UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ON ASME CODE CASES N-498-1 AND N-416-1

ILLINOIS POWER COMPANY

CLINTON POWER STATION

DOCKET NO. 50-461

1.0 INTRODUCTION

Inservice inspection and testing of American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Part 50.55a(a)(3) of Title 10 of Code of Federal Regulations states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulties without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) on the date 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable edition of Section XI of the ASME Code for the Clinton Power Station is the 1980 Edition, through Winter 1981 Addenda. The components (including supports) may meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein and subject to Commission approval.

By letters dated August 8, 1994, and January 19, 1995, the Illinois Power Company (the licensee) requested approval for the implementation of the alternative rules of: 1) ASME Section XI Code Case N-498-1, dated May 11, 1994, "Alternative Rules for 10-Year System Hydrostatic Testing for Class 1, 2, and 3 Systems" pursuant to 10 CFR 50.55a(a)(3) for 10-year hydrostatic testing on Class 3 systems; and 2) ASME Section XI Code Case N-416-1 dated

February 15, 1994, entitled "Alternative Pressure Test Requirement for Welded Repairs or Installation of Replacement Items by Welding Class 1, 2, and 3, Section XI, Division 1," pursuant to 10 CFR 50.55a(a)(3), to be applied to the inservice inspection (ISI) program for the Clinton Power Station.

The Materials and Chemical Engineering Branch, Division of Engineering, has reviewed and evaluated the licensee's request and supporting information to use Code Cases N-498-1 and N-416-1 as proposed alternatives to the Code requirements for the Clinton Power Station.

2.0 EVALUATION

2.1 CODE CASE N-498-1, "ALTERNATIVE RULES FOR 10-YEAR SYSTEM HYDROSTATIC TESTING FOR CLASS 1, 2 AND 3 SYSTEMS"

Component Identification

All ASME Class 3 pressure retaining components.

ASME Code, Section XI, Requirements

Hydrostatic pressure tests per the 1980 edition through Winter 1981 Addenda of Section XI, Table IWD-2500-1, Categories D-A, D-B, and D-C.

Licensee's Basis for Relief

Illinois Power Company (IP) submitted the following information by letter dated January 19, 1995:

> ASME Section XI requires hydrostatic testing of Class 1, 2 and 3 systems to be performed at the end of each 10-year inservice inspection interval. Approved Code Case N-498 provides alternative requirements that may be met in lieu of the Code requirements for the 10-year hydrostatic test for Class 1 and 2 systems. Code Case N-498-1 expands the scope of Code Case N-498 to include Class 3 systems. For the latter, in lieu of the 10-year system hydrostatic test required by ASME Section XI (Division 1) Table IWD-2500-1, Code Case N-498-1 permits alternative requirements to be met. Summarily, these requirements are as follows:
>
> (1) A system pressure test shall be conducted at or near the end of each inspection interval.
>
> (2) The test boundary shall extend to all Class 3 components included in those portions of systems required to operate or support the safety function up to and including the first normally closed valve (including a safety or relief valve) or valve capable of automatically closing when the safety function is required.
>
> (3) A VT-2 visual examination shall be performed with the system maintained at nominal operating pressure. The system shall be pressurized to nominal operating pressure for at least 4 hours for

insulated systems and 10 minutes for noninsulated systems, prior to performing the VT-2 visual examination.

(4) The VT-2 visual examination shall include all components identified in part (2) above.

(5) The test instrumentation requirements of IWA-5260 are not applicable.

It is IP's position that these ASME committee-approved requirements provide an acceptable level of quality and safety in lieu of the requirements for performing a system hydrostatic test.

As noted above, the ASME Section XI test schedule specified for performing periodic Class 3 system hydrostatic tests requires such tests to be completed at (or near) the end of the 10-year inservice inspection interval. Accordingly, due to the large scope of affected systems, system hydrostatic testing at the Clinton Power Station (CPS) is currently included in the workscope for the upcoming refueling outage (RF-5) and the next refueling outage (RF-6) since the 10-year inservice inspection interval concludes with RF-6. Authorization to utilize Code Case N-498-1, therefore, affects the scheduled workscopes of RF-5 and RF-6.

