Table 3.5-3

INTERNALLY GENERATED ROTATING COMPONENT FAILURE

MISSILES INSIDE CONTAINMENT

Missile Identification	Source of Missile	Location	Missile Characteristics			Calculated Maximum Steel Perforation Depth (in.)	Casing Thickness (in.)	Casing Perforation	Missile Residual Velocity After Casing Perforation (ft/s)	Calculated Thickness of Surrounding Material to Prevent		Remarks
			Velocity (ft/s)	Eq. Dia. (in.)	Weight (lbs)					Concrete Spalling (in.)	Steel Perforation (in.)	
Fan blade	Containment normal ACU fan	Containment building El. 120'	318.9	2.	12.7	0.55	0.375	Yes	210.8	7.2	0.3	Missile cannot fully perforate due to stiffening rings
Fan blade	Containment preaccess normal AFU fan	Containment building El. 140'	200.	2	12.2	0.29	0.375	No	---	---	---	---
Fan blade	CEDM normal ACU unit fan	Containment building El. 200'	264.	2	7.5	0.3	0.375	No	---	---	---	---
Fan blade	Reactor cavity normal cooling fan	Containment building El. 80'	211.	2.5	18.3	0.33	0.375	No	---	---	---	----

MISSLE HAS NO EFFECT ON PLANT SAFE SHUTDOWN CAPABILITY NOR COULD IT RESULT IN A CONDITION CAUSING UNCONTROLLED RELEASE OF RADIOACTIVITY.

8309090307

LOS ANGELES POWER DIVISION

PALO VERDE NUCLEAR GENERATING STATION
PROJECT EVALUATION –
DEFICIENCY EVALUATION REPORT
JOB NO. 10407

REPORT NO. 82-53
REV./DATE 1 7/7/83
PAGE 1 OF 3

PREPARED BY	Q. CLASS	UNIT	REFERENCE DOCUMENTS
K. Stwertnik (NAME) 7-8-83 (DATE)	Q	1	NCR CC-3698

PART 21 REPORTABILITY: IF THE ANSWER TO ANY OF THESE CRITERIA (SEE PQPM 16.2 FOR DEFINITIONS) ARE NO THEN THE CONDITION IS NOT REPORTABLE UNDER PART 21.

1. DOES THE DEFECT EXIST IN A BASIC COMPONENT?	☒ YES	☐ NO
2. DOES THE DEFECT PRESENT A SUBSTANTIAL SAFETY HAZARD?	☐ YES	☒ NO
3. HAS THE COMPONENT BEEN DELIVERED OR OFFERED FOR ACCEPTANCE?	☒ YES	☐ NO

PROJECT EVALUATION ☐ INTERIM REPORT ☒ 50.55(e) FINAL REPORT ☐ PART 21 REPORT

I. CONDITION DESCRIPTION

A vane axial fan (Tag No. 1-M-HCN-A01B); installed in the Unit 1 Containment Building, was shut down after over 1,000 hours of operation when a high amperage condition was noted. Inspection of the fan (54" diameter) showed that three blades had failed. The failures resulted in damage to the fan housing and a blade piece had penetrated the containment liner plate, causing a 2"L x 1/2"W rupture. The fan assembly was removed and returned to the manufacturer, Joy Manufacturing, for examination.

The Joy Manufacturing examination determined the cause of the blade failures to be the result of blades being loose (Reference 1). An inspection performed by Bechtel's Materials and Quality Services concluded the same (Reference 2). Reference 1 provides a definitive analysis of how loose blades allowed a load transferal, leading to a fatigue crack in one blade. This blade ultimately failed, with two additional blades failing upon impact with a section of the first failed blade.

Reference 1 attributes the loose blade condition to undertorqued blade attachments. Reference 3, which contains inspection results of all applicable fans in Unit 1 (blade locknut torque and tip angle values), substantiates this evaluation. Reference 3 further indicates this undertorqued blade attachment condition to be recurrent.

II. ANALYSIS OF SAFETY IMPLICATIONS

An engineering evaluation of the subject fan blade failure, performed by Bechtel Engineering, determined that structures, systems and components necessary to maintain safe shutdown remain fuctional following postulated internally generated missile scenarios.

Specifically, the loss of the normal Containment Building HVAC System has no adverse effect upon plant safe shutdown capability since the system is not an essential system.

1

IDENTIFY CALCULATION OR OTHER DESIGN DOCUMENT WHICH WILL BE INITIATED OR REVISED TO SUPPORT THIS EVALUATION.

See References
DOCUMENT TITLE, NUMBER, AND REVISION AND FORECAST COMPLETION DATE

SAR IMPACT ☒ YES ☐ NO

NGS 7/8/83
NGS DATE

PEM EVALUATION AND REPORTABILITY RECOMMENDATION

PEM 7/8/83
PEM DATE

☐ REPORTABLE
☒ NOT REPORTABLE

Furthermore, in a review of all fans located within the containment, no structure, system, or component necessary for a safe plant shutdown was, nor could be, adversely affected by any internally generated rotating missile. (The fact that the containment liner was damaged is immaterial since the liner provides no safety function during this event.)

Finally, an evaluation of similar fans located outside the containment shows that missiles from these fans will not adversely affect structures, systems or components required for safe plant shutdown. 1

Based upon the above discussion, if left uncorrected, the subject condition would not adversely affect the safety of operations of the plant during the lifetime of the plant. Therefore, this condition is evaluated as not reportable under the requirements of 10CFR50.55(e).

III. CORRECTIVE ACTION

1. The containment liner plate has been repaired per the disposition of NCR CC-3698. The gouges not penetrating the liner plate were ground clean, filled with weld material and smoothed to the original configuration. To repair the cut penetrating the liner plate, some concrete behind the cut was first removed, a steel bar was fitted to provide a base for welding, and the cut was then filled with weld material and ground flush.

2. The failed fan has been replaced as documented by NCR SM-1167.

3. SAR Change Notice 1089 has been initiated to correct a comment to FSAR Table 35-3 indicating a missile cannot leave the casing due to stiffening rings (FSAR Section 3.5.1.2). Missiles from the containment normal air circulation unit fans can penetrate the fan casing (through a neoprene boot connecting the fan to the ducting), but based on a subsequent review, there are no adverse consequences to structures, systems, or components required for safe plant shutdown. This change will be incorporated in a future amendment to the FSAR. No changes have been identified as needed to FSAR Section 3.5.1.1, which addresses internally generated missiles from fans located outside containment. 1

4. As indicated by Reference 3, all Unit 1 fans in containment have been reinspected to assure conformance with correct attachment and correct blade angle.

5. Assurance that this condition will be precluded is being pursued by Bechtel Engineering. A meeting is scheduled to be held with representatives from Joy Manufacturing, The Waldinger Corporation, CVI Corporation and Bechtel Engineering to clarify and assign responsibility for assuring that Joy vane axial fan blades are adjusted and torqued per specification requirements prior to being activiated for Units 2 and 3. 1

6. Based upon the evaluation of this failure, it has been determined that no additional physical protection of safety related equipment is required.

REFERENCES

1. Joy Manufacturing Co. Report No. X-992, "Failure Analysis of 54-26-1770 Steel Rotor Returned on NPR-97152 from Palo Verde Nuclear Station", dated October 22, 1982.

2. Bechtel's Material and Quality Services Trip Report, M&QS Log No. 280157, dated October 1, 1982.

3. The Waldinger Corporation "Verification Report" for Joy fans, attachment to Bechtel Power Corporation Letter B/CVI-E-42846 to CVI Corporation, dated December 6, 1982.

REPORT NO. X-992

DATE October 22, 1982

JOY MANUFACTURING CO.

NEW PHILADELPHIA. OHIO

FAILURE ANALYSIS

OF

54-26-1770 STEEL ROTOR

RETURNED ON NPR-97152

FROM

PALO VERDE NUCLEAR STATION

PREPARED BY T.A. Bissett/

CHECKED BY R.D. Foote/

APPROVED BY Dr. J.A. Murphy/

REVISIONS

DATE	PAGES AFFECTED	REMARKS

BACKGROUND

Fan Unit GF-21587 (Customer Mark No. 1-M-HCN-A01-B) was shut down on 9-13-82 when a high amperage condition was noted. Investigation revealed that there had been a blade failure. This fan is a Model 54-26-1770 with a cast stainless steel hub and blades. It was shipped on 7-19-79 on JOY Shop Order NPX-68083. The operating duty is listed at 80,000 CFM at 7.15 inches total pressure. Factory setting based on an AMCA test performed on the first unit is 15° tip angle (hub angle 45-3/4°). The customer has reported a total running time of the unit of 1116 hours.

The entire unit, including failed blades, was returned to JOY Manufacturing Company for inspection and repair.

INSPECTION

The unit was inspected on 9-28-72. Initial inspection showed that three (3) blades had broken; one (1) on the airfoil and two (2) in the threaded shank. There was some damage to the casing but nothing that cannot be repaired. (See photos 1 thru 5). One (1) of the vanes was bent but it can be straightened. The conduit pipe was missing and the motor lead wires completely covered with grease. Two (2) of the rear support rods were bent but not broken although the eyes on the ends had split. The rotor could still be rotated by hand but it was tight indicating that the bearings were in a failure mode. The nose was then removed. The safety wire was still in place although one (1) piece had been damaged. The two (2) blade shanks with nuts were still inside the nose. It was noticed that of the thirteen (13) remaining blades, ten (10) were loose in the hub. The three (3) blades that were still tight were at a somewhat lower angle than the unit had been operating as indicated by the dirt pattern on the hub (see photo 6). This same dirt pattern was visible on all sockets except one (1). Measurements were made for both settings. See Figure 2 for results.

A crack was also noticed on the convex surface of one (1) of the airfoils. See photo 7.

The blades were numbered consecutively starting at the keyways and proceeding clockwise as one looks at the leading edge of the rotor. See Figure 1. The airfoil with the crack became No. 11. The blades were then removed from the hub.

ANALYSIS

Inspection of the failed blades revealed that the airfoil failure (Blade No. 5), photos 8 and 9, and one (1) shank failure (Blade No. 3), photos 10 and 11, were overload failures resulting from impact. Blade No. 7, however, had the appearance of a classic fatigue failure. See photos 11 and 12. Blade No. 11 was sawed so that the crack could be broken out. See photo 13. This crack was also a fatigue crack which had initiated in a casting flaw on the convex surface of the airfoil.

Chemical analysis was performed on the sample blades. Results are listed in Table 1. Specimens were obtained from the shanks of the blades. Results indicate that the material is 17-4PH. Some variability is evidenced but none can be considered significant enough to affect the physical properties, response to heat treatment, or resistance to corrosion.

Physical test results are shown in Table 2 and are in agreement with the requirements for 17-4PH material. Hardness testing revealed all five (5) blades to be within the range of 32 to 36 HRC.

Sections of the blade shank were polished and etched to reveal the microstructure. No undesirable constituents such as eutectic carbides, grain boundary films, etc., were detected. Some interdendritic micro-porosity was present in small amounts. The microstructure consisted of low carbon martensite with a second phase of retained delta ferrite, which is typical.

Normal operating stress in the blade shank is 20,490 PSI resulting from the centrifugal force of the blade. Normally, bending does not exist at this location because of the method of attachment. For Blade No. 7, the final overload section (center) was approximately .97 inches by .14 inches or .136 square inches. For a tensile stress of 160,000 PSI (tested value), this would support a load of 22,000 lbs. This compares reasonably with the known centrifugal load of 17,540 lbs. This is also strong evidence that the failure was relatively high cycle with low bending stress since a high bending load would have caused failure with a much larger center area remaining. SEM fractography of this surface did not reveal any defects at either crack origin that would be responsible for easy fatigue crack initiation. This same SEM fractography reveals a striation spacing that is shown in Table 3. This spacing is apparently in conflict with the rest of the evidence since it would imply a relatively low number of cycles. However, calculating the number of cycles from striation spacing is not very accurate especially with a relatively high mean stress.

For the stress at the base of the airfoil, refer to Figure 3. At the radial location of the crack found in Blade No. 11, the stresses are 15,300 PSI on the concave surface and negative 300 PSI on the convex surface. Note that the crack initiated on the convex side which has practically no normal operating stress. SEM fractography of the fatigue surface reveals the presence of striations with spacings as shown in Table 4. One cannot calculate the number of cycles exactly for this case either. However, tests indicate that for similar types of loading, the actual number of cycles is approximately 30 times the number of striations. Assuming an average striation spacing of .0003 inches yields a number of cycles of 47,000. At 1770 RPM, the total time for crack propagation is from 13 to 26 minutes depending on whether there was 1 or 2 cycles per revolution.

Comparing normal operating loads to the type of loads necessary to create the failure quickly leads one to the conclusion that there were obviously significant variations from normal operating conditions to lead to the failure sequence.

From previous information, we know that the inlet conditions for this particular fan are such that a considerable flow distortion will be present. This, of course, imposes additional cyclic load on the blades. This fact alone would probably not have caused a blade problem. However, the inspection revealed that the blades were loose in the hub. This allows all cyclic loads to be transferred to the threaded blade shank which is not intended to carry such loads. With the blade being free to rock in the hub, it is possible to calculate stresses as high as 150,000 PSI, depending on the amount of tipping that is assumed. In addition, once the blade is loose, the stress concentration factor in the threads becomes a significant factor on bending stress.

CONCLUSIONS

Based on the above, the most likely sequence of events seems to be:

1. Inlet conditions were such that flow distortion existed and imposed additional cyclic load on the blades.

2. At least 11 of the 16 fan blades became loose in the hub.

3. This allowed the cyclic load to be transferred to the threaded shank leading to a fatigue crack on Blade No. 7, which progressed from both sides (reverse bending) of the shank until there was not enough area left to carry the centrifugal force. Overload failure of the center section of the shank occurred at this point.

4. Impact with the airfoil section of Blade No. 7 caused the overload failures on Blades No. 3 and No. 5.

5. The extremely high unbalance force created by three (3) blades missing in one quadrant caused a heavy tip rub on these blades opposite this quadrant. Looking at photos 4 and 5, it appears that this heavy rub occurred at two (2) locations on the casing. This means there would be a very high intermittent bending load applied twice per revolution. This intermittent load led to fatigue crack at the weak point, which was the casting defect near the base of the airfoil on Blade No. 11. This fatigue crack would not have initiated without the very heavy tip rub created by the initial blade failure. This is also consistent with the findings of the SEM fractography where the striation spacing indicates a relatively high stress, low cycle fatigue crack.

The only question left unanswered is why did the blades become loose in the hub. This is totally inconsistent with the operating history of this fan design. To our knowledge, this is the first instance of this occurring. The most plausible explanation is that the blades were not properly tightened. See photo 6. It is apparent from the dirt pattern on the hub that this unit was operated for some period at two (2) different settings. One (1) setting corresponds to the factory setting. The other is about 9° lower (see Figure 2). This angle is much too uniform to have occurred randomly as the blades loosened. In addition, Blades No. 9, 11 and 14 were still tight but at the same angle.

We are, therefore, forced to the conclusion that someone adjusted the blade angles and in doing so neglected to properly tighten the blade nuts. This allowed the blades to work loose and thus led to the fatigue failure on Blade No. 7 by the sequence of events explained previously.

Note that the inspection revealed that the motor leads were covered with grease. In addition, there was a considerable amount of grease on the back side of the C-face mounting plate. This obviously had nothing to do with the blade problem, however, it does indicate that the motor has been overgreased and is quite likely full of grease. If this is the case, it could lead to overheating of the motor, since air cannot circulate properly inside the motor. Naturally, this motor must be checked and cleaned if necessary. In addition, all other motors at the job site should be checked for this overgreasing condition to avoid premature winding failures.

TABLE 1

CHEMICAL ANALYSIS

	RANGE	2428M	2731M	2355M	3240M	2370M
	--	#3	#4	#5	#7	#11
C	.06 max.	.053	.049	.049	.050	.049
Mn	.70 max.	.66	.56	.74	.54	.69
Si	.50-1.0	.92	1.0	1.0	.71	.97
S	.03 max.	.018	.013	.017	.013	.016
P	.04 max.	.019	.016	.021	.014	.018
Cr	15.5-16.7	15.6	15.7	15.5	15.4	15.5
Ni	3.6-4.6	4.1	3.6	3.7	3.7	3.8
Cu	2.8-3.5	3.0	2.8	2.8	2.8	2.8
Cb+ Ta	.15-.40	.15	.10	.16	.21	.16

TABLE 2

PHYSICAL PROPERTIES

	S/N 2731M	S/N 3240 M	
Tensile Strength (ksi)	167	160	105 min.
Yield Strength (ksi)	151	150	85 min.
Elongation (%)	9.5	8	4
Reduction of Area (%)	19	35	--
Hardness HRC	33	33	36 max.

TABLE 3

STRIATION SPACING ON BLADE SHANK

BLADE NO. 7

STRIATION SPACING inches	CRACK LENGTH (a) inches	
.0005	.25	
.0006	.34	(1)
.0010	.34	(1)
.0006	.44	
.0008	.47	

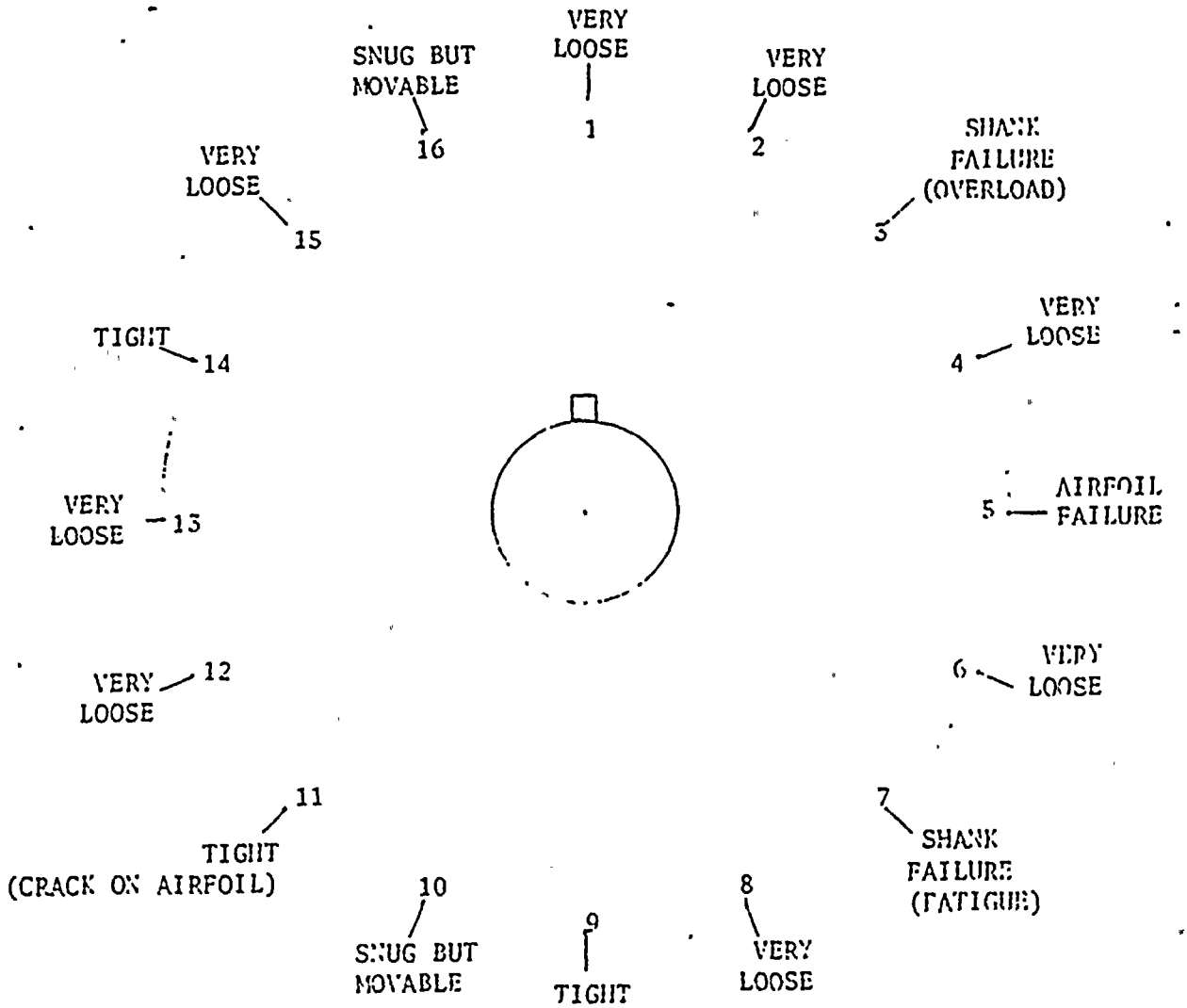
(1) THESE TWO POINTS WERE VERY CLOSELY SPACED.

