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SUBJECT: LER 89-021-01:on 890916,crack on jet pump riser brace due to fatigue.

W/8 ltr.

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Northern States Power Company

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Telephone (612) 330-5500

December 13, 1989

Report Required by
10 CFR Part 50, Section 50.73

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Crack on Jet Pump Riser Brace Due to Fatigue

The updated Licensee Event Report for this occurrence is attached.

Please contact us if you require additional information related to this event.

Thomas M Parker
Manager
Nuclear Support Services

c: Regional Administrator - III NRC
Sr Resident Inspector, NRC
NRR Project Manager, NRC
MPCA
Attn: Dr J W Ferman

Attachment

IE22
1/1

NRC FORM 366 (6-89) | U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92
ESTIMATED BURDEN PER RESPONSE TO COMPLY WTH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

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Monticello Nuclear Generating Plant	0 5 0 0 0 2 6 3	1 OF 1 1

TITLE (4)
Crack on Jet Pump Riser Brace Due to Fatigue

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
0 9	1 6	8 9	8 9	0 2 1	0 1	1 2	1 3	8 9		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N
POWER LEVEL (10): 0 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	XX OTHER (Specify in Abstract below and in Text, NRC Form 366A)
20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	Update Report
20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
	AREA CODE
Michael Sleigh	6 1 2 — 2 9 5 - 1 2 3 8

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
X	A D	S P T	G 0 8 0	N							

SUPPLEMENTAL REPORT EXPECTED (14)

	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	XX NO			

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

A crack was discovered on the upper support brace of one jet pump riser by use of an underwater camera. The crack location is on the lower leaf on the right side (while facing out from vessel centerline) of the upper support brace on the riser for jet pumps 7 and 8.

This event is being reported because of its potential safety significance and generic nature.

Visual inspection of all other riser braces in the vessel were completed. There are no other crack indications on the other leaves of this riser or any other riser in the vessel.

The crack is believed to be the result of high cycle fatigue due to resonance of the upper brace leaf caused by recirculation pump vane passing frequency at greater than 94% pump speed.

A safety evaluation was completed to show that this crack has no effect on plant safety. Operational strategies are in place to prevent additional cracking from occurring.

DESCRIPTION:

On September 16, 1989, with the plant in cold shutdown and the core unloaded, In-Service Inspection (ISI) personnel, during routine inspection, discovered a crack on the upper support brace (SPT) of one jet pump riser (See Figures 1 through 5). Northern States Power and General Electric personnel were performing the ISI.

This event is being reported because of its potential safety significance and generic nature.

The crack is located on the lower leaf on the right side (facing out from the vessel centerline) of the upper support brace on the riser for jet pumps #7 and #8. The crack indication runs about 3/4 of the way across the top of the leaf about 1/2" from the point where it is welded to the vessel wall. There is no indication of any cracking on the underside of this leaf.

The risers are supported by an upper brace which consists of two leaves on each side of the riser and a lower brace which consists of one, thicker leaf. All remaining leaves on this riser and the 9 other risers in the vessel were examined with no other indications found.

CAUSE:

A study was performed to determine the cause of the cracking. The results of this study indicate that the most likely cause of this crack is high cycle fatigue. The natural frequency of the riser brace in its uncracked state coincides with the vane passing frequency of the reactor recirculation pumps (AD) at a speed in the range of 92% to 98% (127 Hz to 135 Hz). The brace has a resonant frequency band width equivalent to less than 1% pump speed that will occur within this speed range. During portions of the last several operating cycles the recirculation pumps were operated in this range. During the last operating cycle recirculation pumps were operated at speeds of 95% to 96%, which is higher than previous cycles. Past visual inspections by ISI personnel have not shown any crack indications on any riser braces. This indicates that the crack occurred during the last operating cycle. Analysis has shown that a crack will be initiated within 10 days once the resonant condition has been established. Since substantial periods of time have been spent at up to 94% pump speed in previous cycles without experiencing cracking, it is believed that resonant conditions must occur above 94% recirculation pump speed.

