

RAS J-134

May 27, 2008

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board Panel

DOCKETED  
USNRC

In the Matter of )  
)  
Entergy Nuclear Generation Company and )  
Entergy Nuclear Operations, Inc. )  
)  
(Pilgrim Nuclear Power Station) )

Docket No. 50-293-LR  
ASLBP No. 06-848-02-LR

May 28, 2008 8:00 am  
OFFICE OF SECRETARY  
RULEMAKINGS AND  
ADJUDICATIONS STAFF

**ENTERGY'S ANSWER OPPOSING PILGRIM WATCH'S MOTION  
TO STRIKE AND REQUEST TO REOPEN THE HEARING**

**I. INTRODUCTION**

Entergy Nuclear Generation Company and Entergy Nuclear Operations, Inc. (collectively, "Entergy") hereby answer and oppose "Pilgrim Watch Motion to Strike Incorrect and Misleading Testimony from the Record," filed on May 15, 2008 ("Motion"). The Motion, which seeks to strike prior testimony or reopen the hearing,<sup>1</sup> lacks merit. The serious accusations that Pilgrim Watch levels against the NRC Staff, Entergy, and their witnesses are baseless. Rather, the Motion simply reflects that Pilgrim Watch failed to properly prepare for the hearing in April, and having failed to present a credible case, now wants to revise the record to make up for its own lack of diligence.<sup>2</sup>

<sup>1</sup> The hearing on this matter concluded on April 10, 2008. On May 12, 2008, the Board directed that all parties should file findings of fact and conclusions of law, and reply findings and conclusions, on June 9 and June 23, respectively. Order (Setting Deadlines for Provisional Proposed Findings and Conclusions on Contention 1, and for Pleadings Related to Pilgrim Watch's Recent Motion Regarding CUFs) (May 12, 2008) slip op. at 3. On May 16, 2008, the Commission directed that the Board close the evidentiary record on Pilgrim Watch Contention 1 and proceed with its stated schedule for the filing of findings of fact and conclusions of law. CLI-08-09, 67 N.R.C. \_\_\_ (2008).

<sup>2</sup> This is but the latest of Pilgrim Watch's continuing efforts to delay and improperly expand the scope of the proceeding. See Pilgrim Watch Motion to Extend Hearing Schedule (Dec. 12, 2007); Pilgrim Watch Motion to Reset Hearing Schedule (Dec. 14, 2007); Pilgrim Watch Motion on Admissibility of Factual Evidence (Dec. 15, 2007); Pilgrim Watch Motion for Clarification (Dec. 21, 2007); Pilgrim Watch Motion for Reconsideration (Dec. 28, 2007); Pilgrim Watch's Motion for Cross Examination (Mar. 17, 2008); Pilgrim Watch Motion to Permit Late Filed Exhibits (Mar. 24, 2008); Pilgrim Watch Motion Requesting the Record be Held Open So that the Board

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Pilgrim Watch's Motion accuses Entergy of failing to disclose the "Miller Pipeline paper,"<sup>3</sup> a document authored by a third party for presentation to a construction trade organization that has been publicly available for over four years. Pilgrim Watch fails to show that Entergy had possession, custody or control of the Miller Pipeline paper. Entergy is under no obligation to perform a literature or internet search for publicly available documents it does not possess. More importantly, the "key facts" that Pilgrim Watch accuses Entergy of failing to disclose were, in fact, disclosed in official project documents produced to Pilgrim Watch by Entergy in accordance with NRC rules. If Pilgrim Watch was unaware of these facts at the hearing, it is only because Pilgrim Watch failed to adequately review the documents that Entergy had produced.<sup>4</sup> Entergy should not be penalized for Pilgrim Watch's failure to do its own research prior to the hearing.

Similarly, Pilgrim Watch's use of the May 12, 2008 letter from John Fitzgerald<sup>5</sup> and other cathodic protection documents to attack the testimony of the NRC Staff's witness, Dr. Davis, is inappropriate. The issue of cathodic protection was introduced by Pilgrim Watch's witness, Mr. Gundersen, who Pilgrim Watch put forth as a competent expert. There is simply no

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May Address a New and Significant Issue [Method to Calculate Cumulative Usage Factors (CUF)] Sua Sponte and Provide Pilgrim Watch an Opportunity for Hearing (Apr. 9, 2008); Pilgrim Watch Motion Regarding the Cumulative Usage Factor (CUF) (May 5, 2008). And just today, Pilgrim Watch filed yet another such motion. See Pilgrim Watch Motion to Include as Part of the Record Exhibits Attached to Pilgrim Watch Motion to Strike Incorrect and Misleading Testimony from the Record of May 15, 2008 (May 27, 2008). This conduct is dilatory, oppressive, and inappropriate.

<sup>3</sup> Motion at 2; *Jonathan Raymer*, Pilgrim Nuclear Power Station: Salt Service Water Discharge Piping Trenchless Rehabilitation Challenges, Miller Pipeline Corp., Indianapolis, IN ("Miller Pipeline paper").

<sup>4</sup> There have been a number of indications that Pilgrim Watch failed to adequately review Entergy's disclosures in preparation for hearing, including (1) Pilgrim Watch's inaccurate testimony concerning the drawings that Entergy had produced (see Entergy's Motion in Limine to Exclude Pilgrim Watch Testimony and Exhibits (Mar. 10, 2008) at 33-34; Pilgrim Watch's Motion to Permit Late Filed Exhibits (Mar. 24, 2008), in which Pilgrim Watch sought to introduce documents from Entergy's disclosures after the deadline for submission of exhibits); and Mr. Gundersen's testimony that Pilgrim Watch had not given him photographs disclosed by Entergy when Mr. Gundersen prepared his testimony (Tr. 629).

<sup>5</sup> Letter from John H. Fitzgerald III, P.E. to Mary Lampert (May 12, 2008) ("May 12 Letter").

basis for Pilgrim Watch to strike Dr. Davis' testimony or to introduce Mr. Fitzgerald's *post hoc* critique.

Finally, as shown specifically below, there is no merit to Pilgrim Watch's claims that Entergy and the NRC Staff provided inaccurate and misleading testimony. In sum, Pilgrim Watch's Motion is nothing more than an attempt by Pilgrim Watch to get a second, unwarranted bite at the apple. Accordingly, its Motion should be denied.

## **II. PILGRIM WATCH PROVIDES NO BASIS FOR ITS MOTION TO STRIKE**

At the outset, a motion to strike already presented testimony is inappropriate. A motion to strike is limited in scope and function and is used as "an appropriate mechanism for seeking the removal of information from a pleading or other submission that is 'irrelevant'" or "contain[s] technical arguments based on questionable competence." Private Fuel Storage, L.L.C., LBP-05-20, 62 N.R.C. 187, 228 (2005), citing Power Authority of the State of New York (James A. Fitzpatrick Nuclear Power Plant; Indian Point, Unit 3), CLI-01-14, 53 N.R.C. 488, 514 (2001); see also Florida Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 and 4), LBP-85-29, 22 N.R.C. 300, 305 (1985). See also 10 C.F.R. § 2.233(b) (permitting the Presiding Officer to strike argumentative, repetitious, cumulative, unreliable, immaterial, or irrelevant testimony). No provisions in the rules permit a motion to strike testimony on the grounds that the movant disagrees with it.

Rather, the appropriate mechanism for a party to respond to testimony with which it disagrees is to provide contrary testimony and evidence at hearing and present counter argument in its proposed findings of fact. See, e.g., 10 C.F.R. § 2.1209. Pilgrim Watch had a full opportunity to develop rebuttal testimony and present its case at the hearing.

Likewise, Pilgrim Watch's claims that Entergy failed to produce a copy of the Miller Pipeline paper in discovery provides no basis for a motion to strike. Motion at 2. The Commission's regulations require that Entergy produce only those documents "in the possession, custody, or control of [Entergy] that are relevant to the contentions." 10 C.F.R. § 2.336(a)(2)(i). As Pilgrim Watch concedes, the document was neither authored by nor presented to Entergy (Motion at 2 & n.2), but rather is a paper presented by a third party to a construction trade association. Moreover, in discharge of its disclosure obligations under the Commission's regulations, Entergy performed a reasonable search for relevant materials in its possession, custody, or control. This search identified and produced over 10,000 pages of documents relevant to Pilgrim Watch Contention 1. This search did not identify the Miller Pipeline paper, and Pilgrim Watch has made no showing that Entergy ever had possession, custody, or control of this document.

Furthermore, there is no basis to Pilgrim Watch's admitted speculation that Entergy may have engaged Miller Pipeline as an expert in this proceeding "and decided not to disclose that fact." Motion at 2. Entergy did not retain Miller Pipeline in this proceeding. Entergy has not had any contractual relationship with Miller Pipeline during this license renewal proceeding.

Moreover, the facts discussed in the Miller Pipeline paper are fully described in greater detail in official project documents that Entergy did disclose to Pilgrim Watch as part of the discovery process. Pilgrim Watch had these documents months before the hearing yet never raised these issues at the hearing. For example, Entergy provided the project document for the design and analysis of the CIPP liner that fully describes the design, installation, repairs, and

testing of the CIPP liner for both discharge loops of the Salt Service Water (“SSW”) system.<sup>6</sup> The use of different materials for the CIPP in the Loop “A” and Loop “B” SSW discharge lines and the cracking and repair at the elbows during the installation of the CIPP liner are fully described in this document.<sup>7</sup> That Pilgrim Watch simply ignored this and other documents demonstrates that it failed to properly prepare for this proceeding. Such lack of diligence provides no basis to strike testimony – even assuming a motion to strike were the proper mechanism for challenging testimony contrary to a party’s position, which as discussed above, we respectfully submit it is not.

**III. PILGRIM WATCH FAILS TO SATISFY, OR EVEN ADDRESS, THE COMMISSION’S REQUIREMENTS FOR REOPENING AN EVIDENTIARY RECORD**

As with Pilgrim Watch’s other recent motions to belatedly expand the record and scope of this proceeding, Pilgrim Watch fails even to acknowledge and address the Commission’s requirements for reopening an evidentiary record set forth in 10 C.F.R. § 2.326, much less demonstrate that it has met these requirements. In order to reopen a closed record to consider additional evidence, Pilgrim Watch must, among other criteria, (1) demonstrate that its Motion is timely, (2) show that the new evidence would materially affect the outcome of the proceeding, and (3) submit evidentiary affidavits setting forth the factual and technical basis of its claims. See 10 C.F.R. § 2.326. Pilgrim Watch’s Motion fails to address, much less satisfy, these requirements.

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<sup>6</sup> SSW Discharge Piping CIPP Liner Design, Document Number M-1031 Rev. 1” (May 14, 2003) at 6-14 (PILLR0046106-114) (“M-1031”).

<sup>7</sup> Id. See also discussion at Section III.B.1.b infra.

