NMC
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INTERNAL
CORRESPONDENCE

NPM 2002-0599

To: T. Klesper J. McNamara

From: A. J. Cayia

Date: November 8, 2002

Subject: AFW RECIRCULATION LINE ORIFICE EVALUATION

Copy To: T. Taylor D. Schoon J. Boesch S Thomas G Corell
R. Milner J. Freels T. Webb M. Schug File

In accordance with my draft guidance for review of plant modifications, a review of the conceptual replacement AFW orifice design was conducted on November 8, 2002.

Attendees included:

A. J. Cayia (Chairperson)	Renee Milner	Joe McNamara
Jim Freels	John Boesch	Stu Thomas
Tom Klesper		

The review included discussions on engineering's recommended conceptual orifice design, whether it would be flanged or welded in the recirc line, the design functions of the orifice and whether training was impacted in any way.

The panel endorsed the ten-stage flowserve pump division orifice. Engineering was directed to proceed with detailed design and procurement of two orifices for the motor driven pumps and two orifices for the steam driven pumps on an expedited basis. Engineering was also requested to verify that the orifices for the motor driven pumps should be expedited first because of their importance from a risk standpoint. The next review is to be scheduled at the completion of detailed design.

rlp

Attachment: AFW Recirculation Line Orifice Evaluation

A/331

AFW Rirculation Line Orifice Evaluation

Flowserve Valve Division	Flowserve Pump Division
6 stages	10 stages
Length 27 5" (will fit on three pumps)	Length 23 5" (fits all pumps)
Minimum opening 5 holes - 0 209" diameter	Minimum opening 3 holes- 0 3125" diameter
600= flanges (will fit on two pumps)	2" 3000# socket weld ends (fits all pumps)
DG-M03 states 900# flanges	DG-M03 stated 3000# socket welds
O-rings used to seal stages	Each stage welded and Hydrostatic tested
Threaded retainer and snap ring secures stages	All welded construction
Experience in gaseous systems	Experience with pump recirculation lines
Drawing Attached	Drawing Attached
Cost:	Cost: $26,156.00 each
Expedited Delivery:	Expedited Delivery: 8 weeks at additional 25%

The valve division's design can be assembled. The cost of disassembly is a higher probability of failure. The threaded retainer could come loose. Threaded in valve cages (similar design) are locked in with welded locks. The downstream retaining ring is a snap ring. If the element does cavitate, this area would pit and cause snap ring failure. Zion used a 7-stage orifice (similar number of stages) and saw degradation in this area after years of service. The o-rings have a service life and will degrade. Leakage past the o-rings will cut the area, similar to steam cutting on valve seats. The valve division's design will only fit in two of the recirculation lines, without line rerouting. Flanges are not required or recommended. The elements should not require cleaning since the openings are sized for Service Water. Previously welded in orifices have been inspected in place, probably though the flow meter orifice, refer to RCE 99-081.

The valve division wants adjustability to ensure meeting flow rates, and the retainers could be seal welded after final adjustment. Since the recirculation flow does not need to be 126 gpm and 89 gpm as stated in the FSAR. A larger flow rate window is acceptable and the FSAR will be changed.

The basis for the FSAR change is that failure of the SR recirculation isolation AOV is within the scope of failure of the AFW pump. If the AOV fails open, the affected pump cannot provide its design flow of 200/400 gpm to the Steam Generators.

I recommend using the pump divisions design. The orifices are available in 8 weeks with expediting at a cost of $130,000. These flow orifices were designed analytically, if actual flow tests are required additional costs will be incurred.

Critical Attributes

The final design must balance cavitation concerns against debris trapping The flow restriction device/orifice must meet the system design pressure and temperature requirements of 1440 psi and 100 F, refer to DG-M03 and the minimum recirculation requirements for the Byron Jackson pumps (SN 681-S-1028/29) of 130 gpm for 1500 hours or 75 gpm for 60 hours and for the Byron Jackson pumps (SN 681-S-1030/31) of 75 gpm for 1500 hours or 50 gpm for 60 hours, refer to Flowserve's letter to John P. Schroeder dated March 2, 2001. After these time intervals, the pump manufacturer recommends evaluation/inspection The desired flow is 130 gpm and 75 gpm, since the 1500 hours exceeds PBNPs monitoring programs This will require an FSAR update, since Section 10.2 3 states that the recirculation flow is approximately 126 gpm In addition, any replacement welds should be oversized in a 2/1 configuration as described in EPRI technical reports TR-107455 and TR-111188 The purpose for the oversized socket welds is to reduce the potential for high-cycle fatigue due to recirculation line vibration.

