607

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	)	
LONG ISLAND LIGHTING COMPANY	)	Docket No. 50-322-OL
(Shoreham Nuclear Power Station, Unit 1)	)	

SUPPLEMENTAL TESTIMONY OF DR. ROBERT N. ANDERSON, PROFESSOR STANLEY CHRISTENSEN, G. DENNIS ELEY, AND RICHARD B. HUBBARD REGARDING SUFFOLK COUNTY'S EMERGENCY DIESEL GENERATOR CONTENTION CONCERNING CYLINDER BLOCKS

SUFFOLK COUNTY
October 18, 1984

DS03

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I. INTRODUCTION

1.Q. What is the purpose of this testimony?

A. (All). This testimony addresses new information on cylinder blocks disclosed by Supplemental Testimony filed on September 20, 1984, on behalf of LILCO's witness panel and by subsequent discovery. That information concerns: (1) cracks in the cam gallery area of all EDG cylinder blocks, including the replacement block for EDG 103; (2) circumferential cracks around the cylinder counterbore landing; and (3) changes in LILCO's measurements of cracks in the blocks.

2.Q. What conclusions have you reached as to these matters?

A. (All). Our conclusions may be summarized as follows:

(1)(a) Cracks in the camshaft gallery area of the original EDG 103 cylinder block have been found to be far more extensive and more than twice as deep than first represented by LILCO and FaAA. Analysis of fractography and metallography of crack samples shows that these cracks were originally formed as hot tears during the casting process, were unsuccessfully attempted to be repaired with welding, and have since propagated.

(b) Similar cracks are in the cam gallery areas of the blocks of EDGs 101 and 102. These cracks will continue to propagate, and those blocks are therefore unsuitable for nuclear service.

(c) Cam gallery cracks have been found in the replacement block for EDG 103 after operation of that engine during testing. Inspection records show that no such cracks were present before the replacement block was placed into operation. Accordingly, these cracks occurred due to operating stresses.

(2) Circumferential cracks were recently discovered during destructive examination of the original EDG 103 block. LILCO and FaAA did not thereafter reinspect EDGs 101 and 102 for circumferential cracks, but assume they are present extending continuously 360 degrees around the circumference of the liner landing of each cylinder. Examination of sections of the original EDG 103 block shows the circumferential crack to be relatively deep and propagating. Circumferential cracks in EDGs 101 and 102 may cause EDG failure.

(3) Sectioning of the original EDG 103 block disclosed that the large stud-to-stud crack between cylinder numbers 4 and 5, which LILCO and FaAA had represented to be 5-1/2 inches deep, was really 3 inches deep. The erroneous measurement of this crack suggests other crack measurements may be wrong. Further, the inability of LILCO, FaAA, and TDI Owners Group inspections to discover the circumferential cracks or the nature and extent of the cam gallery cracks casts considerable doubt on the reliability of those inspections.

II. CAM GALLERY CRACKS

3.Q. What cracks were found by FaAA and/or LILCO in the camshaft gallery area of the original EDG 103 block?

A. (Hubbard, Anderson). The FaAA Block Report issued in June 1984 and LILCO's cylinder block testimony stated that there were "crack indications" in the cam galleries of all three EDGs, with the longest measuring 4-1/2 inches long and 0.375 inch deep in EDG 103.[1/] This information proved to be erroneous when, in late August, FaAA sectioned portions of the original EDG 103 block. Inspections showed cracks in all nine camshaft gallery saddle areas; there was a single 3 inch long crack, while the other eight cracks ranged in length from 4-1/4 inches to 5-3/8

1/ See Exhibit 7 to Suffolk County EDG testimony at 4-6; see also Testimony of Roger L. McCarthy, et al., August 14, 1984, at 62-63, and Exhibit B-52 (since deleted by LILCO).

inches.[2/] Some of these cracks were measured by FaAA after sectioning and found to be from 0.5 inch to 0.906 inch deep in a block wall only 1.25 inches thick.[3/] FaAA found that all of these cracks had been ground and welded. Some representative photographs of these cracks are shown in Exhibit S-3.

4.Q. What do you believe initially caused the cam gallery cracks in the original EDG 103 block to form?

A. (Anderson). Based upon my examination of the sections removed by FaAA from the block and of numerous photographs of these cracks, they appear to be hot tears formed initially during fabrication of the block. This theory is supported by the fact that the cracks were filled with welding material in an apparent effort to repair them.

5.Q. Do you agree with FaAA's conclusion that these cam gallery cracks did not propagate after their formation during the casting process?

A. (Anderson). No. That conclusion is based upon FaAA's erroneous interpretations of a "dark oxide" on the surface of a crack sectioned from cam gallery No. 7, the presence of high concentrations of calcium on the surface of that crack, the absence of a "rust-colored oxide," and the appearance of the crack surface.

6.Q. Was the sectioned crack surface covered with a thick dark oxide?

2/ FaAA Liquid Penetrant Examination Report, 8/24/84 (Exhibit S-1).

3/ Exhibit S-2.

A. (Anderson). FaAA did not analyze the crack surface to determine the presence of oxygen, so the substance is not necessarily an oxide. Although it is possible that all or part of the coating is an oxide, I believe the darkness of its color is attributable to graphite from "graphitization" or graphitic corrosion of the surface of the crack, and not to oxidation at extremely high temperatures as hypothesized by FaAA. Graphitic corrosion occurs in gray cast iron in relatively mild (low temperature) environments.[4/] The graphite would have the effect of darkening a rust-colored oxide on the crack surface. The presence of minute particles of dirt and the oil to which the crack would be exposed could contribute to the darkness of the surface. The EDX chemical analysis of the surface performed by FaAA would not detect the presence of carbon (and hence, graphite).

7.Q. If most of the substance covering the crack surface is an oxide, is FaAA correct that the oxide could only have formed in high temperatures and in the presence of air during cooling at the time of the casting process?

A. (Anderson). No. First, I believe FaAA's conclusion is based in part on their misinterpretation of the cause of the "dark" color of the surface substance. As indicated above, I believe that the darkness of the color is attributable to the surface presence of carbon due to graphitization, and does not indicate that the substance was the product of oxidation at ex-

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4/ Fontana and Greene, Corrosion Engineering (McGraw-Hill, 1978) at 70-71.

tremely high temperatures. Red or rust-colored oxides, unlike dark oxides, are formed in low and moderate temperature environments and would have the dark appearance of the surfaces I examined if graphitization had taken place.

Second, the block casting is formed under strong reducing conditions where air cannot enter. Initially, the block casting mold is literally burning. If air did enter the cam gallery area, it could do so only by diffusion in small amounts over a short period before the surface metal cools to the point where any hot tears present would not form oxides. If this had occurred, there would only be a small amount of oxide with uneven distribution over the crack surface. Thicker layers of oxide would occur at the mouth of the crack than lower down, because the mouth would have been exposed to more oxygen during the cooling period than the bottom of the crack. However, the substance covering the crack appeared fairly uniform in thickness.

Third, the cracks in the sections I examined appear to have been ground and widened in preparation for the welding repairs, because they narrow abruptly below the weld material; a normal hot tear configuration would have a more uniformly V-shaped configuration. Thus, in the ordinary course of events, an oxide formed during the cooling process would have been removed in the upper area of the crack where the grinding took place; but the crack surface from which the weld had separated had a uniform layer of the dark substance from the top to the bottom of the crack.

Alternatively, if the oxide layer postulated by FaAA formed at the time of the casting process was not all removed by the pre-welding grinding, then the oxide should have been present on the side of the crack to which the weld material was still adhered. I examined cross sections of the crack under a microscope and observed no sign of the so-called dark oxide in the area of the crack to which weld material was still adhering.

8.Q. Does the presence of high concentrations of calcium on the crack surface support FaAA's conclusion that the "oxide" covering that surface was introduced during casting while the crack was exposed to high temperatures?

A. (Anderson). No. FaAA's chemical analysis disclosed the presence of calcium in some, but not all, areas which were tested. In all samples where calcium was detected, sulfur was also detected in proportionate amounts. Therefore, I believe that the presence of concentrations of calcium resulted from exposure of the crack surfaces to calcium sulfide, which is often present in diesel oil lubricants and dye penetrants. Thus, the calcium was introduced after the block had been cast and cooled completely.

9.Q. Do you agree with FaAA's conclusion that the relative uniformity of the "oxide" layer on the entire crack surface shows that no crack propagation has occurred?

A. (Anderson). No. A relatively uniform layer throughout the crack's surface is consistent with graphitic corrosion. While the ferritic material corrodes or rusts at different points in

time as the crack propagates, the graphitic corrosion leaves a surface layer of graphite. This graphite forms a protective layer so that the corrosion stops and the surface becomes relatively uniform over time.

10.Q. Does the absence of any beach marks in the crack suggest that there was no propagation of the crack after it was initially formed?

A. (Anderson). No. Because of its brittle nature, cast iron does not form beach marks during the process of crack propagation.

11.Q. Is there additional evidence that the cam gallery cracks are propagating?

A. (Anderson). Yes. Exhibit S-4 is two photographs showing the magnified surface of a portion of a cam gallery crack that was sectioned by FaAA. The photographs show that the weld material (the white area in the upper left) has pulled loose from the cast iron surface of the crack, but that some cast iron was still adhering to the weld material. This shows that the weld material pulled free from the crack surface due to operating stresses, as opposed to heat shrinkage.

12.Q. Are there cracks in the cam gallery areas of the blocks of EDG 101 and 102?

A. (Hubbard, Anderson). Yes. LILCO has reported the presence of these cracks in all of the EDG blocks. The cam gallery area of the EDG 101 block was subjected to magnetic particle ("MP") examination on September 20, 1984 and to liquid

penetrant ("LP") examination the following day. The inspection reports (attached respectively as Exhibits S-5 and S-6) disclosed cracks in the cam gallery areas of all eight cylinders, ranging up to 2-3/4 inches long. Mr. Rau of FaAA examined the cam gallery bearing saddles Nos. 8 and 9 on the block of EDG 102 and found welded crack indications about 2-1/2 inches long in both areas.

(Anderson). Based upon photographs of the cracks in the camshaft gallery areas of the blocks of EDGs 101 and 102, the descriptions of those cracks by FaAA personnel, and LILCO inspection reports, I believe these cracks are similar to those found in the original block of EDG 103. While the lengths of the cracks in the EDG 101 block may be somewhat shorter than those in the original EDG 103 block, they are, like those in the latter block, propagating cracks. Hence, I believe the blocks of EDGs 101 and 102 are unsuitable for nuclear service.

14.Q. Were cracks found in the cam gallery area of the replacement block for EDG 103?

A. (Hubbard, Anderson). Yes. The areas of cam bearing saddles numbers 2 and 8 were inspected by LILCO both before and after grinding (on September 30 and October 1, 1984) while preparing EDG 103 for additional testing. The test reports show cracks in both of these areas, ranging up to 2 inches long.[5/]

15.Q. Were these cracks present in the block before it was used during operation of EDG 103?

5/ Exhibit S-7.

A. (Hubbard, Anderson). No. LILCO has supplied us with copies of reports of all inspections of the replacement block by or on behalf of TDI, LILCO, Stone & Webster, FaAA, and the TDI Owners Group, or any agent of LILCO, pertaining to the cam gallery area. None of these reports disclosed any indications in that area. Moreover, LILCO retained an expert, Mr. C. R. Isleib, to observe the casting of the replacement block and conduct a detailed inspection of it after cleaning and before it was painted. The Isleib inspection report concluded:

> Careful inspection revealed no cold or hot cracks or tears, nor any cold shuts visible to my naked eye, nor under the 5x glass I used. Special attention was paid to internal fillets such as in the camshaft bearing saddle areas.[6/]

We therefore conclude that the cracks in the camshaft gallery area of the replacement block initiated, or propagated from sub-surface defects, during and as a result of the operation of EDG 103.

III. CIRCUMFERENTIAL CRACKS

16.Q. Are there circumferential cracks in the original block of EDG 103?

A. (Hubbard, Anderson). Yes. The FaAA Block Report erroneously stated that none of the EDG blocks had circumferential cracks. Circumferential cracks are cracks at the corner formed by the cylinder liner counterbore and the cylinder liner landing; a representational drawing of a circumferential crack is shown in

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6/ The Isleib report is attached as Exhibit S-8.

Exhibit S-9.[7/] After August 14, FaAA found "some" circumferential cracks when it sectioned portions of two cylinders of the original EDG 103 block, according to LILCO's Supplemental Testimony. Actually, the LILCO report of magnetic particle inspections conducted on September 19, 1984[8/] shows circumferential cracks extending 100 percent around the circumference of all eight cylinders.

17.Q. Are there circumferential cracks in the blocks of EDGs 101 and 102?

A. (Hubbard, Anderson). Apparently LILCO and its agents have conducted no inspections since September to determine this. They claim that it is difficult to inspect for circumferential cracks, and simply assume that they are present in the EDG 101 and 102 blocks, running continuously 360 degrees around the circumference of each cylinder.[9/]

18.Q. Do you agree with FaAA's testimony that circumferential cracks in the EDG blocks are "shallow"?

A. (Anderson). No. FaAA's statement that the cracks are "shallow" is based upon examination of sections of portions of only two cylinders from EDG 103, with a maximum depth which FaAA says is 3/8 inch. There is no data to determine whether circumferential cracks in other cylinders may be deeper. I have made an

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7/ Exhibit S-9 is Figure 1-1 of the FaAA Block Report.

8/ The Magnetic Particle Examination Report is attached as Exhibit S-10.

9/ Deposition of Charles A. Rau, Harry F. Wachob, and Robert K. Taylor, October 11, 1984, at 20.

examination of circumferential cracks in the sections analyzed by FaAA, and I observed that below the tip of the 3/8-inch crack are multiple small disconnected cracks branching out into the cast iron material. The linking up of the main crack with the branch cracks would in my estimation extend the crack to over one inch in depth. This would extend about 2/3 completely through the block material thickness running at a 45 degree angle from the corner of the counterbore landing to the cylinder between the stud bosses.10/

FaAA speculates that circumferential cracks in the blocks of EDGs 101 and 102 would be smaller than those in the original 103 block, because of the allegedly inferior mechanical properties of that block. I conducted a microscopic examination of a specimen of the liner landing ledge from the original EDG 103 block, and observed that it contained appreciably less amounts of Widmanstaetton graphite than appeared in other portions of the block as shown by LILCO's block exhibit B-33. Therefore, I do not believe one can validly predict that circumferential cracks are smaller in the blocks of EDGs 101 and 102.

19.Q. Do you agree with FaAA's conclusion that circumferential cracks will "grow slowly, arrest, and will not cause any operational problems"?

A. (Anderson). No. The fact that the original EDG 103 block did not fail due to the circumferential cracks by the time it failed and was scrapped for other reasons, does not support

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10/ FaAA estimates that the thickness is 1-1/2 inches at that point. Deposition of Rau, et al., at 14.

FaAA's conclusion that the circumferential cracks will not propagate to the point of impairing EDG operation. As described above, the circumferential crack I examined had numerous branches below its tip and appeared to be propagating. The operating history of EDG 103 is therefore cause for concern with EDGs 101 and 102 rather than evidence of their reliability.

20.Q. Can circumferential cracks cause operation of an EDG to fail?

A. (Christensen, Eley). Yes. A circumferential crack could permit some up and down movement of the cylinder liner relative to its position against the gasket sealing the liner to the cylinder head. Such movement could cause leakage of combustion gases, requiring premature shutdown of the engine. In the event the crack propagates through the counterbore, the cylinder liner landing would separate from the block, causing the cylinder liner to fall into the crankcase. This would cause serious damage to the EDG and probable catastrophic failure.

IV. CRACK INSPECTIONS

21.Q. What changes in crack depth measurements has LILCO made as a result of FaAA's sectioning of portions of the original block of EDG 103?

A. (Hubbard). LILCO sectioned the large stud-to-stud crack between cylinder numbers 4 and 5 of the original block of EDG 103 and found it had a depth of 3 inches, rather than 5-1/2

inches as previously reported in the FaAA Block Report and LILCO's written testimony.

22.Q. Is there any basis for LILCO's Supplemental Testimony that "the actual depth of the cracks in the original EDG block are shallower than previously thought"?

A. (Hubbard). No. The depth of only one single crack was revised by the Supplemental Testimony. The Supplemental Testimony does, however, cast considerable doubt upon the reliability of inspections for cracks in the EDG cylinder blocks carried out by LILCO, FaAA and the TDI Owners' Group. First, the erroneous measurement of the crack in the original EDG 103 block suggests that other crack measurements may also be wrong, whether over-stating or under-stating crack depths. Second, before last month neither LILCO, FaAA nor the TDI Owners' Group had discovered the existence of circumferential cracks in the EDGs, despite numerous inspections. Third, before last month none of those organizations had discovered that the camshaft gallery cracks were twice the assumed depth and had been welded. The final DR/QR Report for Shoreham was issued and LILCO's testimony was filed in this case in reliance upon faulty inspection data.

