Westinghouse Electric Corporation
Power Generation Group
Steam Turbine Division
Lester Branch Box 9175
Philadelphia Pennsylvania 19113

March 14, 1980

Darrell G. Eisenhut, Acting Director
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Eisenhut,

Your letters of February 25, 1980, to licensees with operating Westinghouse steam turbines requested certain site specific and generic information relative to turbine disc integrity. You urged in your letter that the licensees address the generic questions and coordinate the responses through an owners' group.

Licensees with nuclear power plants and Westinghouse steam turbines have formed a Turbine Disc Integrity Task Force, with Mr. Wayne Stiede of Commonwealth Edison Company selected as Chairman. Westinghouse has been working with this Task Force to generate responses to your generic questions.

At a Task Force meeting on March 12 and 13, 1980, the utilities present prepared and approved consesus responses to each of your generic questions. The Task Force further directed Westinghouse Electric Corporation to transmit these responses directly to you. The purpose of this letter is to transmit that information to you.

It is our understanding that Mr. Wayne Stiede, Chairman of the Task Force, will also confirm to you by separate letter, the Task Force's decision to have Westinghouse transmit these responses direct to you. We also understand that each utility, in their specific response to your letter to that utility, will discuss the extent to which they agree with these consensus responses.

If you have any questions on these, please contact me.

Sincerely,

J. M. Schmerling per PSZ

J. M. Schmerling,
Disc Integrity Program Manager

cc: W. J. Ross, Operating Reactors Branch
USNRC, Washington DC 20555

dupe 8003180533

GENERIC QUESTIONS - TO BE COMPLETED IN 20 DAYS

I. Describe what quality control and inspection procedures are used for the disc bore and keyways.

ANSWER:

Chemical analyses are made from each heat of steel. During manufacture mechanical tests are made from the disc bore region. These include tensile and Charpy v-notch impact tests. Each disc bore region is subject to ultrasonic and magnetic particle inspections. On later units, the disc keyways are inspected after machining, using liquid penetrant techniques.

For in-service inspection two ultrasonic techniques, namely the tangential aim and radial aim scans, have been developed to detect and determine the depth of disc keyway and bore cracks. The in-service ultrasonic inspection does not require unshrinking discs from the rotor.

The tangential aim scan is used to locate cracks. The technique requires sound energy to be coupled and directed tangentially towards the keyway from a precalculated position on the hub. This is accomplished by means of a compound angled plexigalass wedge. The wedge is machined to provide a contoured face which makes complete contact with the disc hub, while aiming the sound energy at the disc bore/keyway. Crack indications occuring in the vicinity of the keyway apex and at the bore will reflect the sound energy. The tangential aim scan is performed both in the clockwise and counterclockwise directions to permit locating crack indications with respect to the keyway apex.

A radial aim technique is used to confirm cracks located by the tangential aim scan. The technique is also used to determine the crack depth by comparing the time lapsed in obtaining a ultrasonic reflection from the crack with the time to obtain a reflection from the keyway or bore.

II. Provide details of the Westinghouse repair/replacement procedures for faulty discs.

ANSWER:

When cracks are found by an inservice inspection their severity is evaluated by means of an allowable life calculation. The allowable life is relatable to the time required for the crack to grow to critical size for fracture. Based upon the results of this calculation, the following actions may be taken:

A. If the affected disc has a calculated allowable life greater than zero a reinspection of the disc is recommended at approximately one-half of the allowable life.

B. If the affected disc has an allowable life less than or close to zero, one or more of the following may be employed:

1. The affected disc is removed by "machining", and is replaced with a collar and pressure drop baffle.

2. Upstream keyways may be drilled oversize to remove cracks after the downstream disc is removed.

3. The affected disc may be replaced . This requires unstacking and restacking several discs on the rotor.

III.A. What immediate and long term actions are being taken by Westinghouse to minimize future stress corrosion problems with turbine discs?

ANSWER:

The following short range actions are being taken:

1. Those discs which have been observed to be most susceptible to stress corrosion cracking are being redesigned. The new designs will achieve lower bore stresses and utilize lower yield strength material. These changes will increase the margin against stress corrosion cracking.

2. Designs that will eliminate spacers and bore keyways are being explored.

The following long range solutions are being examined:

1. Bore Heating - Ways and means to keep the disc keyways dry are being explored.

2. Sealing - Ways of sealing the hub and bore from the steam environment are being studied.

3. Coatings - Another method of sealing is to apply a protective coating. We are continuing to experiment with different coatings, but extensive work is still required to develop processes for their application and to demonstrate their benefits.

4. Partial Integral Rotors - Since one piece forgings cannot be procured at this time, we are exploring the possibilities of partial integral rotors where the first two or three discs are made a part of the shaft. Only the last few discs will have to be shrunk on.

5. Integral Rotors - A welded rotor design is being evaluated as a means to produce an integral rotor.

III.B. What actions are being recommended to utilities to minimize stress corrosion cracking?

ANSWER:

Westinghouse has developed recommended limits for steam purity. When these limits are exceeded corrective actions should be taken.

IV.A. Identify the impurities known to cause cracking in the low pressure turbines, and their sources.

ANSWER:

The main chemical species known to cause or contribute to stress corrosion of steam turbine materials in steam environments are:

Sodium hydroxide
Sodium chloride
Sodium sulfate
Oxygen

The sources of these impurities are under study.

IV.B. Discuss the relationship between steam generator chemistry and steam chemistry relative to the introduction of corrosive impurities into the turbine, including phosphate, AVT, and BWR chemistry.

ANSWER:

Analyses of material within LP disc cracks from PWR units shows the presence of Na, K, Ca, Si, Cl, OH, and C together with Fe, Co, V, Al and Ni ions.

In PWR units with recirculating steam generators, the total carry-over of non-volatile dissolved solids, such as NaOH and NaCl depends mainly on the mechanical carry-over. However, where ammonia is used for pH control such as with the all volatile water treatment, carry-over of anions may increase due to a formation of volatile ammonium salts.

In the PWR units with once-through steam generators, the high pressure turbine steam purity is similar to the feedwater purity. Most impurities entering the steam generator are carried directly into the turbine.

The published information on BWR systems indicates the concentration of oxygen in the steam is in the range of 10 to 30 ppm. With respect to other elements, however, it is likely that high steam purity standards will be maintained for control of radioactivity. To achieve this, BWR reactor water is generally double demineralized.

IV.C. Discuss the mechanism of deposition of these impurities that can lead to their concentration in certain areas of keyways and bores.

ANSWER:

The impurities from steam can get into shrunk-on disc bores and keyways in several possible ways:

1. After deposition in the steam path during operation, corrodents can wash into disc keyways during layup due to moisture condensation.

2. In the wet steam regions, the moisture can dry on hot metal surfaces.

3. As long as the disc retains its shrink fit we are not aware of any mechanism which can concentrate impurities on the bore.

V. What role does the refluxing action in the steam separation portion of the steam generator have on scrubbing corrosive impurities from the steam?

ANSWER:

Two modes of transport of corrosive impurities from the steam generator to the turbine are mechanical entrainment and volatility.

The non-volatile chemical species are transported by mechanical entrainment which is normally expected to be small.