Visual inspections indicate that the cracked lower leaf has some cross-sectional reduction (thinning) which may have been caused by grinding performed during weld fit-up. This thinning is unique to this riser brace leaf and appears to have reduced the cross-sectional area by about 30%. It also appears that there is some lack of fusion in the weld at the point on the leaf where the crack initiated. These factors, thinning, work hardening from grinding and lack of weld fusion, may have contributed to the cracking of this riser leaf by making it more susceptible to any of the possible crack initiating mechanisms (i.e. resonance, IGSCC, ductile tearing).

ANALYSIS:

The lower riser brace leaf (Leaf #3 in Figure 1) has a calculated natural frequency of 358 Hz, which is well removed from resonant conditions. Therefore resonance is not expected to occur at the lower brace. Evaluation of normal and accident jet pump loading indicates that stresses with only the lower brace in place are within acceptable limits. This shows that the loss of the entire upper brace would not affect the operability of the risers or the associated jet pumps.

All of the riser brace leaves have been visually inspected by ISI personnel with no other crack indications or thinning found. Operational strategies have been adopted to eliminate the concern for additional fatigue cracks. Operation of the Hydrogen Water Chemistry system reduces the possibility of IGSCC occurring in other riser brace leaves. The sound condition of the other riser braces, along with these preventive actions, provides assurance that additional cracking from any of the postulated crack initiating mechanisms will not occur.

The adopted operational strategies are based on analysis of the resonance characteristics of the riser braces and on jet pump vibration data taken during single loop operation. The first mode of resonance (out of phase motion) occurs in these riser brace leaves at recirculation pump speeds in the range of 70% to 80%; but, the stresses during this mode of resonance are not large enough to be a fatigue concern. The second mode of resonance (in phase motion), which may occur in the 92% to 98% pump speed range, is the only mode which is capable of producing stresses with an amplitude high enough to produce fatigue cracking.

The as-clad weld surface of the vessel has an additional weld pad buildup at these locations and riser braces are then welded to the pad. The crack is entirely within the base-metal of the brace, follows the toe of the weld and has no indications of branching. This is indicative of fatigue cracking and not IGSCC. Crack propagation into the weld metal by fatigue is highly unlikely because of geometry and the nature of the stress loading. Propagation into the weld metal by IGSCC is unlikely because of the greater weld metal resistance to IGSCC.

The potential effect of loose parts has also been evaluated. If the cracked riser brace leaf becomes detached from its current position on the jet pump riser, the part would fall to the bottom of the shroud annulus region and rest undisturbed on the top of the jet pump support plate. This is based on the fact that the riser brace leaf is shielded from the recirculation inlet nozzle by jet pumps #8, #9 and #10 (See Figure 6) making it unlikely that it could be entrained by the recirculation suction flow during its fall to the bottom of the shroud annulus region. As the part is not expected to migrate to the core region via the recirculation loop flow, there is a negligible potential for fuel bundle flow blockage and subsequent fuel damage. For the same reason, there is virtually no potential for interference with control rod drive operation. However, if the jet pump riser brace directly above the recirculation loop suction nozzle is assumed to fail, the riser brace leaf may be carried into the recirculation piping due to suction flow. The following paragraphs describe the potential consequences of a loose part migrating to other portions of the recirculation system and reactor vessel.

Considering the size of the part, it is possible that it may cause some damage to the recirculation pump internals. However, there is no safety implication with respect to the plant's operation since this postulated recirculation system failure is bounded by the recirculation pump seizure event previously analyzed for and documented in Chapter 14 of the Updated Safety Analysis Report (USAR). The impact energy of this loose part exiting through the pump impellers will not be sufficient to damage the pump casing and degrade the pressure boundary integrity.

