May 6, 2003

Mr. Michael Krupa
Director, Nuclear Safety & Licensing
Entergy Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213-8293

SUBJECT: ARKANSAS NUCLEAR ONE - UNIT 1 (ANO-1), ARKANSAS NUCLEAR ONE - UNIT 2 (ANO-2), AND WATERFORD STEAM ELECTRIC STATION, UNIT 3 (WATERFORD 3) - RE: REQUEST FOR RELIEF FROM THE INSERVICE INSPECTION (ISI) PROGRAM REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) BOILER AND PRESSURE VESSEL CODE (CODE) EXAMINATION FOR REPAIRS PERFORMED ON REACTOR VESSEL HEAD (RVH) PENETRATION NOZZLE REPAIRS (TAC NOS.: MB5653, MB4290, AND MB4264)

Dear Mr. Krupa:

By letter dated February 28, 2002, as supplemented by letters dated April 2, April 16, June 17, (3 letters: CNRO-2002-0031, 0CAN060201, and 0CAN060202), July 8, 2002, and February 11, 2003, Entergy Operations, Inc. (Entergy, the licensee) requested relief from performing examinations of base material weld repairs made to the RVH nozzles as required by ASME Code, Section XI, IWA-4331(a) and Section III NB-2539-4 for Waterford 3. Similar requests for relief were made by Entergy for ANO-1 by letter dated July 8, 2002, as supplemented by letters dated June 17, 2002 (2 letters: 0CAN060201, and 0CAN060202), and February 11, 2003, and for ANO-2 by letter dated March 4, 2002, as supplemented by letters dated April 4 and June 17, 2002 (3 letters: CNRO-2002-0031, 0CAN060201, and 0CAN060202), and February 11, 2003.

The U. S. Nuclear Regulatory Commission (NRC) staff concludes that, based on the submittals discussed above, compliance with the Construction Code repair non-destructive examination (NDE) requirements is impractical, and the alternative NDE of RVH nozzles repair welds under ISI Program Relief Request No. ANO1-R&R-001, Revision 0 for ANO-1, ANO2-R&R-001, Revision 0 for ANO-2, and W3-R&R-001, Revision 0, for Waterford 3, provides reasonable assurance of the repair weld's structural integrity. Therefore, relief is granted pursuant to 10 CFR 50.55a(g)(6)(i) for the third 10-year ISI interval for ANO-1 and ANO-2, and the second 10-year ISI interval for Waterford 3.

Additionally, the staff concludes that performing examinations of base material weld repairs made to the RVH nozzles, as required by ASME Code, Section XI, subsection IWA-4331(a), are inappropriate due to material constraints, and the alternative to the Code requirements, under ISI Program Relief Request No. ANO1-R&R-001, Revision 0 for ANO-1, ANO2-R&R-001, Revision 0 for ANO-2, and W3-R&R-001, Revision 0, for Waterford 3, provides an acceptable level of quality and safety. Therefore, pursuant to the provisions of 10 CFR 50.55a(a)(3)(i), relief is granted for the third 10-year ISI interval for ANO-1 and ANO-2, and the second 10-year ISI interval for Waterford 3.

In view of the immediate and possible need during the past refueling outage (October 2002), the NRC staff gave a verbal authorization on October 18, 2002, for Relief Request ANO1-R&R-001, Revision 1, for ANO-1. However, ANO-1 did not apply the subject relief request to any repairs of ANO-1 nozzles during the Fall 2002 refueling outage.

The third 10-year ISI interval of ANO-1, ends on May 31, 2007; the third 10-year ISI interval of ANO-2, ends on March 25, 2010; and the second 10-year ISI interval for Waterford 3, ends on June 30, 2007.

The NRC staff's safety evaluation is enclosed.

