FROM: Northern States Power Company
Minneapolis, Minnesota 55[illegible]
R. O. Duncanson, Jr.

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TO: Dr. Peter A. Morris

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REMARKS:

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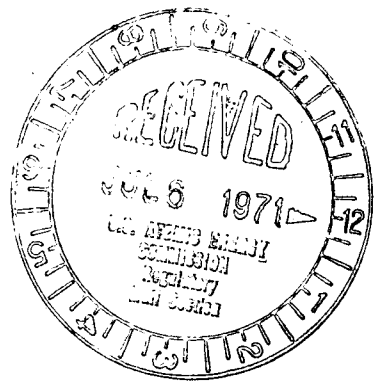
MINNEAPOLIS, MINNESOTA 55401

July 2, 1971



Dr Peter A Morris, Director
Division of Reactor Licensing
United States Atomic Energy Commission
Washington, D C 20545

Dear Dr Morris:

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

Main Steam Flow Restrictor Anomaly

In our letter of May 12, 1971, concerning inoperable main steam line high flow sensors, we reported a significant discrepancy between the measured differential pressure and the vendors calculated flow restrictor calibration curve. This letter reports the progress and results to date of the investigation of this phenomenon and our plans for further investigation.

The flow restrictors perform two safety functions. First, they are designed to limit the steam flow from the reactor vessel to 200% of rated flow in the event of a main steam line break outside of primary containment. Secondly, they provide a differential pressure signal which is used to initiate main steam isolation. The Technical Specifications require the isolation setpoint to be $\leq$ 140% of rated flow.

The data available at the time the discrepancy was first discovered indicated that the measured pressure differential was about 40% of the value predicated by the vendor's calibration curve. The setpoints of the high flow sensors were immediately reduced from 122 psid to assure that the Technical Specification limit would not be exceeded.

An immediate review of the restrictor design data and the physical installation was conducted. Independent calculations performed by NSP, the designer (General Electric Co.), and the vendor (the Permutit Company) verified that the calculated calibration curve was correct. The location of pressure taps, condensing chambers, and sensing instruments, as well as the slope and routing of sensing lines was verified as correct. Vendor representatives were called to the site by General Electric Co. to examine the installation and review the data. NSP has not received a report of their findings or conclusions.

The possibility that the restrictors were installed backwards has been eliminated. The restrictors were factory installed near one end of an approximately 12 foot long section of pipe. The actual location of the primary taps shows that these sections of pipe are correctly installed. Correct installation is also confirmed by the fact that the high pressure tap is upstream of the low pressure tap. If the restrictors were backwards the relative positions of the high and low pressure taps would also be backwards, since the restrictor throat would be the lowest pressure point regardless of the direction of flow.

Prior to resuming operation following an extended cold shutdown for turbine repairs, which ended on June 18, 1971, insulation was removed from the C steam line and the restrictor was radiographed. The radiograph verified that the restrictor throat diameter was correct and that the restrictor was correctly installed.

In discussion with representatives of General Electric Co. we were informed that:

1) This phenomena has been observed at several General Electric Co. BWR plants outside of the United States, some of which have been in operation for a considerable time.

2) The phenomena appears to be associated with restrictors manufactured by a particular vendor.

3) Differential pressure vs. flow data at other plants where the phenomena has been observed has been repeatable and has not changed as a function of time.

4) There is a likelihood that there may be a leakage path within the flow restrictor which would reduce the differential pressure. However, we were assured that the structural integrity of the restrictors has been reviewed and is not adversely affected.

5) The ability of the restrictors to limit flow to 200% of rated has not been affected.

6) Modifications are being made on restrictors for other plants which have not yet gone into operation and tests of these modifications are being planned.

7) Plans are being made to perform scale model tests on piping layouts using steam. These tests may help determine whether the problem is due to the nozzle design or location.

