CONDENSATE PIPING OVERPRESSURE EVALUATION

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NUCLEAR ENGINEERING	ENGINEERING EVALUATIONS
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ABSTRACT

On July 13, 1989 while Unit 2 was in Mode 3 operation, portions of the low pressure feedwater piping was overpressurized during operational valve alignments and damaged the low pressure switches for the main feedwater pumps. A system walkdown identified no leaks, the switches were replaced and preliminary piping stress evaluations performed on July 21, 1989 determined that no yielding had occurred.

The event has been determined to be a short duration pressurization to a conservative pressure of 1580 psig, affecting only non-safety related, non ASME class piping systems. The affected systems include the feedwater suction piping, the blowdown heat exchanger tube side and the heater drain pump discharge piping.

This evaluation covers, in more detail, the event and the effect on all components within the identified systems. All piping, valves, flanges, instrumentation, and other equipment have been evaluated. Piping stress calculations were performed for all affected piping and fittings, detailed computer stress analysis were performed for the flanges, and calculations were performed to determine the effect on bolting. Valves and other equipment were evaluated by a review of vendor design documentation and discussions with the vendors. This evaluation concludes that no damage, with the exception of the low pressure switches, had occurred due to the pressurization event. Although our conclusion is that no damage has occurred, prudent recommendations are included for inspections during the Unit 2 second refueling outage of some affected components to ensure continued optimum performance.

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1.0 INTRODUCTION

On July 13, 1989 while PVNGS Unit 2 was preparing to initiate long path recirculation, an operator observed that the main feedwater pump low pressure annunciators alarmed, although a low pressure condition was known not to exist. The alarms would not clear even though the operators verified adequate suction pressure. These switches were removed from the system for examination and the bellows of the switches were found to be deformed which explained why the switches did not reset. The condition of the bellows indicated that they had been severely overpressurized

Based on information supplied by EED (System Engineering), a preliminary stress evaluation for the affected piping was performed by NED (Design Engineering) soon after EED's notification on July 21, 1989, while Unit 2 was at 20% reactor power. The evaluation was performed for the conditions of 1580 psig and 100 deg F and verified that the pipe stresses were no greater than what would be allowed during a hydrostatic test, per ANSI B31.1 which limits the piping system to less than 90% of the yield at the test temperature. EED conducted a walkdown of the system with the lagging in place and did not identify any leaks that could be attributed to the overpressurization. Based on the result of the initial evaluation and the system walkdown, both NED and EED agreed that an increase to full power would not jeopardize either personnel safety or system components.

1.1 Objective

This report provides the summary of the engineering investigation, evaluation and recommendations of the overpressurization event. Recommendations are to be completed during the Unit 2 second refueling outage. Stress calculations were performed to appropriate codes and standards to evaluate the effect of the overpressurization on piping and components. Design factors and vendor evaluations were used to address the valves, instruments and mechanical components.

1.2 Background

The condensate system consists of 3 condensate pumps that feed 3 parallel trains of low pressure feedwater heaters, heating the condensate from 120 deg F to 350 deg F at the FWP (main feedwater pump) suctions during full power operation. Also feeding into the FWPs is the heater drain pumps discharge, which collects the drains from the high pressure feedwater heaters. These systems are essential to power production but are not safety related, and are not required to prevent or mitigate the consequences of an accident.

Following the trip on July 13, EED tested check valve SGN-V431, Figure 1.2-2, verified that it allowed backleakage, and requested rework of the valve, which was performed to work order 00369951. The rate of the backleakage through the check valve was unknown, and the operator did hear an unusual noise when cracking open the FWP bypass valve, FWN-V013, to initiate long path recirculation. The system lineup, Figure 1.2-1, has been reconstructed from the operators logs and interviews. The system engineer was able to redevelop the scenario of the system alignments and identified the following system piping that experienced the overpressurization;

(1) the FWP suction piping from the FWP bypass valve back to the condensate check valve CDN-V189;
(2) the heater drain pump discharge piping from check valves EDN-V119 and 168 to the connection with the FWP suction piping;
(3) the steam generator blowdown heat exchanger and piping to valve CDN-V096 (valve was closed during the event).

2.0 SCOPE OF EVALUATION

Tables 2.0-1 and 2.0-2 list the Unit 2 line numbers and associated drawings that were reviewed to identify the scope of this evaluation. This evaluation covers pumps and strainers, piping and fittings, valves, flanges and fasteners, a heat exchanger and instrumentation that were subjected to the overpressurization. Reference Figure 2.0-1 for the boundary definitions of the evaluation.

The components *upstream* of the FWP experienced pressures above the normal and operating pressures for their respective systems. By review on an individual basis, each category of components was inspected, evaluated and if necessary, recommendations for future actions presented. In contrast, all components *downstream* of the FWP were not overpressurized, because the systems' design pressure of 1875 psig is greater than the event pressure.

2.1 System Evaluation

The leaking check valve (SGN-V431) pressurized the FWP discharge piping during the time the AFP-N was feeding the steam generators. This worst case pressure was conservatively determined to be a maximum of 1560 psig, when considering approximately 50 gpm to each steam generator, and the AFP-N recirculation flow of 300 gpm. When the FWP bypass valve (FWN-V013) was slowly opened to establish long path recirculation, a overpressurization travelled through the upstream piping, that had been at approximately 490 psig. This overpressurization propagated through the piping and was dissipated by flow from the FWP seals and the blowdown heat exchanger relief valve.

Dynamic loads are not considered because the bypass valve was slowly opened and the overpressure decayed within 1 minute, therefore it is considered a slow transient. Due to open lines in this piping and the apparent seating of SGN -V431, the pressure was dissipated and returned to normal condensate pump discharge pressure of 490 psig. At the pressure experienced, the seal water lines though the FWPs allowed a flowrate of approximately 70 gpm each, and the blowdown heat exchanger thermal relief flow of approximately 60 gpm. Within 1 minute after receiving the erroneous FWP low suction pressure alarm, several control room operators read 490 psig for the FWP suction pressure.

The event occurred approximately 15 hours after the reactor trip, and the piping and water upstream of the FWP had cooled to approximately 100 deg F. The approximate 1 minute duration of the overpressurization through the piping limited the flow of upstream water into the pressurized piping, therefore the high pressure occurred in piping at 100 deg F. Heatup of the piping probably occurred in the following 15 minutes while the FWP bypass valve remained open and the AFP-N was on, but was not coincident with the high pressure.

A realistic pressure that the system may have experienced would be 1200 psig. This pressure is based upon the following evidence:

1) The system would not have experienced the complete AFP-N shut off pressure because of the additional flows out of the feedwater piping.
2) A nonquantifiable pressure drop would occur through the check valve, SGN-V431.
3) The operators read 490 psig very soon after the event.
4) Damage to the instruments' bellows was duplicated at 1200 psig, by a test conducted by EED.

Although this evidence exists, the analysis was performed at the conservative value of 1580 psig, which is the shutoff head of the AFP-N, because no direct evidence exists for a lower value.

3.0 COMPONENT INVESTIGATION, EVALUATION AND RECOMMENDATION

All component evaluations were performed for the conservative conditions of *1580 psig* and *100 deg F.*

3.1 Main Feed Pump and associated vendor supplied equipment

Investigation

The system walkdown included the FWP and associated equipment and did not identify any leaks or visually observed deformation that could be attributed to the overpressurization. Normal operation has continued, without any identification of unusual equipment performance.

Evaluation

The scope of the FWP evaluation is included in Table 3.1-1. According to equipment drawing M011-84-1 and the vendor, Byron Jackson, the main feedwater pump casing, including suction and discharge nozzles, have been hydrostatically tested at 2800 psig (pump casing design pressure is 1750 psig). Therefore it is very unlikely that the pump pressure boundary was affected by the pressure of 1580 psig. It is also unlikely that there is any impact or damage to the internal parts of main feedwater pump, including impeller, shaft throttle bushing, and wear ring because neither FWP was in operation during the overpressurization.

The main feedwater pump suction strainer is #2 mesh, with 3/4"x 1/8" strap screen welded to the screen on the inside, as shown on vendor drawing M011-6-5, was subjected to almost equal pressure on both sides. No deformation or damage will be expected on this equipment. The connecting flanges and bolting were not supplied by Byron Jackson and are evaluated under section 3.3.

