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Nuclear Generation Group

August 14, 2009

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: **R.E. Ginna Nuclear Power Plant**
Docket No. 50-244

Response to Request for Additional Information Re: Fourth Interval Inservice Inspection Program Relief Request No. 24 – (TAC No. ME1364)

Reference 1: Letter to USNRC Document Control Desk from Joseph Pacher (Ginna LLC), Fourth Interval Inservice Inspection Program Submittal of 10CFR50.55a Request Number 24, dated May 22, 2009.

Reference 2: Letter to John Carlin (Ginna LLC) from Douglas Pickett (NRC), Request for Additional Information Re: Fourth Interval Inservice Inspection Program Relief Request No. 24 – (TAC No. ME1364), dated July 15, 2009.

On May 22, 2009, R.E. Ginna Nuclear Power Plant (Ginna LLC) submitted Relief Request No. 24 (Reference 1) to the NRC for review and approval. On July 15, 2009, the NRC issued a Request for Additional Information (RAI) (Reference 2) regarding the Ginna LLC submittal. The Enclosure to this letter provides the Ginna LLC responses to the RAI questions.

Ginna requests that this relief request be approved by August 31, 2009 to support the upcoming Refueling Outage.

Should you have questions regarding this matter, please contact Thomas Harding at 585.771.5219, or Thomas.HardingJr@Constellation.com.

A047
NRR

WPLNRC-1002188

Very truly yours,

Paul M. Swift

PS/MR

Enclosure: Response to Request for Additional Information

cc: S. J. Collins, NRC
D.V. Pickett, NRC
Resident Inspector, NRC (Ginna)

ENCLOSURE
Response to Request for Additional Information

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ENCLOSURE
Response to Request for Additional Information

Request for Additional Information
Regarding R.E. Ginna, Unit 1 Relief Request No. 24
On the Inspection of the Unit's Bottom Mounted Instrumentation Nozzles

Recently, the NRC invoked the inspection requirements of American Society of Mechanical Engineers Code Case N-722, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182, Section XI, Division 1," via the incorporation of Title 10 of the Code of Federal Regulations 50.55a(g)(6)(E). As a result, pressurized water reactor (PWR) licensees are required to perform a 100 percent bare vessel inspection of their unit's reactor pressure vessel (RPV) bottom mounted instrumentation (BMI) nozzles during every other refueling outage (RFO) beginning with the unit's first RFO after January 1, 2009.

One objective of the bare metal visual inspections is to detect leakage of reactor coolant through primary water stress corrosion cracking (PWSCC) of the nozzle alloy 600 base material or alloy 82/182 J-groove weld material before the leaked coolant causes consequential damage. Potential consequential damage includes 1) corrosion of the RPV alloy steel base material and 2) PWSCC of the alloy 600 nozzle base material from the outside diameter (OD) of the nozzle. Such cracking has been observed in RPV upper head penetrations to be circumferential in orientation which creates the possibility of nozzle ejection.

In R.E. Ginna, Unit 1's case, for some BMI nozzles, a paint or coating has wicked up into and sealed and occluded the annular gap between the alloy 600 nozzle and the alloy steel base material. It is possible that the paint or coating could prevent egress of the leaked coolant from the annular gap, which could facilitate the initiation and growth of OD circumferential cracking and inhibit the ability to detect leakage via visual examination. To address this, the licensee has proposed to perform a best effort visual inspection of all R.E. Ginna, Unit 1 BMI nozzles during the unit's 2009 RFO and volumetric (ultrasonic) examinations of all R.E. Ginna, Unit 1 BMI nozzles during the unit's scheduled 2011 RFO.

Regarding the 2009 visual examination of occluded BMI nozzles:

1. *Provide a discussion of how visual examination or leak detection provides a basis for ensuring circumferential PWSCC is not occurring on the outside diameter of the alloy 600 nozzles if the annulus is plugged and occluded by paint.*

Response:

The detailed visual inspection that has been performed at Ginna has been performed unimpeded with insulation on a combination of a bare metal, and coated metal surfaces during post refueling outages. The Ginna site specific procedure EP-VT-116 "Visual

Examination of Reactor Vessel Head" has been improved to include the requirements to look for coating that is blistering, bulging, or deteriorated in the annulus area. The Ginna procedure also has a VT-1 visual resolution requirement which is a higher resolution than the Code Case N-722 VT-3 resolution requirement. Based upon present code case N-722 requirements to perform a bare metal visual inspection every other refueling outage, an improvement to detect potential leakage from reactor vessel Bottom Mounted Instrumentation (BMI) is realized by performing a higher VT-1 resolution inspection and a detailed visual examination during each refueling outage.

Detection of Primary Water Stress Cracking Corrosion (PWSCC) on the outside of the BMI nozzle by visual examination or leakage detection would not be impeded by an annulus that is occluded by coating based upon the following response to question number 2.

2. *Provide copies and a discussion of any qualification or simulation testing that supports your conclusion that "the paint is unlikely to retain a leak." This should include: a discussion of any actual shear strength or adhesion strength test data available for the paint/coating on the bottom of the R. E. Ginna, Unit 1 RPV; copies of the original paint/coating specification, application procedures and qualification report, as necessary to demonstrate the materials characteristics of the paint/coating; and, an assessment of the load which would be placed on the coating by leakage into the annular region.*

Response:

This response has been divided into three parts to address the different components of the question:

"Provide copies and a discussion of any qualification or simulation testing that supports your conclusion that "the paint is unlikely to retain a leak. This should include: a discussion of any actual shear strength or adhesion strength test data available for the paint/coating on the bottom of the R. E. Ginna, Unit 1 RPV;"

Shear strength or adhesion test data is not available for the coatings on the bottom of the Ginna reactor pressure vessel. A best effort attempt to remove a coating sample will be performed during the 2009 RFO. Testing on this coating specimen could lead to the development of actual coating cohesive bond strengths for use in future evaluations and to help to determine the post 2011 options.

Although shear strength or adhesion strength test data is not available, Ginna LLC contracted the services of an independent registered professional engineer who is a coatings consultant to the nuclear industry. An independent assessment of the coating condition on the lower reactor vessel head was requested. His conclusion combined with the Ginna LLC reviewer comments of the expected current state of the coating condition on the Ginna reactor vessel lower head annulus area provides new insights into the less than optimal adhesion strength of the coating in the annulus area. The consultant's findings are documented in Attachment 1. The review of the consultant conclusions by the Ginna Coatings Program Owner is included in Attachment 2.

