X] Commitments Exist (Identify in accordance with 6.1.4.5) See page 2

[X] Commitments Met - none negated
[ ] Commitments need changing - Describe and justify commitment changes on continuation sheet
[ ] Safety Engineering and/or Nuclear Licensing have been contacted to make changes

B) Impact on License, Plans, or Programs [Check box(es) if no impact]

No Impact		No Impact		No Impact	
[X]	Operating License	[X]	Quality Assurance Program	[X]	Offsite Dose Calculation Manual (ODCM)
[X]	Technical Specifications (Including Bases)	[X]	Radiological Emergency Response Preparedness Plan (RERP)	[X]	Process Control Program (PCP)
[X]	Environmental Protection Plan	[X]	Physical Security Plan	[X]	Inservice Inspection - Inservice Testing Program (ISI-IST)
[X]	Core Operating Limits Report (COLR)	[X]	Safeguards Contingency Plan	[X]	Inservice Inspection - Non-Destructive Examination (ISI-NDE)
[ ]	UFSAR	[X]	Security Personnel Training and Qualification Plan		
[X]	Fire Protection Program				

[ ] License Change Request (LCR) required
List LCR(s): 94-149-UFS

C) Effect on Environment

[X] No effect on environment
[ ] Environment affected - contact Fermi Environmental Engineer and indicate resolution

D) Need for Safety Evaluation (check appropriate answer) Safety Evaluation No. (if required) ______

Yes	No		
[X]	[ ]	1.	Is this a change to the facility, including assumptions, as described in the UFSAR?
[ ]	[X]	2.	Is this a change to a procedure, including assumptions, as described in the UFSAR?
[ ]	[X]	3.	Does this change constitute a Special Test?

- If any answers are "yes" and the NRC Safety Evaluation Report is available, attach NRC Safety Evaluation.
- If any answers are "yes" and no NRC Safety Evaluation Report is available, initiate a Safety Evaluation.
- If all answers are "no", provide the basis to support that determination on a continuation sheet.

E) Prepared by R. L. TASSELL	F) Approved by
R L Tassell Date 8-1-94	Larry E. Schuerman Date 8-2-94
	LARRY E. SCHUERMAN

PRELIMINARY EVALUATION CONTINUATION SHEET

A) Document Identification EDP-26726	B) Revision If Approved 0

PART 2A) REVIEW OF COMMITMENTS (Continued)

[X] Commitments Exist (list)

CECO

RACT 89630, 89633, 90436, 91211, 92074, 91248

DER 88-2122, 89-0245, 92-0195

MISC OTH-89-004, SEN 057, NOTE 89-042

NO IMPACT

ALL AFFECTED DDVEND DRAWINGS

No Commitments

UFSAR

RACT 204, 4113, 1527, 2156, 2157, 2123, 87288, 3263, 2597, 5851, 4144, 5212, 3756, 3757, 89292, 89613, 89069, 1498, 88432, 90381

DER 90-0453, 92-0497, 90-0509

MISC MISC032-SUP 1, MISC032, NOTE82-003, SOER90-002-RC01

NO IMPACT

N3000

RACT 204, 1016, 1501, 6107, 7916, 90383, 90384, 91101, 91103, 94023, 94024, 94025, 94026, 94072, 94074, 94119, 94129

OER DER's 86-044, 071, 076, 079
87-033, 065
NO-85-701, NP-84-012
NP-85-061, 438, 499, 546, 593, 635, 654, 701

MISC MISC044
NOTE 79-037, 80-003, 91-083, O&MR256, 262, 268, 284, 337
OTH 91-017-LIC9, 92-049-AIT, 92-054-INPO, SEN 084, SOER-84-006, 84-006-RC1- RC7
SER 84-035, 84-091, 85-006, 86-007, 91-004, 91-012, 91-016, 91-018, 92-021
SOER-84-006, 84-006-RC1 thru RC7

NO IMPACT

N3011

RACT No Commitments

MISC SER 87-005

NO IMPACT

PRELIMINARY EVALUATION CONTINUATION SHEET

A) Document Identification	B) Revision If Approved
EDP-26726	0

PART 2D) NEED FOR SAFETY EVALUATION (Continued)

Response to Questions:

1. This modification is considered a change to the facility, including assumptions, as described in the UFSAR, see Safety Evaluation 94-0073

2. This modification replaces the 7th & 8th stage blades and diaphragms of all three LP turbines with pressure plates and as stated above is a change to the facility. The effect on the system results in a loss of approximately 200 megawatts at 100 % reactor power and a very slight change in the thermodynamics after the 6th stage thru the number 1 and 2 heaters. This does not change the function of any equipment or system as defined in the UFSAR. Therefore, this is not a change to any procedure, including assumptions, as described in the UFSAR.

3. Due to the major repair work and modifications, including this EDP, as the result of the December 25th incident, additional start-up testing and monitoring will be performed, including the completion of the power up-rate testing that could not be completed last cycle. However, replacing the LP 7th & 8th stage blades and diaphragms with pressure plates does not require a Special Test, as described in the UFSAR, the SER, or the Fermi 2 Technical Specifications. The Special Test Section, 4.8, described in FMD-CT1 has been reviewed.

REFERENCES:

ARMS – INFORMATION SERVICES	
DTC: TCEDP DSN 26726.006 REV: 0	
DATE: 8-3-94 RECIPIENT NO: 362	

1. Work Requests for this EDP

   W.R. 000Z940425 - LP 1 Installation

   W.R. 000Z940426 - LP 2 Installation

   W.R. 000Z940423 - LP 3 Installation

2. EDP-10533, Turbine LP Blading Row #8 ripple spring modification performed in 1989.

3. Temporary Modification 940015 / W.R. 00Z942362 - Monitoring of the Extraction Steam lines in the condenser.

4. Temporary Modification 940016 / W. R. 000Z942363 - Monitoring equipment for piping outside the condenser in the Turbine Bldg.

5. Fax from Mills Alloy Steel Company to G. Kulju, dated 6/8/94 - Material Questions - Copy attached.

6. Fax from Phillip R. Ratliff, Westinghouse, to G. Kulju, dated 6/9/94 - Response to Material Questions in item 5 - Copy attached.

7. Memo dated 6/9/94 from P. Temple and approved by K. Howard, which was provided to Purchasing (G. Kulju) providing additional guidance in the response to Material Questions in item 5 - Copy attached.

8. Memo to G. Kulju from P. Tracy, dated 6/29/94 - Documenting information provided to Westinghouse and Ort Tool on design changes to the fabrication drawings and/or clarification - Copy attached.

9. Memo to G. Kulju from P. Tracy, dated 7/1/94 - Clarification of Technical issues related to manufacturing of the pressure plates provided to Westinghouse and Ort Tool- Copy attached.

10. Fax to R. Wynn, Westinghouse and L. Weber, Ort Tool from P. Tracy, dated 7/5/94 - Clarification of info provided under item 9 - Copy attached.

11. Fax to R. Wynn, Westinghouse and L. Weber, Ort Tool from P. Tracy, dated 7/6/94 - Clarification of omissions on fabrication drawing - Copy attached

12. Memo to G. Kulju from P. Tracy, dated 7/7/94 - Documenting information provided to Westinghouse and Ort Tool on design changes to the fabrication drawings and/or clarification - Copy attached.

13. Memo to G. Kulju from P. Tracy, dated 7/8/94 - Documenting information provided to Westinghouse, Ort Tool and PX Engineering on design changes to the fabrication drawings and/or clarification - Copy attached.

14. Westinghouse letter, dated 7/13/94 to L. Fron - Pressure Plate Evaluation Report.

15. PX Engineering letter, dated 7/14/94 to Gary Kulju - LP Stage 8 Pressure Plates

SIGNATURES			
A) Prepared By R. L. Tassell		B) Checked By	
Sign R L Tassell	Date 8-1-94	Sign [signature]	Date 8/2/94

JUN-08 94 14:19 FROM:LOVEJOY IND. 216-786-9279 TO:7131358613?6 PAGE:002/002

Lovejoy Steel Company

DIVISIONS OF LOVEJOY INDUSTRIES, INC.

TELEFAX MESSAGE

Mills Alloy Steel Company

7300 Northfield Road • Cleveland, Ohio 44146

Telephone: 216/786-8200 • FAX: 216/786-9279 • WATTS: 800/328-8465

Page 1 of 2

Date 6/8/94

TO: Gary Kulpa

COMPANY: Detroit Edison

FAX NO.: 313-586-1306

REFERENCE: P.O. # NR-291692

FROM: John Waickman

FAX'D TO Westinghouse @ ~ 1715 on 6-8-94 407-281-5048

Gary,

The plates for your above referenced purchase order are being processed presently; all the heats have been poured.

However, one of the [5" thick] plates has pit holes in it. The mill wants to know if they can weld repair this plate.

Mills Alloy will insist on UT testing the plate afterwards if weld repairing is authorized. Documentation will be requested as well.

Drawing of this plate has been provided by the mill.

