INGERSOLL-RAND
PUMPS

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10/10/91

Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Attn: Roy Fuhrmeister

Subject: 10CFR21 Reportability of a Potential Safety Hazard From Broken Cast Iron Diffusor Pieces in Auxiliary Feed Water Pumps

Dear Roy:

Per our telephone conversation this morning, Ingersoll-Rand Company is hereby notifying the NRC about a potential safety hazard from broken cast iron diffusor tips in auxiliary feed water pumps at sixteen (16) different nuclear sites.

Enclosed please find the engineering background, damage evaluation, conclusions, recommendations, location of damage sketch, typical damage pattern sketch, copies of photographs, and a listing of the utilities, sites, pump types, order numbers, quantities and pump serial numbers.

If you have any questions from an engineering standpoint, please call Phil Nagengast at (908) 859-8360, and for quality control issues call me at (908) 859-7603.

Sincerely yours,

Greg Young

Greg Young
Quality Assurance Supervisor
Quality Assurance Department

sla

Enclosures

CC: R. Litts, I-R QA Mgr.
P. Nagengast, I-R P.E.

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The purpose of this letter is to update the NRC on Ingersoll-Rand's evaluation of damage experienced by several utilities on auxiliary feedwater (AFW) pumps of Ingersoll-Rand manufacture with cast iron internals. These are our model HMTA units.

BACKGROUND

The problem was initially noted at the VEPCO/Surry 2 Nuclear Power Plant in mid 1988. A drop in performance of the AFW pump flow was noted during recovery from a full power reactor scram. It was subsequently found that small pieces of metal had broken loose from internal pump parts (diffusers), and had travelled through the pump discharge piping to eventually lodge in a venturi. The resultant blockage caused a decrease in flow to the steam generator. An inspection of the AFW pumps was performed, and it was determined that the metal pieces found in the piping were metal broken from some of the diffuser vanes within the pump. The diffusers were made of cast iron. Some cavitation damage was evident, being most severe near the leading edge of the diffuser vane surfaces. Considerable corrosion pitting of the cast iron internals was observed, and crack-like crevices were also noted in a number of areas along the vane to shroud junctions.

The first stage diffuser suffered the greatest cavitation/corrosion/erosion damage, and appeared to be the originating point of the initial vane breakage. Other stages exhibited similar types of damage, though to a lesser degree. The other AFW pumps of the same or like designs servicing the same system at this plant were inspected and found to have similar damage. Photos and figures of typical damage observations are attached.

DAMAGE EVALUATION

After careful visual and microscopic examination by Ingersoll-Rand's engineers and metallurgists the following conclusions were drawn:

1) The primary cause of the diffuser vane inlet edge breakage was the undermining of the vane inlet ends due to the accumulated hours of operation of the pump at minimum flow, on the low flow recirculation line used for inservice testing. The plant had been in commercial service for 15 years at the time of the subject failure.

2) Some of the damage in the diffuser passage surfaces in areas other than at the vane leading edge is also cavitation related.

3) The crack-like linear indications in some areas of the vane-to-shroud junctions, under close examination, were found to be elongated cavities formed by pitting action, not fatigue cracks. This particular damage pattern is not familiar to IR from previous experience. At this time it is thought to be attributable to combined cavitation-erosion-corrosion damage associated with the low flow operation.

4) Corrosion damage was found to be present in randomly grouped and linearly oriented pits in other areas of the diffuser passage surfaces. The presence of corrosion products found in some of these pits under metallurgic examination may be indicative of a low level cavitation type of attack where the cavitation bubble collapse is not intense enough to fully remove corroded material by fatigue or yield.

Similar damage patterns, but of lesser intensity, have been observed on the AFW pumps at other nuclear plant sites. See attached listing.

CONCLUSIONS

Based upon the facts presented above, Ingersoll-Rand concludes that the damage observed is primarily due to accumulated operating time on the pump at the minimum flow condition. The diffuser inlet vane end cavitation is typical of what would be expected of such operation. The groups of pitting within the diffuser passageways are also of a pattern sometimes found with vane cavitation damage.