Review of the seal water injection piping and manual valves (1-1/2", schedule 40 and 300# rating),and associated pressure control valves (600 #) indicates that sufficient safety margin exists on the pressure boundary parts, but the valve packing may be degraded. The pressure controllers and pressure switches used in the seal water injection lines have relatively low pressure ranges (0-50 or 50-250 psig normal). The vendor indicated that the pressure in seal water injection lines when pump is not operating would be lower

than 1580 psig because of the continuous seal water flow back to condenser and receiving tank.

Recommendation

Byron Jackson suggested that the instrumentation used in the seal water injection and return lines be checked. Refer to Section 3.5 for the discussion of the instrumentation and Table 3.5-1 for the recommendations.

3.2 Valve Evaluation

Investigation

The valves subjected to the overpressurization due to the auxiliary feedwater system pressure in the suction side of the FWP piping were visually inspected during the system walkdown. During the walkdown, no evidence of external leakage was noted, and no problems have been identified during operation at full power.

Evaluation

The evaluation of all affected valves has been categorized into 3 groups of similar valves. The groups of valves are:

3 inch and larger upstream of the FWP
2.5 inch and smaller upstream of the FWP
All manual valves downstream of the FWP.

3.2.1 3 inch and larger valves upstream of the FWP

Evaluation

These valves are analyzed as one group because they are procured in accordance with 300 lb class rating of ANSI B16.34. Conversations with the valve manufacturers and ANPP calculations, 02-MC-ZZ-500, indicate that the pressure integrity of these valves was not compromised. Hydrostatic tests of these valves were conducted at 1080 psig. There are significant safety margins built into the valves, and one vendor is aware of pressures as high as twice the shell test that caused no impact to the valve integrity.

The most susceptible valve parts to overpressurization are the gasket and the stem assembly. These components would fail before significant damage to other valve parts would occur. As noted, the gasket did not fail. In addition, the fact that the system is operating at 100% power without bonnet leakage or other anomalies is indicative of the valve integrity.

Critical areas of these valves were evaluated. The hinge pins on the check valves would not be subject to any loadings since the closed valve disk is transferring the load to the valve seat ring. The valve vendors are not aware of any instances where a valve disk has actually broken in pieces and travelled downstream. For the disks of the subject valves, the material used is ductile and subject to bending rather than brittle fracture. The FWPs are protected from debris in the flow by the strainers which have 1/2" openings.

Recommendation

Table 3.2-1 lists the valves to be monitored for abnormal behavior (e.g. packing or

bonnet leaks), with corrective actions to be taken as necessary. At the next refueling outage, the Table lists valves to be disassembled and inspected for internal damage and if anomalies are noted, the inspection program should extend to other valves. Otherwise, all other valves should be only stroked to ensure normal, full motion..

3.2.2 2-1/2 inch and smaller valves upstream of the FWP

Evaluation

In general, the 2-1/2 inch and smaller valves, including control valves, subjected to overpressurization were procured per piping material classification GBDB as 600 lb rated valves, manufactured in accordance with ANSI B16.34. These smaller size valves are generally instrument root valves or drain/vent valves and are not regularly repositioned during the normal operation of the plant. The hydrostatic shell test for 600 lb valves, in accordance with MSS-SP61, is in excess of 2200 psig. Therefore system pressure to 1580 psig did not exceed the shell tested condition for the 2-1/2 inch and smaller valves and the pressure integrity of these valves has not been compromised.

Recommendation

The vendors indicate that valves are susceptible to internal damage (i.e. stem bending, seat leakage, etc.) and may not function as designed. The root valves or drain/vent valves are not required to change state during normal plant operation and therefore it is recommended that a sample of the valves be stroked during the next refueling outage for evidence of binding and/or leakage, reference Table 3.2-2. Stroking of the 2 1/2" seal water return control valves is recommended to determine if stem binding has occurred. If the stroking program identifies problems, a sample of valves should be disassembled and inspected to evaluate the cause for the problem.

3.2.3 All manual valves installed downstream of the FWP

Evaluation

These valves, listed in Table 3.2-3, are analyzed as one group because they were procured in accordance with a 900 lb or greater rating of ANSI B16.34. In general, the feedwater piping down stream of the main feedwater pumps is procured in accordance with the piping material class DBDB as identified on drawing 13-P-ZZG-012. The ANSI B16.34 valve rating specified for the valves in this material class is 900 lb for large bore (3 inch and larger) and 1500 lb for small bore (2-1/2 and smaller). The analysis comprised of reviewing the plant documentation to ensure that the valves were procured as 900 lb rated. Per ANSI B16.34, the maximum working pressure for a 900 lb rated valve at 100 deg. F is in excess of 2200 psig.

In order to ensure that all the manual valves downstream of the FWP were procured in accordance with material class DBDB, Engineering reviewed the documentation for each valve as identified in the SIMS data base and verified that all valves were procured in accordance with the 900 or 1500 lb rating of ANSI B16.34. Therefore, none of the valves were subjected to pressure above the maxi-

mentation for each valve as identified in the SIMS data base and verified that all valves were procured in accordance with the 900 or 1500 lb rating of ANSI B16.34. Therefore, none of the valves were subjected to pressure above the maximum working pressure as allowed by the ANSI B16.34 code. In addition, this system was hydrotested to approximately 1800 psig during original installation.

Recommendation

No actions are recommended to be taken.

3.3 Flanges and Fasteners

Flanges and fasteners for piping and valves have been evaluated to determine the effect of the overpressurization on their ability to perform their function, and was limited to the components that were overpressurized.

3.3.1 Fasteners

Investigation

The piping walkdown following the event did not identify any flange leaks that could be attributed to the overpressurization, which confirms the integrity of both the flanges and the associated fasteners.

Evaluation

The fasteners in the piping flanges and pressurized valve bonnets that were evaluated for the overpressurization event are listed in Table 3.3-1. The flange bolting evaluated is for the heater drain pump discharge piping and the FWP suction strainer, and the valve bonnets evaluated are located in the CD, FW and ED systems. For the piping flanges and bonnets, the bolting and nuts were not overstressed during the overpressurization. This evaluation was performed per calculation 02-MC-ZZ-500, in accordance with generally accepted static engineering evaluation considering the bolt strength and the pressurized condition.

Recommendation

Valve body-bonnet bolting and flange bolting should be inspected for any minor leakage. If leaks are identified, flange bolting should be re-torqued per 13-PN-205 and valve body-bonnet bolting per the vendor specification. These actions should take place during the next refueling outage.

3.3.2 Flanges

Evaluation

Table 3.3-1 lists the 10 sets of flanges identified within the boundary of the piping subjected to overpressurization. All these flanges are 300 lb weld neck type flanges manufactured in accordance with ANSI B16.5 and MSS-SP-44, with pressure rating of 740 psig at 100 deg F and a hydrotest pressure of 1125 psig. These flanges were evaluated in accordance with the requirements of ASME Section III, non-mandatory Appendix XI. (It should be noted that the flanges are under the jurisdiction of the B31.1 Power Piping Code, but this code does not provide detailed rules for the evaluation of the flanges.) Based on the results of these evaluations, it was demonstrated that the 30-inch flanges have the highest stresses.

The 30-inch set with the highest loadings and the highest stresses was selected as the worst case for further evaluation.
The worst case flange was evaluated by the finite element method, using ANSYS with 2D harmonic (stiff 25) elements, reference calculation 02-MC-ZZ-609. The loadings and locations of loadings used in the finite element analysis were based upon Appendix XI evaluations for the flange. The analysis showed the high stress area to be in the hub approximately 1/3 the length from the narrow end. The stresses are at this peak value on the surface and attenuate rapidly to lower levels of stress. The stresses in this region are:

$S_{hub} = 46.2$ ksi $\quad S_{tangential} = 49.4$ ksi $\quad S_{radial} = 5.7$ ksi

These stresses are less than either 1.5 S_y (54 ksi) or $3S_h$ (52.5 ksi).

These allowables are reasonable limits for one time occurring stresses and are within the intent of the B31.1 code wherein it states; "it is intended that a designer capable of applying more complete and rigorous analysis to special or unusual problems shall have latitude in the development of such designs and the evaluation of complex or combined stresses." Stresses at or below these limits demonstrate that the flanges remain in an operable condition and no significant distortions or damage has occurred. Further, a one time application of these stresses has an insignificant impact on the fatigue life of the flanges. This is further evidenced by the results of surface nondestructive examinations and visual examinations which showed no signs of distortion, damage or leakage.

