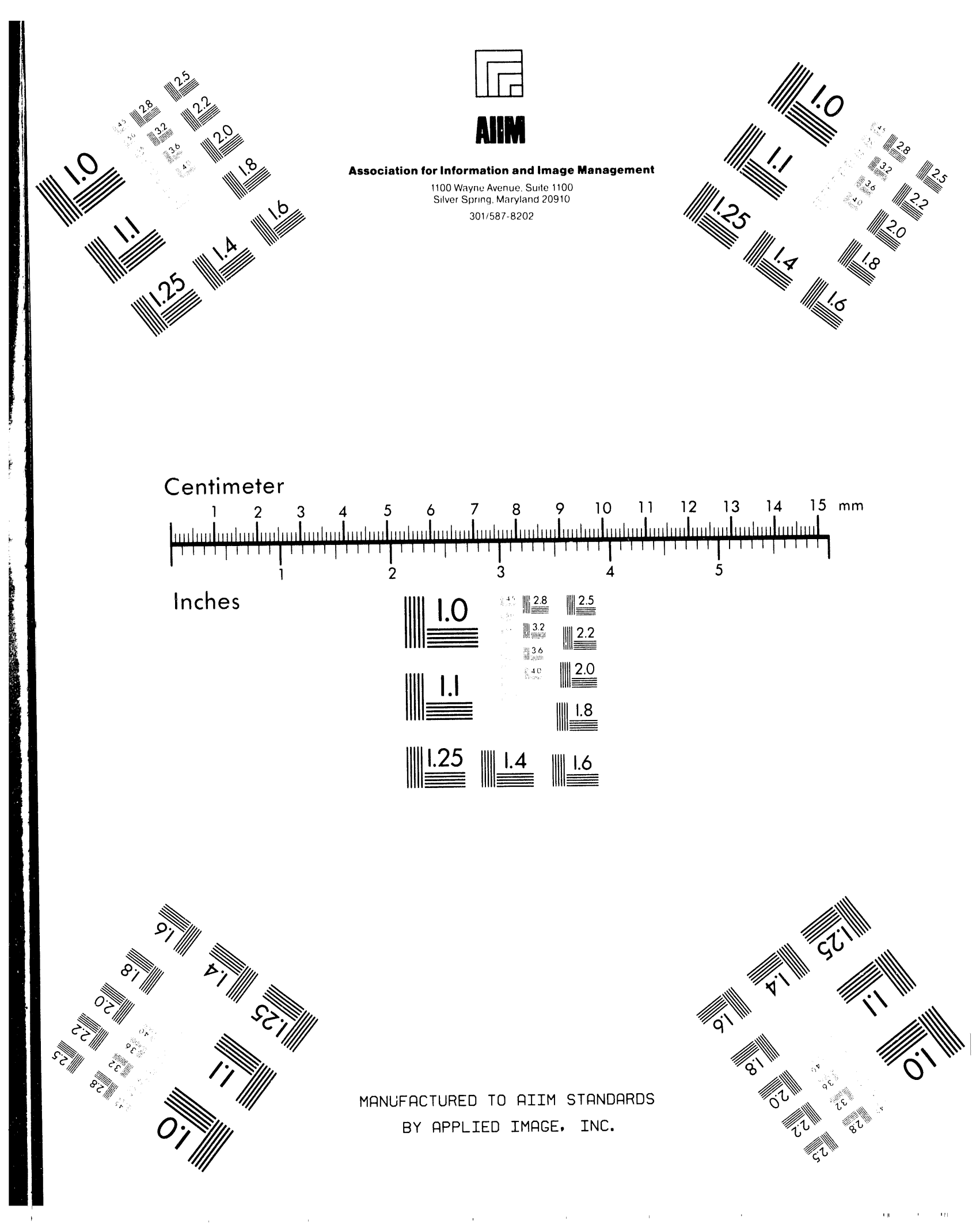
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by

W. D. Hamilton, Engineer
B-C Maintenance Engineering
B-C Reactor Operation

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PROCESS WATER FLOW TESTS - C REACTOR

INTRODUCTION

The power calculator at C Reactor and the process pump flowmeters at 190-C use orifice plates as primary sensing elements. These orifices were designed for considerably less flow and at the present higher flows, the reactor riser pressure is appreciably reduced as the result of the inefficiency of the orifices. The differential pressures across these orifices are:

	ΔP	at	Flow (gpm)
105-C Power Calculator	464.4" H_2O		19,000
190-C Pump Flowmeter	331.0" H_2O		12,000

Only a portion of the differential pressure across an orifice is recovered. The amount is dependent upon the ratio of the orifice diameter to pipe diameter. According to Ref. No. 1, the permanent loss across these two orifices is 16 psi. Again, according to Ref. No. 1, the permanent pressure loss resulting from properly sized venturi elements would be 1.6 psi, for a resultant decrease in system pumping resistance of 14 to 15 psi. This would permit higher process water flow and reactor power levels.