The crack-like linear pitting seen at the vane-to-shroud juncture has not been observed before, to our knowledge. Since many similar pumps are in service in industrial applications with less operating time at minimum flow, we suspect that the damage is related to minimum flow operation.

RECOMMENDATIONS

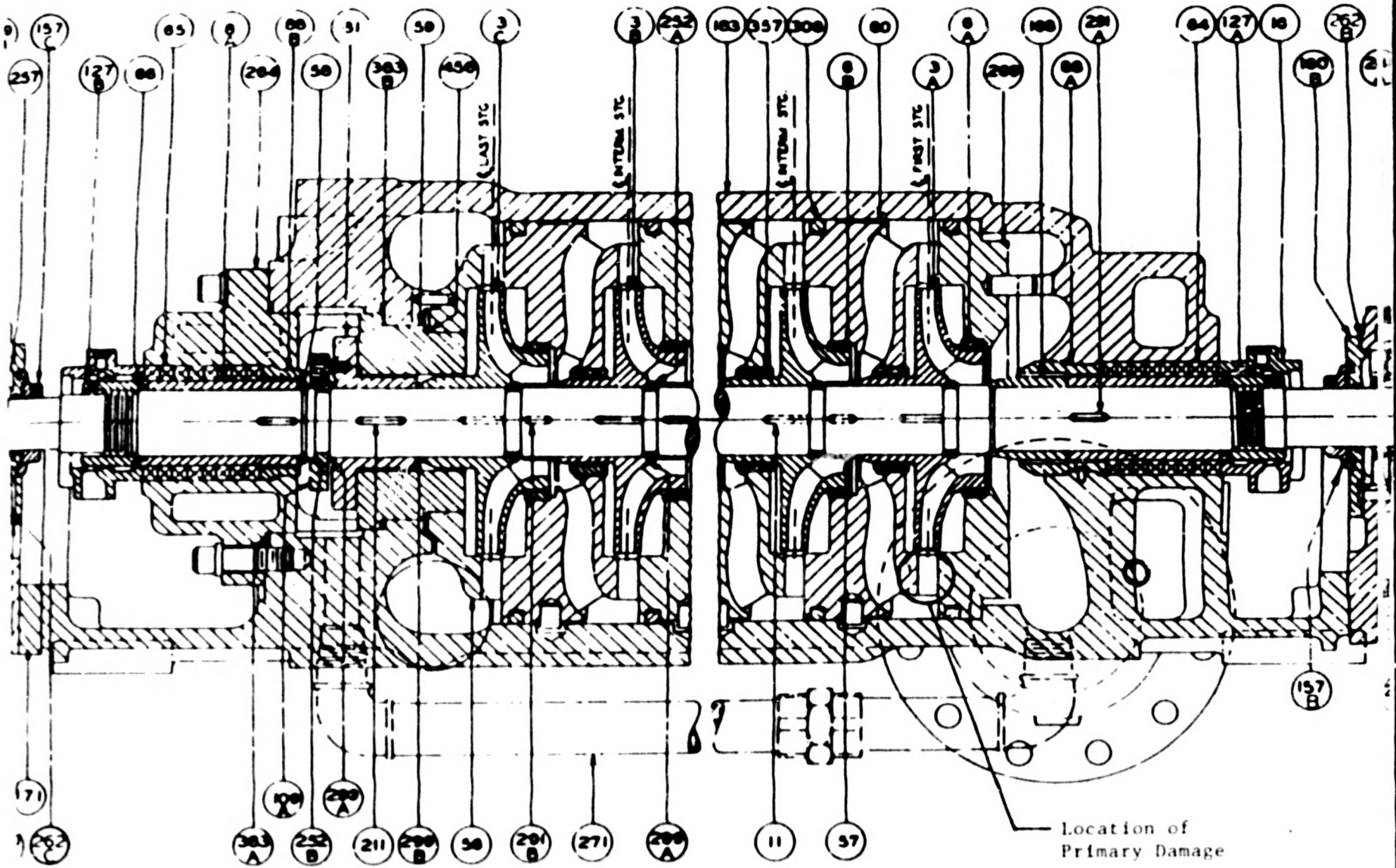
NRC information notice No. 88-87 alerted the industry to the potential flow reduction problem, based upon the VEPCO Surry 2 experience. Subsequently INPO issued a more detailed report on the same problem. Ingersoll-Rand issued a Technical Bulletin 70-89 (3AP90) to our service, sales and repair offices, and several follow-up letters, advising them of the problem.