The steam generator scrubbing equipment has minimum effectiveness in preventing the transport of volatile impurities, such as ammonium chloride, to the turbine. The concentration of volatile impurities in turbine steam is determined by their concentration in the steam generator bulk water and their specific volatility coefficient which differs with each species.

VI. To what extent can the buildup of corrosive impurities in the LP turbine be alleviated? What would be the effects of the following action:

A. Pumping moisture separator condensate to condenser?

ANSWER:

Pumping moisture separator condensate to the condenser would be beneficial in units with condensate polishing . In units without condensate polishing, there will be no effect.

B. Periodically moving (the) point of condensation to prevent locallized buildup of corrosive impurities.

ANSWER:

Conceptually, dilution of contaminants by increased levels of moisture and their subsequent transport to the condensate system could substantially reduce the buildup of impurities. However, the effectiveness of this technique and the means for successful control of the local environment of particular turbine parts must be developed and experimentally verified.

Several of the less volatile active corrodants, such as sodium chloride and sodium sulphate precipitate as concentrated liquid solutions in a region slightly above the equilibrium saturated vapor line of pure water. This region occurs locally within a given stage during normal operation and migrates toward the turbine exhaust as load reduces. Control of the zone can be affected by changes in load and moisture separator reheater (MSR) outlet temperature.

VII Describe fabrication and heat treatment sequence for discs, including thermal exposure during shrinking operation.

ANSWER:

The typical sequence for producing a disc forging includes the following operations, not all of which are necessarily applicable to any given disc.

A. Melting and casting of Ingot. Most discs manufactured since the early 1960's are made using basic electric furnace steel which is vacuum stream degassed or vacuum-carbon-deoxidized.

B. Forging The ingot is heated to forging temperature, block forged and cut into 2 to 4 pieces from which the individual disc forgings are made.

C. Preliminary Heat Treatment This step consists of austenitizing and tempering the forging to promote structure uniformity, grain refinement, and good machineability.

D. Preliminary Machining The forging is machined to the disc contour.

E. Preliminary Ultrasonic Inspection Typically the supplier makes a partial ultrasonic inspection of the forging to assure that the quality warrants continued manufacturing effort.

F. Heat Treatment for Properties The forging is austenitized and tempered at appropriate temperatures to achieve the desired mechanical properties. Cooling from the austenitizing treatment is achieved by water quenching. After tempering the forging is cooled in the furnace at a controlled rate.

G. Mechanical Properties Tensile properties are tested to determine if the required strength level has been achieved. Since about 1960, Charpy v-notch impact tests are made on each forging.

H. NDE Inspection The forgings are rough machined to the Westinghouse drawing requirements and an ultrasonic inspection of the flat surfaces of the hub, web, and rim of the disc is performed.

I. Stress Relief This treatment is required when a significant amount of metal is machined off of the forging after it has been heat treated for properties. The stress relief treatment is 50-100° F below the tempering temperature. Cooling is accomplished by a controlled furnace cool.

J. Mechanical Properties When a stress relief is used, the mechanical properties are tested after the stress relief treatment. (Reference Step G)

K. Dimensional Check The forging is machined to a clean surface, the balance of test prolongations are removed, and the dimensions checked. The forging is then shipped to Westinghouse for final machining and assembly onto the rotor.

L. NDE Inspection A fluorescent magnetic particle inspection is performed after finish machining (This inspection was not applied during the early 1970's.)

M. Shrinking Discs On the Rotor Shaft The assembly operation consists of four parts; namely, preparation of the shaft, preparation of the discs, assembly of the rotor and pinning of the discs to the shaft.

1. Preparation of the Shaft After final shaft machining and inspections are complete the shaft is cleaned with degreaser and dry lint-free cloths, and is mounted in a vertical position. The surface of the rotor that will be in contact with the disc is coated with lubricant.

2. Preparation of the Disc. After final machining and inspections are complete the disc surfaces and blades are cleaned to remove foreign material. Prior to heating for assembly the disc bore diameter is measured and compared to that of the drawing to assure a correct shrink fit. The disc is placed on an assembly fixture, leveled and loaded into a furnace which is at 300^{o}F or less.

3. Assembly of the Rotor The disc is slowly heated to the required shrink temperature between 600^{o} and 750^{o} F. When the shrink temperature is reached the disc is removed from the furnace and lowered onto the shaft.

4. Axial Aligning and Pinning of Discs. Liners are placed at the exhaust face of each disc to assure the proper axial location. The keyways are then drilled. Since the early 1970's, a penetrant inspection is performed in the keyway prior to inserting the key.

VIII Discuss the effect of any local residual stresses on the cracking mechanism.

ANSWER:

Depending on their nature and magnitude, residual surface stresses can have an effect on crack initiation. Proper control exercised in the selection of machining parameters results in compressive stresses which are usually beneficial. At the apex of the keyway, the residual stresses may be influenced by local yielding as a result of the stress concentrating action of the keyway.

APPENDIX A
WESTINGHOUSE PROPRIETARY

Notes on Answers to
Site Specific Question 1D

1. Type of material is Ni-Cr-Mo-V alloy steel similar to ASTM A-471. The minimum yield strength specified for each disc is given in Section B.

2. Tensile properties data of tests taken from the disc hub are given in Section B. Data obtained from rim material are presented in Section C.

3. Toughness properties are also presented in Sections B and C. As described above, Section B contains hub properties and Section C contains rim properties. Upper shelf energy is not presented when it is the same as the room temperature energy.

4. The keyway temperature is presented in Section G. This is the calculated temperature two inches from the exhaust face of the disc at the bore during full load operation with all moisture separator reheaters functioning (where applicable).

5. The maximum expected keyway crack size has been calculated for each disc in each unit and is given in Section H. This is done by multiplying the crack growth rate by the time the unit was in operation prior to the disc/keyway inspection. For units not yet inspected, the time used should be the expected operating time when the unit will be inspected. The crack growth rate is given in Section G in response to Question I.D.8.

6. The critical crack size at 1800 rpm and at design overspeed is presented in Section F. It is calculated using the relationship:

$$A_{CR}\text{ (eff)} = \left[\frac{Q}{1.21\pi} \left(\frac{K_{IC}}{\sigma_{BORE}} \right)^2 - R \right]^{b,c,e}$$

Where [K_{IC} is the lower of either the room temperature or upper shelf fracture toughness. σ_{BORE} is the bore stress given in Section E in answer to I.D.9. Q is the shape factor based upon an A:2C ratio of 1:4. This is a change from previous Westinghouse calculations where a 1:10 ratio was conservatively applied. The 1:4 ratio is supported by observed keyway crack geometrics, and agrees with the ratio we believe the U.S. Nuclear Regulatory Commission uses for their analyses. R is the radius of the keyway.] b,c,e

7. This is the ratio of Item 5 to Item 6 and is shown in Section I.

8. The crack growth rate is given in Section G. These crack growth rates are the minimum expected rates based upon known cracks to date. Westinghouse has changed the basis for determining these rates to utilize the NRC gray book operating hours. It is believed this agrees with the way the NRC staff determines crack growth rates. Except for four units, the crack growth rate of the number one disc and number 6 disc of BB 80 and BB 81 turbines should be assumed to be zero since this disc operates dry under normal conditions. The four exceptions are Haddam Neck, Indian Point 2, Indian Point 3, and Cooper 1.

