UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ALTERNATIVE REPAIR OF THE CORE SHROUD VERTICAL WELDS

NINE MILE POINT NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-220

1.0 INTRODUCTION

By letter dated February 3, 1999 (the application), as supplemented by letter dated April 14, 1999, Niagara Mohawk Power Corporation (NMPC and licensee) transmitted to the NRC a contingency repair plan for the core shroud vertical welds at Nine Mile Point Nuclear Station, Unit No. 1. The function of the repair is to structurally replace vertical core shroud welds V4, V9, and V10, even if these welds are postulated to be completely cracked. The repair has been developed as an alternative repair to the requirement of ASME Boiler and Pressure Vessel Code (ASME), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components." Use of the alternate repair was requested pursuant to 10 CFR 50.55a(a)(3)(i). The repair design is consistent with, and meets the guidelines of the Boiling Water Reactor Vessel and Internals Project, as stated in their report BWRVIP-02, "Core Shroud Repair Design Criteria," and as accepted by the NRC staff by letter and safety evaluation (SE) dated September 29, 1994. The design specifications for the repair are provided in Enclosure 3 of NMPC's application. The repair is designed to satisfy the structural requirements of Section III, Division 1 - Subsection NG, "Core Support Structures," of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), 1989 edition.

2.0 DESIGN DESCRIPTION

The repair clamp design and installation drawings are provided in NMPC's application. Some of these drawings are extracted and attached to this SE. Attached Figure 1-1 shows the locations of the NMP1 core shroud welds. The NMP1 repair plan addresses vertical welds V4, V9, and V10, and the repair clamps can be installed on each weld independently; i.e., depending upon shroud inspection results, any one, two, or three welds may be repaired with these repair clamps. Attached Figure 1-3 shows the vertical weld clamp assembly installed across vertical weld V4. Attached Figure 1-4 is an exploded view of the vertical weld clamp assembly before installation across vertical weld V9 or V10.

Each repair clamp consists of a clamp plate and two bayonet eccentric/threaded pin assemblies. The clamp is installed in openings that are machined in the shroud by an electric discharge machining (EDM) process on each side of the cracked vertical weld. The repair weld clamp transmits the shroud hoop pressure force that would otherwise be transmitted through the shroud vertical weld. The structural load path is from the shroud, through a bayonet eccentric/threaded pin to the clamp plate, through the clamp plate and other bayonet eccentric/threaded pin assembly, and back to the shroud.

Enclosure

The clamp is installed by extending the threaded pin through the bayonet eccentric and the plate, into the cutout in the shroud wall. This cutout consists of two overlapping holes with their centers slightly displaced along the horizontal axis. One hole is large enough to allow the flange on the end of the threaded pin to pass through. The clamp assembly is then fixed in position so that the threaded pin flange, extending beyond the inner surface of the shroud wall, is aligned along the central axis of the smaller hole. The pins are then torqued to a predetermined value, bringing the flange surfaces of the pins into contact with the shroud's inner surface. The bayonet eccentrics are then fixed into position by means of the locking screws that extend into the mating holes in the eccentrics.

3.0 EVALUATION

The repair clamps for NMP1 are fabricated from solution annealed Type XM-19 stainless steel, and XM-19 material is used for all parts of the repair clamp assembly, including the locking screw. XM-19 material is resistant to stress corrosion cracking and has been used successfully in the BWR reactor coolant system environment. No welding or thermal cutting is used in the fabrication and assembly of the repair clamp components.

The leakage paths through the shroud holes are effectively sealed by the extended seal ring portions of the clamp plate that are machined to a radius equal to the shroud radius and seat on the shroud surface. The preload between the pin flanges, the clamp plate, and the shroud prevents relative displacement between the repair clamp and the shroud due to flow-induced vibration loading.

The significant operational design loads for the repair clamp are those due to differential pressure across the shroud and differential thermal expansion between the shroud and repair clamp. The accident condition loads and load combinations, such as those due to a recirculation line break and seismic events, are summarized in Table 4-1 of Enclosure 3 of NMPC's application.

The stresses in the repaired core shroud were evaluated using a finite element model. This model includes the repair clamp and the shroud with the machined holes for the clamp. Calculations were provided for the repair at two separate locations on the shroud cylinder, namely at vertical welds V9/V10 and V4.