The conclusions of the consultant and reviewer are that several factors are expected to influence the coating adherence to the substrate in the annulus area as summarized below:

- The manufactured surface finish of the nozzle outside diameter (OD) (as specified in the design drawings) and the as-machined bore diameter of the lower head would not be expected to promote good bonding of the coating to these materials without additional surface preparation. Therefore, there is reasonable assurance that the bond (adhesion) between the coating and substrate is weak in the annulus area compared to the remainder of the lower head. It is expected that the surface preparation on the remainder of the lower head was better prepared based on the coating manufacturer specifications and accessibility, as compared to the annulus area.

- The product data sheet for the Koppers product discusses that "all of the organic binder (resin) in the coating is burned off when the material is heated," which was accomplished "during initial startup testing of Ginna." From this the consultant concluded that "the coating film will exhibit very low cohesive and adhesive strengths [and] … if the coating film was to see reactor coolant system pressure (~2200 psig), it would immediately disintegrate." This would allow the "hot, high pressure water to leak out of the annulus space. This leakage and attendant crystallization of boric acid would be readily evident during the periodic visual inspections performed by qualified personnel."

- If any organic binder did remain, zinc type coatings would not form a uniform matrix of cohesive bonds between individual zinc particles as compared to other types of coatings such as epoxy. Due to the unequal size and spacing of the zinc particles, the structure of the coating would not be expected to be a matrix or a uniform structure, which results in a non-uniform bonding in the coating and a weaker internal cohesion of the coating. Blisters form when a fluid under the coating film exerts a pressure stronger than both the adhesion and internal cohesion of the coating. Blisters typically form from osmosis of water through the coating film, which may only require pressures of "several ounces/sq in".

- The references provided by the Ginna LLC reviewer also document the potential effect of water on coating in the annulus area. Assuming that the J-groove weld is cracked and providing a source of water to the annulus region, and given the expected poor bonding conditions described above, the effects of the water on the coating would cause the coating to "disintegrate," or at the very least blister. The Ginna station NDE procedure used for lower head inspections call for the VT-1 type inspections of the annulus region and include a specific inspection step to inspect for "bulging" at the annulus. These inspections are being performed during each RFO at a frequency which exceeds the requirements for a bare metal visual exam of every other refueling outage required by Code case N-722.

- Assuming a crack in the annulus area, the 2235 psi normal RCS operating pressure will exert approximately five pounds of force on the coating in the annulus area. The expected five pounds of force in the annulus area is larger than the force that is required to initiate a blister, which is typically "several ounces/sq. in". If "disintegration" does not occur, the formation of blisters and "bulging" at the annulus-head interface is expected to occur and be detected during inspections performed using the Ginna Station Lower head NDE inspection procedure.

"*...copies of the original paint/coating specification, application procedures and qualification report, as necessary to demonstrate the materials characteristics of the paint/coating;*"

Specific information on the Ginna BMI coating is not available. However, Attachment 3 provides available Technical data for a product that is specified for coating in the original Westinghouse E-specification 676206, for the reactor vessel, Koppers, Bitumastic Hi-Heat Gray. Attachment 4 provides additional Koppers, Bitumastic Hi-Heat Gray product descriptive information.

"*...an assessment of the load which would be placed on the coating by leakage into the annular region.*"

An assessment of the load which would be placed on the coating by leakage into the annular region was estimated at approximately five (5) pounds force by dividing RCS pressure by the circumferential area of the annular region. Information on coating coverage of the annular region of each bottom mounted instrument and the inspection of the coating is provided below.

Coating occlusions vary at each penetration. A review conducted by the Ginna Station NDE Level III examiner on 1-26-09, documents that per his review, 10 of the 36 penetrations are 100% occluded. Other penetrations that are occluded vary from a low of 8.5% occluded to high of 94.5 % occluded. The NDE examiner summarizes his findings as 10 penetrations being 100% occluded, 21 penetrations greater than 50% occluded and 5 that are less than 50% occluded.

Comparisons of previous year photographs are included in the reviews by the VT level 3 examiner following each RFO inspection in order to judge changes in appearance of the overall head and annulus conditions. These comparisons provide reasonable assurance that there will be detection of any bulges or blistering.

As requested in the alternative to code case N-722, Ginna is currently scheduled to perform the lower head visual inspection as described above during the upcoming Fall 2009 RFO, followed by UT inspection of the ID of the penetration material during the 2011 RFO. Ginna LLC has engaged in industry BMI inspection guideline development and applied the appropriate inspection option for the Ginna BMI. This formed the basis for the Ginna BMI UT inspection during the 2011 RFO in that the MRP-206 Guideline included the UT option for 2 loop, 18 month cycle plants. Ginna LLC plans to determine the best path going forward following review of the 2011 RFO results.

In regard to the path forward following the 2011 RFO inspections, it should be noted that additional discussions have been and continue to be held with EPRI to determine if it is possible to devise a test plan utilizing an existing EPRI mock-up presently in use at an EPRI sub-contractor location. The preliminary discussions include a concept to apply a similar coating and determine if the coating inhibits leakage detection on that mockup. Discussions are still ongoing as to how to determine the test objectives and definition of success. Additional discussions are also ongoing to determine any additional alternatives that may be available for coating removal adjacent to the penetration area.

3. *Provide a timeline and description of the qualification of ultrasonic test equipment that will be used during the volumetric examination of the nozzles proposed for the 2011 RFO. Include a description of the probes and mockups and the dates that the mockups and probes were, or will be, procured. This information is necessary for the staff to assess the status of qualification activities to date. If no qualification activities have yet been completed, please identify what kind of administrative actions have been put in place to ensure that you will not discover, during the qualification activities, any impediments to volumetric inspection that would necessitate any additional submittals requesting delay, deferral or relief from the commitment to complete the volumetric examination.*

Response:

Ginna LLC has committed to build blind two (2) loop specific samples and to perform a two (2) loop specific BMI qualification for preparation of the 2011 outage. The funding for all qualification and 2011 examination work has been approved. The general project plan is outlined below:

- Determine and finalize alternative examination requirements - 5/15/2009. Complete.
- Ginna LLC to procure EPRI NDE center support for conceptual drawings 5/15/2009. Complete

- Submit conceptual drawings to vendors for the manufacture of mockups - 7/1/2009. Complete
- Vendors to submit proposals to fabricate 2 loop BMI mockups - 8/15/2009. Complete.
- Initiate a purchase order to the mockup vendor for manufacturing 2 loop BMI mockups - 9/1/2009.
- A formal request for quote will be submitted to the inservice inspection vendors for the various phases of qualification and 2011 RFO examination - 11/1/2009.
- Mockup vendor to complete 3 blind mockup samples and 1 open mockup sample - 12/1/2009.
- Ginna LLC and EPRI personnel will establish qualification requirements 1/15/2010.
- Perform receipt inspection and mockup characterization - 1/15/2010.
- Provide open mockup to inservice inspection vendors for off peak outage technique validation - 2/1/2010 to 6/1/2010.
- Inservice inspection vendor to perform blind procedure qualification and personnel qualification - 6/1/2010.
- Work with the vendor to prepare for bottom mounted instrumentation examination implementation - 3/1/2011.
- Document examination results and perform data evaluation - 4/30/2011.