Sincerely,

/RA/

Robert A. Gramm, Chief, Section 1
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-313, 50-368, and 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

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Accession No. ML031270067
*The SEs from the staff for ANO-1 and ANO-2 dated March 12, 2003, and for Waterford 3 dated March 13, 2003, have been used with minor editorial changes.
**See Previous Concurrence

OFFICE	PDIV-1/PM	PDIV-1/LA	DE/EMCB	OGC	PDIV-1/SC
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FROM THE REQUIREMENTS OF THE

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

BOILER AND PRESSURE VESSEL CODE (CODE) EXAMINATION FOR REPAIRS

PERFORMED ON REACTOR VESSEL HEAD PENETRATIONS

ARKANSAS NUCLEAR ONE - UNIT 1 (ANO-1), DOCKET NO. 50-313,

ARKANSAS NUCLEAR ONE - UNIT 2 (ANO-2), DOCKET NO. 50-368,

AND WATERFORD STEAM ELECTRIC STATION, UNIT 3 (WATERFORD 3),

DOCKET NO. 50-382

1.0 INTRODUCTION

By letter dated February 28, 2002, as supplemented by letters dated April 2, April 16, June 17, (letter number CNRO-2002-0031) and July 8, 2002, and February 11, 2003, Entergy Operations, Inc. (Entergy, the licensee) requested relief from performing examinations of base material weld repairs made to the reactor pressure vessel (RPV) nozzles as required by ASME Code, Section XI, IWA-4331(a) and Section III NB-2539-4 for Waterford 3. Similar requests for relief were made by Entergy for ANO-1 by letter dated July 8, 2002, as supplemented by letter dated February 11, 2003, and for ANO-2 by letter dated March 4, 2002, as supplemented by letters dated April 4 and June 17, 2002 (3 letters: CNRO-2002-0031, 0CAN060201, and 0CAN060202), and February 11, 2003.

2.0 BACKGROUND

The Inservice Inspection (ISI) of the ASME Code Class 1, Class 2, and Class 3 components is to be performed in accordance with Section XI of the ASME Code and applicable editions and addenda, as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i).
10 CFR 50.55a(a)(3) states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the applicant demonstrates that: (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 difficulty 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) will 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) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The ISI Code of record for the second 10-year ISI interval for Waterford 3 and for the third 10-year ISI interval for ANO-1 and ANO-2 is the 1992 Edition of Section XI of the ASME Code with portions of the 1993 Addenda.

3.0 EVALUATION OF RELIEF REQUEST

Subject of Relief Request:

Entergy states that there is adequate evidence to determine that performing examinations of base material weld repairs made to the RPV nozzles, as required by ASME Code, Section XI, subsection IWA-4331(a), are inappropriate because of material constraints, and proposed an alternative to the Code requirements, which provides an acceptable level of quality and safety, pursuant to the provisions of 10 CFR 50.55a(a)(3)(i). Additionally, pursuant to the provisions of 10 CFR 50.55a(g)(6)(i), Entergy requests relief from ASME Code, Section III, subsection NB-2539.4, which requires a radiographic examination (RT) of completed repair welds when the depth of the repair cavity exceeds the lesser of 3/8-inch or 10 percent of the section thickness, due to impracticality of performing the RT.

The Items for which Relief is Requested:

ANO-1: The 69 RPV head penetration nozzles, that include 68 control rod drive mechanism (CRDM) nozzles, and 1 instrument nozzle.

ANO-2: The 90 RPV head penetration nozzles, that include 81 control element drive mechanism (CEDM) nozzles, 8 incore instrumentation (ICI) nozzles, and one vent line nozzle.

Waterford 3: The 102 RPV head penetration nozzles, that include 91 CEDM nozzles, 10 ICI nozzles, and one vent line nozzle.

Code Requirements for which Relief is Requested:

ASME Code, Section XI, paragraph IWA-4170(b), 1992 Edition, requires that "repairs and installation of replacement items shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later Editions and Addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and Code Cases may be used." The original construction code for the RPVs for the three plants are as follows:

ANO-1:	ASME Code, Section III, Subsection NB, 1965 Edition, Summer 1967 Addenda.
ANO-2	ASME Code, Section III, Subsection NB, 1968 Edition, Summer 1970 Addenda.
Waterford 3:	ASME Code, Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda. Fracture toughness requirements comply with Summer 1972 Addenda.

