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AmerGen Energy Co., LLC
Clinton Power Station Unit 1
Core Shroud Repair
GE Input to 10CFR50.59 Evaluation by CPS

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1. INTRODUCTION

Due to the concern for existing cracking of the core shroud welds H3, H4, H5, H6B, a replacement of the shroud horizontal welds will be installed in the AmerGen's Clinton Power Station Unit 1 (CPS).

The purpose of this report is to provide the input to CPS evaluation for the stabilizer installation on the Clinton core shroud per 10 CFR 50.59. Based on the results of the review/evaluation, it is concluded that the installation of the core shroud repair is acceptable. It should be noted that because the repair is an alternative to ASME Section XI repair/replacement requirements, the repair is to be submitted to the NRC in accordance with 10CFR50.55a(a)(3)(i) for review and approval.

1.1 GENERAL

Welds H1 through H7 of the core shroud will be structurally replaced by a set of four stabilizer assemblies. Figure 1 shows the locations of welds H1 through H7 and Figure 2 shows a stabilizer assembly. Each stabilizer attaches at the top to the shroud flange and to the shroud support plate at the bottom.

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1.2 Design

Significant cracking within the heat affected zone adjacent to the horizontal shroud welds has been observed at numerous BWRs. Based on this knowledge, and to minimize the consequences of existing cracking of welds H3, H4, H5, H6B at CPS, a shroud repair is being implemented. The replacement will structurally replace all of the horizontal girth welds in the shroud with a set of four tie rod stabilizer assemblies.

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The stabilizer assemblies are designed and fabricated as safety related components. The installation of the stabilizer assemblies structurally replaces the functions of welds H1 through H7.

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1.3 Materials

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1.4 System Evaluation

A comprehensive system evaluation has been performed on the impacts of the proposed shroud modification and the result indicates that there is no need for a new safety analysis, no system degradation, and no need for changes in system documentation, set points or Technical Specifications.

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1.4.2 Steam Separation System

The leakage flow has the effect of slightly decreasing the flow per separator and slightly increasing the separator inlet quality. The separator performance is based on the applicable separator test data over the operating water level range. [[

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1.4.3 Jet Pumps

The shroud repair leakage has no significant impact on the sub cooling of the flow in the downcomer. Hence, there is no change in the net positive suction head and the margin to jet pump cavitation remains adequate. There is no impact on jet pump performance compared with the normal design condition.

1.4.4 Core Monitoring

The impact of the leakage results in an over prediction of core flow by about 0.045% of core flow. [[

]] Therefore, it is concluded that the impact is insignificant.

1.4.5 Anticipated Abnormal Transients

The code used to evaluate performance under anticipated abnormal transients and determine fuel thermal margin includes carryunder as one of the inputs. Since there is no significant change in carryunder due to leakage, the thermal limits are not impacted.

1.4.6 Emergency Core Cooling System

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]]. Therefore, it is also expected that the conclusion drawn for the current analysis below would be applicable for the bounding 120% extended power uprate condition.

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]] This PCT value is significantly lower than the 10CFR50.46 acceptance criteria of 2200^{0}F. Furthermore, this shroud repair does not affect the limiting break location, limiting break size nor the limiting single failure. This 6°F PCT increase will be reported to the NRC via the standard 10CFR50.46 submittal.

1.4.7 Fuel Cycle Length

[[ ]] in a minor effect (~ 0.05 days) on fuel cycle length and is considered negligible.

1.4.8 Coolant Inventory Volume and Downcomer Flow Area

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]] it was

determined that the reduction in coolant inventory due to the installation of the repair hardware is less than the available margin used in the safety analysis.

The impact of the additional flow blockage by the repair hardware installed in the downcomer on the coolant recirculation hydraulic resistance, loop pressure drop, reactor coolant level, and the coolant flow rate was determined to be negligible.

1.4.9 Conclusions

The impacts of the leakage flows through the shroud repair holes have been evaluated. The results show that at up to bounding EPU conditions of 120% of rated power and rated core flow the leakage flow from the shroud repair holes, is predicted equal to about 0.045% of core flow. This leakage flow is sufficiently small so that the steam separation system performance, jet pump performance, core monitoring, fuel thermal margin and fuel cycle length are not significantly impacted. [[

]] Even with this 6^{0}F increase in the PCT, the PCT is about 600^{0}F below the 10CFR50.46 acceptance criteria of 2200^{0}F. This modification will have no adverse impact on the Transient analyses, Accident analyses, ATWS, Stability, and EOOS currently in place for Clinton operations.