Ingersoll-Rand's recommended action plan to the nuclear plants has been:

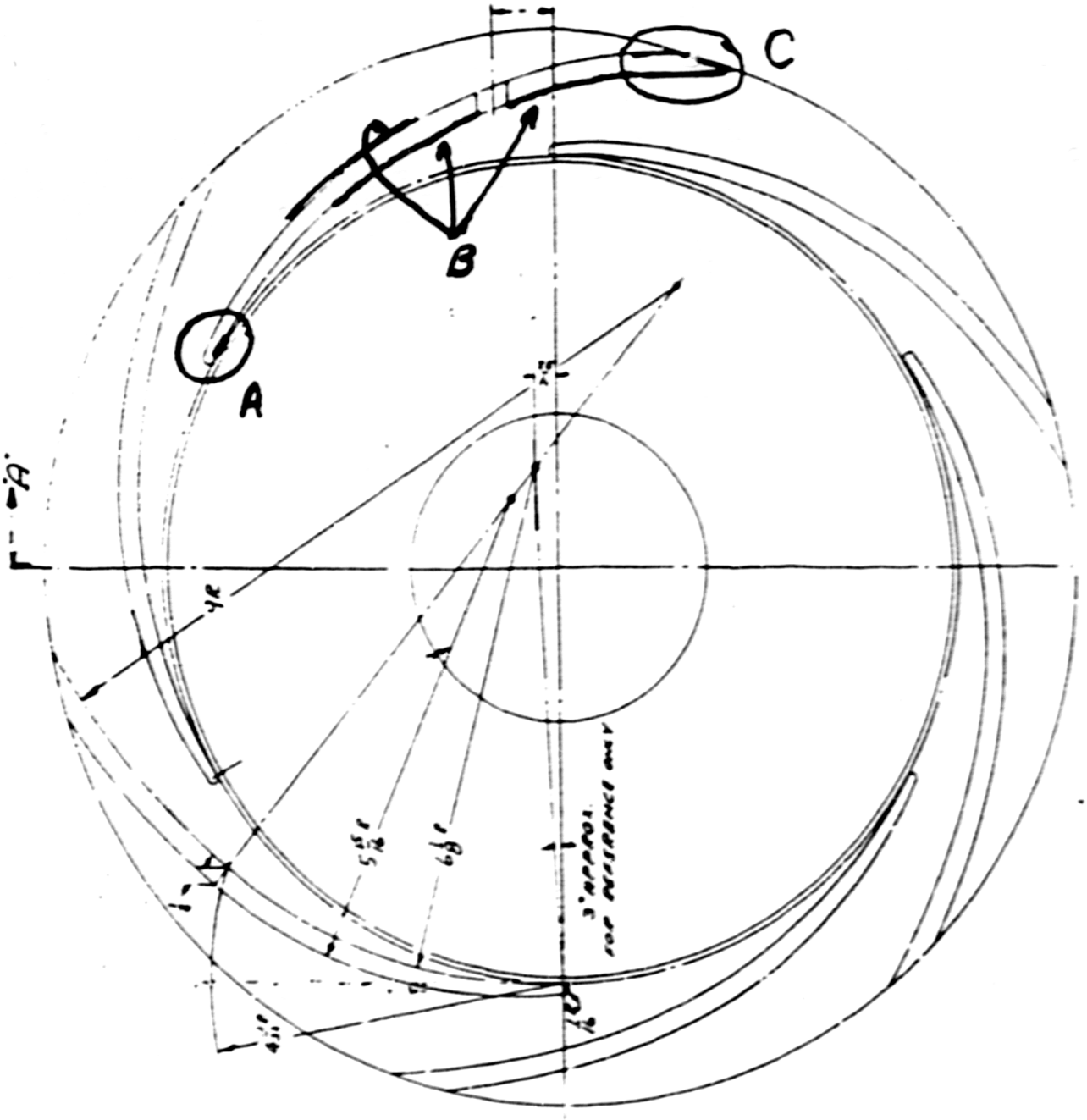
1) Inspect the pumps at reasonable intervals for possible damage to the cast iron diffuser and channel ring parts.