The probe designs have been discussed with the inservice inspection vendors. The two (2) loop probe designs will be sensitive to ID connected as well as OD connected flaws in both the axial and circumferential orientations. Existing probe designs will be adjusted to the Ginna two (2) loop BMI design. The probes are expected to consist of forward scatter time of flight ultrasonic transducers and an eddy current coil. The vendors are in a state of readiness and are expected to have probes for the anticipated June 2010 qualification timeframe.

The BMI two (2) loop mockup design will be manufactured under a quality program using the Ginna BMI design. The mockup will consist of an alloy 600 tube material that is welded with Alloy 82/182 weld metal to a stainless steel clad carbon steel simulated vessel block, using various weld angles. The simulated flaws will be manufactured in accordance Reference 1 page 4 specifications. A blind sample matrix of simulated flaws has been established that covers ID connected, as well as OD connected flaws in both the axial and circumferential orientations. The specific probes will not be purchased but will be provided as part of the examination service.

The qualification process will provide an assessment of the two (2) loop BMI examination capability. If qualification is not successful, it is anticipated that there will be enough time for procedure or hardware improvements by the April 2011 RFO timeline.

4. *Discuss how 2011 volumetric examination of the volume of the nozzle alloy 600 base material, as detailed in figure 1 on your submittal, will ensure that PWSCC through the J-groove weld has not resulted in leakage of reactor coolant into the annular region between the alloy 600 nozzle and the alloy steel RPV bottom head for those nozzles that have paint/coating plugging and occluding the outer portion of the annulus.*

Response:

The examination volume described in Reference 1, Figure 1 provides a full volume of inspection of the nozzle base metal and to the extent possible weld interface. Industry experience has shown volumetric examination of the nozzle base material provides insights to J weld material condition. The following discussion is a comparison of cracking behavior of Alloy 82/182 weld with Alloy 600 base material.

There are a large number of examples of service experience where Alloy 600 base metal and Alloy 82/182 welds were exposed to the same environment. Experience has shown that the base metal nearly always cracks in a shorter time than the weld metal. The following discussion and review of these cases will provide a basis for this rationale.

Reactor vessel upper head penetrations were first observed to be cracking in service as a result of a 1991 leak at Bugey Unit 3. Since that time some upper head cracking incidents have been reported. Most cases involved base metal cracking, but there have been a few instances of weld metal cracking as well. Examples of cases where base metal cracked in the upper head penetrations, but not welds, are in INPO reports for Millstone 2, Beaver Valley 1, and ANO 1.

This topic has been studied in depth, both experimentally and through destructive examination of parts from service. Westinghouse reviewed the service experience of these materials in 2003 and has published several papers in this area (References 2 and 3). They concluded that welds will typically require at least twice as long as the base metal to crack. Reference 3 reported that EDF has examined the replaced heads from 11 different units, with 754 welds, and found no cracks. These findings are significant, since each of these heads were replaced because of cracks in the base metal. The service times for these heads ranged from 60,000 to 140,000 hours.

More specific to the bottom head, the only cracking incident which has occurred is at South Texas (Reference 4), where a manufacturing anomaly led to PWSCC of the head penetration tubes. In these two tubes, the cracks occurred in the base metal around the attachment welds, again supporting the conclusion that the PWSCC prefers base metal over weld metal.

Additional evidence is obtained through industry examination data for upper and lower heads as documented in Reference 5.

This leads to the conclusion that the inspections of the BMI nozzles by ultrasonic examination provide a reasonable approach to maintaining the integrity of the BMI nozzle region. The planned Reference 1, Figure 1 nozzle volumetric examination volume is considered to provide additional assurance as compared to the present N-722 visual examination requirements for detection of bottom mounted nozzle degradation. The ultrasonic examination is also considered to provide a predictive examination since it will detect a crack prior to its appearance at the external surface.

The ultrasonic examination is not impacted by whether the nozzle annulus contains coating or not. Neither an open nozzle annulus, nor a coated nozzle annulus will transmit the sound energy from an ultrasonic examination and thus the coatings would have no impact on the ability to inspect the planned nozzle base material volume.

Ginna LLC has also committed to perform the detailed visual examination during the 4/2011 outage.

5. *Discuss any additional operator training that may be implemented regarding operator response to BMI failure scenarios for the interim period from now until the volumetric examinations of all R.E. Ginna, Unit 1 BMI nozzles will be completed in 2011.*

Response:

The Ginna simulator does not currently model a Reactor Coolant System (RCS) break at the bottom of the vessel location. However, the Ginna Emergency Operating Procedures (EOPs) are based on the Westinghouse Emergency Response Guidelines (ERGs). As such, they are symptom based and are not tied directly to a specific event or break location except for the general event category such as Loss of Coolant (LOCA), Steam Generator Tube Rupture (SGTR), etc. We believe that this event would be properly diagnosed as a LOCA based on Reactor Coolant System (RCS), Containment Pressure, and Radiation Monitor indications. The operator response would be driven within the appropriate procedures by current parameters rather than break location. The Operators will perform the response and recovery actions necessary to maintain the core covered, regardless of the break location. To validate this scenario, Ginna LLC will model a RCS break at the bottom of the vessel during the next simulator upgrade, scheduled for completion before the end of the Fall 2009 outage. The scenario will be tested, and if there are significant differences in the required response, all operating crews will be trained during the first training cycle following startup from the September 2009 Refueling Outage.