The licensee stated that the repairs would be conducted in accordance with the 1989 Edition of ASME Code, Section III.

The 1989 Edition of ASME Code, Section III, paragraph NB-2539 addresses the requirements for performing repairs by welding, which include defect removal, qualification of welding procedures and welders, blending of repaired areas, and examination of repair welds. As required by subparagraph NB-2539.4, each repair weld shall be examined by the magnetic particle examination (MT) or liquid penetrant examination (PT) method. In addition, when the depth of the repair cavity exceeds the lesser of 3/8 inch or 10 percent of the section thickness, the repair weld shall be radiographed after repair, in accordance with subsubarticle NB-5110 and to the acceptance standards of paragraph NB-5320.

The 1992 Edition of ASME Code, Section XI imposes repair requirements that supplement or amend the repair rules of the Construction Code. Subparagraph IWA-4331(a) establishes the non-destructive examination (NDE) requirements that are applicable to defect removal surfaces or repair cavities prepared for welding. Subparagraph IWA-4331(a) requires that after grinding, the affected surfaces, including surfaces of cavities prepared for welding, shall be examined by the MT or PT method to ensure the indication is reduced to an acceptable limit in accordance with article IWA-3000. This NDE is not required when the defect elimination removes the full thickness of the weld and the back side of the weld joint is not accessible for removal of examination materials.

Licensee's Proposed Alternative:

The licensee's request addresses NDE associated with repairs to the nozzle materials on the inner diameter (ID) above, adjacent to, and below the J-groove weld, plus outer diameter (OD) repairs below the J-groove weld. As an alternative to the MT or PT of the repair cavity required by subparagraph IWA-4331(a), the licensee proposes to perform ultrasonic inspection (UT) and eddy current testing (ET) of the repair area to characterize the flaws. After characterization, flaws that exceed the acceptance limits of the flaw evaluation will be reduced to an acceptable size prior to welding. Upon completion of welding, the repair weld will be examined by the UT and ET methods to verify the as-left dimensions of the flaw comply with the acceptance limits. When the ET cannot be performed due to the surface profile of the repair weld, then a PT will be performed as an alternative. UT acceptance criteria will be under paragraph NB-5330, while the PT examination and acceptance criteria will be in accordance with paragraph NB-2546.

As an alternative to the MT or PT of the completed repair weld, in accordance with subparagraph NB-2539.4 of ASME Code, Section III, the licensee proposes to perform an ET or PT if the surface profile prohibits the effective performance of the ET. The ET will be performed with a 5 millimeter (mm)-diameter cross-wound probe design that will be capable of detecting defects both open to the surface and subsurface defects to a maximum depth of 0.030 inches.

As an alternative to RT of completed repair welds when the depth of the repair cavity exceeds the lesser of 3/8 inch or 10 percent of the section thickness, the licensee proposes to perform a UT and ET of the repair weld as discussed above.

Licensee's Basis for Relief:

In accordance with 10 CFR 50.55a(a)(3)(i), the proposed alternative to UT and ET of the repair weld versus MT or PT of the repair cavity is requested by the licensee on the basis that the alternative provides an acceptable level of quality and safety. The licensee stated that the use of MT on the ANO-1, ANO-2, and Waterford 3 nozzle material repair cavity is not appropriate because the nozzle materials (SB-167/SB-166, SB-167/SB-166, and SB-167, respectively, for the three plants) are nickel alloy and therefore, nonmagnetic. Since the principle of detecting flaws by MT requires that magnetic lines of flux be disrupted by the presence of a flaw, and no flux lines can be generated in this material, MT is ineffective. In this instance, only PT would be appropriate for the repair excavation.