The pressure reducing device must drop the pressure by about 1335 psid at 130 gpm/1285 psid at 75 gpm The basis for the differential pressures are the previous Purchase Orders 4500429416/4500291375 The flow restrictors procured under these POs performed adequately, refer to IT-8A, IT-9A tested on 10/25/02. In addition, the approximate Cv values of the installed devices were provide to the vendor as well as in-. house modeling of the system in Proto-Flow The Proto-Flow model is "for information only" but does provide correlation within 2.5% of the 1335 psid design value. Past Purchase Orders have also had noise limits of 75 DBA, and noise limits should be included in future POs.

The flow restriction device/orifice can be subjected to Service Water. Service Water is inherently dirty, but it is filtered through 1/8" strainers, refer the Service Water DBD-12, Section 3.2.5 (Source 1). Accepted practice is to size downstream components for larger particles. The replacement flow restriction orifice/device is required to pass 3/16" particles. Water quality statements will be in the Purchase Order.

DB pipe class requires 3000# socket weld fittings. Stainless steel material is also recommended in the original pump specification. Stainless steel will withstand the high velocity and turbulence within the orifice. The associated piping is also stainless. The requirements for 3000# fittings and stainless steel material will also be in the Purchase Order.

Conceptual design of Aux Feedwater Orifice Modification
MR 02-039*A-D

Concise Statement of Problem

The installed flow control devices in the auxiliary feedwater recirculation lines are modified valves with anti-cavitation trim Some of the internal passages in this trim are only 0.021" by 0.090" A small amount of debris was found in the P-38A recirculation line's flow control device, refer to CAP 29952. The debris caused a reduction in the recirculation line flow during quarterly testing

In addition, previously installed 3-stage plate style orifices cavitated. The resulting noise and vibration in the piping system was unacceptable and may have caused cracking in nearby socket welds To address the weld failures, the welds in the recirculation line were reconfigured to 2/1 per EPRI technical reports TR-107455 and TR-111188

Options

The manufacturer of the installed modified valves with anti-cavitation trim (Flowserve Valve Division) was contacted. Flowserve Valve Division reviewed their design to determine if trim that could past a 3/16" particle could be developed. Trim that could pass a 3/16" could not be designed. Flowserve Valve Division also looked at installing 2 valves in series and determined that this option still did not provide sufficient pressure drop with 3/16" openings Flowserve Valve Division is now designing a MegaStream orifice. This orifice uses 3 plates with a series of 3/16" holes in each plate. This design must be flanged in and Flowserve needs two additional days of engineering at $2000 per day to determine if the MegaStream orifice will work. There is insufficient space to install flanges on recirculation line in its current configuration. Data on the MegaStream orifice is attached.

The manufacturer of the previously replaced 3-stage orifices (Flowserve Pump Division) was also contacted. The 3–stage orifice has ½" openings, but the device cavitated at design flow. Flowserve Pump Division stated that the 3-stage model is a commercial design without noise or cavitation limits Flowserve Pump Division redesigned the orifice given a no cavitation requirement. The proposed orifice uses 10 stages and has no openings less than 0.234". This orifice has 2" socket welded ends and will fit in the piping run between the elbow and CST isolation valve. In addition, Flowserve Pump Division evaluated the multi-stage orifices use at Zion Nuclear Plant. The AFW pumps at Zion have higher discharge head and were determined not to be within our parameters. Because the orifice must be designed for our flow requirements, for our pump head and our system losses, finding an orifice at another facility is very unlikely.