TABLE 4

STRIATION SPACING AT BASE OF AIRFOIL

BLADE NO. 11

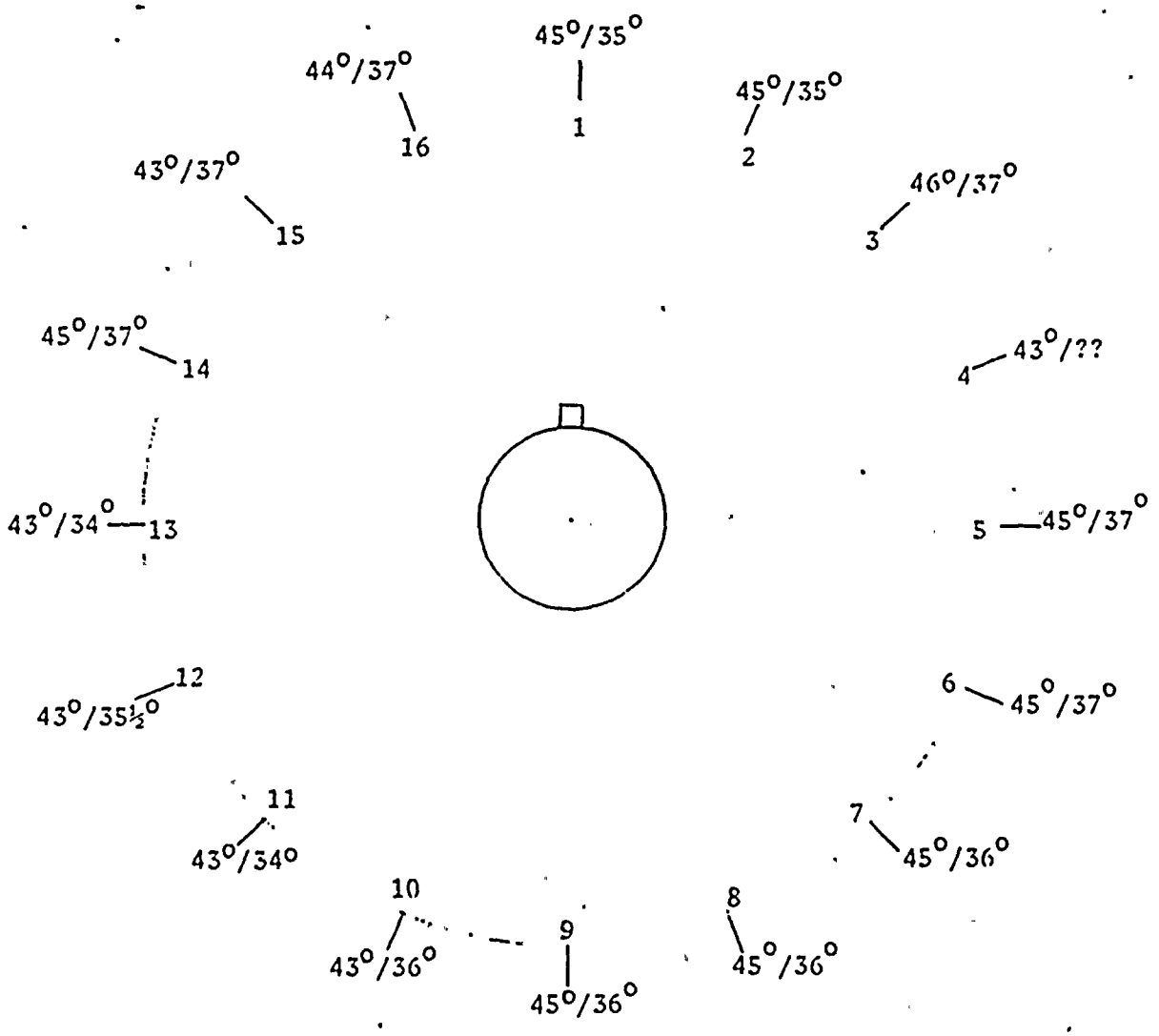
STRIATION SPACING inches	CRACK LENGTH (a) inches
.00025	.10
.00030	.18
.00070	.41
.00067	.47



LOOKING AT LEADING EDGE OF ROTOR

FIGURE 1

SUMMARY OF BLADE STATUS IN HUB



HUB ANGLES AS MEASURED FROM DIRT PATTERN ON HUB. ANGLES ESTABLISHED BY INSTALLING A BLADE, LINING UP WITH THE DIRT PATTERN, THEN MEASURING ANGLE. FIRST NUMBER CORRESPONDS TO ORIGINAL SETTING. SECOND PATTERN ON BLADE NO. 4 WAS NOT SUFFICIENTLY VISIBLE TO ESTABLISH ANGLE.

FIGURE 2

HUB ANGLE VS. BLADE NUMBER

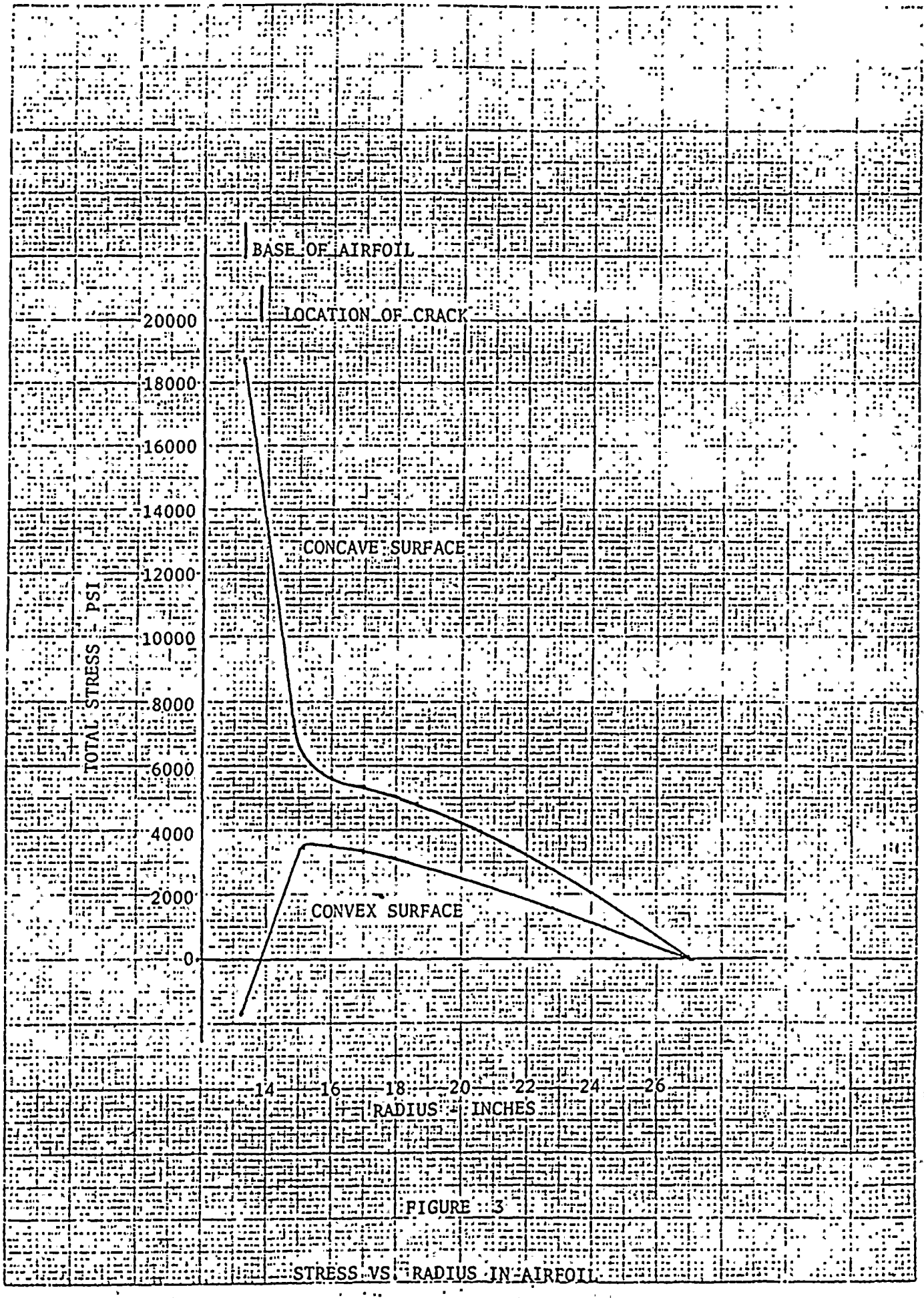
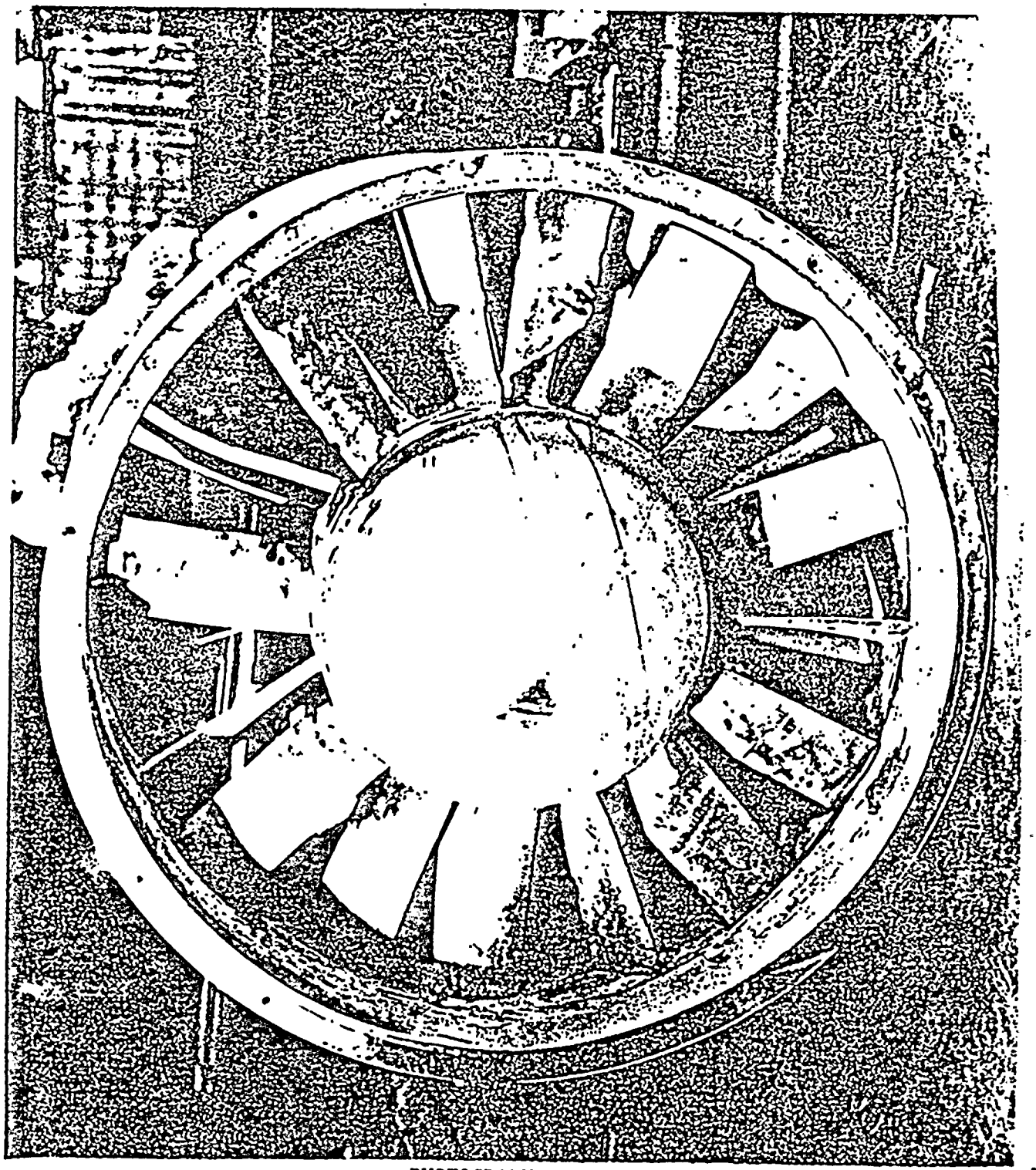


