# Summary Report of
# Safety and Relief Valve
# Installation and Re-Analysis
# for ASME Class 1 and Class 2 Systems
# In Indian Point Unit No. 2

July 13, 1972

## 1. INTRODUCTION

In accordance with the May 12, 1972 AEC Directorate of Licensing letter to Con Edison (Reference 1), a review has been conducted for pressure-relieving devices located in systems that would be functionally classified in accordance with ANS-N18.2* and Safety Guide No. 26** as ASME*** Class 1 and 2. The analytical methods used are described in Section 5, Methods of Analysis. The results of the review and modifications required for the main steam safety and relief valve installations previously presented to the Atomic Safety and Licensing Board (Tr. 5424) are summarized herein. Other pressure relieving devices have been completely reanalyzed as requested. The re-analysis indicated that, in some cases, incorporation of properly evaluated valve thrust forces required relocation and addition of supports and restraints (Table 2) to insure that all stresses in the piping systems, under the combination of all applicable loads, are within code allowable values.

In the case of the three (3) pressurizer safety valves, it was determined that weld overlay reinforcement would be required

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*ANS-N18.2, Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, January 1972.

**Safety Guide 26, Quality Group Classifications and Standards, March 23, 1972.

***ASME Code 1971 Edition.

to bring the stresses within the applicable code allowable values for the combined loading condition.

2. SCOPE

The safety-relief valve installations reviewed for structural adequacy in accordance with the AEC request are:

a) Reactor Coolant System Pressurizer Safety Valves and Power Operated Relief Valves.

b) Main Steam Safety Valves and Power Operated Relief Valves.

c) Chemical and Volume Control System relief valves on the letdown lines, reactor coolant pump seal water return, charging pump discharge and volume control tank.

d) Residual Heat Removal System - Reactor coolant side.

e) Safety Injection System Accumulator tank, Accumulator nitrogen supply and high head safety injection pump discharge.

f) Hydrogen Recombiner System.

g) Component Cooling Water System - inside containment boundary.

h) Service Water System - inside containment boundary.

3. DESIGN AND INSTALLATION CRITERIA

1) Connected piping designed, fabricated, erected, supported, inspected, and tested in accordance with Power Piping Code ANSI B31.1.0., 1967 Edition.

2) Connected piping materials and allowable stresses in accordance with Power Piping Code ANSI B31.1.0, 1967 Edition.

3) Vessel Codes - American Society of Mechanical Engineers, Boiler and Pressure Vessel Code, Section III, Nuclear Vessels, 1965 Edition with applicable adenda.

4. SIGNIFICANT ASSUMPTIONS

1) Detailed stress analysis of the ASME Class 1 and 2 safety-relief and power operated relief valve installations were performed considering the following loads:

a. Thrust Loading - Applied to the piping system when valve operates. The thrust force caused by valve discharge is composed of velocity and pressure components that include considerations for the fluid flow behavior and dynamic action of the valve.

The loads are based on the rated full flow and the corresponding system overpressure. (including thrust peak loads and directional changes due to dynamics of flow).

b. Weight Loading - A load caused by the piping, fluid and valve deadweight.

c. Seismic Loading - Loads resulting from the Design Basis Earthquake ground accelerations of 0.1g vertical and 0.15g horizontal.

d. Internal Pressure - Loads caused by internal piping fluid pressure.

2) All loads described in (1) above are assumed to act simultaneously.

3) Maximum combined stresses tabulated were based on an evaluation of combined loading conditions considering both single and multiple valve operation where applicable, and peak dynamic loads at the first two elbows downstream of the safety valve.

5. METHODS OF ANALYSIS

The stress analysis of the safety and power operated relief valve installations was performed using standard analytical methods for valve installations and connected piping between natural supports.(1) A summary of the various analytical

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(1) Natural supports - those supports beyond which considered loads are not transmitted or are of insignificant value.

methods used to evaluate these installations is presented in Table 1. A description of the methods noted in Table 1 follows:

a) U. S. Navy MEL-40 computer program was used to evaluate the stresses in a piping system caused by dead weight and loads applied externally to the piping system.

b) ADL-PIPE computer program was used to input the dynamic response and evaluate the corresponding stresses resulting from the seismic occurrence.

c) Pressure-volume analysis was used to define the pressure stresses in uniform tubular pipe section.

d) Pressure-area analysis was used to define the pressure stresses in pipe wall sections where the thickness varies.

e) Local stress analysis of the effects of externally applied loads at nozzle or pipe junctures was performed using CYLNOZ computer program which is based on Reference 2.