A finite element computer program, ANSYS, which has been benchmarked and previously accepted by the NRC for a variety of applications, was used to demonstrate that the stresses in the core shroud and the repair clamp, with the associated vertical welds postulated to be completely cracked, meet the requirements of the ASME Code, Section III, Division 1 - Subsection NG, 1989 Edition for the conditions specified in the shroud vertical weld repair design specifications given in NMPC's application.

The stresses at the limiting locations of the core shroud are summarized in Table 4-2 of Enclosure 3 of the NMPC's application for the normal operating and accident load cases defined in the design specification for the repair. The limiting calculated stresses in the core shroud for service levels A, B, and C, have been shown to be less than the code–allowable values specified in ASME Code Subsections NG-3222, 3223, 3224, and 3227. The bearing

stress at the clamp/shroud interface and the peak stresses, summarized in Table 4-2 of Enclosure 3 to NMPC's application, have been determined to be within allowable values specified in Subsection NG 3227 of the ASME Code.

The peak stresses due to alternating loads and resulting fatigue usage have been calculated. The maximum fatigue usage in the repair assembly due to thermal expansion (including startup and shutdown) loads occurs in the bayonet hole in the repair clamp plate. The fatigue usage at this location is negligible. The maximum fatigue usage in the shroud at the repair attachments has also been determined to be negligible, as discussed in Section 4.3.2 of Enclosure 3 of NMPC's application. The fatigue usage from flow induced vibration has also been determined to be well below the allowable value of 1.0. Thus, the clamp displacements or alternating stresses due to flow-induced vibration will be insignificant.

The structural integrity of the repair clamp was evaluated under accident condition loads. The calculated limiting stresses in the clamp during the governing loss of feedwater thermal transient and the main steam line break are summarized in Table 4-2 of Enclosure 3 of NMPC's application. These have been determined to be within allowable limits specified in ASME Code Section III, Subsections NG-3223 and NG-3224.

The stress and seismic analyses for the core shroud tie-rod repair were evaluated to determine if there is any impact from the vertical weld repair. The tie-rod repair assumes that the shroud will retain a cylindrical configuration under all applicable loads and load combinations. This is one of the functional requirements for the vertical weld repair.

The fuel loads during a seismic event would be transmitted directly through the top guide or core support plate rings to the tie-rod radial restraints. Therefore, it is the stiffness of these rings, and not the stiffness of the shroud cylinders, that affects the fuel seismic response.

For a shroud cylinder with fully-cracked vertical welds and end conditions that provide no lateral shear restraint, the lateral stiffness would be reduced. Since shroud stiffness is a parameter in the shroud seismic model, this reduction could impact the seismic analysis results. However, this potential was determined to be insignificant. The hinged connection in the analytical model provides shear transfer between the shroud cylinders and permits the shroud cylinders to retain their uncracked moment of inertia and rotational stiffness.

A clearance of 0.75 inch was designed between the shroud and the tie-rod mid-supports. For this clearance, no lateral seismic loads were applied to the shroud during a seismic event. However, with the as-installed clearance of 0.375 inch between the shroud and the mid-supports, there are several Level D load combinations where the relative seismic displacement at the mid-support exceeds the 0.375 inch clearance. The resulting mid-support load was evaluated as a primary load, and the loads reacted by the vertical weld repair were determined to be acceptable (Section 4.5 of Enclosure 3 of NMPC's application).

On the basis of its review, the NRC staff finds NMPC's assessment to be reasonable and acceptable. Therefore, the NRC staff concludes that the vertical weld repair will have no impact upon the tie-rod repair and the supporting stress and seismic analyses.

Loose Parts Consideration

The various pieces that make up the repair assemblies are captured and restrained by appropriate locking devices such as locking cups and crimping. These locking device designs have been used successfully for many years in reactor internals. Loose pieces cannot occur without failure of the locking devices or repair assembly components. Such locking devices and the stresses in the pieces which make up the repair clamps are well within allowable limits for normal plant operation.

Inspections

In addition to certain pre-modification inspections, NMPC will perform a post-modification inspection before the reactor pressure vessel is reassembled. This inspection will confirm and record proper installation of each repair clamp assembly by television visual inspection from both the inside and outside of the shroud. The inspection will verify that all parts are installed as required and no foreign objects remain.

Inspection of the repair clamps during future refueling outages will be in accordance with Section 4.2 of BWRVIP-07, "BWR Vessel Internals Project Guidelines for Reinspection of Core Shrouds." The reinspection will involve the visual inspection of the overall clamps and the threaded pin-to-eccentric and locking screw-to-eccentric crimp areas to confirm that no change has occurred since their post-modification inspection.