Please advise as soon as possible. Thank you.

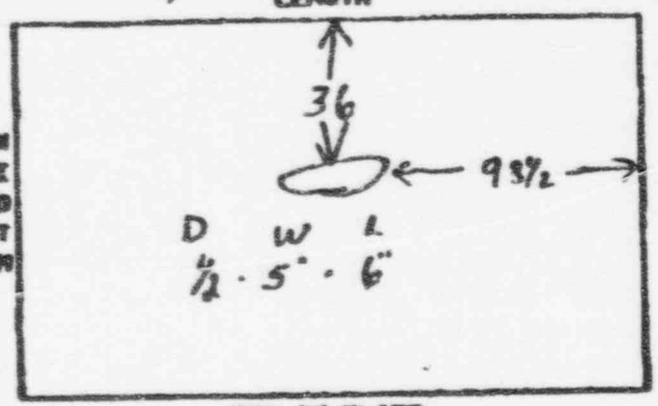
Regards,
John Waickman

JUN 08 '94 10:33AM P.2

MARATHON LeTOURNEAU CO. STEEL GROUP: PLATE INSPECTION RECORD DATE: 6-7-94

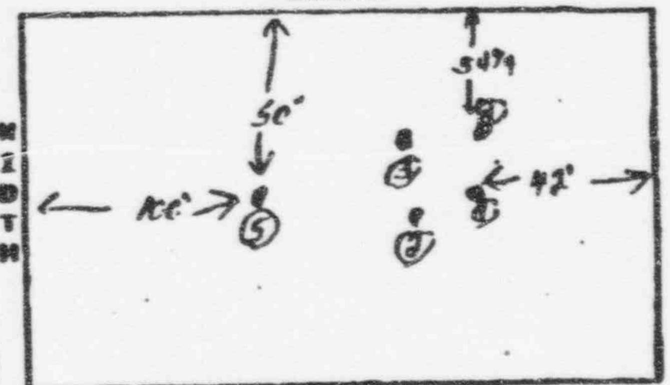
4E711 CUSTOMER 6654	SIZE	HEAT #	SLAB #	GRADE	INSP. BY	WELD BY
MILLS Alloy 1790562	5" X 96 X 119½	D32-WSL	ES46-4258	SA387-22 CL.2	CSN	

TOP OF PLATE



SURFACE DEFECT DESCRIPTION

BOTTOM OF PLATE



SURFACE DEFECT DESCRIPTION

D - W - L
#1 - ¼ - 6 - 8½
#2 - ¼ - 1" - 1½
#3 - ¼ - ¾ - 1
#4 - ¼ - ¾ - 2½
#5 - ½ - 6 - 2½

JUN-08 94 14:18 FROM: QUALITY DIV. 216-786-3279 TO: 7131335861386 PAGE: 01/02

Form FIP-CM1-12 Att 6 Pg 1/1 050793

Facsimile Cover Sheet

To: Mr. Gary Kulju
Company: Detroit Edison Company
Phone: 313-586-4098
Fax: 313-586-1306

From: Phillip R. Ratliff
Company: Westinghouse Electric Corporation
Phone: 407-281-5640
Fax: 407-281-5047

Date: 06/09/94
Pages including this cover page: 3

Comments: The following transmission is in response to your request for assistance and approval in the disposition of the defects in the pressure plate material. Please call if anything in this response is unclear.

Westinghouse
Electric Corporation

[illegible]

Dear Mr. Kalju:

This letter is to convey the recommendations and preliminary approval for repair of the defective pressure plate material as described in our telephone conversation of 6/8/94 and the fax from the supplier. The defect(s) as described are only known to be surface defects at this time. Assuming that further volumetric NDE does not reveal interior defects, Westinghouse agrees to and approves of the weld repair, stress relief and NDE process as a means to repair this plate material.

The weld repair of the baffle plate is approved and acceptable provided that proper repair procedures are followed. As part of a proper repair procedure and prior to initiation of said repair, we require that the vender conduct ultrasonic inspection around the defect (approximately five inches around the periphery of each defect) to determine volumetric soundness. If volumetric indications are present, advise Westinghouse immediately before commencing repairs. If volumetric soundness is determined, proceed with processing required repair procedure information to Westinghouse.

For final approval of this repair to be given by Westinghouse, it is required that the vender submit their welding procedures, i.e. WPS, PQR, qualified in accordance with ASME Section IX for review. In addition to this information, we require that the vender provide a detailed outline of the cavity evacuation (blending), MT inspection of cavity, welding, post weld heat treatment (PWHT) and final contact UT inspection of finished weld repair. Once this information is received, Westinghouse will provide final approval of the repair if the documentation is found to be acceptable. If the information is found to be deficient in anyway, specific areas for improvement will be provided to DECO.

I hope that you will find this response to be acceptable to both DECO and the material vender. The Westinghouse approach is intended to assure that proper repair procedures are identified and followed to yield an acceptable material for use in construction of the pressure plate.

Please have the vender supply all required documentation to :

Phillip Ratliff
Manager, Turbine Service Programs
Westinghouse Electric Corporation
MC-101
4400 Alafaya Trail
Orlando, Florida 32826-2399

Alternately, the required material may be Faxed to 407-281-5047.

Sincerely yours,

Phillip R. Ratliff

Phillip R. Ratliff

cc. Tracy Nelson, Westinghouse MC-303
Jim Moore, Westinghouse, Detroit

FERMI 2
JUNE 9, 1994

SUBJECT: Detroit Edison Purchase Order NR - 291692,
PLATE WELD REPAIR TECHNICAL REQUIREMENTS

References: 1. June 9, 1994 Westinghouse (P. Rariff) fax to Detroit Edison (G. Kuju)
2. June 8, 1994 Mills Alloy Steel Co. fax to Detroit Edison (G. Kuju)

Written By: P. I. Temple, Plant Engineering *P. I. Temple*

Approved By: K. E. Howard, Supervisor, Plant Engineering *K. E. Howard*

Weld repair of the one A387 - Grade 22, Class 2 plate described in the June 8, 1994 fax from Mills Alloy Steel Company may be undertaken pending acceptance of the following criteria and the completion of the intermediate steps. These are explained below. The end use of these plates requires that they be drilled with several thousand holes and through thickness integrity is very important. The repair of this plate is contingent upon assurance that the plate has this integrity.

A. Prior to beginning repairs please complete the following:

1. Repairs may be completed using the guidance of ASTM Specification A20 and the following requirements. Please submit the welding procedures, the welding procedure qualification reports, and welder qualifications for review and approval.

2. Please submit the nondestructive examination procedures and certifications of the examiners who will perform the examinations. These shall meet the requirements of ASNT standard SNT-TC-1A.

3. The subject plate shall be examined in accordance with ASTM specification A578. The scanning pattern and examination results using Level 1 acceptance criteria shall be reported to Detroit Edison for approval prior to initiating weld repairs.

4. The June 8 discontinuity description is interpreted to be the surface dimensions and does not reflect the actual depth of each. Please excavate each cavity and prepare them for welding. The final dimensions of each cavity and its location on the plate (marked so that it can be located later) is to also be furnished for approval. Each cavity is to be smooth, without sharp corners, permitting full fusion in the cavities.

5. Magnetic particle (MT) nondestructive examination of each cavity shall be performed to ensure that the remaining material is sound. A six (6) inch diameter area beyond the edge of each cavity shall be fully scanned using straight beam ultrasonic examination techniques to ensure that no other undetected discontinuities exist. Acceptance criteria for the examinations is Level 1 of ASTM specification A578.

Repairs may be initiated following completion of these items and approval from Detroit Edison.

B. Weld repair requirements:

1. Welding is to be completed using the welding procedures and welders approved by Detroit Edison. Following completion of welding the plate is to be either stress relieved or normalized and tempered to the original material specification requirements. If the latter is performed the welds must be qualified for these heat treatments.

2. The final weld surfaces shall be prepared for MT and UT examination. The welds and one (1) inch around each shall be fully examined, including a full scan of the area by the UT method. The weld and base material shall be sound, without slag, porosity, cracks, or nonfusion, and blended uniformly into the plate surface.

– End –

NUCLEAR GENERATION MEMORANDUM

Date: June 29, 1994

To: Gary Kulju

From: Paul R. Tracy

Subject: LP Turbines - 7th & 8th Stage Pressure Plates

Reference: GEC Drawings R-LA-94-04766 Shts 1, 2, & 3. A number of technical issues have arisen relative to the fabrication of the subject components. Listed below are the issues and corresponding responses. In addition, all unresolved issues are also listed. As per our discussion, this memorandum will be faxed directly to our suppliers, Ort Tool and Westinghouse.

I. Resolved Issues

A. Threaded fasteners.

1. The referenced drawings specify British standard threads and fasteners.
2. The use of unified threads, [UNC or UNF] as appropriate, is acceptable. All bolting shall be [ASTM A193 Grade B6]. The supplier will be required to have samples of all bolting used, to be provided to a DECO Quality Assurance Representative on request.
3. All bolting used to attach the half rings to the pressure plate shall be staked after final assembly.
4. All other bolting used to attached key, supports, etc., shall <u>not</u> be staked.