## 6. RESULTS AND CONCLUSIONS

Final system conditions associated with the modifications required for the main steam safety and relief valve installations, the pressurizer safety valve installations, and the relocation and addition of supporting devices are summarized in Table 2. The stresses applicable to the final installation of the pressure

relieving devices in accordance with final system conditions are summarized in Table 3 and compared with the allowable stresses from applicable codes.

The evaluation was made to assure that safety relief valve system combined loads (Section 4 above) do not cause stresses above those permitted by the applicable code. This evaluation includes nozzle stresses which are within applicable code allowables. Thermally induced loads and stresses within piping systems were also evaluated for each installation and are less than the ANSI B31.1.0, 1967, code allowable.

The combined stresses at all other points in the valve installations and connected piping were found to be less than those values listed in Table 3.

REFERENCES

1. Docket No. 50-247. Letter from Assistant Director for Pressurized Water Reactors, Directorate of Licensing, to Consolidated Edison Company of New York, Inc., dated May 12, 1972.

2. Bulletin No. 107, Revision 2, dated July 1970. Welding Research Council Bulletin, "Local Stresses in Spherical and Cylindrical Shells due to External Loads" by K. R. Wichman, A. C. Hopper and J. L. Mershon.

TABLE 1

Safety and Relief Valve Methods of Analysis

| System | Valve No. | Thrust | Deadweight | Seismic | Pressure |
|---|---|---|---|---|---|
| Reactor Coolant System - Pressurizer Safety and Power Operated Relief | PCV-464<br>PCV-466<br>PCV-468<br>PCV-455C<br>PCV-456 | MEL-40 | MEL-40 | ADL-PIPE | Pressure Volume |
| | Nozzles | Welding Research Council Bulletin No. 107 used for Nozzle to Shell Connection | | | |
| Main Steam - Safety | MS-45*<br>MS-46*<br>MS-47*<br>MS-48*<br>MS-49* | CYLNOZ (Welding Research Council Bulletin No. 107) | a. MEL-40 for gross piping.<br>b. CYLNOZ for Local Valve Effect. | a. ADL-PIPE for gross piping.<br>b. CYLNOZ for Local Valve Effect. | Pressure Area |
| Main Steam - Power Operated Relief | PCV-1134<br>PCV-1135<br>PCV-1136<br>PCV-1137 | | | | |
| Main Steam - Safety for Turbine Driven Auxiliary Boiler Feed Pump | MS-52 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |

* 4 valves each.

TABLE 1
(Continued)

| System | Valve No. | Thrust | Deadweight | Seismic | Pressure |
|---|---|---|---|---|---|
| Chemical and Volume Control System | RV-203<br>RC-218<br>RC-231<br>RV-234<br>RV-237<br>RV-263<br>RV-264 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |
| | Volume Control Tank Nozzles | Welding Research Council Bulletin No. 107 used for Nozzle to Shell Connection | | | |
| Auxiliary Coolant System | RV-1836 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |
| Safety Injection System | RV-892A<br>RV-892B<br>RV-892C<br>RV-892D<br>RV-1816<br>RV-855 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |
| | Accumulator Nozzles | Welding Research Council Bulletin No. 107 used for Nozzle to Shell Connection | | | |
| Hydrogen Recombiner | 1884<br>1671 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |
| Service Water | SWN-42<br>(5 valves) | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |

TABLE 1
(Continued)

| System | Valve No. | Thrust | Deadweight | Seismic | Pressure |
|---|---|---|---|---|---|
| Component Cooling Water System | 819A<br>819B<br>783A<br>783B<br>783C<br>783D<br>821H<br>792 | MEL-40 | MEL-40 | MEL-40 | Pressure Volume |