The NRC staff finds these inspection plans to be reasonable and acceptable.

CONCLUSION

The proposed repair had been designed as an alternative to the requirements of ASME Boiler and Pressure Vellel Code (ASME), Section XI. Based on its review, as discussed above, the NRC staff finds that the repair clamp assembly is compatible with the BWR environment, and its structural design meets the acceptance criteria of the ASME Code Section III, Subsection NG for normal operational and accident condition loads. NMPC's inspection plans during installation and during subsequent refueling outages will provide acceptable verification of proper installation and performance of the repair. Therefore, the proposed repair plan provides an acceptable level of quality and safety and is acceptable as an alternate to the requirements of the ASME Code pursuant to 10 CFR 50.55a(a)(3)(i).

Attachments:
1. Figure 1-1 NMP1 Core Shroud Welds
2. Figure 1-3 Installed V4 Clamp Assembly
3. Figure 1-4 Exploded View of V9/V10 Clamp Assembly

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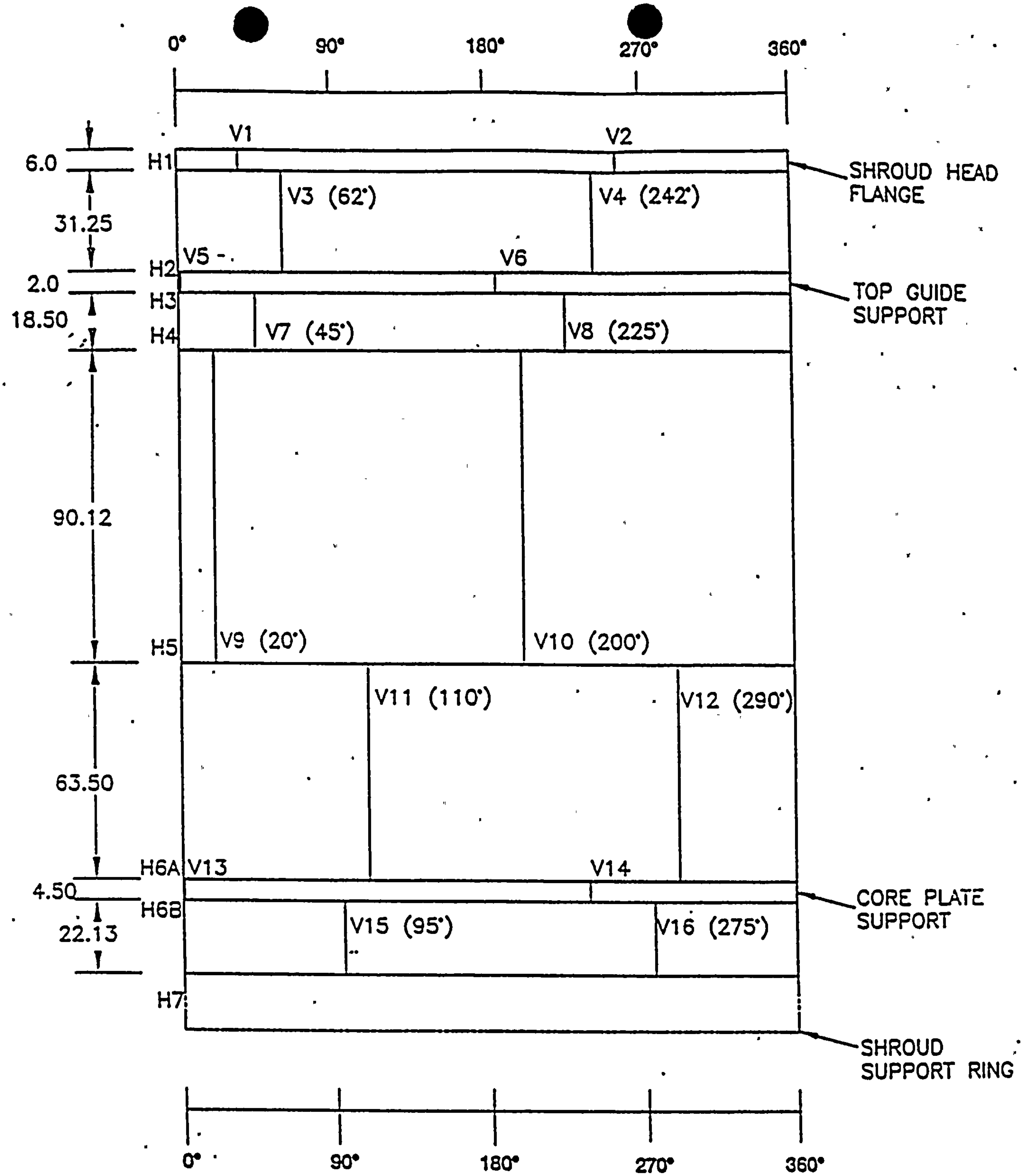