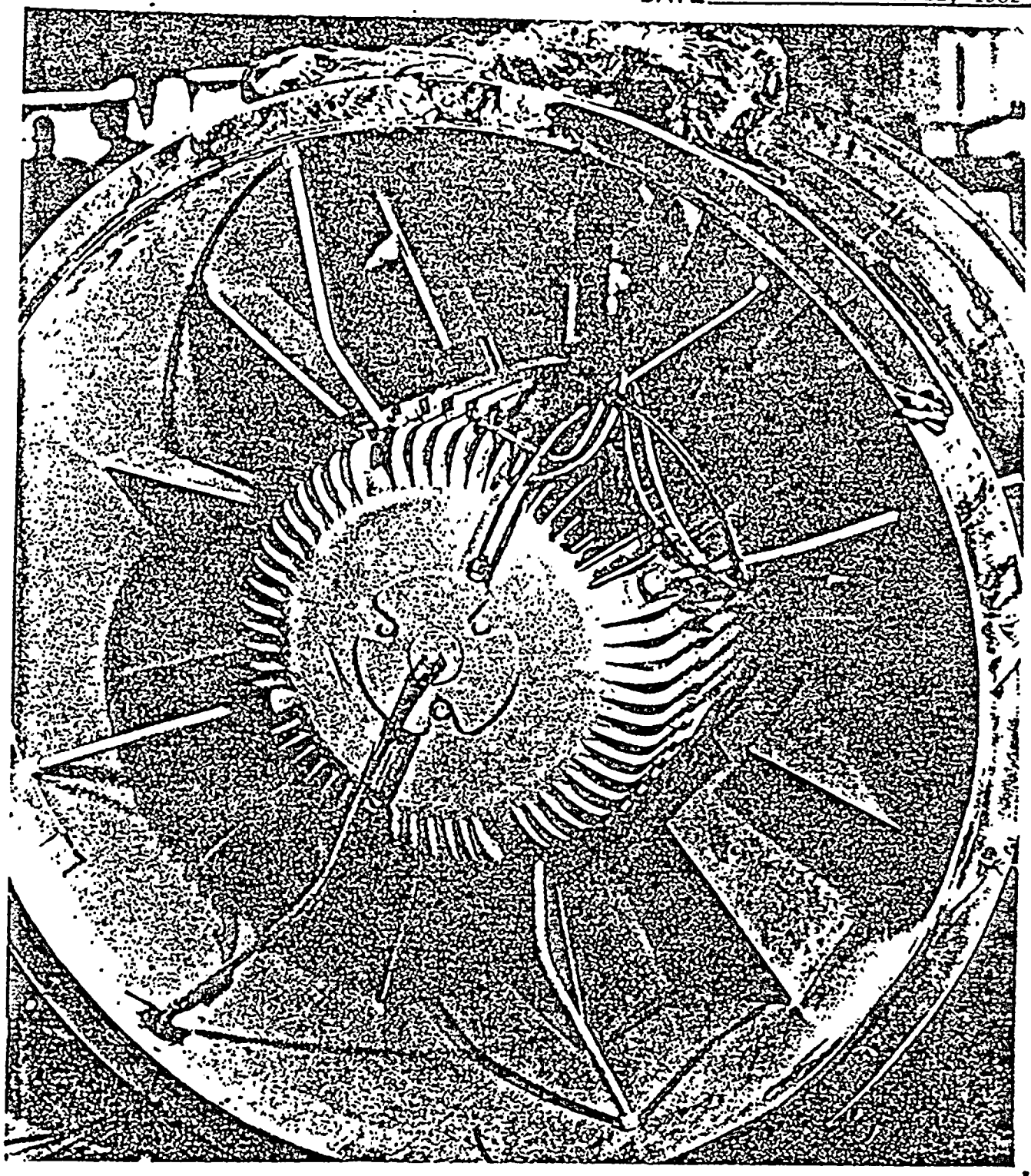
FIGURE 3

STRESS VS RADIUS IN AIRFOIL



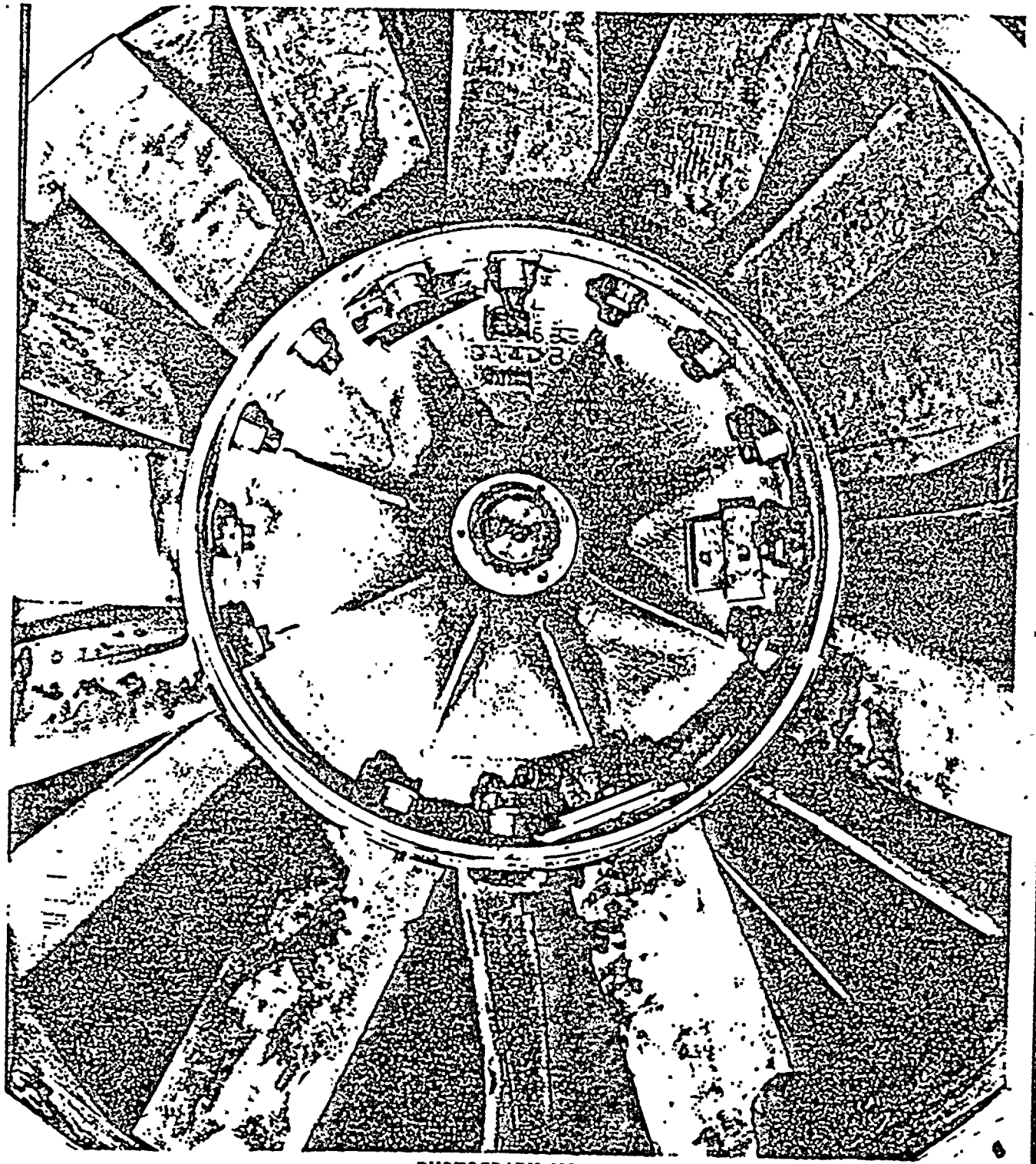
PHOTOGRAPH NO. 1

OVERALL VIEW OF DAMAGE FROM INLET



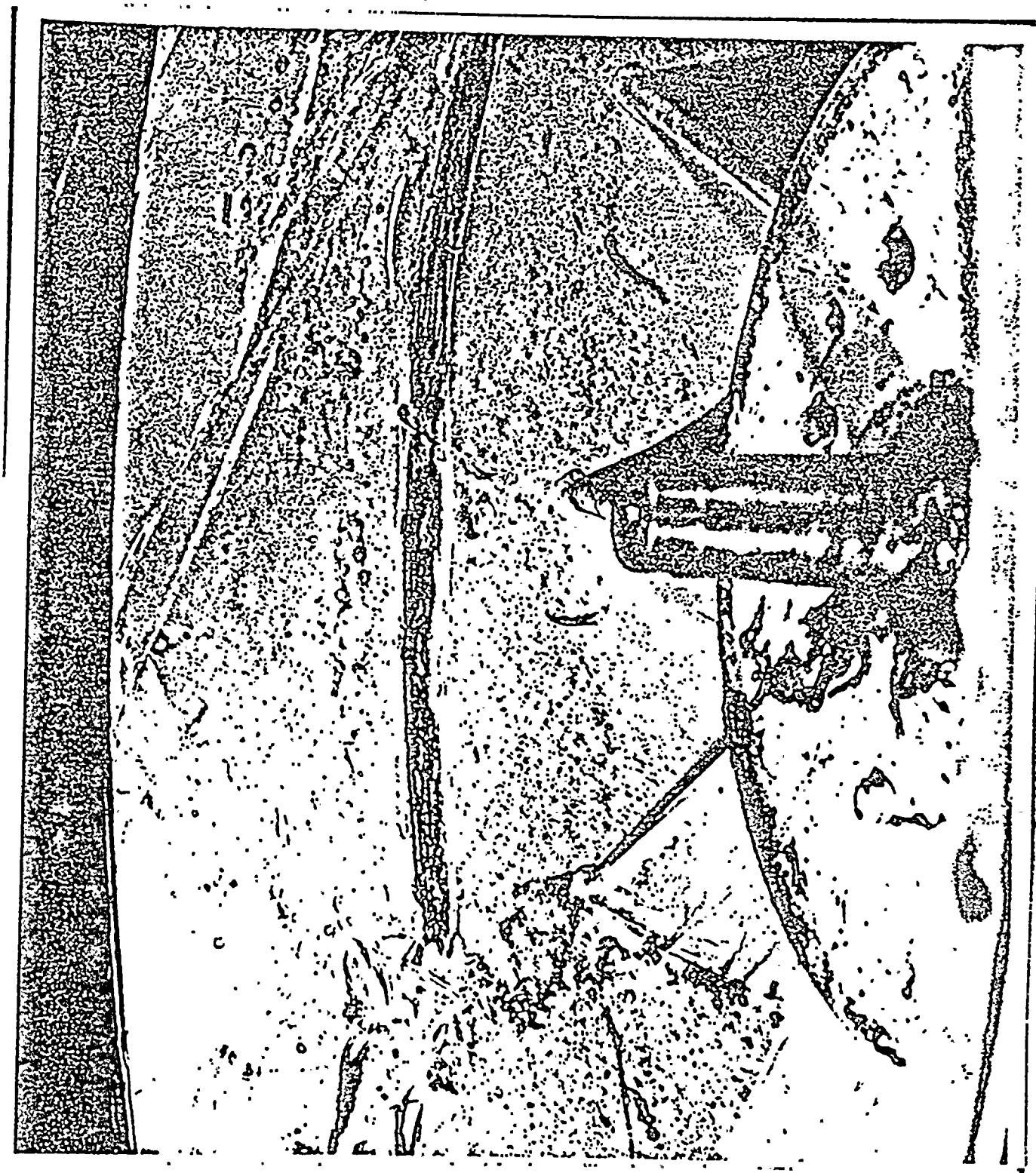
PHOTOGRAPH NO. 2

OVERALL VIEW OF DAMAGE FROM DISCHARGE



PHOTOGRAPH NO. 3

VIEW OF ROTOR WITH NOSE REMOVED

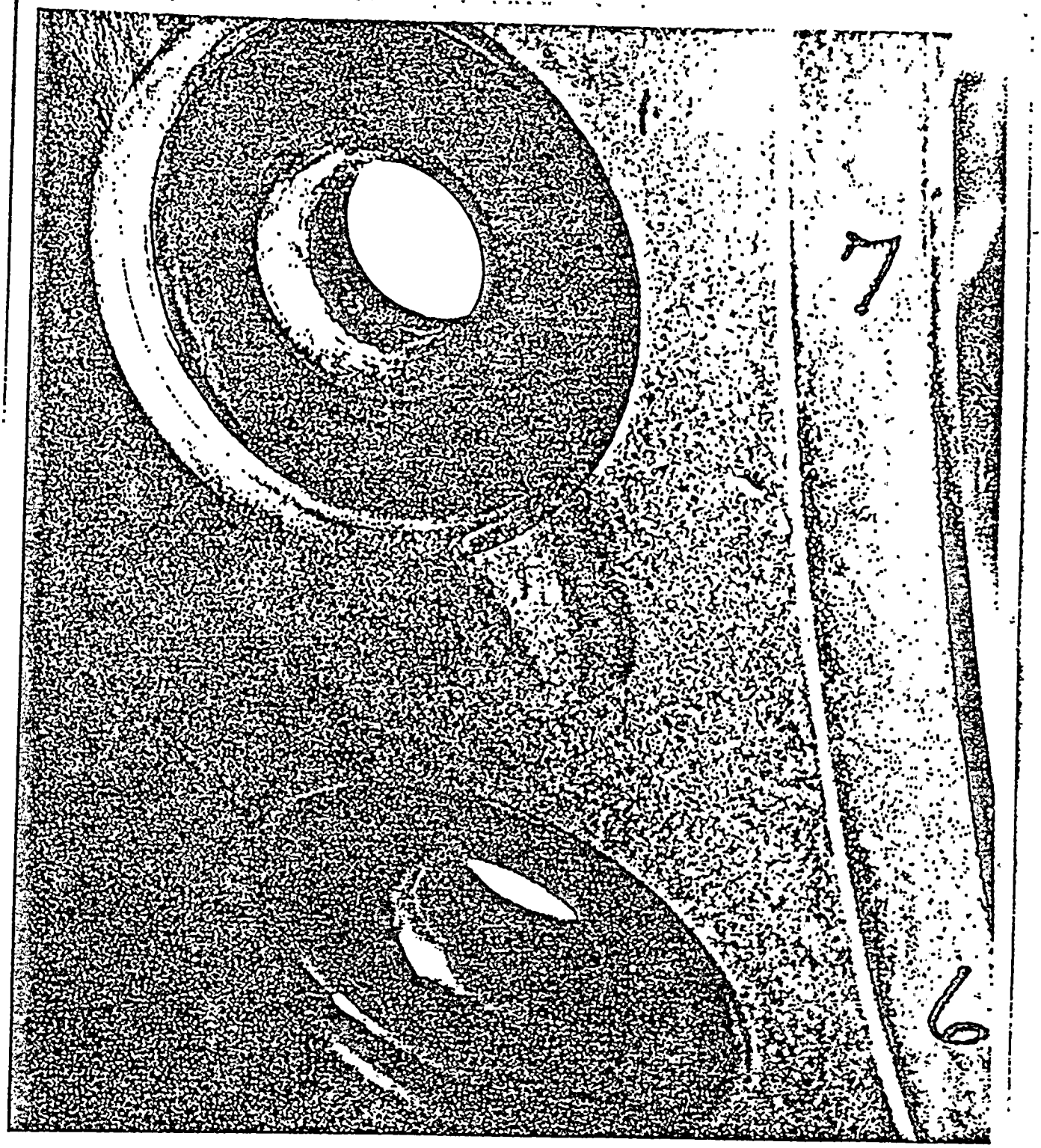


PHOTOGRAPH NO. 4

VIEW OF DAMAGE TO CASING

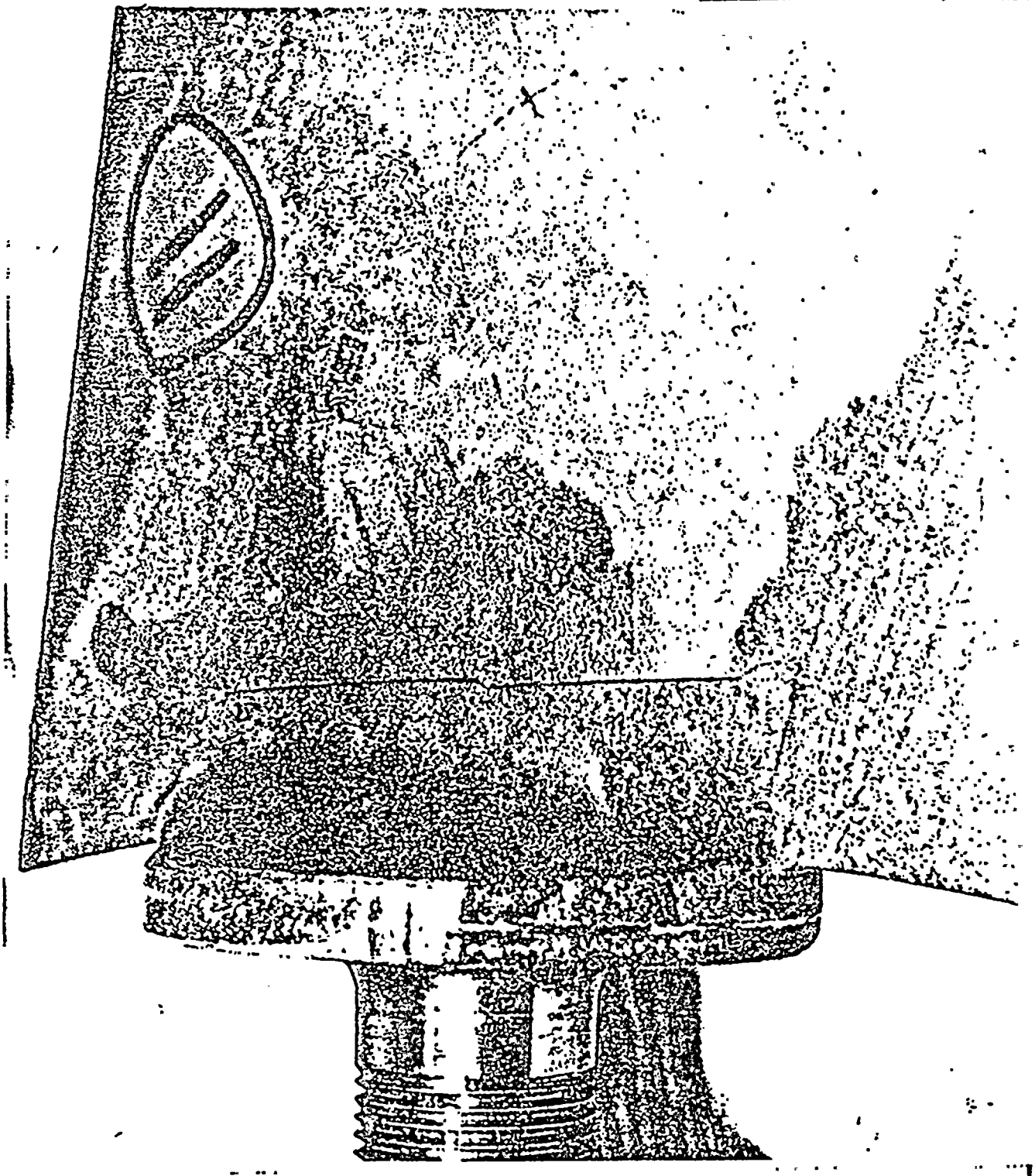
PHOTOGRAPH NO. 5

VIEW OF DAMAGE TO CASING



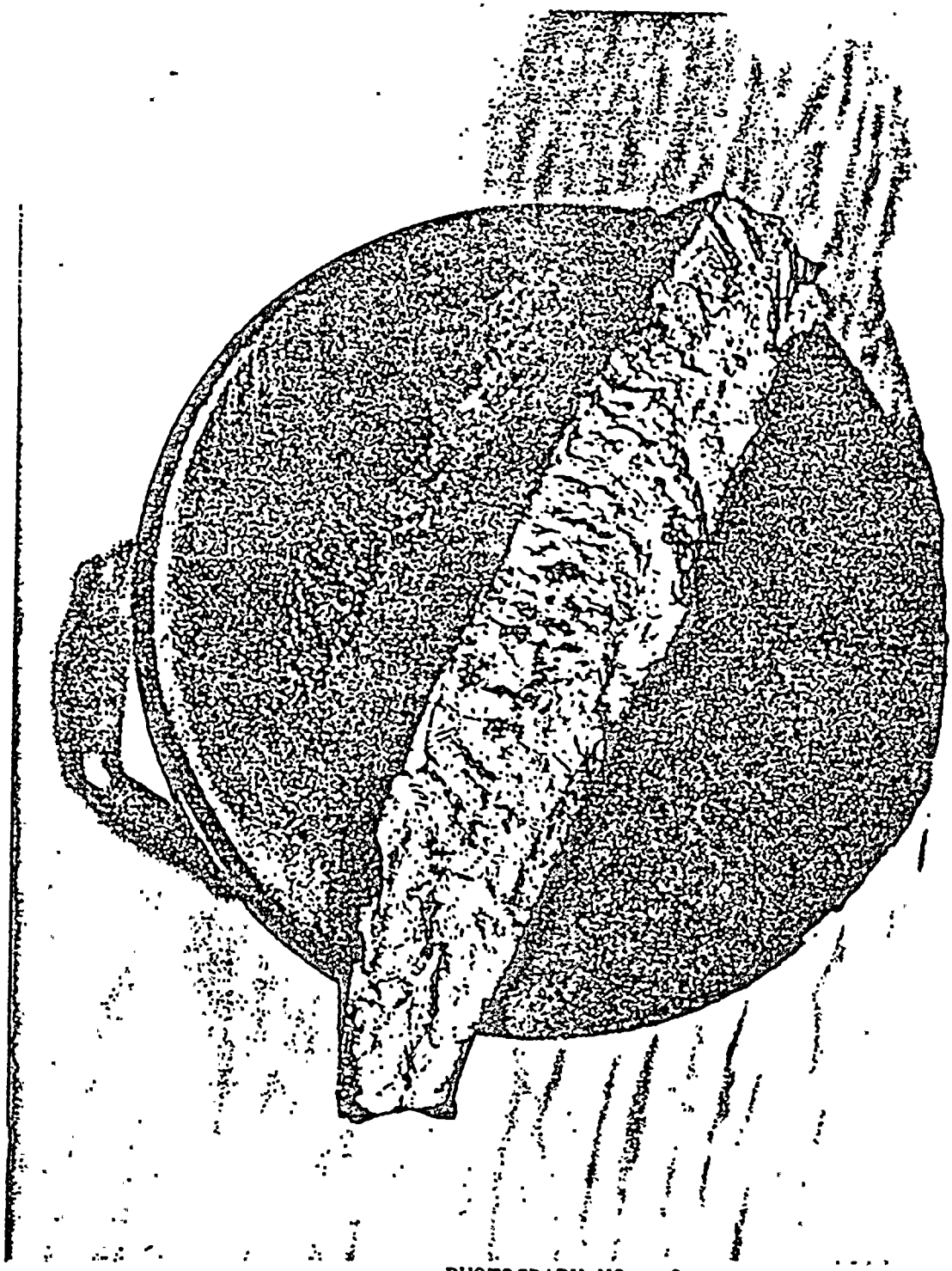
PHOTOGRAPH NO. 6

VIEW SHOWING DUAL DIRT PATTERN ON HUB



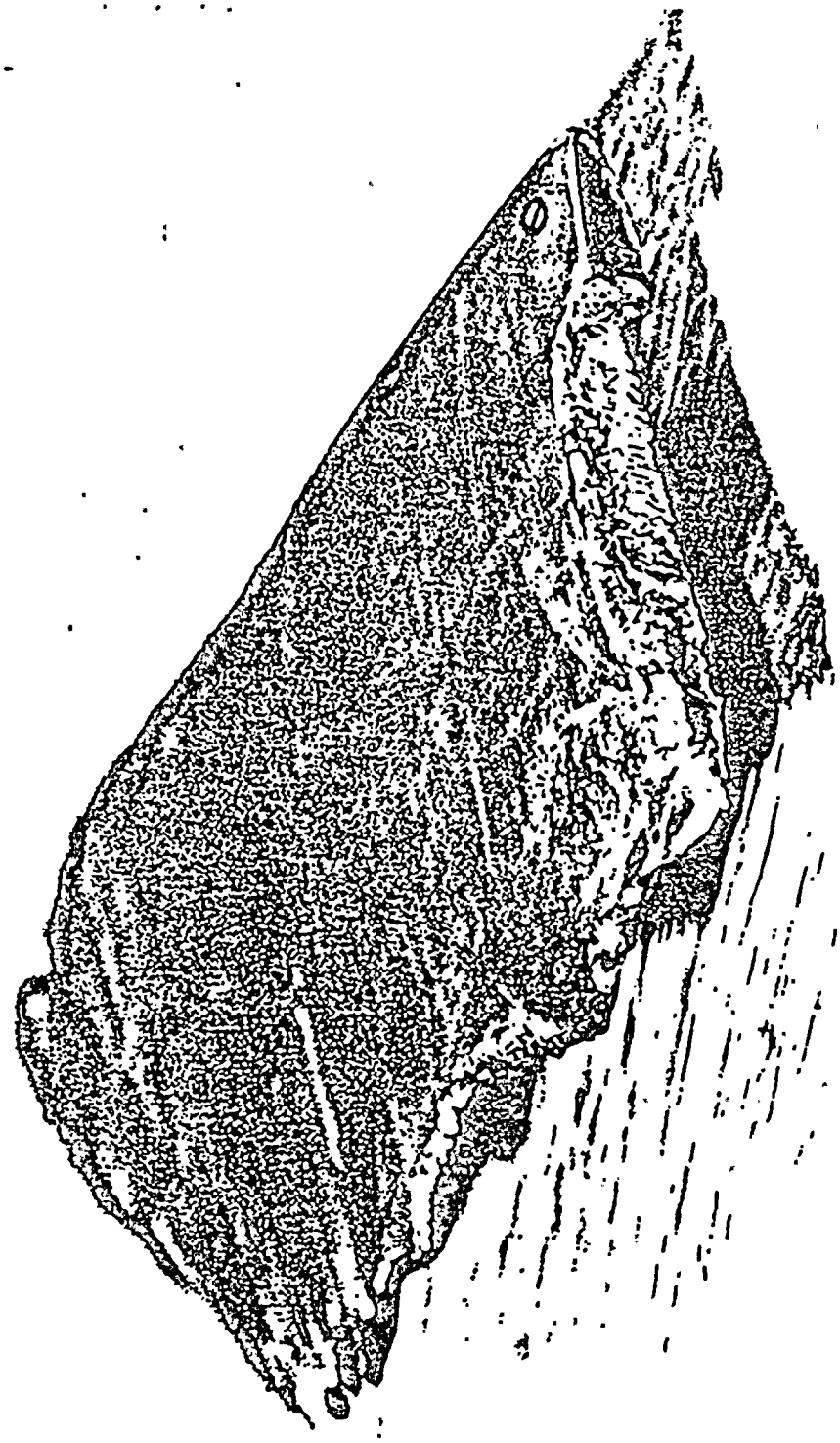
PHOTOGRAPH NO. 7

VIEW SHOWING CRACK ON CONVEX SURFACE OF BLADE NO. 11



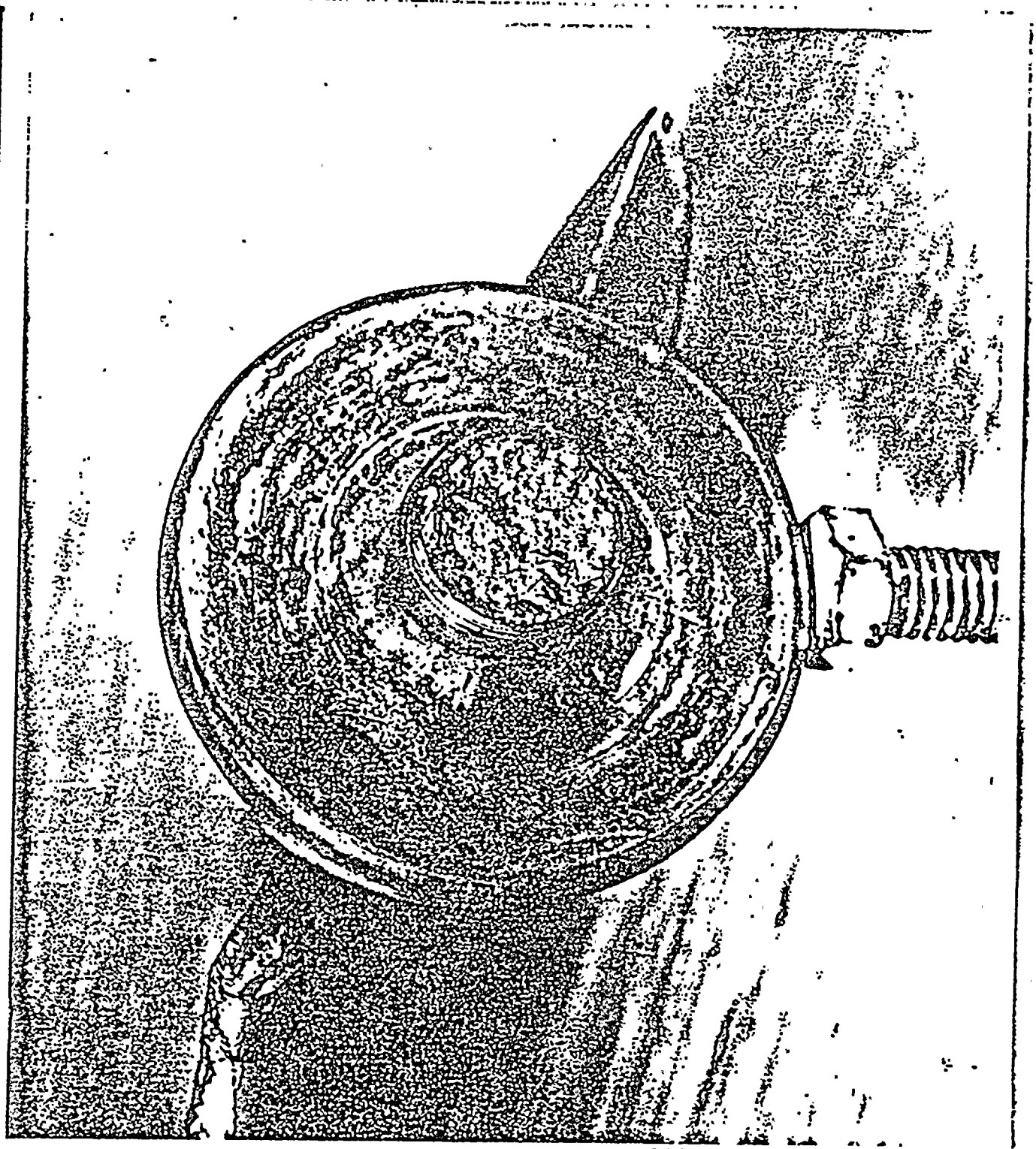
PHOTOGRAPH NO. 8

VIEW OF HUB SIDE OF AIRFOIL FAILURE OF BLADE NO. 5



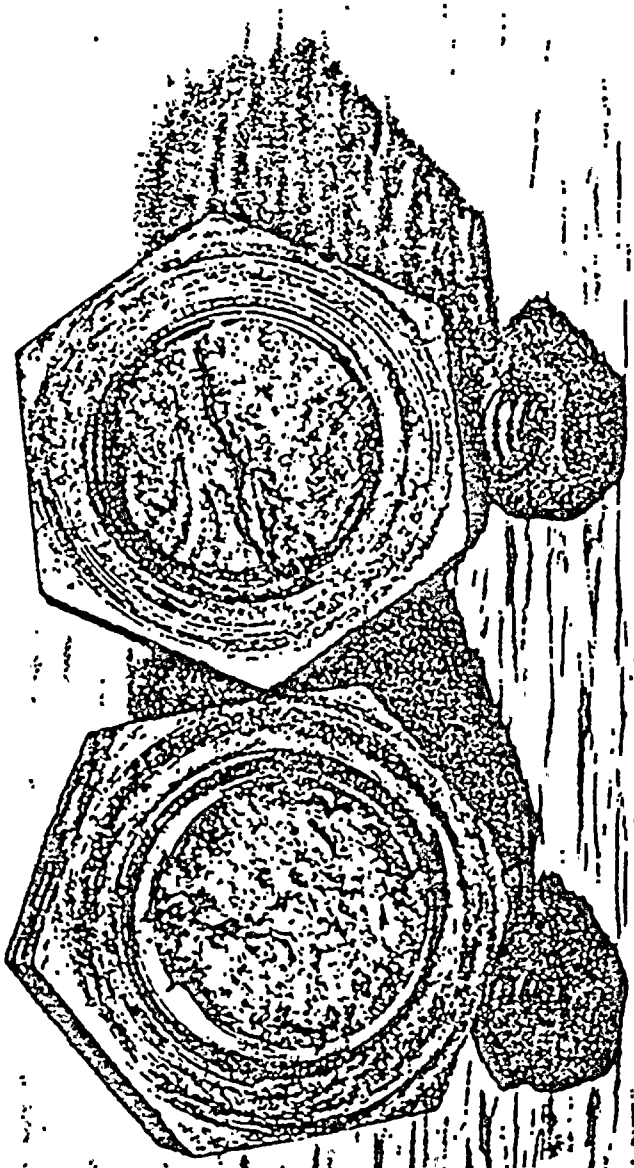
PHOTOGRAPH NO. 9

VIEW OF AIRFOIL SIDE OF AIRFOIL FAILURE ON BLADE NO. 5



PHOTOGRAPH NO. 10

VIEW OF AIRFOIL SIDE OF BLADE NO. 3 (OVERLOAD)

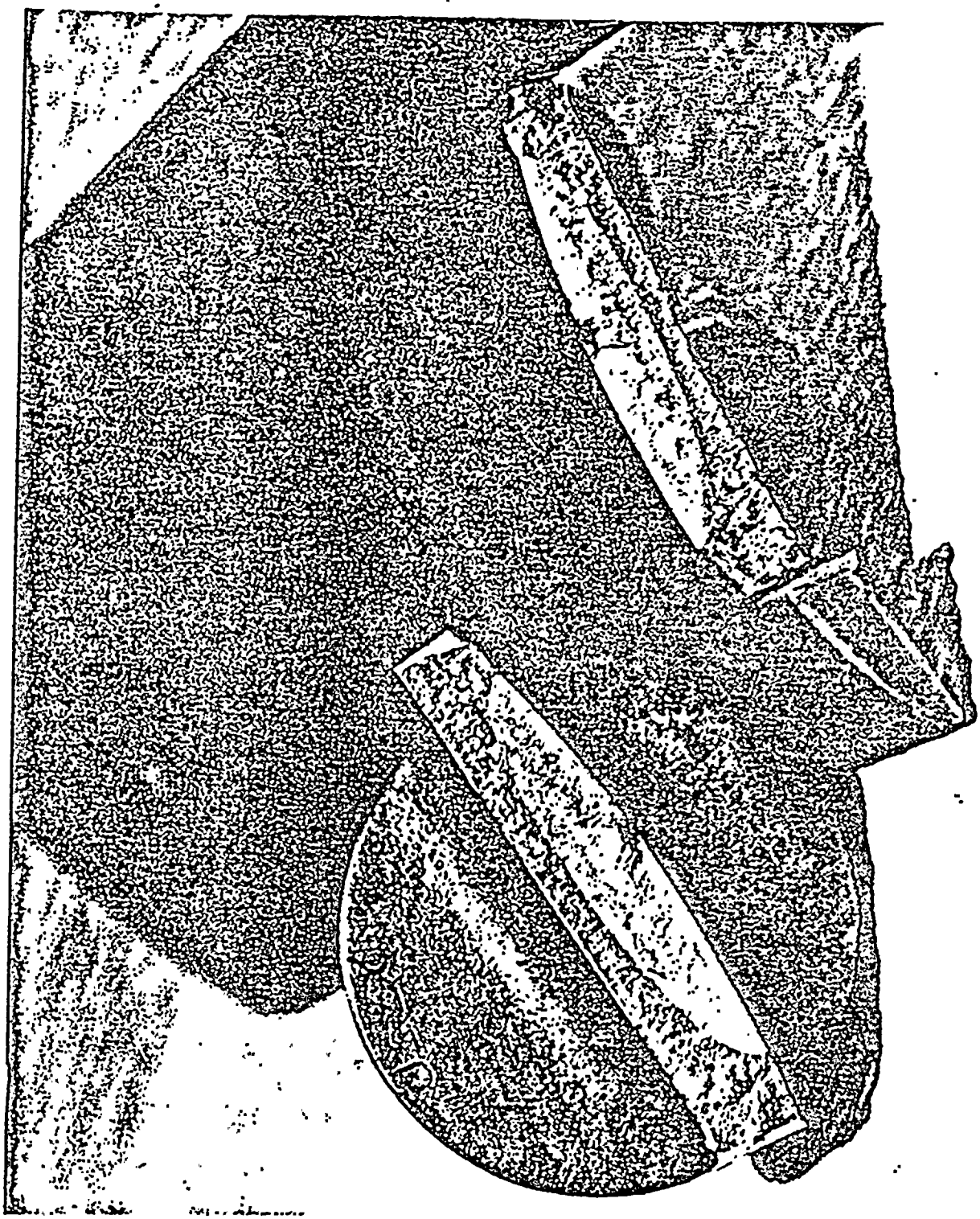


PHOTOGRAPH NO. 11

VIEW OF HUB SIDE OF SHANK FAILURES
BLADE NO. 3 - BOTTOM
BLADE NO. 7 - TOP

PHOTOGRAPH NO. 12

VIEW OF AIRFOIL SIDE OF BLADE NO. 7



PHOTOGRAPH NO. 13

VIEW OF BOTH SIDES OF CRACK IN BLADE NO. 11

1D10
2M

BECHTEL GROUP, INC.
Research and Engineering
Materials and Quality Services

Letter File No. _____

Date October 1, 1982

To: R. A. Keidel From: R. A. White

Location WC/E1/A41 Tel. 930-2404

Subject: **TRIP REPORT**

Date of Trip:

Project Name Palo Verde
Project No. 10407-002 M&QS Log No. 280157
Project Spec. No. 13-MM-620

From Sept. 29 To Oct. 1, 1982

Destination: New Philadelphia, Ohio

Copies to: B. D. Hackney/R. A. Manley
Z. Milatovic'
F. A. Fakhri
W. G. Bingham

Type of Trip:

☒ Supplier Joy Mfg. (Name)

☐ Client _____ (Name)

☐ Jobsite

PURPOSE OF TRIP:

To determine cause of blade failure on a vaneaxial air conditioning fan. 175132

JOB 10407
FILE - M-14-07
mm-620
OCT 5 '82

INTRODUCTION/DESCRIPTION OF PROBLEM:

A vaneaxial fan failed at the Palo Verde jobsite after 11,016 hours. The unit was removed and shipped back to Joy Mfg. for examination.

The fan blades are cast 17-4PH made by Valcast. The hubs are CA40. The nuts and washers that hold the blades to the hub are galvanized steel.

CONCLUSIONS AND RECOMMENDATIONS:

1. The blade failures were a result of the blades being loose.
2. The motor appeared to be overgreased.
3. All similar fans at the jobsite should be checked for torque, blade angle and for cracks visually. The blades in the fan that has operated the longest should be liquid penetrant tested (PT) (without dissassembling) on both sides. All examinations should be witnessed by a Joy representative.
4. The motors should be checked to determine if any others are over greased.

Form MQS-008-1
Rev. 9/81

BECHTEL GROUP, INC.
Research and Engineering
Materials and Quality Services

Letter File No. _____

Date October 1, 1982

To: R. A. Keidel From: R. A. White

Subject: TRIP REPORT (continued)
Project Name Palo Verde
Project No. 10407-002 M&QS Log No. 280157

PARTICIPANTS:

NAME	COMPANY OR PROJECT AFFILIATION AND TITLES
See Attached Sheet	

DETAILS OF INVESTIGATION (discussion of observations, action taken and other pertinent data):

At the time of our arrival the fan had been removed from the housing. The condition was as follows:

1. All blades (or pieces of blades) were loose on the hub.
2. There is dust evidence that the blades ran at two different pitches.
3. One blade failed in the threaded shank by alternating tension - compression.
4. One blade failed in the threaded shank by overload.
5. One blade failed away from the shank from overload.
6. One blade was severely deformed and had a piece missing.
7. One blade had a straight crack away from the hub, parallel to the tip.
8. The remaining blades had various nicks and other signs of mechanical damage.
9. Tip rubbing was evident on most blades except the ones that failed.
10. There were two holes in the housing where failed blades had penetrated.

M&QS REPRESENTATIVE:

R. A. White

Form MQS-008-2 Rev. 03/81

DETAILS OF INVESTIGATION (CONTINUED):

11. The motor electrical leads were covered with grease. Joy reported the bearings were "gone", i.e. badly worn.

12. The hub had only a couple of very minor gouges.