1.5 Seismic and Dynamic Analysis

A Seismic/Dynamic analysis of the CPS has been performed to obtain shroud repair design loads as well as loads in selected NSSS components to support the shroud repair project. These loads were used for the new repair hardware design, as well as to validate the integrity of the reactor vessel internal structures and to ensure emergency shutdown. Analyses were completed for a range of postulated shroud weld cracks as well as for a fully uncracked configuration with shroud repair hardware installed.

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In order to insure that the installation of the stabilizer design does not adversely affect the existing dynamic qualification of the RPV and internals, assuming no defective welds are present, analyses for the uncracked case were performed with and without the shroud repair in place. It was concluded that Seismic & Dynamic loads in the RPV and internal structures are decreased, or at least not significantly increased, by the shroud stabilizer installation. It was also shown that loads in the RPV and internals are generally reduced by the inclusion of the most limiting combination of assumed cracks. [[

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The piping input motion response spectra taken at the RPV attachment points are essentially the same for the uncracked benchmark model without the shroud repair hardware and the bounding shroud crack model with the shroud repair hardware. Therefore, no impact on piping occurs as a result of the repair hardware installation.

1.6 Design Evaluation

The results of the structural evaluations per References 6.1 and 6.2 are documented in References 6.7 through 6.9. References 6.7 and 6.8 address the ASME Section III RPV and shroud support system while Reference 6.9 addresses the stabilizers and shroud. The stabilizers and affected shroud and RPV components are shown to satisfy the USAR structural requirements using the USAR load combinations. The displacements of the core support plate and the top guide are limited to the allowable displacements given in Reference 6.1, for all load combinations.

1.6.1 Load Combinations

The following governing load combinations and their classification (per Clinton USAR and the New Loads Evaluation load combinations) were considered for the stabilizer design:

Normal: Weight, normal operating pressure differences and temperatures

Upset 1:	Weight, upset operating pressure differences and normal operating temperature plus OBE plus SRV_{ALL}
Upset 2:	Weight, Upset pressure differences, plus maximum transient temperature
Emergency:	Weight plus upset operating pressure differences plus SRV_{ALL} plus LOCA
Faulted 1:	Weight plus SSE plus AP plus main steam line LOCA pressure differences
Faulted 2:	Weight plus SSE plus SRV_{ALL} plus LOCA plus main steam line LOCA pressure differences.
Faulted 3:	Weight plus SSE plus Recirculation Line LOCA loads plus upset pressure differences.

The above governing load combinations and their classification per CPS USAR were considered for the shroud and affected shroud components.

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An evaluation of the effects of shroud stiffness on tie rod preload is documented in Reference 6.8. The lowest tie rod thermal preload occurs when the tie rods are installed on the uncracked shroud and subsequently shroud welds including H1, H2, H3, H4, H5, H6A, H6B, and H7 crack.

The lowest resulting tie rod preload was still found to provide a net compression on the shroud. Therefore, no crack separation will occur during normal operation.

Section 4.3 of CPS Core Support Stress Analysis Report (Reference 6.8) provides the details of the shroud compression/separation characteristics and the tie rod loads based on the worst possible scenario. The summary of these evaluations is shown in Reference 6.8, and the results are acceptable.

The tie rod preload was also shown to be sufficient to maintain net compression of the shroud during the normal and upset condition with upset operating pressure differences and temperature plus OBE plus SRV.

1.6.2 Results

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]]. The predicted deflections of both the top guide and the core plate, for all load combinations, are within the allowables defined in the design specification (Reference 6.1)

The shroud repair hardware was shown to have met all the limits in the design specification for all load combinations.

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There is essentially no fatigue damage of any of the repair hardware components (Reference 6.9).

1.6.3 Loose Parts Consideration

The repair hardware assemblies are designed to minimize the number of parts and to prevent a loose part. All components are mechanically constrained using pin fasteners, threaded fasteners (all threaded joints are drilled and pinned), and locking springs which engage into slots and prevent loosening due to vibration. Locking devices are not used as primary load carrying components and are carefully placed to assure that inadvertent overload will not occur. In order to prevent a loose part for the long term, IGSCC is considered by limiting the sustained stress levels, using IGSCC resistant materials, and precluding any welding. In addition, a periodic inspection program is planned by the utility. Sustained tensile stresses in Alloy X-750 components are less than ½ Sy (50% of yield stress at temperature) and thus initiation of IGSCC is highly unlikely.