ENCLOSURE
Response to Request for Additional Information

References

1. Letter to USNRC Document Control Desk from Joseph Pacher (Ginna LLC), Fourth Interval Inservice Inspection Program Submittal of 10CFR50.55a Request Number 24, dated May 22, 2009.
2. W.H. Bamford and J. Hall, 'A Review of Alloy 600 Cracking in Operating Nuclear Plants: Historical Experience and Future Trends', in Proceedings of the 11th International conference on Environmental Degradation of Materials in Nuclear Power Systems – Water Reactors, Stevenson, WA, August 2003, ANS 2003
3. W.H. Bamford and N.A. Palm, 'Service Experience with Alloy 600 and Associated Welds in Operating Pressurized Water Reactors, Including Repair Activities.
4. Materials Reliability Program: South Texas Project Unit 1 Bottom Mounted Instrumentation Nozzles (#1 and #46) Analysis Reports and Related Documentation (MRP-102).
5. Materials Reliability Program: Inspection Data Survey Report MRP-219 Rev.2

Attachment 1

White Paper, Engineering Evaluation of the Painted Ginna Bottom Mounted Instrumentation (BMI) Nozzles

WHITE PAPER
ENGINEERING EVALUATION OF THE PAINTED GINNA BOTTOM MOUNTED INSTRUMENTATION (BMI) NOZZLES

Prepared by

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August 6, 2009

Damon J Peters	Coatings Engineer	8-13-2009
Ginna Review by:	**Title**	**Date**

INTRODUCTION

This White Paper has been prepared to provide an engineering evaluation of the painted Ginna Bottom Mounted Instrumentation (BMI) nozzles. The information provided in this White Paper will be used to respond to USNRC Requests for Additional Information (RAI) Nos. 1 and 2 in its letter dated July 15, 2009 (Subject: Request for Additional Information RE: Fourth Interval Inservice Inspection Program Relief Request No. 24 – [TAC No. ME 1364]).

USNRC RAI'S

The two USNRC RAI's addressed in this White Paper are contained in a letter dated July 15, 2009 (Subject: Request for Additional Information RE: Fourth Interval Inservice Inspection Program Relief Request No. 24 – [TAC No. ME 1364]):

"1. Provide a discussion of how visual examination or leak detection provides a basis for ensuring a circumferential PWSCC is not occurring on the OD of the Alloy 600 nozzles if the annulus is plugged and occluded by paint."

"2. Provide copies and a discussion of any qualification or simulation testing that supports your conclusion that "the paint is unlikely to retain a leak." This should includes: a discussion of any actual shear strength or adhesive strength test data available for the paint/coating on the bottom of the R.E. Ginna, Unit 1 RPV; copies of the original paint/coating specification, application procedures and qualification report, as necessary to demonstrate the material characteristics of the paint/coating; and, an assessment of the load which would be placed on the coating by leakage into the annular region."

VALIDATION OF VISUAL INSPECTION OF THE REGION OF THE GINNA BMI NOZZLES

During work on GSI-191, "Assessment of Debris Accumulation on PWR Sump," the USNRC requested that Industry validate the use of visual examination of coated surfaces to identify precursors of failure of the paint coating system or underlying substrate.

In response to this request, EPRI and NUCC (Nuclear Utility Coating Council) initiated a field study of paint coating system visual appearance versus paint coating system adhesion. This study was published by EPRI as Report No. 1014883, "Plant Support Engineering: Adhesion Testing of Nuclear Coating Service Level I Coatings" dated August 2007. The conclusions of the report are, in part:

"Review of the adhesion test data confirms that aged, visually intact, design-basis-accident- (DBA-) qualified coatings (from various manufacturers) that exhibit no visual anomalies (that is, no flaking, peeling, chipping, blistering, etc.) continue to exhibit system pull-off adhesion at or in excess of the originally specified (ANSI N5.12 and ASTM D5144) minimum value of 200 psi."

"Based on this testing, it is concluded that the containment coatings monitoring approach contained in ASTM D5163, as implemented by licensees, and endorsed by USNRC in RG 1.54 Rev.1 and NUREG 1801 Volume 2, Appendix XI.S8, is valid."

The USNRC concurred with the EPRI/NUCC findings concerning the use of visual inservice inspection of paint coatings. In its document entitled "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation (March 2008)," USNRC states:

"The staff has reviewed this report (EPRI Report No. 1014883, ed.) and determined that it provides adequate supporting evidence that the containment coatings monitoring approach contained in ASTM D5163, as implemented by licensees, and endorsed by USNRC in Regulatory Guide 1.54, Rev. 1, and NUREG 1801 (the "GALL Report," ed.), Vol. 2, Appendix XI.S8, is valid."

Additionally, visual inspection is the primary screening protocol for ASME Section XI, Subsections IWE and IWL containment liner inspections, which also involves carefully examining coated liner plate for any anomalies which might be precursors to paint coating failure or indicators of substrate failures.

Based on current Industry practices endorsed by USNRC, visual examination in accordance with written procedures by trained and qualified personnel of the paint coating on the reactor vessel in the BMI nozzle region is appropriate and technically acceptable.

WILL THE PAINT COATING ON THE BMI NOZZLE REGION EXHIBIT VISUAL INDICATIONS OF A LEAK DUE, FOR INSTANCE, TO A CIRCUMFERENTIAL PWSCC CRACK ON THE OD OF THE ALLOY 600 BMI NOZZLES?

1. **What is the paint coating which was applied to the BMI Nozzle region of the reactor vessel during fabrication?**

   Review of available documentation concerning the Ginna reactor vessel reveals two references to the paint coating which was applied to the BMI Nozzle region of the reactor vessel during fabrication.

   A. The Addendum to Westinghouse specification 67626 for the Ginna reactor vessel states, in Section 4.3.7, "The specific type of paint used for the vessel will be chosen by the Supplier and approved by WAPD."
   B. The Approved vendor drawing for the reactor vessel, 117802E (see FSAR Figure 8-2,"Arrangement of Reactor Vessel Longitudinal Section (117802E)," contains a General Notes No. 5, "5. All Carbon Steel Surfaces are painted with two coats Hi Heat Gray Paint ..."
   C. A Technical Data Sheet for Koppers Protective Coating Zinc Rich Bitumastic Hi-Heat Gray is included. (Attachment 1).

2. **What are the properties of Koppers Protective Coating Zinc Rich Bitumastic Hi-Heat Gray?**

   A. The Koppers Protective Coatings Technical Data Sheet for Zinc Rich Bitumastic Hi-Heat Gray does not specifically state the formulation of the paint coating material. Also, in the 1960's, Material Safety Data Sheets (MSDS) were not required. Parts of the Koppers organization was sold to Carboline Company in the early 1990's and no records concerning Koppers Zinc Rich Bitumastic Hi-Heat Gray are now available from either Carboline or Kop-Coat (the successor to Koppers). As such, all technical statements below are based on the expertise of the writer of this White Paper and historical information obtained from various sources.