The blades were removed from the hub and fluorescent penetrant inspected. There were some minor surface indications but no additional cracks were detected. The blade that was cracked was cut and broken to reveal the fracture face. This revealed a semi-elliptical crack typical of fatigue from one side.

Valcast agreed to take 5 of the 16 blades (representing the three heats involved) and run chemistry and tensile properties. They also agreed to run scanning electron microscope examinations of the two fatigue failures. This will reveal striation spacing so that a stress level and a stress intensity range (ΔK) can be estimated. Results should be available about October 8. ← Joseph - please follow up

Joy agreed to get a representative to the jobsite about October 4 so the remaining similar fans can be checked.

The fan at Joy should be repaired in about two weeks. The time required to clean the motor governs this schedule.

Joy mentioned that tip rub may not result in a surge in amperage, which was the reason the fans were shut off and examined.

RAN/nlj

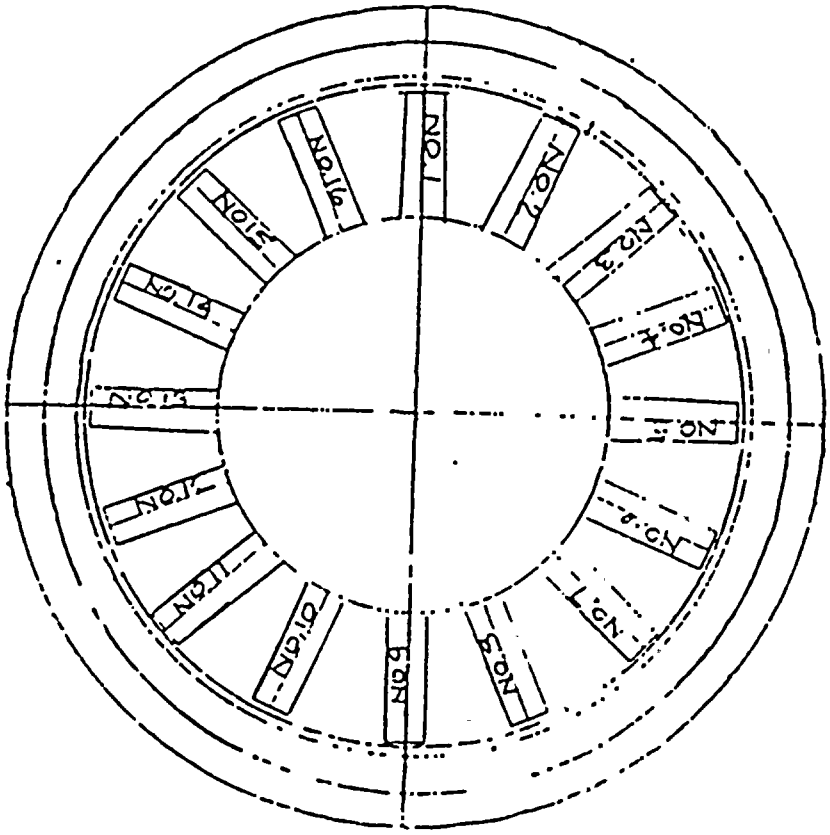
Trip Report
Job 10407

PARTCIPANTS:

NAME	COMPANY OR PROJECT AFFILIATION AND TITLES
Thomas Bissett	Joy, Project Engineer
John Neurnyer	Valcron (Valcast), Sales Eng.
Leonard Ceriotti	Valcast, Division Mgr.
Joe Gersinger	Valcron/Valcast, Sales Dept.
Loren Milatovic'	Bechtel, HVAC Group Ldr.
R. A. White	Bechtel, Materials & Corrosion Group Mgr.
John Murphy	Joy, Mgr.-Engr.
Barry Scholles	Joy, Product Mgr. - Nuclear
Frank Pietro	Joy, Appl. Engineer - Nuclear
Mel McAfee	Joy, Q.A. Analyist

JOY VANE AXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A01B SERIAL NO. CF-21595
(TAGGED 3-M-HCN-A01B DUE TO NCR NO SM-1167)
54" DIA. 26" S.S. HUB SERIES 2000 - SINGLE STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 15°



BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

BLADE NO. 1 - 400 FT./LBS.	9 - 400 FT./LBS.
2 - 400 FT./LBS	10 - 400 FT/LBS.
* 3 - 340-360 FT./LBS.	* 11 - 340-360 FT./LBS.
4 - 400 FT./LBS.	12 - 400 FT./LBS.
5 - 400 FT./LBS.	13 - 400 FT /LBS.
6 - 400 FT./LBS.	14 - 400 FT./LBS.
* 7 - 340-360 FT./LBS.	15 - 400 FT./LBS.
8 - 400 FT./LBS.	16 - 400 FT./LBS.

* INDICATES BALANCING WEIGHT WAS ADDED TO BLADE

TEST RESULTS 10-6-82

P.M. SEE ATTACHED SHEET REFLECTING TORQUE VALUES VERIFIED FOR FAN UNIT TAG NO. 1-M-HCN-A01B. UNIT IS TAGGED 3-M-HCN-A01B DUE TO NCR SM-1167 AUTHORIZING SWITCHING FANS AFTER ORIGINAL FAN LOST BLADES. TIP ANGLES WERE VERIFIED & WERE ALL AT THE REQUIRED 15° TIP ANGLE

R. B. K...
10-6-82

REFERENCE 3 to DER 82-53

bcc: W. G. Bingham
R. R. Stiens
D. R. Bonano
V. Najarian
J. R. Schuh
All w/o encl.

B/CVI-E-42846
MOC 230177
December 6, 1982

CVI Corporation
P. O. Box 2138
Columbus, Ohio 43216

Attention: Mr. Gene Myers
Project Engineer

Subject: Arizona Nuclear Power Project
Bechtel Job 10407
Verification Report for Joy Fans
File: MM-620

Dear Mr. Myers:

Please find enclosed the Verification Report of blade angle and lock nut torque for Containment Building Joy vane-axial fans. This report was prepared by Waldinger's personnel in conjunction with Joy's representative.

This report covers Unit 1 fans only. We request that you provide us your plan of action to assure that a similar problem does not occur on Units 2 and 3.

Please respond by December 15, 1982.

Very truly yours,

BECHTEL POWER CORPORATION

ORIGINAL SIGNED BY:
V. NAJARIAN

W. G. Bingham
Project Engineering Manager
Los Angeles Power Division

WGB:ZM:gt

Enclosure: Verification Report (31 pages, 1 copy)

cc: E. E. Van Brunt, Jr. w/encl.
G. C. Andognini w/encl.
J. R. Bynum w/o encl.
D. B. Fasnacht w/encl.
J. M. Allen w/encl.
APS/DDC w/encl.

WE HEREBY CERTIFY THAT EACH BLADE LOCKNUT HAS BEEN VERIFIED OR RE-TORQUED TO A VALUE OF 400 FT./LBS., AND EACH BLADE TIP ANGLE (AS SPECIFIED BELOW) VERIFIED OR RESET, ON THE FOLLOWING FANS:

FAN UNIT TAG NO.	SERIAL NO.	TIP ANGLE 0°
1-M-HCN-F01A (2-STAGE)	GF-21598	26½°
1-M-HCN-F01B (2-STAGE)	GF-21599	26½°
1-M-HCN-A01A (SINGLE STAGE)	GF-21586	15°
1-M-HCN-A01B (SINGLE STAGE)	GF-21595	15°
1-M-HCN-A01C (SINGLE STAGE)	GF-21588	15°
1-M-HCN-A01D (SINGLE STAGE)	GF-21589	15°
*1-M-HCN-A02A (2-STAGE)	GF-21608	24°
*1-M-HCN-A02B (2-STAGE)	GF-21609	24°
*1-M-HCN-A02C (2-STAGE)	GF-21610	24°
*1-M-HCN-A02D (2-STAGE)	GF-21611	24°
1-M-HCN-A03A (SINGLE STAGE)	GF-21616	29½°
1-M-HCN-A03B (SINGLE STAGE)	GF-21617	29½°
1-M-HCN-A03C (SINGLE STAGE)	GF-21618	29½°
1-M-HCN-A03D (SINGLE STAGE)	GF-21619	29½°

*SECOND STAGE ROTOR HAS NOT BEEN VERIFIED.