The previous evaluation was performed for a conservative pressure of 1580 psig, but evidence suggests that the actual pressure may have been lower, approximately 1200 psig. For this pressure, the peak stress, $S_{tangential}$, is determined to be 37.8 ksi. For this condition, the maximum flange stress corresponds to a 5% stress value over yield.

Field equotip hardness testing results of 30-inch, 16-inch and 6-inch flanges confirmed that the material is the specified ASTM A-105, and demonstrated a normal hardness distribution for A-105 material, as established by NUMARC and the nuclear industry in response to NRC Bulletin 88-05. Actual laboratory tensile testing of A-105 steel have shown that the equotip hardness values corollate to a conservative tensile strength since actual tensile values are slightly higher than predicted. Field walkdowns and inspection of the piping system including flanges have verified that the flanges are not leaking and have maintained gasket sealing capability, which indicates no distortion. Magnetic particle testing of two 30-inch flanges showed the flanges to be free of cracks and damage.

Recommendation
Based on the calculations, magnetic particle tests, no identified leaks, damage or distortion, the evaluation demonstrates that the flanges are suitable to remain in service, therefore no actions are recommended.

3.4 Blowdown Heat Exchanger

Investigation

The piping walkdown included the blowdown heat exchanger, associated components and piping and identified no problems that could be attributed to the overpressurization. The relief valve is weeping, and will be investigated during the next refueling outage. The cause for this leakage cannot be attributed to the overpressurization, as regular walk-downs are not made in this area to determine whether the weeping was preexisting. The blowdown flows directly to the condenser and is processed through the condensate demineralizers. Because the steam generator blowdown demineralizers are not used, the blowdown heat exchanger is not in service, so leakage from the valve does not impact plant operation.

Evaluation

The blowdown heat exchanger tube side experienced a maximum pressure of 1580 psig during the event. The inlet valve, CDN-V096, from the low pressure feedwater heaters was closed and isolated those heaters from the pressure. During the event, the thermal relief on the heat exchanger, SCN-PSV8, is assumed to have lifted, but no credit is taken for that in the evaluation of the heater integrity.

Also, taking no credit for any pressure that may have been present on the shell side, which would have reduced the pressure differential, the overpressurization of the tube side is acceptable by a narrow margin; the maximum allowable pressure without overstressing the tubes, as calculated by the vendor, is 1664 psig. The tube side of the heat exchanger was hydrotested to 900 psig. The shell side of the heat exchanger is not of concern. The tube side safety relief valve body is capable of withstanding 1580 psig without damage.

Recommendation

Since the heat exchanger was not overpressurized, no action is recommended to be taken. It has been the vendor's experience that the thermal relief valves chatter upon depressurization prior to reseating, leading to possible scoring of the seats. It is recommended that they be examined for seat scoring and to ensure proper reseating, reference Table 3.4-1.

3.5 Instrumentation

Investigation

As noted in the Introduction, the effects of the pressure were first noted on the FWP low suction pressure switches, which have been replaced. The walkdown made following the overpressure did not identify any other leaking or inoperable instruments that could be attributed to the pressurization. The instruments have been working satisfactorily since the plant has been at full power. The FWP low suction pressure switches are the only instruments that require replacement, other instruments are recommended to be inspected and recalibrated, during the next refueling outage, as shown in Table 3.5-1.

An experiment was conducted to supplement the quantitative evaluation of the pressurization. Bellows identical to the failed ones were subjected to increasing pressures until the degree of deformation was similar to the failed bellows. This occurred at 1200 psig. The pressurization continued until 1580 psig, where significantly greater deformation was evident.

Evaluation

All the instrumention on the suction side of the FWP was evaluated to determine the effects of the high pressure on the accuracy, integrity and reliability of the instrumentation.

The review that was established for assessing potential damage to instrumentation was based on the following elements:

a.) Visual inspection for failures i.e., broken instrument assemblies, leaking flanges and connections, etc.

b.) Review of plant vendor data files and purchase orders to determine the maximum safe design pressures of the impacted instrumentation.

c.) Direct contact with manufacturers and suppliers to augment information contained in the vendor data files and to provide clarification in respect to original design documents. This was by facsimile or telecon.

d.) Review of the SIMS database, Instrument & Calibration Data List, 13-J-ZZI-001 and 13-J-ZZI-003.

The review established two distinct courses of action;

a.) Replace instrumentation and associated components as noted.

b.) Inspect and recalibrate instrumentation. Components failing to calibrate to prescribed tolerances/accuracy per design basis would be subject to repair or replacement.

Analysis of those instruments evaluated for overpressurization yielded the following findings: reference Table 3.5-1 for tag numbers and recommendations.

a.) PRESSURE INDICATORS - Ashcroft

These pressure indicators have a stated maximum operating pressure of 1500 psig. The manufacturer states that the device should recover from overpressure of 1.25X the upper range. However, it should be noted that in such instances it is possible to fatigue the Bourdon tube and render the instrument useless. The instruments are required to be inspected for damaged Bourdon tubes, and recalibrated.

b.) PRESSURE SWITCHES - United Electric

The low pressure suction switches for the FWP have a maximum pressure range of 600 psig. The devices evidenced catastrophic failure and were subsequently replaced.

The FWP high pressure switches have a maximum operating pressure range of 3000 psig. No further action is required.

c.) FLOW TRANSMITTERS - Rosemount

These instruments have a maximum recoverable pressure limit of at least 2000 psig, as such these instruments should not have any deleterious effects subject to the overpressurization. No further action is required.

d.) DIFFERENTIAL PRESSURE - Barton
These instruments have a maximum design pressure of 1500 psig and exhibit a possibility for damage subject to the overpressurization. It is required that the bellows of these units be inspected and the instruments be recalibrated.

e.) PRESSURE INDICATING TRANSMITTERS - Rosemount
These instruments have a maximum recoverable pressure limit of at least 2000 psig, as such these instruments should not have any deleterious effects subject to the overpressurization. No further action is required.

f.) FLOW ELEMENTS - Dieterich
These instruments have a maximum operating pressure of 2000 psig and should experience no detrimental effects due to the overpressurization. No further action is required.

g.) TEMPERATURE ELEMENTS - Weed
Review of vendor documentation reveals that these devices make use of thermowells. The thermowells have maximum stated working pressures of 3750 psig. No further action is required.

h.) FLOW INDICATORS - Barton
These flow indicators have a stated maximum operating pressure of 600 psig. No data on pressure excursion impacts was found. Based on this information the potential for damage to these units is probable, therefore inspection of the body bellows and calibration is required for these instruments.

i.) TEMPERATURE SWITCHES - United Electric
These instruments utilize a sealed capillary and bulb configuration, in most instances the bulb is installed utilizing a thermowell. The temperature bulbs have a maximum operating pressure of 2300 psig. No further action is required.

j.) TEMPERATURE INDICATOR - Ashcroft
This instrument is installed in a thermowell which will withstand a maximum operating pressure of 3750 psig. No further action is required.

k.) PRESSURE RELIEF VALVES - Lonergan
These valves have a maximum rating of 5000 psig. No further action is required.

l.) SAMPLE COOLERS - Graham
These devices have a maximum working pressure of 3728 psig. The overpressurization would not have affected the performance of these coolers. No further action is required.

m.) MISC. COMPONENTS

(1) **Tubing**- the design pressure on the tubing is based on 3/8"O.D. with 0.065" wall with an allowable stress of 18,750 psi at 400 degrees Fahrenheit.. Using the more conservative temperature factor for 304SS of 0.93, the derived maximum working pressure is determined by the following calculation:

Working Pressure = 18,750 x 0.402 *x 0.93 = 7,010
(*Lame's Formula)

Therefore, the overpressurization falls within the design parameters of the tubing.

(2) **Tubing Fittings** - the tube fittings are Swagelok, 316SS and have a calculated maximum working pressure based upon the female fitting which has the lower working pressure, that is adjusted by using the conservative temperature factor of 0.93. The derived maximum working pressure is:

Working Pressure = 5,000* x 0.93 = 4,650 psi
(*Swagelok manufacturer's data, C-983, page 32)

Therefore, the overpressurization falls within the design parameters of the fittings.

(3) **Tubing Valves** - the instrument valves are Whitey, 316SS and have a maximum pressure rating of 3,000 psig at ambient temperature per the vendor specification. The derived maximum working pressure is determined by the following calculation;

Working Pressure = 3,000 x 0.93 = 2,790 psi

Therefore, the overpressurization falls within the design parameters of the tubing valves.