TABLE 2

Summary of Final System Conditions

| System | Valve No. | Final Condition |
|---|---|---|
| Main Steam Safety Valves | MS-45*<br>MS-46*<br>MS-47*<br>MS-48*<br>MS-49* | Discharge piping modified: nozzle to main steam pipe connection reinforced by weld buildup. |
| Main Steam - Safety for Turbine Driven Auxiliary Boiler Feed Pump | MS-52 | Remove support on inlet piping; add support on discharge piping. |
| Main Steam Power-Operated Relief Valve | PCV-1134<br>PCV-1135<br>PCV-1136<br>PCV-1137 | Restraints added to discharge piping and main steam pipe. |
| Reactor Coolant System Pressurizer - Safety Valves | PCV-464<br>PCV-466<br>PCV-468 | Vessel safety valve nozzles and safe-ends reinforced, restraints relocated on discharge piping. |
| Pressurizer Power-Operated Relief Valves | PCV-455C<br>PCV-456 | Restraints relocated on discharge piping. |
| Chemical and Volume Control System | RV-203 | Restraint added to discharge piping. |
| | RV-218 | Restraint added to discharge piping. |
| | RV-264 | Restraints and supports added to discharge piping. |

* 4 valves each.

TABLE 2
(Continued)

| System | Valve No. | Final Condition |
|---|---|---|
| Auxiliary Coolant System | RV-1836 | Restraints added to inlet and discharge piping. |
| Safety Injection System | 892A<br>892B<br>892C<br>892D | Restraint added to discharge piping. |
| | 1816 | Modified support to provide rigid restraint. |
| $H_2$ Recombiner | 1671 | Add support on discharge piping. |
| Component Cooling Water | 783A | Add support on discharge piping. |
| | 783B | Add restraint on discharge piping. |
| | 783C | Add restraint on discharge piping. |

TABLE 3

Summary of Stresses Applicable to
Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KS |
|---|---|---|---|---|---|
| Reactor Coolant System Pressurizer | | | | | |
| Safety Valves | PCV-464<br>PCV-466<br>PCV-468 | (Stainless Steel) Nozzle to Pipe (A-403-WP-316, 650°F) | (Stainless Steel) 12.6 | ANSI B31.1.0 (1967) | (Stainless Steel) 19.2 |
| | | (Carbon Steel) Manifold Junction (A-106, Grade B, 400°F) | (Carbon Steel) 16.7 | ANSI B31.1.0 (1967) | (Carbon Steel) 18.0 |
| Power Operated Relief Valves | PCV-455C<br>PCV-456 | Nozzle to Pipe (A-376, Type 316, 650°F) | 9.2 | ANSI B31.1.0 (1967) | 19.2 |
| | Nozzles | Nozzle Body (SA-216, Grade WCC, 650°F) | 23.7 | ASME Section III, Class A (1965 Edition plus addenda through 1968) | 28.9 |

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Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KSI |
|---|---|---|---|---|---|
| Main Steam | | | | | |
| Safety Valves | MS-45*<br>MS-46*<br>MS-47*<br>MS-48*<br>MS-49* | Main Steam Header at Weldolet (A-155, Grade KC-70, Class 1, 560°F) | 17.0 | ANSI B31.1.0 (1967) | 21.0 |
| Main Steam - Safety for Turbine Driven Auxiliary Boiler Feed Pump | MS-52 | Elbow on inlet side (A-106, Grade B, 560°F) | 15.4 | ANSI B31.1.0 (1967) | 18.0 |
| Main Steam Power Operated Relief Valves | PCV-1134<br>PCV-1135<br>PCV-1136<br>PCV-1137 | Main Steam Header at Weldolet (A-155, Grade KC-70, Class 1, 560°F) | 20.9 | ANSI B31.1.0 (1967) | 21.0 |
| Chemical Volume Control System | | | | | |
| Letdown Line | RV-203 | Elbow on inlet side. (A-312, Type 304, 400°F). | 12.3 | ANSI B31.1.0 (1967) | 17.9 |

*4 valves each.

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Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress KSI |
|---|---|---|---|---|---|
| Seal Water Return Line | RV-218 | Elbow on inlet side. (A-312, Type 304, 240 F) | 10.1 | ANSI B31.1.0 (1967) | 19.3 |
| Charging Pump Discharge Line | RV-231<br>RV-234<br>RV-237 | Elbow on inlet side. (A-312, Type 304, 250 F) | 9.6 | ANSI B31.1.0 (1967) | 19.3 |
| Letdown Line | RV-263 | Tee on inlet side. (A-312, Type 304, 200°F) | 10.4 | ANSI B31.1.0 (1967) | 19.8 |
| Volume Control Tank | RV-264 | Second support on discharge side. (A-312, Type 304, 250°F). | 12.3 | ANSI B31.1.0 (1967) | 19.3 |
| | Nozzle | Shell at nozzle penetration. (SA-240, Type 304, 250°F). | 13.1 | ASME Section III, Class C (1965 Edition plus addenda through summer (1967). | 16.5 |