The scope of Class 3 systems affected by this Code Case at CPS includes the following:

- Division 1, 2 and 3 Shutdown Service Water system (SX), including SX piping to the Fuel Pool Cooling and Cleanup system (FC) heat exchangers.

- Division 1 and 2 FC system, including the common supply and return piping.

- Instrument Air system (IA), including the charging line to the Automatic Depressurization (ADS) backup air bottles, and piping to the ADS/non-ADS safety relief valve and feedwater check valve accumulators.

- Diesel Generator Air Start system, including piping to the accumulator relief valves.

- Diesel Fuel Oil system (DO), including suction and discharge piping to the first isolation valve.

- Nuclear Boiler system (NB), including the piping downstream of the reactor head vent isolation valve and various instrument lines.

- Reactor Core Isolation Cooling system (RI), including instrument lines from the steam flow element to the instrument panel.

The out-of-service time and costs (in terms of man-hours and radiation exposure) associated with performing code-required testing are considered unwarranted in light of the fact that system integrity can be adequately confirmed through alternative, less costly testing (per N-498-1) that has been determined to be just as effective.

The hardships involved in performing the code-required hydrostatic tests are due mainly to the shear magnitude of the test scope and the difficulties associated with isolating the system or portions of the system to perform the hydrostatic testing. For example, to perform the hydrostatic test on the Division II SX system (currently scheduled for RF-5), the equipment unavailability will be about 48 hours. This estimate is based on encountering minimal problems during performance of the test. If significant difficulties do occur in testing, which may be anticipated for the SX system, accumulated dose and equipment unavailability could be much higher.

The SX system includes approximately 4000 feet of large bore piping and 40 test boundary valves. Six of the boundary valves are large butterfly valves (greater than 8") which tend to leak under hydrostatic pressure. If leakage by these valves exceeds the capacity of the test pump, the test would have to be delayed until the valves are repaired. Clearly, this will have an adverse impact on the outage duration and personnel radiation exposure. [Under system operating (non-test) conditions, leakage through these valves is not a concern, but such leakage can present a problem during testing, due to the potential effect on the test results when the valves serve as test boundary valves.]

The hardships to perform the hydrostatic test on the other two divisions of the SX system are essentially the same. By implementing the alternative testing provisions of Code Case N-498-1, personnel radiation exposure, outage duration, and costs can be significantly reduced. Similar arguments apply to the other noted systems as well. Work plans for performing hydrostatic testing of the other noted systems have not yet been completed at this time, but a quantifiable, unnecessary amount of radiation exposure would certainly result from performing hydrostatic testing on these systems or portions of systems inside the drywell, such as the Instrument Air and Nuclear Boiler systems.

Proposed Alternative Testing

The licensee proposed to use the alternative contained in Code Case N-498-1, a system leakage test, in lieu of hydrostatic testing, for Class 3 systems.

Evaluation/Conclusions

Information prepared in conjunction with ASME Code Case N-498-1 notes that the system hydrostatic test is not a test of the structural integrity of the system, but rather an enhanced leakage test. That this was the original intent as indicated in a paper by S. H. Bush and R. R. Maccary, *"Development of In-Service Inspection Safety Philosophy for U.S.A. Nuclear Power Plants,"* ASME, 1971. Piping components are designed for a number of loadings that would be postulated to occur under the various modes of plant operation. Hydrostatic testing only subjects the piping components to a small increase in pressure over the design pressure, and therefore, does not present a significant challenge to pressure boundary integrity, since piping dead weight, thermal expansion, and seismic loads, which may present far greater challenge to the structural integrity of a system than fluid pressure, are not part of the loading imposed during a hydrostatic test. Accordingly, hydrostatic pressure testing is primarily regarded as a means to enhance leakage detection during the examination of components under pressure, rather than as a measure to determine the structural integrity of the components.