B. Surface finishes.

1. The only specified surface finish, N8 [32 RMS] applies only to the key fit areas. This finish is to be maintained.
2. All other machined surfaces should be finished to "normal" machined finish quality, approximately [125 RMS.]

Revised later, see index item 10, page 1
PT 8-1-94

C. Stress relief of pressure plates.
   1. The question was raised concerning the need to stress relieve the plates after cutting to preclude the possibility of cracking during machining operations.
   2. Based upon discussions with DECO Metallurgist, John E. Schaefer, on 6-29-93, our position is:
      a. Plate material, ASTM A387-87 Grade 22 Class 2, is a low carbon material, <0.15%, and, hence, is not prone to excessive hardening.
      b. The DECO recommendation is to not stress relieve the plates, with the following conditions:
         1) Recommended cutting process is plasma arc; cutting should be done to allow the machining removal of approximately 1/4" of material after the cut. This should remove any significant effects of the heat affected zone.
         2) Flame cutting is not recommended due to the potential of additional distortion. If the supplier plans on using this process, additional discussions and approval are required.

D. Overall surface machining.
   1. DECO does not require that the entire perforated surface area be machined. Only O.D. and I.D. areas are required, with appropriate surface cleaning and de-scaling.
   2. Should the supplier elect to not machine the entire surface, than steps shall be taken to assure that no significant discontinuities exist when the upper and lower halves are fitted together. Specifically, any discontinuities, or steps, should be dressed out at a rate of approximately
      1" per 1/16" step.
   3. After all machining is complete, all surfaces must be thoroughly cleaned and completely free of all oil and grease. All surfaces should be wiped down with alcohol soaked line-free rags. This should be done during each phase of the assembly process.

II. Unresolved Issues
   A. Minimum allowable plate thickness.
   B. NDE examination of plates.

Page 3

cc: L.Fron
J.Drolz
F.Wszelaki
P.Hudson
N.Kepler
J.Lotter
R.Szkotnicki
D.DiAntonio
R.Wynn - Westinghouse
Fax (407) 281-3171
-2330

L.Weber - Ort Tool
D.Pickard - Ort Tool
Fax (313) 848-4308

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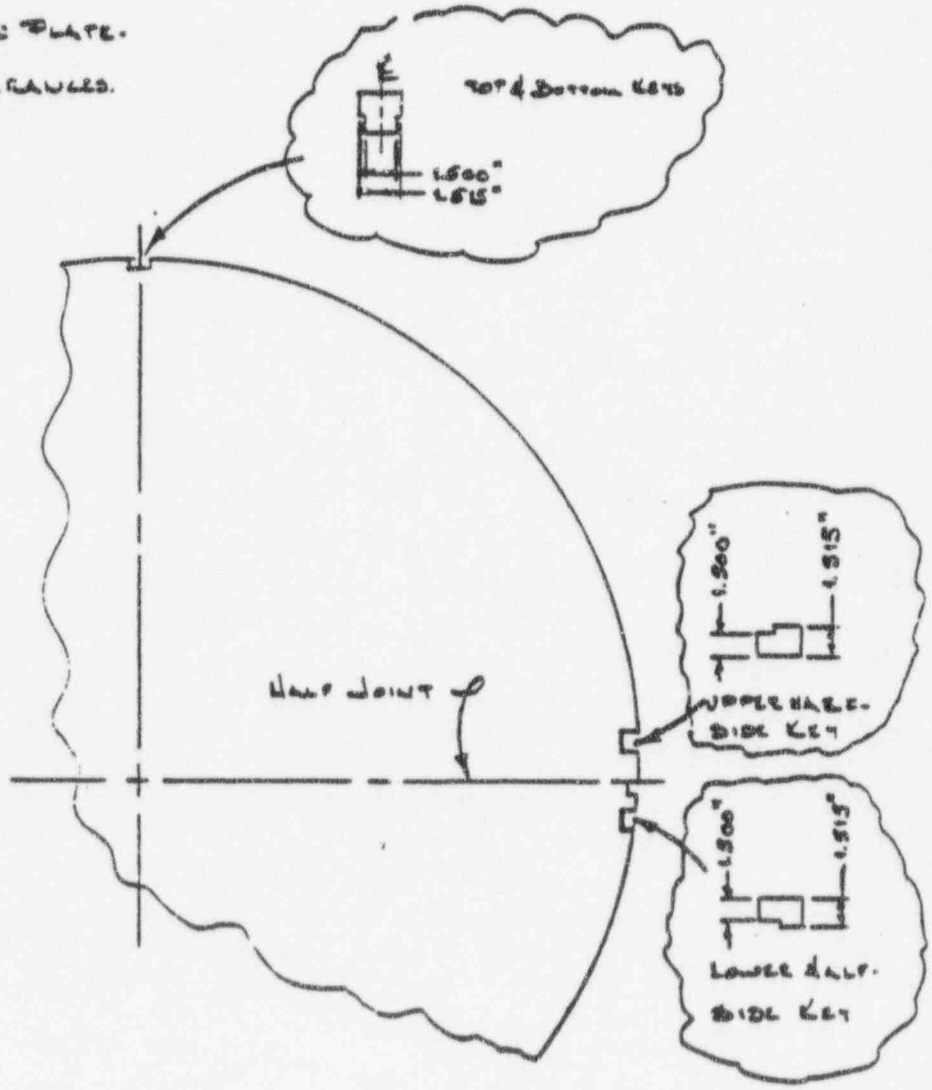
PRESSURE PLATE.
KEY CLEARANCES.



Paul R. Gray
7-8-94

NUCLEAR GENERATION MEMORANDUM

Date: July 1, 1994

To: Gary Kulju

From: Paul Tracy

Subject: <u>LP Turbines - Test 7th. and 8th. Stage Pressure Plates.</u>

Reference: GEC Drawing R-LA-94-04766 S471.2.83.

The purpose of this memorandum is to continue to clarify Technical issues related to their manufacture.

I. **Resolved Issues**

A. Stress relief and cutting of pressure plates.
   1. This memorandum changes direction provided in the 6-29-94 memo, item IC.
   2. Flame cutting is acceptable, but must be preceded by pre-heating to 400° F.
   3. Re-affirm that stress relief is not required, and could potentially cause plate distortion. If the Supplier chooses to stress relief plates after cutting, the procedure must be provided to DECO for approval.

B. NDE examination of plate prior to, or during, manufacture will not be required.

C. 8th. Stage pressure plate details - Sheet 2.

   1. Lifting bolt holes around circumference:
      a. All holes are oriented radially from center line.
      b. The drawing <u>incorrectly</u> specifies six (6) holes on the top half and four (4) holes on the bottom half. The <u>correct</u> configuration is four (4) holes on the top half and two (2) holes on the bottom half as dimensioned on Sheet 2.
   2. On the cross-section view, the O.D. chamfer on the plate side is 1 1/4" x 45°. The chamfer on the half ring side is 1/8" x 45°.

   NOTE: The above details are based upon the existing 8th. Stage Diaphragms.

D. 7th. Stage pressure plate details - Sheet 1.

1. Lifting bolt holes around circumference.
   Same comments as for 8th. stage; refer to Sheet 1 for correct dimensions.
2. On the cross-section view, the O.D. chamfer on both the plate and half ring sides is 1/8" x 45°.
   NOTE: The above details are based upon the existing 7th. Stage Diaphragms.

E. Minimum plate thickness.
After conferring with both GEC and Westinghouse, the following conclusions have been reached:

1. 5" plate thickness is preferred to minimize in-service deflection.
2. No true minimum thickness value has been established to date.
3. A thickness of 4.75" would be acceptable, but DECO must be informed prior to machining below the 5" value. In addition, the supplier will be responsible for maintaining the overall plate-half ring assembly dimensions.

II. Unresolved Issues.

None

PRT/jmr

cc: L. Fron
J. Drolz
J. Andrew
N. Kepler
J. Lotter
R. Szkotnicki
D. DiAntonio
R. Wynn - Westinghouse
Fax (407) 281-3171 or
Fax (407) 281-2330
L. Weber - Ott Tool
D. Pickard - Ott Tool
Fax (313) 848-4308

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Detroit Edison

Enrico Fermi II

POWER GENERATION - NUCLEAR TURBINE REPAIR GROUP

FACSIMILE COVER SHEET

PAGES INCL. COVER: 1

TO: R. WUNN & L. WEBER, D. PICKARD

COMPANY: WESTINGHOUSE & MET TOOL

PHONE: FAX (407) 281-5171 & FAX (313) 848-4308

FROM: PAUL TRACH

PHONE #: (313) 586-1659

FAX #: (313) 586-1671

COMMENTS: RE: LIFTING BOLT HOLES - SEE MEMO TO G. KULLA FROM P. TRACH DATED JUNE 1, 1994. THE HOLES ARE TO BE DRILLED 4.75" DEEP AND TAPPED 4" DEEP FOR 3"-4 UNC-2B THREADS. THE PLANT IS PURCHASING EYE-BOLTS TO MATCH THESE THREADS.