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1.6.4 Limitations to Shroud Weld Inspection

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1.7 Installation Concerns

The installation crew will be trained, and the installation of the repair hardware qualified on a full-scale prototypical mock-up, including prototypical mock-up hardware using the actual installation tooling and procedures at the GE BWR Training Facility in San Jose, California. This training and qualification will ensure that the proper installation of the hardware is accomplished. Several specific concerns related to installation are addressed below.

1.7.1 Potential Debris Generated by Installation Processes

The stabilizer installation involves the following operations that could generate small objects or debris that may remain in the reactor after the repair is completed.

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The shroud support plate is a low flow area. Thus, swarf or particulates from honing which comes to rest on the shroud support plate is not expected to migrate significantly. Any swarf or honing particulate, which may be picked up from the shroud support plate, is acceptable as discussed below.

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Therefore, it is believed that the shroud stabilizer installation will not adversely affect the reactor recirculation pump seal performance or life.

The potential for the particles generated by the installation processes having adverse effects on instrumentation was also reviewed. Because the remaining particles are expected to be dispersed by the flow throughout the reactor and there is no flow through the instrumentation that could draw in these particles if through-flow were to be present, it is not expected that these particles would be able to migrate into the instrumentation lines to cause plugging or other adverse effects. Therefore, it is very unlikely that these particles will have any effect on the instrumentation.

In summary, reliable and efficient collection of the EDM particles and the metal particles generated by the installation of the shroud stabilizers eliminates any potential problems that could be caused by these particles. A small amount of particles that may not be collected by the EDM electrode flushing system do not represent a concern for fuel fretting and subsequent fuel damage nor do they represent a concern for CRD seal wear, reactor recirculation pump seal life, or adverse effects on instrumentation. Field experience from previous repairs has not identified any operational problems due to the particles generated by the installation processes. In the unlikely event that any abnormal results should occur from an EDM process, they will be addressed by a separate evaluation at the time they occur.

1.7.2 Control of Parts and Tooling During Installation

Parts and tooling are logged and controlled per plant tool control procedures prior to installation in the vessel. Parts and tooling are checked for loose parts and foreign material prior to installation and verified to be still intact upon removal. Tools are designed for foreign material exclusion (FME) by minimizing the number of parts, locking fasteners, and providing lead-ins and lead-outs to avoid impact on the tool. Additionally, personnel are trained in the proper use of the tools and on FME awareness.

1.7.3 Protection of Plant Components During Installation

Safety kinks of the lifting cable are used to assure safe lifting or lowering of tools and/or hardware components. Where safety kinks are not practical due to heavy components, a dynamometer is used to aid the operator in determining when the tool weight changes as contact is made with reactor components. Personnel have been trained on the installation techniques necessary to protect delicate items, such as jet pump sensing lines, during full-scale mockup training.

All lifting and handling equipment, which lift loads in excess of 750 pounds, have been designed in accordance with NUREG-0612 requirements for Special Lifting Devices and has been load tested to 300% of the loads being lifted. Certifications are maintained in the Project Quality Assurance file. All other lifting devices have been designed to at least twice the load being lifted and tested to 1.25 times the maximum load.

No activity is planned in the spent fuel pool area, and therefore there should be no concern for the pool liner.

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2. REASON FOR CHANGE

Cracks have been observed in the core shrouds of several BWRs. The USNRC has issued a generic letter, Reference 6.10, which required inspection or repair. Since CPS core shroud has cracks at welds H3, H4, H5, and H6B installation of stabilizers was chosen for CPS. This evaluation discusses the preemptive installation of the stabilizers. The stabilizers structurally replace welds H1 through H7 welds in CPS shroud. This Safety Evaluation is based on the assumption that all of the horizontal girth welds H1-H7 have significant cracking. However, as stated earlier, there is no degradation of function if the stabilizers are installed in the absence of cracks.