IP requested approval for the implementation of the alternative rules of ASME Section XI Code Case N-498-1, dated May 11, 1994, "Alternative Rules for 10-Year System Hydrostatic Testing for Class 1, 2, and 3 Systems" in lieu of 10-year hydrostatic testing of Class 3 systems (IP may use Code Case N-498 for Class 1 and 2 systems, as it is approved in Regulatory Guide (RG) 1.147). The rules for Class 1 and 2 systems in N-498-1 are unchanged from N-498. Revision N-498-1 encompasses Class 3 components and specifies requirements for Class 3 that are identical to those for Class 2 components. In lieu of 10-year hydrostatic pressure testing at or near the end of the 10-year interval, Code Case N-498-1 requires a visual examination (VT-2) be performed in conjunction with a system leakage test (in accordance with paragraph IWA-5000).

Currently, licensees incur considerable time and radiation dose carrying out hydrostatic test requirements. A significant amount of effort may be necessary (depending on system, plant configuration, Code Class, etc.) to temporarily remove or disable Code safety and/or relief valves to meet test pressure requirements. The safety assurance provided by the enhanced leakage gained from a slight increase in system pressure during a hydrostatic test are offset or negated by the following factors: having to gag or remove Code safety and/or relief valves, placing the system in an off-normal state, erecting temporary supports in steam lines, possible extension of refueling outages, and activities to set up testing with special equipment and gages.

Class 3 systems do not normally receive the amount and/or type of Non-Destructive Examinations that Class 1 and 2 systems receive. While Class 1 and 2 system failures are relatively uncommon, Class 3 leaks occur more frequently and the failure mode typically differs. Based on a review of Class 3 system failures requiring repair for the last five years in Licensee Event Reports and the Nuclear Plant Reliability Data System databases, the most common causes of failures are erosion-corrosion (EC), microbiologically induced corrosion (MIC), and general corrosion. Licensees generally have programs in place for prevention, detection, and evaluation of EC and MIC. Leakage from general corrosion is readily apparent to inspectors when performing a VT-2 examination during system pressure tests. The industry indicates that experience has demonstrated that in general, leaks are not being discovered as a result of hydrostatic test pressures propagating a preexisting flaw through wall. They indicate that leaks, in most cases, are being found when the system is at normal operating pressure.

Giving consideration to the minimal amount of increased assurance provided by the increased pressure associated with a hydrostatic test, versus the pressure for the system leakage test, and the hardship associated with performing the ASME Code required hydrostatic test, the staff finds that compliance with the Section XI hydrostatic testing requirements results in hardship and/or unusual difficulty for the licensees without a compensating increase in the level of quality and safety. Accordingly, the licensee's proposed alternative, use of Code Case N-498-1 for Code Class 3 systems, is authorized for CPS pursuant to 10 CFR 50.55a(a)(3)(ii). IP's alternative is authorized until such time as the Code Case is published in a future revision of Regulatory Guide 1.147. At that time, if the licensee intends to continue to implement this Code Case, the licensee is to follow all provisions in Code Case N-498-1, with limitations issued in Regulatory Guide 1.147, if any.

2.2 CODE CASE N-416-1, "ALTERNATIVE PRESSURE TEST REQUIREMENT FOR WELDED REPAIRS OR INSTALLATION OF REPLACEMENT ITEMS BY WELDING CLASS 1, 2, and 3"

Component Identification

ASME Class 1, 2, and 3 Piping Systems

ASME Code Section XI Second Interval Requirements

The 1980 Edition through Winter 1981 Addenda, Section XI, IWA-4700(a) requires that a system hydrostatic test be performed in accordance with IWA-5000 after repairs by welding on the pressure retaining boundary.