Conceptual Solution

Install 10 stage orifices to replace the valve style orifices on all four Auxiliary Feedwater Pumps. The orifices have an overall length of 23.5" and will fit between the elbow and CST isolation valve in each line, replacing the installed valve style orifices. The design flow rate for the turbine driven pumps will be 130 gpm, and the design flow rate for the motor driven pumps will be 75 gpm. These flow rates are based on Flowserves letter dated 3/2/01 detailing our four pumps (SN's 681-S-1028/29/30/31) minimum flow requirements, and are the same values used for previous orifices. Recirculation flow rates are also given in the FSAR. The minimum opening in these orifices will pass any particles that pass though the Service Water Zurn strainers, which have 1/8" openings. Note that the Zurn strainers have a bypass line Furthermore, Service Water samples taken on the Auxiliary feedwater supply had maximum particle sizes of about 0.090", refer to NPM 99-1323.

Operating experience has documented Ty-raps, Zebra mussel shells and other debris caught in flow orifices. No orifice can be designed to pass large debris/FME. Since no orifice can be designed not to clog or alter flow, Control Room AFW pump recirculation flow indication is strongly recommended to further ensure adequate AFW pump flow.

Critical Attributes

The final design must balance cavitation concerns against debris trapping. The flow restriction device/orifice must meet the system design pressure and temperature requirements of 1440 psi and 100 F, refer to DG-M03 and the minimum recirculation requirements for the Byron Jackson pumps (SN 681-S-1028/29) of 130 gpm for 1500 hours or 75 gpm for 60 hours and for the Byron Jackson pumps (SN 681-S-1030/31) of 75 gpm for 1500 hours or 50 gpm for 60 hours, refer to Flowserve's letter to John P Schroeder dated March 2, 2001. After these time intervals, the pump manufacturer recommends evaluation/inspection The desired flow is 130 gpm and 75 gpm, since the 1500 hours exceeds PBNPs monitoring programs This will require an FSAR update, since Section 10.2 3 states that the recirculation flow is approximately 126 gpm In addition, any replacement welds should be oversized in a 2/1 configuration as described in EPRI technical reports TR-107455 and TR-111188. The purpose for the oversized socket welds is to reduce the potential for high-cycle fatigue due to recirculation line vibration.

The pressure reducing device must drop the pressure by about 1335 psid at 130 gpm/1285 psid at 75 gpm The basis for the differential pressures are the previous Purchase Orders 4500429416/4500291375. The flow restrictors procured under these POs performed adequately, refer to IT-8A, IT-9A tested on 10/25/02. In addition, the approximate Cv values of the installed devices were provide to the vendor as well as in-house modeling of the system in Proto-Flow. The Proto-Flow model is "for information only" but does provide correlation within 2.5% of the 1335 psid design value. Past Purchase Orders have also had noise limits of 75 DBA, and noise limits should be included in future POs.

The flow restriction device/orifice can be subjected to Service Water. Service Water is inherently dirty, but it is filtered through 1/8" strainers, refer the Service Water DBD-12, Section 3.2.5 (Source 1). Accepted practice is to size downstream components for larger particles. The replacement flow restriction orifice/device is required to pass 3/16" particles. Water quality statements will be in the Purchase Order.

DB pipe class requires 3000# socket weld fittings. Stainless steel material is also recommended in the original pump specification. Stainless steel will withstand the high velocity and turbulence within the orifice. The associated piping is also stainless. The requirements for 3000# fittings and stainless steel material will also be in the Purchase Order.

FLOWSERVE

Pump Division
Nuclear Group
Flowserve Pumps
IDP Pumps

07 November 2002

Wisconsin Electric Power Co
Point Beach Nuclear Plant
6610 Nuclear Road
Two Rivers, WI 54241

Attention Ms. Carol Torgerson

Subject: Byron Jackson Auxiliary Feed Pump
Orifice Parts Quote
FLS Quote 982-00014

Dear Carol:

We are pleased to present this quotation in accordance with the engineering preliminary drawing as submit to Point Beach earlier this week. We have assigned FLS Quote 982-00014 to our proposal.

In order to avoid delays with processing, manufacturing and receipt of the components, we kindly request that your purchase order be in accordance with the following indicators in our proposal. FOB Point, Payment Terms, Serial Number (S/N), Part Numbers (P/N), Shipping schedule and QA manual designation.

Auxiliary Feed Pump
S/N 691-1028/31
3x4x9, DVMX

For S/N 691-S-1028/29, Description	Part Number	Price Each	Shipment
Orifice, 10-stage, Drawing D005955	10128019	$26,156 00	18 Weeks
For S/N 691-S-1030/31 Orifice, 10-stage Drawing D005956	10128020	$26,156.00	18 weeks

Expediting: The above Orifices can be expedited to a 8 week lead time, for an additional 25% per Orifice.