TABLE 3

Summary of Stresses Applicable to
Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KSI |
|---|---|---|---|---|---|
| Safety Injection System | | | | | |
| Accumulators | RV-892A<br>RV-892B<br>RV-892C<br>RV-892D | Elbow on inlet side. (A-312, Type 304, 300°F) | 16.3 | ANSI B31.1.0 (1967) | 18.0 |
| | Nozzle | Shell at nozzle penetration. (SA-516, Grade 70, 300°F). | 17.1 | ASME Section III, Class C. (1965 Edition plus addenda through Summer 1967). | 17.5 |
| Accumulators Nitrogen Supply | RV-1816 | At support on discharge side. (A-312, Type 304, Ambient). | 3.7 | ANSI B31.1.0 (1967) | 22.5 |
| High Head Injection | RV-855 | Tee on inlet side. (A-312, Type 316, 120°F). | 5.7 | ANSI B31.1.0 (1967) | 20.8 |

TABLE 3

Summary of Stresses Applicable to
Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KSI |
|---|---|---|---|---|---|
| $H_2$ Recombiner | 1884 | Tee on inlet side. (A-312, Type 304, 150°F). | 6.5 | ANSI B31.1.0 (1967) | 20.8 |
| | 1671 | Anchor at Equipment (A-53, Grade A, 150°F) | 7.0 | ANSI B31.1.00 (1967) | 12.3 |
| Component Cooling | 821H | First tee on inlet side. (A-106, Grade B, 150°F). | 13.0 | ANSI B31.1.0 (1967) | 18.0 |
| | 792 | First elbow on inlet side. (A-53, Grade A, 120°F). | 6.9 | ANSI B31.1.00 (1967) | 12.3 |
| | 783A | Tee on inlet side. (A-106, Grade B, 550°F) | 13.9 | ANSI B31.1.0 (1967) | 18.0 |

TABLE 3

Summary of Stresses Applicable to
Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KSI |
|---|---|---|---|---|---|
| | 783B | Tee on inlet side. (A-106, Grade B, 550°F). | 9.8 | ANSI B31.1.0 (1967) | 18.0 |
| | 783C | Tee on inlet side. (A-106, Grade B, 550°F). | 12.1 | ANSI B31.1.0 (1967) | 18.0 |
| | 783D | Tee on inlet side. (A-106, Grade B, 550°F). | 10.7 | ANSI B31.1.0 (1967) | 18.0 |
| | 819A | Connection on 12" line. (A-53, Grade A, 120°F). | 3.0 | ANSI B31.1.0 (1967) | 12.3 |
| | 819B | Connection on 12" line. (A-53, Grade A, 120°F). | 4.3 | ANSI B31.1.0 (1967) | 12.3 |

TABLE 3

Summary of Stresses Applicable to
Mounting of Pressure Relieving Devices
Indian Point Unit No. 2

| System | Component No. | Location of Maximum Stress (Including Material and Operating Temperatures) | Maximum Combined Stress, KSI | Applicable Code | Allowable Stress, KSI |
|---|---|---|---|---|---|
| Service Water System | SWN-42A | Elbow on inlet side. (A-312, Type 304, 270°F). | 4.7 | ANSI B31.1.0 (1967) | 19.0 |
| | SWN-42B | Support point on discharge. (A-312, Type 304, 270°F). | 3.4 | ANSI B31.1.0 (1967) | 19.0 |
| | SWN-42C | Connection on 10" pipe. (A-312, Type 304, 270°F). | 5.6 | ANSI B31.1.0 (1967) | 19.0 |
| | SWN-42D | Inlet Flange Weld (A-312, Type 304, 270°F). | 3.7 | ANSI B31.1.0 (1967) | 19.0 |
| | SWN-42E | Inlet Flange Weld (A-312, Type 304, 270°F). | 2.7 | ANSI B31.1.0 (1967) | 19.0 |
| Auxiliary Coolant System | | | | | |
| RHR Heat Exchanger | RV-1836 | First elbow on discharge side. (A-312, Type 304, 350°F). | 12.2 | ANSI B31.1.0 (1967) | 18.3 |

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