Figure 1-1. Nine Mile Point - Unit 1
NMP-1 Core Shroud Welds

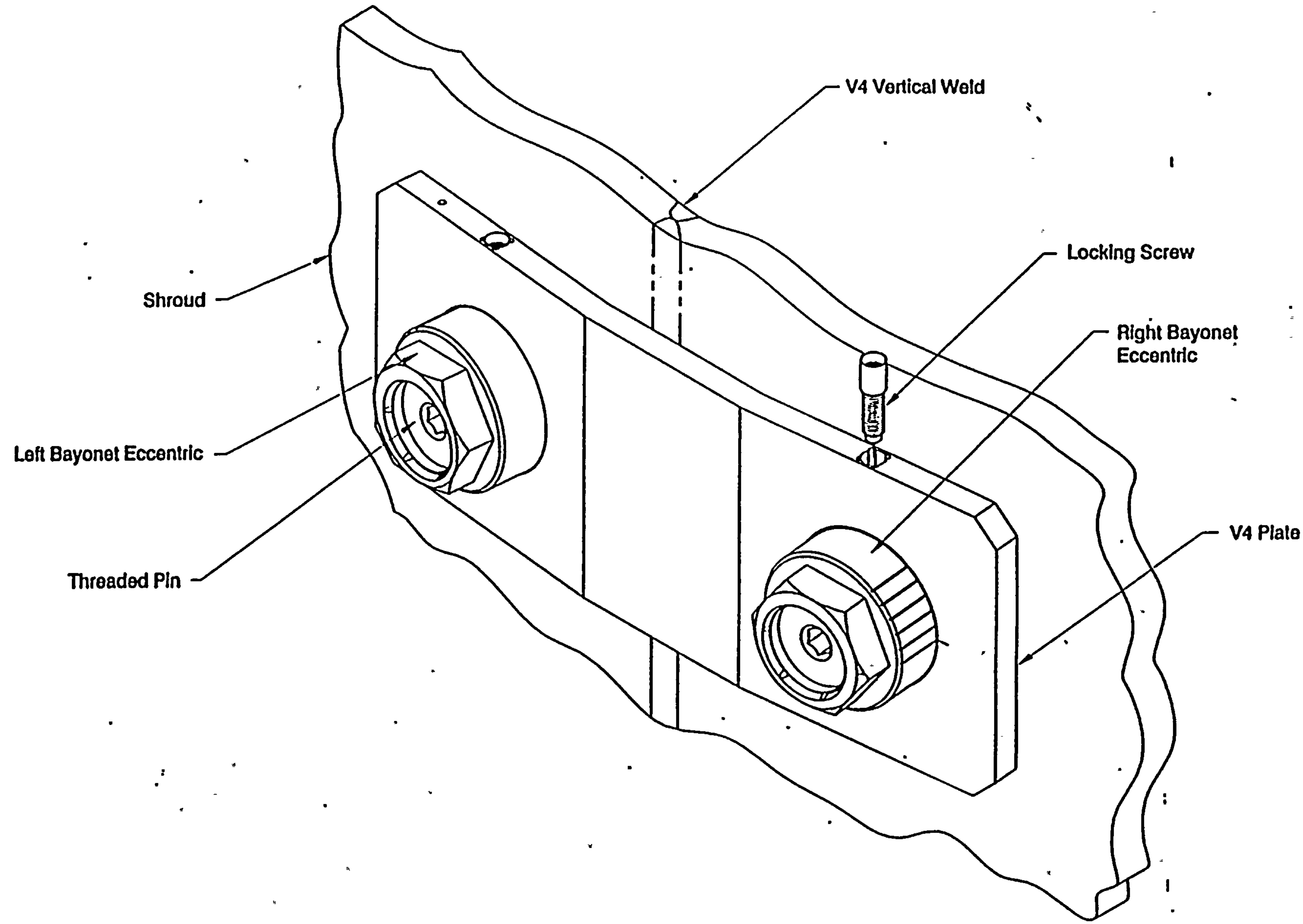

Figure 1-3. Nine Mile Point - Unit 1
Installed V4 Vertical Weld Clamp Assembly