**A. Pilgrim Watch's Motion To Reopen the Hearing is Inexcusably Late**

At the outset, Pilgrim Watch's Motion for the Board to consider new evidence is not timely. Commission case law has long established that to reopen a closed evidentiary record, a movant must "act promptly after the relevant information bec[omes] available." Public Service Company of New Hampshire (Seabrook Station, Units 1 and 2), CLI-90-06, 31 N.R.C. 483, 487 (1990), citing Duke Power Co. (Catawba Nuclear Station, Units 1 and 2), CLI-83-17, 17 N.R.C. 1041, 1048-50 (1983). Further, the movant must show that the issue sought to be raised could not have been raised earlier. Pacific Gas & Electric Co. (Diablo Canyon Nuclear Plant, Units 1 & 2), ALAB-775, 19 N.R.C. 1361, 1366 (1984). A Board must reject a motion to reopen the record predicated on information that has been available for more than a year. Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1), ALAB-815, 22 N.R.C. 198, 201 (1985). Here, the Miller Pipeline paper relied on by Pilgrim Watch was dated March 22-24, 2004 and thus has been available to the public for over four years – indeed, for approximately two years before intervention petitions were due in this proceeding. Pilgrim Watch has made no showing that this document was not available to it long before now. The facts discussed in the Miller Pipeline paper are described in greater detail in the project documents that Entergy affirmatively disclosed to Pilgrim Watch as part of the discovery process and which Pilgrim Watch had several months before the hearing. See discussion supra Section II and infra Section III.B.1.b. Each of the major claims regarding CIPP raised by Pilgrim Watch is discussed in more detail in these documents than in the Miller Pipeline paper.

Likewise, Pilgrim Watch has made no showing that the purported cathodic protection evidence on which it seeks to rely has been unavailable to it before now. Pilgrim Watch has had ample opportunity to litigate its concerns here. Indeed, Mr. Arnold Gundersen, Pilgrim Watch's

testifying expert, raised cathodic protection as an issue in his testimony and rebuttal testimony.<sup>8</sup> Pilgrim Watch offers no reason why it could not have proffered the cathodic protection information it seeks to raise here before now, or retained an additional expert if the subject matter exceeded Mr. Gundersen's competence. Indeed, Pilgrim Watch suggests that the Board "perform a simple GOOGLE search" on various key phrases related to cathodic protection, which allegedly turns up "countless, instructive hits" on this issue. Motion at 14. In light of the ease with which Pilgrim Watch has found this publicly available information, Pilgrim Watch should have heeded its own advice and performed its research prior to the hearing, not after. In short, it is now too late for Pilgrim Watch to seek to reopen the record based on this information.

**B. Pilgrim Watch Has Failed to Demonstrate that a Materially Different Result Would Be Likely**

To reopen a closed evidentiary record, Pilgrim Watch also "must demonstrate that a materially different result would be or would have been likely had the newly proffered evidence been considered initially." 10 C.F.R. § 2.326(a)(3). Pilgrim Watch has also failed to meet this standard.

Although no decision has in fact yet been reached on Pilgrim Watch Contention 1, the record is closed "on the portion of the proceeding with respect to which new information is being proffered" and it is therefore appropriate to consider "whether the additional information might potentially alter the result [the Board] would reach in its absence." Houston Lighting & Power Co. (South Texas Project, Units 1 and 2), LBP-85-42, 22 N.R.C. 795, 799 (1985); see also Private Fuel Storage L.L.C. (Independent Spent Fuel Storage Installation), CLI-05-12, 61 N.R.C. 345, 350 (2005) ("reopening requires a showing that new information will 'likely' trigger a

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<sup>8</sup> Declaration of Arnold Gundersen Supporting Pilgrim Watch's Petition for Contention 1 (Jan. 26, 2008) at pp. 5, 8-9, 13, 19; Testimony of Arnold Gundersen Supporting Pilgrim Watch's Contention 1 (Mar. 6, 2008) at pp. 25, 43, 45, 48, 49, 53.

‘different result’”). In considering the significance of newly proffered information, it is necessary to consider whether the information is new factual information. LBP-85-42, 22 N.R.C. at 799. In this regard, “[d]iffering analyses of experts of factual information already in the record do not normally constitute the type of information for which reopening of the record would be warranted.” *Id.*, citing Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant, Units 1 and 2), ALAB-644, 13 N.R.C. 903, 994-95 (1981) (rejecting a motion to reopen a hearing record based on a new seismic analysis where the seismic motion records were not new and “either were or might have been addressed” at hearing) (emphasis added); see also LBP-85-42, 22 N.R.C. at 799.

Pilgrim Watch fails to show that the additional information might potentially alter the result that the Board would reach in its absence. The information on which Pilgrim Watch relies (even if it were timely raised) discusses information either contained in documents disclosed to Pilgrim Watch in discovery, or otherwise available to Pilgrim Watch, which might have been addressed by Pilgrim Watch at the hearing. Moreover, Pilgrim Watch has failed to make any showing that the assertedly new information would materially affect the result of the hearing.

**1. Pilgrim Watch Makes No Showing of a Materially Different Result with Respect to the CIPP Liner**

The Miller Pipeline paper is fully consistent with Entergy’s testimony. Many of Pilgrim Watch’s claims allegedly based on the Miller Pipeline paper are nowhere to be found within the four corners of the paper. Moreover, Pilgrim Watch ignores conclusions stated in the Miller paper that the CIPP, as ultimately installed, met the specifications. See, e.g., Miller Pipeline paper at 9 (“The results of testing were used to confirm compliance with physical property specifications”); id. (“final inspection revealed that the cured in place pipe liner fit tight to the

interior surface of the host pipe”). Moreover, official project documents disclosed by Entergy during the discovery process fully cover the topics and matters discussed in the Miller Pipeline paper.<sup>9</sup> This information was fully available to Pilgrim Watch to raise at the hearing, but it simply failed to do so.

**a. Buried Piping within the Scope of Contention 1**

Pilgrim Watch erroneously claims (Motion at 3) that the Miller Pipeline paper contradicts Entergy’s sworn testimony regarding application of CIPP to the buried SSW system discharge piping. The scope of Contention 1 is limited to buried pipe, and therefore Entergy’s expert testimony only addresses buried pipe that is part of relevant systems. Entergy’s prefiled testimony of Steven Woods and Brian Sullivan makes clear that the entire lengths of the buried SSW discharge pipe, Loops “A” and “B,” are lined with CIPP.<sup>10</sup> The non-buried portions of the SSW system are outside the scope of Contention 1 and are not addressed in Entergy’s testimony.

Nothing in the Miller Pipeline paper contradicts Entergy’s testimony. Nowhere does the Miller Pipeline paper suggest that any portion of buried SSW discharge system piping is not lined with CIPP. The only contradictions are with Pilgrim Watch’s erroneous simplification and interpretation of the Miller paper.

Pilgrim Watch claims that “Entergy incorrectly stated that the entire piping was lined; when in fact the liner was not applied in an area near and inside the auxiliary building—approximately 10 feet outside the building and an indeterminate footage inside the building.”

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<sup>9</sup> See *infra* Section III.B.1.b (discussing Entergy documents M-1031 and M-624).

<sup>10</sup> Testimony of Alan Cox, Brian Sullivan, Steve Woods, and William Spataro on Pilgrim Watch Contention 1, Regarding Adequacy of Aging Management Program for Buried Pipes and Tanks and Potential Need for Monitoring Wells to Supplement Program (Jan. 28, 2008) (“Entergy Expert Testimony”) at A42.

Motion at 3.<sup>11</sup> However, as reflected in Figures 2, 3, and 5 provided in the Miller Pipeline paper, the statement upon which Pilgrim Watch relies refers to the portion of the SSW system contained within the access vault adjacent to the auxiliary building.<sup>12</sup> SSW piping inside of the vault adjacent to the auxiliary building is not buried and is fully accessible. Entergy never stated that the piping in the vault or inside the auxiliary building was lined with CIPP, and indeed such piping (*i.e.*, that which is not buried) is simply beyond the scope of Contention 1.

Thus, the information in the Miller Pipeline paper does not contradict either evidence presented by Entergy or developed by the NRC Staff. Indeed, the Miller Pipeline paper expressly states as follows:

In April 2001, PNPS developed a specification for lining Loop “A” and Loop “B” from the last flange connection at the Auxiliary Building piping vault to the end of the discharge pipe at the outfall.<sup>13</sup>

In short, the Miller Pipeline paper fully confirms, consistent with the testimony of Entergy’s witnesses, that the entire lengths of the buried SSW discharge pipe, Loops “A” and “B,” are lined with CIPP.

**b. “Field application” of the CIPP Liner**

Pilgrim Watch erroneously claims that Entergy failed to disclose or mention information related to the installation of the CIPP liner. Motion at 1, 3. Pilgrim Watch is simply incorrect, as Entergy has disclosed official project documents that discuss the design and installation of the CIPP liner at length.

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<sup>11</sup> Pilgrim Watch accuses the NRC Staff of the same inconsistency:

PW notes that this same factual inaccuracy is repeated by NRC Staff in the SER, 3-37, “Since then, the entire length of both SSW buried discharge loops have been lined internally with pipe linings cured in place – “B” Loop in 2001 and “A” Loop in 2003.”

Motion at 3 n.3 (emphasis added).

<sup>12</sup> Miller Pipeline paper at 4, 5, 8.

<sup>13</sup> Miller Pipeline paper at 3 (emphasis added); see also id. at 7 (“preparation . . . included opening the vault”).

Specifically, in M-1031,<sup>14</sup> in a section aptly titled “Results from CIPP Installation & Testing SSW Loop “B” in RFO-13,” the installation, repairs, and testing of the CIPP liner in SSW discharge pipe loop “B” are discussed in detail.<sup>15</sup> Similarly, in a section entitled “Results from CIPP Installation & Testing SSW Loop “A” in RFO-14,” M-1031 provides the same detailed information regarding the installation, repairs, and testing of the CIPP liner in SSW discharge pipe loop “A.”<sup>16</sup> The discussions in these sections describe the high temperatures reached in the curing of the epoxy resin in Loop B, the splitting and repair of the CIPP liner at the bends, and the use of a different, but equivalent polyester resin for Loop A. Moreover, as reflected in M-1031, Entergy conducted inspections and tests of the CIPP liner for both Loop “B” and Loop “A” which demonstrated that the CIPP, as installed, met the design specifications.<sup>17</sup> All of this information is provided in greater detail than is summarized in the Miller Pipeline paper and nothing in the Miller Pipeline paper is inconsistent with M-1031.

Thus, it appears that Pilgrim Watch simply failed to review, prior to the hearing, the information provided in Entergy’s disclosures on installation of the CIPP. Failure to prepare one’s own case is surely not cause to reopen the record. Because Pilgrim Watch in fact had the information that it mistakenly asserts was missing, the matters Pilgrim Watch raised “might have been addressed” at hearing and thus are not the proper subject of a motion to reopen the record. Diablo Canyon, ALAB-644, 13 N.R.C. at 994-95. Accordingly, Pilgrim Watch cannot show that the Miller Pipeline paper is materially different from the information that was in Pilgrim

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<sup>14</sup> A copy of M-1031 is provided for the Board’s information as Attachment A. It is recognized in this respect that a response to motion to reopen the record may supply documents that may be considered in ruling on the motion. See Private Fuel Storage L.L.C., *supra*, CLI-05-12, 61 N.R.C. at 350-55.