Clyde Lester Ethridge — 10-20-82

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

DATE

R. B. Kissel — 10-20-82

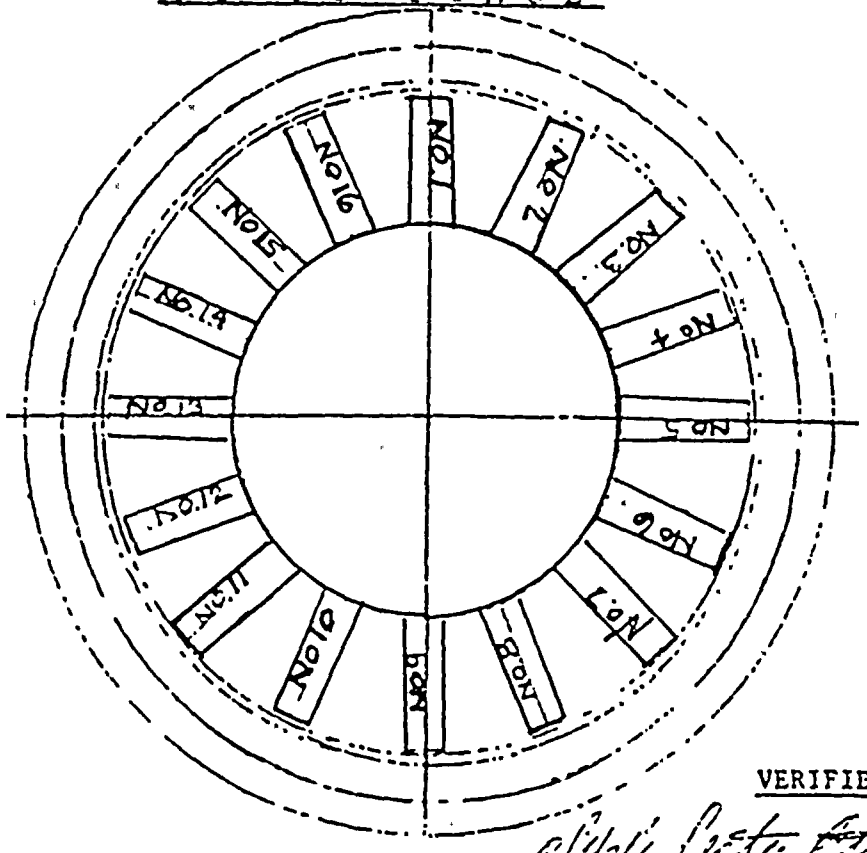
R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER
THE WALDINGER CORPORATION

DATE

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-F01A SERIAL NO. GF-21598
34" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 26½°

FIRST STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE: 10-12-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

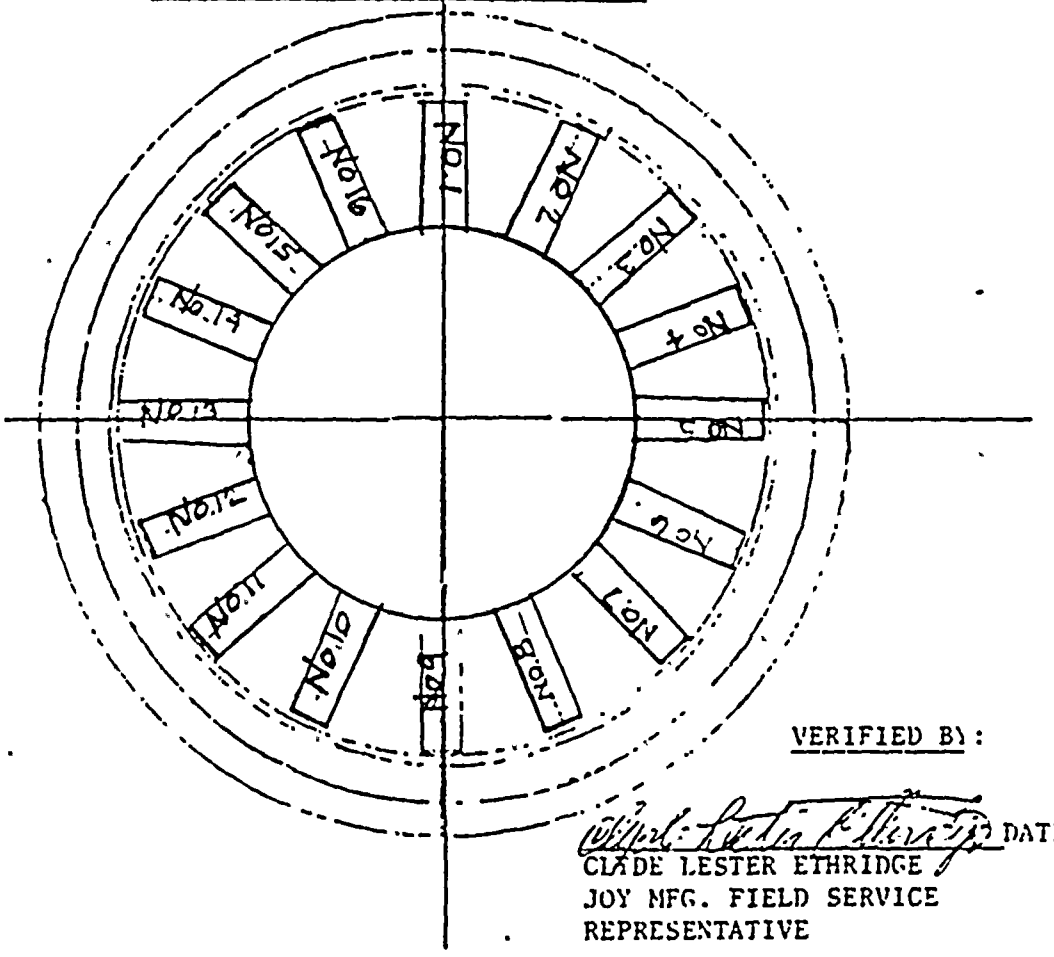
Blade No.	*1 - 280 - 300 Ft./Lbs.	9	- 400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 400 Ft./Lbs.
	4 - 400 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-F01A SERIAL NO. GF-21598
34" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT/LBS.
TIP ANGLE: 26½°

SECOND STAGE



VERIFIED BY:

DATE: 12-11-95

CLADE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

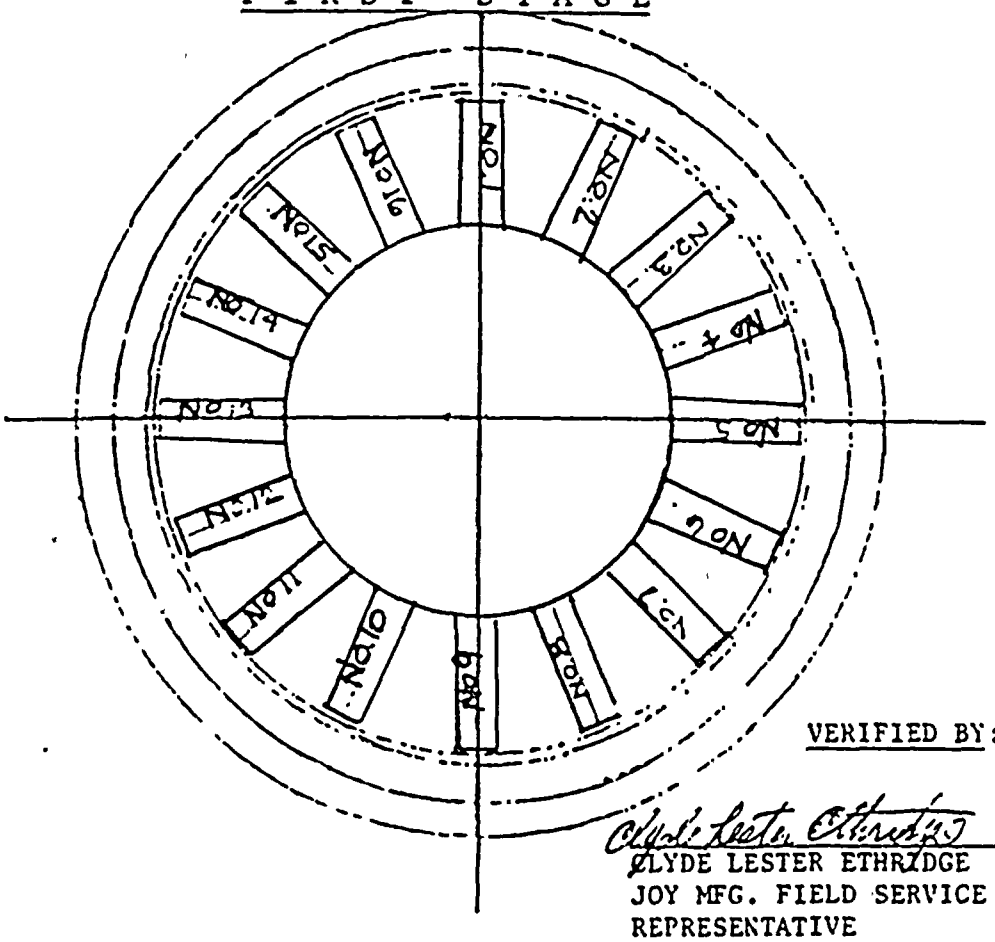
BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

BLADE NO. 1 - 400 Ft./Lbs.
2 - 400 Ft./Lbs.
3 - 400 Ft./Lbs.
4 - 400 Ft./Lbs.
5 - 400 Ft./Lbs.
6 - 400 Ft./Lbs.
7 - 400 Ft./Lbs.
8 - 400 Ft./Lbs. 2° Off
9 - 400 Ft./Lbs.
10 - 400 Ft./Lbs.
11 - 400 Ft./Lbs.
12 - 400 Ft./Lbs.
13 - 400 Ft./Lbs.
14 - 400 Ft./Lbs.
15 - 400 Ft./Lbs. 2° Off
16 - 400 Ft./Lbs.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-F01B SERIAL NO. GF-21599
34" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 26½°

FIRST STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE: 12-12-82
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

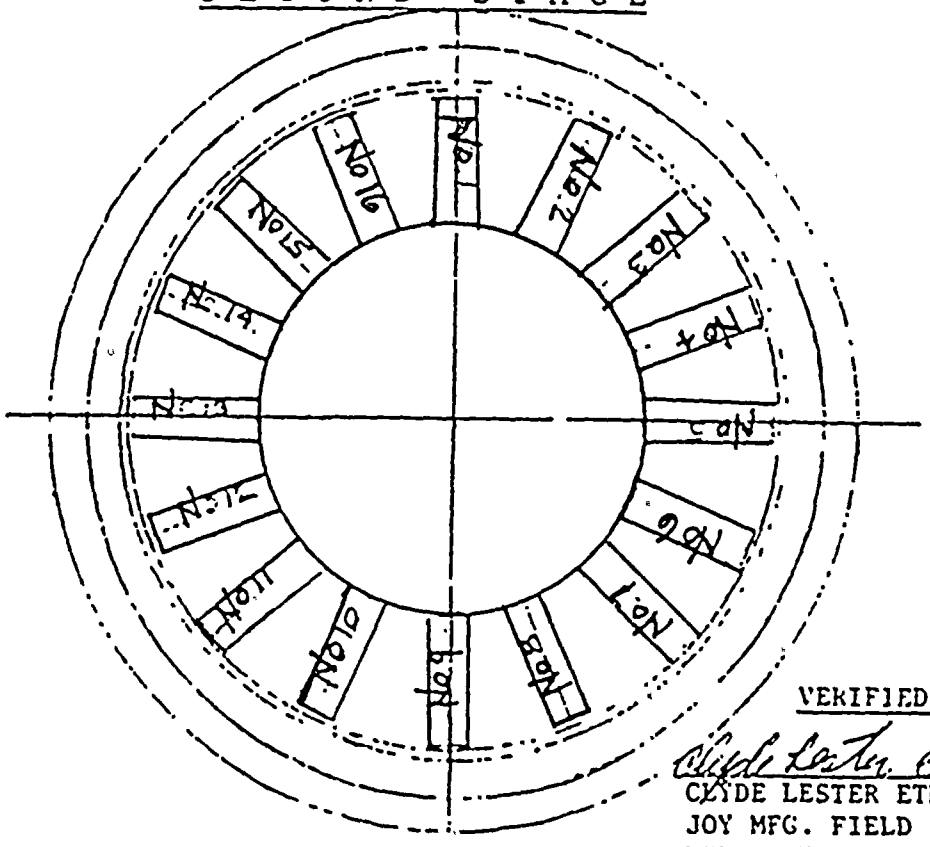
Blade No.	*1 - 360-380 Ft./Lbs.	9	- 400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 360-380 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 400 Ft./Lbs.
	*4 - 400 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "K"
UNIT TAG NO. 1-M-HCN-F01B SERIAL NO. GF-21599
34" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 26½°

SECOND STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE: 12-12-5

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No. *1 - 400 Ft./Lbs. 5½° Off	9 - 400 Ft./Lbs. 5½° Off
2 - 400 Ft./Lbs. 5½° Off	10 - 400 Ft./Lbs. 5½° Off
3 - 340-360 Ft./Lbs. 5½° Off	11 - 400 Ft./Lbs. 5½° Off
4 - 400 Ft./Lbs. 5½° Off	12 - 400 Ft./Lbs. 5½° Off
5 - 400 Ft./Lbs. 5½° Off	13 - 400 Ft./Lbs. 5½° Off
6 - 400 Ft./Lbs. 5½° Off	14 - 400 Ft./Lbs. 5½° Off
7 - 400 Ft./Lbs. 5½° Off	15 - 400 Ft./Lbs. 5½° Off
8 - 400 Ft./Lbs. 5½° Off	16 - 400 Ft./Lbs. 5½° Off

Note: See Attached Verification Report Concerning Tip Angles.

*Indicates Balancing Weight Was Added To Blade.

VERIFICATION REPORT

UNIT TAG NO. 1-M-HCN-F01B SECOND STAGE

REFERENCE: A) CVI FINAL ASSEMBLY DRAWING
FF-15624 REV. A
BECHTEL LOG NO. 13-10407-M620-63-2

B) JOY BLADE SETTING VS. HUB/TIP
ANGLE DRAWING NO. FF-12088
REV. D SHEET 3 of 10 - ATTACHED

VERIFICATION OF TIP ANGLES WAS PERFORMED ON SECOND STAGE ROTOR WITH THE FOLLOWING RESULTS:

(1) LAYOUT OF TIP ANGLE ON SECOND STAGE REFLECTED A 32° ANGLE.

(2) LAYOUT OF TIP ANGLE ON FIRST STAGE RESULTED IN A 26½° ANGLE.

(3) REFERENCE A) DRAWING FAN DATA SPECIFIES A 4 3/4 BLADE SETTING. STAINLESS STEEL ROTORS DO NOT HAVE SETTING INCREMENTS AT ROOT OF BLADE. CROSS-REFERENCING ATTACHED REFERENCE B) DRAWING INDICATES AN APPROX. 26½° REQUIRED TIP ANGLE FOR A 4 3/4 BLADE SETTING. LES ETHRIDGE (JOY MFG. FIELD SERVICE REPRESENTATIVE) CONFIRMED THE 26½° TIP ANGLE WITH INFORMATION SUPPLIED, FROM JOY ENGINEERING.

TIP ANGLES WERE CORRECTED ON SECOND STAGE REFLECTING REQUIRED TIP ANGLE AND FIRST STAGE ROTOR.

R. B. Kissel

R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER

10-15-82

DATE

HARDEN _____ QUENCH _____ DRAW _____

HARDEN _____ QUENCH _____ HARDNESS

UNLESS OTHERWISE NOTED: ALL DIMENSIONS IN INCHES; MACHINING DIMENSIONS LIMITED TO FRACTIONAL ± 1/64, DECIMAL ± .005, ANGULAR ± 1/2°; STRUCTURAL DIMENSIONS LIMITED TO ± 1/16. DO NOT SCALE THIS DRAWING.

E.O. NBU951 DATE 8-12-69

REVISIONS

SERIES 2000 - BLADE SETTING VS HUB & TIP ANGLES

Blade P/N 3387210-2 Controllable Pitch
Blade P/N 3387243-1

26½" Hub

Setting	Hub Angle-Degrees	TIP ANGLE - DEGREES									
		34	36	38	42½	45	48	54	60	66	72
0	63	50	47	44½	40½	38½	36	32	29	26½	25
1	58	45	42	39½	35½	33½	31	27	24	21½	20
2	53	40	37	34½	30½	28½	26	22	19	16½	15
3	48	35	32	29½	25½	23½	21	17	14	11½	10
4	43	30	27	24½	20½	18½	16	12	9	6½	5
5	38	25	22	19½	15½	13½	11	7	4	1½	0
6	33	20	17	14½	10½	8½	6	2	-1	-3½	-5
7	28	15	12	9½	5½	3½	1	-3	-6	-8½	-10
8	23	10	7	4½	½	-1½	-4	-8	-11	-13½	-15
9	18	5	2	-½	-4½	-6½	-9	-13	-16	-	-

PATTERN No. _____ SIMILAR TO _____

FINISH SYMBOLS

SYM	MICRO INCHES	DESCRIPTION	SYM	MICRO INCHES	DESCRIPTION
A	4	PRECISION POLISH	G	250	ROUGH MACH.
B	8	FINE POLISH	H	500	HEAVY ROUGH
C	16	COMMON POLISH	K	1000	EX. HEAVY ROUGH
D	32	GRIND OR EQUAL			
F	63	SMOOTH MACH.			

JOY MANUFACTURING CO.
PLANT LOCATION AS INDICATED BELOW

BUFFALO, N. Y. — NEW PHILADELPHIA, O.
CLAREMONT, N. H.
FRANKLIN, PA.
GALT, ONTARIO, CAN.
GREENOCK, SCOTLAND

SERIES 2000 BLADE SETTING VS HUB/TIP ANGLE FOR ALL FAN DIAMETERS

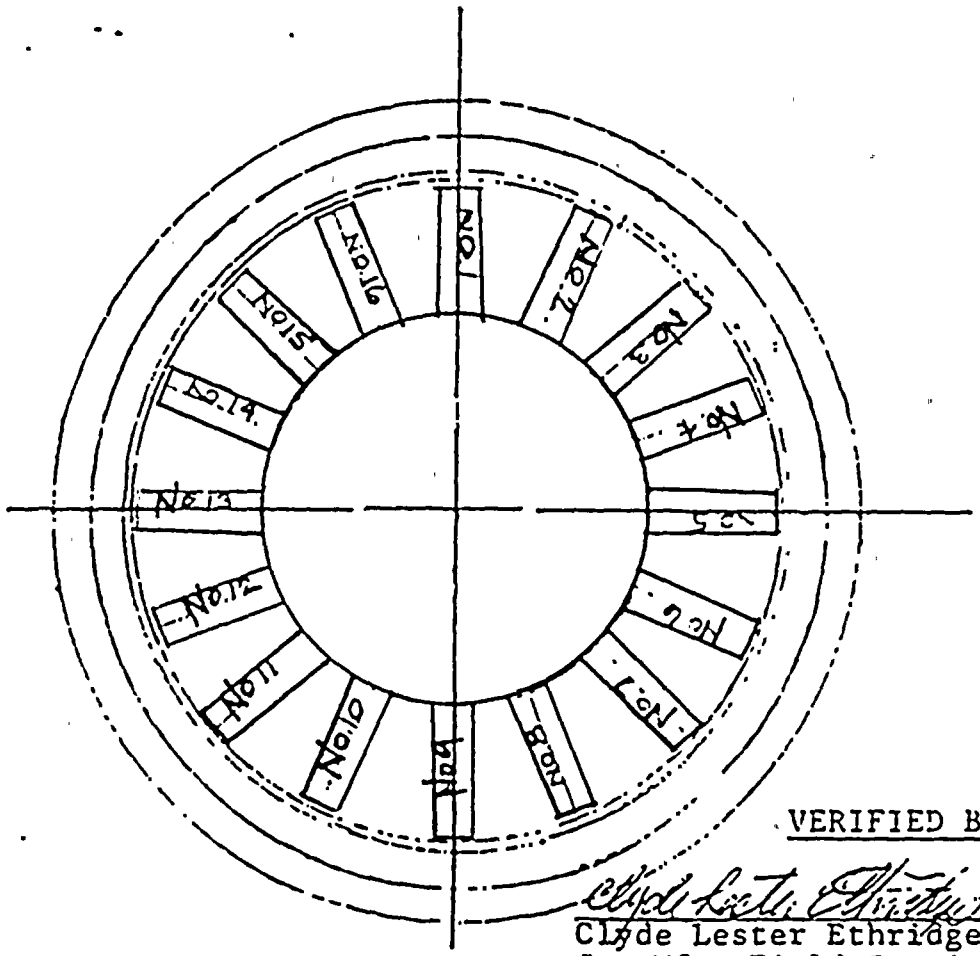
DR. BY R. F. | TR. BY | CK. BY | APPD. BY H. H.
DATE | DATE | DATE | DATE

SUPERSEDES _____ SCALE _____ CLASS _____
SUPERSEDED BY _____
REPLACES _____

FF 12023

Joy Vaneaxial Fan - Quality Class "R"
Unit Tag No. 1-M-HCN-A01A Serial No. GF-21586
54" Dia. 26" S.S. Hub Series 2000 - Single Stage

Blade Locknut Torque: 400 Ft./Lbs.
Tip Angle: 15°



VERIFIED BY:

Clyde Lester Ethridge DATE: 6-7-

Clyde Lester Ethridge
Joy Mfg. Field Service
Representative

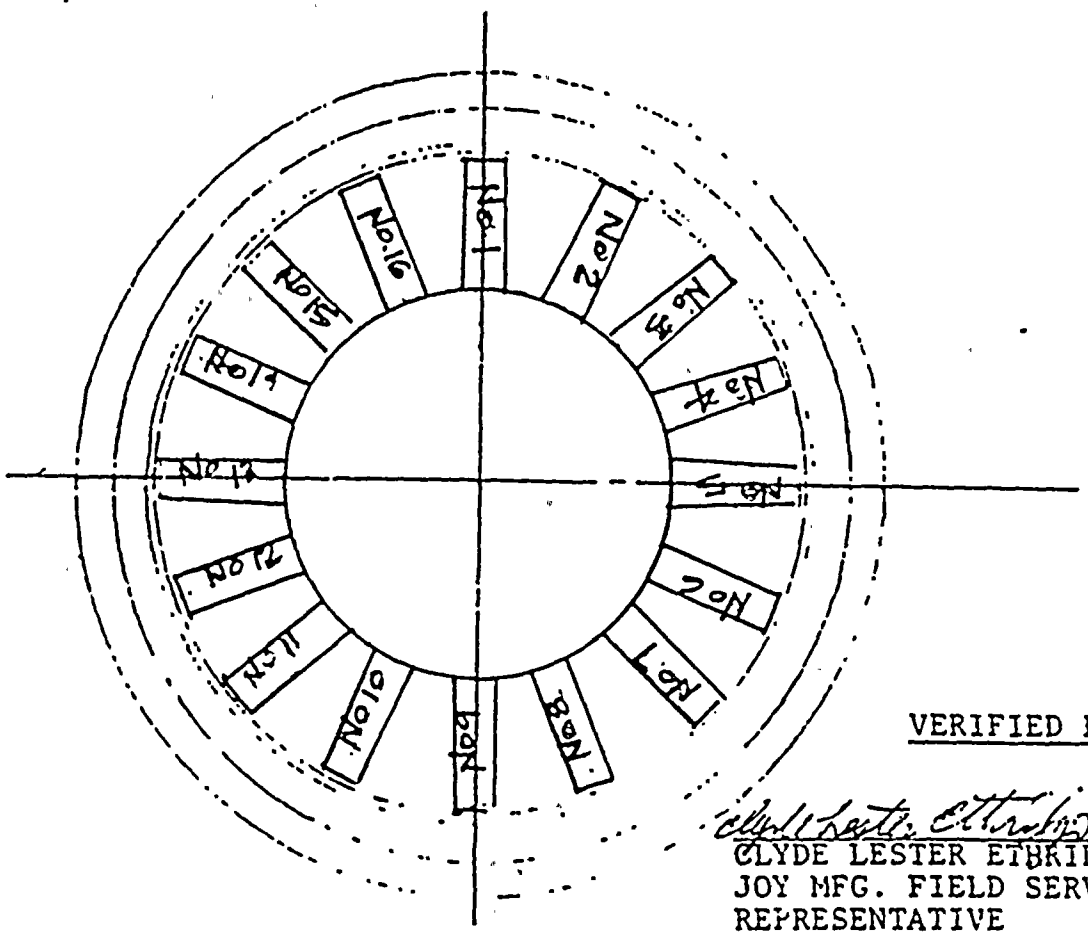
Blade Locknut Torque & Tip Angle Verified @:

Blade No.	*1 - 280 - 300 Ft./Lbs.	9	- 400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	*3 - 320 - 340 Ft./Lbs.	11	- 400 Ft./Lbs.
	4 - 400 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 320 - 340 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A01B SERIAL NO. GF-21595
(TAGGED 3-M-HCN-A01B DUE TO NCR NO. SM-1167)
54" DIA. 26" S.S. HUB SERIES 2000 - SINCLE STAGE

BLADE LOCKNUT TORQUE: 400 Ft./Lbs.
TIP ANGLE: 15°.



VERIFIED BY:

Clyde Lester Ethridge DATE: 10-6-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

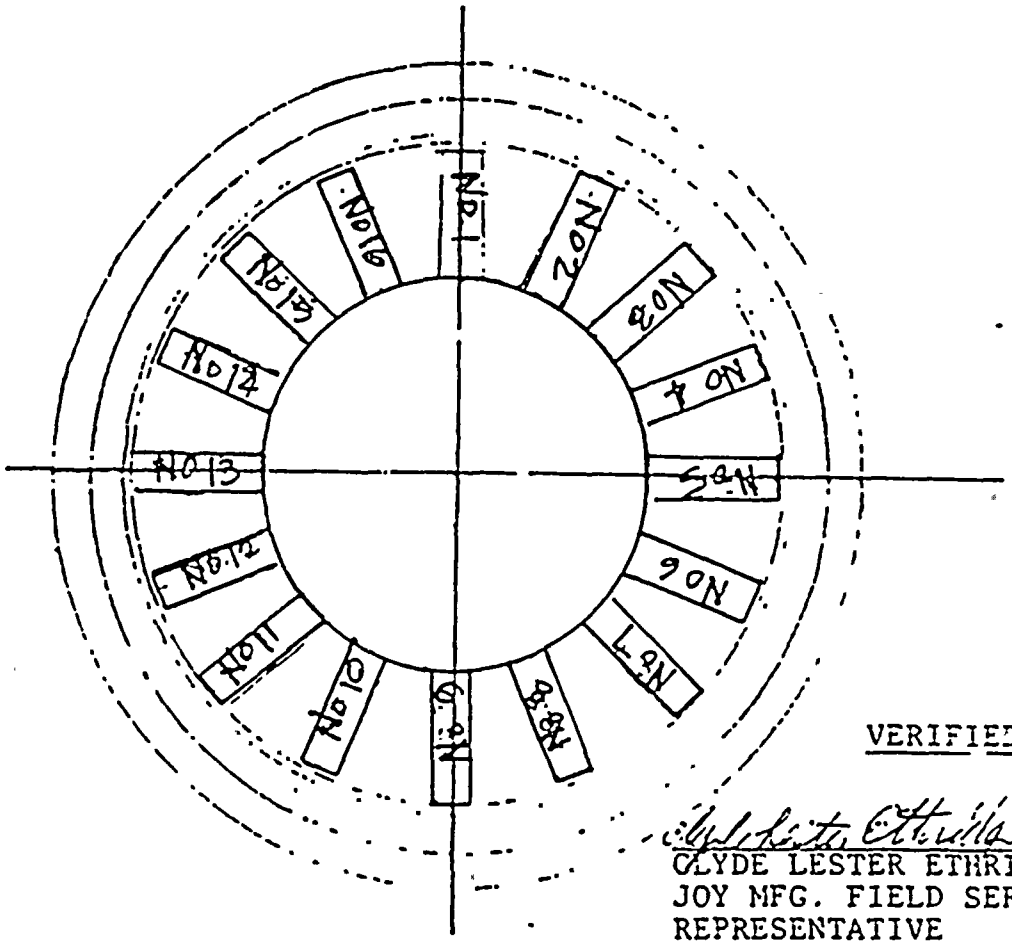
BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

BLADE NO.	1 - 400 Ft./Lbs.	9	- 400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	*3 - 340-360 Ft./Lbs.	*11	- 340-360 Ft./Lbs.
	4 - 400 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	*7 - 360-380 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A01D SERIAL NO. GF-21589
54"' DIA. 26" S.S. HUB SERIES 2000 - SINGLE STAGE

BLADE LOCKNUT TORQUE: 400 Ft./Lbs.
TIP ANGLE: 15°



VERIFIED BY:

Clyde Lester Ethridge DATE 10-6-9

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

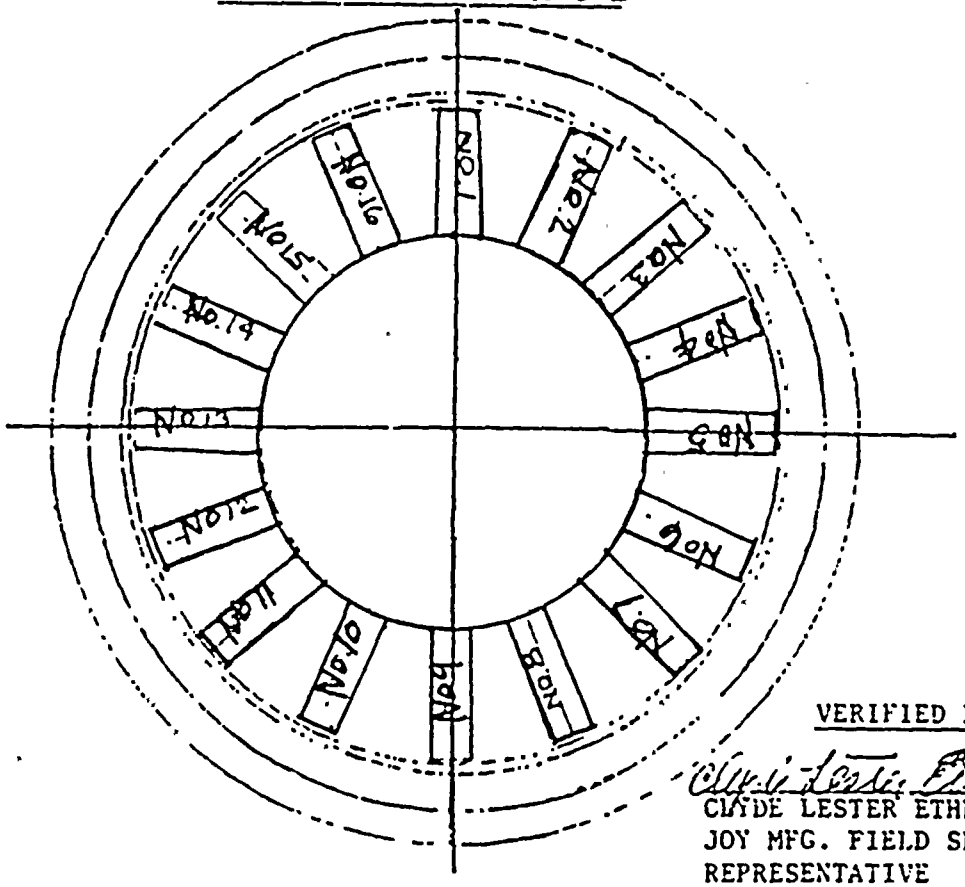
BLADE NO.	1 - 340-360 Ft./Lbs.	9	- 320-340 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 320-340 Ft./Lbs.
	*4 - 280-300 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 320-340 Ft./Lbs.
	*8 - 320-340 Ft./Lbs.	*16	- 320-340 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO.1-M-HCN-A02A SERIAL NO. GF-21608
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 24°

FIRST STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE: 10-1-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

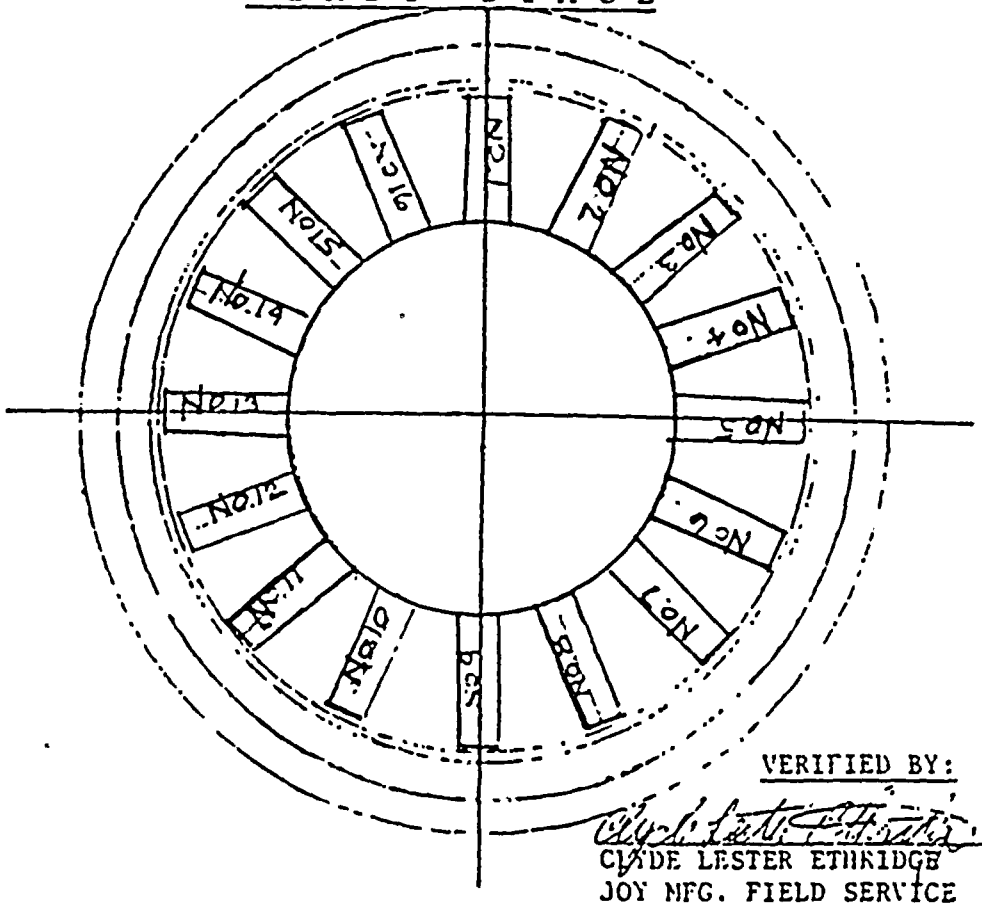
Blade No.	*1 - 400 Ft./Lbs.	9 -	400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10 -	400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11 -	400 Ft./Lbs.
	4 - 400 Ft./Lbs.	12 -	280-300 Ft./Lbs.
	5 - 400 Ft./Lbs.	13 -	400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14 -	400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15 -	400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16 -	400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A02B SERIAL NO. GF-21609
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 24°

FIRST STAGE



VERIFIED BY:

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

DATE: 11-15-

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No.	1 - 400 Ft./Lbs.	9 - 400 Ft./Lbs.	
	2 - 400 Ft./Lbs.	10 - 400 Ft./Lbs.	
	3 - 400 Ft./Lbs.	11 - 400 Ft./Lbs.	
	*4 - 280-300 Ft./Lbs.	12 - 400 Ft./Lbs.	
	5 - 400 Ft./Lbs.	*13 - See Attached Ver. Report	
	6 - 400 Ft./Lbs.	*14 - 360-380 Ft./Lbs.	
	7 - 400 Ft./Lbs.	*15 - 400 Ft./Lbs.	
	8 - 400 Ft./Lbs.	16 - 400 Ft./Lbs.	

*Indicates Balancing Weight Was Added To Blade.

VERIFICATION REPORT

UNIT TAG NO. - 1-M-HCN-A02B FIRST STAGE

VERIFICATION OF "AS INSTALLED" BLADE NO. 13 WAS UNABLE TO BE RECORDED; DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBILITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADE.

DUE TO THE ABOVE SITUATION, LOCKNUT WAS TIGHTENED WITH A (24") CRESCENT WRENCH, AND WE WERE UNABLE TO TURN THE LOCKNUT. PREVIOUSLY, I HAD INSTRUCTED CRAFT TO TRY AND TIGHTEN A LOCKNUT THAT WAS VERIFIED @ 400 FT./LBS. WITH THE SAME (24") CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

R. B. Kissel

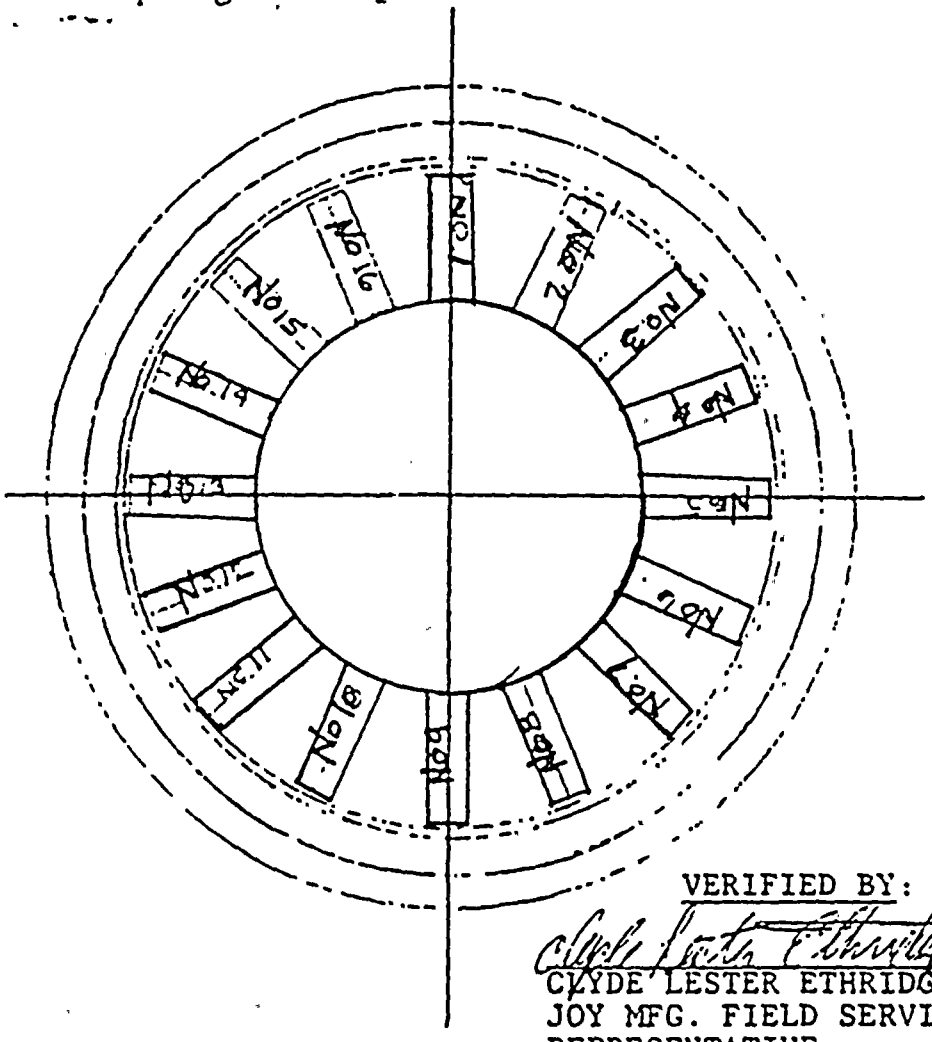
R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER

10-10-82

DATE

Joy Vaneaxial Fan - Quality Class "R"
Unit Tag No. 1-M-HCN-A03A Serial No. GF-21616
36" Dia. 26" S.S. Hub Series 2000 - Single Stage

Blade Locknut Torque: 400 Ft./Lbs.
Tip Angle: 29½°



VERIFIED BY:

DATE: 8-9-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

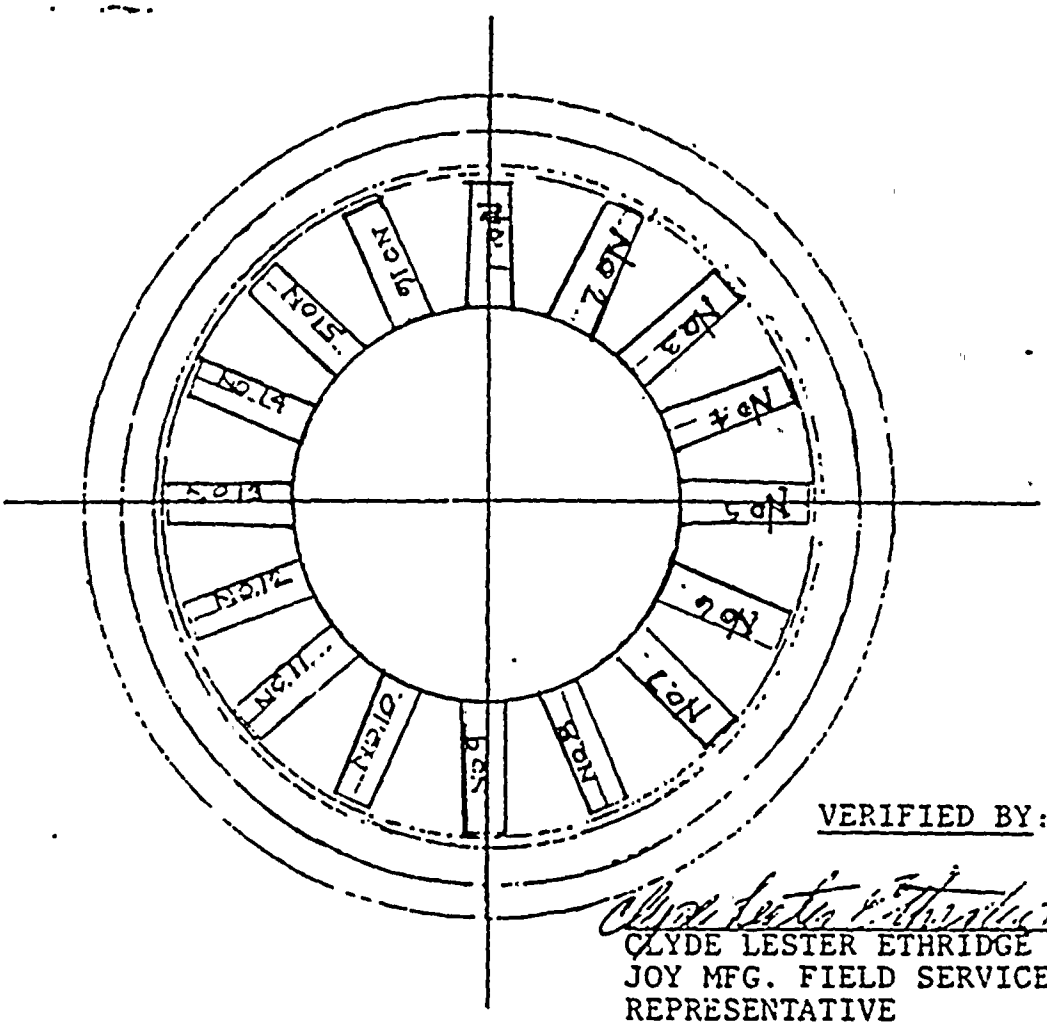
BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No.	*1 - 320 - 340 Ft./Lbs.	*9	- 360 - 380 Ft./Lbs.
	*2 - 400 Ft./Lbs.	*10	- 400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 400 Ft./Lbs.
	4 - 400 Ft./Lbs.	*12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

Joy Vaneaxial Fan - Quality Class "R"
Unit Tag No. 1-M-HCN-A03B Serial No. GF-21617
36" Dia. 26" S.S. Hub Series 2000 - Single Stage

Blade Locknut Torque: 400 Ft./Lbs.
Tip Angle: 29½°



VERIFIED BY:

Clyde Lester Ethridge DATE: 10-7-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

VERIFICATION OF TORQUE & TIP ANGLES WAS UNABLE TO BE PERFORMED ON SUBJECT FAN: DUE TO CRAFT INADVERTENTLY STARTING TORQUEING PROCESSES WHILE LES ETHRIDGE AND MYSELF WERE INVOLVED IN VERIFICATION AT ANOTHER LOCATION. TIP ANGLES WERE CORRECTED AND EACH LOCKNUT TORQUED TO THE SPECIFIED VALUE.