Associates

LIQUID PENETRANT EXAMINATION REPORT

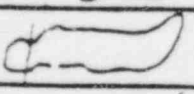
A. Material	Type: GRAY CAST IRON	Fabricated Process:	[ ] Welded [ ] Worked	[X] Cast
	Geometry: [ ] Pipe [ ] Plate [ ] Rod [X] Other:			
Cross Section Thickness:	Max 2 Inch	Min 1 1/4 Inch	Surface Condition: [ ] Machined [ ] As Fabricated	[X] Ground [ ] Other:

B. NDE Procedure No. 6.2	Surface/Mat'l. Temp. 68°F	M & TE. No. N/A	MWR/RR. No. N/A

Inspection Materials	Brand	Designation	Batch No.
1. Pre-Cleaner	MAGNAFLUX	SKC-NF/ZC-7B	84A028
2. Penetrant	MAGNAFLUX SPOTCHECK	SKL-HF/SKL-S	70073
3. Emulsifier and/or Remover	MAGNAFLUX	SKC-NF/ZC-7B	84A028
4. Developer	MAGNAFLUX SPOTCHECK	SKD-NF FORMULA B	816092
5. Post Examination Cleaner	MAGNAFLUX	SKC-NF/ZC-7B	84A028

Sketch or other detail (use other side if necessary):

SEE PHOTOGRAPHS

C. Evaluation	Report below those indications observed and the pertinent information required. Where additional space is required, use other side.		
Location	Size (Inches)	Description	Action (Accept/Reject, and comment as necessary)
1. # 1	3"	FINE	ACC
2. # 2	5 3/8"		
3. # 3	4 3/4	FINE with PITS	
4. # 4	5"	FINE and open with PIT	 1/2" root cracks
D. Acceptance Criteria	NONE MAPING GREEN ONLY		Operator: [signature] Level: II Date: 8-14-84

F. Attach

Nicklysis Associates

LIQUID PENETRANT EXAMINATION REPORT

A. Material	Type: GRAY CAST IRON	Fabricated Process:	[ ] Welded [X] Cast [ ] Worked	P
	Geometry: [ ] Pipe [ ] Plate [ ] Rod [X] Other:			OLD DG103 Block
Cross Section Thickness:	Max 2" Inch	Min 1 1/4" Inch	Surface Condition: [ ] Machined [X] Ground [ ] As Fabricated [ ] Other:	

B. NDE Procedure No. 62	Surface/Mat'l. Temp. 68°F	M & TE. No. N/A	MWR/RR. No. N/A
Inspection Materials	Brand	Designation	Batch No.
1. Pre-Cleaner	MAGNAFLUX	SKC-DF/ZC-2B	84A028
2. Penetrant	" "	SKL-HF/SKL-S	7D023
3. Emulsifier and/or Remover	" "	SKC NF/ZC-2B	84A028
4. Developer	" "	SKD-NF FORMULA B	81G092
5. Post Examination Cleaner	" "	SKC-NF/ZC-2B	84A028

Sketch or other detail (use other side if necessary):

N/A

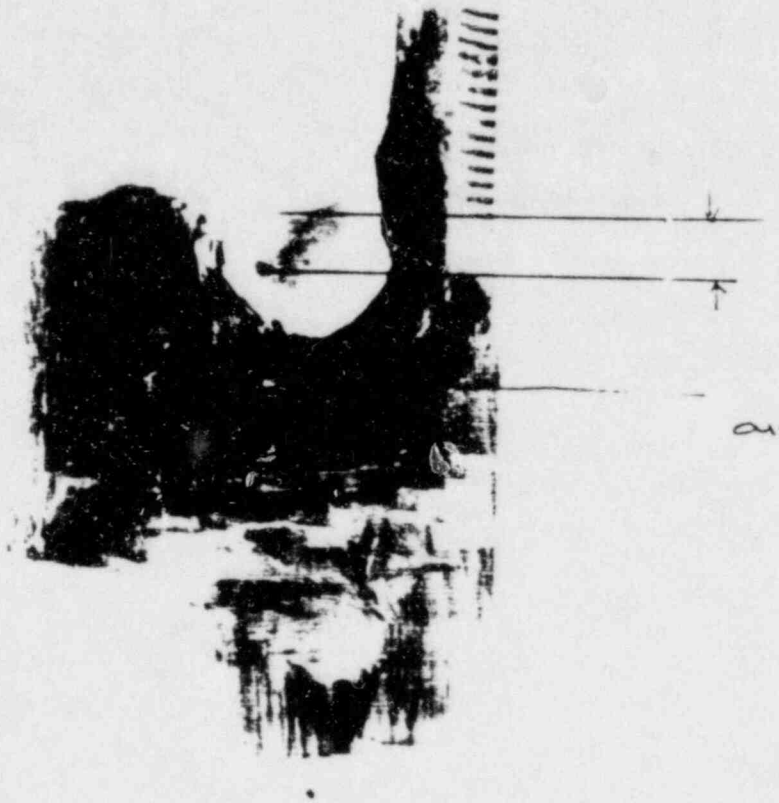
C. Evaluation	Report below those indications observed and the pertinent information required. Where additional space is required, use other side.		
Location	Size (Inches)	Description	Action (Accept/Reject, and comment as necessary)
1. #5	4 3/4	Five-open pits & Porosity	
2. #6	5 1/8	open	← weld area
3. #7	4 1/2	Five open with Porosity	
4. #4	5 1/4	open Five with large porosity	
D. Acceptance Criteria			Operator: [signature] Level: II Date: 5-24-84
E. Attest	[illegible]	Level	Date

N/A

Job Number 7396 Date 9·17·84

Job Name SNPS Page 1 of 4

By M. Sommer



Measured with 6" scale with .001" graduations.

outlined Area is Dye Penetrant

	MAX
.734	.78

H + W
C + C

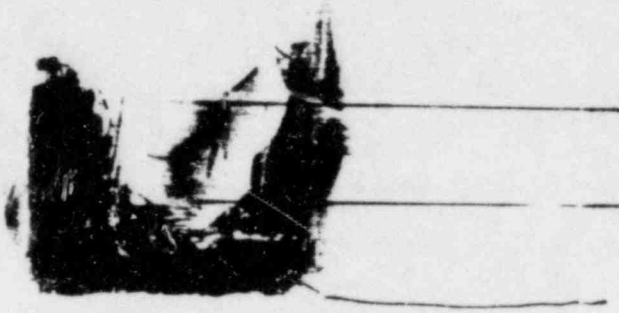
7396 244 ACE 9/21/84

Failure Analysis Associates

Job Number 7396 Date 9.11.84

Job Name SNPS Page 2 of 4

By M. Sommer



Measured with 6" scale with .001" graduations

outlined area is dye penetrant

R - .75 .906

- .688 .728

HTW
CAR

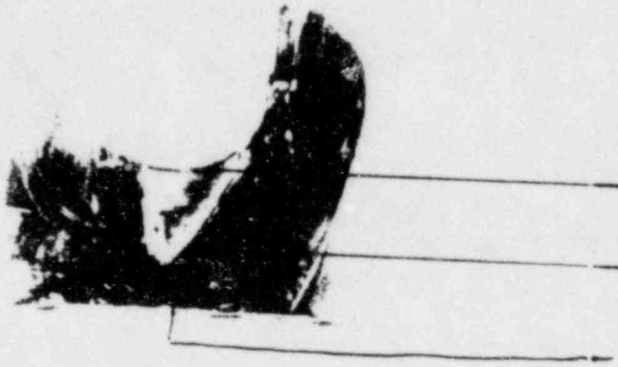
7396-244 pc. 11 9/21/84

Failure Analysis Associates

Job Number 7396 Date 9·17·84

Job Name SNPS Page 3 of 4

By M. SOMMER



R - 0.875"

Measurement taken with 6" scale with .001" graduations

outlined area is Dye penetrant

HTW
CAL
9/21/94

7396·244 pc.13

Failure Analysis Associates

Job Number 7396·

Job Name SNPS

By M. SOMMER

Date 9·17·84

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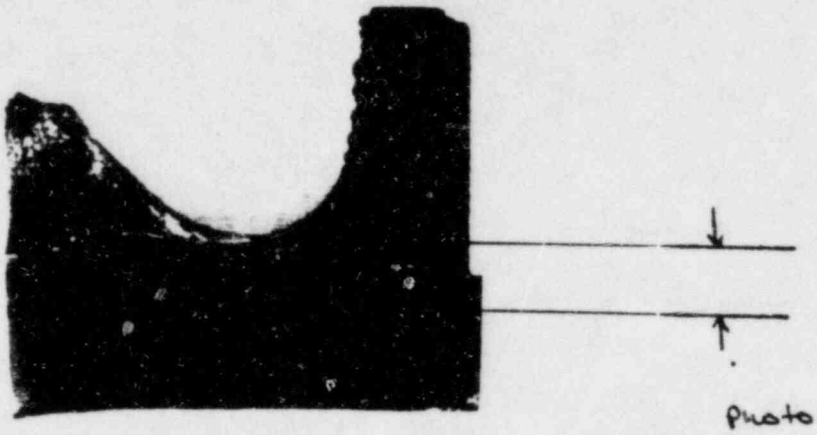


t = 17/32"

measurment taken with 6" scale with .001" graduations

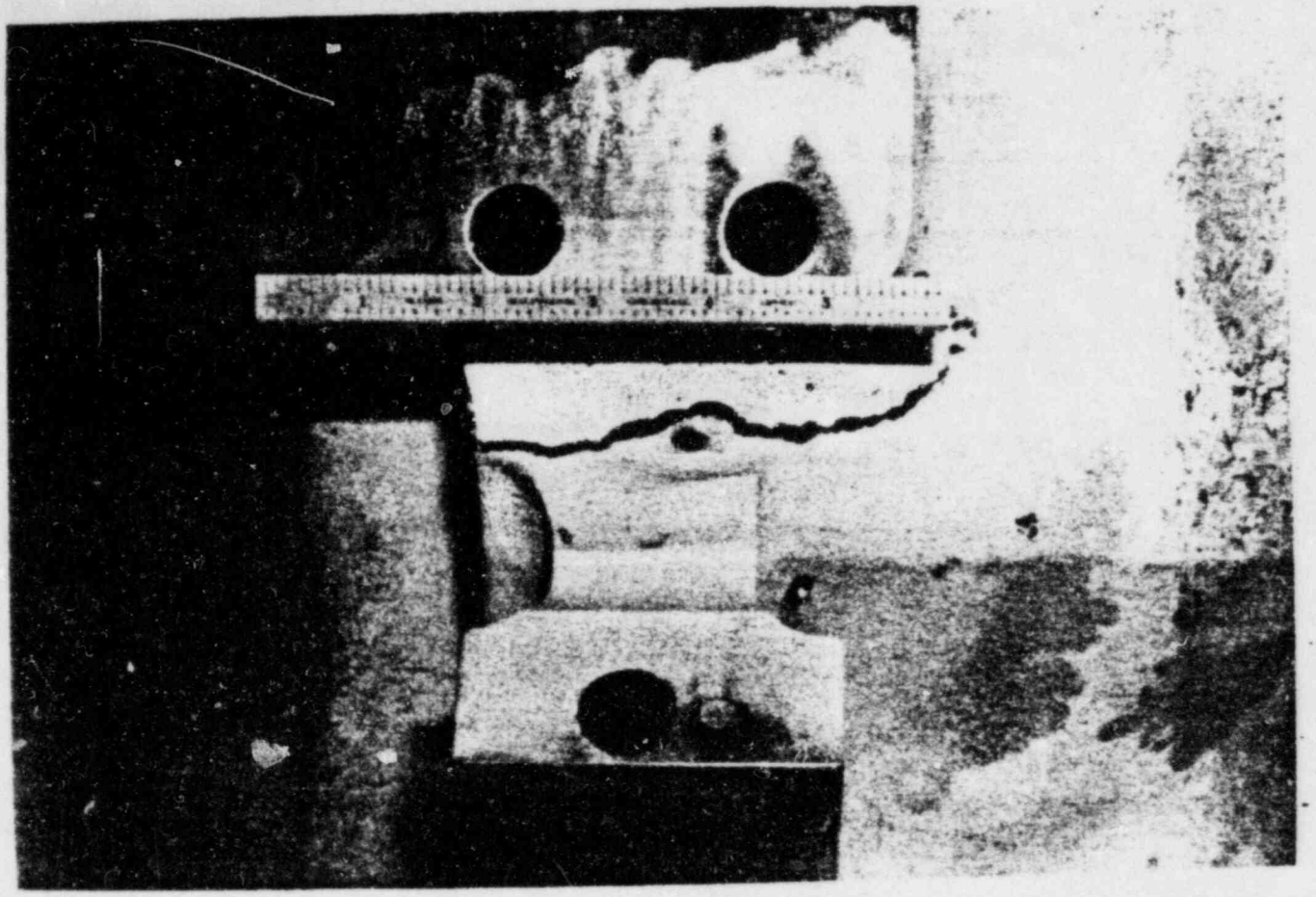
Photo: As polished condition

		MAX
-	.828"	.906"
R	.5"	.547"

7396·244 pc 17

HHW
JAR
9/24

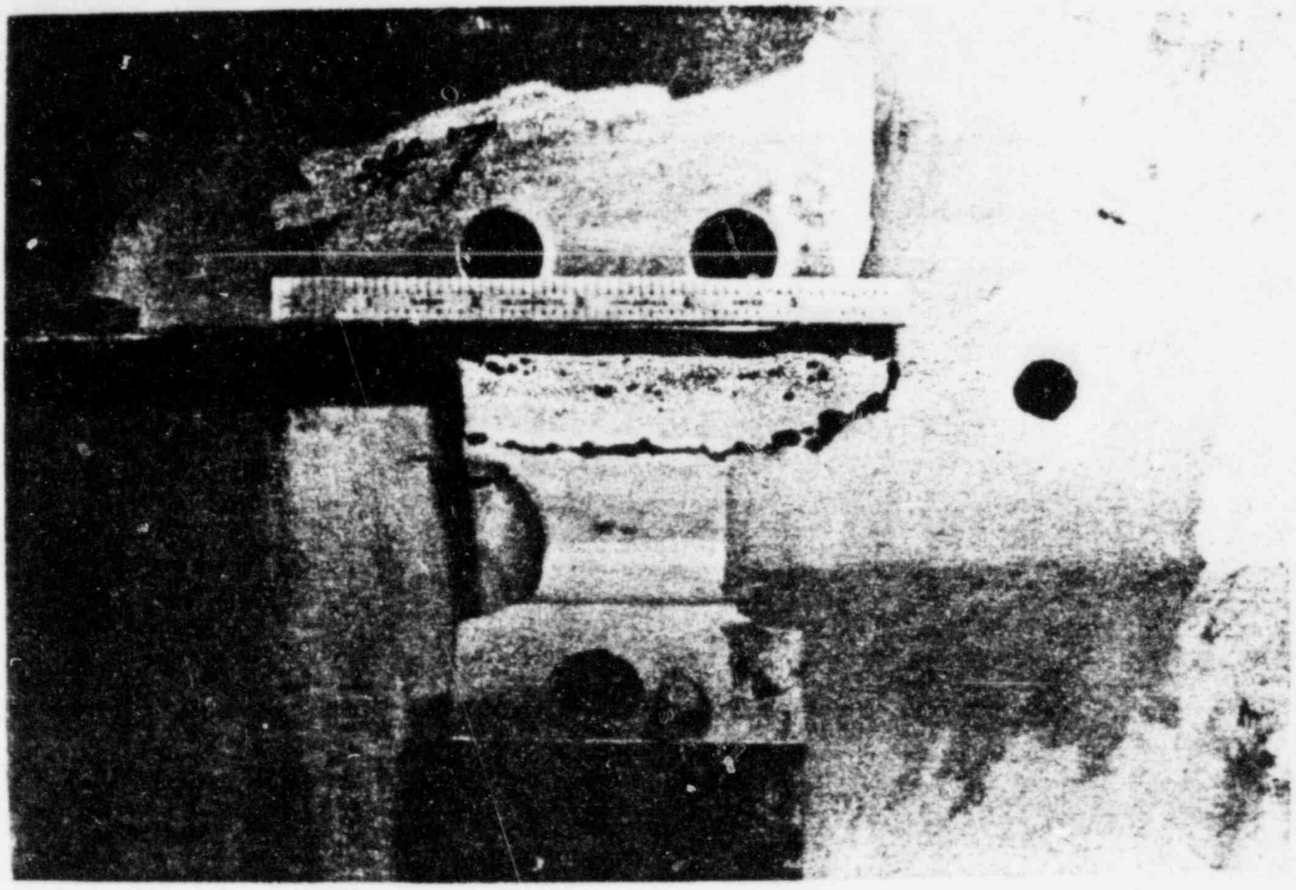
Failure Analysis Associates



ORIGINAL BLOCK - EDG 103

CAM GALLERY BEARING SADDLE #5

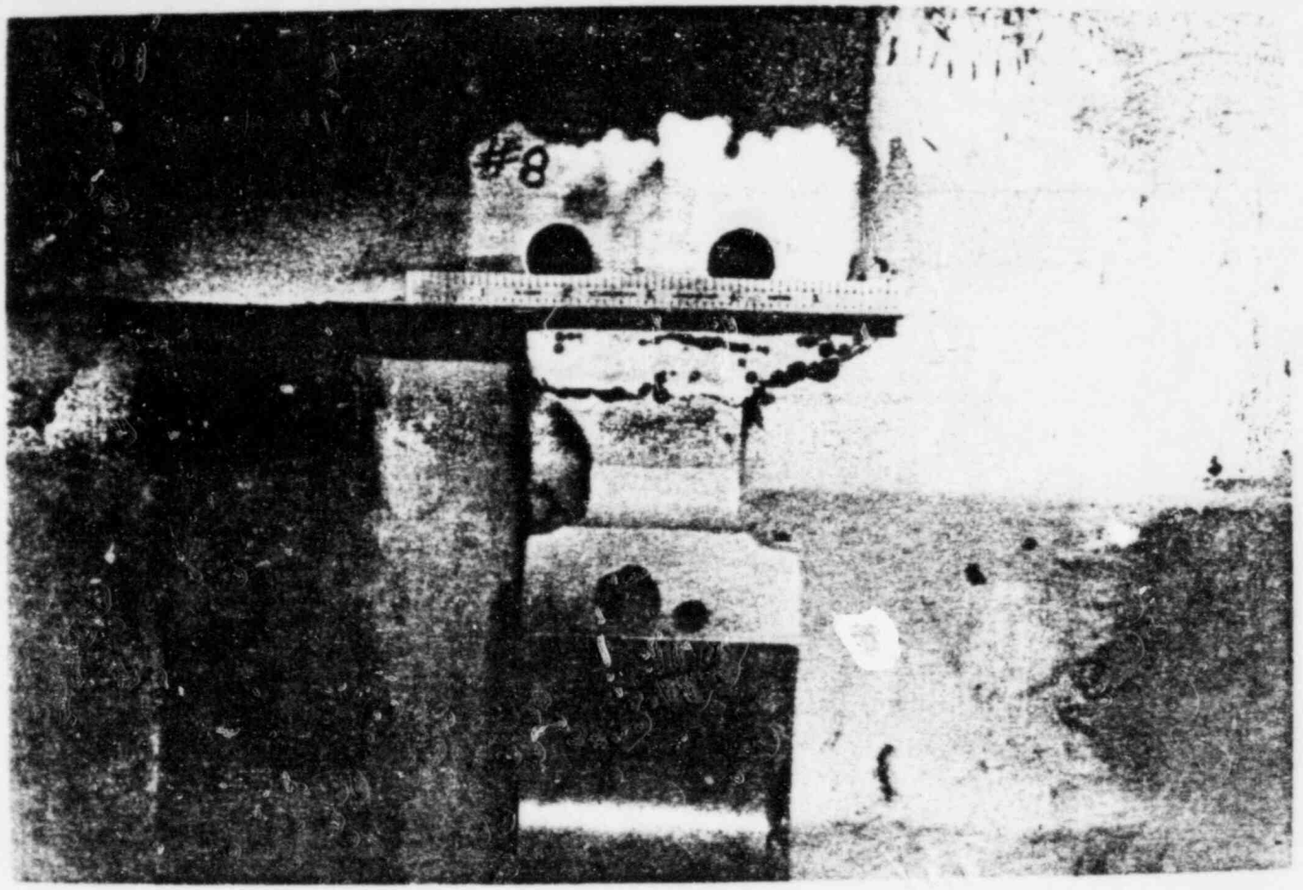
FaAA PHOTO - 8/24/84 - Rool 05125



ORIGINAL BLOCK - EDG 103

CAM GALLERY BEARING SADDLE #7

FaAA PHOTO - 8/24/84 - ROLL 05125



ORIGINAL BLOCK - EDG 103

CAM GALLERY BEARING SADDLE #8

FaAA PHOTO - 8/24/84 - ROLL 05125

Cam Saddle #7
Face 1, I613
X50

Cam Saddle #7
Face 1, I613
X100

ORIGINAL BLOCK - EDG 103

FaAA Photos - 9/4/84

MAGNETIC PARTICLE EXAMINATION REPORT

NCI

COMPONENT I.D.