The licensee indicated that the PT required by subparagraph IWA-4331(a) is necessary only to assure that the flaw has been completely removed prior to welding. When the flaw is left in the component by design in accordance with paragraph IWA-4310, then the PT is no longer beneficial. The licensee stated that the final UT and ET of the repair weld would assure that the size of the flaw did not exceed the acceptance limits of ASME Code, Section XI, subarticle IWB-3600 after welding, and that the structural integrity of the RPV head penetration nozzle is maintained. Furthermore, the licensee stated that the alternative UT method has been shown to be effective in detecting and sizing subsurface flaws that will be embedded by the repair weld, thereby providing an acceptable level of quality and safety.

As stated by the licensee, the UT will use a combination of Time of Flight Diffraction (TOFD) and standard 0° pulse-echo techniques. The TOFD approach uses two pairs of 0.250-inch diameter, 55° refracted-longitudinal wave transducers pointed at each other. One of the transducers sends sound into the inspection volume and the other transducer receives the reflected and diffracted signals as they interact with the material. There will be one TOFD pair looking in the axial direction of the penetration tube and one TOFD pair will be looking in the circumferential direction of the penetration tube. This UT technique will be used in the pre-inspections for flaw characterization and in the post-repair inspections.

The licensee stated the standard 0° pulse-echo UT approach uses two, 0.250-inch diameter straight beam transducers. One transducer uses a center frequency of 2.25 mega-hertz (MHz) while the other uses a frequency of 5.0 MHz. The 0° technique is primarily responsible for plotting the penetration tube OD location and the J-groove attachment weld location, which will aid in determining defect orientation and sizing information. The licensee also stated that the 0° technique will be capable of locating and sizing any laminar-type defects that may be encountered. These transducers can interrogate the weld repair area for lack of fusion and other laminar-type defects. This technique will be used in the pre-inspections for flaw characterization and in the post-repair inspections.

In accordance with 10 CFR 50.55a(a)(3)(i), the proposed alternative to ET of the repair weld versus MT of the repair weld is requested by the licensee on the basis that the alternative provides an acceptable level of quality and safety. The licensee stated that using MT on the repair weld is inappropriate due to the nonferromagnetic SB-166 and SB-167 nickel alloy material used, as previously stated above. The licensee stated that the use of ET will provide an acceptable level of quality because this method of testing has been shown to be effective in detecting both surface and subsurface flaws up to 0.030-inches deep.

In accordance with 10 CFR 50.55a(g)(6)(i), the proposed alternative to UT and ET of the repair weld versus RT when the depth of the repair cavity exceeds the lesser of 3/8-inch or 10 percent of the section thickness is requested by the licensee on the basis of impracticality of performing the RT. The licensee indicated that RT is not appropriate for base material weld repairs of RPV head penetration nozzles because the RT techniques require that the source of radiation be placed as near normal (90°) to the item being examined with the film in contact with the item on the opposite surface. The licensee stated that an attempt to RT repair welds in the RPV nozzles would have the radiation source placed at various angles other than 90°, penetrating material from fractions of an inch up to multiple inches of thickness. Image quality indicators would have to be placed on the inside bores of the RPV head penetration nozzles and multiple exposures would be required. The licensee also stated that image distortion would increase as the repair weld moved up the nozzle bore, and the required radiographic sensitivity and geometric unsharpness values would not be obtainable. In some cases, clearance between the RPV nozzles and the RPV head would make RT techniques impossible to satisfactorily complete. Since meaningful RT cannot be completed, the licensee proposes UT and ET of the repair welds.

Evaluation:

The original Construction Code for the RPVs for the three plants are as follows:

ANO-1	ASME Code, Section III, Subsection NB, 1965 Edition, Summer 1967 Addenda.
ANO-2	ASME Code, Section III, Subsection NB, 1968 Edition, Summer 1970 Addenda.
Waterford 3	ASME Code, Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda. Fracture toughness requirements comply with Summer 1972 Addenda.