3. DESIGN AND LICENSING DOCUMENTATION REVIEW

The CPS USAR (Reference 6.3) was reviewed. The results of that review are as follows. The numbers in (e.g. 3.9.5.1.1) are the paragraph numbers from which the information was extracted.

(3.9.5.1.1)	Gives a brief description of the shroud and shroud support
(3.9.5.3.6 & Tables 3.9-2, 3.9-2 (a), 3.9-2(b)	Defines the required load combinations for RPV & Shroud support, and Core support structures.
(4.1.2 and 4.5.2)	Description of Internals, and Materials used

4. 10CFR50.59 EVALUATION

The following is not intended to be a complete 10 CFR 50.59 evaluation. However, within the GE scope of supply, the following provides summarized justifications for the answers to the license amendment criteria. The intent of this appendix is to aid AmerGen in producing their official 10 CFR 50.59 evaluation.

4.1 Safety Analysis Report

1. [ ] Yes [X] No Will the change proposal result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the USAR?

Basis: The structural integrity of the core shroud assembly has a Safety function in maintaining core flooding to 2/3rd core height in the event a recirculation Loss of Coolant Accident. (LOCA). The elevation of 2/3rd core height corresponds to midway between the elevations of the H3 & H4 welds in the shroud. The separation of a section of the shroud from the remainder of the shroud assembly would compromise the ability to keep the core flooded to 2/3rd core height. The function of the repair hardware assembly is to provide a mechanical clamping function for the horizontal welds of the shroud and thus prevent the separation of a section of the shroud from the remainder of the shroud. The further function of the repair hardware is to maintain the alignment of core plate and the top guide/grid so that the fuel assembly alignment is maintained and control blades can be inserted for the plant shutdown. The repair reestablishes the function of maintaining core flooding to 2/3rd core height flooding and by its design does not increase the frequency of occurrence of an accident previously evaluated in the USAR.

2. [ ] Yes [X] No Will the change proposal result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system or component (SSC) important to safety previously evaluated in the USAR?

Basis: The installation of the repair hardware assembly will not increase the likelihood of a shroud assembly failure, and thus reduce the probability that shroud section could become detached from the remainder of the shroud assembly. The installation of the repair hardware assembly will not otherwise affect the structure, function, or performance of the Jet Pump Assembly or ECCS system.

3. [ ] Yes [X] No Will the change proposal result in more than a minimal increase in the consequences of an accident previously evaluated in the USAR?

Basis: The failure of shroud horizontal welds during reactor operation would result in the loss of the structural integrity of the core shroud. This would affect the required (assumed) function to keep the core flooded to 2/3rd core height in the event of a LOCA. However the consequences of this event would not be affected by the installation of the replacement repair assembly (leakage and increase in PCT of 6^0F due to repair is insignificant). Installation would reduce the consequences of an accident if welds were cracked since it would keep the core plate and top guide/grid alignment so that control blades can be inserted for the plant shutdown.

4. [ ] Yes [X] No Will the change proposal result in more than a minimal increase in the consequences of a malfunction of a SSC important to safety previously evaluated in the USAR?

Basis: The installation of the repair hardware assemblies will not adversely affect the function of the core shroud, or will not adversely affect a plant operating condition, nor plant operations with respect to nuclear safety. Also, equipment environment, operating ranges or loadings (e.g., stress or pressure) will not be affected. No new safety-related equipment interaction, safety-related equipment failure mode, adverse operating scenario or sequence of events will be created by the installation of the repair hardware assembly. The challenges to equipment important to safety will not be increased. The transient analyses in the USAR will not be affected. The repair hardware assembly will not create a new safety-related equipment failure mode, create the possibility of a new limiting transient, or create a new sequence of events that can result in a radiological release above a current operating, 10 CFR 50, Appendix I, ALARA or 10 CFR 20 limit. Therefore, the installation of the repair hardware assembly cannot create the possibility for a malfunction of a SSC important to safety with a different result than any previously evaluated in the USAR.

5. [ ] Yes [X] No Will the change proposal create a possibility for an accident of a different type than any previously evaluated in the USAR?