To cause flow blockage at a fuel bundle, the part must migrate to the vessel lower plenum and then be carried by flow towards the core region. Since the jet pump nozzle diameter is 3 inches, any part less than 3 inches in any one dimension is capable of exiting the jet pump nozzle and being discharged into the lower plenum of the reactor vessel. Based on the flow velocity regime at the vessel lower plenum, it is estimated that any part 2.4 inches or less in diameter could be lifted by the flow and carried toward the core region.

Parts of this size are expected to go through the fuel support inlet orifice but will be trapped at the lower tie plate grid. To initiate boiling transition in a fuel bundle, the part would have to cause a fuel bundle flow blockage of 59% or more, which corresponds to an 86% blockage at the lower tie plate. To achieve 86% flow blockage at the lower tie plate grid would require at least 4 pieces of 2.4 inches by 2.4 inches migrating to the same fuel bundle (out of 484 bundles in the core). The probability for such an event is about 9E-9 and is therefore considered negligible.

To cause potential interference with control rod operation, the part must migrate through the spacers located along the length of the fuel bundle and exit at the top of the core. It must then reverse direction against the flow to drop into a control rod guide tube via the bypass region. To complete this tortuous path, the part must be very small (less than 0.1 inches) and for such a small part, the control rod drive hydraulic forces are more than adequate to overcome any potential mechanical friction. Therefore, there is no potential for interference with control rod operation.

Since the riser leaf is made from stainless steel, an approved material for in-reactor use, there is no concern for corrosion or chemical reaction with other reactor materials.

CORRECTIVE ACTION:

A safety evaluation was completed prior to plant startup to document that this condition does not constitute a change to any plant license basis or involve an unreviewed safety question as defined in 10CRF50.59.

Operating strategies have been established to provide assurance that additional cracking from any of the postulated crack initiating mechanisms will not occur. These strategies include the continued use of Hydrogen Water Chemistry and recirculation system restrictions. Based on operating experience, which shows that the resonance condition occurs above 94% recirculation pump speed, operating procedures have been established to limit pump speed to less than or equal to 94%. Jet pump vibration under single loop operating conditions are higher than at balanced operating conditions by a factor of 2 or more. In order to maintain the vibration levels lower than what is covered by the analysis for rated balanced flow conditions, a procedural limit of 40% pump speed in single loop operation has been established.

Long term corrective actions are being evaluated.

A Nuclear Network transmittal has been made to alert other utilities.

ADDITIONAL INFORMATION:

1. Failed Component Identification: GE Designed Jet Pump Riser Brace

2. Previous Similar Events: NONE

3. Attached Figures.

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Monticello Nuclear Generating Plant	0 5 0 0 0 2 6 3	8 9	— 0 2 1	— 0 1	0 7 OF 1 1

TEXT *(If more space is required, use additional NRC Form 366A's)* (17)