<sup>15</sup> M-1031 at 6-9 (PILLR0046106-109).

<sup>16</sup> Id. at 10-14 (PILLR0046110-114).

<sup>17</sup> Id. at 6-14 (PILLR0046106-114).

Watch's possession prior to the hearing. Rather, Pilgrim Watch is complaining of information that was not presented due to its own lack of diligence.

Furthermore, Pilgrim Watch's claims that the testimony of Entergy's witnesses is contradicted by newly discovered information concerning the field application of the CIPP are simply false. Pilgrim Watch's claims are not supported by the Miller Pipeline paper or any other evidence or document. As such, they provide no basis for reopening the record.

First, Pilgrim Watch claims that, because Loops "A" and "B" utilize different CIPP liner material as indicated in the Miller paper, the two loops are not "equivalent so that their performance and 'life expectancy' cannot be assumed to be the same." Motion at 4. However, the Miller Pipeline paper makes no such statement, so this claim is nothing more than unsupported speculation by Pilgrim Watch. Indeed, contrary to Pilgrim Watch's unsupported claim, the Miller Pipeline paper notes that Entergy employed a resin specialist to ensure that polyester resin could be used "in place of epoxy and still meet the design requirements."<sup>18</sup> This is fully confirmed by the official project design document, M-1031.<sup>19</sup>

Contrary to Pilgrim Watch's claims, this information is consistent with the testimony of Entergy's witnesses. Entergy's witnesses clearly specified in their pre-filed testimony that the CIPP liner material for Loop "A" "consists of a nonwoven polyester felt tube that is saturated with a resin and catalyst system" whereas the CIPP liner for Loop "B" uses "an epoxy resin and

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<sup>18</sup> Miller Pipeline paper at 7.

<sup>19</sup> M-1031 states in relevant part as follows:

Based on the RFO 13 experience, it was decided to use a different resin for the Loop-A discharge line CIPP. The resin selected is a isophthalic polyester rather than an epoxy. The principle design parameters remain identical and there are no changes to the required strength characteristics or the resulting thickness required for the CIPP. The physical parameters for the polyester resin, including flexural and tensile strength, coefficient of thermal expansion, and long-term stability are comparable to the epoxy resin.

M-1031 at 10 (PILLR0046110) (emphasis added).

hardener system . . . with a polyurethane or polyethylene inner membrane.”<sup>20</sup> Furthermore, Entergy’s expert witness, William Spataro, testified to the characteristics of both types of liners as follows:

The ½” thick CIPP liner, consisting of polyester felt material with a resin and catalyst system or an epoxy resin and hardener system, forms a smooth, hard surface that resists moisture intrusion and abrasion, and is resistant to most chemicals and all waters. The CIPP liner is superior to the rubber liner since it is an epoxy and polyester thermosetting resin that cures in place with a smooth hard surface that is resistant to biofouling and other forms of degradation. Such an impervious membrane forms an excellent protective barrier protecting the carbon steel from internal corrosion.

Entergy Expert Testimony at A45 (emphasis added).

Thus, there are no contradictions between Entergy’s testimony and the information that Pilgrim Watch incorrectly characterizes as new. Based on Entergy’s sworn expert testimony and documents Entergy produced, it is clear that the CIPP liner in loops “A” and “B” are equivalent. Pilgrim Watch has not produced any evidence that claims otherwise. The Miller Pipeline paper does not declare that the CIPP liners in loops “A” and “B” have different characteristics; neither does Pilgrim Watch’s expert. Rather, it is solely Pilgrim Watch’s representative that makes this naked assertion. Pilgrim Watch fails to produce any evidence at all, let alone evidence that could demonstrate that a materially different result would be likely.

Again with no supporting evidence, Pilgrim Watch also declares that the repaired portions of Loop “B” are inferior in quality. Motion at 4-5. This claim is a fabrication from whole cloth with no support other than the naked assertion of Pilgrim Watch’s representative. Both the Miller Pipeline paper and M-1031 clearly describe how the CIPP liner was repaired using Belzona 1311 Ceramic-R-Metal epoxy compound. M-1031 goes further and says that “[t]he 1311 repair compound is a modified epoxy with strength properties that are considerably

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<sup>20</sup> Entergy Expert Testimony at A43.

higher than the CIPP liner epoxy felt composite and was installed to a thickness greater than the nominal ½” thickness of the liner.” M-1031 at 7 (PILLR0046107). Therefore, Pilgrim Watch again utterly fails to demonstrate that consideration of the Miller Pipeline paper would likely trigger a materially different result.

Pilgrim Watch also claims “there is no indication that samples from patched areas and elbows were tested.” Motion at 7. Again, Pilgrim Watch has failed to review Entergy documents. M-1031 says, “[t]esting was also performed on specimens cast from a sample of Belzona 1311 Ceramic R-Metal epoxy compound that was used for CIPP lining repairs . . . .” M-1031 at 14 (PILLR0046114). In fact, Entergy tested samples not only from the repair Belzona material, but also from both loops upon completing installation. According to Entergy’s specification for the CIPP, M-624, “the finished CIPP shall be inspected by visual examination over the entire length and shall be free of significant voids (air bubbles, dry spots, pits, and cracks).” The document goes on to say “cracks are not permitted and any affected areas of CIPP shall be removed by cutting or excavating to completely remove the crack.”<sup>21</sup> Once more, Pilgrim Watch is simply making an unsubstantiated and incorrect assertion that reflects its failure to have reviewed documents disclosed by Entergy. Once more, Pilgrim Watch fails to demonstrate that a materially different result would be likely.

Finally, Pilgrim Watch claims that “the probability of worker error is increased if the task is challenging,” referring to the need to install the CIPP liner during a refueling outage. Motion at 5. As in the other instances, Pilgrim Watch offers no evidence whatsoever to support the claimed materiality of this assertion. The Miller Pipeline paper provides no evidence of worker

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<sup>21</sup> Pilgrim Nuclear Power Station Specification for Cured-In Place-Pipe (CIPP) Lining for SSW Discharge Piping Specification Number M-624 (“M-624”) (March 12, 2003) at 10. Entergy also provided this document to Pilgrim Watch as part of its document disclosures, and a copy of M-624 is provided for the Board’s information at Attachment B.

error, and indeed expressly refers to inspections and other activities specifically intended to ensure conformance of the work with specifications and other requirements.<sup>22</sup> Furthermore, the Pilgrim nuclear power plant has a well-experienced staff with processes and controls in place to correctly perform challenging tasks.<sup>23</sup>

In short, the asserted newly discovered evidence supports none of the claims advanced by Pilgrim Watch in its motion. The testimony of Entergy is wholly consistent with this information, and Pilgrim Watch has made no showing that a materially different result would likely be triggered by consideration of this new information.

**c. No Contradiction Regarding the Structural Integrity of the CIPP Exists**

Pilgrim Watch also claims that the Miller Pipeline paper contradicts “Entergy’s statements at the hearing” that the CIPP liner “has the structural integrity of a pipe.” Motion at 5-6. However, Entergy clearly stated at the hearing that the CIPP is not relied upon to maintain structural integrity under seismic loads. Tr. at 618 (“it’s the pipe that’s relied on to meet the seismic stresses”) (Counsel for Entergy arguing objections to introduction of proposed Pilgrim Watch exhibit); Tr. at 621 (“the cured in place piping inside it is not relied on to meet the seismic stresses”) (Counsel for Entergy arguing objections to introduction of proposed Pilgrim Watch exhibit).

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<sup>22</sup> See, e.g., Miller Pipeline paper at 9 (“final inspection revealed the cured in place pipe liner fit tight to the interior surface of the host pipe”). See also *id.* at 7 (“team spent several days performing quality assurance inspections and reports to confirm that the materials conformed to specifications”).

<sup>23</sup> Pilgrim Watch also claims that the vendor did not provide a warranty for the CIPP liner. Motion at 6. However, Entergy never claimed in any of its documents or testimony that the CIPP liner was warranted by the manufacturer. The basis for the 35 year expected life of the CIPP is actual field experience with such epoxy and polyester liners. See Tr. at 655, 723 (Sullivan); at 681 (Spataro) As discussed at the hearing, Entergy will perform inspections at 10 year periodic intervals to confirm the CIPP is performing as expected, with the first such inspection being prior to period of extended operation under the renewed license. Tr. at 774 (Sullivan); at 776 (Cox).

The testimony of Alan Cox cited by Pilgrim Watch is not to the contrary. His testimony refers solely to pressure loads and not external structural loads, such as seismic or soil overburden. Mr. Cox's testimony clearly stated that the CIPP was analyzed to withstand pressure loads inside and outside: "it's actually analyzed to be able to stand the pressure loads and the loads from outside the hydraulic pressures of the water above it as if there was no outside pipe." Tr. at 678. Although the statement is mischaracterized, the portion of Mr. Cox's testimony quoted by Pilgrim Watch in fact makes the topic of his discussion clear,

It is analyzed for the head of water above it and the -- because the pipe runs downhill, it actually draws a vacuum in parts of it. So it's analyzed to a negative 11 pounds per square inch from the outside, and it's analyzed to -- I can't remember the -- whatever the design pressure is from the inside.

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The cured-in-place-pipe has a separate analysis. It says it can withstand the normal pressure loads acting within and from outside.

Motion at 6; see also Tr. at 678 (emphasis added).

This distinction drawn by Mr. Cox between pressure loads for which the CIPP is analyzed and structural loads for which it is not analyzed was clearly understood by Pilgrim Watch's witness, if not Pilgrim Watch's representative. Tr. at 706 ("This liner, just to make sure, is not a seismic barrier. It is a pressure barrier.") (Gundersen). Thus, Pilgrim Watch's assertion (Motion at 5-6) that Entergy claims that the CIPP liner "has the structural integrity of a pipe," is "earthquake proof," and is designed to "withstand ground movement" (Motion at 5-6) is simply wrong. Entergy has never argued or implied that the CIPP liner is relied on for structural integrity or seismic loads and Pilgrim Watch's attempt to so characterize Entergy's testimony fails. The asserted contradiction with the Miller Pipeline paper simply does not exist.

**d. Pilgrim Watch's Other Claims of Contradiction and Incorrect and Misleading Testimony are Wholly Without Merit**

As demonstrated above, Pilgrim Watch's claims that Entergy's witnesses gave incorrect and misleading testimony that is contradicted by the Miller Pipeline paper are simply not true. The testimony of Entergy's witnesses is fully consistent with the Miller Pipeline paper and official project documents concerning the CIPP. It is Pilgrim Watch – not Entergy – that has fabricated claims from whole cloth that are unsupported by facts or evidence.