B. Based on the Koppers Technical Data Sheet, the existing appearance of the paint coating on the BMI Nozzles region (see attached Photograph 1), and the state of paint coating technology in the mid-1960's when the paint coating was manufactured and applied, it is evident that the Koppers Zinc Rich Bitumastic Hi-Heat Gray can be generically classified as an inorganic metallic zinc film. The Koppers Zinc Rich Bitumastic Hi-Heat Gray product data sheet, in the section entitled, "Curing time," states:

> "Once the coating has dried, the unit's temperature should be raised gradually and evenly over a 6 to 8 hour period, to 500°F, then maintained at that temperature for a period of 24 to 48 hours. (Do not raise the temperature above 150°F until the coating has dried.) This will burn off the organic vehicle and fuse the zinc to the surface."

In the case of the Ginna reactor vessel, the paint coating would have achieved full cure when the vessel was heated during the plant startup process.

The melting temperature of zinc is 754°F, therefore the term "fuse" as used by Koppers in Attachment 1, Section "F", "Drying Time", is a misnomer, since the metallic zinc filler in the paint coating will not melt at 500°F. Rather, the paint coating film is an agglomeration of 10 μm to 20 μm particles of metallic zinc and zinc oxide. Since the binder is burned off during cure of the coating, the resultant coating film will exhibit very low cohesive strength and, as such, will readily disintegrate if pressure is applied.

C. In the 1960's and 1970's, it was common for manufacturers to paint coat steam generators, pressurizers and reactor vessels with high temperature coatings, either zinc or aluminum filled, as a temporary measure to prevent corrosion during transportation and storage of these items during plant construction. The high temperature paint coatings served no purpose after the plant was put into operation and, as such, the adhesive and cohesive strengths of the paint coating applied to the various machined/smooth metallic surfaces on, for instance, a reactor vessel, were not a consideration. Modern plant practice is to eliminate these paint coatings and protect vessels using plastic wrap ("shrink wrap").

D. In the time frame of Ginna construction, the selection of Koppers Zinc Rich Bitumastic Hi-Heat Gray was appropriate and technically acceptable for its intended purpose (temporary corrosion protection of the reactor vessel during plant construction). Construction of Ginna pre-dated the ANSI Standards for DBA-qualification of nuclear containment coatings (ANSI N101.2, ANSI N101.4 and ANSI N 5.12). As such, no DBA testing of this paint coating material exists nor would have been required by the Ginna licensing basis.

3. **<u>If a primary system leak occurred due to circumferential PWSCC on the OD of the Alloy 600 BMI nozzles, would the Koppers Zinc Rich Bitumastic Hi-Heat Gray coating provide a visual indication of the primary coolant leakage into the annulus between the Alloy 600 BMI nozzle and the steel reactor vessel?</u>**

The answer to this question is a definite "yes," based on the following considerations.

A. A primary coolant leak into the annulus space between any given Inconel 600 BMI nozzle and the carbon steel reactor vessel would produce an environment of borated water at ~2200 psig and ~540 degrees F if it is assumed that the existing paint coating acts as a seal of the annulus space. Since water is an incompressible fluid, all surfaces in the annulus (steel, Inconel 600 and paint coating) would be uniformly exposed to this high pressure (~2200 psig). Since the existing paint coating has essentially no cohesive strength, the paint coating film would disintegrate, allowing hot, high pressure water to leak out of the annulus space. This leakage and attendant crystallization of boric acid would be readily evident during the periodic visual inspections by qualified personnel.

B. The Koppers Zinc Rich Bitumastic Hi-Heat Gray paint coating material, according to the manufacturer's technical data sheet, is rated for continuous exposure at 800 degrees F and thus would not be damaged by the elevated temperature alone. This premise is validated because no heat-produced anomalies in the existing paint coating have been identified to date during periodic visual inspections of the BMI nozzle area.

C. As described in the Koppers Zinc Rich Bitumastic Hi-Heat Gray product data sheet, all of the organic binder (resin) in the paint coating is burned off when the material is heated to 500°F for 6 to 8 hours. This condition would have occurred during initial startup testing of Ginna. The remaining paint coating film thus consists of 10 μm to 20 μm discrete particles of metallic zinc and zinc oxides. Since all binder (resin) was burned off during the curing process, the resultant zinc / zinc oxides paint coating film will exhibit very low cohesive and adhesive strengths since no binder remains to provide cohesive strength to the paint coating film. If the paint coating film were to see reactor coolant system pressure (~2200 psig), it would immediately disintegrate. This disintegration and associated boric acid deposits from reactor coolant leakage would be readily identified by visual inspection of the affected area.

Please note that cohesive failure of the Koppers Zinc Rich Bitumastic Hi-Heat Gray paint coating material has already spontaneously occurred during normal plant operation due to the very low paint coating film cohesive strength (See red circle on Photograph 1).

D. The steel reactor vessel annulus surface, if exposed to hot borated water in the event of a primary coolant leak, would corrode. The corrosion product produced, iron oxide, would expand to 5 to 10 times the volume which had been occupied by the metallic iron prior to oxidation. This expansion of corrosion product would produce blisters, sometimes referred to as carbuncles, in the coating film, which would be readily evident during visual inspection of the coating.

ATTACHMENTS

1. Koppers Protective Coatings Bitumastic Hi-Heat Gray manufacturer's technical data sheet RC2-039 – March, 1969

PHOTOGRAPHS

1. 66-1_12.jp

ATTACHMENT 1

KOPPERS
Protective Coatings

BITUMASTIC HI-HEAT GRAY

BITUMASTIC HI-HEAT GRAY

A. GENERAL CHARACTERISTICS

Bitumastic Hi-Heat Gray is a self-priming, gray colored protective coating especially formulated for use on metal surfaces subjected to high temperatures (800°F. Continuous; 1200°F. Intermittent). As received, it consists of a container of vehicle and another of metallic zinc powder. After incorporation of the zinc powder in the vehicle the product has about the same consistency as ordinary paint.

B. COMPOSITION

Bitumastic Hi-Heat Gray is composed of a special base vehicle, proper driers, and pigmented with metallic filler.

C. PREPARATION OF SURFACES

Before applying **Bitumastic Hi-Heat Gray** to metal surfaces, all dust, dirt, loose mill scale, welding scale, rust, oil, unbonded or incompatible paint, grease, residual acids, alkalies or other foreign matter must be removed as completely as possible from the surfaces to be coated. It is recommended that rust, scale and paint be removed by sand or grit blasting, flame cleaning, hand or power brushing and/or scraping. All surfaces must be dry before the coating is applied.