SYSTEM

PLANT/LOCATION

A. MATERIAL	TYPE	FABRICATED PROCESS	☐ WELDED ☒ CAST ☐ WORKED	
	GEOMETRY	☐ PIPE ☐ PLATE ☐ ROD	☒ OTHER:	
CROSS SECTION THICKNESS	MAX / MIN	PIPE DIA.	SURFACE CONDITION	☐ MACHINED ☐ GROUND ☒ AS FABRICATED ☐ OTHER
B. NDE PROCEDURE NO.	MWR/RR NO.	EQUIPMENT I.D. S/N / MATE NO.		
TECHNIQUE	☐ PRODS	☒ YOKE	☐ COIL	☐ OTHER
CURRENT	☒ AC	☐ DC	☐ HW/DC	☐ 10 lb PLATE ☐ 40 lb PLATE
	AMPS / AMPS. PER. IN.	PROD SPACING YOKE	PRODS	
MATERIALS	☐ DRY	☒ WET	BRAND/DESIGNATION	Batch #53C036

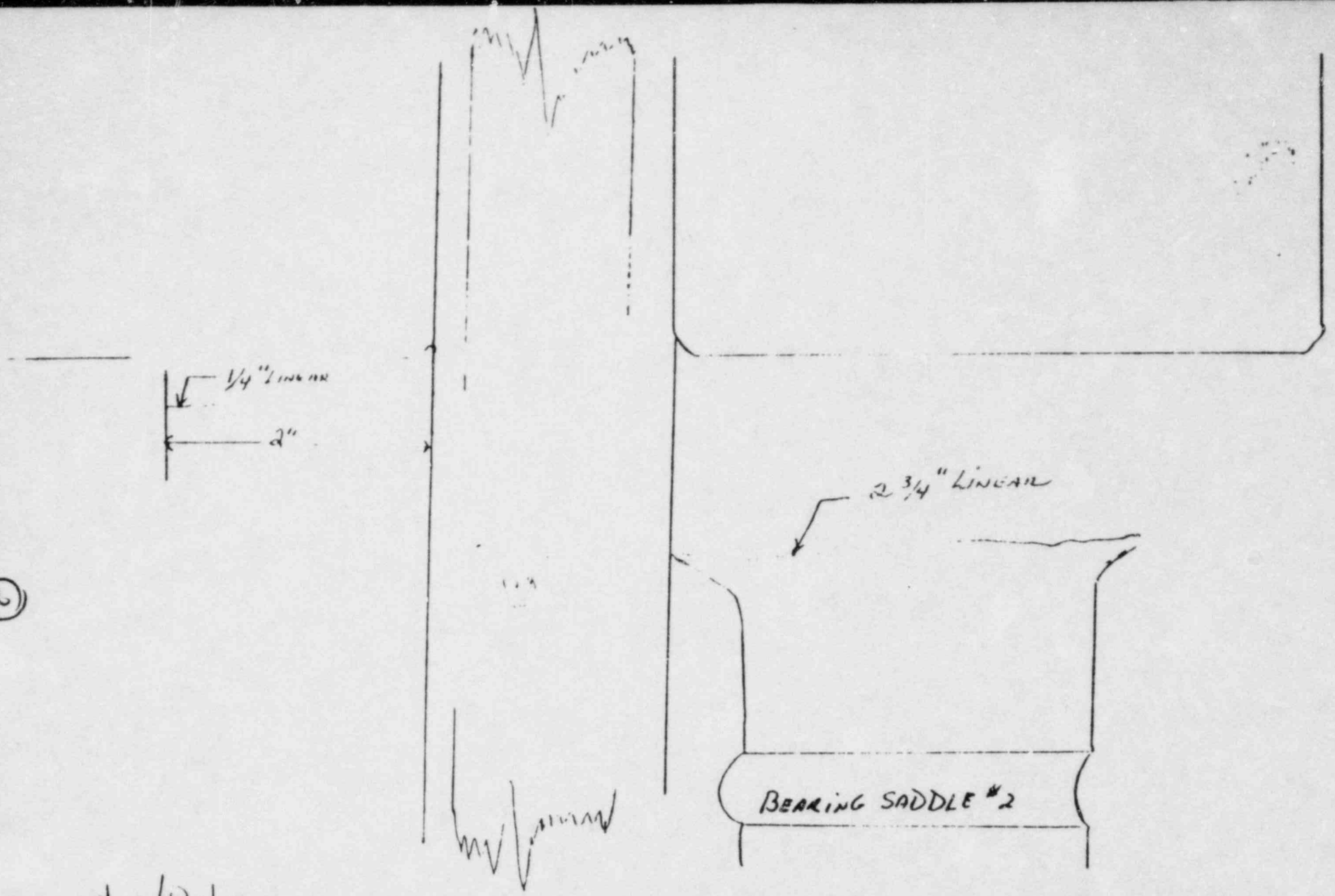
SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

See attached sheets

C. EVALUATION — REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE

	LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1	See	attached	sheets	
2				
3				
4				

D. ACCEPTANCE CRITERIA	NDE 12 para 22	OPERATOR / LEVEL II	DATE 9/26/94
E. ATTEST			



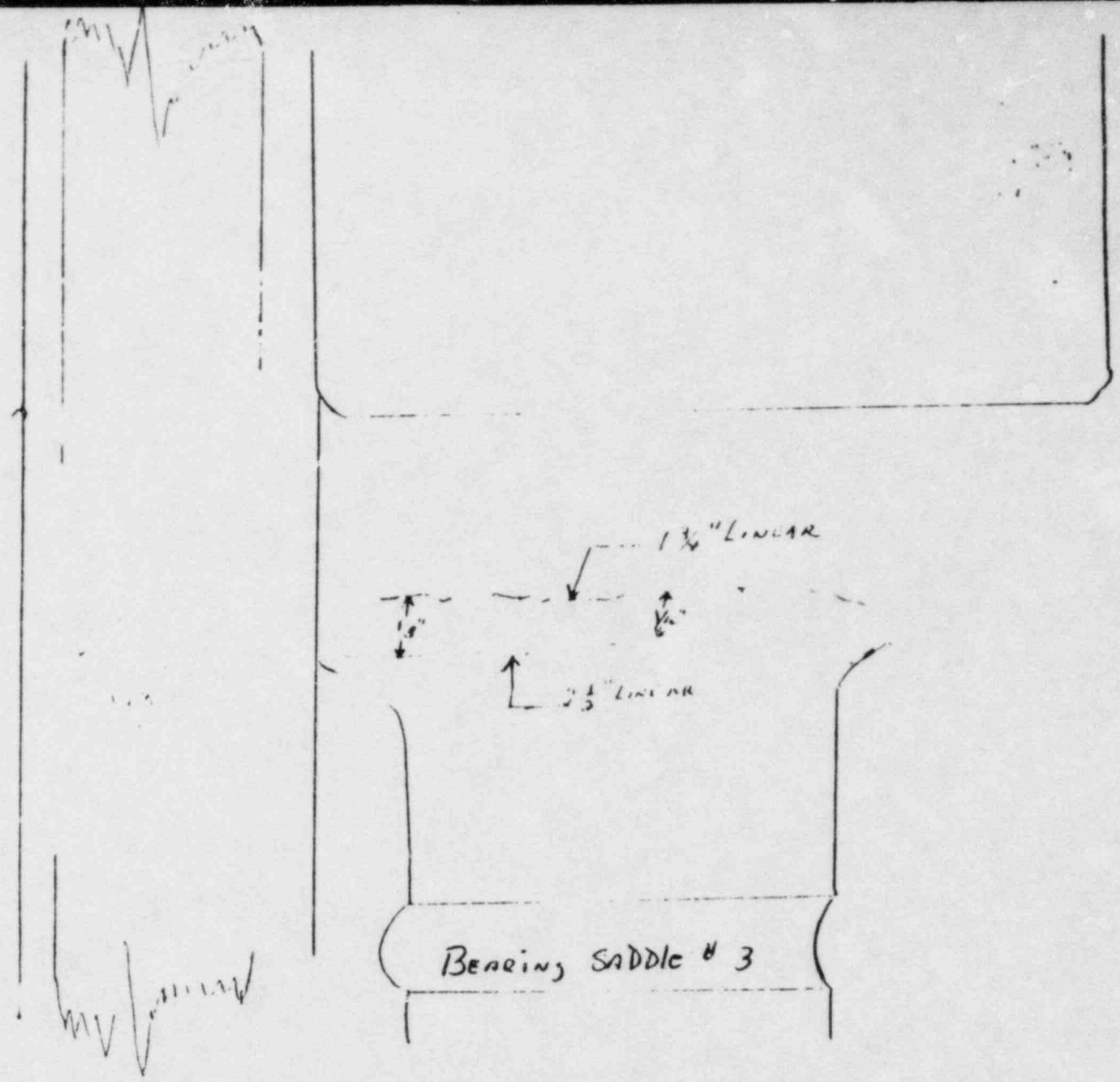
(2)

Inspector/Date

Ed Bl 9/20/84

AGNETIC PARTICLE Inspection Results of IRYS # EDG-101 CAM GALLEY AREA #1 CYLINDER AREA

-YPE PARTICLE USED: WET METHOD (Fluorescent), EQUIPMENT: YOKE



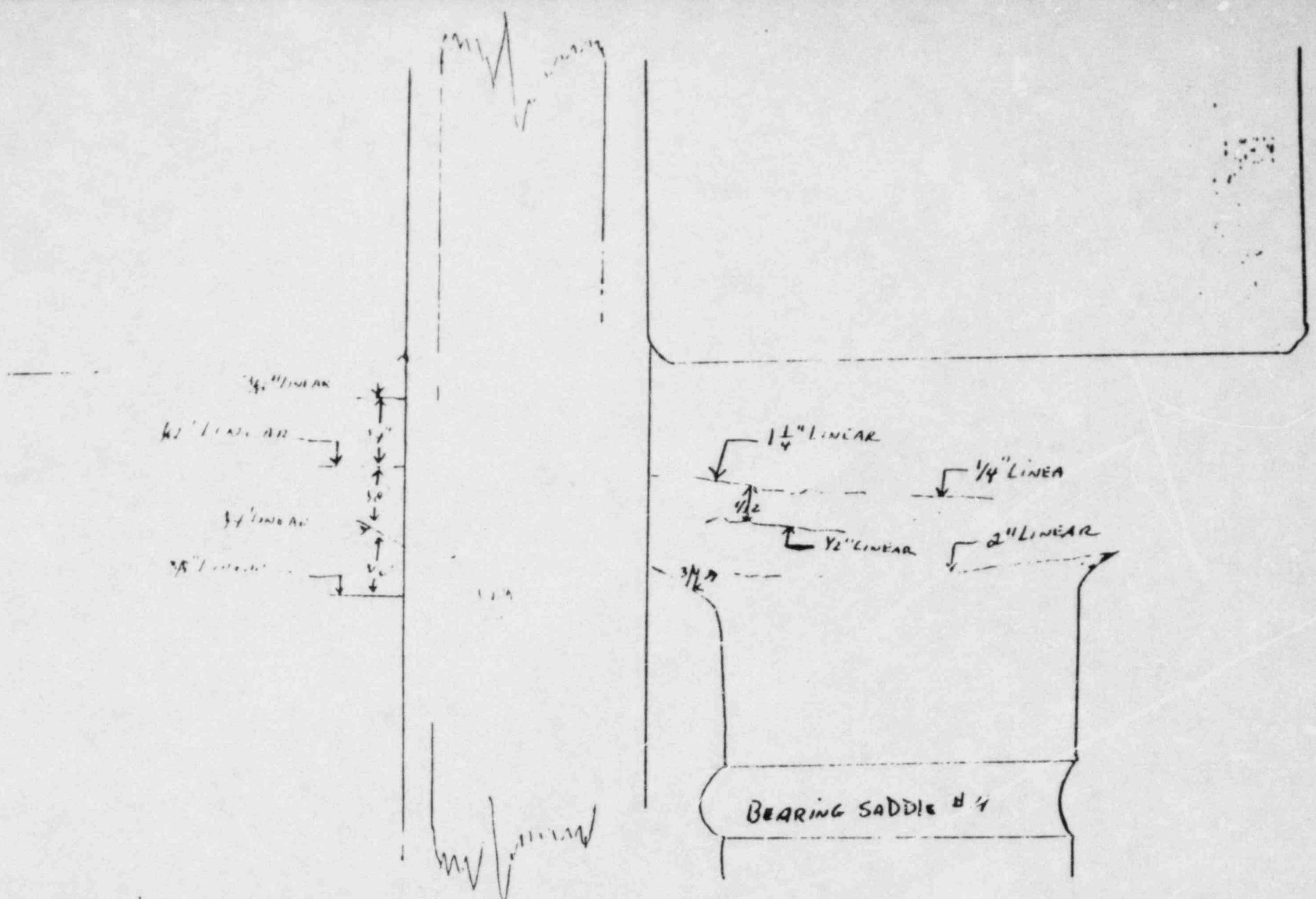
(W)

Inspector/Date

Victor Clark 7/20/87

MAGNETIC PARTICLE Inspection Results of 1R43 & EDG-101 CAM GALLERY AREA # 2 cylinder DRSN

VPE PARTICLE used: WET METHOD (Fluorescent) EQUIPMENT: YOKE



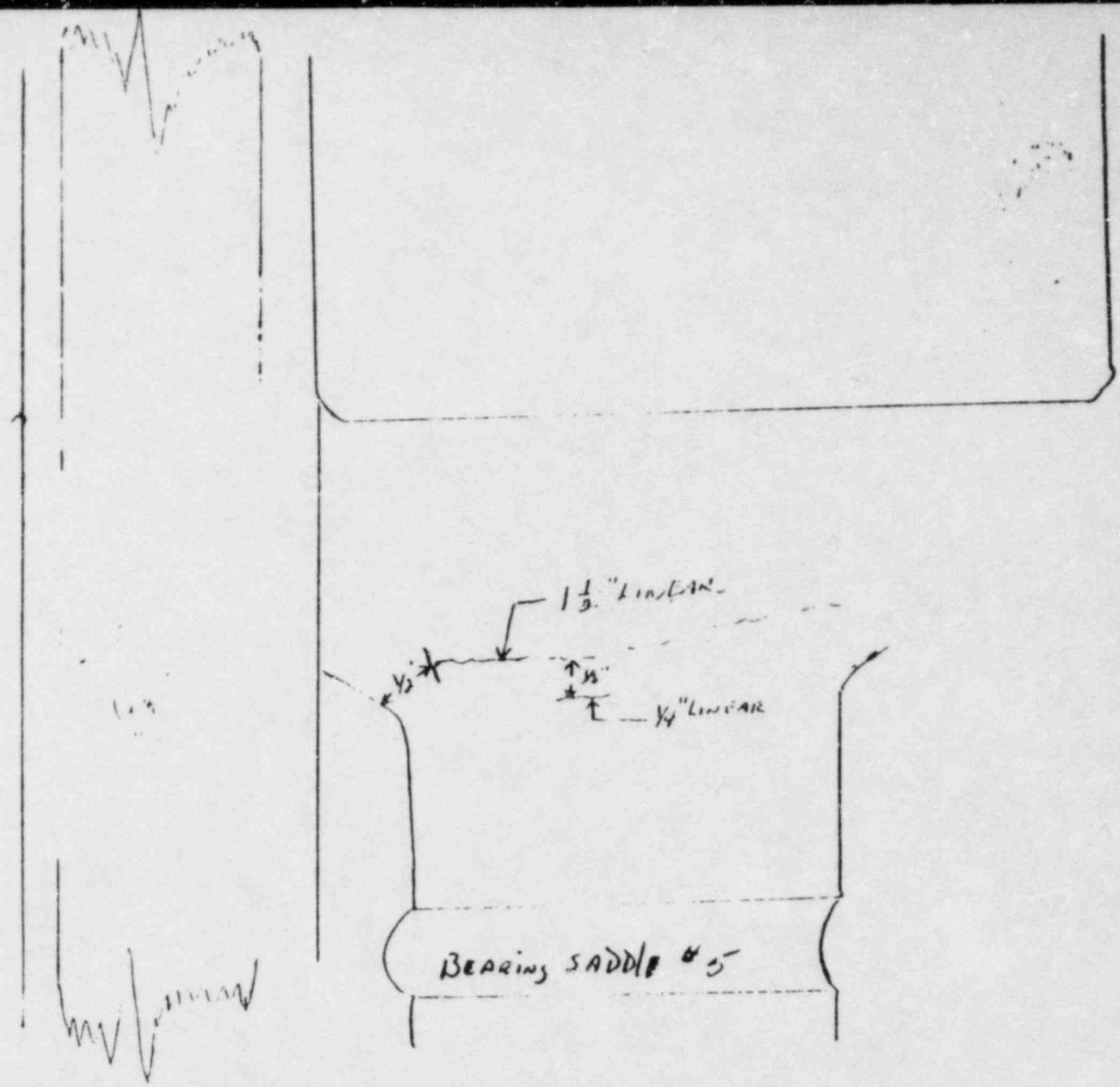
(4)

Inspector/Date

[illegible]

Magnetic Particle Inspection Results of 1RY3AEDG-108 CAM Galley AREA #3 Cylinder AREA

Type Particle: WET method (Fluorescent) Equipment: YOKE



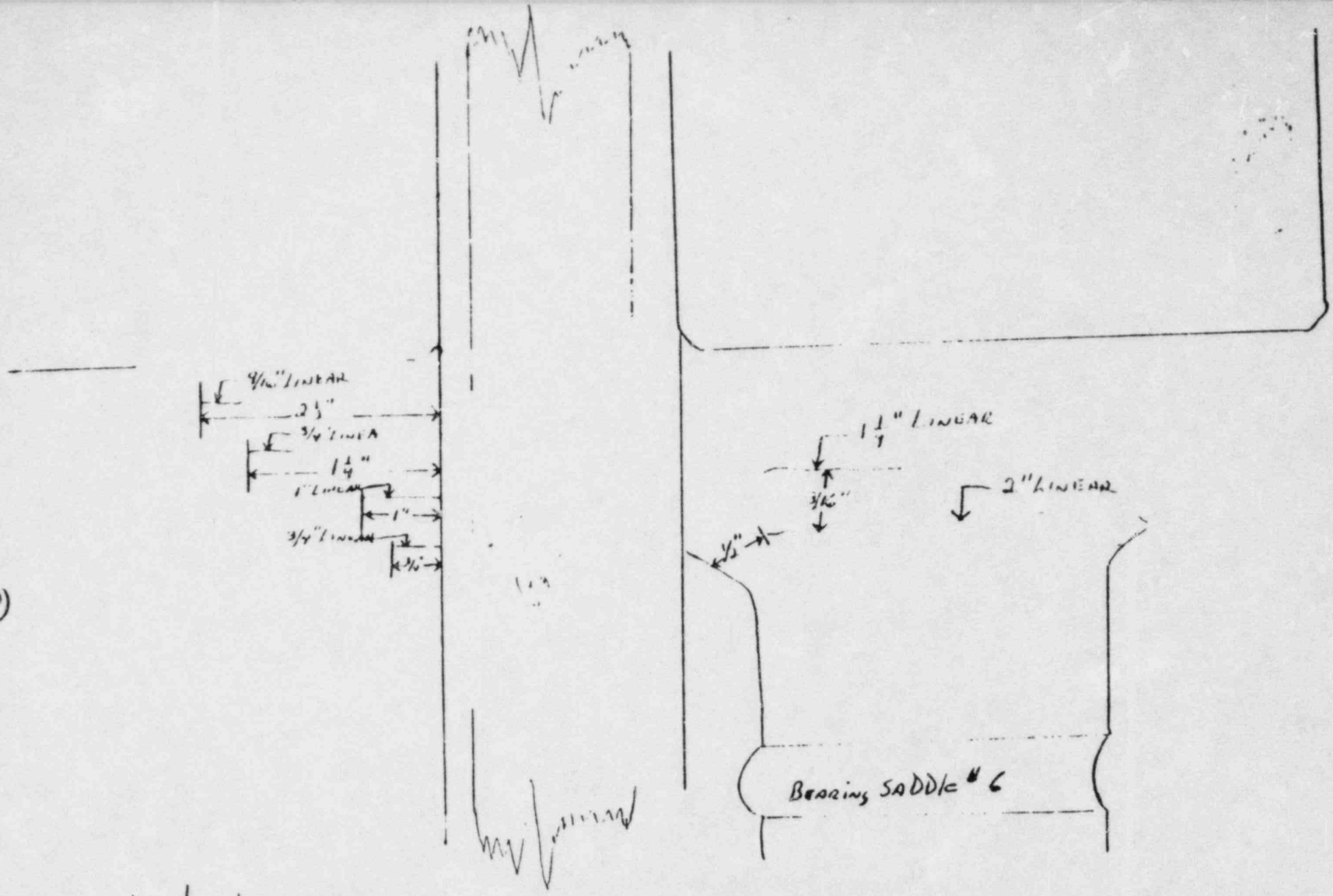
(5)