Likewise Pilgrim Watch's other claims regarding alleged incorrect and misleading testimony by Entergy witnesses are simply untrue. Citing a draft document not in evidence, Pilgrim Watch claims that the parties "all agree that the SSW Discharge rubber liner is not credited with a protective function." Motion at 1. The document reads, however, since "for identifying aging effects the liner is not credited with a protective function, aging effects are identified for carbon steel in contact with salt water." Motion at 2 (emphasis added). The document does not state that the liner is not properly credited as part of the aging management program consistent with the GALL Report.

As explained by Entergy's witness Mr. Cox with respect to similar language in the aging management review report for the SSW system (discussed below), if Entergy had credited a qualified protective life for the rubber liner, CIPP or coating (whatever the protective covering), there would be no aging effects on the underlying metal and no need for an aging management program. Hence, in determining the need for an aging management program, no protective function is credited, but the aging management program includes reliance on the protective coating or liner combined with inspections to ensure that it remains in place. In short, there is no

contradiction as claimed by Pilgrim Watch and as essentially acknowledged by Pilgrim Watch's expert.<sup>24</sup>

Similarly, Pilgrim Watch's argument that the Board should strike allegedly inaccurate and misleading testimony from the record concerning the protective capability of coatings (Motion at 7-8) is both inappropriate and wrong. Again, Pilgrim Watch's sole basis is language from the aging management review report for the SSW system that "[s]ince the coating does not have a specified life, aging effects are evaluated as if the carbon steel was not coated."<sup>25</sup> Again, the point is that, if specified life were assumed for the coating, there would be no need for an aging management program. As explained by Mr. Cox at the hearing:

What [the quote] simply means is if [Entergy] had a specified life of the coating, a guaranteed life, [Entergy] would have no aging effects. We would have no entries in the aging -- in the license renewal application for that component. We would have none listed as the aging effect. We would have no aging management program listed or required to manage aging effects. What we've done here is since there is no qualified life of the coating we have said that loss of material of that underlying metal is possible, so we have to have an aging management program. The aging management program in this case is actually relying on the coating and the inspections that we do periodically of the coating to prevent the loss of material from that surface.<sup>26</sup>

In short, there is absolutely no basis for Pilgrim Watch's wholly inappropriate effort to strike Entergy's testimony, or reopen the record, on the basis of this language.

Finally, Pilgrim Watch argues that Entergy ignores the fact that the CIPP liners "simply protect the interior from corrosion," whereas the real issue is corrosion from the exterior attacking the metal." Motion at 7. This argument in the context of discussing the CIPP is a *non sequitur*. As the Board well knows, Entergy has an entirely separate aging management program

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<sup>24</sup> See Tr. at 748-49 (Gundersen).

<sup>25</sup> See Board Exhibit 70 ("Aging Management Review of the Salt Service Water System") at 10.

<sup>26</sup> Tr. at 748 (Cox) (emphasis added).

in place for the exterior surface of the pipe. Pilgrim Watch's follow on statement that "[w]e know, from Entergy's own disclosures and the vendor's paper that coating can deteriorate in months and cannot be relied upon" (Motion at 7) is a wholly irrelevant, gratuitous and completely inaccurate and unsupported statement. The record has a plethora of evidence concerning the protective capability of coatings (and liners) that will be set forth in Entergy's findings.

In short, Pilgrim Watch's other arguments of allegedly inaccurate and misleading testimony by Entergy witnesses are inappropriate for a motion to strike or reopen the record and moreover are simply untrue.

**2. Pilgrim Watch Makes No Showing of a Materially Different Result with Respect to Cathodic Protection**

Wholly apart from the inexcusable lateness of Pilgrim Watch's claims of asserted newly found evidence on cathodic protection discussed above, the Motion makes no showing that its proffered information on cathodic protection, even if considered, would likely trigger a materially different result. Pilgrim Watch's belated information (1) does not take into account the unique circumstances of operating cathodic protection at a nuclear power plant, and (2) ignores the fact that cathodic protection is but one of two acceptable alternatives for the license renewal aging management of buried pipes.

Dr. Davis testified that the NRC did not mandate the use of cathodic protection as part of the license renewal aging management program for buried piping because of a concern that the rectifiers may be safety-related equipment such that the failure of a rectifier could result in operation under a "limited condition of operation" ("LCO") of the plant's technical specifications that could require shutdown of the plant until the rectifier were repaired. Tr. at

770 (Davis). Pilgrim Watch's newly found expert, Mr. Fitzgerald, states in response that "[u]nless there is a NRC rule requiring this, there is no reason to have to shut down the plant if the rectifier should go off."<sup>27</sup> The Motion transforms Mr. Fitzgerald's qualified statement to the unequivocal declaration that "[t]here is no reason to have to shut down the plant if the rectifier should go off." Motion at 10 (emphasis in original).

Obviously, neither Mr. Fitzgerald<sup>28</sup> nor Pilgrim Watch's representative are familiar with the NRC regulations concerning LCOs that are included in the technical specifications for operating nuclear power plants. The NRC's regulations expressly require that when a LCO "is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met." 10 C.F.R. § 50.36(c)(2) (emphasis added). Thus, the failure of a safety-related rectifier, should cathodic protection be required, could result in an LCO and plant shutdown as Dr. Davis testified. Thus, unlike other applications of cathodic protection where the outage of a rectifier for a short time is of no operational concern,<sup>29</sup> even the temporary outage of a safety-related rectifier at a nuclear power plant could place a large burden on plant operations for little material benefit.

Hence, the development of an alternative license renewal aging management program for buried piping that does not rely upon cathodic protection. Tr. at 770 (Davis). As explained by Entergy's witness Mr. Cox, the GALL Report<sup>30</sup> accordingly provides for two alternative license renewal aging management programs for buried piping. These are M-28 (which employs cathodic protection) and M-34 (which employs protective coatings and inspections in lieu of

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<sup>27</sup> May 12 Letter at 2 (emphasis added).

<sup>28</sup> While reflecting some work on cathodic protection systems at nuclear power plants, Mr. Fitzgerald's resume shows no experience in nuclear power plant operations.

<sup>29</sup> See May 12 Letter at 2.

<sup>30</sup> Generic Aging Lessons Learned (GALL) Report (NUREG-1801) Rev. 1 (2005).

cathodic protection). “They are alternatives” and “either one is acceptable.” Tr. at 769 (Cox) (emphasis added).<sup>31</sup> Here, Pilgrim is employing protective coatings and related inspections under M-34 and not cathodic protection under M-28.

In short, Pilgrim Watch can make no showing that the assertedly new found evidence concerning cathodic protection, even if considered, could likely trigger a materially different result. At bottom, argument on the technical feasibility of employing cathodic protection at nuclear plants is irrelevant because cathodic protection is just one acceptable option for the aging management of buried pipes. Entergy does not rely on cathodic protection as an element of its buried pipe aging management program, and therefore the myriad of issues that Pilgrim Watch seeks to raise and litigate at this late stage of the proceeding are wholly irrelevant and would not lead to a materially different result even if considered by the Board.

**C. Pilgrim Watch Has Failed to Submit Affidavits Setting Forth the Factual and/or Technical Basis of its Claims**

Finally, Pilgrim Watch’s attempt to reopen the evidentiary hearing record must also fail because the Motion is not accompanied by any affidavit setting forth the factual and/or technical bases for its claims. 10 C.F.R. § 2.326(b). The Miller Pipeline paper (Exhibit 1), the letter from Mr. Fitzpatrick (Exhibit 2), and the emails discussed in the Motion and also attached at Exhibit 3 are not sworn, notarized statements and are therefore not affidavits. The regulation governing motions to reopen the record requires that affidavits be submitted in support of the factual and/or technical bases therein. 10 C.F.R. § 2.326(b).

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<sup>31</sup> In the table on page 9 of the Motion, this testimony of Mr. Cox is incorrectly cited to transcript page 770. Pilgrim Watch seeks to strike this allegedly “incorrect statement made by Mr. Cox, Entergy’s expert.” Motion at 8. However, Pilgrim Watch provides no argument why this statement is allegedly incorrect, much less why it should be stricken. The argument in the table on page 9 of the Motion solely concerns Dr. Davis’s testimony and does not address Mr. Cox’s testimony. Moreover, the May 12 letter of Mr. Fitzgerald discusses neither Mr. Cox’s testimony nor acceptable aging management programs under the GALL Report.

**IV. CONCLUSION**

For the foregoing reasons, the Board should deny Pilgrim Watch's Motion.

Respectfully Submitted,

A handwritten signature in black ink that reads "Paul Gaukler". The signature is written in a cursive style with a horizontal line underneath the name.

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Dated: May 27, 2008

**UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION**

Before the Atomic Safety and Licensing Board

In the Matter of	)	
	)	
Entergy Nuclear Generation Company and	)	Docket No. 50-293-LR
Entergy Nuclear Operations, Inc.	)	ASLBP No. 06-848-02-LR
	)	
(Pilgrim Nuclear Power Station)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Entergy's Answer Opposing Pilgrim Watch's Motion to Strike and Request to Reopen the Evidentiary Hearing," dated May 27, 2008, were served on the persons listed below by deposit in the U.S. Mail, first class, postage prepaid, and where indicated by an asterisk, by electronic mail, this 27<sup>th</sup> day of May 2008.

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Paul A. Gaukler

# **Attachment A**

RTYPE A2.20

NUCLEAR ORGANIZATION  
CONTROLLED DOCUMENT CHANGE NOTICE (CDCN)

CDCN Log No. 03-1304

MANUAL TITLE: <u>Mechanical Calculations</u> RTYPE <u>B4.01</u>
DOCUMENT TITLE: <u>SSW Discharge Piping CIPP Liner Design</u>
DOCUMENT NO.: <u>M-1031 Rev. 1</u>

NEW DOCUMENT  REVISION  RETIRE

REVISION NO.: <u>1</u>	OTHER KNOWN DOCUMENTS AFFECTED _____ _____ _____
NO. OF PAGES ATTACHED: <u>63</u>	
SECTION(S) AFFECTED: _____	

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**GENERAL REASON FOR CHANGE**

Change in Work Process       Change in Related Document

Error in Previous Revision

Other: \_\_\_\_\_

**SPECIFIC PURPOSE AND SUMMARY OF CHANGES (attach additional pages if necessary)**

Calculation update for RFO-14 Installation of SSW Loop-A CIPP liner under PDC 01-09.

COPY ATTACHED IS FOR DCC CAPTURE.