The ISI Code of record for ANO-1 and ANO-2 in their third 10-year ISI interval, and for Waterford 3 in its second 10-year ISI interval is the 1992 Edition of Section XI of the ASME Code, with portions of the 1993 Addenda pertaining to pressure testing. The licensee stated that the repairs would be conducted in accordance with the 1989 Edition of the ASME Code, Section III. Pursuant to 10 CFR 50.55a(b)(1), the use of ASME Code, Section III up to and including Editions through the 1995 Edition and the 1996 Addenda is allowed, subject to specific limitations and modifications. There were no limitations or modifications for the 1989 Edition of ASME Code, Section III listed that applies to this relief request; therefore, the use of the 1989 Edition of ASME Code, Section III for the repair is acceptable.

The 1992 Edition of ASME Code, Section XI, subparagraph IWA-4331(a) states that, after final grinding for defect removal, the affected surfaces shall be examined by the MT or PT method to ensure that the indication has been reduced to an acceptable limit, in accordance with Article IWA-3000. The 1989 Edition of ASME Code, Section III, subparagraph NB-2539.4, also states that each repair weld shall be examined by the MT or the PT methods.

The licensee indicated that the alternative of performing a final UT and ET of the repair weld would provide an acceptable level of quality and safety, versus performing MT or PT of the repair cavity as required by the Code. The licensee also stated that performance of the MT was inappropriate due to the nonmagnetic properties of the material, PT was not beneficial because a portion of the flaw was remaining prior to welding, and that the UT and ET of the repair weld would characterize the remaining flaw or reveal any weld defects. The staff finds that the MT is not appropriate due to the nonmagnetic properties of the nozzle material.

In its letter dated June 17, 2002 (0CAN060202), the licensee transmitted Wesdyne proprietary Report WDI-TJ-007-02-P, Revision 0, “Demonstration of Volumetric Ultrasonic Inspection of CRDM Nozzles Using the Open Housing Scanner." Wesdyne provided the results of five demonstrations using the UT and ET techniques that are to be used on ANO-2. The licensee stated that the same techniques were to be used as NDE alternatives on ANO-1 and Waterford 3. WDI-TJ-007-02-P states that the results of demonstrations one through four confirm that the UT and ET procedures are capable of detecting and sizing both ID- and OD-initiated axial and circumferential flaws in RPV penetration nozzles.

WDI-TJ-007-02-P states that demonstration five was performed on a nozzle ID repair weld, which is similar to the field configuration described by the licensee where the alternative NDE is to be performed on the ANO-1 and ANO-2 RPVs. The subject mockup was made using the weld repair process in a sample of a penetration tube. A 3/8 inch (nominal) deep cavity was excavated along the ID of the mockup tube using the electrical discharge machining (EDM) process, then the sides of the cavity were machined with a 4:1 taper. After welding the cavity, the weld face was machined using the EDM process to be flush with the surrounding base material to the contour of the ID of the tube. To simulate welding flaws, three flat-bottom holes were drilled from the OD of the tube in the area of the repair weld. The depth of the holes nominally represented flaws at the weld fusion line with the base material, at one third, and two thirds the thickness of the repair weld. The demonstration showed that these flaws were successfully detected using the UT procedures described.