D. MIXING

The vehicle should be stirred first until the pigment and filler are thoroughly dispersed. Sufficient vehicle should then be added and mixed with the metallic zinc powder to make a heavy paste. Finally, the remainder of the vehicle should be added to the paste and the mixture thoroughly stirred to produce a uniform product. Mix only as much material as will be used during the day. Do not attempt to store the coating in a mixed condition.

E. RATE OF APPLICATION

Bitumastic Hi-Heat Gray is applied only by brushing. One coat should be applied at a rate of 400 – 450 square feet per gallon. This will give a dry film thickness of 2 – 3 mils. The coating should be spread evenly taking care to brush it into pits, cracks or crevices thoroughly to obtain a uniform thin film. If thinning is necessary to reduce the consistency in cold weather, use no more than 1/2 pint of mineral spirits or turpentine per gallon. The coating should be stirred frequently during application.

F. DRYING TIME

Bitumastic Hi-Heat Gray dries to touch in 18 – 24 hours; the actual rate of drying is dependent upon operating temperatures of the surfaces to which the coating is applied. Once the coating has dried, the temperature of the unit should be raised gradually to 500°F. for a period of 24 – 48 hours. This will burn off the organic solvents and fuse the metallic zinc to the surface. Provisions should be made to bring the painted surface to 500°F. minimum within one week after application.

G. TEMPERATURE OF SURFACES

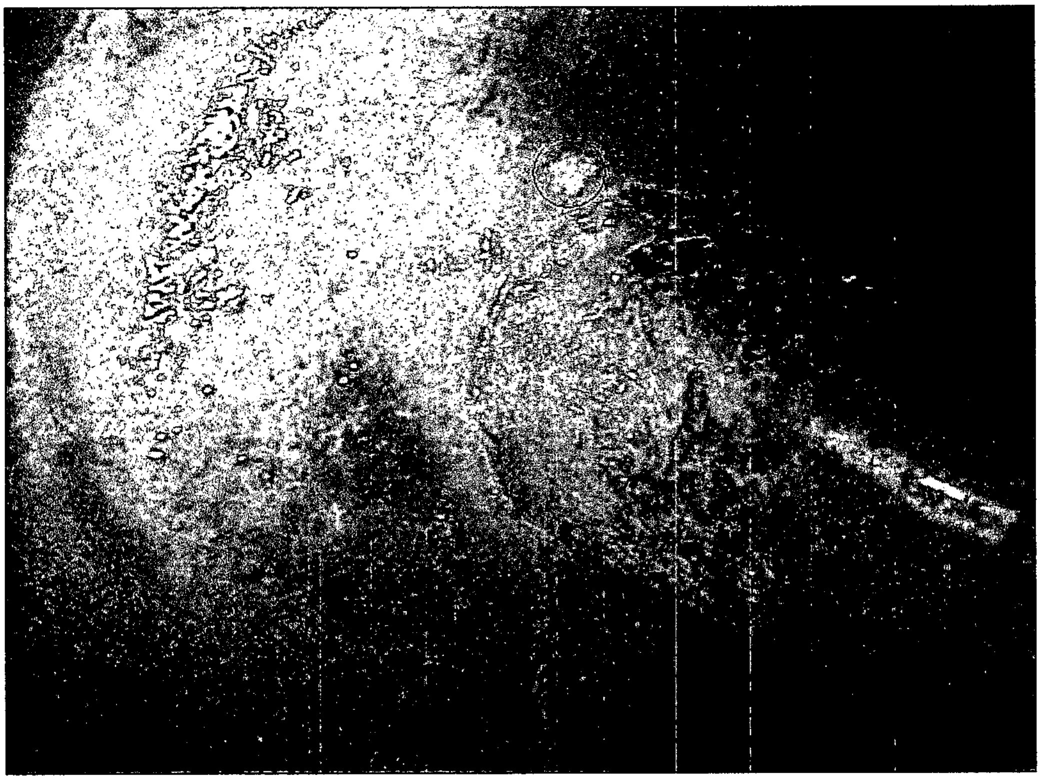
The temperature of the surface being coated should not be below 35°F. nor above 150°F. during application and should not be increased until the coating is thoroughly dry.

The coated surface should not be subjected to weathering for any longer than one week prior to reaching the minimum temperature of 500°F.

H. CLEANING EQUIPMENT

Brushes and other equipment should be cleaned using turpentine or mineral spirits.

PHOTOGRAPH NO. 1



Attachment 2

Owners Acceptance Review (White Paper)

Owner's Acceptance Review
Prepared by: Damon J. Peters, Ginna Coating Engineer

White Paper "Engineering Evaluation of the Painted Ginna Bottom Mounted Instrumentation (BMI) Nozzles," which was prepared by Jon R. Cavallo, PE, PCS.

Extent of Review:

The review encompasses checking the references of the section "Validation of Visual Inspection of the Region of the Ginna BMI Nozzles." In particular, the review of references is specific to the GSI-191 discussion.

The review also includes the discussion on "the properties of Koppers Protective Coating..." In general the review of this section was not to validate the statements, but to ensure that the statements are reasonable from a coatings perspective.

The final section, #3, in response to the NRC RAIs was also reviewed. It has been deemed prudent to elaborate on the engineering basis for why there will be visual indication in the coating if RCS leakage was to occur at the reactor lower head BMI nozzle region.

Discussion:

The references used in the discussion on GSI-191, have been reviewed and determined to be acceptable. That is the references comply with Ginna's design basis, and are in compliance with regulatory requirements for the Ginna's Containment Coatings Program. Specifically, the coatings program visually inspects containment coatings to ensure that the condition of the coatings systems are not degraded, and continue to satisfy their design requirements of protecting the substrate to which they have been applied. This is an NRC supported conclusion, as quoted from the "NRC Staff Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Coatings Evaluation" in the white paper.