9. The bore tangential stress at 1800 rpm and at design overspeed are presented in Section E. The values presented include the stresses due to shrink fit and centrifugal force loads only. Additional analyses to include thermal stresses and pressure stresses are being made but are not presently available.

10. The fracture toughness, K_{IC}, of each disc is calculated from the Charpy v-notch and tensile data. The values, presented in Sections B and C are calculated at the upper shelf temperature or room temperature, whichever gives the lower result.

11. The minimum yield strength specified for each disc is presented in Section B.

Note: There are five discs on three units where complete data is not available to answer all of the questions. We believe the NRC staff considers the ratio A/A_{CR} as the critical paramater. Westinghouse is calculating "worst case" ratios for these discs. If there is a problem, please contact the Westinghouse Projects Manager or Engineer.

APPENDIX A

WESTINGHOUSE PROPRIETARY

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK	81
2. UNIT	ROBINSON #2 (REP)
3. CUSTOMER:	CAROLINA P&L
4. LP#	1
5. LOCATION	GOV
6. DISC#	1
7. TEST NO.	TD55539

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD (MIN. Y.S. [110.0]b,c,e (KSI))
2. SUPPLIER: BETHLEHEM STEEL

	b,c,e
3. Y.S. (KSI)	[121.000
4. U.T.S. (KSI)	137.500
5. ELONGATION	20.5
6. R.A.	67.7
7. FATT (DEG.F)	-95.0
8. R.T. IMPACT(FT.LB.)	99.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	99.0
11. U.S. KIC (KSI.SQRT(IN.))	237.14]

C. MATERIAL PROPERTIES (RIM)

	b,c,e
1. Y.S. (KSI)	[121.500
2. U.T.S. (KSI)	138.000
3. ELONGATION	21.0
4. R.A.	68.3
5. FATT (DEG.F)	-95.0
6. R.T. IMPACT(FT.LB.)	99.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI.SQRT(IN.))	237.60]

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.23]b,c,e	[.31]b,c,e	[.05]b,c,e	[.009]b,c,e	[1.74]b,c,e	[.48]b,c,e	[.13]b,c,e

NI	AS	SB	SN	AL	CU	S
[3.54]b,c,e	[ ]b,c,e	[.0006]b,c,e	[ ]b,c,e	[ ]b,c,e	[ ]b,c,e	[.012]b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	[62.700
2. 2160 (120%)	(KSI)	71.000]

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	[4.70
2. A-CR-OS (OVERSPEED) (IN.)	3.58]

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	[377
2. ESTIMATED MAX DA/DT (IN/HR)	[illegible]]

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [0] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [0] b,c,e

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GOV
6. DISC# 2
7. TEST NO. TD55574

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] (KSI)) b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL

b,c,e

3. Y.S. (KSI)	[124.500
4. U.T.S. (KSI)	136.000
5. ELONGATION	20.0
6. R.A.	67.5
7. FATT (DEG.F)	-120.0
8. R.T. IMPACT(FT.LB.)	92.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	92.0
11. U.S. KIC (KSI*SQRT(IN.))	231.07]

C. MATERIAL PROPERTIES (RIM)

b,c,e

1. Y.S. (KSI)	[122.500
2. U.T.S. (KSI)	132.000
3. ELONGATION	21.7
4. R.A.	69.3
5. FATT (DEG.F)	-120.0
6. R.T. IMPACT(FT.LB.)	70.5
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	198.57]

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.24] b,c,e	[.29] b,c,e	[.01] b,c,e	[.009] b,c,e	[1.60] b,c,e	[.40] b,c,e	[.13] b,c,e

NI	AS	SB	SN	AL	CU	S
[4.05] b,c,e	[ ] b,c,e	[.002] b,c,e	[.017] b,c,e	[ ] b,c,e	[ ] b,c,e	[.007] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	[61.500
2. 2160 (120%)	(KSI)	69.800]

F. CRACK DATA

b,c,e

1. A-CR-OP (1800 RPM) (IN.) [4.63
2. A-CR-OS (OVERSPEED) (IN.) 3.51]

G. SERVICE DATA

b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [301
2. ESTIMATED MAX DA/DT (IN/HR) .311-004]

H. CALCULATED CRACK SIZE AS OF MAY 1980
A(IN.) [1.275] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO.
A/Acr (OVERSPEED) [.363] b,c,e

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK		81
2. UNIT	ROBINSON #2 (REP)	
3. CUSTOMER:	CAROLINA P&L	
4. LP#		1
5. LOCATION		GOV
6. DISC#		3
7. TEST NO.	TE26447	

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [120.0] (KSI)) TE b,c,e
2. SUPPLIER:

	b,c,e
3. Y.S. (KSI)	121.500
4. U.T.S. (KSI)	132.500
5. ELONGATION	21.5
6. R.A.	62.3
7. FATT (DEG.F)	-153.0
8. R.T. IMPACT(FT.LB.)	75.0
9. U.S. IMPACT TEMP. (DEG.F)	80.0
10. U.S. IMPACT ENG. (FT.LB.)	75.0
11. U.S. KIC (KSI*SQRT(IN.))	204.63

C. MATERIAL PROPERTIES (RIM)

		b,c,e,
1. Y.S. (KSI)		127.000
2. U.T.S. (KSI)		138.500
3. ELONGATION		21.5
4. R.A.		67.7
5. FATT (DEG.F)		-153.0
6. R.T. IMPACT(FT.LB.)	-	
7. U.S. IMPACT TEMP. (DEG.F)	-	
8. U.S. IMPACT ENG. (FT.LB.)	-	
9. U.S. KIC (KSI*SQRT(IN.))		.00

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.28] b,c,e	[.32] b,c,e	[.05] b,c,e	[.005] b,c,e	[2.00] b,c,e	[.51] b,c,e	[.10] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.50] b,c,e	[.014] b,c,e	[24PPM] b,c,e	[.002] b,c,e	[.001] b,c,e	[.09] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	70.600
2. 2160 (120%)	(KSI)	81.600

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	2.60
2. A-CR-OS (OVERSPEED) (IN.)	1.85

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F)
2. ESTIMATED MAX DA/DT (IN/HR)

[.934-.065 / 239] b,c,e

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [.064] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.040] b,c,e

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GOV
6. DISC# 4
7. TEST NO. TD55587

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: MIDVALE HEPPENSTALL

		b,c,e
3.	Y.S. (KSI)	114.500
4.	U.T.S. (KSI)	126.500
5.	ELONGATION	22.2
6.	R.A.	69.7
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	104.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	104.0
11.	U.S. KIC (KSI*SQRT(IN.))	237.20

C. MATERIAL PROPERTIES (RIM)

		b,c,e
1.	Y.S. (KSI)	114.000
2.	U.T.S. (KSI)	127.500
3.	ELONGATION	23.0
4.	R.A.	70.3
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	107.5
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	240.89

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.25] b,c,e	[.25] b,c,e	[.01] b,c,e	[.010] b,c,e	[1.67] b,c,e	[.38] b,c,e	[.11] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.42] b,c,e	[ ] b,c,e	[.0023] b,c,e	[.017] b,c,e	[ ] b,c,e	[ ] b,c,e	[.010] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	61.300
2. 2160 (120%)	(KSI)	71.400