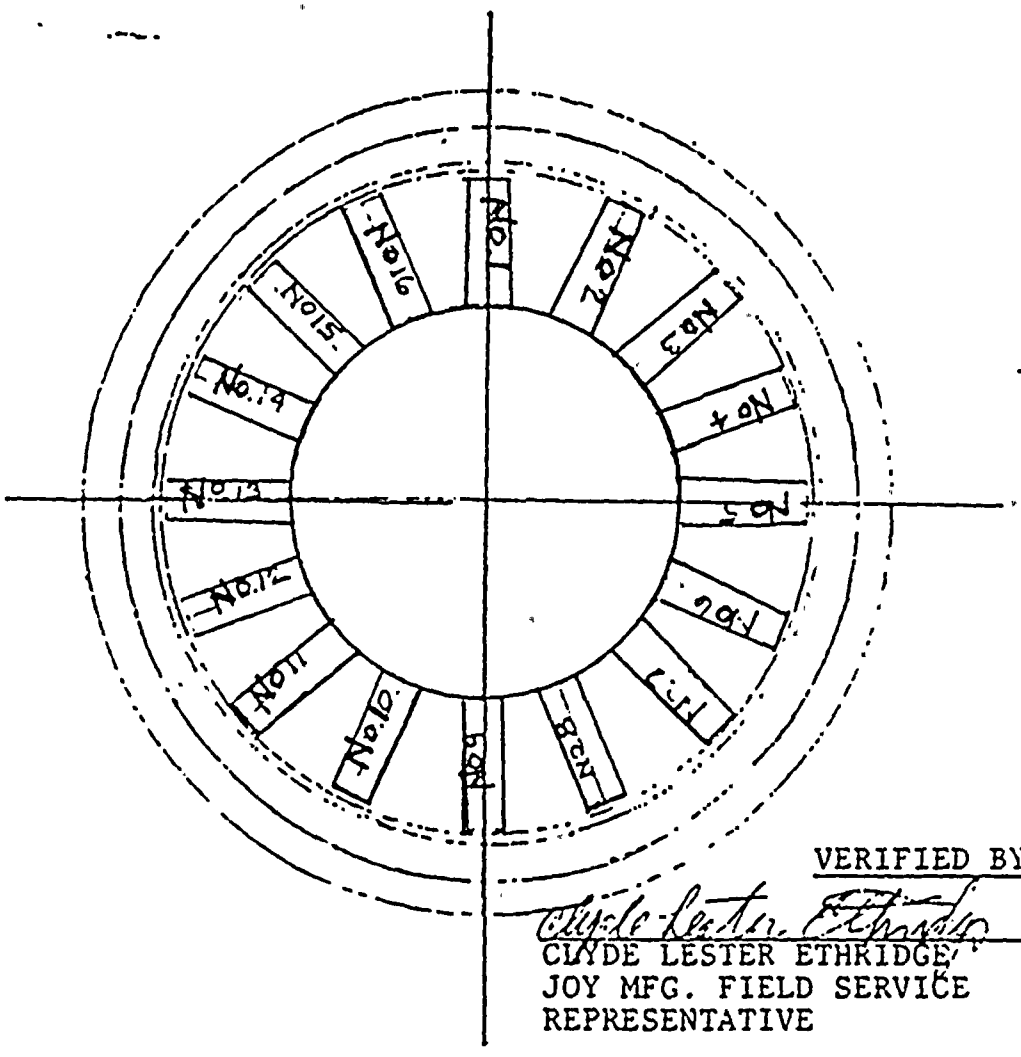
R. B. Kissel

R. B. Kissel
Assistant Project Engineer

10-7-82
Date

Joy Vaneaxial Fan - Quality Class "R"
Unit Tag No. 1-M-HCN-A03D Serial No. GF-21619
36" Dia. 26" S.S. Hub Series 2000 - Single Stage

Blade Locknut Torque: 400 Ft./Lbs.
Tip Angle: 29½°



VERIFIED BY:
Clyde Lester Ethridge DATE: 6-5-
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

BLADE NO.	*1 - 360-380 Ft./Lbs.	*9	- See Attached Ver. Report
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 360 - 380 Ft./Lbs.
	4 - 400 Ft./Lbs.	12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	13	- 400 Ft./Lbs.
	6 - 340 - 360 Ft./Lbs.	14	- 340 - 360 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	*8 - 360-380 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

VERIFICATION REPORT

UNIT TAG NO. 1-M-HCN-A02D FIRST STAGE

VERIFICATION OF "AS INSTALLED" BLADE NO. 1 AND NO. 15 WAS UNABLE TO BE RECORDED; DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBILITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADE.

DUE TO THE ABOVE SITUATION, LOCKNUTS WERE TIGHTENED WITH A (24") CRESCENT WRENCH, AND WERE ABLE TO OBTAIN A (1/2) TURN ON BLADE NO. 1 AND (3/4) TURN ON BLADE NO. 15. IN ADDITION, I INSTRUCTED CRAFT TO TRY AND TIGHTEN A LOCKNUT PREVIOUSLY VERIFIED @ 400 FT./LBS. WITH THE SAME (24") CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

R. B. Kissel

R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER

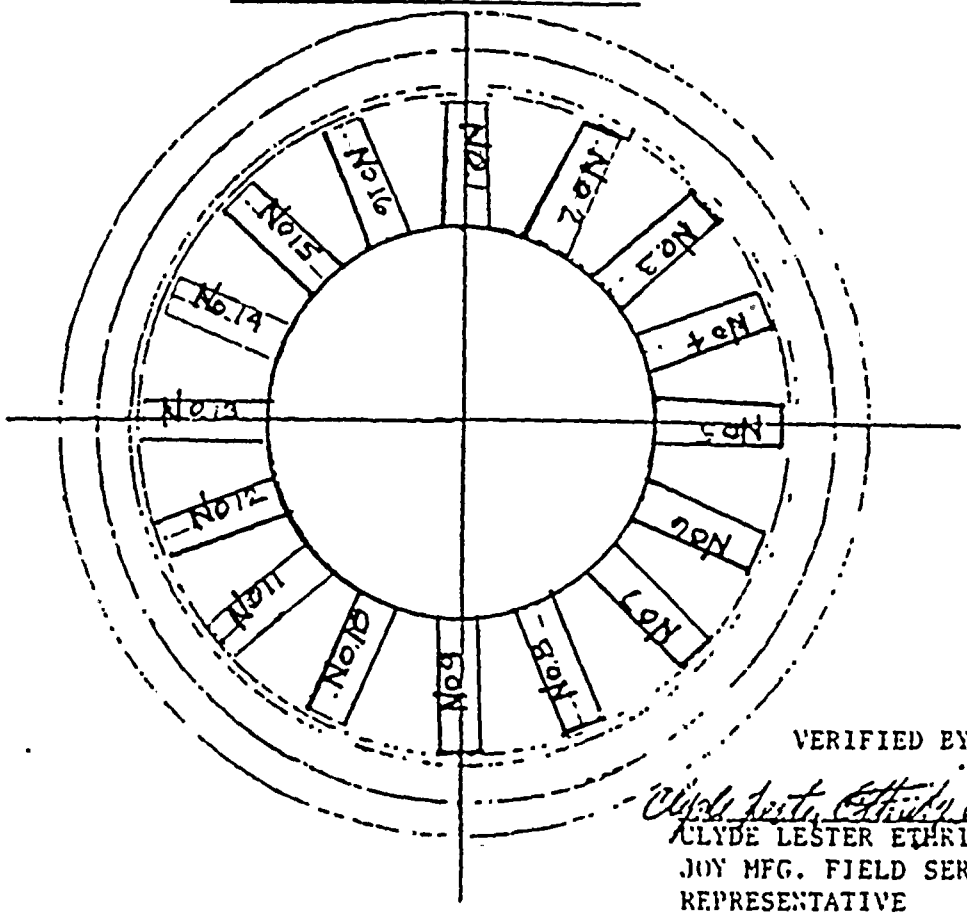
10-10-82

DATE

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A02D SERIAL NO. GF-21611
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 24°

FIRST STAGE



VERIFIED BY:

Clyde Lester Etheridge DATE: 11-12-91

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No. *1 - See Attached Ver. Report
2 - 400 Ft./Lbs.
3 - 400 Ft./Lbs.
*4 - 340-360 Ft./Lbs.
5 - 400 Ft./Lbs.
6 - 400 Ft./Lbs.
7 - 400 Ft./Lbs.
8 - 400 Ft./Lbs.
*9 - 340-360 Ft./Lbs.
10 - 400 Ft./Lbs.
11 - 400 Ft./Lbs.
12 - 400 Ft./Lbs.
13 - 400 Ft./Lbs.
14 - 400 Ft./Lbs.
*15 - See Attached Ver. Report
16 - 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

VERIFICATION REPORT

UNIT TAG NO. - 1-M-HCN-A02C FIRST STAGE

VERIFICATION OF "AS INSTALLED" BLADE NO. 1 WAS UNABLE TO BE RECORDED: DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBILITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADE.

DUE TO THE ABOVE SITUATION, LOCKNUT WAS TIGHTENED WITH A (24") CRESCENT WRENCH, AND WE WERE ABLE TO OBTAIN A (1/2) TURN OF THE LOCKNUT. PREVIOUSLY NOTED, I INSTRUCTED CRAFT TO TRY AND TIGHTEN A LOCKNUT THAT HAD BEEN VERIFIED @ 400 FT./LBS. WITH THE SAME (24") CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

R. B. Kissel

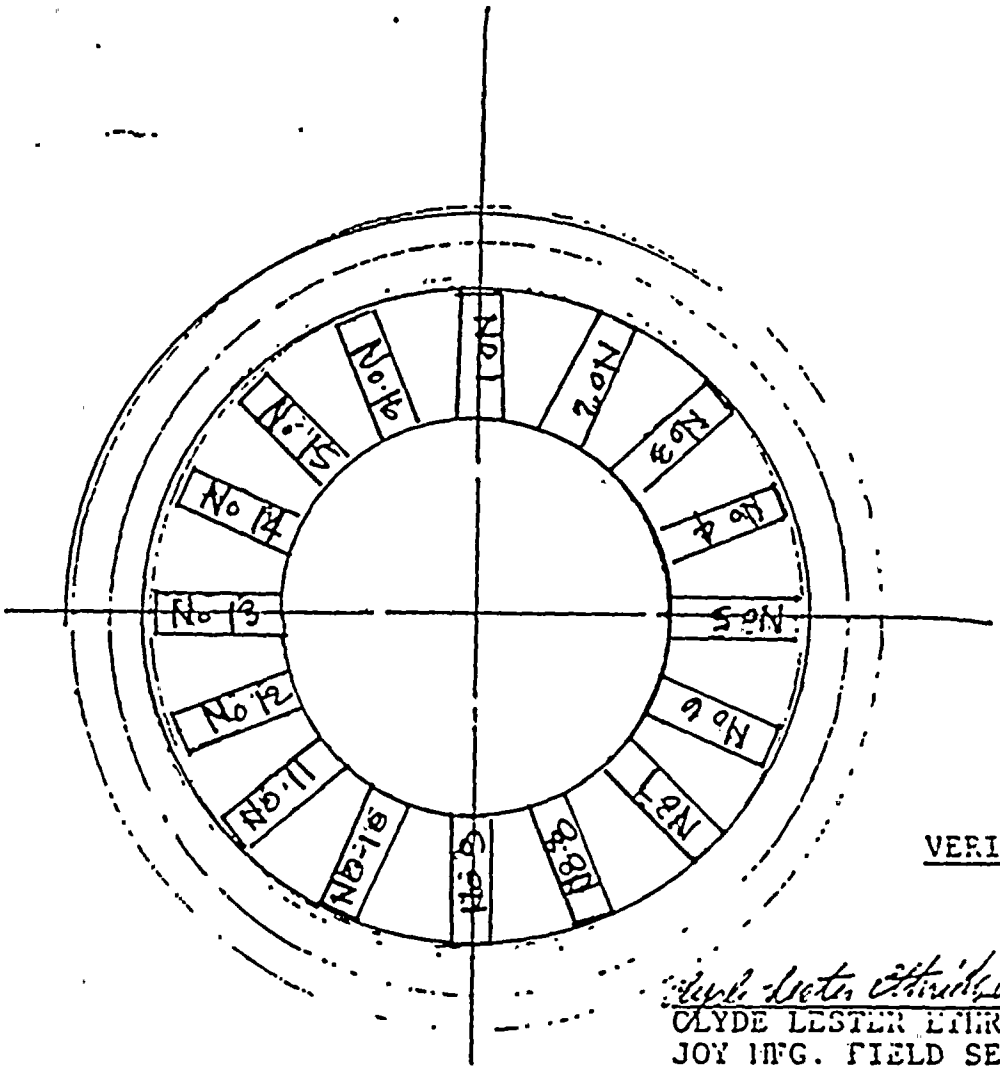
R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER

10-10-82

DATE

UNIT TAG NO. 1-M-HON-AUIC SERIAL NO. GF-21588
54" DIA. 26" S.S. HUB SERIES 2000 - SINGLE STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 15°



VERIFIED BY:

Clyde Lester Ethridge DATE: 10-5-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

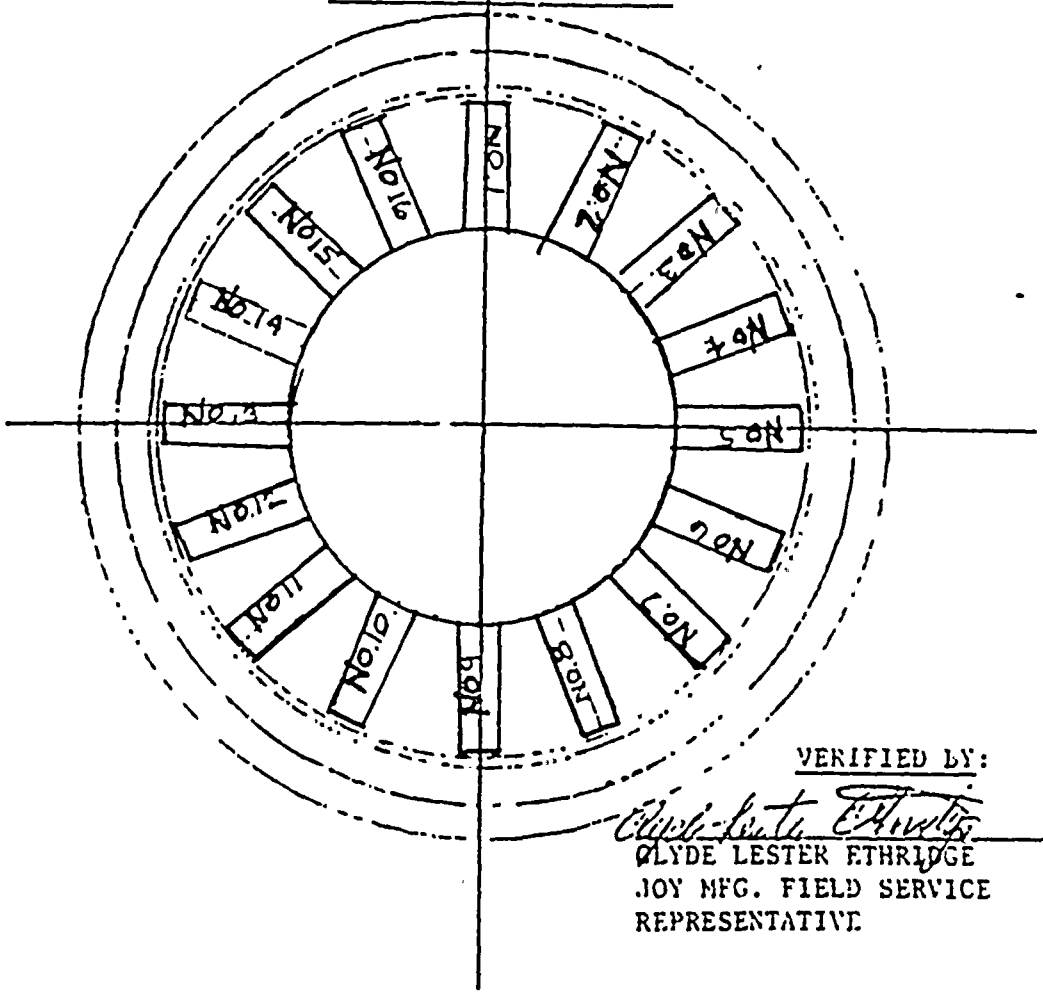
BLADE NO.	1 - 400 Ft./Lbs.	9 -	400 Ft./Lbs. 1° Off
	*2 - 320-340 Ft./Lbs.	10 -	400 Ft./Lbs. 2° Off
	3 - 400 Ft./Lbs.	11 -	400 Ft./Lbs.
	*4 - 280-300 Ft./Lbs. 2° Off	12 -	320-340 Ft./Lbs.
	5 - 400 Ft./Lbs.	13 -	400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14 -	400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15 -	400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16 -	400 Ft./Lbs.