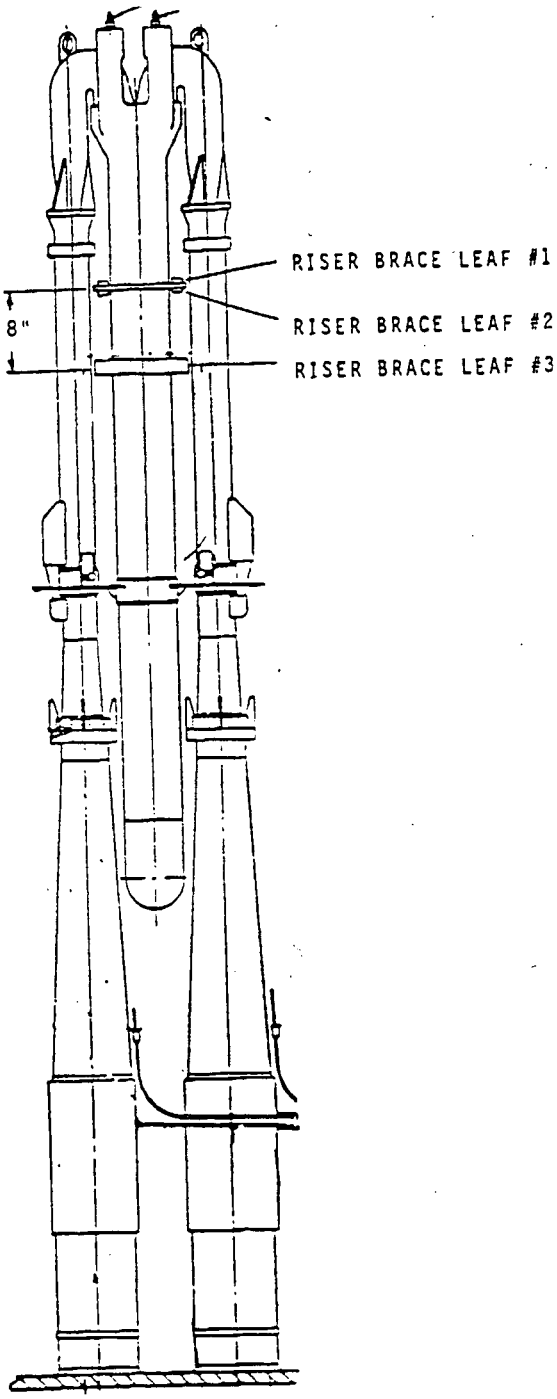

Figure 1. Jet Pump Assembly

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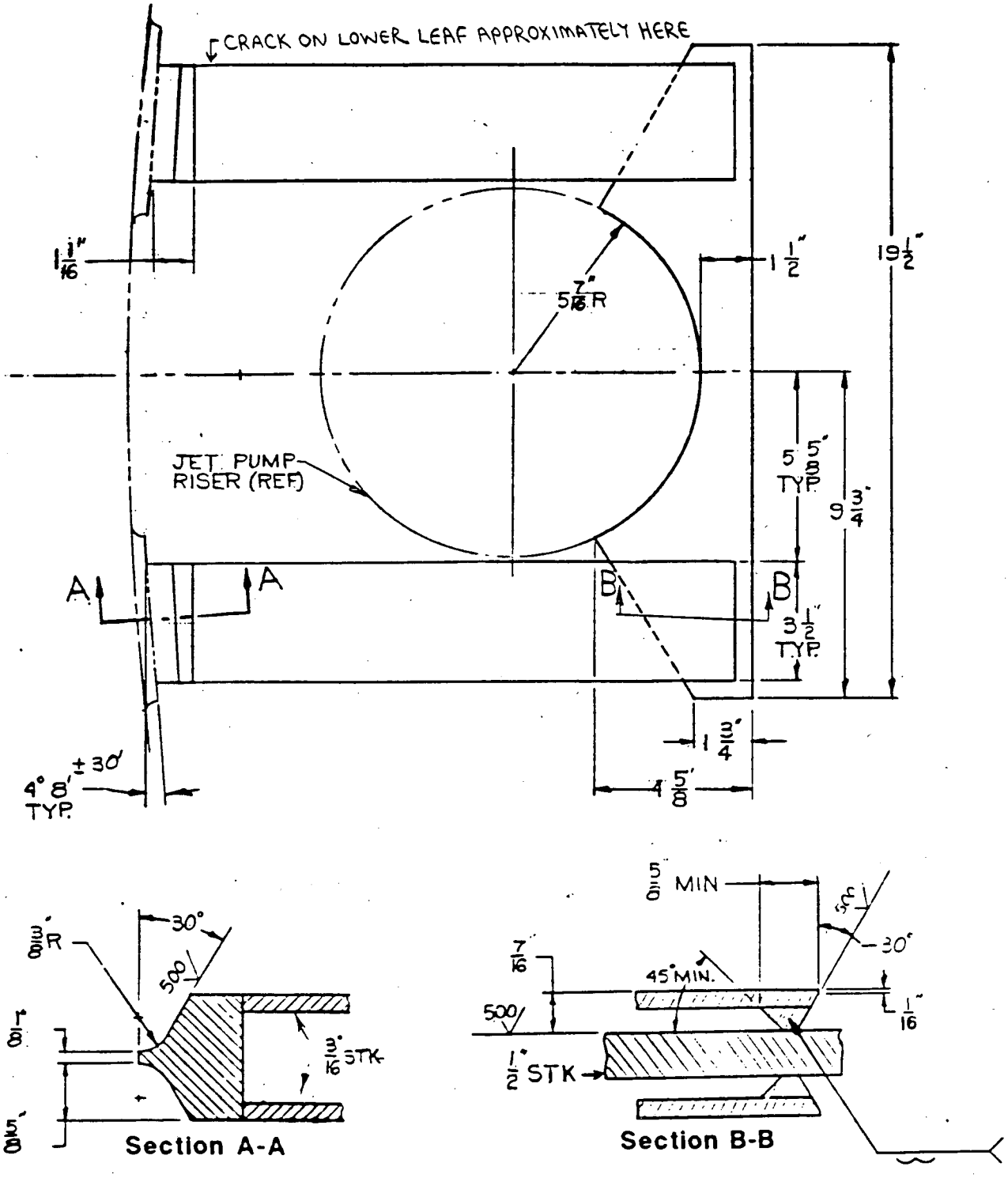