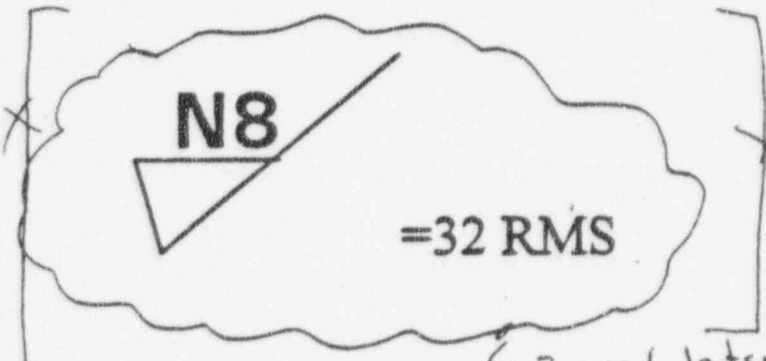
Paul Trach
7-5-94

c.c. G. Kulla

TOTAL P.01

GEC TOLERANCING STANDARDS

"Untoleranced decimal dimensions are to be within the following limits (tolerances must not be cumulative!): Bore diameters, slot & recess depths and widths: size to +.010". Shaft diameters and spigot heights: size to -.010". Centre distances and centers to faces size +/- .005""



Revised later, see index item 10, page 1

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NUCLEAR GENERATION MEMORANDUM

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 1
To J. Lotter +	From Paul Tracy
#6 Kalin	Co.
Dept. Shared Copy in Mail	Phone # 6-1659
Fax # 6-1306	Fax # 6-1671

Date: July 7, 1994

To: Gary Kalju

From: Paul Tracy

Subject: <u>LP Turbines - 7th. and 8th. Stage Pressure Plates.</u>

Reference: GBC Drawing R-LA-94-04766 Sheets 1, 2, and 3.

The following items require additional clarification.

I. Referring to Sheets 1 and 2, there is a reference to nine (9) Locating Pegs per half section, part number R265Z0377.3. These items are to be supplied with the Pressure Plates, with the following detail:

A. Material Clarification: UNS Designation R91151 (410 S.S.)
B. Use 3/4" round stock and thread as required.
C. Install pegs and initial machining length such that they protrude 0.150" above surface. The final, overall thickness dimension of Pressure Plate, Half Ring, and Locating Peg will be provided, based upon actual casing groove width.

II. As part of the fabricating contract, each Supplier, Westinghouse, Ort Tool, and FX Engineering is required to assemble the Half Rings to the Pressure Plates and supply all necessary fasteners. It has not previously been clearly stated that this work will include:

A. Finish machining of Half Ring surface to establish the overall assembly thickness.
B. Machining of key ways and installing key in the Plate-Half Ring Assembly.
C. Installing and finish machining of Locating Pegs, referred to in Item I above.

PRT/jmr

cc: L. Pron
J. Drolz
F. Wszelaki
P. Hudson
N. Kepler
J. Lotter
R. Szkotnicki
D. DiAntonio
R. Wynn - Westinghouse
Fax (407) 281-3171 or -2330
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D. Pickard - Ort Tool
Fax (313) 848-4308

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NUCLEAR GENERATION MEMORANDUM

Date: July 8, 1994

To: Gary Kulku

From: Paul Tracy

Subject: LP Turbine - 7th and 8th Stage Pressure Plates

Reference: GEC Drawings R-LA-94-04766, Sheets 1, 2 and 3

The following items clarify points addressed in previous memorandums:

I. Locating peg length and location

A. See memo dated July 7, 1994; Refer to sheets 1 & 2.

B. Based upon actual casing groove widths, tabulated below by casing, are the required, overall, pressure plate, half ring, and locating peg dimensions.

LP2	Required Dimensions
8th stage front (stm); upper and lower	9.675"
7th stage front (stm); upper and lower	8.249"
7th stage rear (gen); upper and lower	8.003"
8th stage rear (gen); upper and lower	9.006"
LP1	
8th stage front (stm); upper and lower	9.248"
7th stage front (stm); upper and lower	8.264"
7th stage rear (gen); upper and lower	7.997"
8th stage rear (gen); upper and lower	9.005"
LP3	
8th stage front (stm); upper and lower	9.249"
7th stage front (stm); upper and lower	8.244"
7th stage rear (gen); upper and lower	7.997"
8th stage rear (gen); upper and lower	9.012"

C. Location of locating pegs; due to localized wear in existing casings, will be revised as follows:

1. 7th stage (Sheet 1)

a. Peg adjacent to half joint (Drawing Zone K-10): change 2.5" to 4.5".

July 7, 1994
Gary Kulju
LP Turbines - 7th & 8th Stage Pressure Plates
Page 2

b. Peg adjacent to vertical centerline (Drawing Zone B-2): change from 1° to left of center to 1° to right of center.

c. Second peg above half joint (Drawing Zone F-9): change from 27.5° to 28.5°. The remaining two pegs shall maintain the spacing of 22.5° from the second peg.

2. 8th stage (Sheet 2)

a. Peg adjacent to half joint (Drawing Zone K-11): change 5° to 7°.

b. Peg adjacent to vertical centerline (Drawing Zone B-3): change from 1.125° to left of center to 3.125° to left of center

c. Second peg above half joint (Drawing Zone G-11): change from 1° to right of 22.5° mark to 3° to right.

d. Third peg above half joint (Drawing Zone D-9): change from 1° to right of 22.5° mark (total of 45°) to 3° to right.

e. Fourth peg above half joint (Drawing Zone B-6): change from 1° to right of 22.5° mark (total of 67.5°) to 2° to left.

II. Key Way Dimensions

A. See fax from Paul Tracy, dated July 6, 1994; refer to Sheet 3.

B. All keys are dimensioned 0.015" oversized to accommodate fitting into the casings. Therefore, it is necessary to remove this excess on half of the key to fit it into the pressure plate. The keys should be machined using the following guidelines:

1. The top and bottom keys should cut back equally on both sides so that the key is centered.

2. The side keys should be machined on one side only, such that the excess material is on the side away from the half joint (see attached sketch for clarification).

PRT/klb

cc: D. DiAntonio
J. Drolz
L. Fron
P. Hudson
N. Kapler
J. Lotter
A. Rcac

D. Pickard - Ort Tool (Fax 313-848-?308)
G. Scruton - PX Engineering (Fax 617-749-9410)
R. Sakotnicki
L. Weber - Ort Tool
F. Wszelaki
R. Wynn - Westinghouse (Fax 407-281-3171 / -2330)

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px engineering company, inc.

296 Lincoln Street, Route 3A
Hingham, Massachusetts 02043
Telephone (617) 749-9111
Fax (617) 749-9410

Letter No. 94071401. Page 1 of 1

Thursday, July 14, 1994

Detroit Edison Company
Fermi Nuclear Generating Station
6400 North Dixie Highway
Newport, MI 48166

Attention: Mr. Gary Kulju,

Reference: LP Stage 6 Pressure Plates

1. In reference to your FAX of 7/11/94, Memo dated 7/8/94 from Paul Tracy:

   1.1 From paragraph 1.A. If it is applicable to our scope of work, please send us a copy of "memo dated July 7, 1994".

   1.2 From paragraph 1.B please clarify the "6th stage" pressure plates you require, i.e. steam or generator end, LP1, LP2....

   1.3 From paragraph II.A. If it is applicable to our scope of work, please send us a copy of fax dated "July 6, 1994".

2. In reference to your FAX of 7/14 /94, Memo dated 7/14/94 from Paul Tracy:

   2.1 Attached is our welding procedure #W-166-SR, submitted for your approval.

   2.2 The length of the bars in our possession are not long enough to permit the lap joining of alternative No. 2.

Very truly yours,

px engineering company, inc.