Signature of Initiator: Philip D. Anzisi      Owner: R.M. Pace

Date Initiated: 05/21/2003

Date Issued by Document Services 5/27/03

**HOT ISSUED**

MAY 21 2003

DOCUMENT CONTROL CENTER  
PNPS



CALCULATION COVER PAGE

<input type="checkbox"/> IP-2 <input type="checkbox"/> IP-3 <input type="checkbox"/> JAF <input checked="" type="checkbox"/> PNPS    RTYPE <u>B4.01</u>						
Calculation No. <u>M-1031</u>			Revision <u>1</u>		Sheet 1 of <u>37</u> Plus <u>26</u> Pgs Attachments Total Pgs = <u>63</u>	
Title: <u>SSW Discharge Piping CIPP Liner Design</u>					<input checked="" type="checkbox"/> QR <input type="checkbox"/> NQR	
Discipline: <u>Mechanical Engineering</u>					Design Basis Calculation? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
This calculation supercedes/voids calculation: <u>N/A</u>						
Modification No./Task No./ER No: <u>FDC 01-09 ER #02113394</u> <u>MR #10000754 (RFO-13 Loop-B) MR #02103966 (RFO-14 Loop-A)</u>						
<input checked="" type="checkbox"/> No software used <input type="checkbox"/> Software used and filed separately (Include Computer Run Summary Sheet) <input type="checkbox"/> Software used and filed with this calculation						
System No./Name: <u>#29 SSW</u>						
Component No./Name: <u>SSW Discharge Lines Loop-A and Loop-B</u>						
Print / Sign						
REV #	STATUS (Prel, Pend, A, V, S)	PREPARER	REVIEWER/ DESIGN VERIFIER	OTHER REVIEWER/ DESIGN VERIFIER	APPROVER	DATE
0	A	Philip D. Harizi	Steven P. Woods	N/A	Raymond M. Pace	05/18/01
1	A	<i>P.D. Harizi</i> Philip D. Harizi	<i>S.P. Woods</i> Steven P. Woods	N/A	<i>Raymond M. Pace</i> Raymond M. Pace	05/20/03

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RECORD OF REVISIONS

Calculation Number: M-1031

10300 0576

Revision No.	Description of Change	Reason For Change
0	Original issue of calculation in accordance with PDC 01-09 including as-built CIPP material test results for SSW Loop-B installed in RFO-13.	N/A
1	Update calculation in accordance with PDC 01-09 including as-built CIPP material test results for SSW Loop-A installed in RFO-14.	Completed CIPP installation for both SSW discharge loops.

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- B. Summary of Results
- C. Method of Solution
- D. Input Data and Assumptions
- E. Calculations / Analyses
- F. References
- G. List of Attachments

Attachment 1	=	<u>5</u>	Pgs
Attachment 2	=	<u>5</u>	Pgs
Attachment 3	=	<u>4</u>	Pgs
Attachment 4	=	<u>2</u>	Pgs
Attachment 5	=	<u>4</u>	Pgs
Attachment 6	=	<u>6</u>	Pgs

Total Pages Cover / Front Matter / Sections A to G	=	<u>37</u>	Pgs
Total Pages Attachments 1 to 6	=	<u>26</u>	Pgs
TOTAL PAGES	=	<u>63</u>	Pgs

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**CALCULATION SHEET**

CALC. # M-1031

REV. 1 DATE 14-MAY-2009

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**A. Statement of Problem**

This calculation provides the design for a Cured-In-Place-Pipe (CIPP) lining for the Salt Service Water (SSW) buried discharge piping at Pilgrim Nuclear Power Station (PNPS). The purpose of the CIPP is to provide a new internal lining for the existing steel pipe that can withstand the imposed hydraulic and mechanical loads while maintaining the structural integrity of the discharge pipe for soil, overburden, seismic, and live loads [Ref. 1].

The SSW piping to receive the CIPP is the discharge piping for Loop "A" and Loop "B" from the last flange connection in the Auxiliary Building piping vault to the end of the discharge pipe at the Seal Well opening.

The Loop "A" discharge piping is approximately 240 ft total (length to be lined) with three(3) 45-degree elbows and one(1) 90-degree long radius elbow [Ref. 2].

The Loop "B" discharge piping is approximately 225 ft total (length to be lined) with four(4) 45-degree elbows and one(1) 90-degree long radius elbow [Ref. 3].

This calculation also includes the as-built CIPP material test results from lining the Loop "B" discharge in RFO-13 and the Loop "A" discharge in RFO-14.

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B. Summary of Results

The CIPP minimum required thickness ( $t_{MIN}$ ) is 0.450". The final CIPP nominal design thickness ( $t_{NOM}$ ) based on the minimum required thickness increased by 10% to account for thickness variations in the actual installation is 0.495". A standard 13.5 mm (0.531") liner thickness is the appropriate thickness to use.

The analysis demonstrates that stresses in the CIPP liner remain within acceptable limits for all internal or external pressure loading on the liner plus other sustained and occasional mechanical and differential thermal expansion loads including those that result from interaction with the original steel pipe.

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CALCULATION SHEET

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REV. 1 DATE 14-MAY-2003

SHEET 6 OF 37

Results from CIPP Installation & Testing SSW Loop "B" in RFO-13

This section of the calculation was added after the installation, inspection, and testing for the SSW discharge line CIPP work in RFO-13 was completed for Loop-B in accordance with PDC 01-09 [Ref. 13].

SSW Loop-B discharge piping received a successful CIPP lining installation in RFO-13 under PDC 01-09. An attempt to also line SSW Loop-A discharge piping was aborted when problems developed with the epoxy beginning to cure after the wetout process but prior to starting the inversion process. These problems were attributed to unusually high ambient temperature conditions ( $> 90^{\circ}\text{F}$ ) during the epoxy batching and wetout process.

The SSW Loop-B liner was cured at elevated temperature using a steam/air mixture at approximately  $180^{\circ}\text{F}$ . Inspection of Loop-B after the CIPP installation revealed that the liner had severed circumferentially and separated in three locations during the cooldown after curing as reported in NCR 01-038 [Ref. 17]. The first severed location was after the second horizontal 45-degree elbow from the inlet end. The second and third severed locations were in both ends of the vertical 45-degree elbow turning down to the seal well discharge. These three locations where the epoxy liner had severed were attributed to restrained thermal contraction upon cooldown following the curing process. Each of the locations is at an elbow at the end of a long straight run of pipe that is constrained between two elbows.

It is apparent based on the evidence that the epoxy sets (the term "gel" is often used) at an elevated temperature in excess of  $180^{\circ}\text{F}$  (actual peak epoxy temperature is not known) and fully cures into the solid structural compound at this elevated temperature. Upon cooling down, restrained thermal contraction occurs and builds tensile stress over the entire decreasing temperature range from at least  $180^{\circ}\text{F}$  down to the normal ambient of approximately  $50^{\circ}\text{F}$ .

It had previously been considered that the potential to build up high tensile stress during the first cooldown from curing would be minimized by a plastic creep or relaxation effect that would relieve these initial stresses. It is apparent that this relaxation of stress during cooldown did not occur. The large ( $> 130^{\circ}\text{F}$  differential) temperature reduction during the cooldown caused the thermal contraction stress to exceed the tensile strength of the liner, which resulted in the severing and separation that was seen in the Loop-B installation for each long run that was restrained between two elbows.

The restrained thermal contraction stresses, which were induced by the first-time cooldown from elevated temperature curing, were completely relieved by the severing that occurred at the three elbow locations. The CIPP lining was repaired as described below. Subsequent to the relieving of the thermal stresses and the epoxy repair, the assumptions in this calculation for in-service restrained thermal contraction stresses over the temperature range from  $30$  to  $100^{\circ}\text{F}$  are valid for the life of the CIPP installation.

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CALC. # M-1031

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The CIPP liner was repaired using Belzona 1311 Ceramic R-Metal epoxy compound in accordance with FRN 01-09-02 [Ref. 14] and CGI-861 [Ref. 21]. The CIPP polyurethane membrane was removed by abrasion for approximately a 2" width back from the severed edges and the epoxy surface was roughened and scored as a means to achieve a good surface for bonding to the repair epoxy. The 1311 epoxy compound was installed by troweling and contouring such that the repair was built up to a greater thickness than the CIPP lining with a crown that was contoured onto the roughened surface of the severed ends. The entire repair at each location was performed as a single application to the full thickness.

The 1311 repair compound is a modified epoxy with strength properties that are considerably higher than the CIPP liner epoxy felt composite and was installed to a thickness greater than the nominal 1/2" thickness of the liner. The repair was required to meet the same minimum flexural and tensile properties as the CIPP liner.

Testing of samples from the CIPP installation was performed in accordance with Specification M-624 [Ref. 1] and CGI-860 [Ref. 4]. The following physical properties were measured for the test specimens described below, and are critical characteristics that provided the basis for acceptance of the CIPP installation:

- Average Thickness
- Flexural Modulus of Elasticity
- Flexural Strength
- Tensile Strength

Flexural testing was performed on three specimens taken at both the entrance and termination point (total six specimens) to determine the Flexural Modulus of Elasticity and the Flexural Strength in accordance with ASTM Standard D790 [Ref. 23]. Testing was required only for the flatwise orientation of the specimens.

Tensile testing was performed on three specimens taken at both the entrance and termination point (total six specimens) to determine the Tensile Strength in accordance with ASTM Standard D638 [Ref. 22].

The average thickness of all samples was  $\geq 0.495"$ .

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**CALCULATION SHEET**

CALC. # M-1031

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Testing was performed on samples taken from the SSW Loop-B CIPP liner for the parameters in the following table (see attached report). The test results for Flexural Modulus and Flexural Strength exceeded the rated values while the test results for Tensile Strength were below the rated values as shown below:

Physical Property		Rated Short-Term Value	SSW Loop-B Inlet Sample	SSW Loop-B Outlet Sample
Flexural Modulus	=	300,000 PSI	407,400 PSI	375,600 PSI
Flexural Strength	=	4,000 PSI	5,618 PSI	4,173 PSI
Tensile Strength	=	4,000 PSI	2,711 PSI	3,316 PSI

(Test results from Massachusetts Materials Research)

These test results were accepted as satisfactory via NCR 01-048 [Ref. 18]. The design analysis for the CIPP installation is included in this calculation. The actual tensile strength value used in the analysis is 1,333 PSI, which is one-third of the rated value of 4,000 PSI. The reduction factor of three applied to the rated values is to account for environmental effects. The above test data shows that the lowest measured value is more than two times the tensile strength value used ( $2,711 / 1,333 = 2.03$ ).

An additional Loop-B inlet sample was tested independently and showed more favorable results (see below). Nonetheless, the reduction factor of three used in the analysis is known to be very conservative for epoxy resin materials, which are far more stable than other polymers and do not deteriorate or age significantly even for long-term service. Furthermore, this analysis includes an additional factor of safety equal to two for the allowable primary stresses. Therefore, these results are acceptable and the SSW Loop-B CIPP installation is considered to meet the design requirements in this analysis.

An additional Loop-B inlet sample was sent to a different independent test lab that is known to have particular expertise in testing of composite plastics (see attached report). These results were as follows:

Physical Property		Rated Short-Term Value	SSW Loop-B Inlet Sample
Flexural Modulus	=	300,000 PSI	337,995 PSI
Flexural Strength	=	4,000 PSI	6,325 PSI
Tensile Strength	=	4,000 PSI	3,629 PSI

(Test results from HTS Inc.)