(4) **Orifice Plates** - these devices are designed to the line class of the piping in accordance to ANSI B31.1. Since the line does not demonstrate signs of leakage based on the system walkdown, the orifice plate does not need to be removed and inspected. As these devices are designed in accordance to the line pressure limitations it is anticipated that these devices have an extremely low probability of failure subject to the overpressurization and do not require inspection or rework.

o.) CONTROL VALVE ACTUATORS - Fisher/Leslie
The manufacturer excludes any possible damage to the actuator as a function of the overpressure. No further action is required.

p.) PRESSURE SWITCHES - Ashcroft
These instruments are rated below the overpressure and exhibit a high potential for damage. Due to the potential for damage to these units, inspection of the diaphragms is required, and if not damaged, they should be recalibrated.

r.) PRESSURE CONTROLLERS - Leslie
These instruments are rated below the overpressure and exhibit a high potential for damage. With this potential for damages, inspection of the bellows is required, and if not damaged, recalibrated.

Instrumentation Recommendation
Table 3.5-1 provides recommendations in accordance with the evaluation.

3.6 Piping and Fittings

Investigation

Following the event, the system walkdown did not identify any leaks or problems that were attributable to the high pressure. Furthermore, the lines have continued to operate properly since the plant has been at full power.

Evaluation

After the boundaries of the overpressurization were identified, a thorough review was made of the piping isometrics to identify all fittings and components within the piping system. Feedwater, condensate, heater extraction, and secondary chemical lines were evaluated and included 3/8", 1", 2", 6", 12", 16", 24", and 30" size piping. All 30" pipe is purchased with a 0.75" minimum wall per the piping specification. These lines consisted of four material types; A-106 Gr B, A-53 Gr B, A-155 Gr KC 70, and SA-213 TP 304. The fittings consisted of four materials, A-234 Gr WPB, A-234 Gr WP-BW, A-105, and A-182 Gr F-304. The detailed calculations for the overpressurization of the piping systems are documented in stress calculation 02-MC-ZZ-501.

It has been determined that all the fittings on these lines are standard fittings, and comply with ANSI B31.1 paragraph 126.1. Individual material properties of the piping and fittings have been used in the evaluation.

3.6.1 Basis / Methodology of Analysis
A criteria was established consistent with the ANSI B31.1 Piping Code for the safety of personnel as well as operability of the piping systems.

Two equations were examined to determine the acceptability of these parameters. The input, results and recommendations are shown in Tables 3.6-1 and Table 3.6-2 .

a.) A sustained loading equation (eqn 11A of section 104.8.1 of B31.1 using the longitudinal pressure stress added to the maximum deadweight stress found in the individual pipeline) was compared to a $1.2S_h$ allowable. The longitudinal pressure stress term is based on 1580 psi. The maximum deadweight stress for each pipeline was obtained

from existing computer analysis, and does not exceed 5566 psi. A 1.2 factor is used for the allowable per section 102.2.4 of B31.1 which states that an event with a duration of less than 1% of the operating period is allowed a 20% increase in the maximum allowable stress found in Appendix A of B31.1.

b.) The hoop stress of each pipe size was calculated per eqn. 4, section 104.1.2 of B31.1 (these hoop stress values include the corrosion and mill tolerance allowances). These values were compared to an "allowable" designated as 90% of the yield strength of each material at a temperature of 100F (per section 137.1.4 of B31.1, which states that at no time during the pressure test shall any part of the piping system be subjected to a stress greater than 90% of its yield strength at test temperature). Yield stresses for materials ranged from 30000 to 38000 psi.

Pipe stress analysis has taken into consideration the increase in stress level at joints between transition pieces or fittings with straight pipes as required by ANSI B31.1. The formulas from the Code are used to determine these stress intensification factors and have been used in the stress calculations.

The weld joint efficiencies are taken into account by Code in determining the allowable stress values. Stress calculations have used these allowable stress values.

3.6.2 Analysis / Findings

Using the two equation criteria described in section 3.6.1, and comparing the results to the designated allowable values, the following is determined:

a.) All of the piping and fittings passed the given code allowable of $1.2S_h$, per Section 102.2.4 of ANSI B31.1 for a short duration overpressurization on a regular basis.

b.) All of the piping and fittings passed the "below or equal to" criteria of 90% yield strength.

3.6.3 Conclusion

The hoop stress values for all pipe and fittings do not exceed the 90% yield stress allowable All pipe and fittings meet the requirements of section 137.1.4 and 102.2.4 of B31.1 and stress are acceptable. Therefore, the safety and operability of the system is not compromised.

Recommendation

The evaluation has determined that the stress levels in the pipe and fittings are acceptable, therefore no actions are recommended.

4.0 SUMMARY OF RECOMMENDATIONS

The evaluation of all the affected components was performed using the conditions of 1580 psig and 100 deg F, with a duration of 1 minute. The event has been determined to be an overpressurization of the FWP upstream piping system, that was dissipated within 1 minute by flows out of the system.

For the components requiring action, the short term recommendations consist of replacement of the FWP low suction pressure switches, which has been completed.

The long term recommendations for the next refueling outage are presented in the attached Tables and consist of:

> 3" and larger valves upstream of the FWP - disassembling and inspecting selected valves, stroking all valves.
>
> Instrumentation - calibrating the instrumentation that has been pressurized beyond their normal range.
>
> 2-1/2" and smaller valves upstream of the FWP - stroking a sample of these valves for normal operation.
>
> Flanges - inspecting all body-bonnet and piping flanges for leakage, and actions taken if leaks are identified.
>
> Blowdown heat exchanger relief valve - inspecting for proper reseating

For components not recommended to be inspected or already reworked, the evaluation has shown that the performance of the components has not be degraded by the pressurization.

TABLE 2.0-1

UNIT 2 - LINE NUMBERS SUBJECTED TO 1580 PSIG

SUCTION SIDE PIPING (MAIN FEED PUMP)	DISCHARGE SIDE PIPING (MAIN FEED PUMP)
FW-036-GBDB-30"	FW-011-DBDB-10"
FW-037-GBDB-30"	FW-013-DBDB-10"
FW-036-GBDB-2"	FW-038-DBDB-12"
FW-037-GBDB-2"	FW-039-DBDB-12"
FW-065-HCDB-3/8"	FW-040-DBDB-18"
FW-066-HCDB-3/8"	FW-007-DBDB-24"
CD-155-GBDB-12"	FW-015-DBDB-18"
CD-156-GBDB-12"	FW-008-DBDB-24"
CD-225-GBDB-1"	FW-051-DBDB-1"
CD-225-GBDB-2"	FW-052-DBDB-1"
CD-085-GBDB-2"	FW-007-DBDB-24"
CD-085-GBDB-1"	FW-007-DBDB-2"
CD-085-GBDB-30"	FW-008-DBDB-2"
CD-225-GBDB-30"	FW-007-DBDB-26"
CD-225-GBDB-24"	FW-008-DBDB-26"
CD-085-GBDB-24"	FW-061-DBDB-3/4"
ED-157-GBDB-16"	FW-062-DBDB-3/4"
ED-218-GBDB-16"	FW-045-DBDB-1"
SC-020-GBDB-6"	FW-048-DBDB-1"
SC-109-GBDB-6"	FW-015-DBDB-2"
SC-026-GBDB-6"	FW-006-DBDB-26"
SC-280-GBDB-1"	FW-009-DBDB-26"
SC-281-HBDB-1"	FW-005-DBDB-26"
	FW-010-DBDB-26"
	FW-004-DBDB-26"
	FW-003-DBDB-26"
	FW-043-DBDB-1"
	FW-046-DBDB-1"
	FW-003-DBDB-24"
	FW-004-DBDB-24"
	FW-017-DBDB-32"
	FW-042-DBDB-24"
	FW-002-DBDB-24"
	SG-186-DBDB-12"
	SG-186-DBDB-16"
	SG-187-DBDB-12"
	SG-001-DBDB-24"
	SG-004-DBDB-24"
	SC-204-DCDB-3/8"
	SC-203-DCDB-3/8"