Two theories exist concerning the cause of the low differential pressure measurements. First, it is possible that there is leakage between the welding ring and the pipe wall, or between the welding ring and the upstream or downstream sections, such that the pressure is increased in the low pressure sensing line. The second theory is that the upstream pressure is being incorrectly measured because of a possible non-uniform static pressure distribution caused by elbows in the line upstream of the restrictor.

The Operations Committee has reviewed the situation on several occasions and has approved continued plant testing based upon the verification of correct installation and throat diameter, the repeatability of the pressure vs. flow data, and the assurance from the designer that: 1) The present high flow isolation setpoints were within the technical specifications, 2) the restrictor will limit flow to 200% of rated, and 3) the structural integrity of the restrictors is adequate. The Operations Committee will continue to review any new information as it becomes known. A quorum of the Safety Audit Committee was informed of the situation, including both consultants from outside the NSP and GE organizations, and they concurred with the Operations Committee. The subject is again scheduled for review at the next SAC meeting.

Pressure differential vs. flow data was obtained as power was increased during the startup test program. Shortly after reaching 100% steam flow for the first time a main steam line high flow trip occurred, resulting in main steam isolation and a reactor scram. The trip was due to hydraulic "noise" in the differential pressure signals. Snubbers have now been installed in the sensing lines to damp the noise. Also, the setpoints of the high flow sensors have been adjusted to 43 psid. Extrapolation of the measured data indicates that this is below 140% of rated flow.

The vendors calculated calibration curve and the measured data are shown on the attached log-log plots. The data has been plotted vs. total feedwater flow, which is essentially equal to total steam flow under steady state conditions. Feedwater flow was accurately measured using certified calibration flow nozzles. The measured data is from two sources; the average of the indications from the high flow switches, and the output of the transmitters for the control room flow indicators. The data scatter, which is particularly noticeable at flow of 50% of rated or less, is primarily due to the inherent nonlinearity and deadband in these instruments.

A special test was conducted to obtain data for restrictors B and D at flows up to about 113% of rated. The test was conducted by closing isolation valves in the A & C lines and adjusting reactor power to obtain the desired flows. The data continued to follow the extrapolated curve and lends additional confidence that the extrapolation to 140% of rated flow is valid.

Readings from the high flow switches are being recorded and evaluated daily to detect any changes in the pressure vs. flow relationship. A memo has been issued to inform the operating crew of the situation and request that they remain particularly alert to changes in indicated steam flow and other parameters which could indicate a steam leak, such as reactor water level, main steam tunnel area temperature, feedwater flow, and power level.

The steam flow instrumentation used for the control room indicators and recorder has been recalibrated based on the measured data and assuming that the steam flow in each line is equal to one-fourth of the total feedwater flow under steady state conditions. Over the range of 30-100% power the agreement between indicated steam and feedwater flows is good.

The plant design includes instrumentation which compares turbine first stage pressure, which is directly proportioned to turbine steam flow, with total reactor steam flow. An alarm is initiated when reactor steam flow exceeds turbine flow by more than 400,000 lb/hr. (This is less than 24% of rated flow through one steam line). This instrumentation has been tested and is fully operational.

Although further testing has been approved, we feel it is important to continue to pursue a more complete understanding of this anomaly. We are presently attempting to obtain the following information from or through the General Electric Company.

1) Information regarding the assumptions and methods of calculation used to determine the flow limiting capability of the restrictors.

2) Additional information concerning the likelihood of leakage and the mechanism of such leakage and the effect on the structural integrity of the restrictors.

3) An analysis of all available data from Monticello and other plants, including a comparison of the design of restrictors which have exhibited the problem with those that have functioned properly. Also, we suggested that postulated theories as to the cause of the low readings be evaluated against the data and that their reasonableness be established by calculations or measurements.