CONCLUSIONS AND RECOMMENDATIONS

C Reactor is the only reactor totally equipped with orifices in the power calculator and process pump flowmeters. B, D, DR, F, and H Reactors are equipped with venturi elements in both the power calculator and pump flowmeters. K Reactors are predominantly equipped with venturi elements, although not of optimum size. The orifice assemblies(6) in the process water headers for the power calculator system should be replaced with venturi elements sized to produce 150" H_2O differential pressure at 19,000 gpm header flow. The orifice assemblies used to produce the process pump flow differential pressure should be replaced with venturi elements sized to produce 100" H_2O differential pressure at 12,000 gpm pump flow.

DISCUSSION

The permanent pressure loss due to the inefficiency of the orifices is 16 psi. This was calculated as follows, based on tables in Ref. No. 1:

Pressure loss = differential pressure (" H_2O) x .03613" H_2O/psi x 1.00-efficiency

Power calculator loss = 464.4" H_2O x .03613" H_2O/psi x 1.00 - .4 = 10 psi

Pump flowmeter loss = 331" H_2O x .03613" H_2O/psi x 1.00 - .5 = 6 psi

The data used to determine the efficiency of the orifices is as follows:

Power calculator - BPF No. 3587

Orifice diameter: Varies from 15.04 to 15.071
Pipe ID: 22"
d/D: .685
Δp: 464.4" H_2O at 19,000 gpm

Pump flowmeter - BPF No. 3776

Orifice diameter: 12.530
Pipe ID: 16.5"
d/D: .75941
Δp: 331" H_2O at 12,000 gpm

According to Ref. No. 1, a venturi element recovers 85 percent of the differential pressure developed across it. Accordingly, the pressure loss can be estimated as follows for venturi elements sized to produce a differential pressure of 150" H_2O for the power calculator and 100" H_2O for the pump flowmeters:

Total loss = 150 + 100" H_2O x .03613 x 1.00 - .85 = 1.4 psi

By replacing existing orifices with venturi elements, riser pressure can be increased 16.0 - 1.4 = 14.6 psi.

According to Ref. No. 2, an increase of 15 psi on the riser will produce an increase flow of approximately 1600 gpm, resulting in a substantial reactor power increase. On April 9, 1961, tests were conducted during reactor operation to determine the process water flow resistance characteristics. The data from these tests are shown on Table No. 1. All data was taken simultaneously. The flow and discharge pressure of each pump was recorded. In 105-C, the flow of each header, total flow, and top of each riser pressure was recorded. The control pressure to 105-C was reduced 15 psi in 5 psi steps. At each step all of the afore mentioned readings were recorded along with subsequent power reductions.

Pump No. 1 was shut down. This caused an unbalance in flow between the near and far headers. This caused some pumps to actually increase in flow when the pressure was reduced. Due to expected inaccuracies in the gauges, discharge pressure figures are accurate to approximately ±3 psi, top of riser pressure (TORP) to ±1 psi, header flow to ±50 gpm, and pump flow ±25 gpm.

The results of these tests, when extrapolated, confirm the data in Ref. No. 2. This reference also includes pump characteristic curves, which indicate the 190-C process pumps are capable of supplying the additional flow.

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TABLE 1

4-9-61 Time: 2030		Operating Pressure	Operating Pressure Minus 5 psi	Operating Pressure Minus 10 psi	Operating Pressure Minus 15 psi
	Time	2031	2048	2104	2120
105-C					
Top of Riser "A" Pres. psi		400	395	389	382
Top of Riser "B" Pres. psi		400	392	390	382
Top of Riser "C" Pres. psi		402	400	393	390
Top of Riser "D" Pres. psi		402	400	397	390
A_1 Header - Flow (gpm)		16700	16790	16800	16700
A_2 Header - Flow (gpm)		17600	17600	17780	17600
A_3 Header - Flow (gpm)		18000	18000	18150	18000
B_1 Header - Flow (gpm)		14420	14200	14000	13850
B_2 Header - Flow (gpm)		15300	15000	14750	14650
B_3 Header - Flow (gpm)		14000	13700	13400	13350
Shield Flow (gpm)		1325	1325	1305	1325
Total Flow Recorder (gpm)		96000	95800	95000	94200
190-C					
Pump No. 1 - Shutdown					
Pump No. 2	Flow gpm	10600	9950	9950	9900
	Discharge Pres. psi	460	450	445	440
Pump No. 3	Flow gpm	10500	10500	10300	10150
	Discharge Pres. psi	460	455	445	440
Pump No. 4	Flow gpm	10750	10300	10300	10250
	Discharge Pres. psi	460	455	445	440
Pump No. 5	Flow gpm	10750	10600	10300	10400
	Discharge Pres. psi	455	450	440	435
Pump No. 8	Flow gpm	10800	10300	10250	10200
	Discharge Pres. psi	470	465	460	455
Pump No. 9	Flow gpm	10000	10200	10300	10600
	Discharge Pres. psi	470	465	460	455
Pump No. 10	Flow gpm	9900	10100	10150	9900
	Discharge Pres. psi	475	475	470	460
Pump No. 11	Flow gpm	9750	10000	10150	9850
	Discharge Pres. psi	475	470	465	460
Pump No. 12	Flow gpm	10350	10300	10250	10250
	Discharge Pres. psi	470	465	465	460
Control Pressure - psi		401	396	391	386
Total Flow - gpm		93400	92550	91950	91500
Change in Flow, gpm			-850	-600	-450
Power (megawatts)		2120	2105	2090	2070

[redacted]

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