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**CALCULATION SHEET**

CALC. # M-1031

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Testing was also performed on specimens cast from a sample of the Belzona 1311 Ceramic R-Metal epoxy compound that was used for the CIPP lining repairs in accordance with CGI-861 [Ref. 21]. Flexural testing was performed on three specimens and tensile testing was performed on three specimens (total six specimens). The test results for Flexural Modulus, Flexural Strength, and Tensile Strength exceeded the rated values as shown below (see attached report):

Physical Property	Rated Short-Term Value	Belzona 1311 Ceramic R-Metal
Flexural Modulus =	300,000 PSI	2,920,000 PSI
Flexural Strength =	4,000 PSI	11,168 PSI
Tensile Strength =	4,000 PSI	5,648 PSI

(Test results from Massachusetts Materials Research)

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CALCULATION SHEET

CALC. # M-1081

REV. 1 DATE 14-MAY-2003

SHEET 10 OF 37

Results from CIPP Installation & Testing SSW Loop "A" in RFO-14

This section of the calculation was added by Revision 1 after the remaining installation, inspection, and testing for the SSW Loop-A discharge line CIPP work was completed during RFO-14 in accordance with PDC 01-09 [Ref. 13].

SSW Loop-A discharge piping received a successful CIPP lining installation in RFO-14 under PDC 01-09. The previous attempt to line the SSW Loop-A discharge piping in RFO-13 had been aborted when problems developed with the epoxy beginning to cure after the wetout process but prior to starting the inversion process. These problems were attributed to unusually high ambient temperature conditions ( $> 90^{\circ}\text{F}$ ) during the epoxy batching and wetout process. As a result of that experience, an alternate CIPP resin system was selected for the Loop-A CIPP liner installation based on the lessons learned in CR-PNP-2001-02301 [Ref. 24].

Following is additional information from the Root Cause Analysis in CR-PNP-2001-02301 and the resulting lessons-learned from the RFO-13 experience in which the CIPP liner was successfully installed in the Loop-B discharge line but the installation attempt was aborted for the Loop-A discharge line.

The aborted installation attempt for the Loop-A discharge in RFO-13 is described and evaluated in CR-PNP-2001-02301 and the lessons-learned from this experience were incorporated into the RFO-14 installation effort. The Root Cause Analysis results and Corrective Actions to Preclude Recurrence did not involve design issues nor did they specifically require that the CIPP design be changed from that successfully used in the Loop-B discharge line.

The problems identified were primarily with the project implementation process at PNPS, the level of knowledge of the PNPS and vendor personnel directly and indirectly involved with the work, and the handling of the aborted CIPP liner and materials. This review resulted in the decision to use a different resin system that has improved workability as described below. Once the epoxy resin/curing agent mixture saturating the liner tube began to polymerize after the wet-out process was completed, the liner became unusable and the polymerization process had to be allowed to continue until the epoxidation reaction was complete.

Based on the RFO-13 experience, it was decided to use a different resin for the Loop-A discharge line CIPP. The resin selected is an isophthalic polyester rather than an epoxy. The principle design parameters remain identical and there are no changes to the required strength characteristics or the resulting thickness required for the CIPP. The physical parameters for the polyester resin, including flexural and tensile strength, coefficient of thermal expansion, and long-term stability are comparable to the epoxy resin.

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The significant benefit of the polyester resin is the much longer "pot life" in the wet-out condition. This is significant because the RFO-13 aborted attempt was due to the spontaneous reaction of the wet-out liner prior to installation. Epoxy resins have a shorter pot life once mixed with their curing agents and are more sensitive to ambient temperature and ultra-violet light impingement. In RFO-13, the combination of unusually hot weather conditions and bright sunlight caused the epoxidation reaction to begin during the wet-out or subsequent handling of the liner. The short pot life for epoxy resin was the principle reason for performing the wet-out process at the installation site rather than offsite.

The corrective actions to preclude recurrence of these problems included performing the wet-out process in a controlled environment. The optimum method is to perform the wet-out at a dedicated offsite CIPP wet-out facility and then transport the fully wet-out liner to the site in a refrigerated truck. To do this, the pot-life of the resin must be sufficiently long to accommodate the handling and transport time plus adequate margin for potential delays. This pot life requirement simply cannot be met by the epoxy resin but is readily accommodated by the polyester resin. In the refrigerated condition (approximately 30 to 40°F), the pot life is approximately 5 days for the epoxy while it is 21 days for the polyester resin.

This design analysis is applicable to Loop-A with the one substitution that the term "epoxy" with respect to the Loop-B CIPP liner resin be replaced with the term "isophthalic polyester" as applied to the "A" discharge line only. The flexural modulus and the flexural and tensile strength requirements are the same for the epoxy and polyester resins. The coefficients of thermal expansion for the epoxy and polyester resins with synthetic fiber filler are also equivalent.

The SSW Loop-A liner was cured at elevated temperature using heated circulating water at approximately 180°F maximum. Inspection of Loop-A after the CIPP installation and curing were complete showed that the liner had not severed or separated during the cooldown due to restrained thermal contraction as had the Loop-B lining. Therefore, in accordance with the PDC 01-09 instructions given in FRN 01-09-04, the restrained thermal contraction tensile stresses were relieved by intentionally making cuts at designated locations if severing did not occur upon cooldown. The first stress relief location was after the first horizontal 45-degree elbow from the inlet end [Ref. 15]. The separation that occurred at this location was approximately 1" and, based on this being the longest straight run of pipe that is restrained between two elbows at 118'-2" versus the next longest straight run at only 24'-4 1/2", no further stress relief cuts were made.

The restrained thermal contraction stresses, which were induced by the first-time cooldown from elevated temperature curing, were relieved by the severing that was done at the first elbow location. The CIPP lining was repaired as described below. Subsequent to the relieving of the thermal stresses and the epoxy repair, the assumptions in this calculation for in-service restrained thermal contraction stresses over the temperature range from 30 to 100°F are valid for the life of the CIPP installation.

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The CIPP liner was repaired using Belzona 1311 Ceramic R-Metal epoxy compound in accordance with FRN 01-09-02 [Ref. 14] and CGI-861 [Ref. 21]. The CIPP polyethylene membrane was removed by abrasion for approximately a 2" width back from the severed edges and the epoxy surface was roughened and scored as a means to achieve a good surface for bonding to the repair epoxy. The 1311 epoxy compound was installed by troweling and contouring such that the repair was built up to a greater thickness than the CIPP lining with a crown that was contoured onto the roughened surface of the severed ends. The entire repair was performed as a single application to the full thickness.

The 1311 repair compound is a modified epoxy with strength properties that are considerably higher than the CIPP liner epoxy felt composite and was installed to a thickness greater than the nominal 1/2" thickness of the liner. The repair was required to meet the same minimum flexural and tensile properties as the CIPP liner.

Testing of samples from the CIPP installation was performed in accordance with Specification M-624 [Ref. 1] and CGI-860 [Ref. 4]. The following physical properties were measured for the test specimens described below, and are critical characteristics that provided the basis for acceptance of the CIPP installation:

- Average Thickness
- Flexural Modulus of Elasticity
- Flexural Strength
- Tensile Strength

Flexural testing was performed on three specimens taken at both the entrance and termination point (total six specimens) to determine the Flexural Modulus of Elasticity and the Flexural Strength in accordance with ASTM Standard D790 [Ref. 23]. Testing was required only for the flatwise orientation of the specimens.

Tensile testing was performed on three specimens taken at both the entrance and termination point (total six specimens) to determine the Tensile Strength in accordance with ASTM Standard D638 [Ref. 22].

The CIPP nominal design wall thickness is 0.495". The controlling parameter for the design thickness of the liner is an external pressure of 25 ft w.g. (-11 PSIG). This design value for external pressure is based on the Calculation M-630 SSW System Hydraulic Analysis [Ref. 8]. The SSW discharge piping downstream of the system RBCCW and TBCCW heat exchangers operates at negative pressure under certain flow conditions due to a "siphon" effect based on the piping elevations and flow rates. The lowest absolute pressure occurs at equivalent piping nodes in Loop "A" and Loop "B" that are at the highest elevation of the discharge piping downstream of the heat exchangers in the Auxiliary Bay vault flanges at EL (+)15.6 ft.

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The limiting case for lowest absolute pressure occurs for emergency operation at the design low tide level. The piping negative pressure is combined with potential external hydrostatic pressure to give an equivalent total external pressure acting on the pipe of 25 ft w.g. (equivalent to -11 PSIG internal pressure). The CIPP liner is also designed based on a positive internal pressure of 30 PSIG, which is greater than the design pressure included in Specification M-300 that applies to the SSW discharge lines downstream of the last valve in the system.

CIPP liner thickness was measured at both the inlet end in the Auxiliary Bay vault and at the discharge outlet in the seawater discharge seal well. The inlet end CIPP thickness was greater than the nominal design wall thickness of 0.495". For the discharge end samples, NCR 03-027 [Ref. 19] reported the thickness to range from 0.466" to 0.507" with an average thickness of 0.490" (including the membrane). Based on a review of the actual installed liner, the condition reported in NCR 03-027 was determined to be "Accept-As-Is". This nonconformance was dispositioned with the following information.

For the installation of the CIPP liner in the SSW discharge line, it has been observed that there is an "end effect" that occurs at the discharge outlet that causes thinning of the end of the lining run after the last 90-degree elbow. This thinning is caused by stretching that occurs as the inversion is ended at the discharge pipe opening and the closed end of the inverted water-filled liner is held back at that position. The configuration of the SSW discharge lines adds to this end effect because there is a 17.4 ft drop in elevation just before going into the last 90-degree elbow at the discharge. This additional static head of water, together with the axial tension from the closed end of the tube inversion, results in liner thinning at the outlet end of the run. The only outlet-end thickness measurement is at the end of the liner where there is a cut made to install the outlet WEKO seal. This location is less than 8" from the pipe outlet and is heavily influenced by the end effect.

From the design of the CIPP liner, it can be seen that the required thickness at the outlet end of the SSW discharge pipe is significantly lower than it is at the inlet end. When the SSW line drops from EL 11 ft to -5.4 ft there is a change in the hydraulic design conditions from negative pressure to positive pressure. The maximum internal operating pressure range for the outlet section of the SSW discharge lines is less than 9.0 PSI occurring at the discharge outlet elevation for the design storm tide at EL +13.5 ft [Ref. 8]. There is no point in the discharge line that experiences greater than a 9 PSI range of pressure.

The CIPP design minimum required wall thickness ( $t_{MIN}$ ) is 0.450 inch, which corresponds to a maximum negative (external) pressure of -11 PSIG and a maximum internal pressure of 30 PSIG. The value of 0.450 inch was increased by 10% to give the final CIPP nominal design wall thickness ( $t_{NOM}$ ) equal to 0.495 inch. The actual nominal thickness of the CIPP liner (based on the tube thickness used) is 0.531 inch, which corresponds closely with the actual inlet end thickness measurements. The average of the outlet end thickness measurements is 0.490 inch. The polyethylene membrane is no greater than 0.012 inch thickness.