Figure 2. Upper Jet Pump Riser Brace

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		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
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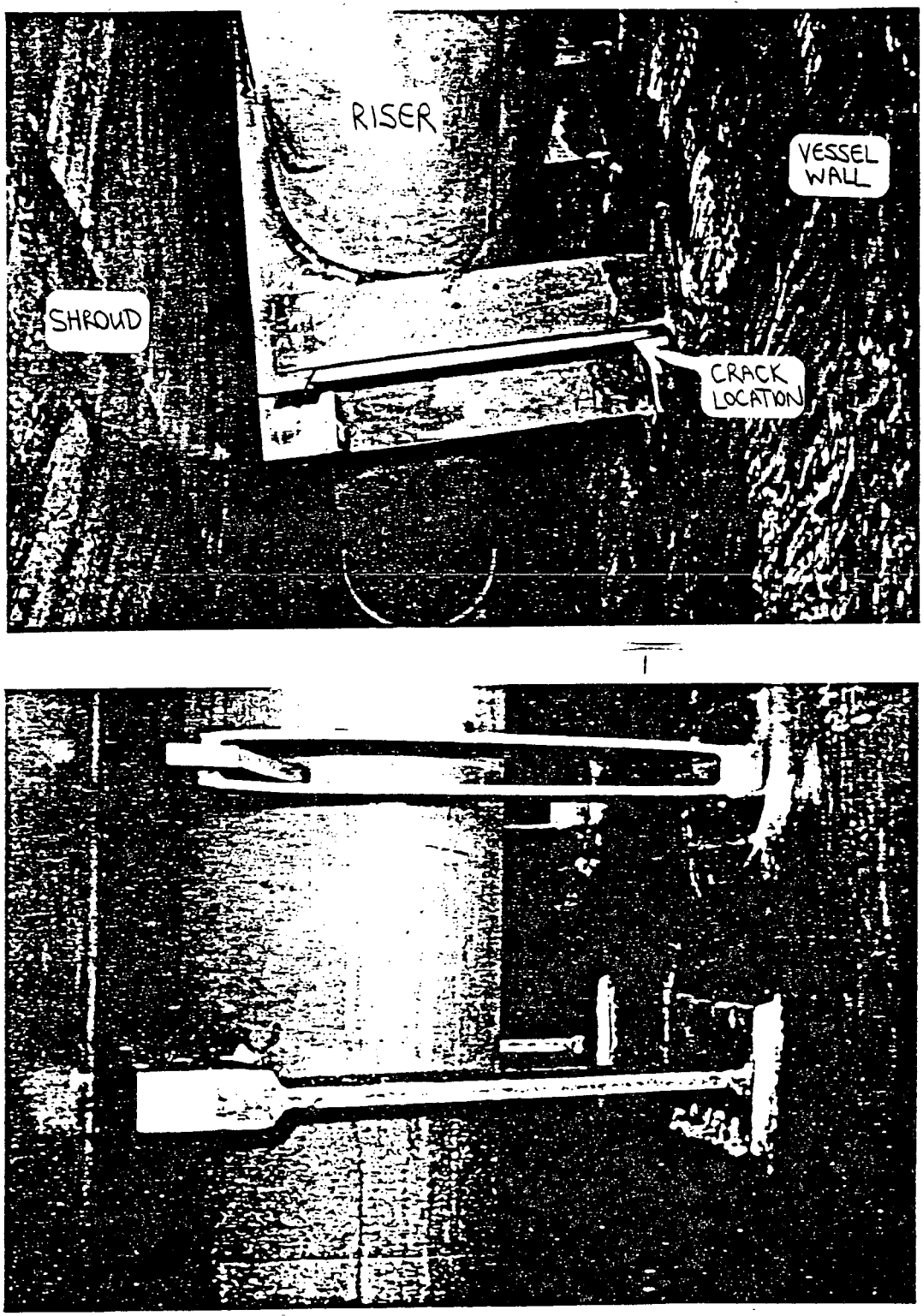