TABLE 2.0-2 REVIEWED DRAWING FOR OVERPRESSURIZATION		
DRAWING NO.	REV. NO.	TYPE OF DOCUMENT
13-M-FWP-001	REV.15	P&ID
13-M-EDP-004	REV.21	P&ID
13-M-EDP-005	REV.20	P&ID
13-M-SCP-004	REV.12	P&ID
13-M-CDP-003	REV.18	P&ID
13-M-AFP-001	REV.28	P&ID
13-M-SCP-005	REV.9	P&ID
13-M-SGP-002	REV.20	P&ID
13-P-CDF-403	REV.12	ISOMETRIC
23-P-FWF-401	REV.5	ISOMETRIC
13-P-EDF-406	REV.9	ISOMETRIC
13-P-EDF-405	REV.10	ISOMETRIC
13-P-SCF-404	REV14	ISOMETRIC
13-P-SGF-406	REV.12	ISOMETRIC
23-P-FWF-403	REV.11	ISOMETRIC
02-C-ZVC-323	REV.18	PIPING LAYOUT

TABLE 3.1-1

MAIN FEEDWATER PUMP AND ASSOCIATED PIPING &COMPONENTS SUPPLIED BY BYRON JACKSON

COMPONENT	TAG NUMBER	RATED PRESSURE	SOURCE
PUMP	FWN-P01A	1750 # CASING	M011-46-7
PUMP	FWN-P01B	1750 # CASING	M011-46-7
STRAINER	FWN-F01A	300 # FLANGE	M011-6-5
STRAINER	FWN-F01B	300 # FLANGE	M011-6-5
CONTROL	PDV-229	600 # FLANGE	M011-107-1 &
VALVE	PDV-230	600 # FLANGE	LESLIE
(PLUG)	PV-231	600 # FLANGE	DITTO
	PV-232	600 # FLANGE	DITTO
PRESSURE	PDIC-229	250 # (MAX. WORKING)	LESLIE
CONTROLER	PDIC-230	250 # (MAX. WORKING)	LESLIE
	PIC-231	250 # (MAX. WORKING)	LESLIE
	PIC-232	250 # (MAX. WORKING)	LESLIE
PRESSURE	PDSL-229	1000#(MAX. WORKING)	ASHCROFT
SWITCH	PDSL-230	1000#(MAX.WORKING)	ASHCROFT
	PSL-231	2000#(MAX. WORKING)	ASHCROFT
	PSL-232	2000#(MAX. WORKING)	ASHCROFT
SEAL INJECTION PIPING		1-1/2" SCH.40 C.S.	M011-4-3
SEAL INJECTION VALVE		1-1/2" 300# C.S.	M011-4-3
SEAL RETURN PIPING		1-1/2" SCH.40 C.S.	M011-4-3
SEAL RETURN VALVE		1-1/2" 300# C.S.	M011-4-3

Table 3.2-1

UNIT 2 - 3 INCH AND LARGER VALVES UPSTREAM OF FWP

VALVE NO	VALVE TYPE	RECOMMENDATION
FWN-V037 * FWN-V034 * EDN-V179 EDN-V120 EDN-V119 SCN-V119 SCN-V120 SCN-V121 CDN-V096	Gate/ 30 inch Gate/ 30 inch Gate/16 inch Gate/ 6 inch Gate/ 6 inch Gate/ 6 inch Gate/ 6 inch Gate/ 6 inch Gate/ 6 inch	Valve pressure boundary for all valves should be monitored or any abnormal behavior (i.e. bonnet leakage, packing leakage etc.). * Valve internals are recommended be inspected during the next refueling outage for evidence of damage due to the overpressurization. FWN-V034 is not required to be inspected.
EDN-V168 CDN-V189 * EDN-V119	Check/ 16 inch Check/ 24 inch Check/ 16 inch	
SCN-VA59 ** SCN-VA60 **	Globe/ 4 inch Globe/ 4 inch	** Choose one of these two valves, preferably SCN-VA60, and inspect the valve internals at the next refueling outage for evidence of damage due to the overpressurization.
EDN-LV-501 # EDN-LV-502 #	Control/12 inch Control/12 inch	# Choose one of these two valves, preferably EDN-LV-502, and inspect the valve internals at the next refueling outage for evidence of damage due to the overpressurization.

TABLE 3.2-2

UNIT 2 2-1/2 INCH AND SMALLER VALVES UPSTREAM OF FWP

VALVE NO.	FUNCTION	RECOMMENDATION
CDN-V628	DRAIN	A sample of these valves should be stroked through the full range of motion, and leak tightness verified. The results are to be evaluated by the System Engineer in conjunction with Nuclear Engineering.
CDN-V801	DRAIN	
FWN-V069	BYPASS VLV	
FWN-V095	VENT	
FWN-V110	ROOT VALVE	
FWN-V051	ROOT VALVE	
FWN-V038	ROOT VALVE	
FWN-V039	ROOT VALVE	
EDN-V499	ROOT VALVE	
EDN-V593	DRAIN	
SCN-VA61	DRAIN	
SCN-VA62	DRAIN	
SCN-V024	ROOT VALVE	
SCN-V293	VENT	
SCN-V287	VENT	
SCN-VM63	DRAIN	
SCN-V022	ROOT VALVE	
SCN-V333	VENT	
EDN-V592	DRAIN	
EDN-V488	ROOT VALVE	
CDN-V092	DRAIN	
CDN-V800	DRAIN	
FWN-V068	BYPASS VLV	
FWN-V091	VENT	
FWN-V109	ROOT VALVE	
FWN-V049	ROOT VALVE	
FWN-V036	ROOT VALVE	
FWN-V035	ROOT VALVE	
FWN-V125	ROOT VALVE	
FWN-V150	ROOT VALVE	
FWN-V151	ROOT VALVE	
FWN-V149	ROOT VALVE	
FWN-V148	ROOT VALVE	

TABLE 3.2-3

UNIT 2 - ALL MANUAL VALVES DOWNSTREAM OF THE FWP

VALVE NO.	RATING	SIZE	RECOMMENDATION
SG-V211	1500	1	No actions are required.
SG-V326	1500	1	
SG-V125	900	12	
SG-V249	1500	1	
SG-V098	900	8	
SG-V432	900	8	
SG-V564	1500	0.5	
SG-V565	1500	0.5	
SG-V124	900	12	
SG-V323	1500	1	
SG-V250	1500	1	
SG-V097	900	8	
SG-V551	1500	0.5	
SG-V550	1500	0.5	
SG-V431	1500	8	
SG-V102	1500	1	
FW-V070	1500	2	
FW-V080	1500	1	
FW-V056	1500	1	
FW-V079	1500	1	
FW-V018	1500	1	
FW-V078	1500	1	
FW-V077	1500	1	
FW-V054	1500	1	
FW-V016	1500	1	
FW-V076	1500	1	
FW-V052	1500	1	
FW-V074	1500	1	
FW-V015	1500	1	
FW-V107	1500	1	
FW-V060	1500	0.5	
FW-V061	1500	0.5	
FW-V059	1500	0.5	
FW-V058	1500	0.5	
FW-V157	1500	1	
FW-V115	1500	1	
FW-V111	1500	1	
FW-V073	1500	1	

TABLE 3.2-3

UNIT 2 - ALL MANUAL VALVES DOWNSTREAM OF THE FWP

VALVE NO.	RATING	VALVE SIZE	RECOMMENDATION
FW-V073	1500	1	No actions are required.
FW-V002	1500	1	
FW-V120	1500	1	
FW-V121	1500	1	
FW-V112	1500	1	
FW-V156	1500	1	
FW-V062	1500	0.5	
FW-V063	1500	0.5	
FW-V065	1500	0.5	
FW-V064	1500	0.5	
FW-V108	1500	1	
FW-V032	1500	1	
FW-V082	1500	1	
FW-V053	1500	1	
FW-V083	1500	1	
FW-V017	1500	1	
FW-V055	1500	1	
FW-V084	1500	1	
FW-V085	1500	1	
FW-V019	1500	1	
FW-V057	1500	1	
FW-V086	1500	1	
FW-V087	1500	1	
FW-V071	1500	2	
FW-V068	1500	1	
FW-V075	1500	1	
FW-V072	1500	2	
FW-V081	1500	1	
FW-V147	1500	1	
FW-V090	1500	1	
FW-V007	900	24	
FW-V020	1500	1	
FW-V124	1500	1	
FW-V021	1500	1	
FW-V005	900	10	
FW-V089	1500	1	
FW-V004	900	12	
FW-V008	900	12	