The licensee stated that the ET procedure would use a 5 mm-diameter cross-wound probe design capable of operating frequencies between 75 and 500 kilo hertz. The diameter of the probe limits detection to flaws 5 mm (.197 inch) in length and, as stated by the licensee, has .030-inch subsurface detection capabilities. The 1989 Edition of ASME Code, Section III, subparagraph NB-2539.4 requires post-repair welds to be PT examined per the requirements of subparagraph NB-2546. The acceptance standards listed in subparagraph NB-2546.3 state that any linear indication exceeding 1/8 inch (.125 inch) is considered unacceptable for material between 5/8 inches to 2.0 inches in thickness. Since the thickness of the SB-166/SB-167 nozzle materials is approximately 5/8 inch (or nominally 0.611 inch for ANO-1, 0.666 inch for ANO-2, and 0.661 inch for Waterford 3), the performance of the ET will detect flaws slightly larger than the .125 inch acceptance criteria. The staff concludes that this is acceptable because: 1) if a linear defect exists in the repair weld, it is highly probable that its length will far exceed the .125 inch acceptance criteria, making the defect detectable by ET; 2) the .125 inch acceptance criteria is for defects identified by PT rather than ET; and 3) the ET is considered a best effort examination in a high dose area. Based on the staff’s review of WDI-TJ-007-02-P, the staff concludes that service-related or post-repair, weld-induced flaws will be detected and sized by the alternative UT and ET methods requested by the licensee.

The 1989 Edition of ASME Code, Section III, subparagraph NB-2539.4 requires that, when the depth of the repair cavity exceeds the lesser of 3/8 inch or 10 percent of the section thickness, the repair weld shall be radiographed after repair in accordance with paragraph NB-5110. Based on the staff review of the configuration, the staff finds that RT would be impractical, the interferences caused by surrounding CRDM penetrations would make RT film placement difficult, and the varying thickness and radius of the head would make Code-required geometric unsharpness and radiographic sensitivity values impractical to meet. Furthermore, the staff concludes from its review of WDI-TJ-007-02-P that the TOFD UT of the repair weld is a suitable

alternative to RT of the repair weld, providing more meaningful interrogation of the repair weld than would be attainable by RT.

Finally, in its supplemental letter dated February 11, 2003, the licensee committed to perform one successive inspection (UT/ET) of repair welds after one cycle of operation, provided the head is not replaced during that outage. The staff concludes this alternative provides reasonable assurance of the structural integrity of the repair weld. The licensee also committed to notify NRC of the need to make repairs, prior to performing repairs on RPV nozzles above the J-weld that involve using these reliefs. The notification will provide information on (a) examination methods; (b) flaw location, orientation, and critical dimensions: and (c) repair plans.

The NRC staff finds that reasonable controls for implementation and subsequent evaluation of proposed changes pertaining to the above regulatory commitments are best provided by the licensee's administrative processes, including its commitment management program. The above regulatory commitments do not warrant the creation of regulatory requirements.

4.0 CONCLUSIONS

The staff concludes that requiring the licensee to comply with the Construction Code repair NDE requirements is impractical. Based on the discussion above, the staff concludes that the alternative NDE of CRDM repair welds under ISI Program Relief Request No. ANO1-R&R-001, Revision 0 for ANO-1, ANO2-R&R-001, Revision 0 for ANO-2, and W3-R&R-001, Revision 0, for Waterford 3, provides reasonable assurance of the repair weld's structural integrity. Therefore, relief is granted pursuant to 10 CFR 50.55a(g)(6)(i) for the third 10-year ISI interval for ANO-1 and ANO-2, and the second 10-year ISI interval for Waterford 3.

Additionally, the staff concludes that performing examinations of base material weld repairs made to the RPV nozzles, as required by ASME Code, Section XI, subsection IWA-4331(a), are inappropriate because of material constraints, and based on the evaluation above, concludes that the alternative to the Code requirements, under ISI Program Relief Request No. ANO1-R&R-001, Revision 0 for ANO-1, ANO2-R&R-001, Revision 0 for ANO-2, and W3-R&R-001, Revision 0, for Waterford 3, provides an acceptable level of quality and safety. Therefore, pursuant to the provisions of 10 CFR 50.55a(a)(3)(i), relief is granted for the third 10-year ISI interval for ANO-1 and ANO-2, and the second 10-year ISI interval for Waterford 3.

These reliefs are authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Activities associated with this relief are subject to third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: T. Steingass

Date: May 6, 2003

Waterford Generating Station 3

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