Inspector/Date

Visual

MAGNETIC PARTICLE INSPECTION RESULTS OF 1R43 #EDG. 108 CAM GALLEY AREA #4 Cylinder Area

TYPE PARTICLE WET Method (FLUORESCENT) EQUIPMENT: YOKE



(6)

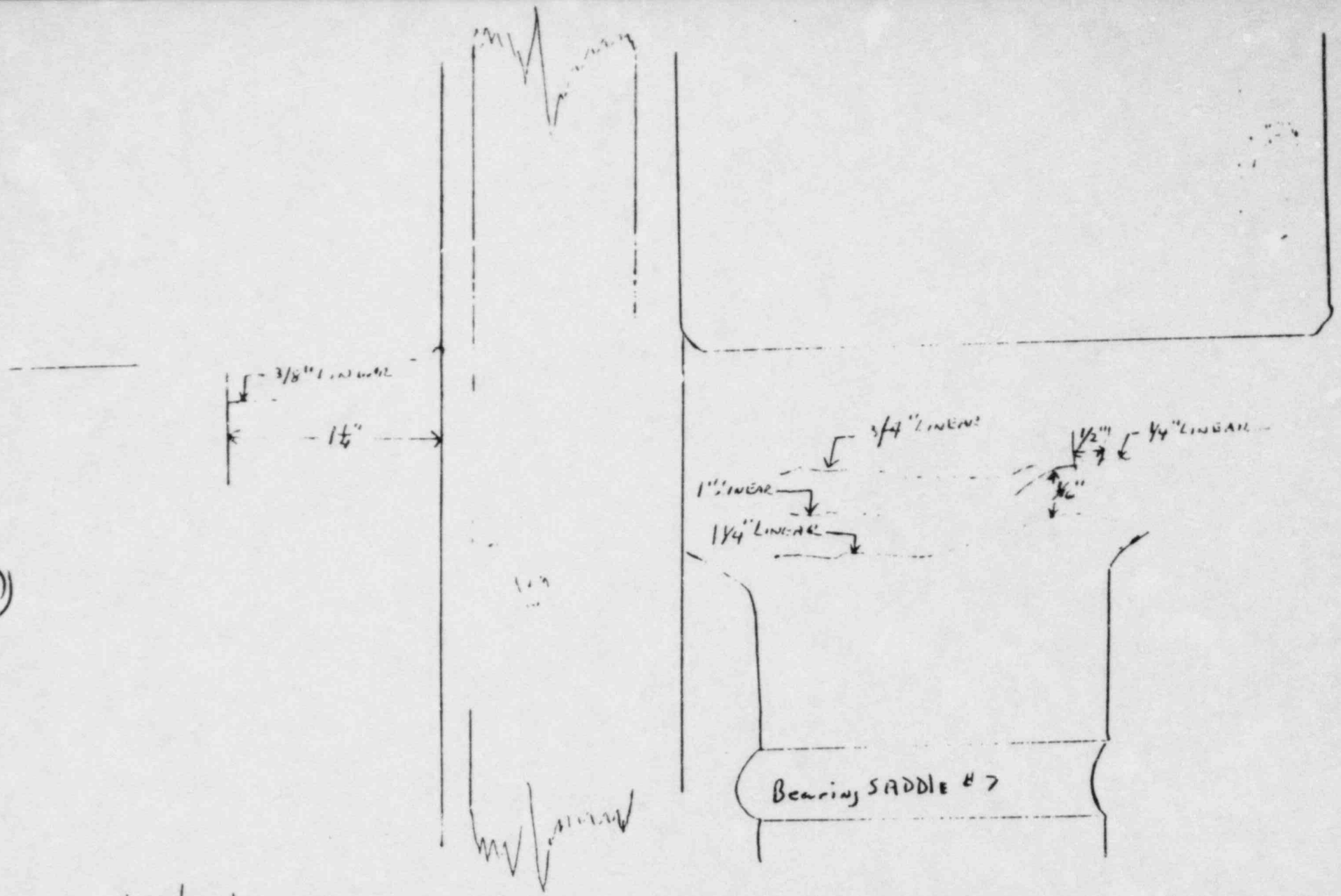
Inspector / Date

Victor Blt 9/20/84

MAGnetic PARTicle Inspection Results of 1R43HEDG-10B CAM GALley AREA #5 cylinder AREA

TYPE PARTicle used: WET method (Fluorescent)

EQuipment: Yoke



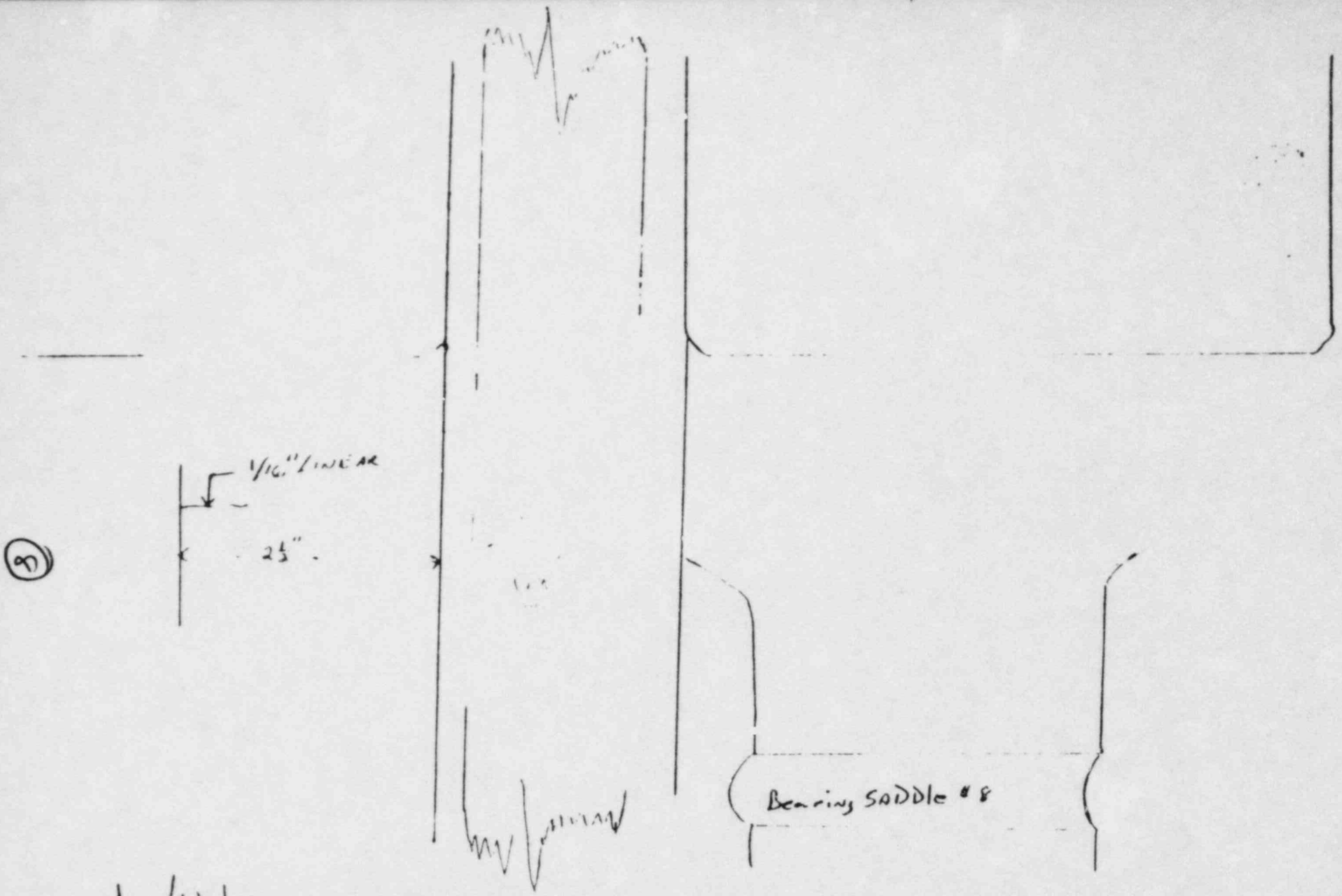
(2)

Inspector/Date ~~[illegible]~~ 8/20/84

MAGNETIC PARTICLE INSPECTION RESULTS OF IR43* EDG101 CAM GALLEY AREA #6 CYLINDER AREA

TYPE PARTICLE USED: WET METHOD (FLUORESCENT)

EQUIPMENT: YOKE

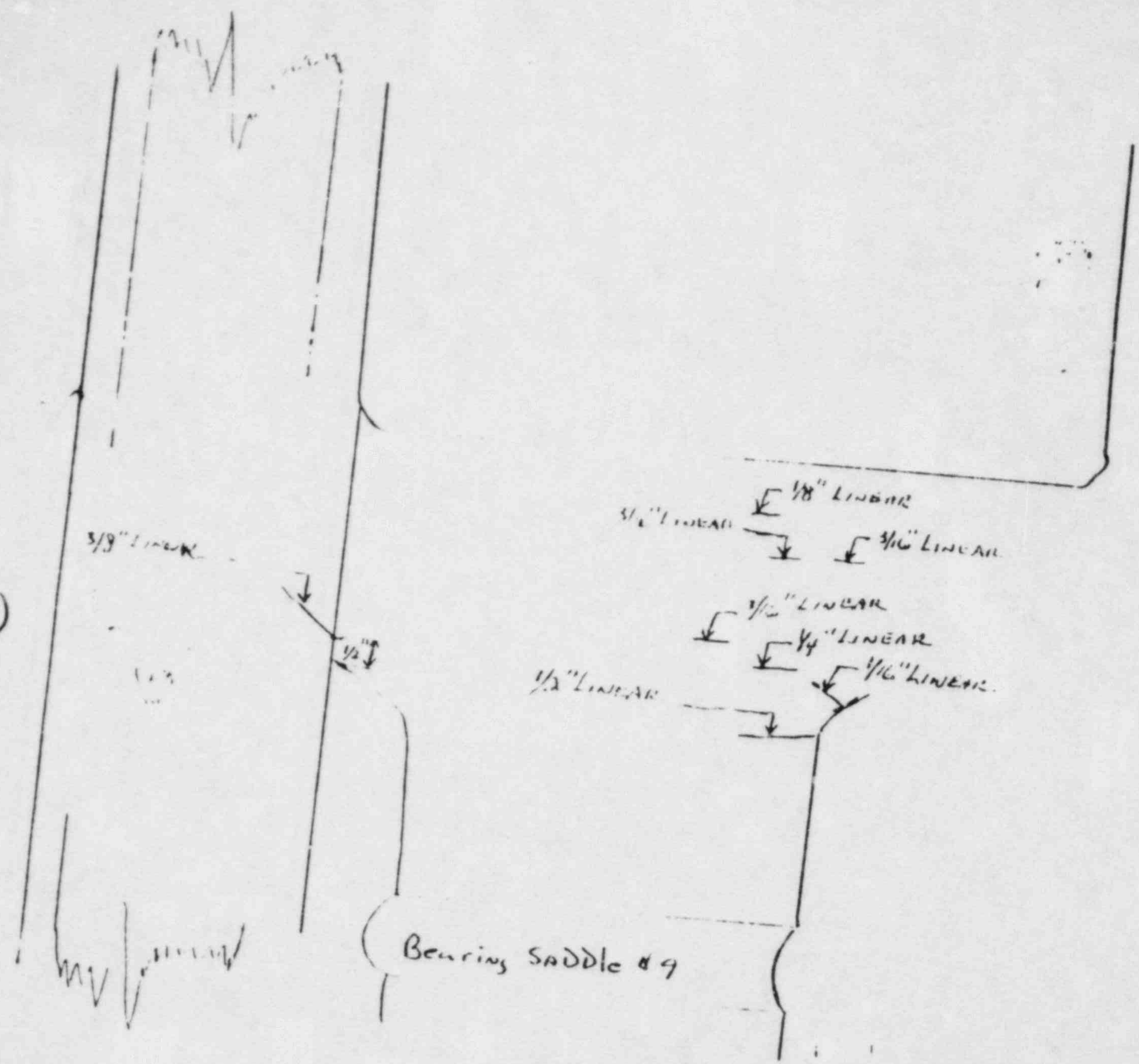


Inspector/Date
~~Dick Ole~~ 9/20/84

MAGNETIC PARTICLE INSPECTION RESULTS OF IR#3 "E" DBL. I Cam GALLEY AREA # 7 CYLINDER AREA

TYPE PARTICLE USED: WET MAGNA. (FLUORESCENT)

EQUIPMENT: YOKE



... C ... OF IR43 * EDB-101 ... GALLEY AREA ... 8 ...

METHOD ...

LIQUID PENETRANT EXAMINATION REPORT

A. MATERIAL	TYPE CS	FABRICATED PROCESS	☐ WELDED	☒ CAST	☐ WORKED
	GEOMETRY	☐ PIPE	☐ PLATE	☐ ROD	☒ OTHER: EDG-101
CROSS SECTION THICKNESS MAX / MIN N/A	PIPE DIA N/A	SURFACE CONDITION	☐ MACHINED	☐ GROUND	
			☒ AS FABRICATED	☐ OTHER	
B. NDE PROCEDURE NO. 6.2	SURFACE MATL. TEMP 72°	MATL. NO. 365	RR 243-2010 MFR. NO. 84-5086		

INSPECTION MATERIALS	BRAND	DESIGNATION	BATCH NO.
1. PRE-CLEANER	MAGNAFLUX	SKC-NF/ZC-7B	844028
2. PENETRANT	MAGNAFLUX	SKL-HF/S	836018
3. EMULSIFIER AND/OR REMOVER	MAGNAFLUX	SKC-NF/ZC-7B	844028
4. DEVELOPER	MAGNAFLUX	SKD-NF	82D111
5. POST EXAMINATION CLEANER	MAGNAFLUX	SKC-NF/ZC-7B	844028

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

See Attached Sheets

C. EVALUATION — REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE.

LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1 See Attached Sheets			Reject/Indications Noted
2 N/A			
3 N/A			
4 N/A			

D. ACCEPTANCE CRITERIA: NDE 6.2 Para. 4.2.2

OPERATOR Cocuzza, Platania, French, Mosby
Level II Date 9-21-84

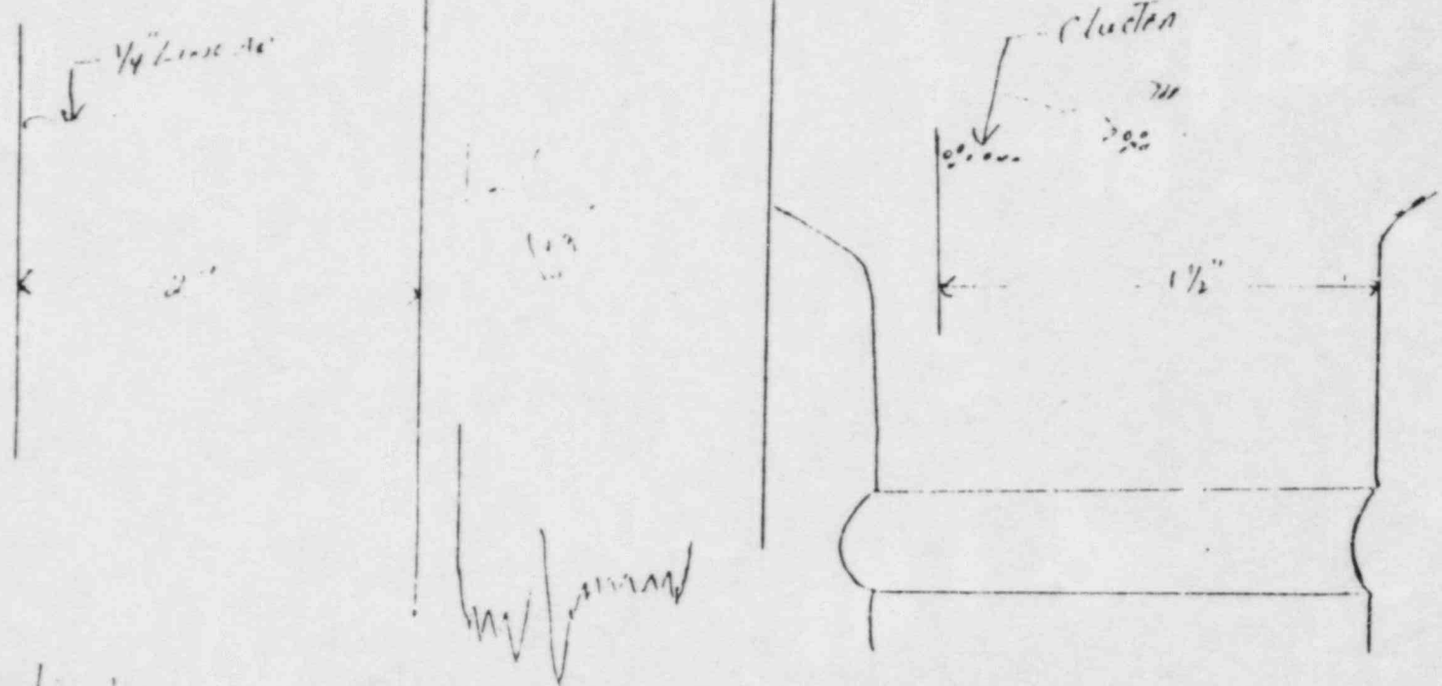
E. ATTEST: Patricia L. Lovack — RESPONSIBLE/CERTIFIED PERSONNEL; II — LEVEL; 9/21/84 — DATE

COMPONENT I.D. IA23 # EDG-101 Can Gallery

SYSTEM EDG

PLANT/LOCATION ENVI-101 2nd.