Figure 3. Construction Photos of Riser Braces

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		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Monticello Nuclear Generating Plant	0 5 0 0 0 2 6 3	8 9	0 2 1	0 1	1 0 OF 1 1

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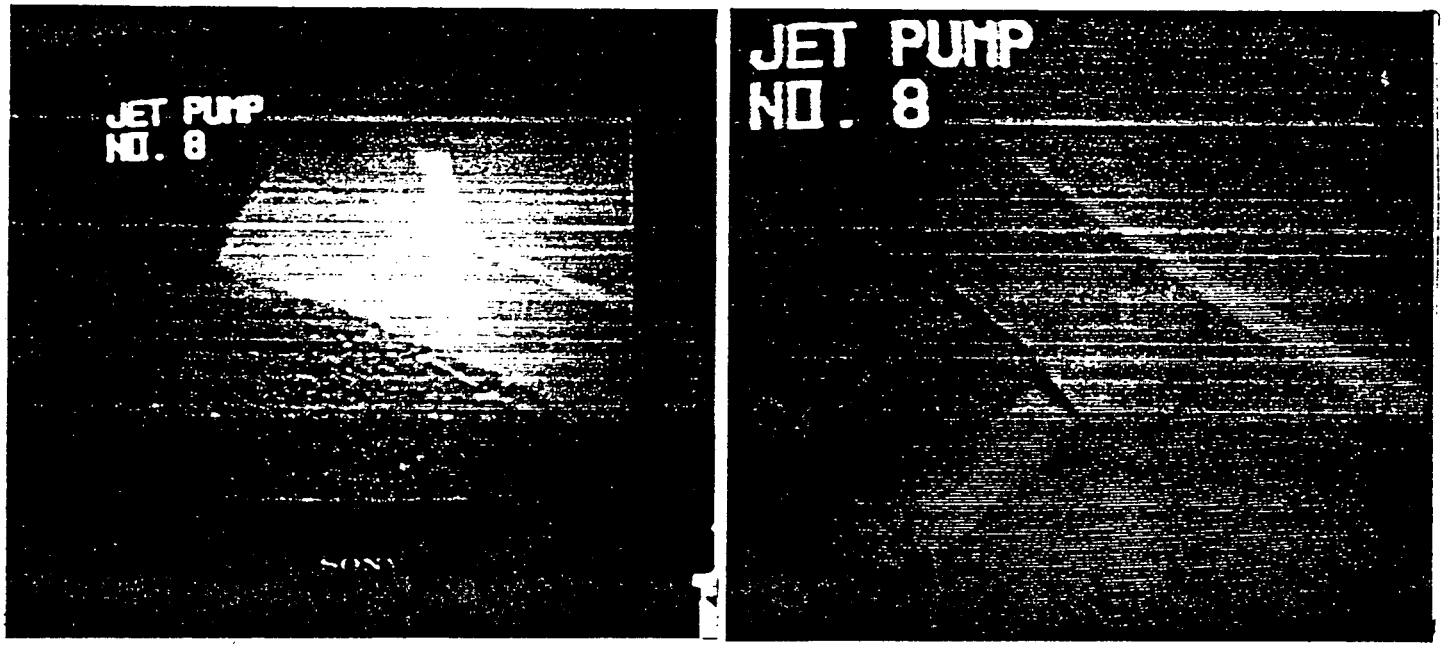