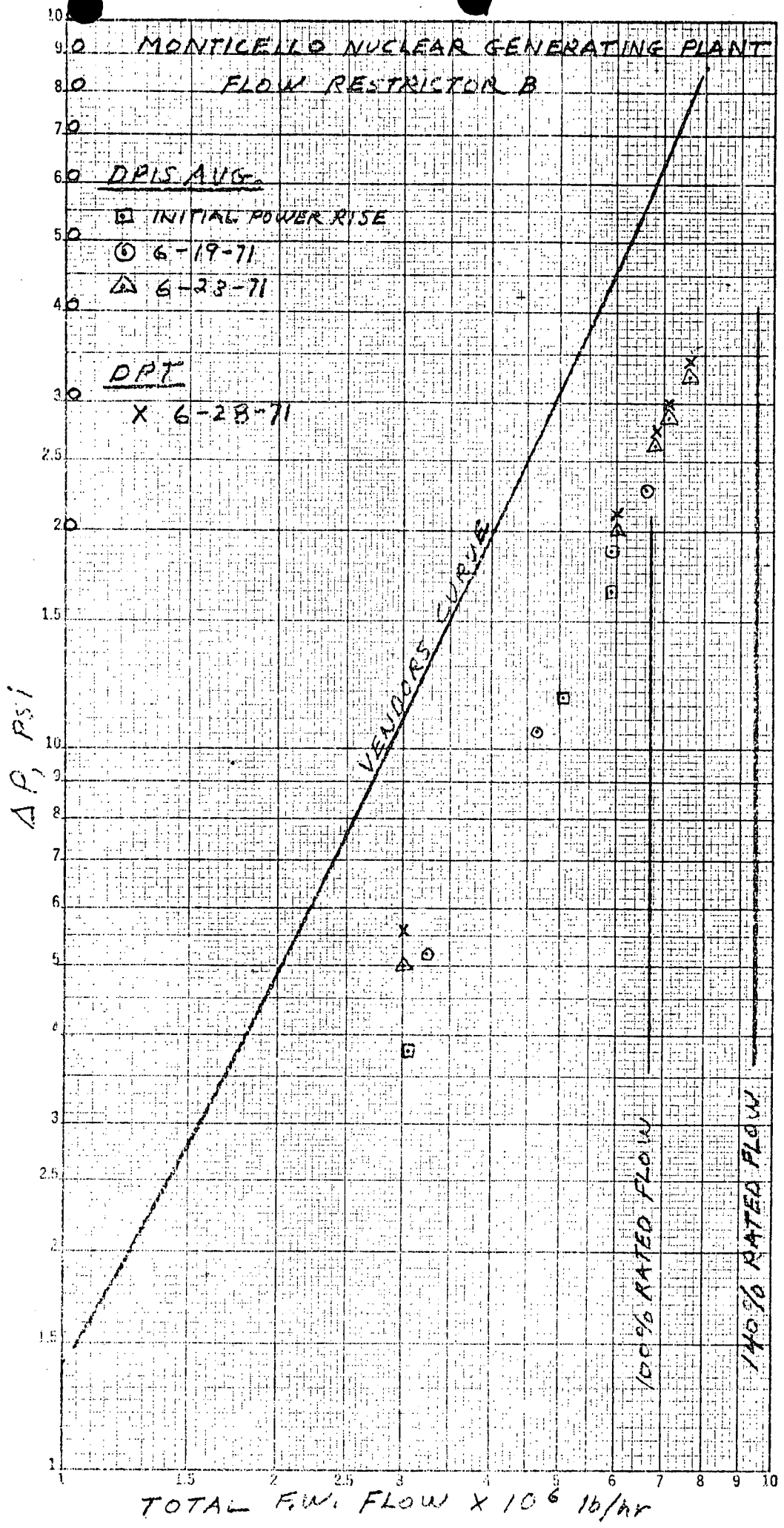
4) Additional information concerning tests and modifications that have been performed or which are planned.