PRE-CLEAN	5 MINUTES
DWELL TIME	10 MINUTES
DEVELOPER	10 MINUTES
TEMP	72° F



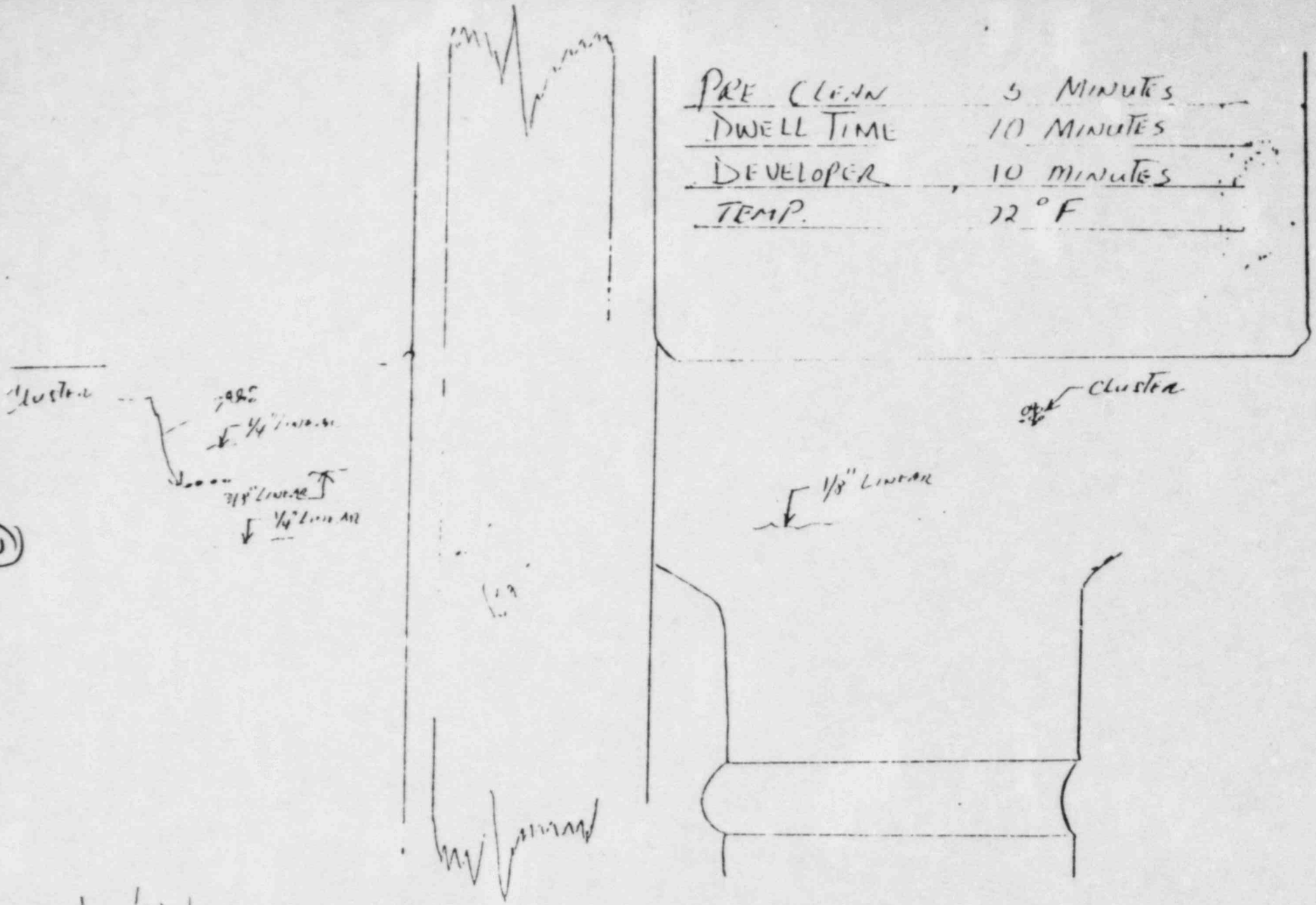
(2)

Inspector/Date

9/21/84

LIQUID PENETRANT INSPECTION RESULTS OF 1243* EDG 101 CAM GALLEY AREA #1 CYLINDER AREA

PRE CLEAN	5 MINUTES
DWELL TIME	10 MINUTES
DEVELOPER	10 MINUTES
TEMP.	72 °F

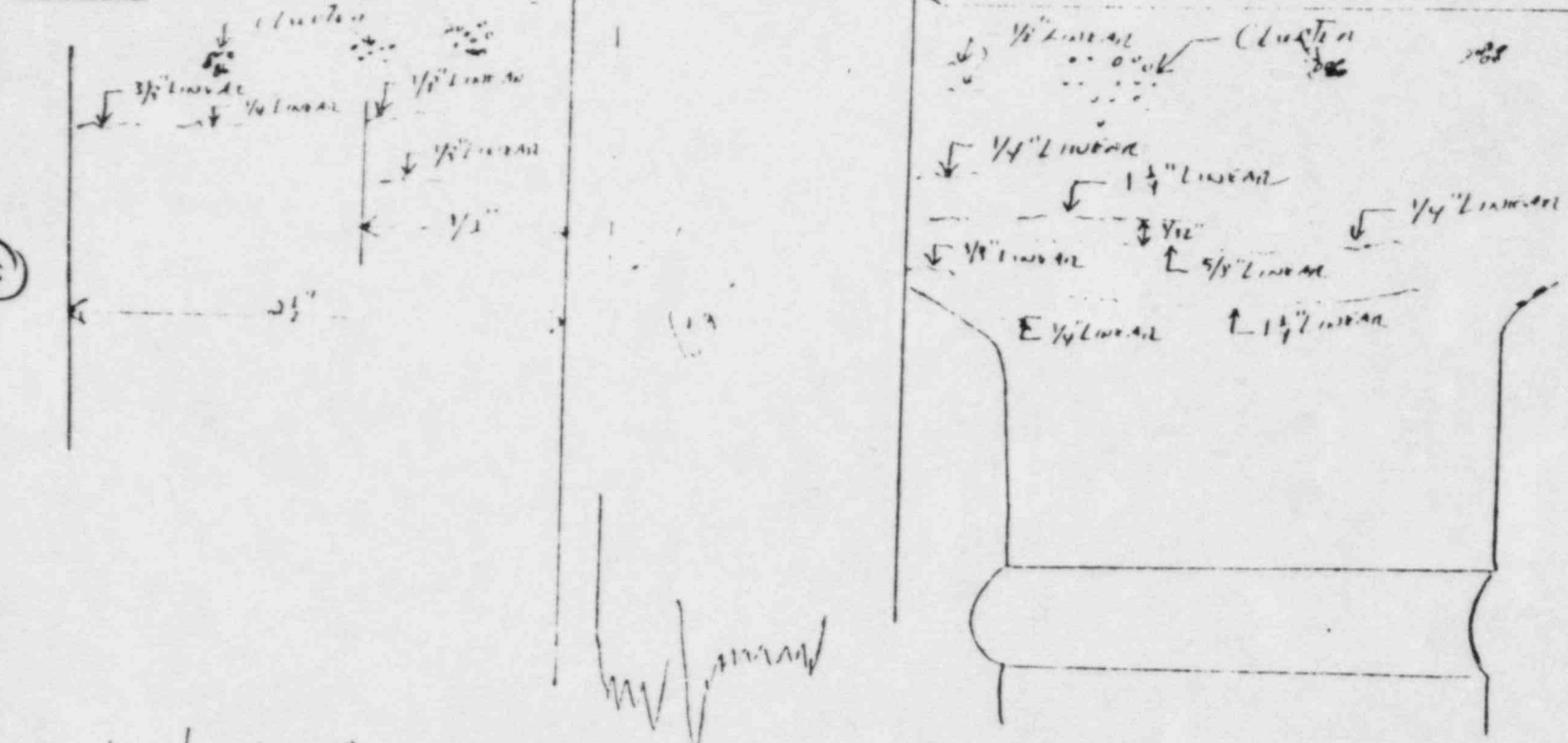


Inspector/Date

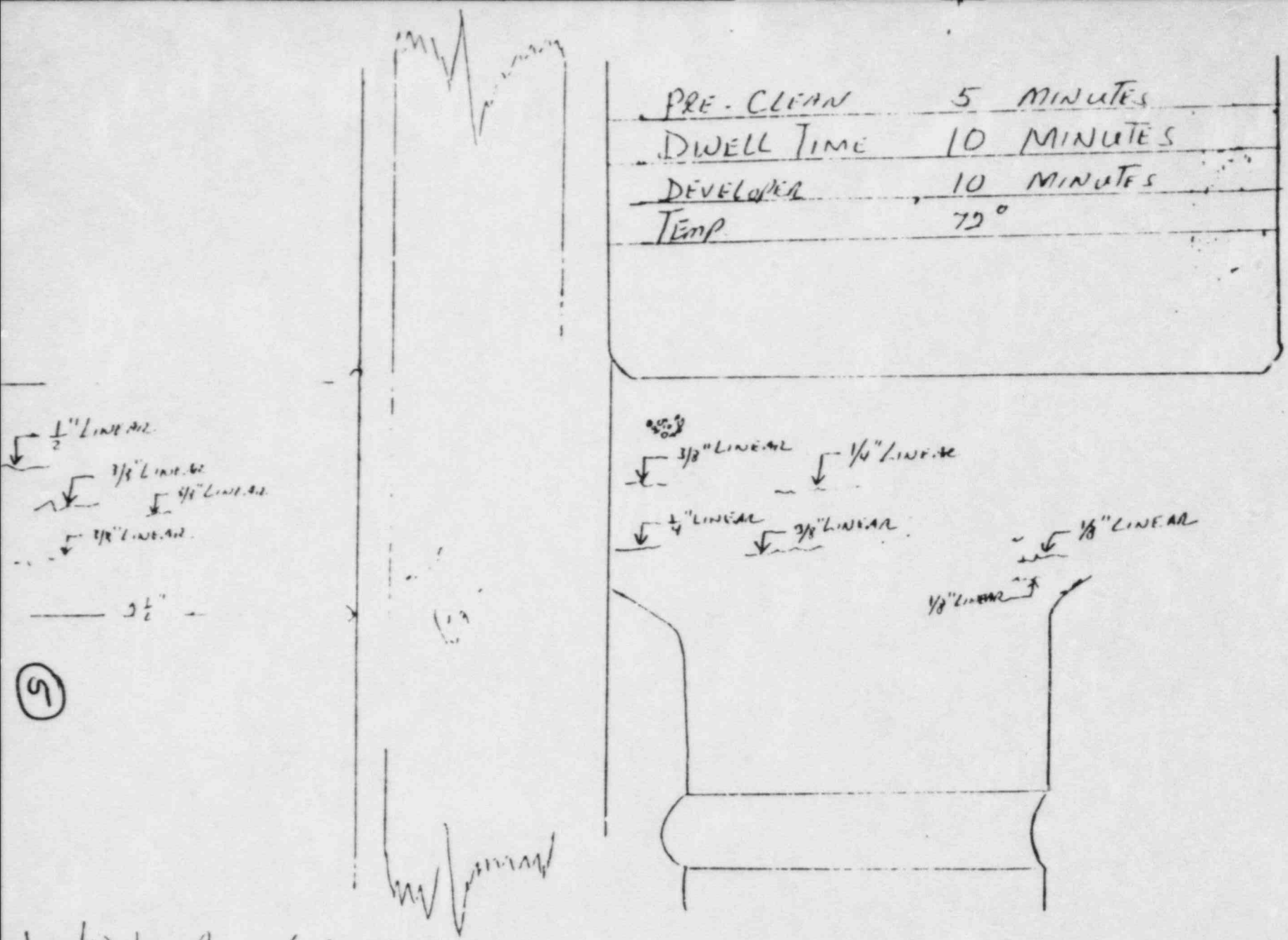
5/31/84

LIQUID PENETRANT INSPECTION RESULTS OF IR43 & EDG 101 CAM GALLEY AREA #2 CYLINDER AREA

PRE CLEAN	5 MINUTES
DWELL TIME	10 MINUTES
DEVELOPER	10 MINUTES
TEMP	72°



LIQUID PROCESSING INSPECTION RESULTS OF IKONEX EDGE 101 CAM GALLEY AREA # 3 CYLINDER AREA

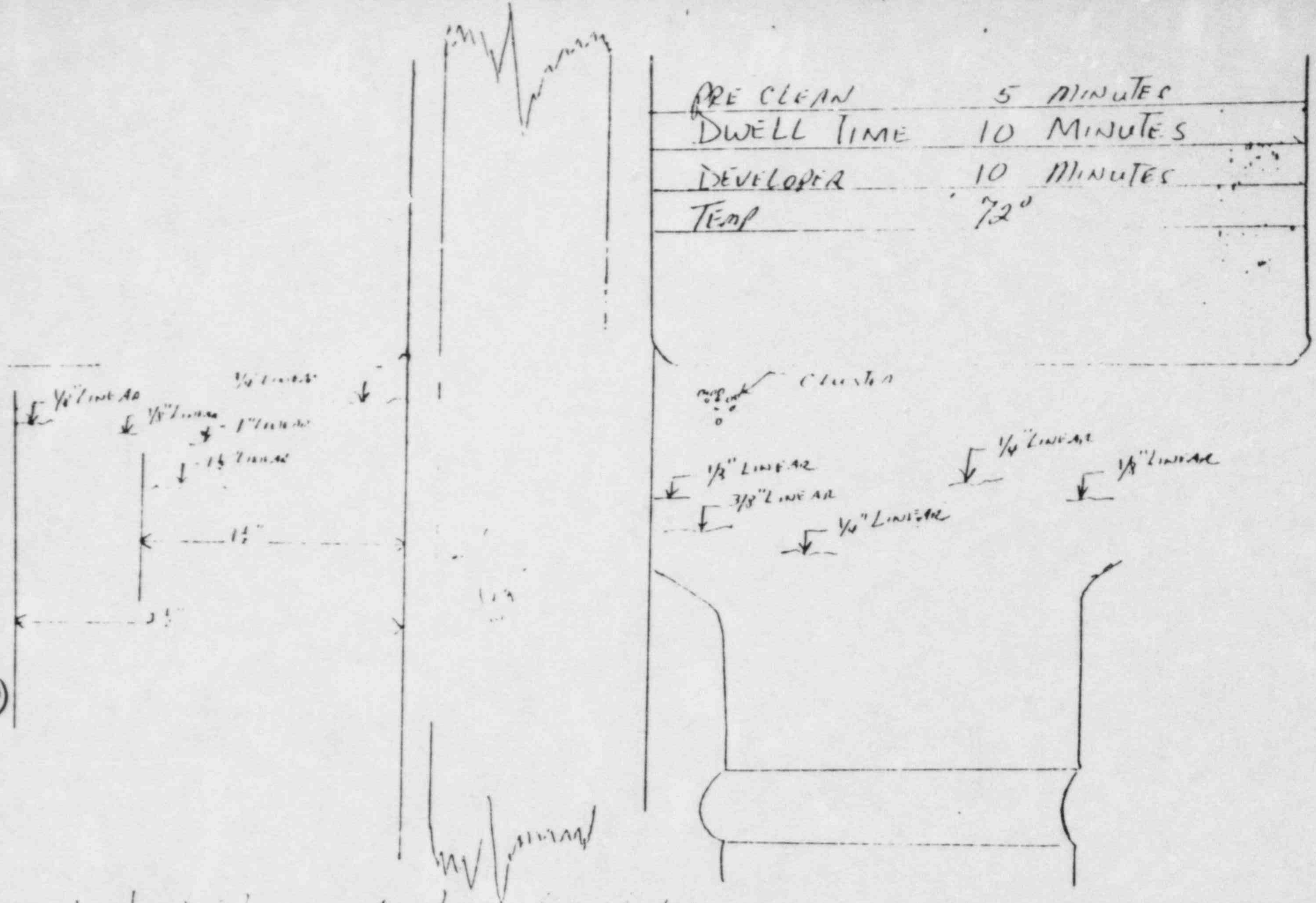


(5)

ctor/Date Jane Moody 7/21/84

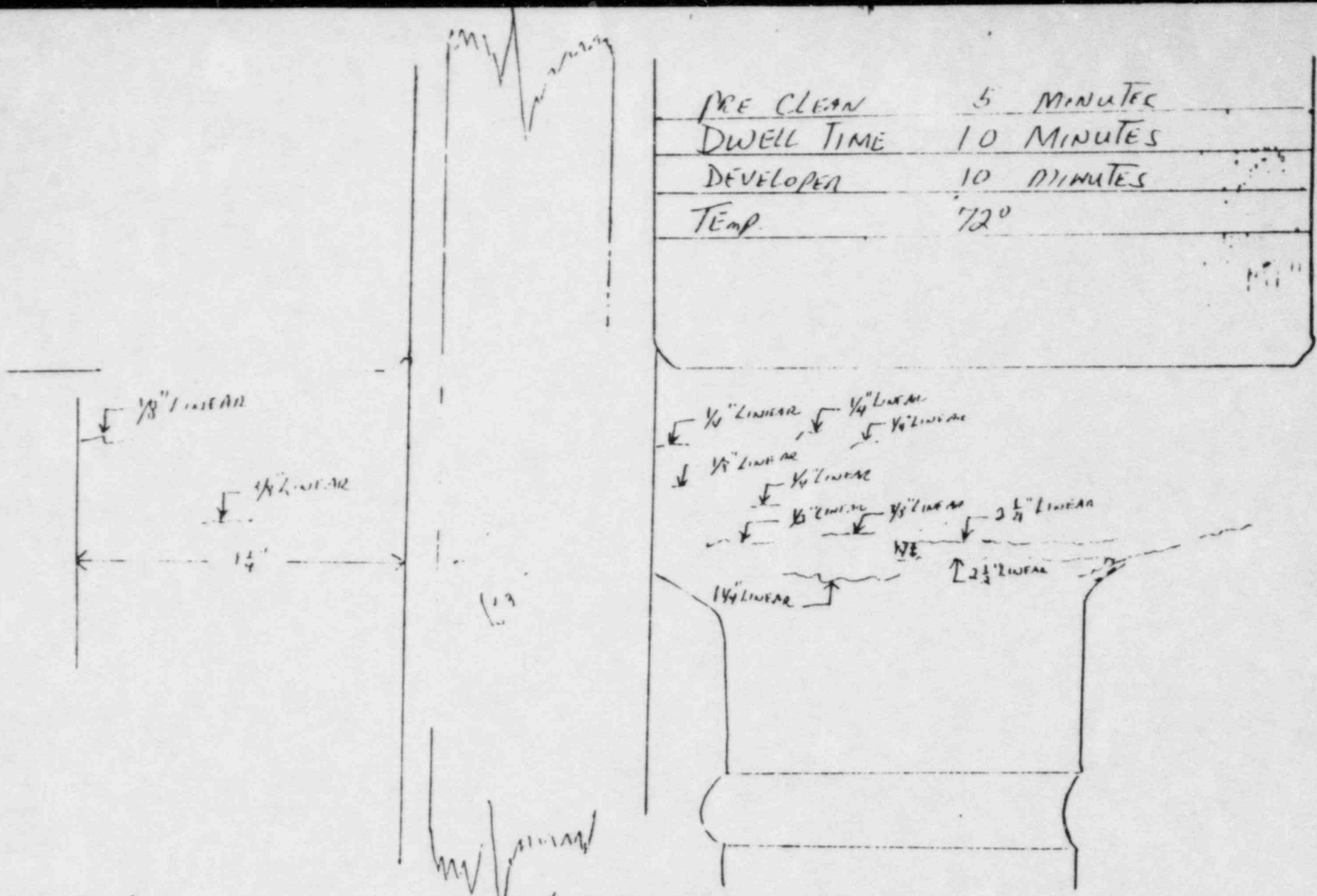
QUID PENETRANT INSPECTION OF WELD OF IRY3 # EDG 101 CAM GALLEY AREA # 4 CYLINDER R.H.A

6



Inspector/Date [illegible]