Basis: The shroud repair assemblies are designed to the structural criteria specified in the Clinton Power Station USAR. The shroud repair assemblies were evaluated using the loads and load combinations applicable to the core shroud. The stresses in the hardware components were determined to be within the design allowables. The increased operating pressures due to Power Re-rate and Increased Core Flow were included in the design analysis. The shroud repair assemblies replace the structural function of the horizontal H1 through H7 welds in the core shroud. This will maintain structural integrity of the shroud, providing the required floodable volume around the core, and maintaining the alignment of the fuel assemblies and control blades. The additional leakage across the shroud support plate resulting from the installation of the shroud repair assemblies was determined to be small, (a 6^0F increase in PCT vs. margin of 600^0F below the acceptance limit of 10CFR50.46) with no significant impact on ECCS performance or the licensing basis fuel peak cladding temperature. Thus, the installation of the shroud repair assemblies will not create the possibility for an accident of a different type than previously evaluated in the USAR.

6. [ ] Yes [X] No Will the change proposal create a possibility for a malfunction of a SSC important to safety with a different result than any previously evaluated in the USAR?

Basis: The new repair hardware design is a modification for the existing shroud that is currently installed. The new design replaces the structural functions of all horizontal welds of the core shroud. The new design will not affect plant operating conditions, nor plant operations with respect to nuclear safety. The new tie rod design has been shown to withstand all required failure modes load combinations.

7. [ ] Yes [X] No Will the change proposal result in a (10CFR50.2) design basis limit for a fission product barrier as described in the USAR being exceeded or altered?

Basis: The repair hardware assembly has no affect on the function or performance of the core shroud, nor any affect on normal plant operation. Plant operations will not be affected, compliance with the Technical Specifications will be maintained, and thus, safety equipment availability will not be affected. Equipment important to safety will continue to be operated within design operating ranges with no change in any design basis limit. The repair hardware assemblies have no affect on the thermal or mechanical properties of fuel bundles for any plant condition. The repair hardware assemblies do not affect the safety analyses in the USAR.

8. [ ] Yes [X] No Will the change proposal result in a departure from a method of evaluation described in the USAR used in establishing a (10CFR50.2) design basis or in the safety analyses?

Basis: The installation of the repair hardware assemblies does not involve any method of evaluation described in the USAR used in establishing a design basis, or in the safety analyses. Therefore, this criterion is not applicable to the installation of the repair hardware assemblies.

5. CONCLUSIONS

This evaluation has addressed the installation of the repair hardware assemblies to modify the shroud design. The review demonstrated that the installation of the repair hardware assemblies does not affect any of the eight criteria addressed above. Based on the results of the review/evaluation, it is concluded that the installation of the core shroud repair is acceptable. It should be noted that because the repair is an alternative to ASME Section XI repair/replacement requirements, the repair is to be submitted to the NRC in accordance with 10CFR50.55a(a)(3)(i) for review and approval.

6 REFERENCES

6.1. 26A6213, Rev. 2, "Shroud Repair Hardware Certified Design Specification".

6.2. 26A6214, Rev. 1, "RPV and CSS Certified Design Specification".

6.3. Clinton Updated Safety Analysis Report, Rev. 10, October 2001.

6.4. BWRVIP-84, "BWR Guidelines for Selection and Use of materials for Repairs of BWR Internals components", EPRI Document No. TR-100248, October 2000 with approved changes per BWRVIP letter 2002-081, dated March 26, 2002 (allowing EDM of X-750).

6.5. GENE-0000-0023-6259-01, Rev. 1, "Clinton Shroud Repair Seismic/Dynamic Analysis Report".

6.6. SAP4G07V, Users Manual, NEDO-10909, Rev. 7, 1979, plus Addendum 1, Rev. 1, December 1995.

6.7. 26A6216 Rev. 0, "RPV Certified Stress Report".

6.8. 26A6217, Rev. 0, "Core Support Structure Certified Stress Report".

6.9. 26A6270, Rev. 0, " Shroud Repair Hardware Certified Stress Analysis Report"

6.10. NRC Generic Letter 94-03, July 25, 1994, "Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors".

6.11. GENE-771-44-0894, Rev. 2, "Justification of Allowable Displacements of the Core Plate and Top Guide--Shroud Repair", November 1994.

6.12. "General Electric Standard Application for Reactor Fuel", General Electric Company, (NEDE-24011-P-A-14).

6.13. "Supplemental Reload Licensing Report for Clinton Power Station Unit 1, Reload 9 Cycle 10", GNF document No. 0000-0016-5277SRLR, rev. 0, dated December 2003.