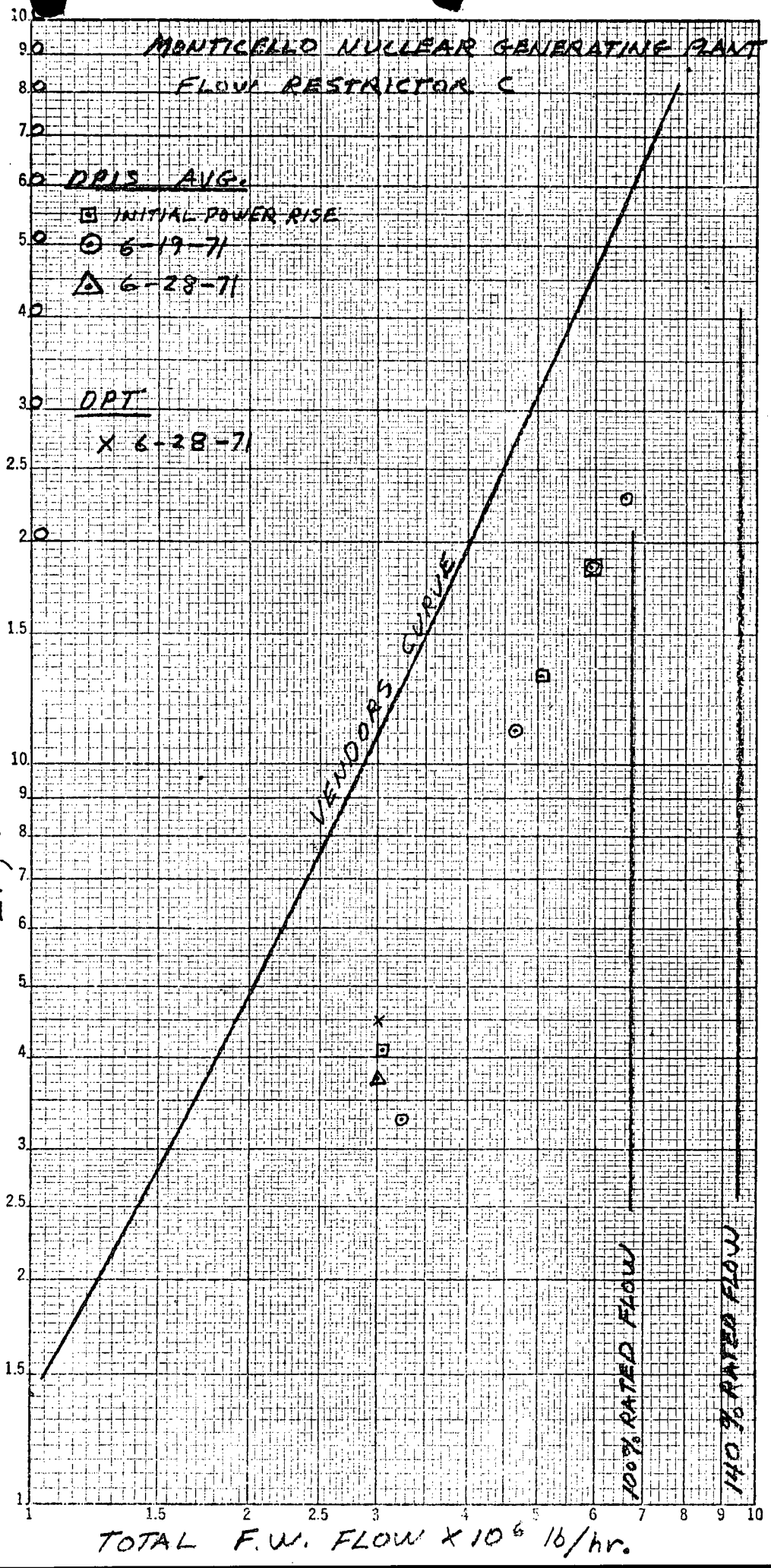
5) Additional information concerning the history of the phenomena.