A review of the summary provided by the independent coatings consultant on "the properties of Koppers Protective Coating..." was performed to determine if the conclusion that the coating will exhibit visual indication of a primary coolant leakage was reasonable. As discussed in the white paper, the Zinc rich coatings following the organic solvents "burn"-ing off will be made up of zinc particles on the order of 10 to 20 μ m with a minimal amount of organic binder remaining. After the initial series of reactor startups that applied heat beyond the specified duration in the Koppers technical data sheet, it can be safely concluded that a majority of the vehicle was "burn"-ed off. Therefore, the remaining cured (hardened) vehicle and zinc particulate, based on engineering judgment, will exhibit a non-uniform structure. The expected total thickness of a single coat of the coating would be 3 mils, or 0.003" compared to a single zinc particle thickness of 0.0004" (10 μm) to 0.0008" (20 μm). Also, even though the zinc particles will be dispersed throughout the coating, there is no means of ensuring the particles are evenly spaced from one another. This lends to a non-uniform coating structure. Due to the unequal size and spacing of the zinc particles, the structure of the coating cannot be a matrix or a uniform structure, which results in a non uniform bonding in the coating and weakens the strength of the coating. In addition to the non-uniform structure, the apparent intention of the coating was to protect the steel surface during vessel transportation. This fact is expected to have some influence on the final condition of the coating. That is, the apparent intent of the coating was for transportation only. Since the coating was not considered to have a critical function (see white paper), the applicators may not have completely followed the application and curing schedules. We know that the nozzles could not have had appropriate surface preparation for the coating, because the drawings for these had a specific surface finish called out that is very smooth in comparison to the surface that would be required to establish a proper bond (adhesion) between the coating and substrate. From inspection photos (see photograph #1 of white paper) examples of sags can be seen on the nozzles. This is an indication of poor surface preparation and application in the area of the nozzles that is, the paint was applied in some cases over the annulus in what appears to be a non-uniform distribution. Therefore, it is expected that the coating is weaker than what a proper surface preparation, application and cure would have produced.

If a primary water leak was to occur and the annulus space was pressurized, it would be expected to break the coating ("disintegrate"); if not at the very least it would form blisters. From Steel Structures Painting Council (SSPC) now known as SSPC: The Society for Protective Coatings Good Painting Practice, [1] page 501, "blistering most often results from surface preparation or applying a coating over a dirty, greasy, moist or contaminated surface." Furthermore, blisters typically form from osmosis of water through the coating film, which may only require pressures of "several ounces/sq. in" ([1] page 500).

Therefore, if the 2235 psi were applied to the annulus area, and the resulting approximate 5 lbs force was considered on the annulus area, the paint would be expected to be visibly degraded in the area of the annulus region.

Blisters form when a gas or liquid under the coating film exerts a pressure stronger than both the adhesion and internal cohesion of the coating ([1] page 499). The bonding strength between the coating and the nozzles is expected to be very low, because of the lack of proper surface preparation. The curing is expected to have burned off much of the binder in the coating (see white paper). Both of these factors can lend to the formation of blisters. Based on the likelihood of blister formation and/or coating breaks, combined with engineering judgment based on the above observations, the conclusions of the white paper entitled "Engineering Evaluation of the Painted Ginna Bottom Mounted Instrumentation (BMI) Nozzles" provides reasonable assurance that the coating <u>will</u> exhibit visual indication of primary coolant leakage into the annulus if RCS leakage were to occur.

References:

1. <u>Good Painting Practice</u>, Steel Structures Painting Manual Volume 1, Steel Structures Painting Council (SSPC) 1982.

Attachment 3

Koppers Protective Coating Technical Data Sheet (Zinc Rich)

TECHNICAL DATA SHEET

KOPPERS
Protective Coatings

TYPE OF COATING
ZINC RICH

Product: BITUMASTIC HI-HEAT GRAY

DESCRIPTION:	A two-component, zinc-filled, polymeric coating having self-priming characteristics. After incorporation of the zinc powder in the vehicle, the coating has about the same consistency as ordinary paint.
USE:	FOR INDUSTRIAL USE ONLY. NOT INTENDED FOR USE IN THE HOME.
	A protective coating especially formulated for use on metal surfaces subjected to high temperatures. (800°F Continuous; 1200°F Intermittent)
TECHNICAL DATA:	
Number of coats:	One only
Volume solids:	63%
Theoretical coverage:	1,010 mil sq. ft./gal.
Coverage to achieve minimum dry film thickness:	270 to 400 sq. ft./gal. (allows for an approximate application loss of 20%.
Film build ratio:	
Minimum dry film required:	2.0 to 3.0 mils
Wet film required:	3.2 to 4.8 mils
Drying time at 70°F. and 50% relative humidity:	
To touch:	18 to 24 hours
Curing time:	Once the coating has dried, the unit's temperature should be raised gradually and evenly over a 6 to 8 hour period, to 500°F, then maintained at that temperature for a period of 24 to 48 hours. (Do not raise the temperature above 150°F. until the coating has dried.) This will burn off the organic vehicle and fuse the zinc to the surface. Note – the coated surface must not be subjected to weathering for any longer than one week before curing, otherwise maximum protective qualities will not be obtained.
Color:	Zinc metal gray

TECHNICAL DATA (Continued):

Thinner: Koppers Thinner 4000. Normally, thinning is not required, however, to reduce the consistency in cold weather, up to 1/2 pint of thinner per gallon can be used.

Cleaner: Koppers Thinner 4000

Surface preparation:

Steel: Surface must be dry and free of dirt, loose mill scale, welding scale, rust, oil, grease, old paint, residual acids, alkalies or other foreign matter. Remove these interference materials by sand or grit blasting, flame cleaning, hand or power wire brushing and/or scraping.

Primer: None

Mixing instructions: Stir the vehicle well. Add sufficient vehicle to the powdered zinc to make a heavy, smooth paste. Add balance of vehicle slowly while stirring the paste. After all vehicle is added, stir thoroughly to obtain a homogeneous mixture. Mix only as much material as will be used during an 8-hour period. Do not attempt to store the mixed material.

Methods of application: The best method of application is by brushing. The coating should be spread evenly taking care to brush it into pits, cracks and crevices thoroughly to obtain a uniform thin film. Conventional air spraying can be used but will have slightly less efficiency. Airless spraying is not recommended. Do not apply at temperatures below 35°F. or when the surface is above 150°F. Do not apply to surfaces that will be exposed to rain before the coating is dry.

Temperature limitations: dry: 800°F. continuous; 1,200°F. intermittent

Storage life: One year minimum

Pot life: 8 hours

Packaging: 1-gallon and 5-gallon kits. Each kit has two containers. The 1-gallon kit has one container with approximately 8 pounds of vehicle and one container with approximately 11 pounds of zinc powder. The 5 gallon kit has one container with approximately 40 pounds of vehicle and one container with approximately 50 pounds of zinc powder.

PRECAUTIONS: Take these precautions during application and before the coating dries:

Liquid vehicle component and mixed paint:

WARNING!

Harmful or fatal if swallowed.

Vapor harmful. Combustible.