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	4.94
2. A-CR-OS (OVERSPEED) (IN.)	3.54

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	198
2. ESTIMATED MAX DA/DT (IN/HR)	.371-005

H. CALCULATED CRACK SIZE AS OF MAY 1988
A (IN.) [.025] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A(Acr) (OVER SPEED) [.007] b,c,e

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GOV
6. DISC# 5
7. TEST NO. TD44487

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] (KSI)) b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL

Item	Value b,c,e
3. Y.S. (KSI)	125.000
4. U.T.S. (KSI)	136.000
5. ELONGATION	20.0
6. R.A.	64.7
7. FATT (DEG.F)	-120.0
8. R.T. IMPACT(FT.LB.)	72.5
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	72.5
11. U.S. KIC (KSI*SQRT(IN.))	203.49

C. MATERIAL PROPERTIES (RIM)

Item	Value b,c,e
1. Y.S. (KSI)	116.000
2. U.T.S. (KSI)	129.000
3. ELONGATION	22.4
4. R.A.	69.3
5. FATT (DEG.F)	-120.0
6. R.T. IMPACT(FT.LB.)	96.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	228.73

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
.25 b,c,e	.25 b,c,e	.01 b,c,e	.007 b,c,e	1.60 b,c,e	.39 b,c,e	.08 b,c,e

NI	AS	SB	SN	AL	CU	S
3.47 b,c,e	b,c,e	.0019 b,c,e	b,c,e	b,c,e	b,c,e	.010 b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	63.000
2. 2160 (120%)	(KSI)	72.900

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	3.32
2. A-CR-OS (OVERSPEED) (IN.)	2.39

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	178
2. ESTIMATED MAX DA/DT (IN/HR)	~~.220~~ -005

H. CALCULATE CRACK SIZE AS OF MAY 1980
A (IN.) [.015] b,c,e

I. CRACK SIZE TO CRITICAL SIZE RATIO
A/Acr (OVERSPEED) [.007] b,c,e

ID # : D081102301

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GOV
6. DISC# 6
7. TEST NO. TD55525

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] (KSI)) b,c,e
2. SUPPLIER: BETHLEHEM STEEL

3. Y.S. (KSI)	118.500	b,c,e
4. U.T.S. (KSI)	136.500	
5. ELONGATION	20.0	
6. R.A.	66.1	
7. FATT (DEG.F)	-90.0	
8. R.T. IMPACT(FT.LB.)	76.0	
9. U.S. IMPACT TEMP. (DEG.F)	75.0	
10. U.S. IMPACT ENG. (FT.LB.)	76.0	
11. U.S. KIC (KSI*SQRT(IN.))	203.76	

C. MATERIAL PROPERTIES (RIM)

1. Y.S. (KSI)	121.500	b,c,e
2. U.T.S. (KSI)	138.000	
3. ELONGATION	20.0	
4. R.A.	62.1	
5. FATT (DEG.F)	-90.0	
6. R.T. IMPACT(FT.LB.)	80.0	
7. U.S. IMPACT TEMP. (DEG.F)		
8. U.S. IMPACT ENG. (FT.LB.)		
9. U.S. KIC (KSI*SQRT(IN.))	211.92	

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.23] b,c,e	[.32] b,c,e	[.01] b,c,e	[.012] b,c,e	[1.79] b,c,e	[.50] b,c,e	[.14] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.58] b,c,e	[ ] b,c,e	[.0010] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.015] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS		
1. 1800	(KSI)	55.500	b,c,e
2. 2160 (120%)	(KSI)	65.400	

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.) [4.41] b,c,e
2. A-CR-OS (OVERSPEED) (IN.) [3.07]

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [193] b,c,e
2. ESTIMATED MAX DA/DT (IN/HR) [0.0]

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [0] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSIZE) [0] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GEN
6. DISC# 1
7. TEST NO. TD55540

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: BETHLEHEM STEEL

	b,c,e
3. Y.S. (KSI)	117.000
4. U.T.S. (KSI)	136.000
5. ELONGATION	21.0
6. R.A.	68.3
7. FATT (DEG.F)	-100.0
8. R.T. IMPACT(FT.LB.)	118.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	118.0
11. U.S. KIC (KSI*SQRT(IN.))	256.14

C. MATERIAL PROPERTIES (RIM)

	b,c,e
1. Y.S. (KSI)	119.000
2. U.T.S. (KSI)	138.500
3. ELONGATION	20.5
4. R.A.	70.3
5. FATT (DEG.F)	-100.0
6. R.T. IMPACT(FT.LB.)	120.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	260.50

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.23] b,c,e	[.31] b,c,e	[.02] b,c,e	[.008] b,c,e	[1.77] b,c,e	[.50] b,c,e	[.13] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.54] b,c,e	[ ] b,c,e	[.0004] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.010] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	62.700
2. 2160 (120%)	(KSI)	71.000

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	5.55
2. A-CR-OS (OVERSPEED) (IN.)	4.24

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	377
2. ESTIMATED MAX DA/DT (IN/HR)	0.0

H. CALCULATE CRACK SIZE AS OF MAY 1980
A (IN.) [0] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [0] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GEN
6. DISC# 2
7. TEST NO. TD55575

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] b,c,e (KSI)) TD
2. SUPPLIER: MIDVALE HEPPENSTALL b,c,e

3. Y.S. (KSI)	126.000
4. U.T.S. (KSI)	139.000
5. ELONGATION	20.5
6. R.A.	60.4
7. FATT (DEG.F)	-120.0
8. R.T. IMPACT(FT.LB.)	74.5
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	74.5
11. U.S. KIC (KSI*SQRT(IN.))	207.28

C. MATERIAL PROPERTIES (RIM) b,c,e

1. Y.S. (KSI)	122.500
2. U.T.S. (KSI)	138.000
3. ELONGATION	21.2
4. R.A.	67.7
5. FATT (DEG.F)	-120.0
6. R.T. IMPACT(FT.LB.)	88.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	223.94

D. CHEMISTRY (each value bracketed, b,c,e)

C	MN	SI	P	CR	MO	V
.24	.29	.01	.009	1.60	.40	.13

NI	AS	SB	SN	AL	CU	S
4.05		.0021	.017			.007

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	61.500
2. 2160 (120%)	(KSI)	69.800

F. CRACK DATA b,c,e

1. A-CR-OP (1800 RPM) (IN.) 3.65
2. A-CR-OS (OVERSPEED) (IN.) 2.75

G. SERVICE DATA b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [~~.311~~ 301]
2. ESTIMATED MAX DA/DT (IN/HR) [~~.004~~]

H. CALCULATED CRACK SIZE AS OF MAY 1980 [1.275] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO A/Acr (OVERSPEED) [.46] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GEN
6. DISC# 3
7. TEST NO. TE26449

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [100.0] b,c,e (KSI)) TC
2. SUPPLIER:

	b,c,e
3. Y.S. (KSI)	129.000
4. U.T.S. (KSI)	140.500
5. ELONGATION	21.0
6. R.A.	65.2
7. FATT (DEG.F)	-158.0
8. R.T. IMPACT(FT.LB.)	72.0
9. U.S. IMPACT TEMP. (DEG.F)	80.0
10. U.S. IMPACT ENG. (FT.LB.)	72.0
11. U.S. KIC (KSI*SQRT(IN.))	205.62