George S. Scruton
Vice - President of Engineering

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Jul 14.94 16:23 No.003 P.03

HINGHAM SHIPYARD TEL:617-749-9410

PX Engineering Company
295 Lincoln Street Hingham, MA 02043

WELDING PROCEDURE SPECIFICATION (WPS)

WPS No.: W-166-SR Date: 7/08/94 Revision No.: 0
Supporting PQRs: W-166

BASE METAL (QW-403, QW-405)	JOINT (QW-402)
P No.: 5A to P No.: 5A	Joint design Groove/Fillet(see pg 2)
Thickness range. 0.1875" to 8.0000"	Backing..... With or without backing
Position(s). All positions	Backing Matl Weld metal
Progression. Vertical Up	Fillet Weld Size All (QW-451.4)
notes	notes

PREHEAT (QW-406)	POSTWELD HEAT TREATMENT (QW-407)
Minimum Temperature. 300 Degrees F.	Temperature range 1300 °F ± 25 °F
Interpass Temp. Max. 600 Degrees F.	Time range 1.00 hr/in. 0.25 hr min.
Preheat Maintenance. Continuous	notes

	All pass(es)			None		
Process / type	SMAW / MANUAL			None		
Process thickness limit.	8.0000" Max.					
GAS (QW-408)						
Shielding Gas / CFH......	N/A / -			None / -		
Trailing Gas / CFH......	N/A / -			None / -		
Backing Gas / CFH.......	N/A / -			N/A / -		
FILLER METAL (QW-404)				None		
AWS classification......	E9018-B3L			SFA#: None F#: -		
SFA Spec. No. & F No....	SFA#: 5.5 F#: 4			None		
A No. or Chem. Comp.....	4			None		
Filler metal trade name.	N/R			None / -		
SAW flux trade name/type	N/A / -			-	-	-
Elec./Wire size (in) ...	1/8	5/32	3/16			
ELECTRICAL (QW-409)				-	-	-
Welding amperage range..	90-160	130-220	200-300	-	-	-
Welding voltage range...	N/R	N/R	N/R	-	-	-
Travel speed (ipm)......	Var.	Var.	Var.	None		
Max. Heat Input (J/in)..	None			N/A / -		
Tungsten Type/Size......	N/A / -			N/A		
Current & Polarity......	DCEN (straight)					
TECHNIQUE (QW-410)				N/A		
String / weave bead.....	String Bead			None		
Orifice / gas cup.......	N/A			None		
Contact tube to work....	N/A			None		
Oscillation.............	N/A			N/A		
Mult./Single electrode..	Single Electrode			None		
Other Technique Notes...						

Multiple or Single Pass (per side).... Single Pass
Multiple or Single Pass (per side).... Single Pass
(n1) No peening done with this procedure.
(n2) No pass greater than 1/2" allowed.
(n3)
(n4) Preheat to 400F if "T" >1/2" and Cr >6% OR base matl min. tensile > 60ksi
(n5)
(n6)
(n7)

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WELDING PROCEDURE SPECIFICATION (WPS)

WPS No.: W-166-SE Date: 7/08/94 Revision No.: 0

JOINT (QW-402)

Single-V groove
Backing : no backing
Root Opening: 3/16" max.
Groove Angle: 50 degree min.
Root Face : 1/8" max.

Single-Bevel groove
Backing : no backing
Root Opening: 3/16" max.
Groove Angle: 45 degree min.
Root Face : 1/8" max.

Single-V groove
Backing : gouged & back welded
Root Opening: 1/4" max.
Groove Angle: 50 degree min.
Root Face : 3/16" max.

Double-Bevel groove
Backing : gouged & back welded
Root Opening: 1/4" max.
Groove Angle: 45 degree min.
Root Face : 3/16" max.

Double-V groove
Backing : gouged & back welded
Root Opening: 1/4" max.
Groove Angle: 45 degree min.
Root Face : 3/16" max.

Single/Double Fillet
Backing :
Root Opening: 3/16" max.
Weld Size : Required fillet plus root opening

Square groove
Backing : T-joint
Root Opening: 1/32" max.

Square groove
Backing : no backing
Root Opening: 3/32" max.

WELD JOINT DESCRIPTIONS SHOWN ARE NOT INCLUSIVE OF ALL OF THOSE FOUND ON A JOB SITE. WELD JOINT DESIGN REFERENCE IN AN ENGINEERING SPECIFICATION OR DESIGN DRAWING SHALL TAKE PRECEDENCE OVER WELD JOINTS SHOWN IN THIS WPS.

Initial cleaning With wire brush clean 1" both sides of weld joint.
Method of back gouging Grind until all defects are removed.

(a) When air-arc is used, remove all slag and carbon accumulation by grinding, chipping, and wire brushing.

(b) Minimum preheat must be maintained during thermal cutting, tacking, and welding operations.

(c) No retainer will be used.

(d) Welds shall be cleaned between each pass. When completed, remove all slag and projections.

(e) Work must be free of oxides, dirt, oil, and moisture.

We certify that the statements in this record are correct and in accordance with the requirements of Sections IX and VIII of the ASME Code.

Prepared By: J. Avellini (7/8/94) QC Manager

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LIST OF MATERIALS

NOTE: For all this material refer to the following drawings, including the changes specified in this EDP, for specific details:

R/LA/94/04766 (T1-3687) - Pressure Plates & Keys
R200(A1)5462 (T1-3688) - Special Socket Headed Screws
R265(A3)3077 (T1-3689) - Locating Pegs

ITEM	QTY	DESCRIPTION	PURCHASE REQ	QA LEVEL
1	12	7th Stage Pressure Plate halves		Non Q
2	12	8th Stage Pressure Plate halves		Non Q
3	12	7th Stage Pressure Plate Half Rings		Non Q
4	12	8th Stage Pressure Plate Half Rings [consisting of 2 quarter rings each due to fabrication limitations]		Non Q
5	48	7th Stage Side Keys [supplied 0.015" oversize]		Non Q
6	48	8th Stage Side Keys [supplied 0.015" oversize]		Non Q
7	24	7th & 8th Stage Top & Bottom Keys [supplied 0.015" oversize]		Non Q
8	336	Special Socket Headed Screws for installation of the Keys		Non Q
9	216	Locating Pegs		Non Q
10	120	7th Stage 7/8" Socket Headed Screws for installation of Half Rings to Press. Plates		Non Q
11	108	8th Stage 1" Socket Headed Screws for installation of Half Rings to Press. Plates		Non Q

All material purchased through the Turbine Group.

SPRS IMPACT

Add a note the following stock code items that all the LP's 7th & 8th stage blades and diaphragms have been replaced with pressure plates per EDP 26726:

450-3773, 450-3774, 482-9881, 482-9882, 482-9890 & 482-9891

SIGNATURES	
A) Prepared By R. L. Tassell Sign R L Tassell Date 8-1-94	B) Checked By Sign [signature] Date 8/2/94

EDP CONTINUATION SHEET

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INSTALLATION INSTRUCTIONS

1. Verify that all the 7th & 8th stage disc serrations are protected with root blocks. During the work performed on the rotors by Westinghouse, the blades were to be cut at the bottom of the airfoils and the blade root sections used as a root blocks. Where necessary, new root blocks fabricated based on using the blade serrations as a pattern, may also have been installed.

2. This modification requires pressure plates to be fabricated along with new half rings, keys and locating pegs. The intent is to have the pressure plate halves shipped assembled with their half rings, keys and locating pegs.

3. Check that the assembly dimensions are per the fabrication drawings, including the modifications identified in this EDP, to insure that the proper clearances will be achieved during and after installation. See Index Item 10 for modifications/clarifications to the fabrication drawings.

4. Install the pressure plates into their respective diaphragm groove in the LP casings with clearances indicated in EDP Index Item 10 and fabrication drawings, Edison file numbers T1-3687, 3688 & 3689. Adjust keys and pegs as necessary to achieve the proper fit-up.

Note: Any deviations in the pressure plates, half rings, keys or locating pegs and/or installation clearances from the fabrication drawings and instructions shall be reviewed and approved by the Turbine Group and documented via a ECR or ABN to the EDP.

SIGNATURES	
A) Prepared By R. L. Tassell Sig [signature] Date 8-2-94	B) Checked By Sign [signature] Date 8/2/94

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POST MODIFICATION TESTING (PMT) / DESIGN CHANGE ACCEPTANCE TESTING (DCAT)

NOTE: This testing will be performed by the Performance Evaluation Group in conjunction with the Turbine Group. Plant Engineering will be a consultant only.

1. During power ascension testing, monitoring the following data will establish a basis for the performance of the pressure plates at various power levels. There is no acceptance criteria required for this data during ascension.

A. Feedwater heaters 1, 2, 3 & 4

1. Shell Pressure

Heaters 1 North, 1 Center, 1 South, 2 North, 2 Center and 2 South shell pressure measurement may be unreliable. EDP-26841 written to modify the reference leg configuration, if implemented during RF-04, will allow for this measurement.

Heaters 3 and 4 shell pressure measurements are available.