6.14. BWRVIP-02, "BWR Core Shroud Repair Design Criteria", EPRI Document No. TR-112642, March 1999.

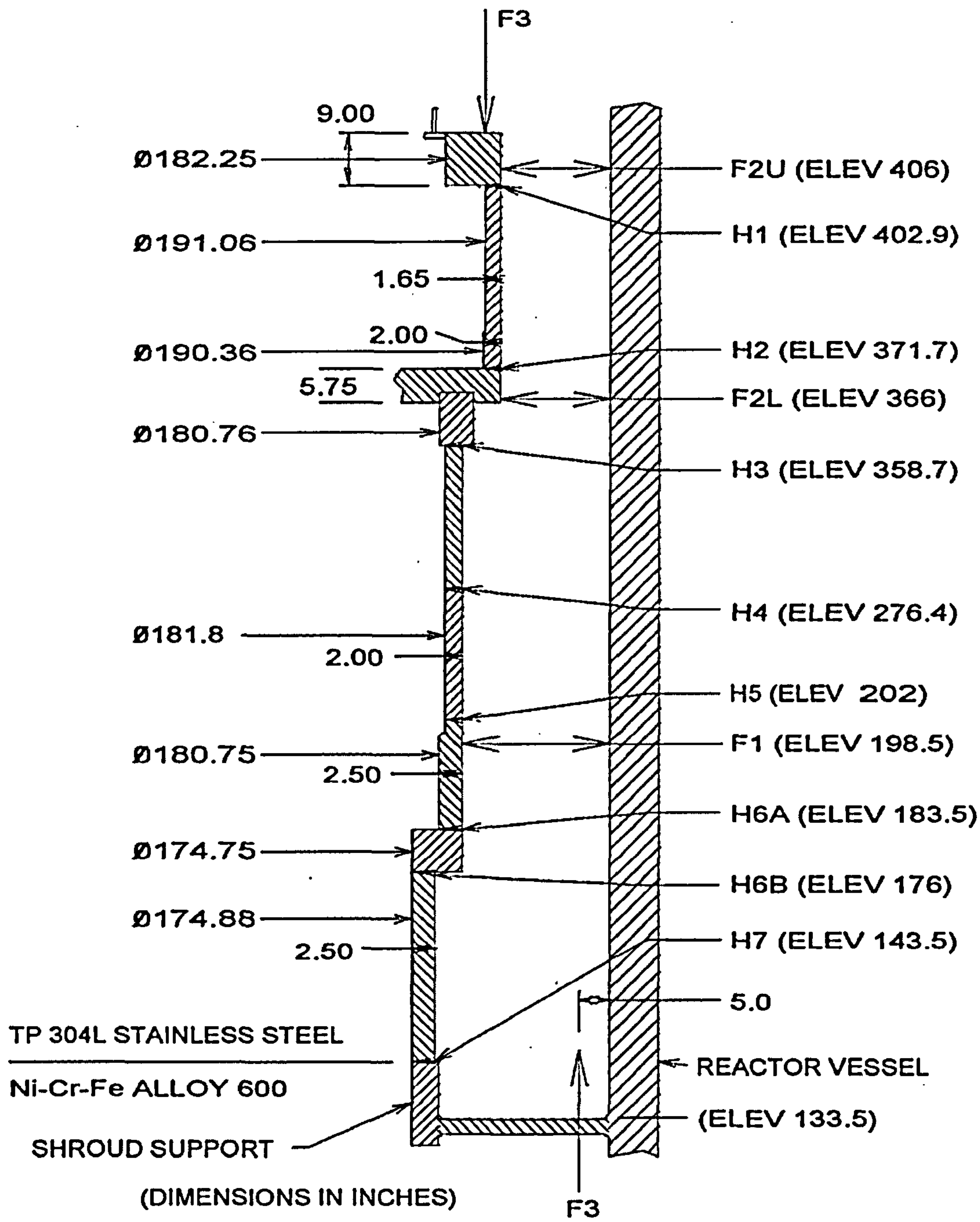

FIGURE 1 WELD NOMENCLATURES

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]] FIGURE 2 STABILIZER ASSEMBLY (4 REQUIRED)

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FIGURE 3 DETAILS OF UPPER STABILIZER

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FIGURE 4. DETAILS OF LOWER STABILIZER