C. MATERIAL PROPERTIES (RIM)

	b,c,e
1. Y.S. (KSI)	126.300
2. U.T.S. (KSI)	138.900
3. ELONGATION	21.0
4. R.A.	65.8
5. FATT (DEG.F)	-158.0
6. R.T. IMPACT(FT.LB.)	-
7. U.S. IMPACT TEMP. (DEG.F)	-
8. U.S. IMPACT ENG. (FT.LB.)	-
9. U.S. KIC (KSI*SQRT(IN.))	.00

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.28] b,c,e	[.32] b,c,e	[.05] b,c,e	[.005] b,c,e	[2.00] b,c,e	[.51] b,c,e	[.10] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.50] b,c,e	[.014] b,c,e	[24PPM] b,c,e	[.002] b,c,e	[.001] b,c,e	[.09] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	70.600
2. 2160 (120%)	(KSI)	81.600

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	2.63
2. A-CR-OS (OVERSPEED) (IN.)	1.88

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	239
2. ESTIMATED MAX DA/DT (IN/HR)	.934-005

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [.064] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVER SPEED) [.034] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1.	BUILDING BLOCK	81
2.	UNIT	ROBINSON #2 (REP)
3.	CUSTOMER:	CAROLINA P&L
4.	LP#	1
5.	LOCATION	GEN
6.	DISC#	4
7.	TEST NO.	TD55589

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] (KSI)) TD b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL

		b,c,e
3.	Y.S. (KSI)	117.500
4.	U.T.S. (KSI)	134.000
5.	ELONGATION	21.5
6.	R.A.	67.5
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	80.5
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	80.5
11.	U.S. KIC (KSI*SQRT(IN.))	209.39

C. MATERIAL PROPERTIES (RIM)

		b,c,e
1.	Y.S. (KSI)	120.000
2.	U.T.S. (KSI)	137.500
3.	ELONGATION	21.5
4.	R.A.	65.9
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	86.0
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	219.09

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.25] b,c,e	[.25] b,c,e	[.01] b,c,e	[.010] b,c,e	[1.67] b,c,e	[.38] b,c,e	[.11] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.42] b,c,e	[ ] b,c,e	[.0023] b,c,e	[.017] b,c,e	[ ] b,c,e	[ ] b,c,e	[.010] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	61.300
2. 2160 (120%)	(KSI)	71.400

F. CRACK DATA

		b,c,e
1.	A-CR-OP (1800 RPM) (IN.)	3.76
2.	A-CR-OS (OVERSPEED) (IN.)	2.67

G. SERVICE DATA

		b,c,e
1.	OPER. TEMP. METAL TEMP. HUB (DEG.F)	198
2.	ESTIMATED MAX DA/DT (IN/HR)	.371 -005

H. CALCULATED CRACK SIZE AS OF MAY 1980

A (IN) [.025] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO

A/Acr (OVERSPEED) [.009] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GEN
6. DISC# 5
7. TEST NO. TD55518

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: BETHLEHEM STEEL

3.	Y.S. (KSI)	119.000
4.	U.T.S. (KSI)	135.000
5.	ELONGATION	19.0
6.	R.A.	57.0
7.	FATT (DEG.F)	-110.0
8.	R.T. IMPACT(FT.LB.)	110.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	110.0
11.	U.S. KIC (KSI*SQRT(IN.))	248.82

b,c,e

C. MATERIAL PROPERTIES (RIM)

1.	Y.S. (KSI)	120.000
2.	U.T.S. (KSI)	138.000
3.	ELONGATION	21.5
4.	R.A.	68.1
5.	FATT (DEG.F)	-110.0
6.	R.T. IMPACT(FT.LB.)	109.0
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	248.60

b,c,e

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.23] b,c,e	[.30] b,c,e	[.03] b,c,e	[.007] b,c,e	[1.56] b,c,e	[.49] b,c,e	[.10] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.54] b,c,e	[ ] b,c,e	[.0007] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.011] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	
1. 1800	(KSI)	63.000
2. 2160 (120%)	(KSI)	72.900

b,c,e

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.) [5.16]
2. A-CR-OS (OVERSPEED) (IN.) [3.76]

b,e,e

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [178]
2. ESTIMATED MAX DA/DT (IN/HR) [.226-005]

b,c,e

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN) [.015] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.004] b,c,e

ID # : D081102302

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 1
5. LOCATION GEN
6. DISC# 6
7. TEST NO. TD55526

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] b,c,e (KSI)) TD
2. SUPPLIER: BETHLEHEM STEEL

b,c,e

3.	Y.S. (KSI)	122.000
4.	U.T.S. (KSI)	138.500
5.	ELONGATION	20.5
6.	R.A.	67.2
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	96.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	96.0
11.	U.S. KIC (KSI*SQRT(IN.))	234.18

C. MATERIAL PROPERTIES (RIM)

b,c,e

1.	Y.S. (KSI)	118.000
2.	U.T.S. (KSI)	135.500
3.	ELONGATION	20.5
4.	R.A.	68.3
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	95.0
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	229.28

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.22] b,c,e	[.30] b,c,e	[.01] b,c,e	[.010] b,c,e	[1.67] b,c,e	[.50] b,c,e	[.11] b,e,e

NI	AS	SB	SN	AL	CU	S
[3.59] b,c,e	[ ] b,c,e	[.0006] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.008] b,c,e

E. BORE STRESS

SPEED (RPM)		STRESS	b,c,e
1. 1800	(KSI)		55.500
2. 2160 (120%)	(KSI)		65.400

F. CRACK DATA

b,c,e

1. A-CR-OP (1800 RPM) (IN.) 5.94
2. A-CR-OS (OVERSPEED) (IN.) 4.17

G. SERVICE DATA

b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) 193
2. ESTIMATED MAX DA/DT (IN/HR) 0.0

H. CALCULATED CRACK SIZE AS OF MAY 1980 b,c,e

A (IN) [0]

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO b,c,e

A/Acr (OVERSPEED) [0]

ID # : D081102303

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK		81
2. UNIT	ROBINSON #2 (REP)	
3. CUSTOMER:	CAROLINA P&L	
4. LP#		2
5. LOCATION		GOV
6. DISC#		1
7. TEST NO.	TD55537	

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] b,c,e (KSI)) TD
2. SUPPLIER: BETHLEHEM STEEL

		b,c,e
3.	Y.S. (KSI)	118.000
4.	U.T.S. (KSI)	135.000
5.	ELONGATION	20.0
6.	R.A.	68.8
7.	FATT (DEG.F)	-135.0
8.	R.T. IMPACT(FT.LB.)	111.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	111.0
11.	U.S. KIC (KSI*SQRT(IN.))	249.02

C. MATERIAL PROPERTIES (RIM)

		b,c,e
1.	Y.S. (KSI)	123.000
2.	U.T.S. (KSI)	140.500
3.	ELONGATION	20.0
4.	R.A.	69.0
5.	FATT (DEG.F)	-135.0
6.	R.T. IMPACT(FT.LB.)	111.0
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	253.93