2. Extraction Steam Temperatures

Heaters 1, 2, 3 and 4

B. Extraction Steam Pressure

Heaters 3 and 4

C. LP 1, 2 and 3 inlet steam temperatures, LP 2 inlet pressure

Inlet temperatures for all three and only inlet pressure for LP 2

The only acceptance criteria during power ascension, related to this modification, is that the parameters being monitored under Temp. Mod.'s 940015 (Strain and acceleration data of 3N, 3S & 4N/S extraction steam lines within the condenser) & 940016 (Strain, acceleration or pressure data on steam supply to H.P. & L.P. turbines and feedwater heaters 3 & 4) remain within acceptable limits. In addition, the feedwater temperature limits, as specified in enclosure A of General Operating Procedure 22.000.03, shall be maintained. These items will be addressed under the main start-up testing program. ~~and the power uprate power ascension testing still required to complete the 105% power uprate test program.~~ RT 8-2-94

SIGNATURES	
A) Prepared By R. L. Tassell	B) Checked By
Sign R L Tassell Date 8-2-94	Sign [signature] Date 8/2/94

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POST MODIFICATION TESTING (PMT) / DESIGN CHANGE ACCEPTANCE TESTING (DCAT)

2. At 100% after uprate power level, monitor the following, to evaluate and reconcile against the new heat balance, reference Edison file T1-3690 , to determine if any operational limitation are required. The evaluation and reconciliation will be part of the Start-up Testing Program and not a restraint to closing out this EDP.

   a. Feedwater Heater #1

      Drains leaving temperatures

   b. LP Turbine Exhaust

      Condenser Heat Load - Using Process Computer Point C017

   c. Condenser Hotwell

      Backpressure and hotwell temperature

   d. Main Generator Output

   e. Gross Heatrate

      Unit Heatrate - using Process Computer Point C099

   f. Feedwater Heater #2 shell side

      Cascade drain temperatures from heaters 3 North and 3 South to heaters 2 North, 2 Center, and 2 South.

The preferred method of parameter measurement is the BOP log data of the process computer, but control room measurements may serve as a second check of the process computer points, or as the only source of data if the process computer crashes or a specific computer point experiences a malfunction.

SIGNATURES	
A) Prepared By R. L. Tassell Sign *R L Tassell* Date 8-1-94	B) Checked By Sign *[signature]* Date 8/2/94

ARMS – INFORMATION SERVICES
DTC: TCEDP DSN: 26726.010 REV: 0
DATE: 8-3-94 RECIPIENT NO: 362

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Rev 0
Page 1 of 4

AFFECTED DOCUMENT DSN: R LA 94 04766 (T1-3687)

I. APPLICABLE TO ALL THREE SHEETS

Add the following notes to drawings:

1. Where specify, the use of unified threads, UNC or UNF as appropriate, is acceptable. All lifting eyes holes are to be UNC.

2. All bolting material shall be ASTM A193 Grade B6.

3. All bolting used to attach the half rings to the pressure plate shall be staked after final assembly.

4. All other bolting used to attached keys, supports, etc., shall not be staked.

5. Overall surface machining

- Surface finish, N8 (125 RMS) applies only to the key fit areas, this shall be maintained. All other machined surfaces should be finished to "normal" machined finish quality, approximately 250 RMS.
- The entire perforated surface area is not required to machined. Only O.D. and I.D. areas are required, with appropriate surface cleaning and de-scaling.
- If the entire surface is not machined, then steps shall be taken to assure that no significant discontinuities exist when the upper and lower halves are fitted together. Specifically, any discontinuities, or steps, should be dressed out at a rate of approximately 1" per 1/16" step.
- After all machining is complete, all surfaces must be thoroughly cleaned and completely free of all oil and grease. All surfaces should be wiped down with alcohol soaked lint-free rags. This should be done during each phase of the assembly process.

6. Tolerances

- Untoleranced decimal dimensions are to be within the following limits (tolerances must not be cumulative!)
- Bore diameters, slot & recess depths and widths: Plus 0.010"
- Shaft diameters and spigot heights: Minus 0.010"
- Center distances and centers to faces size: Plus/Minus 0.005"
- Pressure plate thickness: Minimum is 4.75" with Edison approval

7. Flame cutting of the plates is acceptable, but must be preceded by pre-heating to 400°F, stress relieving is not to be performed without prior DECO approval.

SIGNATURES	
A) Prepared By R. L. Tassell Sign R Tassell Date 8-1-94	B) Checked By Sign [signature] Date 8/2/94

Form FIP-CM1-12 Att 6 Pg 1/1 050793

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AFFECTED DOCUMENT DSN: R LA 94 04766 (T1-3687)

II. SHEET 1

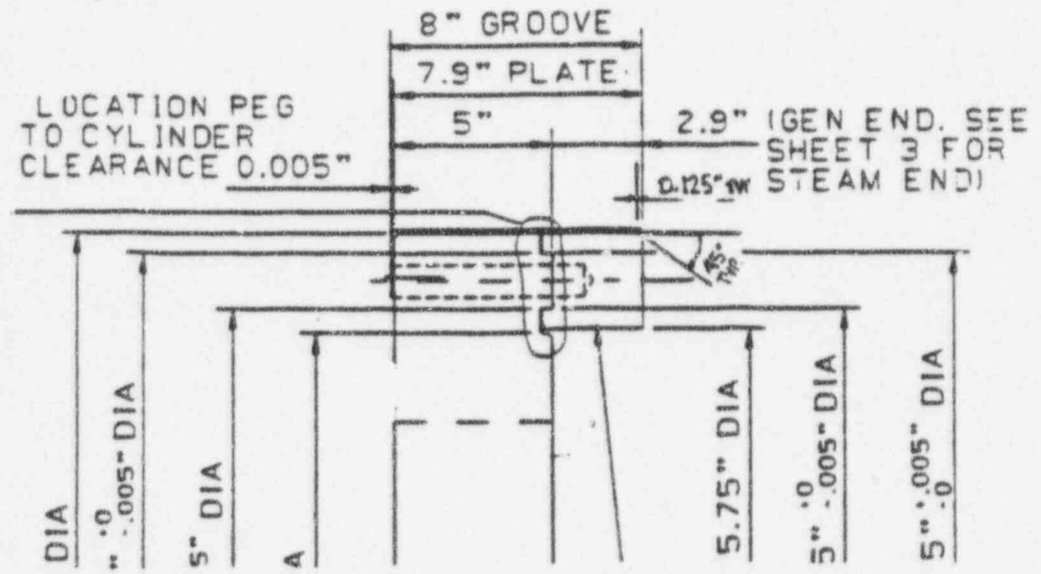
A. Lifting bolt holes around circumference

1. All holes are oriented radially from the center line.

2. The drawing **incorrectly** specifies six (6) lifting bolt holes on the top half and four (4) holes on the bottom half. The **correct configuration** is four (4) holes on the top half and two (2) holes on the bottom half as dimensioned.

3. The holes are to be drilled 4.75" deep and tapped 4" deep for a 2" x 8 UNC - ANSI threads

B. Chamfer Detail



C. Assembly dimensions, based on actual casing groove widths, required for overall pressure plate, half ring, and locating ~~pin~~ peg RPT 6-1-94 dimension.

7th Stage LP's 1, 2 & 3

LP		Required Dimension
1	Front (stm); upper and lower	8.254"
1	Rear (gen); upper and lower	7.997"
2	Front (stm); upper and lower	8.249"
2	Rear (gen); upper and lower	8.003"
3	Front (stm); upper and lower	8.244"
3	Rear (gen); upper and lower	7.997"

III. SHEET 2

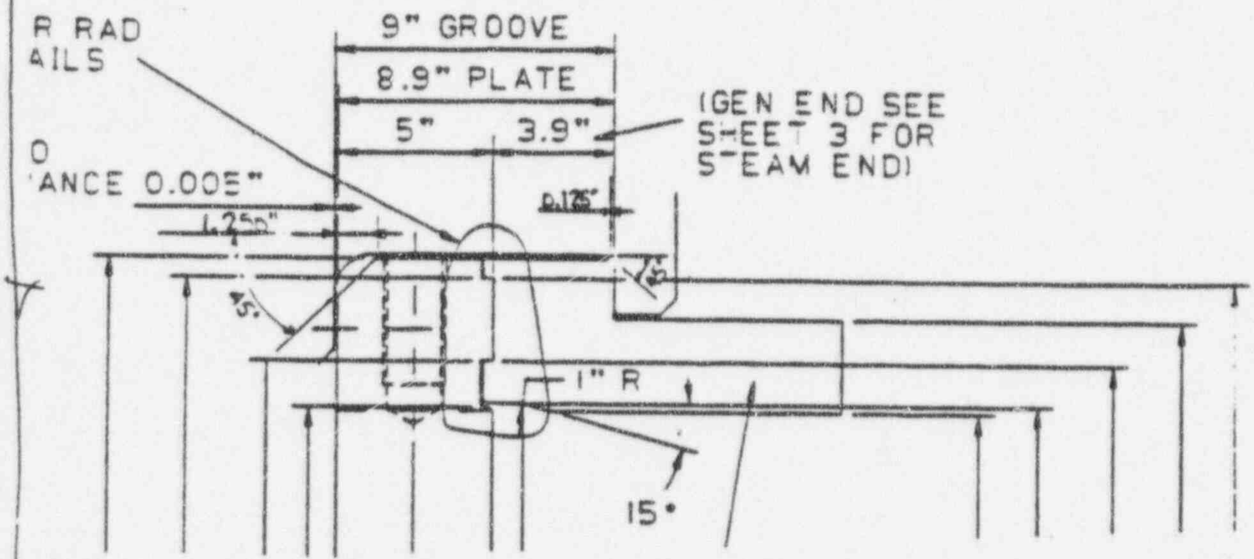
A. Lifting bolt holes around circumference

1. All holes are oriented radially from the center line.

2. The drawing **incorrectly** specifies six (6) lifting bolt holes on the top half and four (4) holes on the bottom half. The **correct configuration** is four (4) holes on the top half and two (2) holes on the bottom half as dimensioned.