Figure 4. Top View of Cracked Leaf

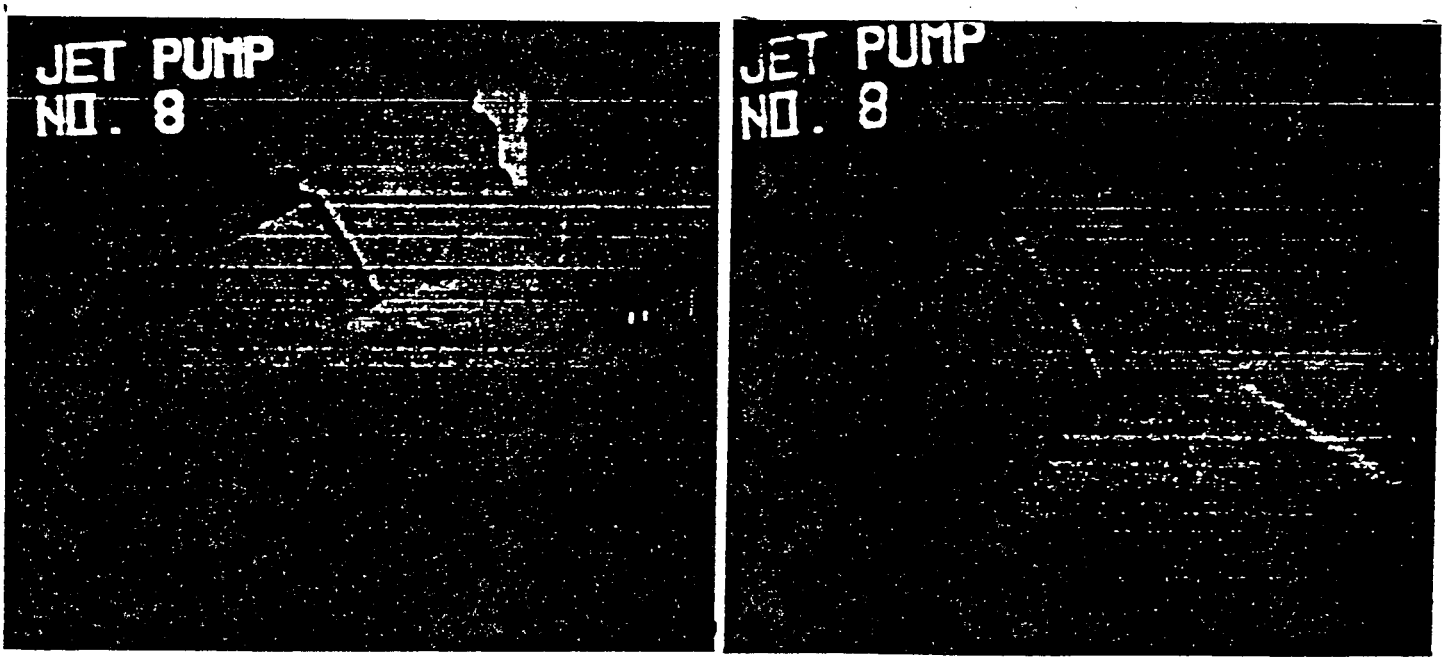

Figure 5. Side View of Cracked Leaf

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		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
Monticello Nuclear Generating Plant	0 5 0 0 0 2 6 3	8 9	— 0 2 1	— 0 1	1 1 OF 1 1