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Testing was performed on samples taken from the SSW Loop-A CIPP liner for the parameters in the following table (see attached report). The test results for Flexural Modulus and Flexural Strength exceeded the rated values while the test results for Tensile Strength were below the rated values as shown below:

Physical Property	Rated Short-Term Value	SSW Loop-A Inlet Sample	SSW Loop-A Outlet Sample
Flexural Modulus =	300,000 PSI	472,000 PSI	411,000 PSI
Flexural Strength =	4,000 PSI	4,240 PSI	5,640 PSI
Tensile Strength =	4,000 PSI	2,720 PSI	3,960 PSI

(Test results from M&P Laboratory)

These test results were accepted as satisfactory via NCR 03-039 [Ref. 20]. The design analysis for the CIPP installation is included in this calculation. The actual tensile strength value used in the analysis is 1,333 PSI, which is one-third of the rated value of 4,000 PSI. The reduction factor of three applied to the rated values is to account for environmental effects. The above test data shows that the lowest measured value is more than two times the tensile strength value used ( $2,720 / 1,333 = 2.04$ ).

The reduction factor of three used in the analysis was known to be very conservative for epoxy and isophthalic polyester resin and catalyst systems, which are far more stable than other polymers and do not deteriorate or age significantly even for long-term service. Furthermore, this analysis includes an additional factor of safety equal to two for the allowable primary stresses. Therefore, these results are acceptable and the SSW Loop-A CIPP installation is considered to meet the design requirements in this analysis.

Testing was also performed on specimens cast from a sample of the Belzona 1311 Ceramic R-Metal epoxy compound that was used for the CIPP lining repairs in accordance with CGI-861 [Ref. 21]. Flexural testing was performed on three specimens and tensile testing was performed on three specimens (total six specimens). The test results for Flexural Modulus, Flexural Strength, and Tensile Strength exceeded the rated values as shown below (see attached report):

Physical Property	Rated Short-Term Value	Belzona 1311 Ceramic R-Metal Lot 1	Belzona 1311 Ceramic R-Metal Lot 2
Flexural Modulus =	300,000 PSI	1,170,000 PSI	1,260,000 PSI
Flexural Strength =	4,000 PSI	8,350 PSI	9,100 PSI
Tensile Strength =	4,000 PSI	4,700 PSI	4,980 PSI

(Test results from M&P Laboratory)

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C. Method of Solution

The CIPP design herein is based on the methods included in ASTM F1216 [Ref. 5] Appendix XI "Design Considerations". The inputs, assumptions, and cases analyzed are in conformance with PNPS Specification M-624 [Ref. 1].

Calculations are performed to determine the required thickness of the CIPP liner based on the following CIPP physical properties:

- Flexural Modulus of Elasticity
- Flexural Strength
- Tensile Strength

These physical properties are critical characteristics that are verified in accordance with CGI-860 [Ref. 4].

The CIPP minimum required thickness ( $t_{MIN}$ ) shall be the larger of that required by either the external load or internal pressure analysis. The final CIPP nominal design thickness ( $t_{NOM}$ ) shall be based on the minimum required thickness increased by 10% to account for thickness variations in the actual installation. The actual thickness recommended to be used is the next standard millimeter thickness greater than the nominal design thickness.

The external pressure analysis is a buckling calculation in which the controlling parameters are the CIPP diameter, thickness, flexural modulus of elasticity, existing pipe ovality, and a dimensionless enhancement factor that accounts for the support and restraint provided by the existing pipe and soil envelope. For this analysis, the existing pipe is assumed to provide the support represented by the "enhancement factor" and to support the soil, overburden, and seismic loads throughout the design life of the installation.

The internal pressure analysis is a ring tension or hoop pressure stress calculation in which the controlling parameters are the CIPP diameter, thickness, and tensile strength. For this analysis, the existing pipe is not assumed to provide any restraint or support for the liner internal pressure but does support the soil, overburden, and seismic loads throughout the design life of the installation.

An additional internal pressure analysis is done in which the existing pipe does provide support for the liner internal pressure but has a hole or opening across which the CIPP liner span is not supported by the pipe. For this case, the CIPP is considered to be a circular flat plate fixed at the edge and subjected to the full internal differential pressure.

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The flat plate analysis is a bending stress calculation in which the controlling parameters are the CIPP diameter, thickness, and flexural strength. There is a maximum diameter hole in the existing pipe above which the CIPP flat plate loading case is less limiting than the ring tension case above.

To confirm the adequacy of the CIPP design for all imposed loads and conditions, an additional pipe stress analysis is also performed. The additional analysis considers the effects of all sustained and occasional pressure, mechanical and restrained thermal expansion loads. To perform a rational analysis that explicitly accounts for both primary and secondary stresses and their effects, a methodology based on ASME B&PV Code Section III Subsections NB-3200 and NB-3650 is used. This is not meant to imply that the CIPP liner is designed in accordance with the totality of the ASME Code Section III criteria but rather uses the methodology to evaluate primary and secondary stresses due to all imposed loads as presented in this calculation.

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D. Input Data and Assumptions

1. The SSW piping to receive the CIPP is the buried discharge piping for Loop "A" and Loop "B" from the last flange connection in the Auxiliary Building piping vault to the end of the discharge pipe at the Seal Well opening [Refs. 1, 2, 3].
2. The purpose of the CIPP installation is to provide a new protective lining capable of withstanding the internal and external hydraulic loads and to protect the existing steel pipe that maintains the structural integrity of the discharge pipe for soil, overburden, seismic, and live loads [Ref. 1].
3. This design is based on providing a CIPP installation that will provide a protective liner for the existing SSW discharge piping with a 35 year design life [Ref. 1].
4. The CIPP process to be used is an epoxy resin and hardener (curing agent) system for Loop-B in RFO-13 and a isophthalic polyester resin and catalyst system for Loop-A in RFO-14. These resins are extremely stable high strength compounds that exhibit long term physical strength, integrity, durability, and chemical resistance [Refs. 10 & 11].
5. The epoxy resin system used for the CIPP in Loop-B is Shell EPON Resin 9215 and Curing Agent 9264. The Shell Chemical Corporation EPON industrial epoxies are high strength modified bisphenol epichlorohydrin based epoxy resins with a propylimidazole curing agent. The AOC Viprel L704-Series isophthalic polyester resin and Akzo Nobel peroxide-based catalyst system used for the CIPP in Loop-A is also a high strength resin formulated for pipe lining applications. These compounds are rated for continuous service up to 140°F and are resistant to acids, bases, sodium hypochlorite, and hydrocarbon solvents [Refs. 10 & 11].
6. The Belzona 1311 Ceramic R-Metal repair epoxy is a very high strength modified epoxide resin with silicon carbide and a diethylenetriamine curing agent. The repair epoxy is used as a "neat" mixture without a felt composite thereby retaining the full strength of the epoxy resin. This compound is also rated for continuous service up to 140°F and is resistant to acids, bases, sodium hypochlorite, and hydrocarbon solvents [Ref. 12].
7. The SSW discharge piping is 22" nominal diameter standard weight carbon steel pipe (0.375" wall thickness) with a 3/16" natural rubber lining thickness. Existing rubber lining and coatings that are intact will remain in place for the CIPP installation [Ref. 1].
8. The CIPP minimum required thickness ( $t_{MR}$ ) shall be the larger of that required by either the external load or internal pressure analysis. The final CIPP nominal design thickness ( $t_{NOM}$ ) shall be based on the minimum required thickness increased by 10% to account for thickness variations in the actual installation. The actual thickness is then rounded to the next standard millimeter thickness greater than the nominal design thickness [Ref. 1].

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9. For the external pressure design case, the analysis of the CIPP liner is based on the original steel pipe being in a partially deteriorated condition. A "partially deteriorated pipe" is one that can support the soil and overburden loads throughout the design life of the installation (see below). For the external pressure case, the original pipe is assumed to provide support to the CIPP liner to resist the ovalizing effect that external pressure can create. However, the original pipe is not required to be integral or free of flaws, cracks, or corrosion. The steel pipe will be inspected prior to the CIPP installation and will be confirmed to meet the original design requirements with repairs made as needed. The "partially deteriorated pipe" is considered to exist at the end of life condition for the CIPP installation [Ref. 5].
10. For the external load analysis, the design equations used shall be for the "Partially Deteriorated Gravity Pipe Condition" in ASTM F1216. For the negative pressure (vacuum) design condition, the CIPP shall be designed as a gravity pipe with the external hydrostatic pressure increased by an amount equal to the negative pressure [Ref. 5].
11. For the internal positive pressure design case, the analysis of the CIPP liner is based on the original steel pipe being in a fully deteriorated condition. A "fully deteriorated pipe" is one that is not structurally sound and cannot support the soil and overburden loads and for which the surrounding soil does not provide adequate side support. The CIPP liner is designed for the positive pressure of 30 PSIG with no assumption of support from the steel pipe. The basis for this requirement is that the CIPP liner is intended to be a pressure boundary that protects the steel pipe from the SSW and therefore shall withstand the maximum SSW pressure based only on the strength of the CIPP liner [Ref. 1].
12. An additional internal pressure design case is based on the original steel pipe being in the partially deteriorated condition where the existing pipe provides support but has a hole or opening across which the CIPP liner span is not supported by the pipe. For this case, the CIPP is considered to be a circular flat plate fixed at the edge and subjected to the full internal differential pressure. The maximum diameter hole ( $d$ ) in the existing pipe for which the flat plate loading case remains applicable is determined and the allowable hole size for the highest design pressure anywhere in the SSW system of 100 PSIG [Ref. 7].
13. For the internal pressure analysis, the design equations used shall be for the "Fully Deteriorated Pressure Pipe Condition" in ASTM F1216. For the additional case described above, the design shall be based on the "Partially Deteriorated Pressure Condition" in ASTM F1216 [Ref. 5].
14. This calculation considers a "partially deteriorated" condition to exist for the original steel discharge line at the end of life for the CIPP installation (35 years). The partially deteriorated steel pipe condition is realistic based on PNPS plant experience, inspection results, and observation of the intact condition of the pipe and external pipe wrap on previously excavated spools coupled with the following explanation of corrosion. Future corrosion from the ID will be inhibited by the new CIPP liner. The OD of the steel pipe experiences conditions that are not highly conducive to corrosion, i.e., external pipe wrap, minimal ground water, and soil conditions of compacted backfill.