TABLE 3.2-3

UNIT 2 - ALL MANUAL VALVES DOWNSTREAM OF THE FWP

VALVE NO.	RATING	SIZE	RECOMMENDATION
FW-V094	1500	1	No action is required.
FW-V122	1500	1	
FW-V024	1500	1	
FW-V025	1500	1	
FW-V012	900	24	
FW-V010	900	10	
FW-V093	1500	1	
FW-V009	900	12	
FW-V013	900	12	
FW-V067	1500	1	

TABLE 3.3-1

FASTENERS FOR FLANGES AND VALVE BONNETS UPSTREAM OF FWP

LINE NUMBER	LOCATION	INDUCED BOLT STRESS *	MIN. APPLIED PRELOAD
FWN-037-GBDB-30"	FWN-F01B	27% of yield	30% of yield
FWN-036-GBDB-30"	FWN-F01A	27% of yield	30% of yield
EDN-157-GBDB-6"	EL. 105' 5"	15% of yield	30% of yield
EDN-157-GBDB-16"	EL. 106' 10"	11% of yield	30% of yield
EDN-157-GBDB-16"	EL. 126' 10"	15% of yield	30% of yield
EDN-218-GBDB-16"	EL. 127' 8"	15% of yield	30% of yield
EDN-218-GBDB-16"	EL. 126' 10"	15% of yield	30% of yield
EDN-218-GBDB-16"	EL. 113' 0"	15% of yield	30% of yield
EDN-218-GBDB-16"	EL. 105' 0"	15% of yield	30% of yield
SCN-109-GBDB-6"	EL. 106' 0"	11% of yield	30% of yield

VALVE MODEL NO.	DWG NO.	INDUCED BOLT STRESS *	MIN. APPLIED PRELOAD
2355-7-BG-WE (40)	P222B-92-4	56% of yield	65% of yield
2355-7-BG-WE (40)	P222B-14-6	56% of yield	65% of yield
2355G-7-BG-WE-(40) BG-X	P222B-340-2	58% of yield	63% of yield
2355-7-WE (.075) WG	P222B-277-5	47% of yield	61% of yield
380-7-WE (40)	P222B-122-4	58% of yield	63% of yield
384-7-WE (40)	P222B-116-3	17% of yield	55% of yield

RECOMMENDATIONS

During the next refueling outage, the flange and body to bonnet connections should be visually inspected for any minor leakage. If leaks are identified, take actions as determined prudent, such as retorqueing bolts per 13-PN-205 or the vendor recommendation.

NOTES:

* Induced calculated bolt stress due to overpressurization event.

Bolt stress and applied preload are calculated in terms of yield stress for comparison bases. Note that the applied preload is greater then the induced loading due to the overpressurization event.

TABLE 3.4-1

BLOWDOWN HEAT EXCHANGER COMPONENTS

2M-SCN-E02	BLOWDOWN HX	No inspection recommended
2J-SCN-PSV8	THERMAL RELIEF VALVE	Inspect seat for scoring and proper reseating, at the next refueling outage.

TABLE 3.5-1

Instrumentation and Control Equipment Overpressure Summary

Tag Number	Maufacturer	Pressure Rating	Comments	Disposition
02JFWNFE0001	Dieterich	2000 psi.	Annubar, Dieterich	No action required
02JFWNFE0002	Dieterich	2000 psi.	Annubar, Dieterich	No action required
02JFWNFT0001	Rosemount	2000 psi.		No action required
02JFWNFT0002	Rosemount	2000 psi.		No action required
02JFWNFT0003	Rosemount	2000 psi.		No action required
02JFWNFT0004	Rosemount	2000 psi.		No action required
02JFWNLV0501	Fisher	600 # Fl.		No action required
02JFWNLV0502	Fisher	600 # Fl.		No action required
02JFWNPDI0309	Barton	1500 psi.	Stamped on side of DPU Unit 224	Inspect and Recalibrate
02JFWNPDI0310	Barton	1500 psi.	Stamped on side of DPU Unit 224	Inspect and Recalibrate
02JFWNPDIC0229	Leslie	250 psi.	Possible Damage	Inspect and Recalibrate
02JFWNPDIC0230	Leslie	250 psi.	Possible Damage	Inspect and Recalibrate
02JFWNPDSL0229	Ashcroft	1000 psi.		Inspect and Recalibrate
02JFWNPDSL0230	Ashcroft	1000 psi.		Inspect and Recalibrate
02JFWNPDV0229	Leslie	600 # Fl.		No action required
02JFWNPDV0230	Leslie	600 # Fl.		No action required
02JFWNPI0085	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPI0086	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPI0095	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPI0096	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPI0107	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPI0108	Ashcroft	1500 psi.		Inspect and Recalibrate
02JFWNPIC0231	Leslie	250 psi.	Possible Damage	Inspect and Recalibrate
02JFWNPIC0232	Leslie	250 psi.	Possible Damage	Inspect and Recalibrate
02JFWNPIT0017	Rosemount	2000 psi.		No action required
[illegible]2JFWNPIT0018	Rosemount	2000 psi.		No action required
[illegible]JFWNPIT0027	Rosemount	2000 psi.		No action required
[illegible]JFWNPIT0028	Rosemount	2000 psi.		No action required
02JFWNPIT0121	Rosemount	4500 psi.		No action required
02JFWNPSH0025A	United Electric	3000 psi.		No action required
02JFWNPSH0025B	United Electric	3000 psi.		No action required
02JFWNPSH0025C	United Electric	3000 psi.		No action required
02JFWNPSH0026A	United Electric	3000 psi.		No action required
02JFWNPSH0026B	United Electric	3000 psi.		No action required
02JFWNPSH0026C	United Electric	3000 psi.		No action required
02JFWNPSL0015A	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0015B	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0015C	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0016A	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0016B	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0016C	United Electric	600 psi.	Damaged & Replaced, range 0 to 600 psi.	Catastrophic Failure, Replace
02JFWNPSL0231	Ashcroft	2000 psi.		No action required
02JFWNPSL0232	Ashcroft	2000 psi.		No action required
02JFWNPSV0083	Lonergan	5000 psi.		No action required
02JFWNPSV0084	Lonergan	5000 psi.		No action required
02JFWNPV0231	Leslie	600 # Fl.		No action required
02JFWNPV0232	Leslie	600 # Fl.		No action required
02JFWNTE0011	Weed	3750 psi.	Thermowell, Telecon with Weed 7/26/89	No action required
02JFWNTE0012	Weed	3750 psi.	Thermowell, Telecon with Weed 7/26/89	No action required
02JSCNAX0530	Graham Mfg.	3728 psi.		No action required
02JSCNAX0567	Graham Mfg.	3728 psi.		No action required
02JSCNFI006A	Barton	600 psi.	Possible Damage, range 0 to 600 psi.	Inspect and Recalibrate
02JSCNFI006B	Barton	600 psi.	Possible Damage, range 0 to 600 psi.	Inspect and Recalibrate
02JSCNTI006	Ashcroft	3750 psi.	Thermowell, Rtg.	No action required
02JSCNTISH0531	United Electric	2300 psi.	Telecon with United Electric 7/26/89	No action required
02JSCNTISH0568	United Electric	2300 psi.	Telecon with United Electric 7/26/89	No action required
02JSGNFT1112	Rosemount	4500 psi.		No action required
02JSGNFT1122	Rosemount	4500 psi.		No action required
02JSGNTE0007	Weed	3750 psi.	Thermowell, Telecon with Weed 7/26/89	No action required
[illegible]GNTE0008	Weed	3750 psi.	Thermowell, Telecon with Weed 7/26/89	No action required