3. The holes are to be drilled 4.75" deep and tapped 4" deep for a 2" x 8 UNC - ANSI threads

B. Chamfer Detail



C. Assembly dimensions, based on actual casing groove widths, required for overall pressure plate, half ring, and locating pin dimension.

8th Stage LP's 1, 2 & 3

LP		Required Dimension
1	Front (stm); upper and lower	9.248"
1	Rear (gen); upper and lower	9.005"
2	Front (stm); upper and lower	9.675"
2	Rear (gen); upper and lower	9.006"
3	Front (stm); upper and lower	9.249"
3	Rear (gen); upper and lower	9.012"

AFFECTED DOCUMENT DSN: R265 A3 3077 (T1-3689)

Material clarification:

Locating pegs are [item 3 - 3/4" O.D.] and are to be fabricated from [410 S.S.]

Initial machining length shall account for the fact that the installed pegs are [to protrude 0.015" above the surface.] For actual complete assembly widths with pegs, see pages 2 & 3 of this index item.

SIGNATURES	
A) Prepared By R. L. Tassell Sign R L Tassell Date 8-1-94	B) Checked By Sign [signature] Date 8/2/94

EDP -26726	
Index Item No. 11	
Rev 0	
Page 1 of 1	

Document to be Revised:
DTC: TMINSL
DSN: VMT11-1.1.7

Add the following note to this Vendor Manual:

The 7th and 8th stage turbine blades and diaphragms have been removed and pressure plates installed . The pressure plates have been designed by the turbine manufacturer, GEC/Alsthom, with an independent review performed by Westinghouse Electric Corporation Turbine Services group and found to be acceptable as an interim measure until the newly designed rotors and blades can be installed.

SIGNATURES	
A) Prepared By R. L. Tassell Sign R L Tassell Date 8-1-94	B) Checked By Sign [signature] Date 8/2/94

EDP -26726	
Index Item No. 12	
Rev 0	
Page 1 of 1	

Documents to be Posted:

DTC	DSN	Edison File No.
DDVEND	LA 146X69	T1-569
DDVEND	LA 231X69	T1-568
DDVEND	LA 2330X69	T1-567
DDVEND	R277A874 PG 1	T1-1187
DDVEND	R277A874 PG 2	T1-1187
DDVEND	R277A875 PG 1	T1-1264
DDVEND	R277A875 PG 2	T1-1264
DDVEND	R277A876 PG 1	T1-1265
DDVEND	R277A876 PG 2	T1-1265
DDVEND	TS 17280	T1-1598

Add the following note to all above mentioned drawings:

The 7th and 8th stage turbine blades and diaphragms have been removed and pressure plates installed . The pressure plates have been designed by the turbine manufacturer, GEC/Alsthom, with an independent review performed by Westinghouse Electric Corporation Turbine Services group and found to be acceptable as an interim measure until the newly designed rotors and blades can be installed. See Vendor Drawings R LA 94 04766 (Deco File No. T1-3687) for pressure plate design and information.

SIGNATURES

A) Prepared By R. L. Tassell	B) Checked By
Sign [signature] Date 8-1-94	Sign [signature] Date 8/2/94

Attachment B

Heat Exchanger Systems, Inc.

Consulting Engineers and Non-Destructive Examination
374 Congress Street, Suite 602, Boston, MA 02210
TEL. (617) 338-6650 FAX (617) 426-7142

July 21, 1994

Via Telecopier:

Mr. Mohan Deora
Detroit Edison Company
6400 N. Dixie Highway
Newport, MI 48166

Subject: Condenser Vibration/Performance Analysis - Fermi Unit 2

Dear Mohan:

Heat Exchanger Systems, Inc. (HES) has performed the subject analyses for the Fermi Unit 2 condenser.

The analyses were performed in order to evaluate the effects of changes to the steam flow rate and enthalpy to the main condenser. The changes in steam conditions are caused by proposed modifications to the L.P. turbine.

The revised values used in the analyses are as follows:

Steam Flow (lb/hr)	Steam Enthalpy (Btu/Lb)
8,129,928	1054.1

The analyses/results were as follows:

Vibration Analysis

Utilizing the HES tube support spacing analysis program and the new value for steam flow, the maximum allowable tube support spacing was determined for the condenser tubed with 22 BWG titanium. The maximum allowable unsupported tube length is 31.19 inches at a condenser pressure of 1.48 inches HgA.

Since the Fermi 2 condenser has anti-vibration staking installed in between the existing support plates for all tubes, the maximum unsupported tube length is less than 20 inches.

Based upon the HES analysis, the increased steam flow to the condenser will not require any additional anti-vibration staking.

The analysis output from the tube support spacing program is attached.

Thermal Performance Analysis

HES determined theoretical condenser pressure based upon the new steam flow rate and enthalpy over a range of circulating water inlet temperature from 60.0°F to 87.5°F.

The analysis was performed utilizing the HES proprietary performance prediction computer program. The analysis assumed 5 circulating water pumps in service and a cleanliness factor of 90%.

The predicted pressures are presented in the table below, along with predicted condenser pressures at the same CW inlet temperatures at the 105 percent power duty (7.79×10^9 BTU/HR).

CONDENSER PRESSURE (INCHES HgA)

CWIT (°F)	105% POWER	NEW DUTY
60.0	1.46	1.61
62.5	1.56	1.71
65.0	1.66	1.82
67.5	1.78	1.94
70.0	1.90	2.07
72.5	2.03	2.22
75.0	2.18	2.37
77.5	2.33	2.53
80.0	2.49	2.71
82.5	2.67	2.90
85.0	2.86	3.10
87.5	3.06	3.32

The thermal performance analysis indicates that condenser pressure will increase 0.15-0.26 inches HgA, depending upon the circulating water inlet temperature.

The condenser pressure performance prediction computer output sheets are attached, alone with the predicted condenser pressures in graphical form.

Should you have any questions or require additional information, please advise.

Sincerely,

Charles D. Hardy

Charles D. Hardy
Senior Mechanical Engineer

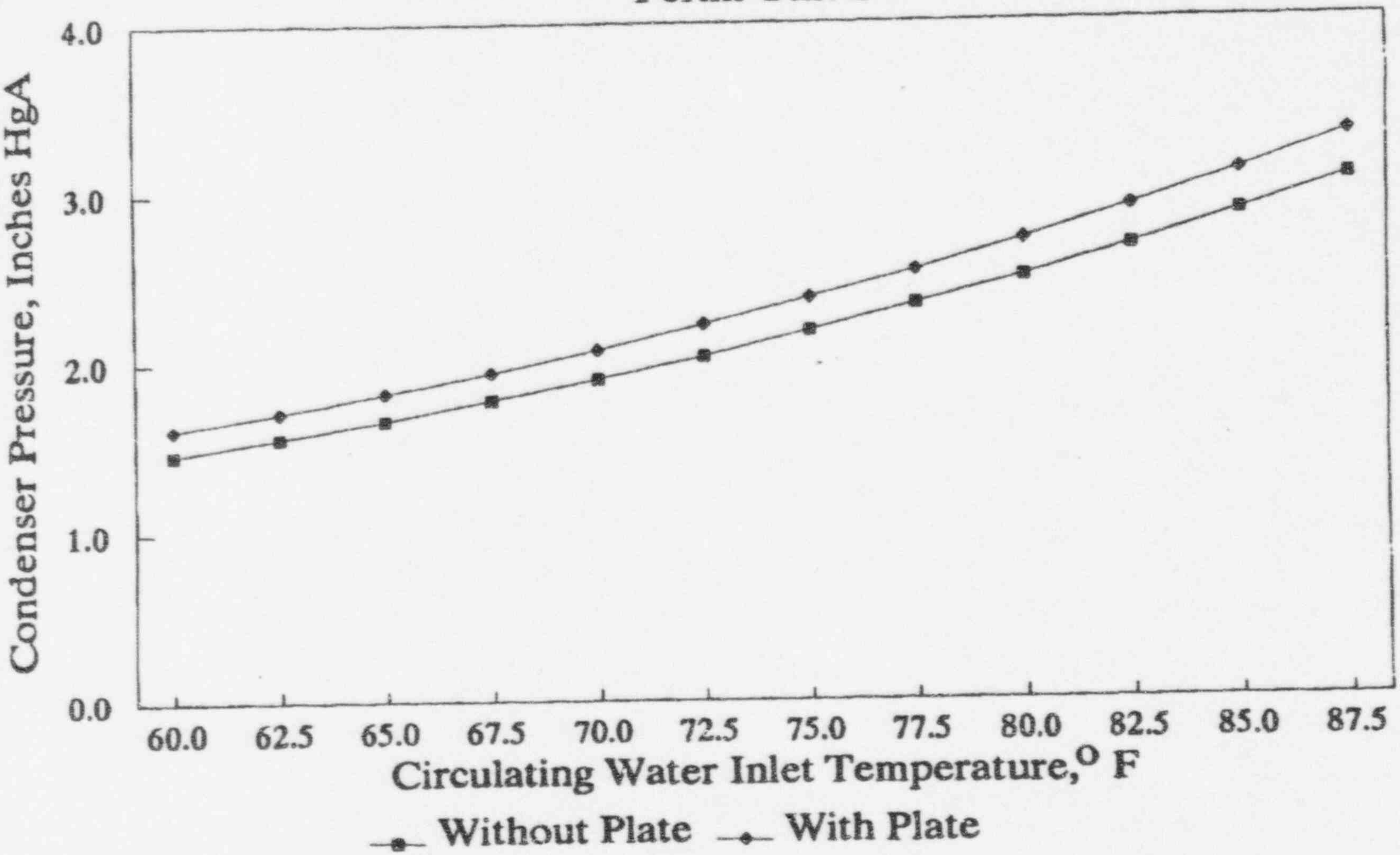
CDH/rcl

Attachment

cc: HES File #711

Condenser Pressure (Inches, HgA)