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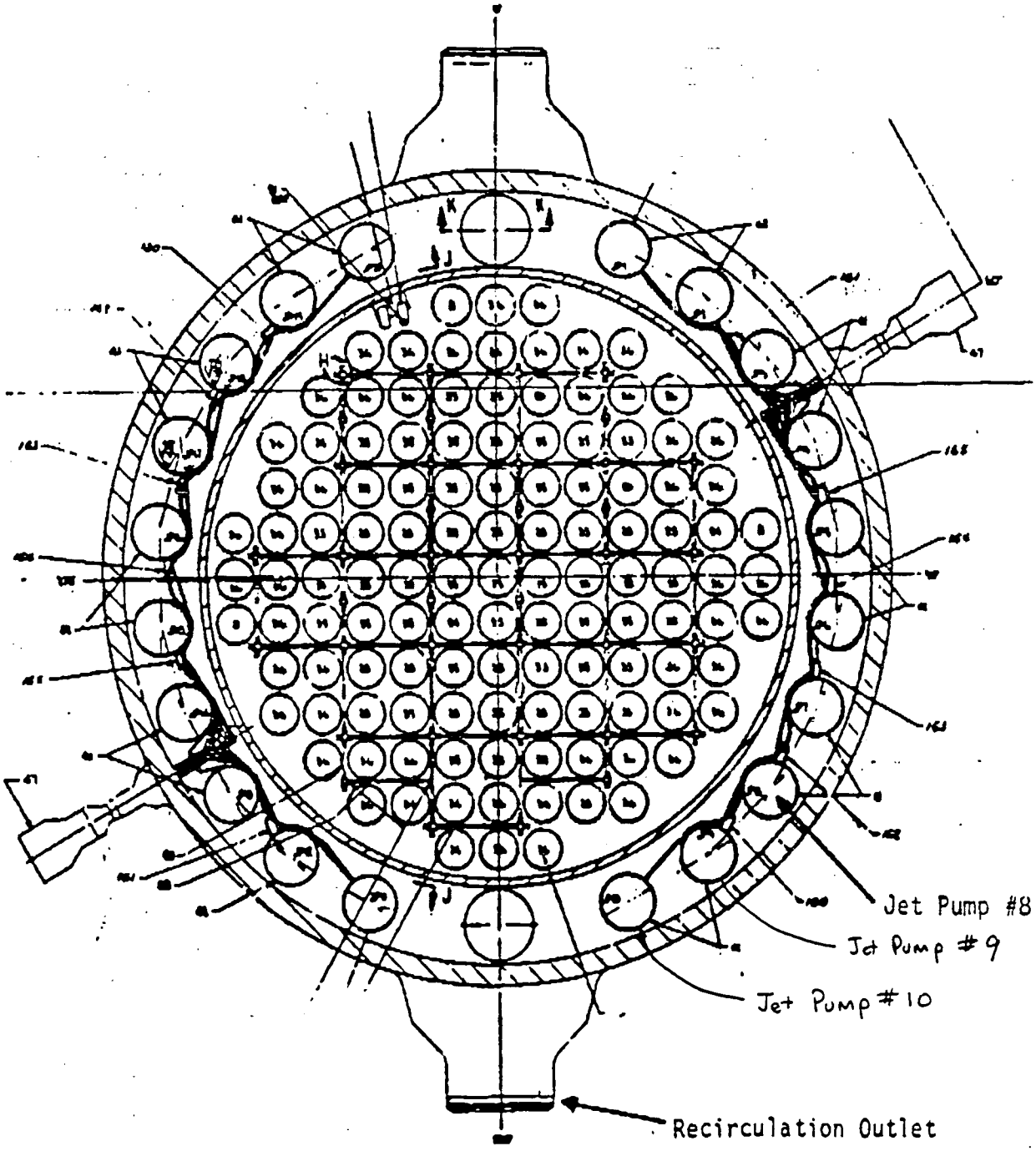

Figure 6. Jet Pump Arrangement