*Indicates Balancing Weight Was Added to Blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A02C SERIAL NO. GF-21610
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 24°

FIRST STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE: 12/12/2

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

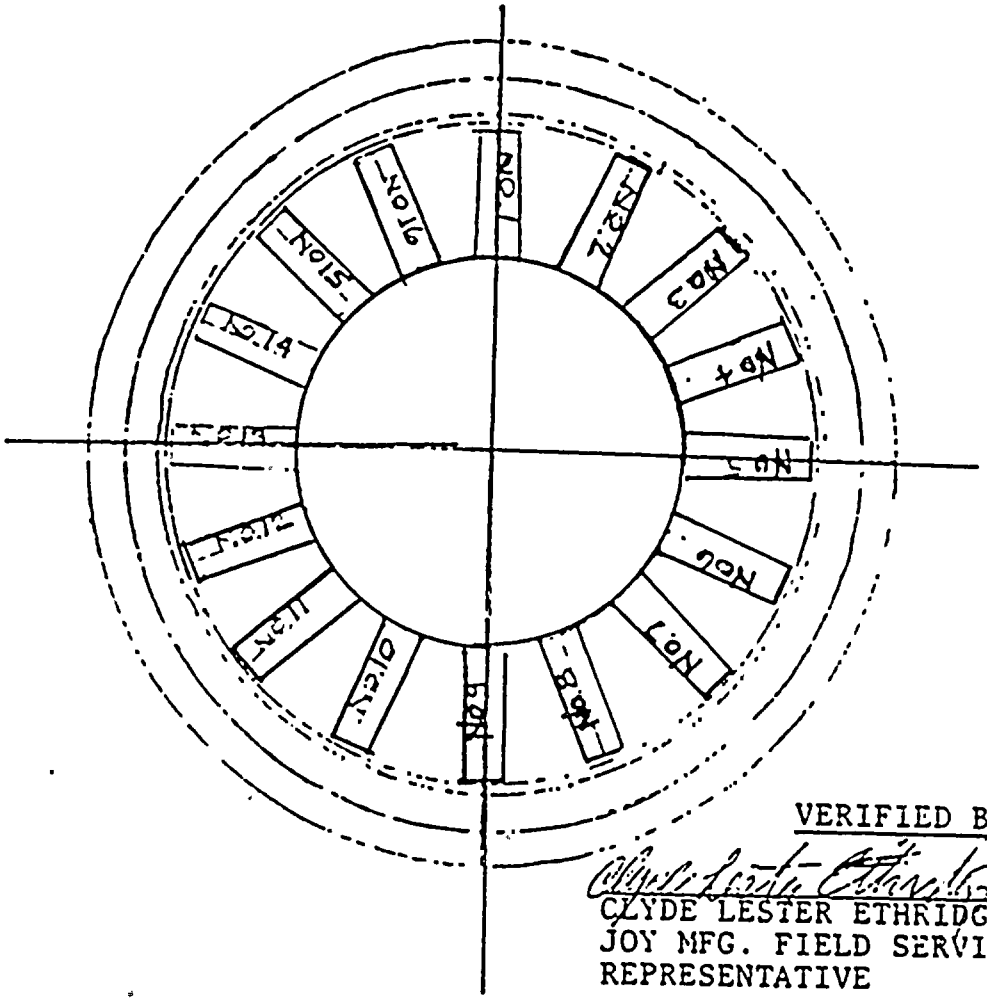
BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

BLADE NO. *1 - See Attached Ver. Report
2 - 400 Ft./Lbs.
3 - 400 Ft./Lbs.
4 - 400 Ft./Lbs.
5 - 400 Ft./Lbs.
6 - 360 - 380 Ft./Lbs.
7 - 400 Ft./Lbs.
8 - 400 Ft./Lbs.
9 - 400 Ft./Lbs.
10 - 400 Ft./Lbs.
11 - 340-360 Ft./Lbs.
12 - 400 Ft./Lbs.
13 - 400 Ft./Lbs.
14 - 400 Ft./Lbs.
15 - 340-360 Ft./Lbs.
16 - 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade.

Joy Vaneaxial Fan - Quality Class "R"
Unit Tag No. 1-M-HCN-A03C Serial No. GF-21618
36" Dia. 26" S.S. Hub Series 2000 - Single Stage

Blade Locknut Torque: 400 Ft./Lbs.
Blade Tip Angle: 29½°



VERIFIED BY:
Clyde Lester Ethridge DATE: 11-9-
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No.	*1 - 400 Ft./Lbs.	*9	- 320-340 Ft./Lbs.
	2 - 400 Ft./Lbs.	10	- 400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11	- 400 Ft./Lbs.
	4 - 400 Ft./Lbs.	*12	- 400 Ft./Lbs.
	5 - 400 Ft./Lbs.	*13	- 400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14	- 400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15	- 400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16	- 400 Ft./Lbs.

*Indicates Balancing Weight Was Added To Blade

VERIFICATION REPORT

Unit Tag No. 1 - M-HCN-A03D

VERIFICATION OF "AS INSTALLED" BLADE NO. 9 WAS UNABLE TO BE RECORDED; DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBLITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADE.

DUE TO THE ABOVE SITUATION, LOCKNUT WAS TIGHTENED WITH A (24") CRESCENT WRENCH, AND WE WERE ABLE TO OBTAIN A (3/4) TURN OF THE LOCKNUT. IN ADDITION, I INSTRUCTED CRAFT TO TRY AND TIGHTEN A LOCKNUT PREVIOUSLY VERIFIED @ 400 FT./LBS. WITH THE SAME (24") CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

R. B. Kissel

R. B. (Buck) Kissel
Assistant Project Engineer

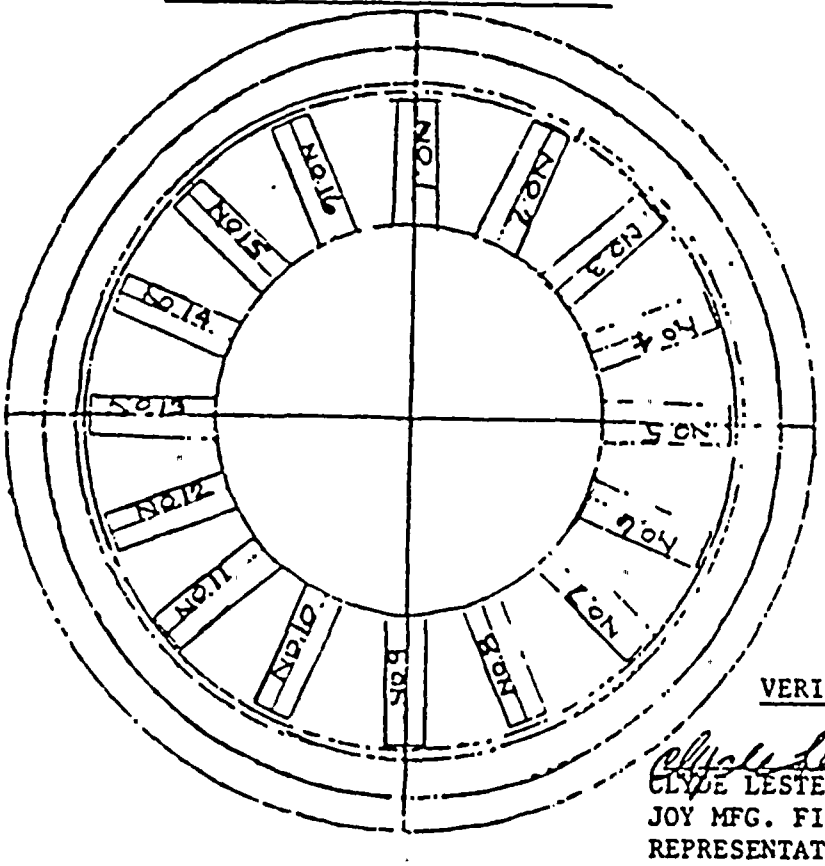
10-8-82

Date

JOY VANEAXIAL FAN - QUALITY "R"
UNIT TAG NO. 1-M-HCN-A02A SERIAL NO. GF-21608
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.
TIP ANGLE: 24°

SECOND STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE 10-21-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No.	*1 - 400 Ft./Lbs.	9 -	400 Ft./Lbs.
	2 - 400 Ft./Lbs.	10 -	400 Ft./Lbs.
	3 - 400 Ft./Lbs.	11 -	400 Ft./Lbs.
	4 - 400 Ft./Lbs.	12 -	400 Ft./Lbs.
	*5 - 280-300 Ft./Lbs.	13 -	400 Ft./Lbs.
	6 - 400 Ft./Lbs.	14 -	400 Ft./Lbs.
	7 - 400 Ft./Lbs.	15 -	400 Ft./Lbs.
	8 - 400 Ft./Lbs.	16 -	400 Ft./Lbs.

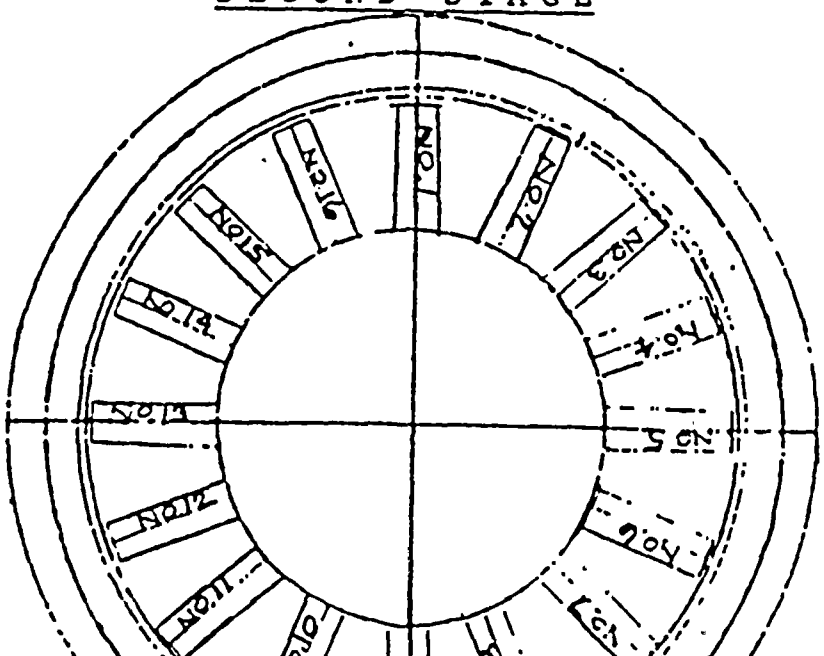
*Indicates balancing weight was added to blade.

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A02D SERIAL NO. GF-21611
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.

TIP ANGLE: 24°

SECOND STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE 10-24-

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE& TIP ANGLE VERIFIED @:

Blade No. 1 - 400 Ft./Lbs.	9 - 400 Ft./Lbs.
*2 - See attached ver. report	10 - 400 Ft./Lbs.
3 - 400 - Ft./Lbs.	11 - 400 Ft./Lbs.
4 - 400 - Ft./Lbs.	12 - 400 Ft./Lbs.
5 - 400 - Ft./Lbs.	13 - 400 Ft./Lbs.
6 - 400 - Ft./Lbs.	14 - 400 Ft./Lbs.
7 - 400 - Ft./Lbs.	15 - 400 Ft./Lbs.
8 - 400 - Ft./Lbs.	16 - 400 Ft./Lbs.

*Indicates balancing weight was added to blade.

VERIFICATION REPORT

UNIT TAG NO. 1-M-HCN-A02D SECOND STAGE

VERIFICATION OF "AS INSTALLED" BLADE NO. 2 WAS UNABLE TO BE RECORDED, DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBILITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADE.

DUE TO THE ABOVE SITUATION, LOCKNUT WAS TIGHTENED WITH A (24") CRESCENT WRENCH, AND WE WERE UNABLE TO TURN THE LOCKNUT. PREVIOUSLY, I HAD INSTRUCTED CRAFT TO TRY AND TIGHTEN A LOCKNUT THAT WAS VERIFIED AT 400 FT./LBS. WITH THE SAME (24") CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

R. B. Kissel

R. B. (BUCK) KISSEL
ASSISTANT PROJECT EGINEER
THE WALDINGER CORPORATION

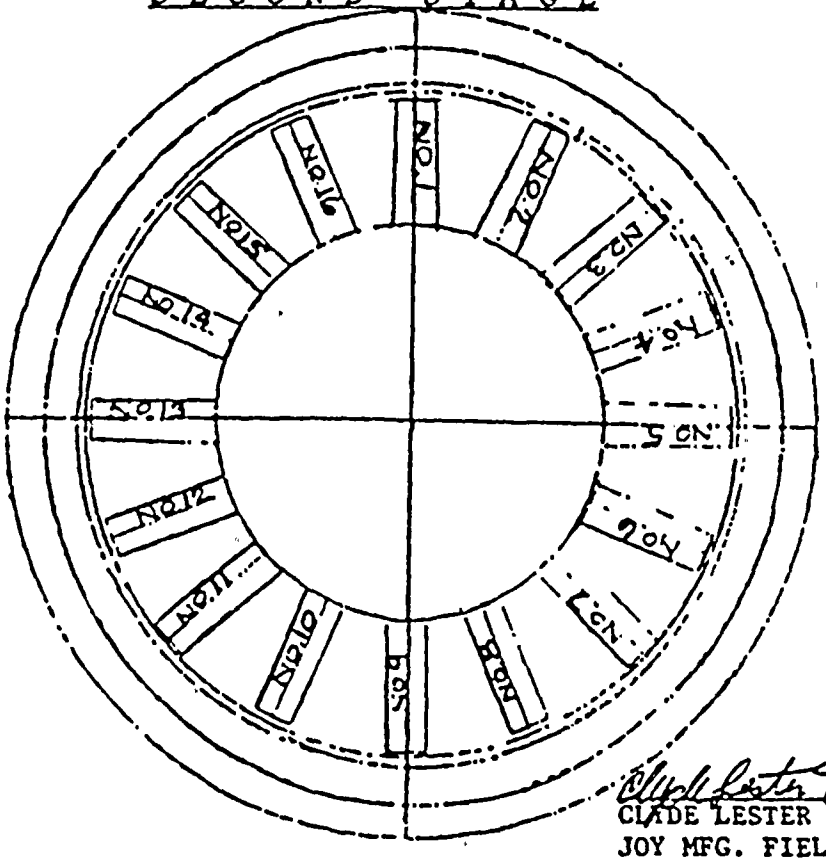
10-24-87
DATE

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG No.1-M-HCN-A02C SERIAL NO. GF-21610
45" DIA. 26" S.S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE: 400 FT./LBS.

TIP ANGLE: 24°

SECOND STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE 10-19-92
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No. 1	- 400 Ft./Lbs.	9	- 400 Ft./Lbs.
2	- 400 Ft./Lbs. - 4° off	10	- 400 Ft./Lbs. - 2° off
3	- 280-300 Ft./Lbs.	11	- 400 Ft./Lbs.
4	- 400 Ft./Lbs.	12	- 400 Ft./Lbs.
5	- 400 Ft./Lbs.	13	- 400 Ft./Lbs.
6	- 400 Ft./Lbs.	*14	- See attached ver. report
7	- 400 Ft./Lbs.	*15	- 340-360 Ft./Lbs.
8	- 400 Ft./Lbs. - 2° off	*16	- See attached ver. report

*Indicates balancing weight was added to blade.

NOTE: See attached report concerning Blade No. 2,8,10,14 & 16.

VERIFICATION REPORT

UNIT TAG NO. 1-M-HCN-A02C - SECOND STAGE

SUBJECT NO. (1): INACCESSIBLE LOCKNUTS

VERIFICATION OF "AS INSTALLED" BLADE NO. 14 and NO.16 WAS UNABLE TO BE RECORDED: DUE TO INACCESSIBILITY WITH THE TORQUE WRENCH (SOCKET). THE CONFIGURATION OF THE BALANCING WEIGHT ELIMINATED ANY POSSIBLITY OF OBTAINING A TORQUE VALUE FOR SUBJECT BLADES.

DUE TO THE ABOVE SITUATION, LOCKNUTS WERE TIGHTENED WITH A (24") CRESCENT WRENCH, AND WE WERE UNABLE TO TURN BLADE NO. 14; HOWEVER, WE WERE ABLE TO OBTAIN A (1/4) TURN ON BLADE NO. 16. PREVIOUSLY, I HAD INSTRUCTED CRAFT TO TRY AND TIGHTEN A BLADE LOCKNUT THAT WAS VERIFIED @ 400 FT./LBS. WITH THE SAME (24") RBK CRESCENT WRENCH. CRAFT WAS UNABLE TO TURN THE LOCKNUT WITH SUBJECT WRENCH.

SUBJECT NO. (2): BLADE TIP ANGLE RESULTS

1. "AS INSTALLED" BLADE NO. 2 RBK TIP ANGLE WAS VERIFIED @ 28°, AND

2. "AS INSTALLED" BLADE NO. 8 & 10 TIP ANGLES WERE VERIFIED @ 22°; RESULTING IN A 6° DIFFERENCE BETWEEN REFERENCED BLADES. BLADE TIP ANGLES WERE CORRECTED, TO THE SPECIFIED 24° TIP ANGLE, AND RE-TORQUED TO 400 FT./LBS.

R.B. Kissel

R. B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER
THE WALDINGER CORPORATION

10-19-82
DATE

Clyde Lester Ethridge

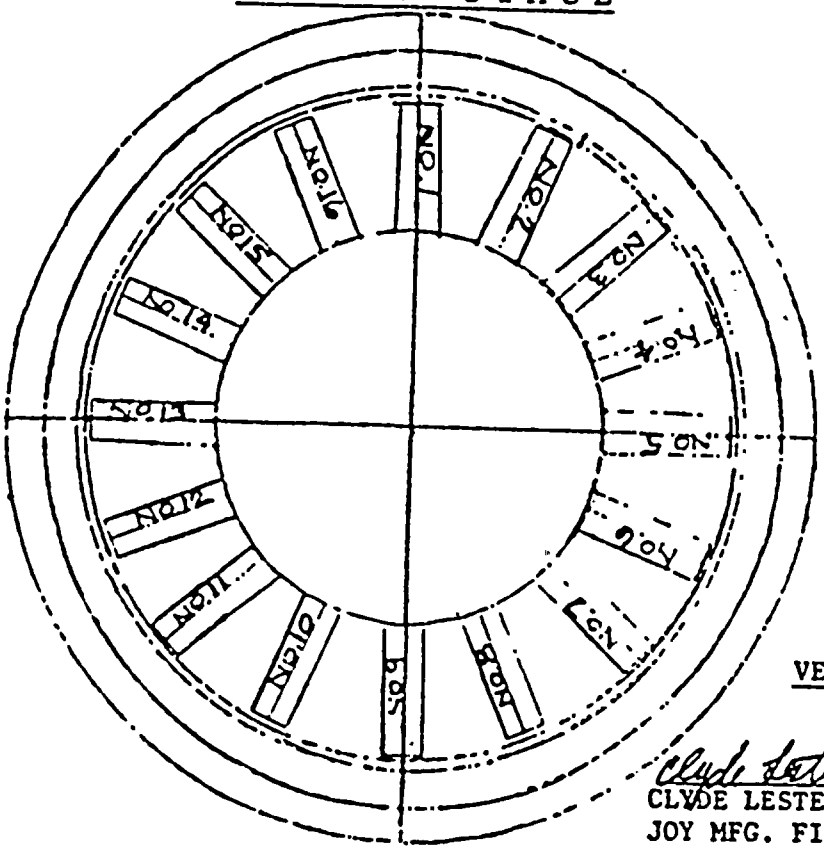
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE .

10-19-82
DATE

JOY VANEAXIAL FAN - QUALITY CLASS "R"
UNIT TAG NO. 1-M-HCN-A02B SERIAL NO. GF-21609
45" DIA. 26" S. S. HUB SERIES 2000 - 2 STAGE

BLADE LOCKNUT TORQUE : 400 FT./LBS.
TIP ANGLE: 24°

SECOND STAGE



VERIFIED BY:

Clyde Lester Ethridge DATE 10-24-5
CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

BLADE LOCKNUT TORQUE & TIP ANGLE VERIFIED @:

Blade No. 1 - 400 Ft./Lbs.	9 - 400 Ft./Lbs.
2 - 400 Ft./Lbs	10 - 400 Ft./Lbs.
3 - 400 Ft./Lbs.	11 - 400 Ft./Lbs. 2° off
4 - 400 Ft./Lbs.	*12 - 400 Ft./Lbs.
5 - 400 Ft./Lbs. 2° off	13 - 400 Ft./Lbs.
6 - 400 Ft./Lbs.	14 - 400 Ft./Lbs.
7 - 400 Ft./Lbs.	15 - 400 Ft./Lbs.
*8 - 400 Ft./Lbs.	16 - 400 Ft./Lbs.

*Indicates balancing weight was added to blade.

NOTE: See attached report concerning blade No. 5 & 11.

VERIFICATION REPORT

UNIT TAG NO. 1-M-HCN-A02B SECOND STAGE

SUBJECT: BLADE TIP ANGLE RESULTS

1. "AS INSTALLED" BLADE NO. 5 TIP ANGLE WAS VERIFIED @ 22°, AND

2. "AS INSTALLED" BLADE NO. 11 TIP ANGLE WAS VERIFIED @ 26° RESULTING IN A 4° DIFFERENCE BETWEEN REFERENCED BLADES.

BLADE TIP ANGLES WERE CORRECTED TO THE SPECIFIED 24° TIP ANGLE, AND RE-TORQUED TO 400 FT./LBS.

R.B. Kissel

R B. (BUCK) KISSEL
ASSISTANT PROJECT ENGINEER
THE WALDINGER CORPORATION

10-24-87
DATE

Clyde Lester Ethridge

CLYDE LESTER ETHRIDGE
JOY MFG. FIELD SERVICE
REPRESENTATIVE

10-24-87
DATE

. . . We hereby certify that each blade locknut has been verified or re-torqued to a value of 400 ft./lbs., and each blade tip angle (as specified below) verified or reset, applicable to the second stage, on the following fans:

Fan Unit Tag. No.	Serial No.	Tip Angle 0°
1-M-HCN-A02A (2-stage)	GF-21608	24°
1-M-HCN-A02B (2-stage)	GF-21609	24°
1-M-HCN-A02C (2-stage)	GF-21610	24°
1-M-HCN-A02D (2-stage)	GF-21611	24°

Clyde Lester Ethridge
Joy Mfg. Field Service
Representative

10-25-82
Date

R. B. (Buck) Kissel
Assistant Project Engineer
The Waldinger Coporation

10-25-82
Date