CONTAINS PETROLEUM DISTILLATE

TECHNICAL DATA
(Continued):

PRECAUTIONS (Continued): Avoid prolonged breathing of vapor or spray mist. Avoid prolonged or repeated contact with skin. Keep away from heat and flame. Keep closures tight and upright to prevent leakage. Keep container closed when not in use. In case of spillage, absorb and dispose of in accordance with local applicable regulations. Do not take internally.

KEEP OUT OF REACH OF CHILDREN.

Use Only With Adequate Ventilation.

In confined areas, use adequate forced ventilation continuously during application and drying. Use fresh air masks, clean protective clothing and explosion-proof equipment. Prevent flames, sparks, welding and smoking.

FIRST AID: In case of skin contact, wash thoroughly with soap and water; for eyes, flush immediately with plenty of water for 15 minutes and call a physician. If inhaled, remove to fresh air. If swallowed, CALL A PHYSICIAN IMMEDIATELY. DO NOT induce vomiting.

IN CASE OF FIRE: Use dry chemical, foam, water fog or CO_2. Cool closed containers with water.

Non-Photochemically Reactive.

Additional precautions for Zinc Powder:

Avoid breathing dust; keep away from feed and food products. Wash thoroughly after handling dust before eating or smoking. Wear a respirator when adding powder to vehicle. Powder must be kept dry to avoid fire. Keep container tightly closed when not in use. Store in a cool dry place. Keep separate from acids, halogenated hydrocarbons and strong alkali hydroxides.

IN CASE OF FIRE: Smother with suitable dry powder. Wear self-contained breathing apparatus.

Any mixture of the liquid vehicle component and zinc powder component will have hazards of both components. Observe all applicable precautions.

January 1980 Supersedes all previous data sheets printed on this product.

Attachment 4

Koppers Protective Coating Bitumastic High Heat Gray

KOPPERS
Protective Coatings

BITUMASTIC
HI-HEAT
GRAY

BITUMASTIC HI-HEAT GRAY

A. GENERAL CHARACTERISTICS

Bitumastic Hi-Heat Gray is a self-priming, gray colored protective coating especially formulated for use on metal surfaces subjected to high temperatures (800°F. Continuous; 1200°F. Intermittent). As received, it consists of a container of vehicle and another of metallic zinc powder. After incorporation of the zinc powder in the vehicle the product has about the same consistency as ordinary paint.

B. COMPOSITION

Bitumastic Hi-Heat Gray is composed of a special base vehicle, proper driers and pigmented with metallic filler.

C. PREPARATION OF SURFACES

Before applying **Bitumastic Hi-Heat Gray** to metal surfaces, all dust, dirt, loose mill scale, welding scale, rust, oil, unbonded or incompatible paint, grease, residual acids, alkalies or other foreign matter must be removed as completely as possible from the surfaces to be coated. It is recommended that rust, scale and paint be removed by sand or grit blasting, flame cleaning, hand or power brushing and/or scraping. All surfaces must be dry before the coating is applied.

D. MIXING

The vehicle should be stirred first until the pigment and filler are thoroughly dispersed. Sufficient vehicle should then be added and mixed with the metallic zinc powder to make a heavy paste. Finally, the remainder of the vehicle should be added to the paste and the mixture thoroughly stirred to produce a uniform product. Mix only as much material as will be used during the day. Do not attempt to store the coating in a mixed condition.

E. RATE OF APPLICATION

Bitumastic Hi-Heat Gray is applied only by brushing. One coat should be applied at a rate of 400 – 450 square feet per gallon. This will give a dry film thickness of 2 – 3 mils. The coating should be spread evenly taking care to brush it into pits, cracks or crevices thoroughly to obtain a uniform thin film. If thinning is necessary to reduce the consistency in cold weather, use no more than 1/2 pint of mineral spirits or turpentine per gallon. The coating should be stirred frequently during application.

F. DRYING TIME

Bitumastic Hi-Heat Gray dries to touch in 18 – 24 hours; the actual rate of drying is dependent upon operating temperatures of the surfaces to which the coating is applied. Once the coating has dried, the temperature of the unit should be raised gradually to 500°F. for a period of 24 – 48 hours. This will burn off the organic solvents and fuse the metallic zinc to the surface. Provisions should be made to bring the painted surface to 500°F. minimum within one week after application.

G. TEMPERATURE OF SURFACES

The temperature of the surface being coated should not be below 35°F. nor above 150°F. during application and should not be increased until the coating is thoroughly dry.

The coated surface should not be subjected to weathering for any longer than one week prior to reaching the minimum temperature of 500°F.

H. CLEANING EQUIPMENT

Brushes and other equipment should be cleaned using turpentine or mineral spirits.

I. PACKAGING

1 gallon kit of 2 containers (approximately 8 lbs. vehicle, approximately 11 lbs. filler). 5 gallon kit of 2 containers (approx vehicle, approximately 50 lbs. fi

J. PRECAUTIONS

CAUTION !

Combustible

Harmful or fatal if swallowed.

CONTAINS PETROLEUM DISTILLATE

In confined areas, provide adequate forced ventilation during application and drying. Use air masks, clean clothing and explosion-proof equipment. Prevent flames, sparks, welding and smoking.

WARRANTY

"All technical advice, recommendations and services are rendered by the Seller gratis. They are based on t... the Seller believes to be reliable and are intended for use by persons having skill and knowhow, at their d... Seller assumes no responsibility for results obtained or damages incurred from their use by Buyer wheth... herein or otherwise. Such recommendations, technical advice or services are not to be taken as a license ... intended to suggest infringement of any existing patent."

RC-2-039-March, 1969 Supersedes all previous data sheets printed on this product.

Attachment 5

List of Regulatory Commitments

Attachment 5
List of Regulatory Commitments

The following table identifies actions committed to in this document by R.E. Ginna NPP. Any other statements in this submittal are provided for information purposes and are not considered to be regulatory commitments. Please direct questions regarding these commitments to Thomas Harding at 585.771.5219, or Thomas.HardingJr@Constellation.com.

Regulatory Commitment	Due Date
A best effort attempt to remove a coating sample from the reactor vessel lower head will be performed during the 2009 RFO	October 31, 2009
Model a Reactor Coolant System Break location at the bottom of the Reactor Vessel for the Ginna Simulator and determine if significant differences in operator response for a bottom of vessel break and a traditional cold leg break exist. If so, schedule additional simulator training during the first training cycle following startup from the Fall 2009 refueling outage.	September 30, 2009
Complete additional simulator training, if required.	November 30, 2009