2) If part replacement is required, use a martinsitic or austenitic steel to replace the damaged components.

3) If possible, conduct the required in-service tests at higher flow rates.



Ingersoll-Rand Model HMTA Pump
Auxiliary Feedwater Service

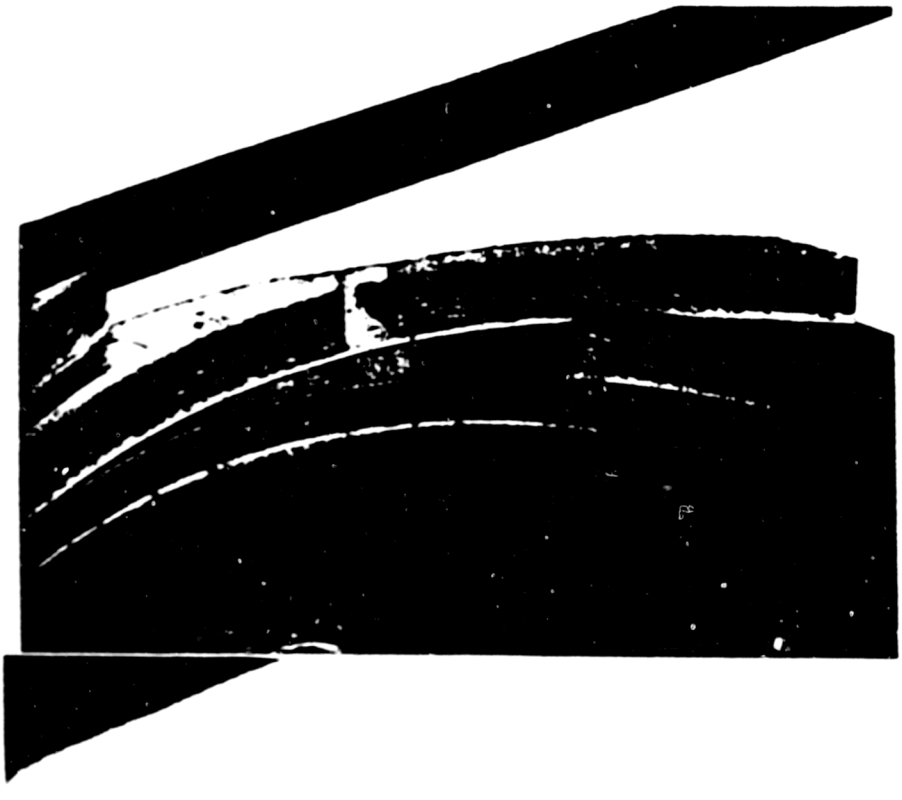


Typical Damage Patterns

Shown above, on one vane , are the locations of the damage patterns observed to varying degree on all of the vanes of the first stage diffuser, and to a lesser degree on smoe of the other diffusers.