Licensee's Basis for Request

> This Code Case of the ASME Boiler and Pressure Vessel Code addresses the use of a (post-maintenance) system leakage test as an alternative pressure test in lieu of performing the (post-maintenance) hydrostatic pressure test required by paragraph IWA-4000 following welded repairs or installation of replacement items by welding, provided the following requirements are met:
>
> (a) Non-Destructive Examinations (NDE) shall be performed in accordance with the methods and acceptance criteria of the applicable subsection of the 1992 Edition of ASME Section III.
>
> (b) Prior to or immediately upon return to service, a visual examination (VT-2) shall be performed in conjunction with a system leakage test, using the 1992 Edition of ASME Section XI, in accordance with paragraph IWA-5000, at nominal operating pressure and temperature.
>
> (c) Use of this Code Case shall be documented on an NIS-2 Form.
>
> These alternative post-maintenance testing requirements have been evaluated by the ASME Code Case Committee and determined to be acceptable for confirming piping integrity following repairs. It is

therefore, IP's position that an acceptable level of quality and safety will be maintained by following the requirements of Code Case N-416-1.

By permitting system leakage testing in lieu of hydrostatic testing, use of Code Case N-416-1 during the upcoming refueling outage would result in an immediate benefit associated with scheduled maintenance activities. Those activities (i.e., those known at this time), and the hardships involved in meeting current code requirements due to those activities are briefly described (by associated component number) below:

a) 1CC107B, Reactor Recirculation (RR) Pump 1B Seal Oil Cool Outlet Valve

   This is a 2" gate valve scheduled for replacement in the upcoming refueling outage. This test will likely involve extensive work near the RR pump in the drywell basement resulting in significant radiation exposure to maintenance and test personnel. The test boundary is also large, as it encompasses the outlet Component Cooling system piping from both the "A" and "B" RR pumps and the motor bearing coolers.

b) 1SX173A, Residual Heat Removal (RHR) Heat Exchanger 1A Bypass Valve

   This is a 10" valve scheduled for replacement in the upcoming refueling outage. The associated hydrostatic test (if performed to current code requirements) will require removal of a flow orifice and the installation of an 18" "pancake." This work will have considerable impact on the outage schedule. Additionally, operation and test personnel will receive radiation exposure since the VT-2 inspection area is inside the RHR "A" heat exchanger room.

c) 1B21F001 and 1B21F002, Reactor Pressure Vessel Head Ventilation Valves

   These valves are 2" valves scheduled for replacement in the upcoming refueling outage. Although the scope is not extensive, radiation exposure could be high due to preparation work required in the drywell.

d) 1C11F122, Control Rod Drive Water Supply Header Check Valve

   This valve is a 2" outboard containment isolation check valve that may be replaced in the upcoming refueling outage. The test scope is small, but the test will be performed in the drywell, resulting in radiation exposure to operation and test personnel.

To repeat, the above activities have already been identified for RF-5. Additional savings in man-hours and exposure could be realized for emergent activities identified during the outage.

Proposed Alternative Examination

The licensee proposes to apply Code Case N-416-1 as alternative rules for welded repairs or installation of replacement items by welding in Class 1, 2, and 3 piping.

Evaluation/Conclusions

In lieu of hydrostatic pressure testing for welded repairs or installation of replacement items by welding, Code Case N-416-1 requires a visual examination (VT-2) be performed in conjunction with system leakage testing using the 1992 Edition of Section XI, in accordance with paragraph IWA-5000, at nominal operating pressure and temperature. This Code Case also specifies that NDE of the welds be performed in accordance with the applicable Subsection of the 1992 Edition of Section III.