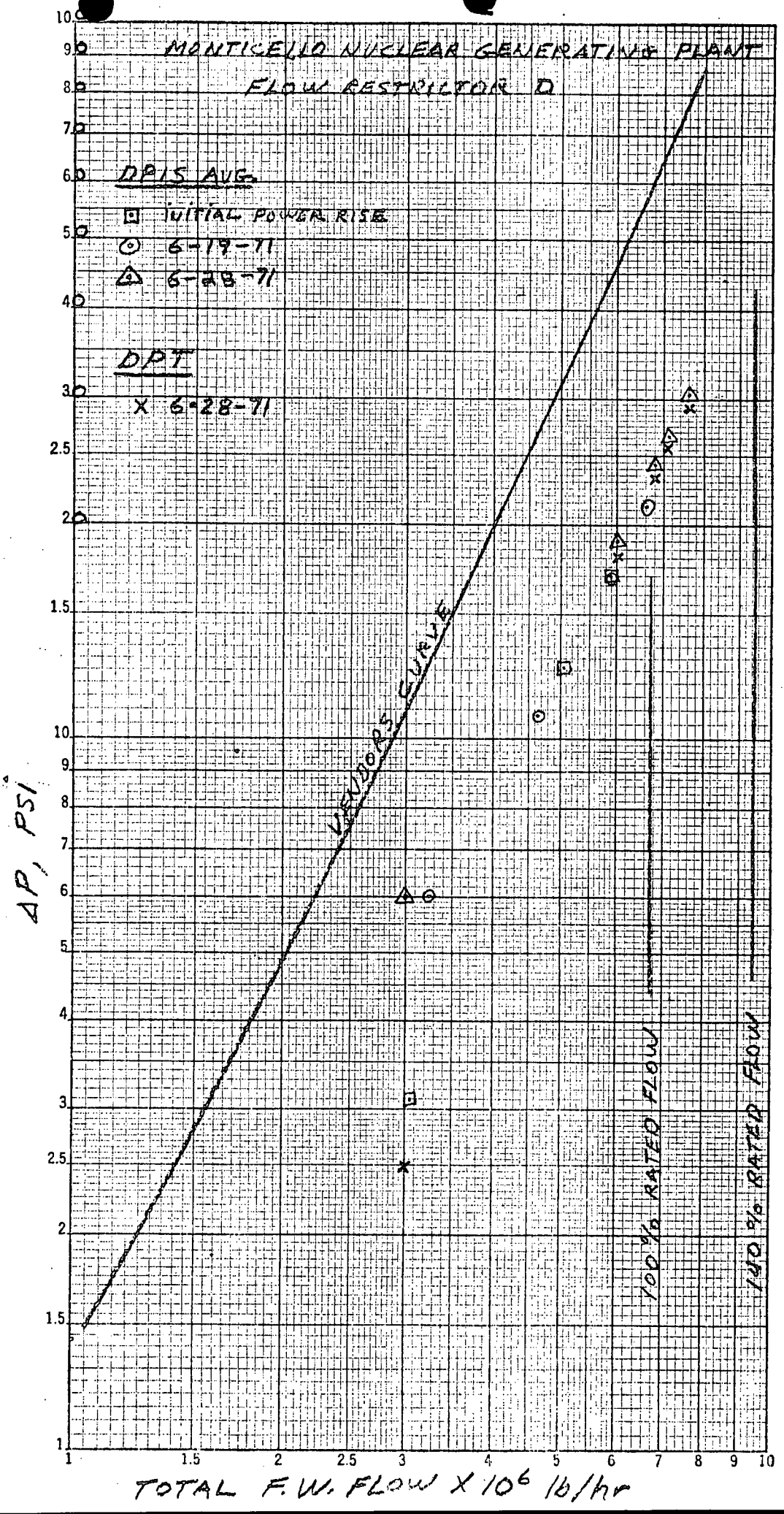
Yours very truly,

R O Duncanson, Jr., P.E.
Gen Supt of Power Plants-Mechanical
Chairman-Monticello Safety Audit Committee