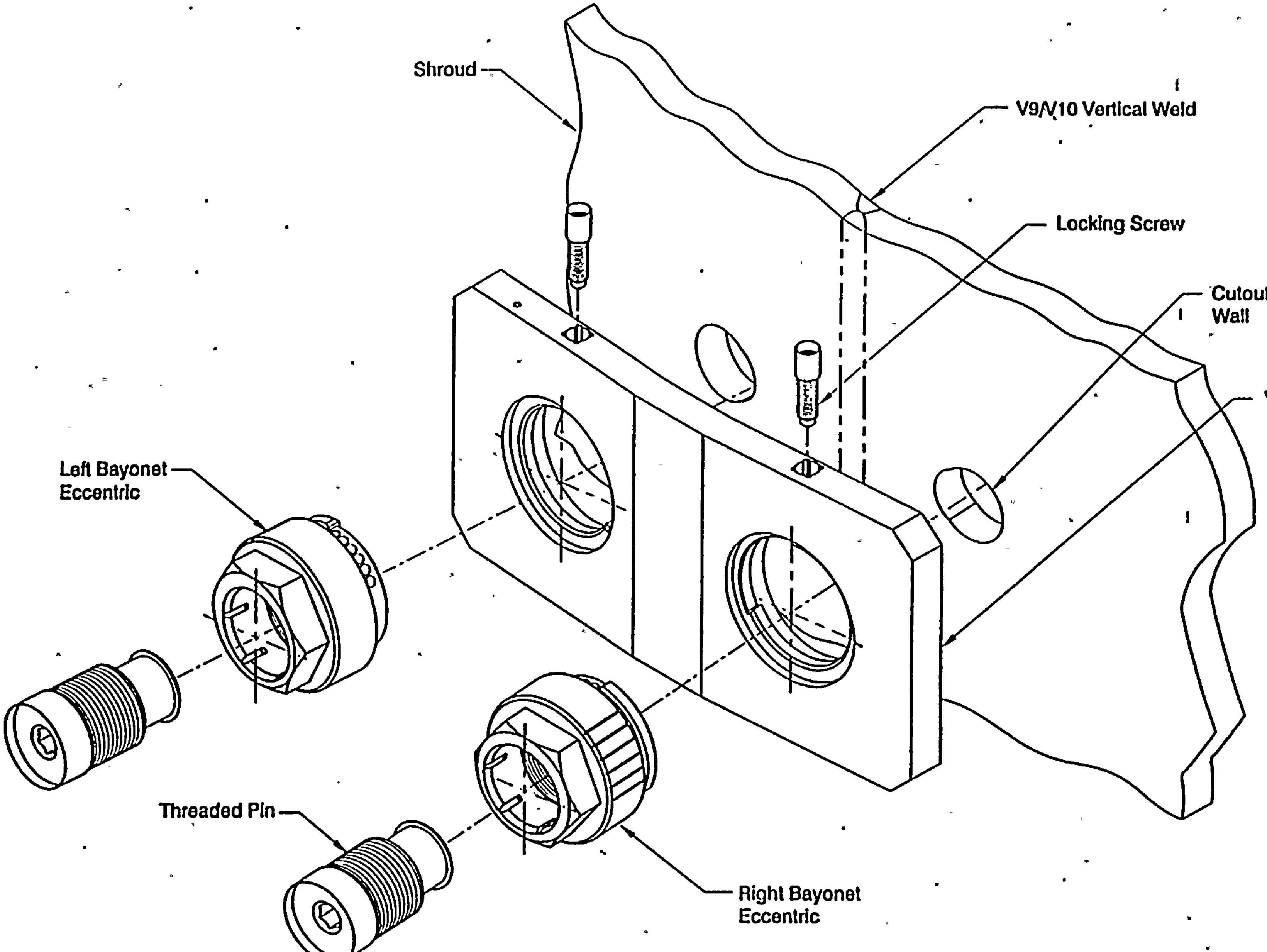

Figure 1-4. Nine Mile Point - Unit 1
Exploded View of V9/V10 Vertical Weld Clamp Assembly

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