The 1989 Edition of Sections XI and III are the latest editions referenced in 10 CFR 50.55a. The staff has compared the system pressure test requirements of the 1992 Edition of Section XI to the requirements of IWA-5000 of the 1989 Edition of Section XI. In summary, the 1992 Edition imposes a more uniform set of system pressure test requirements for Code Class 1, 2, and 3 systems. The terminology associated with the system pressure test requirements for all three Code Classes has been clarified and streamlined. The test frequency and test pressure conditions associated with these tests has not been changed. The hold times for these tests have either remained unchanged or increased. The corrective actions with respect to removal of bolts from leaking bolted connections have been relaxed in the 1992 Edition, but use of this change has been accepted by the staff in previous safety evaluations. The post-welded repair NDE requirements of the 1992 Edition of Section III remain the same as the requirements of the 1989 Edition of Section III. Therefore, the staff finds this aspect of Code Case N-416-1 to be acceptable.

Hardships are generally encountered with the performance of hydrostatic testing performed in accordance with the Code. For example, since hydrostatic test pressure would be higher than nominal operating pressure, hydrostatic pressure testing frequently requires significant effort to set up and perform. The need to use special equipment, such as temporary attachment of test pumps and gages, and the need for individual valve lineups can cause the testing to be on a critical path.

Piping components are designed for a number of loadings that would be postulated to occur under the various modes of plant operation. Hydrostatic testing only subjects the piping components to a small increase in pressure over the design pressure and, therefore, does not present a significant challenge to pressure boundary integrity. Accordingly, hydrostatic pressure testing is primarily regarded as a means to enhance leakage detection during the examination of components under pressure, rather than solely as a measure to determine the structural integrity of the components.

The industry indicates that experience has demonstrated that leaks are not being discovered as a result of hydrostatic test pressures propagating a preexisting flaw through wall. They indicate that leaks in most cases are being found when the system is at normal operating pressure. This is largely due to the fact that hydrostatic pressure testing is required only upon installation, and then once every 10-year inspection interval, while system leakage tests at nominal operating pressures are conducted a minimum of once each refueling outage for Class 1 systems and each 40-month inspection period for Class 2 and 3 systems. In addition, leaks may be identified during system walkdowns by plant operators, which may be conducted as often as once a shift.

Following the performance of welding, the Code requires volumetric examination of repairs or replacements in Code Class 1 and 2, but only requires a surface examination of the final weld pass in Code Class 3 piping components. There are no ongoing NDE requirements for Code Class 3 components, except for visual examination for leaks in conjunction with the 10-year hydrostatic tests and the periodic pressure tests.

Considering the NDE performed on Code Class 1 and 2 systems, and considering that the hydrostatic pressure tests rarely result in pressure boundary leaks that would not occur during system leakage tests, the staff believes that increased assurance of the integrity of Class 1 and 2 welds is not commensurate with the burden of performing hydrostatic testing. However, considering the nature of NDE requirements for Code Class 3 components, the staff does not believe that eliminating the hydrostatic pressure testing and only performing system pressure testing is an acceptable alternative to hydrostatic testing without compensatory measures. Additional surface examinations must be performed on the root pass layer of butt and socket welds on the pressure retaining boundary of Class 3 components, when the surface examination method is used in accordance with Section III.

With this provision applied to Code Class 3 components, the staff concludes that compliance with the Code hydrostatic testing requirements for welded repairs or replacements of Code Class 1, 2, and 3 components would result in hardships without a compensating increase in the level of quality and safety. Accordingly, the licensee's proposed alternative to use Code Case N-416-1 is authorized for Clinton Power Station, pursuant to 10 CFR 50.55a(a)(3)(ii), provided additional surface examinations are performed on the root pass layer of butt and socket welds on the pressure retaining boundary of Class 3 components, when the surface examination method is used in accordance with Section III. Use of Code Case N-416-1, with provision as noted above, is authorized until such time as the Code Case is published in a future revision of Regulatory Guide 1.147. At that time, if the licensee intends to continue to implement this Code Case, the licensee is to follow all provisions in Code Case N-416-1, with limitations issued in Regulatory Guide 1.147, if any.

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