The prices quoted are net to Nuclear Management Co – Point Beach. The prices quoted do not include taxes or freight charges, which may be applicable. The payment terms of this proposal is Net 30 days. The material is proposed FOB: Vernon, California. All parts will be supplied Safety Related, under Flowserve's QA Manual 3rd Edition, dated 04-10-02. Shipment could be accomplished as not noted above. The prices quoted will be held firm for 45 days from the date of the proposal.

It has been our pleasure to prepare this quotation for submittal. Do not hesitate to contact us should you have any questions or if we can be of further assistance to you.

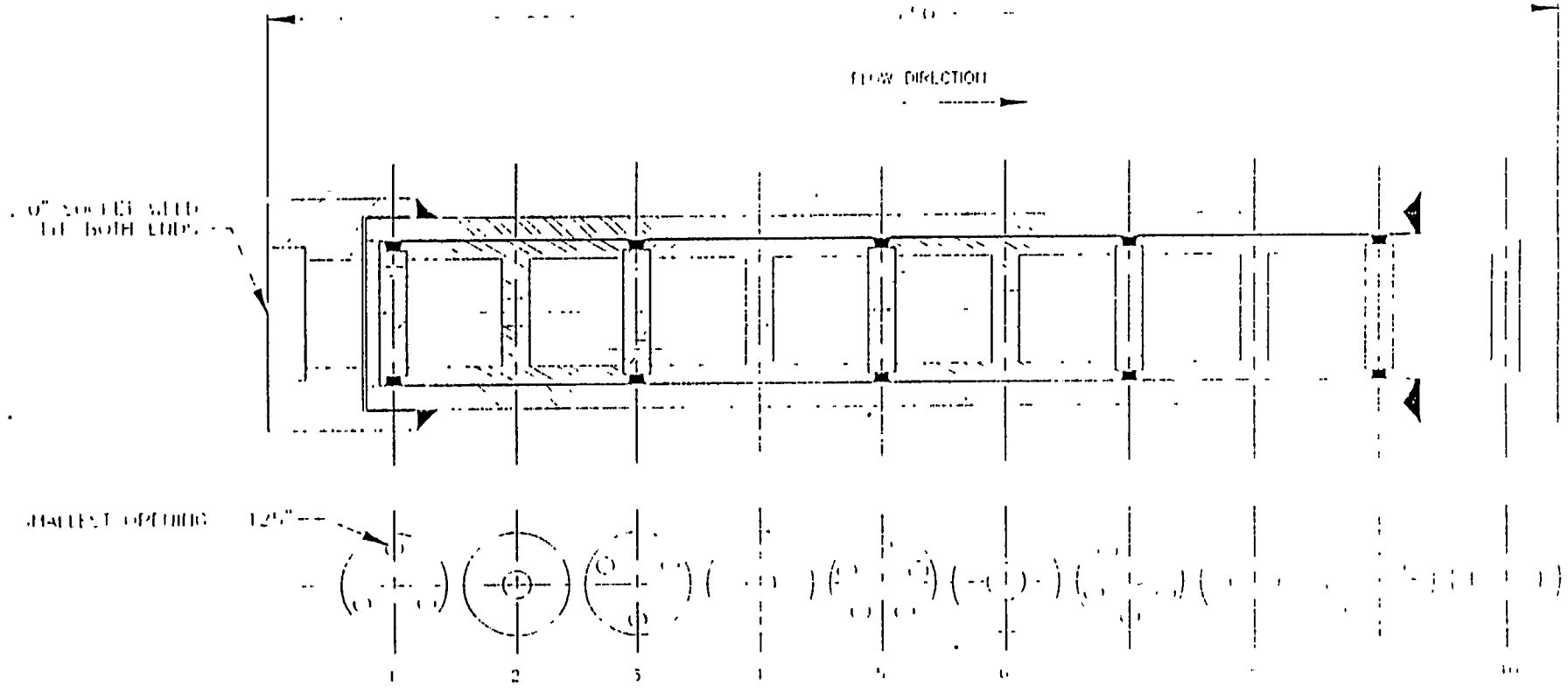
Very Truly Yours,
Flowserve Corporation

Bonnie J. Gill
Parts Sales Coordinator

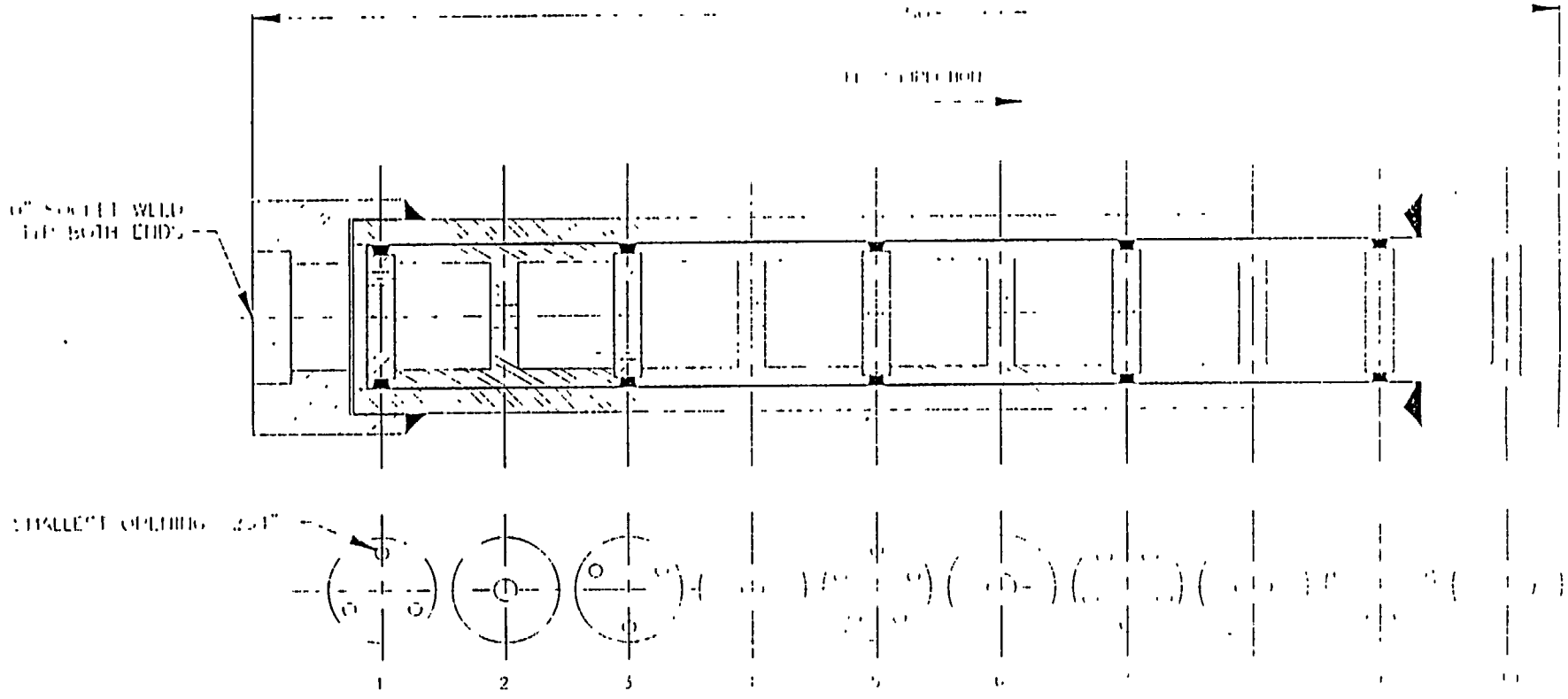
Flowserve Corporation
Pump Division
www.flowserve.com

1400 Powis Court
West Chicago, IL 60185

Telephone 1-888-437-Parts
Facsimile 1-630-762-8996
Email: Bgill@flowserve.com



10 STAGE ORIFICE ASSEMBLY FOR BYRON JACKSON S/N 6R1 [illegible]
INLET PRESSURE 1350 PSIG
OUTLET PRESSURE 15 PSIG
FLOW 140 GPM
OPERATING TEMP 100F
REFERENCE PO NUMBER 0005071, ITEM 001
CUSTOMER TAG - POINT BEACH
DRAWING #DW6005056