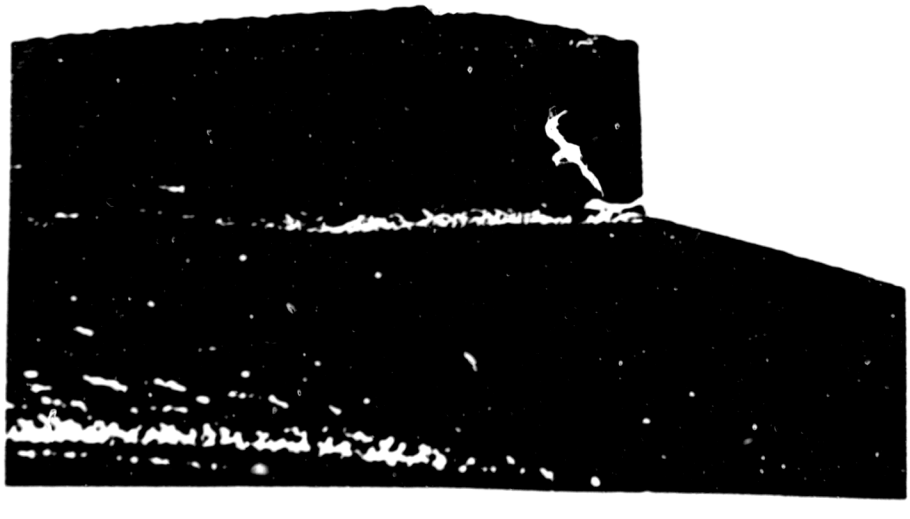
A

Leading edge cavitation damage



B

Vane to shroud junction crevice pattern



C

Vane end crevice pattern

AUXILIARY FEED WATER PUMPS

WITH CAST IRON DIFFUSORS

Utility	Site	Units	Pump	IR Order #	Qty.	Pumps Serial No.
TVA	Sequoyah	1, 2	3HMTA-9	012-36058	4	171-68/69/70/71
			5HMTA-5		2	1271-82/83
TVA	Watts Bar	1, 2	3HMTA-9	012-36183	4	0874-137 - 140
			5HMTA-6		2	0874-141/142
Ala Pwr.	Farley	1, 2	2HMTA-10	012-36090	4	0173-32/33/35/36
			4HMTA-7		2	0173-34/37
VEPCO	N Anna	1, 2	3HMTA-8	001-36038	4	0471-92/93/95/96
			4HMTA-6		2	0471-91/94
VEPCO	Surry	1, 2	3HMTA-8	001-31591	4	0768-72/73/75/76
			4HMTA-6		2	0768-71/74
Duq Lt.	Beaver Valley	1	3HMTA-8	001-32463	2	A69-24/25
			4HMTA-6		1	0669-76
AEP	D C Cook	1, 2	3HMTA-8	031-32274	5	0678-22/23
			4HMTA-6		2	0785-1;0769-56/57 0769-54/55
Con Ed	Ind. Pt.2		3HMTA-9	034-31308	2	0468-262/263
CP&L	Harris	1	4X9NH-7	031-36255	1	0379-7
			3HMTA-9		2	0279-48/58
PSE&G	Salem		3HMTA-8	031-36305	1	0777-85
Maine Yankee			3HMTA-5)	001-32079	1	0669-93
			3HMTA-8)	001-36277	2	1369-68;0673-80
NE Util	Millstone 2		4HMTA-5	034-36045	1	0671-12
			2HMTA-8		2	0671-10/11
PSNH	Seabrook		4X9NH-10)	034-36277	2	0379-120/121
			6HMTA-6)	034-36321	1	0676-24
NYPA	Ind.Pt. 3		3HMTA-9	034-33082	2	0469-153/154
Ark P&L	Nuclear 1		4HMTA-9	006-31739	2	0270-88/89
			5HMTA-4		1	0370-200
TUSI	Comm Pk	1, 2	4HMTA-9	031-36281	4	0576-33/34/36/37
			5HMTA-6		2	0576-35/38
			Total		66	