OVERPRESSURIZATION PIPE STRESS TABLE
TABLE 3.6.1

STRESS CALC. NUMB.	LINE NUMBER	MTRL. TYPE	LONG. STRESS (psi)	MAX. DWT. STRESS (psi)	DWT. + LONG. STRESS (S)	S/S_a	HOOP STRESS (psi) (S_p)	S_p/S_y
FW-503	CD-155-GBDB-12	(1)	13012	2294	15306	0.85	26793	0.766
	CD-085-GBDB-1	(2)	2167	5566	7733	0.43	5037	0.144
	CD-085-GBDB-2	(1)	3761	5566	9327	0.52	8243	0.236
	CD-085-GBDB-24	(1)	14573	2486	17059	0.95	29915	0.855
	CD-085-GBDB-30	(3)	14625	3865	18490	0.88	30020	0.790
	FW-036-GBDB-30	(3)	14625	3865	18490	0.88	30020	0.790
	FW-036-GBDB-2	(1)	3761	5566	9327	0.52	8243	0.236
	FW-065-HCDB-3/8	(4)	3529	5566	9095	0.41	7775	0.260
	CD-156-GBDB-12	(1)	13012	2294	15306	0.85	26793	0.766
	CD-225-GBDB-1	(2)	2167	5566	7733	0.43	5037	0.144
	CD-225-GBDB-2	(1)	3761	5566	9327	0.52	8243	0.236
	CD-225-GBDB-24	(1)	14573	2486	17059	0.95	29915	0.855
	CD-225-GBDB-30	(3)	14625	3865	18490	0.88	30020	0.790
	FW-037-GBDB-30	(3)	14625	3865	18490	0.88	30020	0.790
	FW-037-GBDB-2	(1)	3761	5566	9327	0.52	8243	0.236
	FW-066-HCDB-3/8	(4)	3529	5566	9095	0.41	7775	0.260
ED-506	ED-157-GBDB-16	(1)	13272	1716	14988	0.83	27311	0.780
	ED-218-GBDB-16	(1)	13272	1716	14988	0.83	27311	0.780
SC-505	SC-020-GBDB-6	(1)	9511	2921	12432	0.69	19782	0.565
	SC-109-GBDB-6	(1)	9511	2921	12432	0.69	19782	0.565
CD-504	SC-026-GBDB-6	(1)	9511	1500	11011	0.61	19782	0.565
ZY-564	SC-280-GBDB-1	(1)	2167	1176	3343	0.19	5037	0.144
	SC-281-HBDB-1	(1)	2167	1176	3343	0.19	5037	0.144

MATERIAL TYPE	S_a = CODE ALLOWABLE (1.25Sh)	S_y = YIELD STRESS @ 100F
(1) A106 Gr B	18000 psi	35000 psi
(2) A-53 Gr B	18000 psi	35000 psi
(3) A-155 Gr KC 70	21000 psi	38000 psi
(4) SA-213 TP 304	22560 psi	30000 psi

OVERPRESSURIZATION FITTING STRESS TABLE
TABLE 3.6.2

STRESS CALC. NUMB.	LINE NUMBER	MTRL. TYPE	LONG. STRESS (psi)	MAX. DWT. STRESS (psi)	DWT. + LONG. STRESS (S)	S/S_a	HOOP STRESS (psi) (S_p)	S_p/S_y
FW-503	CD-155-GBDB-12	(5)	13012	2294	15306	0.85	26793	0.766
	CD-085-GBDB-1	(7)	2167	5566	7733	0.43	5037	0.140
	CD-085-GBDB-2	(7)	3761	5566	9327	0.44	8243	0.229
	CD-085-GBDB-24	(5)	14573	2486	17059	0.95	29915	0.855
	CD-085-GBDB-30	(5)	14625	2075	16700	0.93	30020	0.858
	FW-036-GBDB-30	(5)	14625	1514	16139	0.90	30020	0.858
	FW-036-GBDB-2	(7)	3761	5566	9327	0.44	8243	0.229
	FW-065-HCDB-3/8	(8)	3529	5566	9095	0.43	7775	0.260
	CD-156--GBDB-12	(5)	13012	2294	15306	0.85	26793	0.766
	CD-225-GBDB-1	(7)	2167	5566	7733	0.43	5037	0.140
	CD-225-GBDB-2	(7)	3761	5566	9327	0.44	8243	0.229
	CD-225-GBDB-24	(5)	14573	2486	17059	0.95	29915	0.855
	CD-225-GBDB-30	(5)	14625	3313	17938	0.99	30020	0.858
	FW-037-GBDB-30	(5)	14625	2357	16982	0.94	30020	0.858
	FW-037-GBDB-2	(7)	3761	5566	9327	0.44	8243	0.229
	FW-066-HCDB-3/8	(8)	3529	5566	9095	0.43	7775	0.260
ED-506	ED-157-GBDB-16	(5)	13272	1716	14988	0.83	27311	0.780
	ED-218--GBDB-16	(5)	13272	1716	14988	0.83	27311	0.780
SC-505	SC-020-GBDB-6	(5)	9511	2921	12432	0.69	19782	0.565
	SC-109-GBDB-6	(5)	9511	2921	12432	0.69	19782	0.565
CD-504	SC-026-GBDB-6	(5)	9511	1500	11011	0.61	19782	0.565
ZY-564	SC-280-GBDB-1	(7)	2167	1176	3343	0.19	5037	0.140
	SC-281-HBDB-1	(7)	2167	1176	3343	0.19	5037	0.140

MATERIAL TYPE	S_a = CODE ALLOWABLE (1.2Sh)	S_y = YIELD STRESS @ 100F
(5) A-234 Gr WPB	18000 psi	35000 psi
(6) A-234 Gr WPBW	18000 psi	35000 psi
(7) A-105	21000 psi	36000 psi
(8) A-182 Gr F 304	21000 psi	30000 psi