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.21] b,c,e	[.30] b,c,e	[.01] b,c,e	[.011] b,c,e	[1.60] b,c,e	[.49] b,c,e	[.09] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.67] b,c,e	[ ] b,c,e	[.0010] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.014] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	62.700
2. 2160 (120%)	(KSI)	71.000

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	5.22
2. A-CR-OS (OVERSPEED) (IN.)	3.99

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	377
2. ESTIMATED MAX DA/DT (IN/HR)	0.0

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN) [0] b,c,E

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [0] b,c,e

ID # : D081102303

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GOV
6. DISC# 2
7. TEST NO. TD44516

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: MIDVALE HEPPENSTALL

	b,c,e
3. Y.S. (KSI)	125.000
4. U.T.S. (KSI)	135.000
5. ELONGATION	20.3
6. R.A.	60.9
7. FATT (DEG.F)	-110.0
8. R.T. IMPACT(FT.LB.)	76.5
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	76.5
11. U.S. KIC (KSI*SQRT(IN.))	209.54

C. MATERIAL PROPERTIES (RIM)

	b,c,e
1. Y.S. (KSI)	122.000
2. U.T.S. (KSI)	134.500
3. ELONGATION	22.1
4. R.A.	67.3
5. FATT (DEG.F)	-110.0
6. R.T. IMPACT(FT.LB.)	84.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	217.99

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
.26 b,c,e	.25 b,c,e	.01 b,c,e	.009 b,c,e	1.57 b,c,e	.40 b,c,e	.12 b,c,e

NI	AS	SB	SN	AL	CU	S
3.50 b,c,e	b,c,e	.0026 b,c,e	.017 b,c,e	b,c,e	b,c,e	.009 b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	61.500
2. 2160 (120%)	(KSI)	69.800

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	3.74
2. A-CR-OS (OVERSPEED) (IN.)	2.82

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	301
2. ESTIMATED MAX DA/DT (IN/HR)	~~.310-004~~

H. CALCULATED CRACK SIZE AS OF MAY 1980 b,c,e
A (IN.) [1.275]

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO b,c,e
A/Acr (OVERSPEED) [.45]

ID # : D081102303

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK		81
2. UNIT	ROBINSON #2 (REP)	
3. CUSTOMER:	CAROLINA P&L	
4. LP#		2
5. LOCATION		GOV
6. DISC#		3
7. TEST NO.	TE26452	

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. (KSI))	[120 ~~100.0~~] b,c,e	~~TE~~ TE
2. SUPPLIER:		
3. Y.S. (KSI)	135.000	b,c,e
4. U.T.S. (KSI)	146.500	
5. ELONGATION	21.0	
6. R.A.	61.3	
7. FATT (DEG.F)	-160.0	
8. R.T. IMPACT(FT.LB.)	63.5	
9. U.S. IMPACT TEMP. (DEG.F)	0.0	
10. U.S. IMPACT ENG. (FT.LB.)	60.0	
11. U.S. KIC (KSI*SQRT(IN.))	189.59	

C. MATERIAL PROPERTIES (RIM)

1. Y.S. (KSI)	135.000	b,c,e
2. U.T.S. (KSI)	146.500	
3. ELONGATION	21.0	
4. R.A.	64.0	
5. FATT (DEG.F)	-160.0	
6. R.T. IMPACT(FT.LB.)		
7. U.S. IMPACT TEMP. (DEG.F)		
8. U.S. IMPACT ENG. (FT.LB.)		
9. U.S. KIC (KSI*SQRT(IN.))	.00	

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.28] b,c,e	[.29] b,c,e	[.03] b,c,e	[.004] b,c,e	[1.66] b,c,e	[.51] b,c,e	[.07] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.66] b,c,e	[.013] b,c,e	[24PPM] b,c,e	[.004] b,c,e	[.001] b,c,e	[.12] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS		
1. 1800	(KSI)	70.600	b,c,e
2. 2160 (120%)	(KSI)	81.600	

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.)	2.18	b,c,e
2. A-CR-OS (OVERSPEED) (IN.)	1.54	

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	239	b,c,e
2. ESTIMATED MAX DA/DT (IN/HR)	~~.938~~-005	

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN) [.064] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.042] b,c,e

ID # : D08110230З

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GOV
6. DISC# 4
7. TEST NO. TD55591

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] (KSI)) b,c,e	TD	
2. SUPPLIER:	MIDVALE HEPPENSTALL	b,c,e
3. Y.S. (KSI)	124.000	
4. U.T.S. (KSI)	132.500	
5. ELONGATION	21.7	
6. R.A.	66.8	
7. FATT (DEG.F)	-120.0	
8. R.T. IMPACT(FT.LB.)	90.0	
9. U.S. IMPACT TEMP. (DEG.F)	75.0	
10. U.S. IMPACT ENG. (FT.LB.)	99.0	
11. U.S. KIC (KSI*SQRT(IN.))	227.94	

C. MATERIAL PROPERTIES (RIM)

1. Y.S. (KSI)	124.500	b,c,e
2. U.T.S. (KSI)	137.000	
3. ELONGATION	21.0	
4. R.A.	64.7	
5. FATT (DEG.F)	-120.0	
6. R.T. IMPACT(FT.LB.)	90.5	
7. U.S. IMPACT TEMP. (DEG.F)		
8. U.S. IMPACT ENG. (FT.LB.)		
9. U.S. KIC (KSI*SQRT(IN.))	229.04	

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.26] b,c,e	[.25] b,c,e	[.01] b,c,e	[.007] b,c,e	[1.70] b,c,e	[.40] b,c,e	[.12] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.33] b,c,e	[ ] b,c,e	[ ] b,c,e	[.017] b,c,e	[ ] b,c,e	[ ] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS		
1. 1800	(KSI)	61.300	b,c,e
2. 2160 (120%)	(KSI)	71.400	

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.) [4.53] b,c,e
2. A-CR-OS (OVERSPEED) (IN.) [3.24]

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [198] b,c,e
2. ESTIMATED MAX DA/DT (IN/HR) [.3171-005]

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN) [.025] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.008] b,c,e

ID # : D081102303

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK		81
2. UNIT	ROBINSON #2 (REP)	
3. CUSTOMER:	CAROLINA P&L	
4. LP#		2
5. LOCATION		GOV
6. DISC#		5
7. TEST NO.	TD55519	

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] *b,c,e* (KSI))	TD
2. SUPPLIER:	BETHLEHEM STEEL
3. Y.S. (KSI)	122.000
4. U.T.S. (KSI)	141.500
5. ELONGATION	19.0
6. R.A.	61.8
7. FATT (DEG.F)	-115.0
8. R.T. IMPACT(FT.LB.)	99.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	99.0
11. U.S. KIC (KSI*SQRT(IN.))	238.05

b,c,e

C. MATERIAL PROPERTIES (RIM)

1. Y.S. (KSI)	122.000
2. U.T.S. (KSI)	142.000
3. ELONGATION	20.0
4. R.A.	67.5
5. FATT (DEG.F)	-115.0
6. R.T. IMPACT(FT.LB.)	100.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	239.33

b,c,e

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
.23 *b,c,e*	.31 *b,c,e*	.05 *b,c,e*	.007 *b,c,e*	1.70 *b,c,e*	.49 *b,c,e*	.10 *b,c,e*