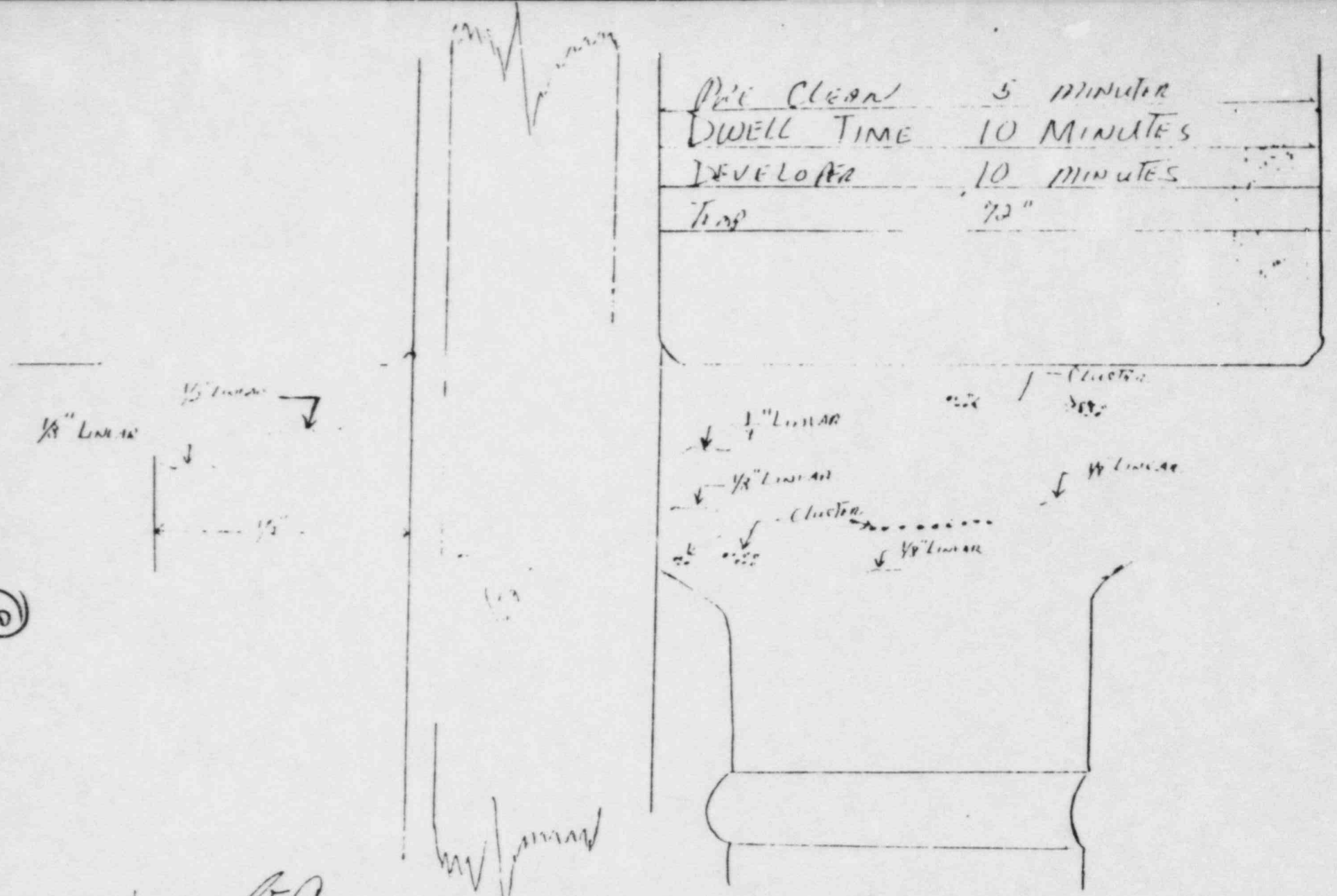
LIQUID PENETRANT INSPECTION RESULTS OF 1R43*EDG101 CAM GALLEY AREA # 5 CYLINDER AREA



(2)

Special Visual Inspection 4/20/84

LIQUID PENETRANT Inspection Results of IR43*EDG101 CAM GALLEY AREA #6 CYLINDER AREA

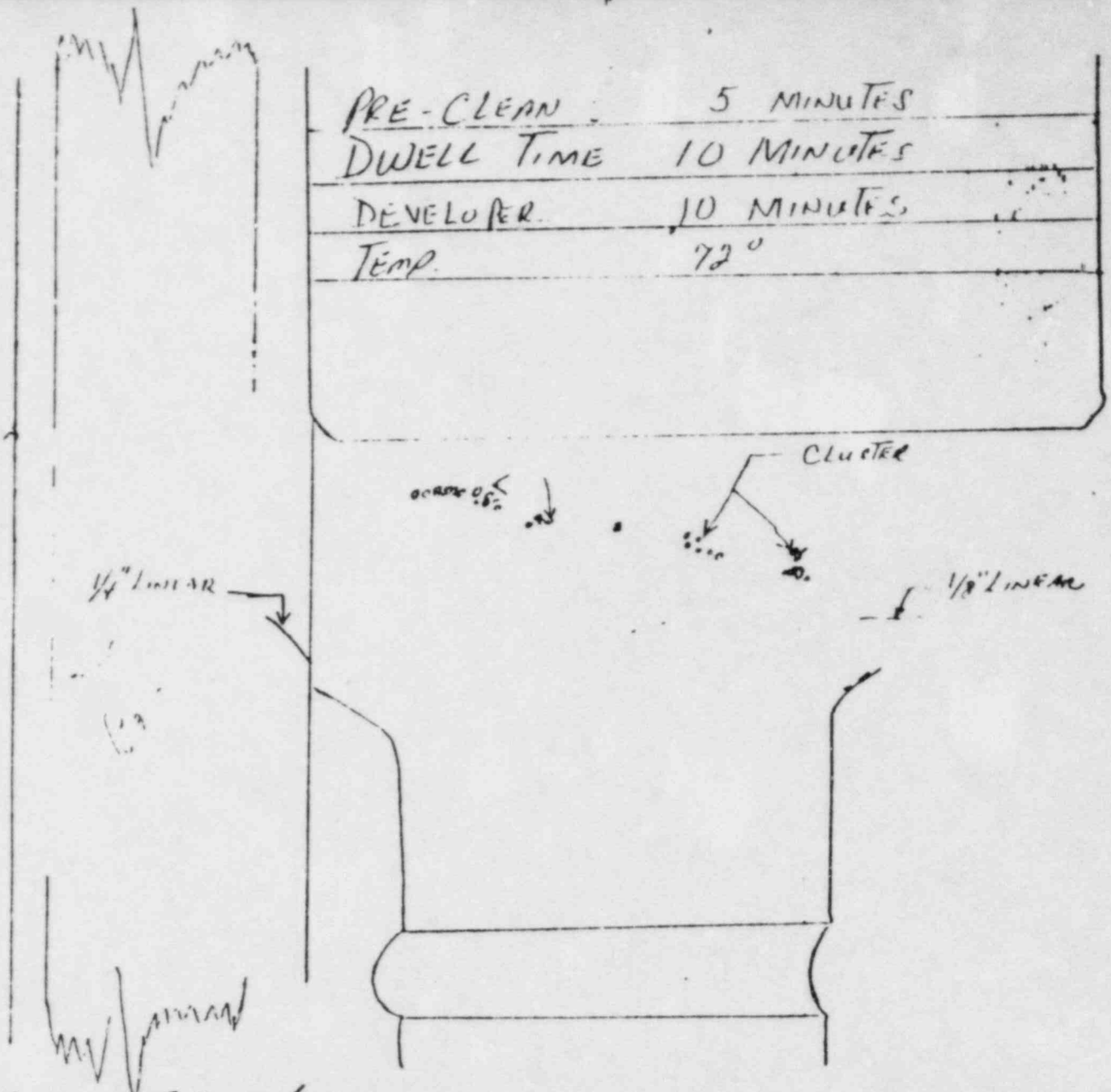


(8)

Inspector/Date [illegible] Level II 5-21-84

LIQUID PENETRANT INSPECTION RESULTS OF 1643 X EDGE/ON CAM GALLEY AREA # 7 CYLINDER AREA

PRE-CLEAN	5 MINUTES
DWELL TIME	10 MINUTES
DEVELOPER	10 MINUTES
TEMP.	72°



(b)

Inspector/Initials [illegible] Level II [illegible]

LIQUID PENETRANT INSPECTION RESULTS OF IR43 & EDS 101 CAM GALLEY AREA #8 CYLINDER AREA.

W. D

1	**LILCO** DEFICIENCY REPORT	☒ FIELD ☐ OTHER	LDR RESPONSIBILITY: M. Herlihy, LSU	LDR NUMBER: 2507
2	SYSTEM/COMPONENT: Emergency Diesel Gen.	SYSTEM DESIGNATOR: 1R43	MARK NO.: 1R43*ENG-103	DATE: 10/1/84 — Q CLASS: ☒ I ☐ II ☐ III
3	MFG./CONTRACTOR: TDI	P.O.: 310552	MATERIAL LOCATION: Control Bldg. EDG-103	REJECT TAG NO.: ☐ YES ☒ NO
4	SPEC. VIOLATED: N/A	DRAWING VIOLATED: N/A	PROCEDURE VIOLATED: NDE 6.2 para. 4.2.2	CODE/STANDARD VIOLATED

5 CONDITION DETAILS

Per results of NDE Inspections performed on 1R43*ENG 103 (Cam Galley area) rejectable indications were noted. This is in violation of the LILCO NDE Manual NDE 6.2 (Liquid Penetrant) paragraph 4.2.2 (See attached LILCO QQA Inspection Reports for condition details)

6 ORIGINATOR: [signature] 10/1/84 (SIGNATURE / DATE) — QQAE: J. Thomas Rose 10/1/84 (SIGNATURE / DATE)

7 RESPONSIBILITY: ☐ LSU ☒ S & W ENG. — SIGNATURE/LEAD SU ENG. — DATE: 10/2/84

8 ACTION: ☐ ACCEPT AS IS ☐ SCRAP ☐ REWORK ☐ REPAIR ☐ MANUAL PROCEDURE ☐ FSAR ☐ OTHER

9 DISPOSITION DETAILS

10 APPROVALS: S & W LEAD ENG./LSU TEST ENG./DATE — PROJECT ENGINEER / DATE

11 LILCO SU ENG. / DATE — LILCO SITE QQA / DATE — REPAIR/REWORK REQUEST NO.

12 ENG. COMPLETE/DATE — RRR COMPLETE: CONST. SUPT./DATE; LILCO SU/DATE — REWORK INSPECTION: ☐ SAT. ☐ UNSAT. LILCO SITE QQA/DATE

13 LDR CLOSED: LILCO SITE QQA/DATE — NEW LDR REPORT NO. ISSUED — REMARKS

FC-9350

(1)

E-84-[illegible]

MAGNETIC PARTICLE EXAMINATION REPORT

IR43 * ED3-103 (Areas of Cam Shoes #3 + #8)

A. MATERIAL	TYPE: Grey IRON	FABRICATED PROCESS: ☐ WELDED ☐ CAST ☐ WORKED	
	GEOMETRY: ☐ PIPE ☐ PLATE ☐ ROD ☐ OTHER:		
CROSS SECTION THICKESS: MAX N.A INCH	MIN N/A INCH	SURFACE CONDITION: ☐ MACHINED ☒ GROUND ☐ AS FABRICATED ☐ OTHER	
B. NDE PROCEDURE NO. 7.1 - 7.2	MWR/RR NO. RR R43 2039	EQUIPMENT I.D. S/N 16186 METE NO. 872 + 836	
TECHNIQUE: ☐ PRODS	☒ YOKE	☐ COIL	☐ OTHER
CURRENT: ☒ AC	☐ DC	☐ HW/DC	☐ 10 lb PLATE ☐ 40 lb PLATE
AMPS N/A AMPS. PER. IN. N/A	PROD SPACING YOKE 8"	PRODS N/A	
MATERIALS: ☐ DRY	☒ WET	MAGNAGLO 14AM PREPARED BATH BRAND/DESIGNATION BATCH #841007	

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

SEE ATTACHED SHEETS

This examination was performed to assist in Placement of strain gauges. M.T. Indications are noted on attached sheets. Also attached is a copy of memo to J. Kelly dated 9/20/84, Revised 9/28/84.

IR43

C. EVALUATION — REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE

LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1			
2		NA	
3			
4			

ED3-Rm-103

D. ACCEPTANCE CRITERIA	N/A	OPERATOR Victor Platania LEVEL II DATE 10/1/84
E. ATTEST	[signature] RESPONSIBLE CERTIFIED PERSONNEL	II LEVEL — 10/1/84 DATE

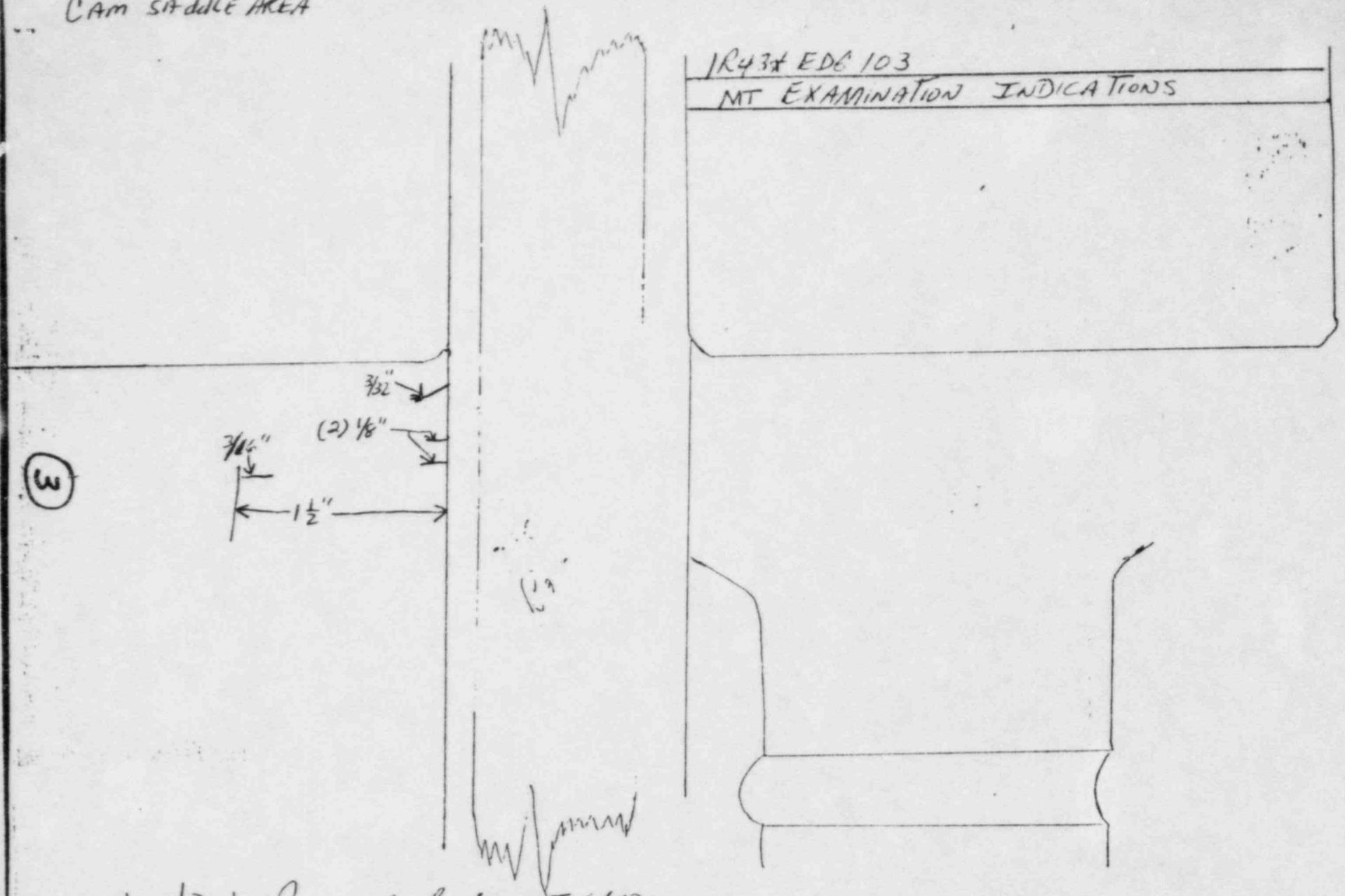
(2)

CYLINDER # 8

CAM SADDLE AREA

RIGHT EDGE 103

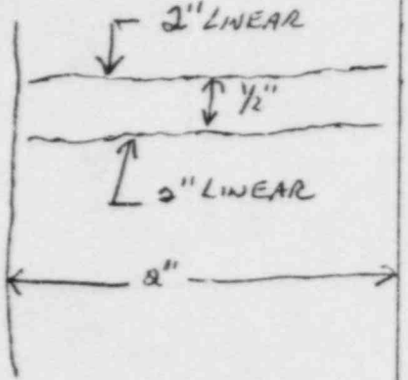
MT EXAMINATION INDICATIONS

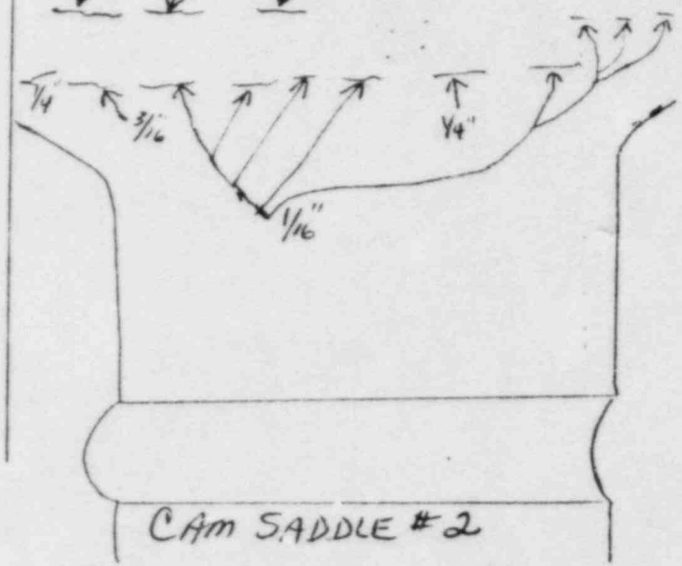


Inspector / Date James Mosby Level II 10/1/84

CYLINDER # 2
-- CAM SADDLE AREA

IR43* EDG 103
MT EXAMINATION INDICATIONS





Inspector/Date James A Morley Level II 10/1/84

September 20, 1984

J. Kelly

4103 MHS 9/20/84

Diesel Engine 101 - Cam Galley Strain Gauge NDE Testing
SHOREHAM NUCLEAR POWER STATION - UNIT 1
W.O. 44430/48923

DR/QR has been requested by FaAA to perform MPI of all Cam Galley saddles on DG-101. This exam would be a repeat of informational MP performed by OQA, LDR 1224, RR 869, 870, 871 and 860. In addition to MP inspections, LP baseline inspections will also be completed.

MPI can not be completed in compliance with LILCO NDE Procedure 7.1 and 7.2, due to access limitations (i.e., Paragraph 4.1.3 NDE 7.1). I have reviewed this deviation with C. Wells, FaAA, Telecon 9/19/84 and R. Kascsak, NED, Telecon 9/20/84, and have received their concurrence that it is acceptable to perform the MP test (i.e., one test with magnetic flux applied in one direction).

If you have any further questions, please call me on ext. 334 or 335.

The informational MPI and mapping described above will be required to assist in placement of strain gauges. NDE 7.1 accept/reject criteria does not apply.

M. H. Schuster

M. H. Schuster

MHS/ds

Approved J. Kelly 9/20/84

(5)

LILCO LONG ISLAND LIGHTING

LIQUID PENETRANT EXAMINATION REPORT

PT

COMPONENT I.D. IR43 EDG-103 (AREAS OF CAM SADDLES #2 & #8)

SYSTEM IC43

PLANT/LOCATION EDG-RM-103

A. MATERIAL	TYPE Grey Iron	FABRICATED PROCESS	☐ WELDED ☒ CAST ☐ WORKED
	GEOMETRY ☐ PIPE ☐ PLATE ☐ ROD ☐ OTHER:		
CROSS SECTION THICKNESS: MAX N/A MIN	PIPE DIA. N/A	SURFACE CONDITION	☐ MACHINED ☒ GROUND (PAINT REMOVED AND LIGHT GRINDING) ☐ AS FABRICATED ☐ OTHER

B. NDE PROCEDURE No. 6.2	SURFACE/MAT'L. TEMP. 82°F	M&TE. NO. 365	MWR/RR. No. RR R43-2029

INSPECTION MATERIALS	BRAND	DESIGNATION	BATCH NO.
1. PRE-CLEANER	MAGNAFLUX	SKC-NF/ZC-7B	82J083
2. PENETRANT	MAGNAFLUX	SKL-HF/S	83G018
3. EMULSIFIER AND/OR REMOVER	MAGNAFLUX	SKC-NF/ZC-7B	82J083
4. DEVELOPER	MAGNAFLUX	SKD-NF/ZP-9B	83H041
5. POST EXAMINATION CLEANER	MAGNAFLUX	SKC-NF/ZC-7B	82J083

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

SEE ATTACHED SHEETS

This examination was performed after area grinding in preparation for placement of strain gauges.