ROD/MHC/ml







MATERIAL SPECIFICATIONS		
PC. NO.	NAME	SPEC.
1	PIPE	ASTM–A106 GR. B
2	WELDING RING	FORGING ASTM–A–105 GR. II
3	UPSTREAM SECTION	CASTING ASTM–A–351 GR. CF 8
4	DOWNSTR. SECTION	CASTING ASTM–A–351 GR. CF 8
5	1 in. (6000#) HALF CPLG.	ASTM–A–105 GR. II
6	1/2 in. SCH. 80 NIPPLE	ASTM–A–106 GR. B
7	FLAT 1/2 in. x 1 in. x 1 in.	ASTM–A–107 GR. 1020

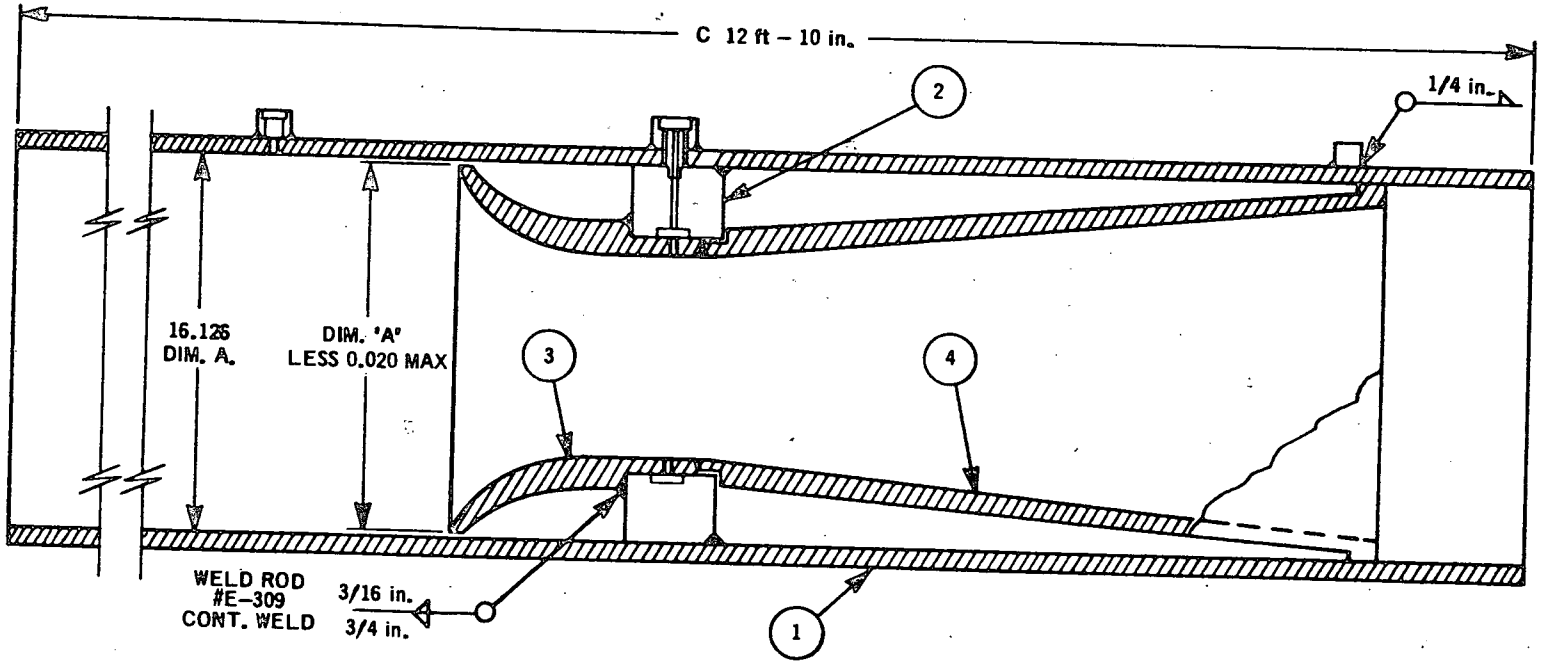


Figure 6-3-1 Main Steamline Flow Restrictor Nozzle