NI	AS	SB	SN	AL	CU	S
3.58 *b,c,e*	*b,c,e*	.0008 *b,e,e*	*b,c,e*	*b,c,e*	*b,c,e*	.008 *b,c,e*

E. BORE STRESS

SPEED (RPM)	STRESS	
1. 1800	(KSI)	63.000
2. 2160 (120%)	(KSI)	72.900

b,c,e

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.)	4.69
2. A-CR-OS (OVERSPEED) (IN.)	3.41

b,c,e

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	178
2. ESTIMATED MAX DA/DT (IN/HR)	~~.220~~ .005

b,c,e

H. CALCULATED CRACK SIZE AS OF MAY 1980
A. (IN) [.015] *b,c,e*

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.004] *b,c,e*

ID # : D08110230 3

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK	81
2. UNIT	ROBINSON #2 (REP)
3. CUSTOMER:	CAROLINA P&L
4. LP#	2
5. LOCATION	GOV
6. DISC#	6
7. TEST NO.	TD55527

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [110.0] (KSI)) b,c,e TD
2. SUPPLIER: BETHLEHEM STEEL

	b,c,e
3. Y.S. (KSI)	124.500
4. U.T.S. (KSI)	139.000
5. ELONGATION	20.0
6. R.A.	67.2
7. FATT (DEG.F)	-115.0
8. R.T. IMPACT(FT.LB.)	101.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	101.0
11. U.S. KIC (KSI*SQRT(IN.))	242.89

C. MATERIAL PROPERTIES (RIM)

	b,c,e.
1. Y.S. (KSI)	119.500
2. U.T.S. (KSI)	136.500
3. ELONGATION	20.0
4. R.A.	68.6
5. FATT (DEG.F)	-115.0
6. R.T. IMPACT(FT.LB.)	99.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	235.76

D. CHEMISTRY (each value b,c,e)

C	MN	SI	P	CR	MO	V
.22	.30	.03	.008	1.70	.50	.12

NI	AS	SB	SN	AL	CU	S
3.63		.0008				.012

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	55.500
2. 2160 (120%)	(KSI)	65.400

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	6.42
2. A-CR-OS (OVERSPEED) (IN.)	4.52

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	193
2. ESTIMATED MAX DA/DT (IN/HR)	0.0

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN) [0] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [0] b,c,e

ID # : D081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GEN
6. DISC# 1
7. TEST NO. TD44541

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD (MIN. Y.S. [110.0] (KSI)) b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL

b,c,e

3. Y.S. (KSI)	116.500
4. U.T.S. (KSI)	132.000
5. ELONGATION	22.6
6. R.A.	66.4
7. FATT (DEG.F)	-120.0
8. R.T. IMPACT(FT.LB.)	72.5
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	72.5
11. U.S. KIC (KSI*SQRT(IN.))	197.07

C. MATERIAL PROPERTIES (RIM)

b,c,e

1. Y.S. (KSI)	116.000
2. U.T.S. (KSI)	133.500
3. ELONGATION	22.8
4. R.A.	69.9
5. FATT (DEG.F)	-120.0
6. R.T. IMPACT(FT.LB.)	80.5
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	208.15

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.27] b,c,e	[.30] b,c,e	[.01] b,c,e	[.009] b,c,e	[1.77] b,c,e	[.52] b,c,e	[.11] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.54] b,c,e	[ ] b,c,e	[.002] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.009] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	62.700
2. 2160 (120%)	(KSI)	71.000

F. CRACK DATA

b,c,e

1. A-CR-OP (1800 RPM) (IN.) 3.13
2. A-CR-OS (OVERSPEED) (IN.) 2.36

G. SERVICE DATA

b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) 377
2. ESTIMATED MAX DA/DT (IN/HR) 0.0

H. CALCULATED CRACK SIZE AS OF MAY 1980 A (IN.) b,c,e [0]

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO A/Acr (OVERSPEED) b,c,e [0]

ID # : D081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1.	BUILDING BLOCK	81
2.	UNIT	ROBINSON #2 (REP)
3.	CUSTOMER:	CAROLINA P&L
4.	LP#	2
5.	LOCATION	GEN
6.	DISC#	2
7.	TEST NO.	TD55576

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: MIDVALE HEPPENSTALL

b,c,e

3.	Y.S. (KSI)	110.000
4.	U.T.S. (KSI)	125.000
5.	ELONGATION	20.5
6.	R.A.	60.4
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	78.5
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	78.5
11.	U.S. KIC (KSI*SQRT(IN.))	200.37

C. MATERIAL PROPERTIES (RIM)

b,c,e

1.	Y.S. (KSI)	116.000
2.	U.T.S. (KSI)	128.000
3.	ELONGATION	22.5
4.	R.A.	69.5
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	80.5
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	208.15

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
.24 b,c,e	.27 b,c,e	.01 b,c,e	.010 b,c,e	1.66 b,c,e	.42 b,c,e	.11 b,c,e

NI	AS	SB	SN	AL	CU	S
3.37 b,c,e	b,c,e	.0020 b,c,e	.017 b,c,e	b,c,e	b,c,e	.010 b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	61.500
2. 2160 (120%)	(KSI)	69.800

F. CRACK DATA

b,c,e

1. A-CR-OP (1800 RPM) (IN.)	3.39
2. A-CR-OS (OVERSPEED) (IN.)	2.55

G. SERVICE DATA

b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	301
2. ESTIMATED MAX DA/DT (IN/HR)	.314-004

H. CALCULATED CRACK SIZE AS OF MAY 1980

b,c,e

A (IN.) [1.275]

I. CRACK SIZE TO CRITICAL SIZE RATIO

b,c,e

A/Acr (OVERSPEED) [.50]

ID # : D081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GEN
6. DISC# 3
7. TEST NO. TE26453

B. MATERIAL PROPERTIES (HUB)

1. TYPE (MIN. Y.S. [120.0] (KSI)) TE b,c,e

2.	SUPPLIER:	
3.	Y.S. (KSI)	135.500
4.	U.T.S. (KSI)	147.000
5.	ELONGATION	20.5
6.	R.A.	60.8
7.	FATT (DEG.F)	-165.0
8.	R.T. IMPACT(FT.LB.)	61.0
9.	U.S. IMPACT TEMP. (DEG.F)	0.0
10.	U.S. IMPACT ENG. (FT.LB.)	61.0
11.	U.S. KIC (KSI*SQRT(IN.))	191.67

b,c,e

C. MATERIAL PROPERTIES (RIM)

1.	Y.S. (KSI)	135.000
2.	U.T.S. (KSI)	145.500
3.	ELONGATION	20.5
4.	R.A.	62.5
5.	FATT (DEG.F)	-165.0
6.	R.T. IMPACT(FT.LB.)	
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	.00

b,c,e

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
.28 b,c,e	.29 b,c,e	.03 b,c,e	.004 b,c,e	1.66 b,c,e	.51 b,c,e	.07 b,c,e

NI	AS	SB	SN	AL	CU	S
3.66 b,c,e	.013 b,c,e	24PPM b,c,e	.004 b,c,e	.001 b,c,e	.12 b,c,e	.012 b,c,e