10 Stud ORIFICE ASSEMBLY FOR BYRON JACKSON S/II [illegible]
INLET PRESSURE 1500 PSIG
OUTLET PRESSURE 15 PSIG
FLOW [illegible] GPM
OPERATING TEMP 100°F
REFERENCE REQ NUMBER 0005071, ITEM 002
CUSTOMER DRC POINT BEACH
DRAWING #DWG005455

FLOWSERVE

Flow Control Division
Anchor/Darling Valves
BW/IP Valves
Valtek Valves

November 7, 2002

Nuclear Management Company
Point Beach Nuclear Plant
Attention:

Subject: Request for Quotation Q005074
Pressure Reducing Device – Aux Feedwater System
Flowserve Quotation No. C12048

In response to the subject inquiry, we are pleased to offer the following quotation.

ITEM	DESCRIPTION		QTY	UNIT PRICE	TOTAL
1	SIZE.	2"	2		
	ITEM:	Pressure Reducing Device Valtek MagaStream			
	CLASS: MAT'L: CODE:	Class 600 Standard Rated 316 Stainless Steel ANSI B16.34 w/10CFR50 and 10CFR21			
	STD FEATURES:	316 Trim Flanged Connections			
	SPECIAL FEATURES:	May be disassembled for maintenance or modification			

PLEASE REFER TO THE ATTACHED TYPICAL SKETCH FOR DESIGN DETAILS

Flowserve FCD Corporation
A Unit of Flowserve Corporation
Flow Control Division

Williamsport Operations
P.O. Box 3428 701 First Street
Williamsport, PA 17701-0428

Phone 570 327 4800
Facsimile 570 327 4805
www flowserve.com

ITEM	DESCRIPTION		QTY	PRICE	TOTAL
2	SIZE	2"	1		
	ITEM:	Pressure Reducing Device Valtek MegaStream			
	CLASS	Class 600 Standard Rated			
	MAT'L.	316 Stainless Steel			
	CODE:	ANSI B16.34 w/10CFR50 and 10CFR21			
	STD FEATURES.	316 Trim Flanged Connections			
	SPECIAL FEATURES:	May be disassembled for maintenance or modification			
	PLEASE REFER TO THE ATTACHED TYPICAL SKETCH FOR DESIGN DETAILS				
3	Design/Seismic Report		1	$	$

NOTES:

1. The valve offered will be custom engineered and manufactured. Therefore, we offer shipment from our facility within weeks after receipt and review of an acceptable purchase order

2. The Pressure Reducing Devices include multiple stages of pressure reduction.

3. Both elements are designed to eliminate cavitation damage.

4. The design flow rates are calculated at the specified desired flow rates for each element. Actual flow rates in service should be well within the specified range.

5. The elements can be disassembled for cleaning or other maintenance. If it becomes necessary to modify the flow range, this may be easily facilitated because of the disassembly feature.

6. The minimum flow area dimensions will range from 0.2" to 0.25"diameters, thus permitting passage of 3/16" (0.188")particles.

7. A Purchase Order issued against this quotation should, at a minimum, reference Quotation No C12048 to ensure fast and accurate order entry. The order should also reflect the valve description and accept the November 7, 2002

comments and terms of this offer

8. Shipment terms are FOB Raleigh, NC prepaid and add Payment terms will be per the attached Terms and Conditions which form a part of our offer.