Figure 1.2-1

FEEDWATER SYSTEM LINEUP

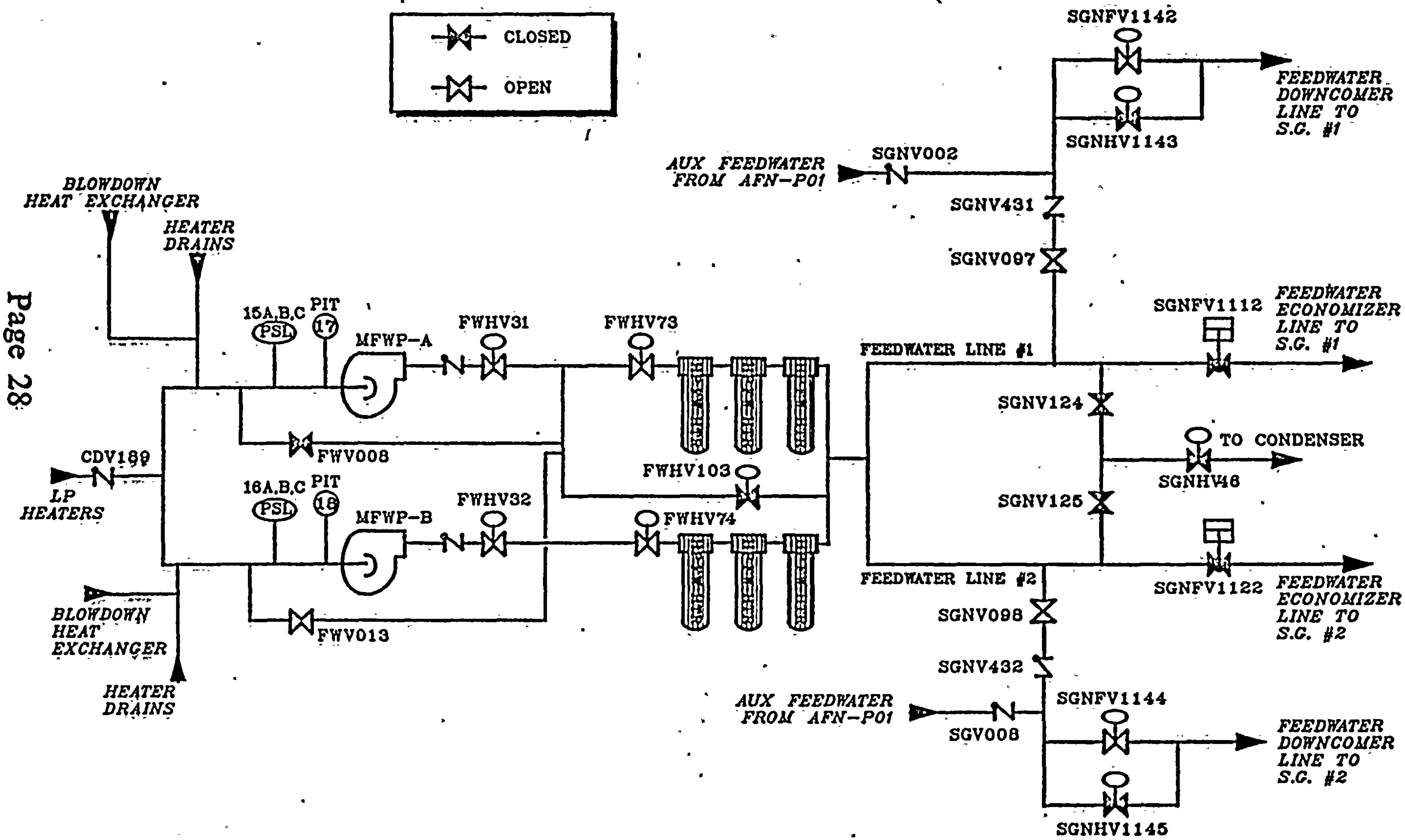
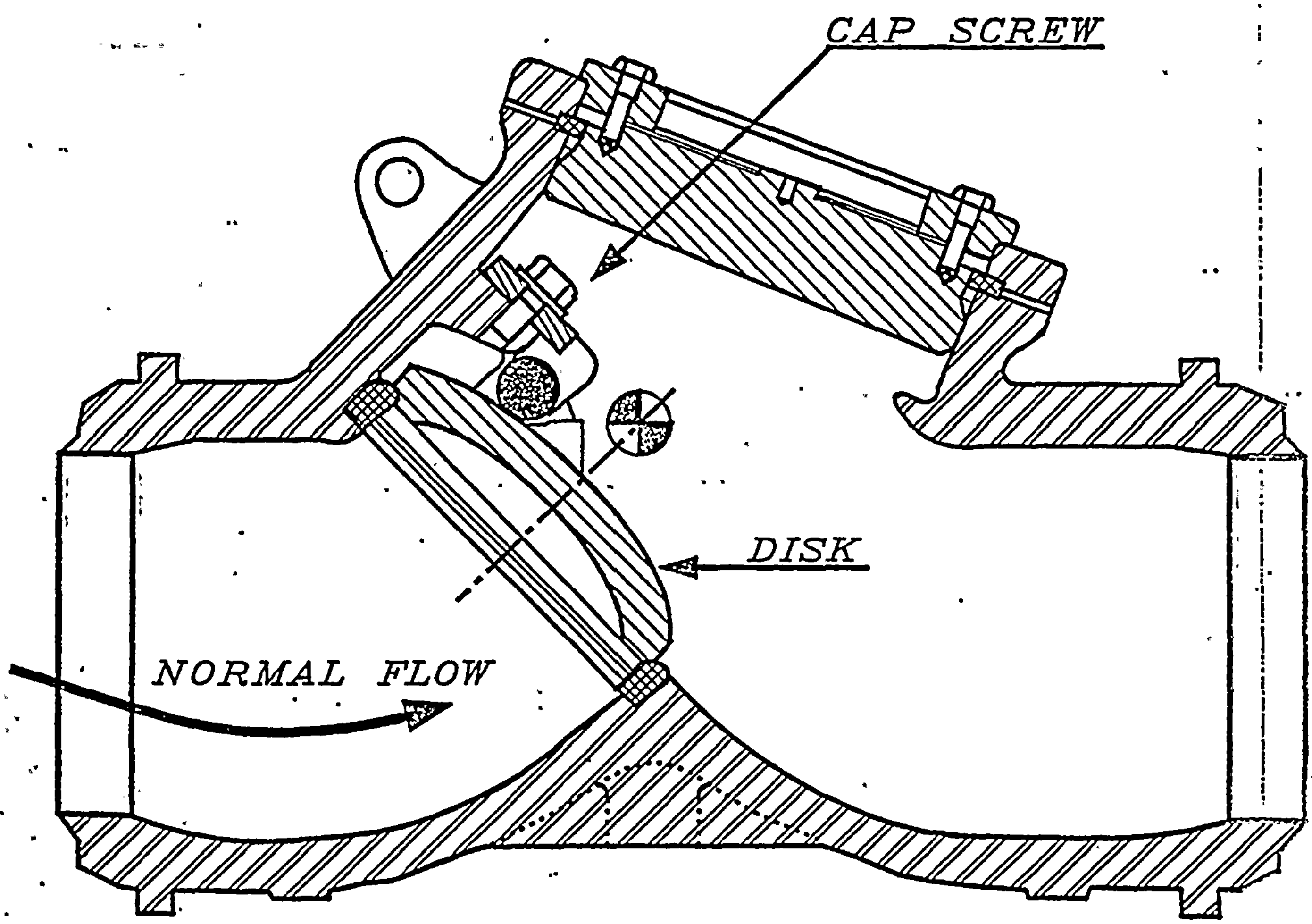


Figure 1.2-2

FEEDWATER CHECK VALVE

(2PSGNV431)



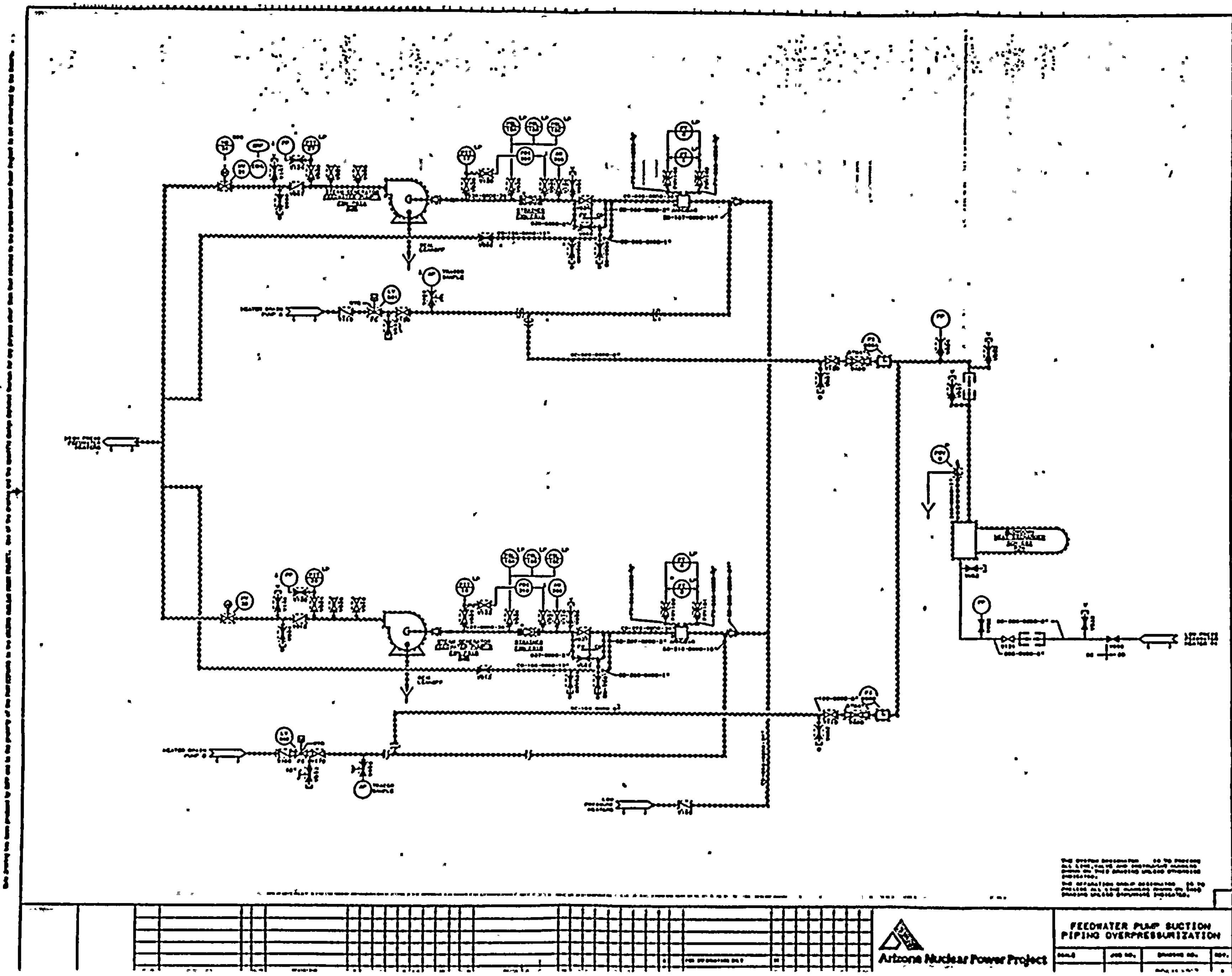

Arizona Nuclear Power Project
FEEDWATER PUMP SUCTION
PIPING OVERPRESSURIZATION

Figure 2