E. BORE STRESS

SPEED (RPM)		STRESS
1. 1800	(KSI)	70.600
2. 2160 (120%)	(KSI)	81.600

b,c,e

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.) 2.24
2. A-CR-OS (OVERSPEED) (IN.) 1.58

b,c,e

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) 239
2. ESTIMATED MAX DA/DT (IN/HR) .934-005

b,c,e

H. CALCULATED CRACK SIZE AS OF MAY 1980 A (IN.) [.064] b,c,e

I. CRACK SIZE TO CRITICAL CRACKED SIZE RATIO [.041] b,c,e

ID # : D081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GEN
6. DISC# 4
7. TEST NO. TD55592

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD (MIN. Y.S. [110.0] (KSI)) b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL

3.	Y.S. (KSI)	[123.000
4.	U.T.S. (KSI)	133.000
5.	ELONGATION	22.0
6.	R.A.	67.5
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	90.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	90.0
11.	U.S. KIC (KSI*SQRT(IN.))	227.09]

b,c,e

C. MATERIAL PROPERTIES (RIM)

1.	Y.S. (KSI)	[124.000
2.	U.T.S. (KSI)	132.500
3.	ELONGATION	22.1
4.	R.A.	66.6
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	88.5
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	225.89]

b,c,e

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.26] b,c,e	[.25] b,c,e	[.01] b,c,e	[.007] b,c,e	[1.70] b,c,e	[.40] b,c,e	[.12] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.33] b,c,e	[ ] b,c,e	[ ] b,c,e	[.017] b,c,e	[ ] b,c,e	[ ] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	
1. 1800	(KSI)	[61.300
2. 2160 (120%)	(KSI)	71.400]

b,c,e

F. CRACK DATA

1. A-CR-OP (1800 RPM) (IN.) [4.49
2. A-CR-OS (OVERSPEED) (IN.) 3.21]

b,c,e

G. SERVICE DATA

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [198
2. ESTIMATED MAX DA/DT (IN/HR) ~~.317~~ .005]

b,c,e

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [.025] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/Acr (OVERSPEED) [.008] b,c,e

ID # : D081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1.	BUILDING BLOCK	81
2.	UNIT	ROBINSON #2 (REP)
3.	CUSTOMER:	CAROLINA P&L
4.	LP#	2
5.	LOCATION	GEN
6.	DISC#	5
7.	TEST NO.	TD44488

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [10.0] (KSI)) b,c,e
2. SUPPLIER: MIDVALE HEPPENSTALL b,c,e

3.	Y.S. (KSI)	122.000
4.	U.T.S. (KSI)	136.500
5.	ELONGATION	20.7
6.	R.A.	67.0
7.	FATT (DEG.F)	-120.0
8.	R.T. IMPACT(FT.LB.)	86.0
9.	U.S. IMPACT TEMP. (DEG.F)	75.0
10.	U.S. IMPACT ENG. (FT.LB.)	86.0
11.	U.S. KIC (KSI*SQRT(IN.))	220.77

C. MATERIAL PROPERTIES (RIM)

b,c,e

1.	Y.S. (KSI)	117.000
2.	U.T.S. (KSI)	131.000
3.	ELONGATION	20.9
4.	R.A.	69.7
5.	FATT (DEG.F)	-120.0
6.	R.T. IMPACT(FT.LB.)	86.0
7.	U.S. IMPACT TEMP. (DEG.F)	
8.	U.S. IMPACT ENG. (FT.LB.)	
9.	U.S. KIC (KSI*SQRT(IN.))	216.54

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.25] b,c,e	[.25] b,c,e	[.01] b,c,e	[.007] b,c,e	[1.60] b,c,e	[.39] b,c,e	[.08] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.47] b,c,e	[ ] b,c,e	[.0019] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.010] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	
1. 1800	(KSI)	63.000
2. 2160 (120%)	(KSI)	72.900

F. CRACK DATA

b,c,e

1. A-CR-OP (1800 RPM) (IN.) [3.98]
2. A-CR-OS (OVERSPEED) (IN.) [2.88]

G. SERVICE DATA

b,c,e

1. OPER. TEMP. METAL TEMP. HUB (DEG.F) [178]
2. ESTIMATED MAX DA/DT (IN/HR) [.226-006]

H. CALCULATED CRACK SIZE AS OF MAY 1980
A (IN.) [.015] b,c,e

I. CRACK SIZE TO CRITICAL CRACK SIZE RATIO
A/ACR (OVERSPEED) [.005] b,c,e

ID # : 0081102304

LP TURBINE DISC INFORMATION

A. UNIT IDENTIFICATION

1. BUILDING BLOCK 81
2. UNIT ROBINSON #2 (REP)
3. CUSTOMER: CAROLINA P&L
4. LP# 2
5. LOCATION GEN
6. DISC# 6
7. TEST NO. TD55528

B. MATERIAL PROPERTIES (HUB)

1. TYPE TD
   (MIN. Y.S. [110.0] b,c,e (KSI))
2. SUPPLIER: BETHLEHEM STEEL

	b,c,e
3. Y.S. (KSI)	111.500
4. U.T.S. (KSI)	128.000
5. ELONGATION	20.5
6. R.A.	61.1
7. FATT (DEG.F)	-110.0
8. R.T. IMPACT(FT.LB.)	123.0
9. U.S. IMPACT TEMP. (DEG.F)	75.0
10. U.S. IMPACT ENG. (FT.LB.)	86.0
11. U.S. KIC (KSI*SQRT(IN.))	211.75

C. MATERIAL PROPERTIES (RIM)

	b,c,e
1. Y.S. (KSI)	115.500
2. U.T.S. (KSI)	135.000
3. ELONGATION	21.5
4. R.A.	67.5
5. FATT (DEG.F)	-110.0
6. R.T. IMPACT(FT.LB.)	129.0
7. U.S. IMPACT TEMP. (DEG.F)	
8. U.S. IMPACT ENG. (FT.LB.)	
9. U.S. KIC (KSI*SQRT(IN.))	266.76

D. CHEMISTRY

C	MN	SI	P	CR	MO	V
[.22] b,c,e	[.30] b,c,e	[.03] b,c,e	[.008] b,c,e	[1.70] b,c,e	[.50] b,c,e	[.12] b,c,e

NI	AS	SB	SN	AL	CU	S
[3.63] b,c,e	[ ] b,c,e	[.0008] b,c,e	[ ] b,c,e	[ ] b,c,e	[ ] b,c,e	[.012] b,c,e

E. BORE STRESS

SPEED (RPM)	STRESS	b,c,e
1. 1800	(KSI)	55.500
2. 2160 (120%)	(KSI)	65.400

F. CRACK DATA

	b,c,e
1. A-CR-OP (1800 RPM) (IN.)	4.79
2. A-CR-OS (OVERSPEED) (IN.)	3.34

G. SERVICE DATA

	b,c,e
1. OPER. TEMP. METAL TEMP. HUB (DEG.F)	193
2. ESTIMATED MAX DA/DT (IN/HR)	0.0

H. CALCULATED CRACK SIZE AS OF MAY 1980 b,c,e
A (IN.) [0]

I CRACK SIZE TO CRITICAL CRACK SIZE RATIO b,c,e
A/ACR (OVERSPEED) [0]