9 The quotation is valid for acceptance for 90 days

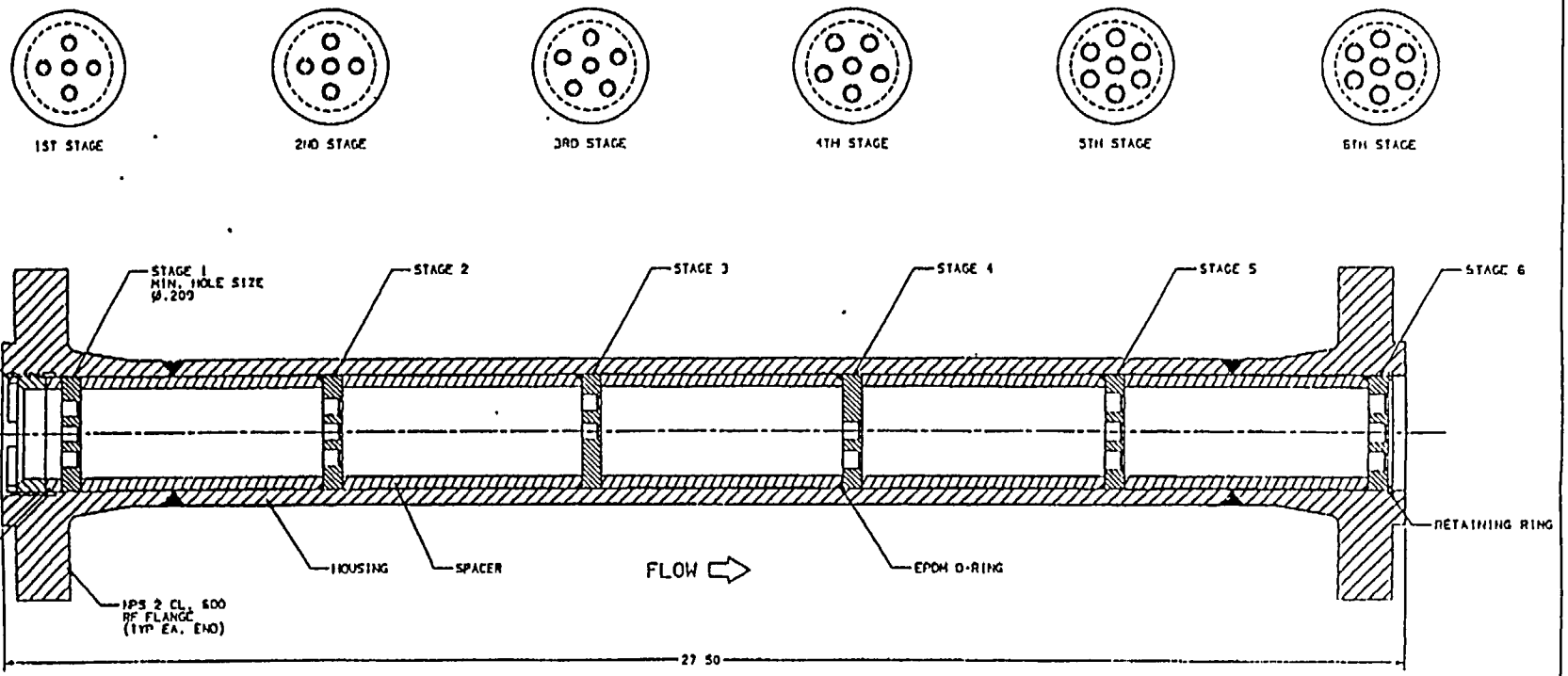
Should you have any questions regarding our quotation or need additional information, please do not hesitate to contact the undersigned at (570) 327-4914

Very truly yours,

FLOWSERVE CORPORATION

James Buedel
Contract Administrator

cc: J. R Schlereth – Flowserve Regional Manager
J. S. Zelenak - Flowserve Product Manager
Encl: Reference Drawings
Terms & Conditions



NOTE:

1. SIZED FOR CAPACITY 150 GPM, ΔP 1335 PSID, 100°F

			VALTEK
			LAYOUT, MNC POINT BEACH NUCLEAR, BACKPRESSURE ELEMENT, ANTI-CAVITATION, 6 STAGE, CV 3.50
			SIZE D, X197577, REV A

10.2.3 SYSTEM EVALUATION

In the event of complete loss of offsite electrical power to the station, decay heat removal would continue to be assured for each unit by the availability of either the turbine-driven auxiliary feedwater pump or one of the two motor-driven auxiliary feedwater pumps, and discharge to the atmosphere via the main steam safety valves or atmospheric relief valves. One motor-driven pump is capable of supplying sufficient feedwater for removal of decay heat from a unit operating at a power of 1518.5 MWt. In this case, feedwater is available from the condensate storage tanks by gravity feed to the auxiliary feedwater pumps. When the water in the condensate storage tanks is depleted, suction for the pumps can be shifted to the service water system via remotely operated MOVs from the control room to provide makeup water from the lake for an indefinite time period.