C. EVALUATION — REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE.

LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1 CAM SADDLE #2	SEE ATTACHED SKETCH OF LINEAR INDICATIONS		REJECT
2 CAM SADDLE #8	SEE ATTACHED SKETCH OF LINEAR INDICATIONS		REJECT
3 N/A	N/A	N/A	N/A
4 N/A	N/A	N/A	N/A

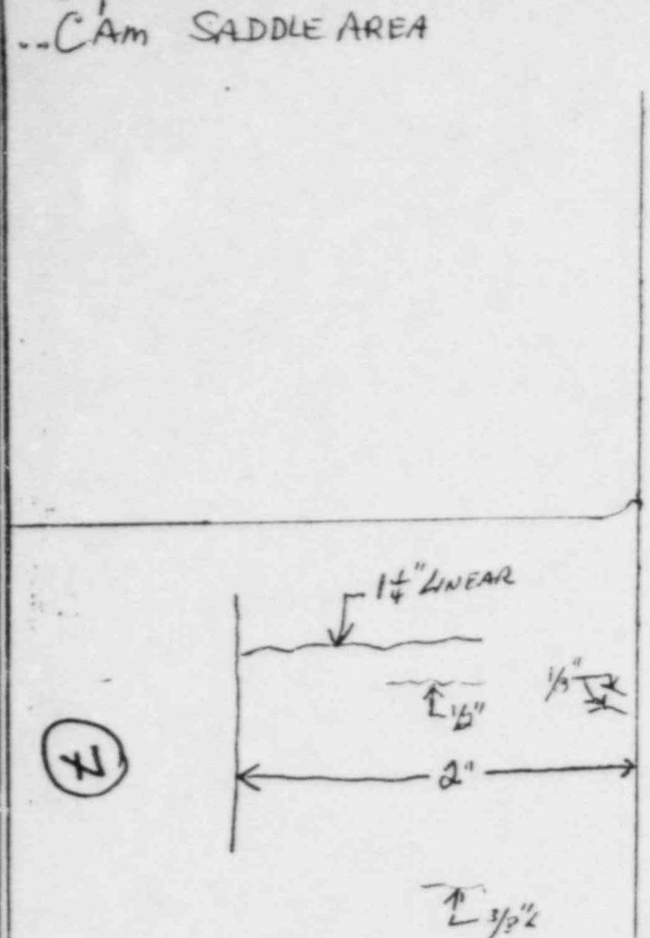
D. ACCEPTANCE CRITERIA: NDE 6.2 NRA 4.2.2

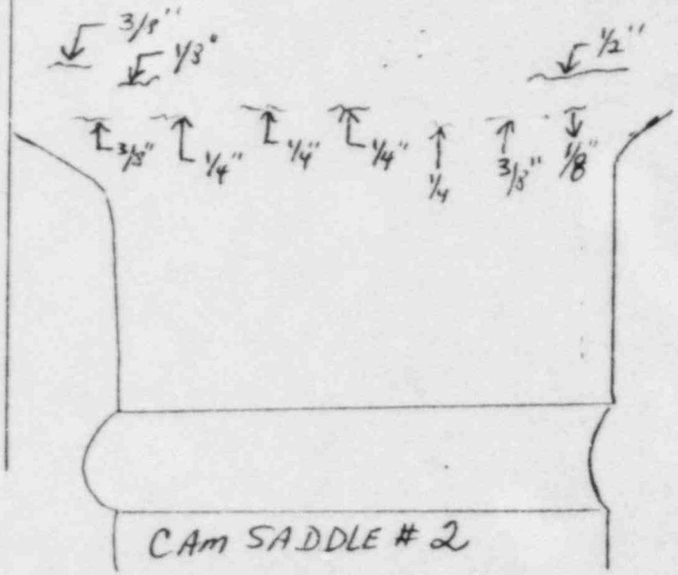
OPERATOR James A Healy / V. Plantania
Level II Date 10/1/84

E. ATTEST: James A Healy (6) — RESPONSIBLE CERTIFIED PERSONNEL — II LEVEL — 10/1/84 DATE

CYLINDER #2
..CAM SADDLE AREA

IR43 * EDG-103
LP EXAMINATION INDICATIONS
PENETRANT DWELL TIME - 10 MIN.
DEVELOPER DWELL TIME - 7 MIN
MATL. TEMP. - 82°F

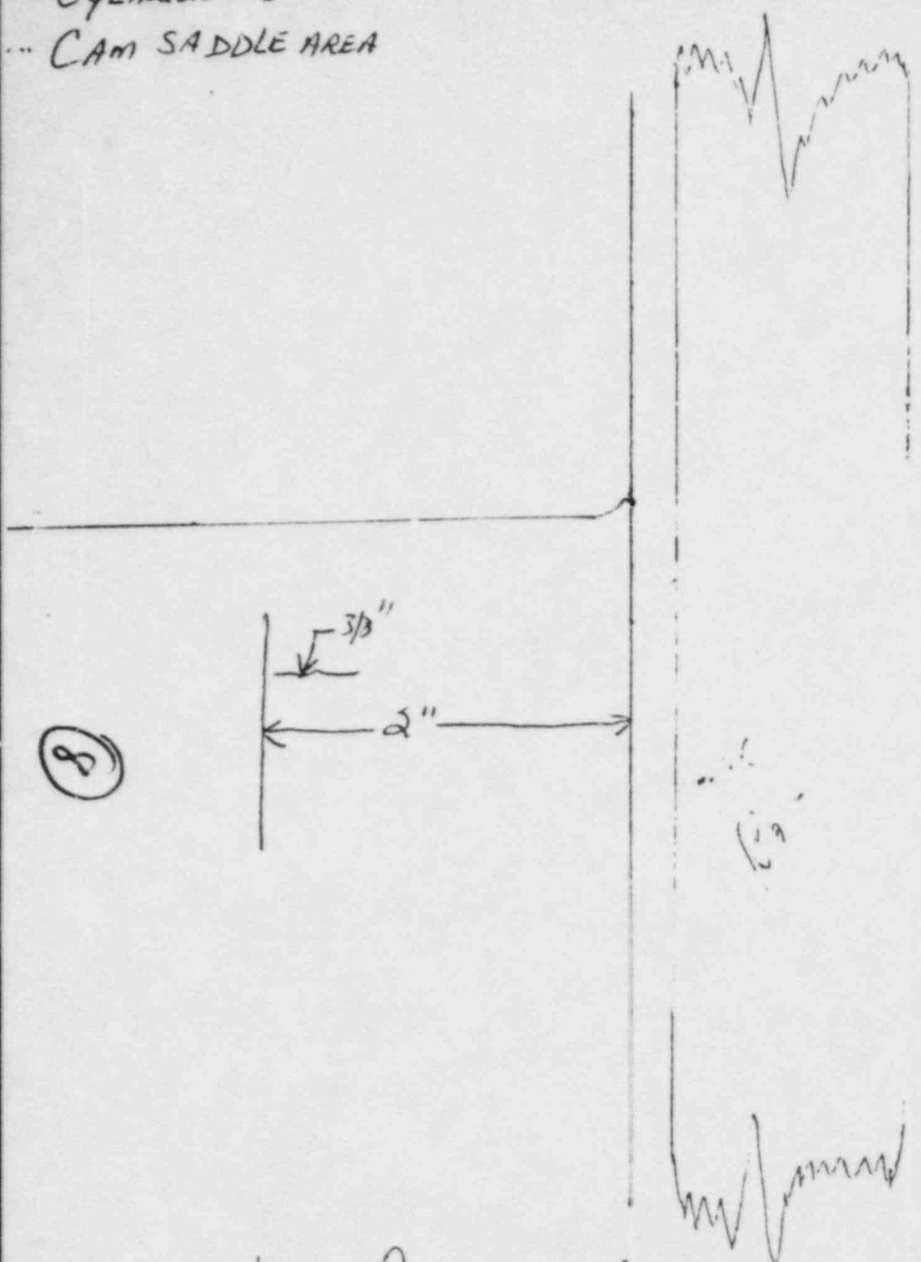


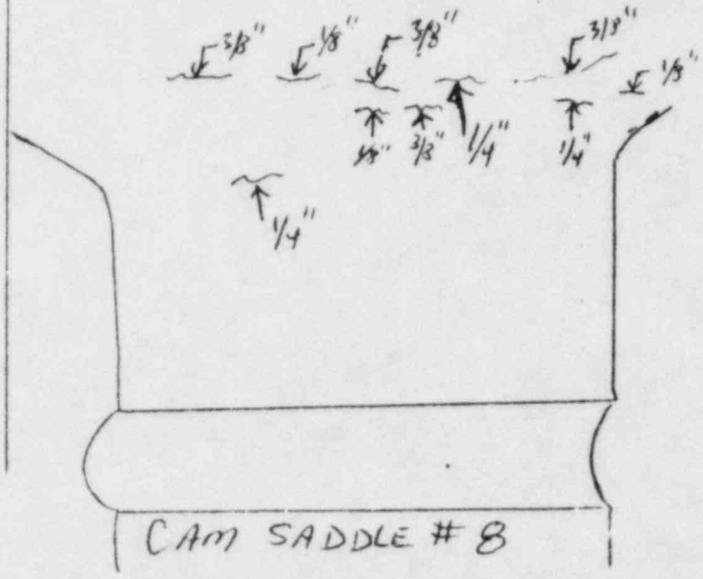


Inspector/Date [signature] Level II 10/1/84

Cylinder # 8
... Cam Saddle Area

IR43* EDG-103
LP Examination Indications
Penetrant Dwell Time - 10 min
Developer Dwell Time - 7 min
Matl. Temp - 82°F





Inspector/Date James Ahrenby Level II 10/1/84

LILCO LONG ISLAND LIGHTING

MAGNETIC PARTICLE EXAMINATION REPORT

MT

A. MATERIAL	TYPE Gray Iron	FABRICATED PROCESS	☐ WELDED ☐ CAST ☐ WORKED
	GEOMETRY ☐ PIPE ☐ PLATE ☐ ROD ☒ OTHER:		
CROSS SECTION THICKNESS	MAX / MIN N/A	PIPE DIA. N/A	SURFACE CONDITION: ☐ MACHINED ☐ GROUND ☐ AS FABRICATED ☒ OTHER Paint Removed and light sanded
B. NDE PROCEDURE NO. 71-72	MWR/RR NO. RR R43 2029	EQUIPMENT I.D. S/N	M&TE NO. 872 4 836
TECHNIQUE	☐ PRODS	☒ YOKE	☐ COIL ☐ OTHER
CURRENT	☒ AC	☐ DC	☐ HW/DC ☐ 10 lb PLATE ☐ 40 lb PLATE
	AMPS N/A; AMPS.PER.IN. N/A	PROD SPACING YOKE 8"	PRODS N/A
MATERIALS	☐ DRY	☒ WET	BRAND/DESIGNATION Magnaglo 14AM Prepared Bath Batch # 84B007

COMPONENT I.D. 1R43*EDG-103 (Areas of Conn. Rods/Cyl. #?)

SYSTEM 1R43

PLANT/LOCATION EDG Rm 103

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

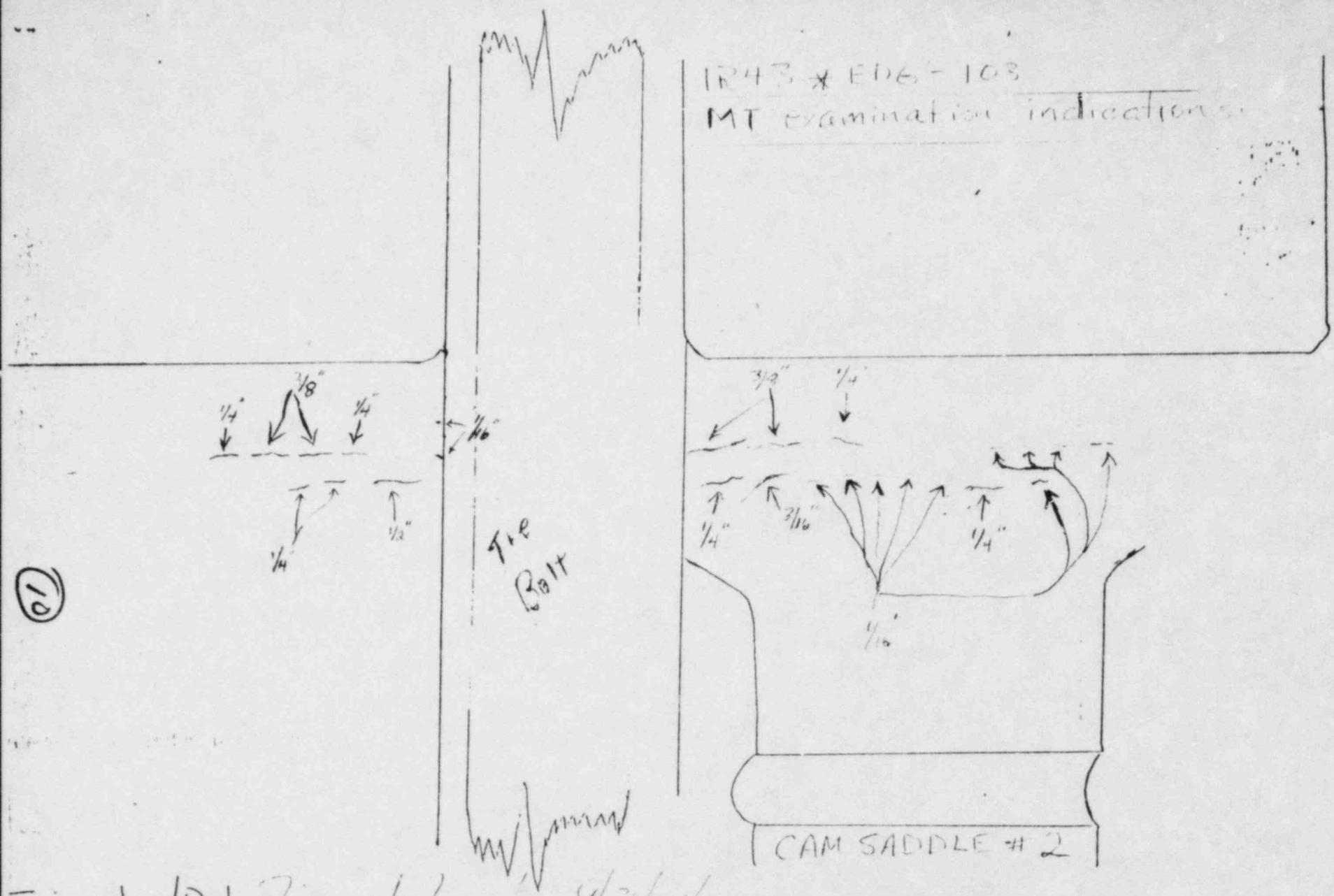
This examination was performed to assist in placement of strain gauges. MT indications are noted on attached sheet. Also attached is copy of J. Kelly Memo dated Sept 20, 1984 - revised 9/25/84.

C. EVALUATION — REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE

LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1		N/A	
2			
3			
4			

D. ACCEPTANCE CRITERIA	N/A	OPERATOR W. J. French / R. Scripture; LEVEL II / Trainee; DATE 9/30/84
E. ATTEST	William J. French — RESPONSIBLE CERTIFIED PERSONNEL	LEVEL II; DATE 9/30/84

(9)



(10)

Inspector/Date

RRR RH3 2029

September 20, 1984

J. Kelly

MHS 9/21/84

#103 MHS

Diesel Engine 101 - Cam Galley Strain Gauge NDE Testing
SHOREHAM NUCLEAR POWER STATION - UNIT 1
W.O. 44430/48923

DR/QR has been requested by FaAA to perform MPI of all Cam Galley saddles on DG-101. This exam would be a repeat of informational MP performed by OQA, LDR 1224, RR 869, 870, 871 and 880. In addition to MP inspections, LP baseline inspections will also be completed.

MPI can not be completed in compliance with LILCO NDE Procedure 7.1 and 7.2, due to access limitations (i.e., Paragraph 4.1.3 NDE 7.1). I have reviewed this deviation with C. Wells, FaAA, Telecon 9/19/84 and R. Kascsak, NED, Telecon 9/20/84, and have received their concurrence that it is acceptable to perform the MP test (i.e., one test with magnetic flux applied in one direction).

If you have any further questions, please call me on ext. 334 or 335.

MHS 9/21/84

The informational MPI and mapping described above will be required to assist in placement of strain gauges. NDE 7.1 accept/reject criteria does not apply.

M. H. Schuster

M. H. Schuster

MHS/ds

Approved J. Kelly 9/20/84

(11)

RRR R43 2029

LILCO
LONG ISLAND LIGHTING

LIQUID PENETRANT EXAMINATION REPORT

PT

COMPONENT I.D. 1R43*ETG-103 (Areas of Cam saddles #2 & #3)

SYSTEM 1R43

PLANT/LOCATION EDG - RM-103

A. MATERIAL	TYPE Gray Iron / A-48	FABRICATED PROCESS	☐ WELDED ☒ CAST ☐ WORKED
	GEOMETRY ☐ PIPE ☐ PLATE ☐ ROD ☒ OTHER: Engine Block		
CROSS SECTION THICKNESS — MAX N/A MIN	PIPE DIA. N/A	SURFACE CONDITION	☐ MACHINED ☐ GROUND ☐ ~~AS FABRICATED~~ ☒ ~~OTHER~~ Paint removed and light grinding

B. NDE PROCEDURE No. 6.2	SURFACE/MAT'L. TEMP. 80° F	M&TE. NO. 345	MWR/RR. No. RRR 843 2029

INSPECTION MATERIALS	BRAND	DESIGNATION	BATCH NO.
1. PRE-CLEANER	Magnaflux	SKC-NF/ZC-7B	82J083
2. PENETRANT	"	SKL-HF/S	83G018
3. EMULSIFIER AND/OR REMOVER	"	SKC-NF/ZC-7B	82J083
4. DEVELOPER	"	SKD-NF/ZP-9B	83H041
5. POST EXAMINATION CLEANER	"	SKC-NF/ZC-7B	82J083

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY

This examination was performed prior to examination area grinding for attachment of strain gauges. After grinding another examination is required.

— See attached —

C. EVALUATION	REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE.

LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1 Cam saddle # 2	N/A	N/A	Accepted / No relevant indications
2 Cam saddle # 3	See attached sketch of linear indications		Reject / Area is to be ground and PT retest performed
3 N/A	N/A	N/A	N/A
4 N/A	N/A	N/A	N/A

D. ACCEPTANCE CRITERIA	NDE 6.2 para 4.2.2	OPERATOR W. J. French / B. Sculptor Level II / [illegible] Date 9/30/83

E. ATTEST	William J. French	II	9/30/83
	RESPONSIBLE CERTIFIED PERSONNEL	LEVEL	DATE

(12)

IR# 3 & FIGS - 103

LP examination indications:

Contrast Dwell Time - 10 min.