Fermi Unit 2



TUBE SUPPORT SPACING

CALC:
DATE: 07-20-1994

PLANT: FERMI UNIT 2
CLIENT: DETROIT EDISON

CALCULATED BY:
CHECKED BY:

GIVEN

TUBE MATERIAL	- TITANIUM	
TUBE O.D.	- 1.00	IN
WALL THICKNESS	- .028	IN
MODULUS OF ELASTICITY	- 14.9	E6 PSI
TUBE MATERIAL DENSITY	- .163	LB/CU IN
TUBE PITCH	- 1.25	IN
TURBINE EXHAUST AREA	- 1074.7	SQ FT
TURBINE FLOW RATE	- 4.06	E6 LB/HR
COOLING FLUID	- LAKE ERIE	
COOLING FLUID DENSITY	- 62.34	LB/CU FT
CONDENSER BACK PRES.	- 1.50	IN HGA
TUBE SUPPORT SPACING	- 39.0	IN

RESULTS

MAX SPAN @ GIVEN BACK PRESSURE - 31.44 IN

MINIMUM PRESSURE FOR GIVEN SPACING - 2.75 IN HGA

THE MINIMUM TUBE STAKE SPACING IS - 31.19 IN
AND IT OCCURS AT A PRESSURE OF - 1.48 IN HGA

HEAT EXCHANGER SYSTEMS INC.
BOSTON,MASS.

CONDENSER PERFORMANCE ANALYSIS
DETROIT EDISON
FERMI UNIT 2
105% POWER-5 CWP'S

CONDENSER DATA

TUBE DIAMETER(INS)	= 1.000	
FIRST MATERIAL	=22BWG, TITANIUM	59592 AVAILABLE TUBES
SECOND MATERIAL	=22BWG, TITANIUM	0 AVAILABLE TUBES
TOTAL DESIGN SURFACE AREA	= 776800.(SQ.FT)	
EFFECTIVE SURFACE AREA	= 776800.(SQ.FT)	

CONDENSER PERFORMANCE

RUN NUMBER	1	2	3	4
CLEAN CONDENSER				
SATURATION PRESSURE(INHG)	1.38	1.47	1.57	1.68
HEAT TRAN.COEFF.(BTU/HR FT2 F)	547	561	573	584
TERMINAL TEMP. DIFF.(F)	10.64	10.23	9.87	9.56
INLET WATER TEMP.(F)	60.00	62.50	65.00	67.50
TEMPERATURE RISE (F)	18.38	18.39	18.40	18.41
CIRCULATING WATER FLOW(GPM)	847500	847500	847500	847500
TUBE VELOCITY(FPS)	6.52	6.52	6.52	6.52
CONDENSER DUTY (MMBTU/HR)	7790.00	7790.00	7790.00	7790.00
CLEANLINESS DATA				
SATURATION PRESSURE(INHG)	1.46	1.56	1.66	1.78
HEAT TRAN.COEFF.(BTU/HR FT2 F)	492	504	516	526
TERMINAL TEMP. DIFF.(F)	12.52	12.06	11.66	11.31
CLEANLINESS FACTOR	.90	.90	.90	.90
CONDENSER PERFORMANCE				
DATE DATA TAKEN	0- 0- 0	0- 0- 0	0- 0- 0	0- 0- 0
TIME DATA TAKEN	0: 0	0: 0	0: 0	0: 0
SATURATION PRESSURE(INHG)	.00	.00	.00	.00
HEAT TRAN.COEFF.(BTU/HR FT2 F)	-145	-140	-135	-131
TERMINAL TEMP. DIFF.(F)	*****	*****	*****	*****
TEMPERATURE RISE (F)	18.38	18.39	18.40	18.41
PERFORMANCE FACTOR(%)	-26.6	-25.1	-23.7	-22.5
SUBCOOLING (F)	.00	.00	.00	.00
VOL OXYGEN CONTENT PPB	0	0	0	0

CONDENSER PERFORMANCE

RUN NUMBER	5	6	7	8
CLEAN CONDENSER				
SATURATION PRESSURE(INHG)	1.80	1.93	2.07	2.22
HEAT TRAN.COEFF.(BTU/HR FT2 F)	594	603	611	618
TERMINAL TEMP. DIFF.(F)	9.30	9.06	8.87	8.70
INLET WATER TEMP.(F)	70.00	72.50	75.00	77.50
TEMPERATURE RISE (F)	18.42	18.43	18.44	18.45
CIRCULATING WATER FLOW(GPM)	847500	847500	847500	847500
TUBE VELOCITY(FPS)	6.52	6.52	6.52	6.52
CONDENSER DUTY (MMBTU/HR)	7790.00	7790.00	7790.00	7790.00
CLEANLINESS DATA				
SATURATION PRESSURE(INHG)	1.90	2.03	2.18	2.33
HEAT TRAN.COEFF.(BTU/HR FT2 F)	535	543	550	556
TERMINAL TEMP. DIFF.(F)	11.01	10.75	10.52	10.33
CLEANLINESS FACTOR	.90	.90	.90	.90
CONDENSER PERFORMANCE				
DATE DATA TAKEN	0- 0- 0	0- 0- 0	0- 0- 0	0- 0- 0
TIME DATA TAKEN	0: 0	0: 0	0: 0	0: 0
SATURATION PRESSURE(INHG)	.00	.00	.00	.00
HEAT TRAN.COEFF.(BTU/HR FT2 F)	-127	-123	-119	-116
TERMINAL TEMP. DIFF.(F)	*****	*****	*****	*****
TEMPERATURE RISE (F)	18.42	18.43	18.44	18.45
PERFORMANCE FACTOR(%)	-21.4	-20.4	-19.5	-18.8
SUBCOOLING (F)	.00	.00	.00	.00
VOL OXYGEN CONTENT PPB	0	0	0	0

TEMP.CORRECTION BASED ON HEI

CONDENSER PERFORMANCE

RUN NUMBER	9	10	11	12

CLEAN CONDENSER

SATURATION PRESSURE(INHG)	2.38	2.55	2.73	2.93
HEAT TRAN.COEFF.(BTU/HR FT2 F)	624	630	634	638
TERMINAL TEMP. DIFF.(F)	8.55	8.43	8.32	8.23
INLET WATER TEMP.(F)	80.00	82.50	85.00	87.50
TEMPERATURE RISE (F)	18.46	18.47	18.48	18.49
CIRCULATING WATER FLOW(GPM)	847500	847500	847500	847500
TUBE VELOCITY(FPS)	6.52	6.52	6.52	6.52
CONDENSER DUTY (MMBTU/HR)	7790.00	7790.00	7790.00	7790.00

CLEANLINESS DATA

SATURATION PRESSURE(INHG)	2.49	2.67	2.85	3.06
HEAT TRAN.COEFF.(BTU/HR FT2 F)	562	567	571	574
TERMINAL TEMP. DIFF.(F)	10.17	10.03	9.91	9.80
CLEANLINESS FACTOR	.90	.90	.90	.90

CONDENSER PERFORMANCE

DATE DATA TAKEN	0- 0- 0	0- 0- 0	0- 0- 0	0- 0- 0
TIME DATA TAKEN	0: 0	0: 0	0: 0	0: 0
SATURATION PRESSURE(INHG)	.00	.00	.00	.00
HEAT TRAN.COEFF.(BTU/HR FT2 F)	-112	-109	-106	-103
TERMINAL TEMP. DIFF.(F)	*****	*****	*****	*****
TEMPERATURE RISE (F)	18.46	18.47	18.48	18.49
PERFORMANCE FACTOR(%)	-18.1	-17.4	-16.8	-16.3
SUBCOOLING (F)	.00	.00	.00	.00
VOL OXYGEN CONTENT PPB	0	0	0	0

TEMP.CORRECTION BASED ON HEI