During a Station Blackout (SBO) event, only the turbine-driven pumps would be available for decay heat removal. The turbine-driven pumps are capable of supplying feedwater to the steam generators without an AC power source. The steam supply and auxiliary feedwater discharge valves are powered from diverse sources of vital 125V DC. Cooling water for the pump and turbine bearings can be supplied from the diesel driven firewater pump. The Technical Specification minimum amount of water in the condensate storage tanks, 13,000 gallons per operating unit, provides adequate makeup to the steam generators to maintain each unit in a hot shutdown condition for at least one hour concurrent with a loss of all AC power. Further information on the SBO event is provided in Appendix A.1. (Reference 1)

In order to meet the design basis, the limiting accident analysis of LOSS OF NORMAL FEEDWATER and LOSS OF ALL AC POWER TO THE STATION AUXILIARIES assumes either that one motor driven auxiliary feedwater pump provides 200 gpm of flow to one steam generator or split between two steam generators within 5 minutes following receipt of a low-low steam generator water level setpoint signal.

These minimum parameters are met or exceeded by system design and verified by required testing. The three other accident analyses which assume auxiliary feedwater initiation for mitigation are LOSS OF EXTERNAL ELECTRICAL LOAD, RUPTURE OF A STEAM PIPE, and STEAM GENERATOR TUBE RUPTURE. For these accidents, minimum auxiliary feedwater assumptions are not specified and in the latter two, auxiliary feedwater isolation to the affected steam generator is assumed. Although the auxiliary feedwater system may be initiated during a SMALL BREAK LOCA, the event has been analyzed with no credit for auxiliary feedwater.

Based on the operating characteristics of the minimum recirculation flow control scheme, a portion of each motor-driven auxiliary feedwater pump's discharge flow will be automatically recirculated to the condensate storage tank for approximately forty-five seconds after the pump starts. The forty-five second time delay in closing the mini-flow recirculation control valves is incorporated in the design to provide for pump stability and cooling during coastdown.

A postulated control failure causing a single motor-driven AFW pump recirculation valve (AF-4007 or AF-4014) to fail open will divert approximately 89 gpm pump flow from the associated steam generator back to the Condensate Storage Tank. However, the AFW flow to the steam generators from the other motor-driven pump and the unit turbine-driven pump are not affected by this failure. Similarly, if the control failure causes a single turbine-driven pump recirculation valve (AF-4002) to fail open, the failure will divert approximately 126 gpm of turbine-driven pump flow to the condensate storage tank, but will not affect flow to the steam generators from either motor-driven pump. For either of these control failures, the AFW system will be capable of supplying greater than the required 200 gpm per unit.

A failure analysis has been made and the results for the auxiliary feedwater pumps show that the failure or malfunction of any single active component will not prevent the system from performing its emergency function. Results are presented below.

Malfunction	Comments and Consequences
One AFW pump fails to start (following loss of main feedwater)	Four AFW pumps provided; each steam-driven pump is dedicated to one unit and each motor-driven pump is shared between units. Any three of the four AFW pumps provide the required feedwater flow to remove sufficient decay heat from both units.
Two AFW pumps fail to stop (trip) when required and subsequently run to failure (following a seismic- induced loss of main feedwater event)	Each AFW pump is provided with low suction pressure protection following a seismic event. Evaluations for a seismic-induced LONF event show that any two AFW pumps provide the required feedwater flow to remove sufficient decay heat from both units operating at 1518.5 MWt.

10.2.4 REQUIRED PROCEDURES AND TESTS

The AF system components are tested and inspected in accordance with Technical Specification surveillance criteria and frequencies. Testing verifies motor-driven pump operability, turbine-driven pump operability including a cold start, and operability of all required MOVs. Control circuits, starting logic, and indicators are verified operable by their respective functional test.

10.2.5 REFERENCES

1. FSAR Appendix A.1, Station Blackout

2. PBNP Fire Protection Evaluation Report (FPER)

3. NRC SER "Safety Evaluation on the Resolution of Unresolved Safety Issue A-46 at Point Beach Nuclear Plant Units 1 and 2 (TAC Nos. M69472 and M69473)", Enclosure page 3 of 10, dated July 7, 1998.

4. NRC SER "ATWS RULE (10 CFR 50.62) TACS 59128 and 59129," August 4, 1988.