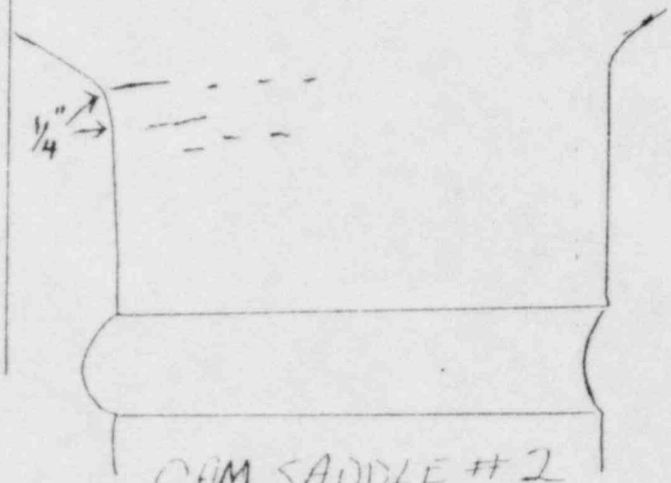
Developer "wet" Time - 7 min.

Melt Temp - 200° F

All indications are
1/16" unless otherwise noted.

(13)

Tie Bolt



Inspector/Date

RHR R43 2029

2739-
Unit S/N 474A
Probe #10/#31

Calibration Check Within Required Range Yes X No ___
850 X 950 ___

Operator R. E. GLAZIER
Date 9/30/84

Component Ident	Known Sample #10	Unknown Sample #31	Acc	Rej	Component Ident	Known Sample	Unknown Sample	Acc	Rej
#8 CAM SADDLE									
CAM SADDLE FILLET	625	620							
LOCK AREA BELOW CAM FOLLOWER PAD	627	643							
" "	630	637							
" "	630	636							
#2 CAM SADDLE									
CAM SADDLE FILLET	622	620							
LOCK AREA BELOW CAM FOLLOWER PAD	633	640							
" "	635	635							
" "	629	637							

REVIEWED BY: [illegible]

Corrected Copy, dtd 5/3/84

May 17, 1984

Mr. Robert M. Kascsak, Manager
Nuclear Systems Engineering Division
Long Island Lighting Company
Post Office Box 618
North Country Road
Wading River, New York 11792

Dear Mr. Kascsak:

Attached is my report of the Delaval foundry heat made on May 2, 1984 and my examination of the gray iron block which was poured for LILCO.

In summary, I observed the furnace charge, melting, and casting procedures; they were representative of very good current practice which would result in an excellent casting, metallurgically. Chemical analysis of the ladle of molten iron from which the block was poured, after additions had been made, showed satisfactory composition. Photomicrographs will be provided by Delaval, as will results of mechanical testing of the test bars.

I inspected the block after cleaning (but before painting) on May 13. With the exception of one gate break-in, the casting appears to be excellent. It is well formed, without holes, cracks, shrinkage or inclusions; it has been thoroughly cleaned and minor fins, veins, and burnt on sand carefully ground off.

The gate break-in on the lower flange, camshaft side, between #3 and #4 cylinders, appeared to have no cracks radiating from it; and can be ground smooth to eliminate possible notch effects. The integrity of the flat sealing surface of the flange is not violated by the break, and its location between flange bolt holes and in front of a major reinforcing

member, plus the machining stock which will be removed from the flange, make its effect on the casting probably insignificant, in my opinion. A review of design stresses in this area should be made to ascertain this.

Some defects, such as microporosity, carbon flotation, and slag inclusions, are often not visible on as-cast surfaces, but can be seen after machining. I will inspect the casting for those defects at that time, if you so desire. Please give me as many days' notice as possible if you want me to do this. I will be out of town for 9 days, June 1-10, but can be reached at 919-986-2503 during that time.

Very truly yours,

C. R. Isleib, P.E.
N.J. Reg. No. 13386
CRI:EMW
Enc.

PREFACE

LILCO commissioned the writer to observe and review Delaval heat 615K and to inspect the 8-cylinder diesel engine block poured from that heat. This included a review of the furnace charge, observation of the heat in progress, melt and ladle additions, tapping, and casting; discussions with foundry and quality assurance management regarding quality control and inspection procedures; and visual inspection of the cleaned casting. The iron was to conform to ASTM Standard Specification A 48, Class 45.

5

CONCLUSIONS - MELTING AND CASTING

Melting and Casting

1. The furnace charge was made up of good quality virgin materials and scrap of known composition. I saw no purchased motor blocks, valves, heads or other scrap which might contain lead, zinc, tin or aluminum inserts which could be deleterious to the graphite or matrix structures or castability of the iron.

2. The meltdown of the 23-ton heat began at 4:00 A. M., May 2, 1984; tapping time was 6:48 A. M. Maximum temperature reached in the furnace was about 2750F; tapping temperature was about 2600F; both measured by immersion thermocouple. This is acceptable good practice and should result in minimum gas in the metal and a well-defined, complete casting.

3. The heat was tapped into one 30-ton bottom-pour ladle which had been preheated to red heat. Ladle additions of Graphidox and 7180 were made during the tap for graphitizing purposes. No delays were encountered; tapping was clean and completely satisfactory.

4. Casting was begun promptly at about 2600F; no stopper trouble was encountered; and the mold was filled in under 2-1/2 minutes, a very good time for this size casting. An in-mold graphitizing block is normal practice at Delaval, to minimize inoculation fade.

5. All mold vents were lit off; no gas explosions occurred; and the risers all fed, judging from examination of the mold later in the morning.

6. It was reported by Superintendent Dobrec that one-, two-, and 3-inch test bars were cast integrally in the mold, off the same gating system, and cooled in the mold along with the casting. Separately cast specimens were also poured.

7. Samples for spectrographic analysis were poured as the heat approached finishing and just before tapping. The final ladle analysis is shown below.

COMMENTS:

The furnace used was a 30-ton capacity three-phase direct arc furnace, acid-lined, rated at 10 tons per hour melting rate. The charge for heat 615K was as follows:

Charge

	Lbs.
Delaval gray iron returns (all shop scrap)	18,400
Structural steel plate, etc.	13,800
Sorel metal pig (4.3 C, 0.2 Si, 0.01 Mn, 0.03 P, 0.02 S)	6,900
Brazilian Foundry pig (0.065 P)	6,900
High Carbon Ferromanganese	170
Graphite	460
Molybdenum oxide briquettes (50% Mo)	175
Ferromolybdenum (62% Mo)	37
Total	46,842

Ladle Additions

SL80 Graphitizer (80% silicon)	184
Graphidox (50% silicon)	46

Casting Composition

	Actual Ladle Analysis (%)
Total carbon	3.05
Manganese	0.78
Silicon	1.82
Phosphorus	0.067
Sulfur	0.055
Chromium	0.03
Nickel	0.11
Molybdenum	0.28
Copper	0.669

Examination of Cleaned Casting

I examined the casting on May 14, 1984, immediately after shotblast cleaning but before painting (and before shop inspection by Delaval) with the objective of locating and identifying any defects, especially those which would be harmful to the casting's integrity and intended service as an engine block.

My examination was visual, aided by a B&L 3x hand magnifying glass, measuring tape and scale, supplementary lights, and a Newage pin brinell portable metal hardness tester. (The purpose of the hardness tester was not to determine definitive hardness levels, but simply to compare hardness levels at several points on the casting and to help detect possible porosity or other casting inhomogeneities.)

The casting was set up on rails and blocks in a well-lighted area so that I was able to examine every surface, interior and exterior, cope and drag sides, as well as core cavities. It was blown free of metal blasting shot for my inspection. Particular attention was given to the head surfaces and each cylinder bore area.

The casting was examined from the viewpoints and the system of organization described in The International Atlas of Casting Defects, publ. 1974 by The American Foundrymen's Society, Des Plaines, Illinois; and the Analysis of Casting Defects, 4th ed., 1st revision, publ. 1974 by the American Foundrymen's Society, Des Plaines, Illinois.

CONCLUSIONS - EXAMINATION OF THE CASTING

1. Metallic Projections

I saw no evidence of thick fins or veins, swells, nor any significant washes, crushes, drops, raises or scabs. Thin fins and thin veins in fillet areas had been carefully ground clean. One minor veined area (1-inch long, thin vein) was noticed in a cored slot on the water jacket side, and some minor veining in an outside flange-sidewall fillet.

2. Cavities

I saw no evidence of surface or corner blowholes or pinholes, nor any shrinks or draws. The casting appears sound.

3. Discontinuities

Careful inspection revealed no cold or hot cracks or tears, nor any cold shuts visible to my naked eye, nor under the 5x glass I used. Special attention was paid to internal fillets such as in the camshaft bearing saddle areas.

4. Surface Irregularities

There are no folds, seams, roughness, buckles, rat-tails, orange peel, slag inclusions, sinks or draws, or clamp-off defects, and no significant crushes, burn-ons or burn-ins, metal penetration or scabs were visible. Very minor burn-ons or metal penetration had been carefully ground clean. One small surface irregularity, 2 inches long by 1/2 inch wide and

1/2 inch deep, in a cope side pocket fillet area near the #4 cylinder liner support ring, water jacket side, I judge insignificant.

5. Incompleteness

There is no sign of misrun, short pour, or runout in this casting, nor should there be, based on my observation of the molten iron temperature and casting sequence on May 2. Gates to the lower block flange (cope side of the casting as poured) measure approximately 3-1/2 inches wide by 2-1/2 inches high. One of these gates, between the #3 and #4 cylinders, camshaft side, suffered a break-in when the gating and risering system was removed. This break-in is between the flange bolt hole locations and in front of a major reinforcing member. It does not extend to the flat sealing surface of the flange; machining stock to be removed will help minimize the significance of this break-in. No cracks or incipient cracks were visible in or radiating from this break-in area.

A second small (2 inches long by 1/2 inch deep) gate break-in exists in the flange below #8 cylinder; this will probably be removed during machining, and I judge it to be insignificant.

No break-in or porosity was visible at the test bar ingate areas, which are located inside the cores in the approximate center of the casting.

6. Incorrect Dimensions

I saw no evidence of casting deformation, mold or core

shift, or ram-off defects in this casting.

7. Inclusions

I saw no metallic inclusions, cold shot, slag, dross, sand, refractory, oxide or graphite flotation defects.

Hardness Tests

In a test for any major unsoundness or inhomogeneities in the casting, I made several hardness measurements using a Newage pin brinell hardness tester. Because the surfaces tested were shot-blasted but not ground, the impression readings are not meant to be a measure of actual brinell hardness level. A properly prepared surface would yield higher values.

The pin indentation diameters that were measured indicated good homogeneity. The heaviest sections, which cooled slowest, showed somewhat greater indentation diameters than the flange, which cooled faster and would be expected to be harder. There was no indication of micro- or gross shrinkage from these observations.

Location	Indentation Diameter (average reading) in millimeters
Flange-Drag side-near ingate break-in area	2.90 - Test 1 2.75 - Test 2
Head surface - between #4 and #5 cylinders	3.20
Head surface, beyond #1 cylinder	3.10
Head surface, outside #5 cylinder	2.90 - Test 1 3.00 - Test 2
Head surface, between #7 and #8 cylinders	3.00

Except for the flange break-in mentioned in Conclusion 5, the casting as judged by my visual inspection is of excellent quality.

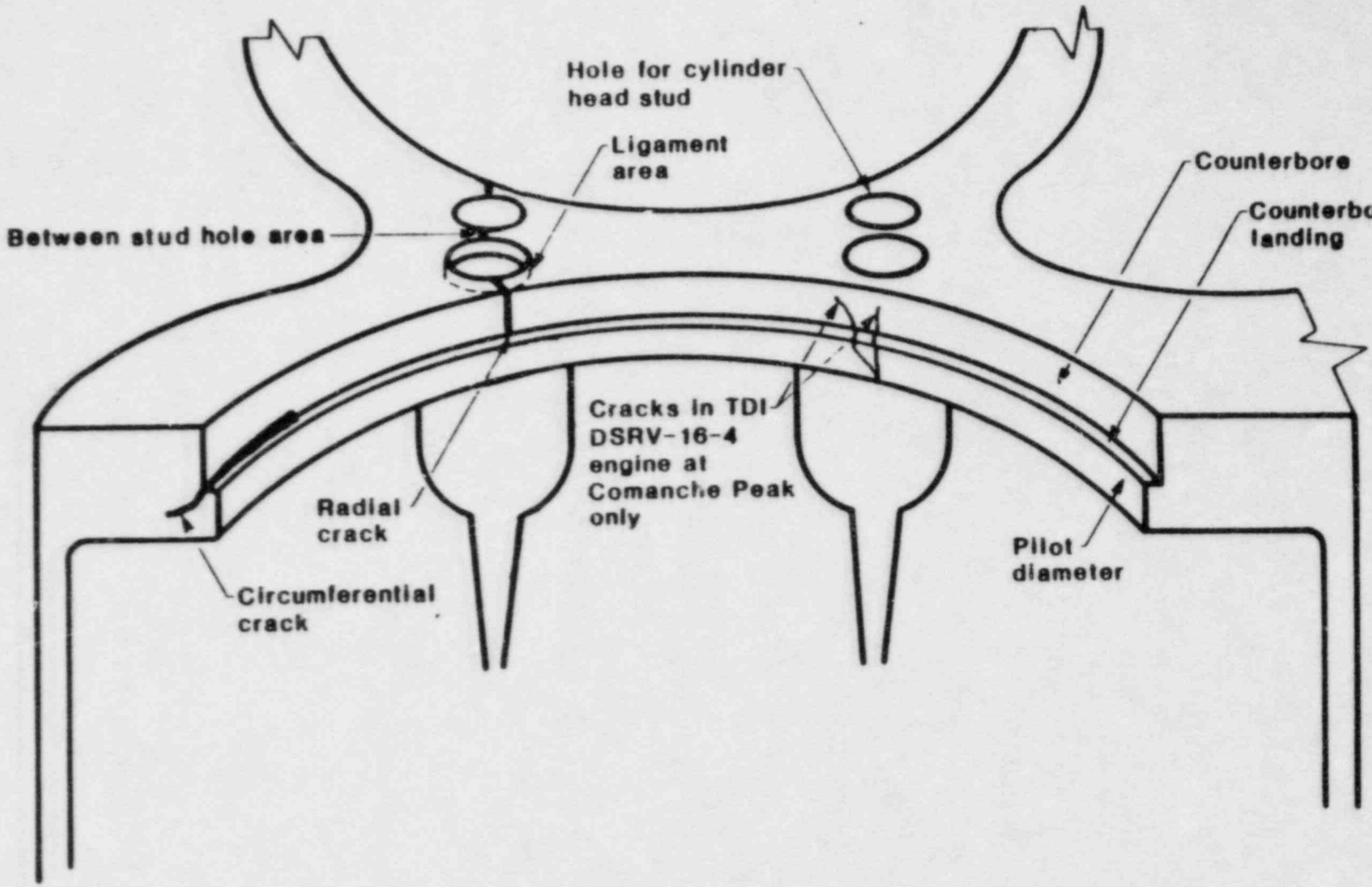


Figure 1-1. Location of cracks.

LILCO
LONG ISLAND LIGHTING

MAGNETIC PARTICLE EXAMINATION REPORT

MT

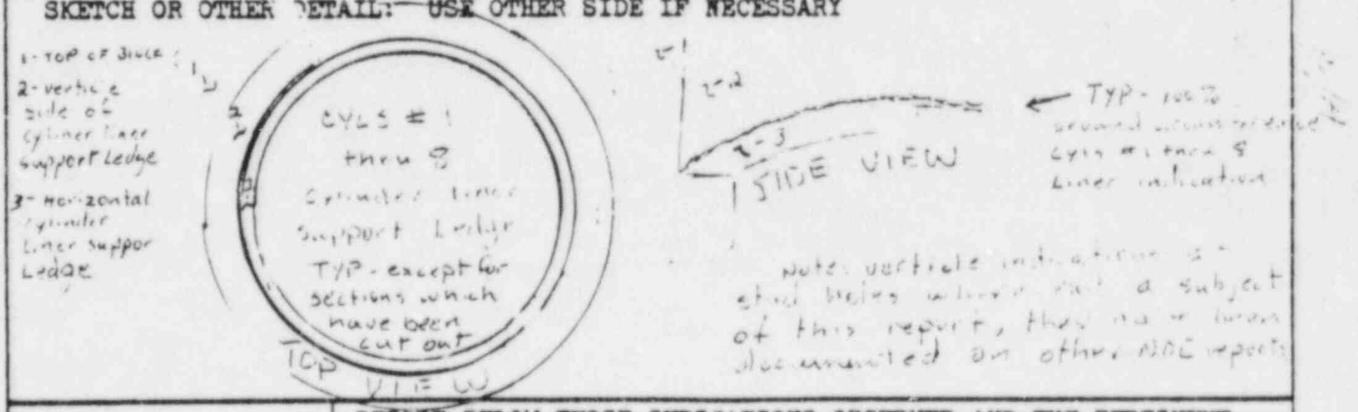
COMPONENT I.D. CRD SCRAP FDE-103 Block

SYSTEM

PLANT/LOCATION TB - Truck Bay

A. MATERIAL	TYPE C/S	FABRICATED PROCESS	☐ WELDED ☒ CAST ☐ WORKED	
	GEOMETRY	☐ PIPE ☐ PLATE ☐ ROD	☒ OTHER: Irregular Block	
CROSS SECTION THICKNESS: MAX / MIN N/A	PIPE DIA. N/A	SURFACE CONDITION	☒ MACHINED ☐ GROUND ☐ AS FABRICATED ☐ OTHER	
B. NDE PROCEDURE NO. 7.1 / 7.2	MWR/RR NO. 83-607 RR3-2011	EQUIPMENT I.D. S/N 16196 M&TE NO. 831 Black Light Meter		
TECHNIQUE	☐ PRODS	☒ YOKE (Parker Probe S/N 4490 Model DA-400)	☐ COIL	☐ OTHER
CURRENT	☐ AC	☒ DC	☐ HW/DC	☐ 10 lb PLATE ☒ 40 lb PLATE
	AMPS N/A AMPS.PER.IN. N/A	PROD SPACING YOKE 3 PRODS N/A		
MATERIALS	☐ DRY	☒ WET	BRAND/DESIGNATION Magnaflux 14A Carrier #[illegible]	

SKETCH OR OTHER DETAIL: USE OTHER SIDE IF NECESSARY



C. EVALUATION	REPORT BELOW THOSE INDICATIONS OBSERVED AND THE PERTINENT INFORMATION REQUIRED. WHERE ADDITIONAL SPACE IS REQUIRED USE OTHER SIDE

	LOCATION	SIZE (INCHES)	DESCRIPTION	ACTION (ACCEPT/REJECT, AND COMMENT AS NECESSARY)
1	Cyls. 1 thru 8	100% around circumference	Linear Indications	Reject / CRD SCRAP FDE-103 Block
2	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A

D. ACCEPTANCE CRITERIA	NDE 7.2 para 4.2.2	OPERATOR W. T. French LEVEL II DATE 9/1/84
E. ATTEST	William T. French	II 9/10/84
	RESPONSIBLE CERTIFIED PERSONNEL	LEVEL DATE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

In the Matter of	
LONG ISLAND LIGHTING COMPANY	Docket No. 50-322-OL
(Shoreham Nuclear Power Station, Unit 1)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the SUPPLEMENTAL TESTIMONY OF DR. ROBERT N. ANDERSON, PROFESSOR STANLEY CHRISTENSEN, G. DENNIS ELEY, AND RICHARD B. HUBBARD REGARDING SUFFOLK COUNTY'S EMERGENCY DIESEL GENERATOR CONTENTION CONCERNING CYLINDER BLOCKS, dated October 18, 1984, have been served on the following this 18th day of October 1984 by U.S. mail, first class, except as otherwise noted.

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DATE: October 18, 1984

By Federal Express
* By Hand Delivery