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15. Localized corrosion of the steel pipe that might occur despite the above considerations is known to occur at an extremely slow rate (well less than 10 mils/year at the most aggressive localized conditions). This localized corrosion would be expected to involve the formation of "tubercles", which are mounds of corrosion products that cap localized regions of metal loss. The tuberculation corrosion process is essentially self-limiting and causes minimal long-term wastage of the base metal for this type of buried steel pipe installation. The long term corrosion that might occur will be bounded by the allowable extent of localized wall thinning included in the SSW buried piping design analysis calculation M-976 [Ref. 9].
16. The long-term (time-temperature corrected) Flexural Modulus of Elasticity ( $E_{FL}$ ) shall be reduced from the short-term by multiplying the short-term value by 0.50. An Enhancement Factor ( $K$ ) value of 7.0 shall be used. An Ovality Reduction Factor ( $C$ ) of 0.90 shall be used, based on a 0.250 inch maximum to mean inside diameter differential [Ref. 1].
17. The long-term (time-temperature corrected) flexural strength ( $S_{FL}$ ) and tensile strength ( $S_{TL}$ ) shall be equal to one-third the rated short-term strength values listed below [Ref. 1].
18. The maximum allowable stress for the external load and internal pressure analyses shall be equal to one-half the long-term flexural and tensile strengths, that is, a Factor of Safety ( $N$ ) equal to 2 shall be used in the design equations [Ref. 1].
19. The SSW discharge piping downstream of the system RBCCW and TBCCW heat exchangers operates at negative pressure under certain flow conditions due to a "siphon" effect based on the piping elevations and flow rates. The piping negative pressure is combined with potential external hydrostatic pressure to give an equivalent total external pressure acting on the pipe of 25 ft w.g. (equivalent to -11 PSIG internal pressure). The CIPP liner is designed based on this same external hydrostatic pressure since the original steel pipe is not required to provide a complete pressure boundary. The CIPP liner is also designed based on a positive internal pressure of 30 PSIG, which is greater than the design pressure included in Specification M-300 that applies only to the SSW discharge lines downstream of the last valve in the system [Ref. 7].
20. The short-term design values to be used shall be as follows [Ref. 1]:

Physical Property	Rated Short-Term Value
Flexural Modulus =	300,000 PSI
Flexural Strength =	4,000 PSI
Tensile Strength =	4,000 PSI

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21. The design loadings shall be as follows [Ref. 1]:

Design Parameter	Design Value
Maximum Internal Pressure/Temperature =	30 PSIG @ 100°F
Minimum Operating Temperature =	30°F
Maximum External Differential Pressure (Minimum Internal Pressure) =	25 ft w.g. (-11 PSIG Internal)

Portions of the SSW discharge piping are normally operating at negative pressure. The Maximum External Differential Pressure of 25 ft w.g. is based on the highest negative operating pressure for the discharge piping plus an accounting for groundwater pressure acting externally. External soil, overburden, seismic, and live loads do not act upon the CIPP liner because the steel pipe will remain the structural component.

22. For a stress intensity range analysis that uses the range of pressures over which the piping operates, the actual maximum internal operating pressure range for the affected section of the SSW discharge lines is less than 9.0 PSI occurring at the discharge outlet elevation in the piping for the design storm tide at EL +13.5 ft, and the maximum range for negative pressure is also less than 9.0 PSI occurring at the highest point in the discharge line at EL +15.6 ft (this pressure range does not include the additional 5 ft external groundwater hydrostatic head included in the external pressure analysis). There is no point in the discharge line that experiences greater than a 9 PSI range of pressure [Ref. 8].
23. The maximum temperature range of operation for the affected section of the SSW discharge lines is 30°F to 100°F [Ref. 7].
24. A tensile modulus of elasticity value of 300,000 PSI is used for stress analysis in conjunction with the long-term tensile strength of 1,333 PSI. This is conservative since the long-term modulus of elasticity is reduced from the short-term by 0.50 while the long-term tensile strength is only one-third the short-term value. Rated short-term value for tensile strength is 4,000 PSI and tensile modulus of elasticity is 550,000 PSI for felt composites [Ref. 10]. Therefore, using 1,333 PSI tensile strength with a modulus of elasticity value of 300,000 PSI will be bounding for all short to long-term conditions.
25. The coefficient of thermal expansion for the CIPP epoxy and polyester resin is equal to or less than  $4.0 \times 10^{-5}$  inch/inch-°F ( $7.2 \times 10^{-5}$  inch/inch-°C) [Refs. 10 & 11].
26. The coefficient of thermal expansion for the Belzona 1311 repair epoxy is equal to or less than  $2.0 \times 10^{-5}$  inch/inch-°F ( $3.6 \times 10^{-5}$  inch/inch-°C) [Ref. 12].

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**E. Calculations / Analyses**

**Definition of Terms**

$D_o$	Outside diameter for the CIPP lining, inches
$d$	Hole or opening diameter in existing pipe wall, inches
$t$	Wall thickness, inches
$t_{MIN}$	Minimum required wall thickness, inches
$t_{NOM}$	Nominal design wall thickness, inches
$P_E$	External hydrostatic design pressure, PSIG
$P_I$	Internal hydrostatic design pressure, PSIG
$P_{MAX}$	Actual maximum operating pressure range, PSI
$K$	Enhancement factor of the soil and existing pipe adjacent to the CIPP
$E_{FS}$	Short-term flexural modulus of elasticity, PSI
$E_{FL}$	Long-term (time-temperature corrected) flexural modulus of elasticity, PSI
$E_{TL}$	Long-term (time-temperature corrected) tensile modulus of elasticity, PSI
$SDR$	Standard Dimension Ratio = $(D_o / t)$
$C$	Ovality reduction factor
$q$	Percentage ovality of original pipe
$M_i$	Resultant moment from design loads, inch-lbs
$N$	Factor of safety
$B_1$	Primary stress index for internal pressure
$B_2$	Primary stress index for moment loading
$C_1$	Secondary stress index for internal pressure
$C_2$	Secondary stress index for moment loading
$C_3$	Secondary stress index for thermal loading
$r_m$	Mean pipe radius = $(D_o - t) / 2$ , inch
$R$	Bend radius of elbow(long radius) = $(1.5 \times D_o)$ , inch
$\sigma_E$	Thermal expansion stress from restraint of free end displacement, PSI
$\sigma_P$	Tensile stress from pressure in hoop or longitudinal direction, PSI
$\sigma_T$	Tensile stress from mechanical loads, PSI
$\nu$	Poisson's ratio
$S_{FL}$	Long-term (time-temperature corrected) flexural strength, PSI
$S_{TS}$	Short-term tensile strength, PSI
$S_{TL}$	Long-term (time-temperature corrected) tensile strength, PSI
$\epsilon$	Strain, inch/inch
$\alpha$	Coefficient of thermal expansion, inch/inch- $^{\circ}F$

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Design Equations

CIPP Design for External Pressure

Partially deteriorated existing pipe condition  
(ASTM F1216 Equation X1.1):

$$P_E = \frac{2K * E_{FL}}{(1 - \nu^2)} * \frac{1}{(SDR - 1)^3} * \frac{C}{N} \quad \text{EQ 1}$$

Where the *Standard Dimension Ratio (SDR)* is:

$$SDR = \frac{D_o}{t} \quad \text{EQ 2}$$

The *Ovality Reduction Factor (C)* is:

$$C = \left( \frac{\left(1 - \frac{q}{100}\right)}{\left(1 + \frac{q}{100}\right)^2} \right)^3 \quad \text{EQ 3}$$

The *percentage ovality of original pipe (q)* is:

$$q = 100 * \frac{(\text{Maximum Inside Diameter} - \text{Mean Inside Diameter})}{\text{Mean Inside Diameter}} \quad \text{EQ 4}$$

CIPP Design for Internal Pressure

Fully deteriorated existing pipe condition  
(ASTM F1216 Equation X1.7):

$$P_I = \frac{2S_{TL}}{(SDR - 2)N} \quad \text{EQ 5}$$

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Partially deteriorated existing pipe condition  
(ASTM F1216 Equation X1.6):

$$P_1 = \frac{5.33}{(SDR-1)^2} * \left(\frac{D_O}{d}\right)^2 * \frac{S_{FL}}{N} \quad \text{EQ 6}$$

The maximum diameter hole ( $d$ ) in the existing pipe for which the CIPP can be considered to be a circular flat plate fixed at the edge and subjected to transverse pressure is determined using the following relation (ASTM F1216 Equation X1.5):

$$\frac{d}{D_O} \leq 1.83 \left(\frac{t}{D_O}\right)^{0.5} \quad \text{EQ 7}$$

The calculations above determine the appropriate value for the CIPP minimum required wall thickness ( $t_{MIN}$ ), which is then used to determine the final CIPP nominal design wall thickness:

$$t_{NOM} = t_{MIN} * 1.10 \quad \text{EQ 8}$$

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CIPP Design Calculations

The mean inside diameter of the existing pipe to be lined:

	22.000"	Pipe O.D.
(2 x 0.375") =	(-) 0.750"	Pipe wall
(2 x 0.188") =	(-) 0.375"	Rubber lining
20.875"		Mean I.D.

The value 20.875" will be the *outside diameter* ( $D_o$ ) for the CIPP lining used in the following design equations.

The existing pipe is assumed to have an ovality with a maximum differential between the maximum and mean inside diameter of 0.250", therefore the ovality reduction factor is:

$$q = 100 * \frac{[(20.875 + 0.250) - 20.875]}{20.875} = 1.20$$

$$C = \left[ \frac{\left(1 - \frac{1.20}{100}\right)}{\left(1 + \frac{1.20}{100}\right)^2} \right]^3 = 0.90$$

The long-term (time-temperature corrected) flexural modulus of elasticity ( $E_{FL}$ ) is:

$$E_{FL} = 0.50(E_{FS}) = 0.50(300,000) = 150,000 \text{ PSI}$$

The long-term (time-temperature corrected) flexural strength ( $S_{FL}$ ) is:

$$S_{FL} = 0.333(E_{FS}) = 0.333(4,000) = 1,333 \text{ PSI}$$

The long-term (time-temperature corrected) tensile strength ( $S_{TL}$ ) is:

$$S_{TL} = 0.333(E_{TS}) = 0.333(4,000) = 1,333 \text{ PSI}$$

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CIPP design involves finding the *Standard Dimension Ratio (SDR)* that satisfies the internal and external pressure design cases using the design values for the flexural and tensile properties for the liner.

The *Standard Dimension Ratio* is calculated for a CIPP thickness of 0.450":

$$SDR = \frac{20.875}{0.450} = 46.4 \quad (\text{dimensionless})$$

The design external hydrostatic pressure corresponding to the partially deteriorated existing pipe condition is:

$$P_E = \frac{2 * (7.0) * (150,000)}{1 - (0.3)^2} * \frac{1}{(46.4 - 1)^3} * \frac{0.90}{2} = 11.1 \text{ PSIG (external)}$$

The design internal hydrostatic pressure corresponding to the fully deteriorated existing pipe condition is:

$$P_I = \frac{2 * (1,333)}{(46.4 - 2) * 2} = 30.0 \text{ PSIG (internal)}$$

An internal hydrostatic pressure design case is also considered for the partially deteriorated existing pipe condition where the existing pipe provides support but has a hole or opening across which the CIPP liner span is not supported by the pipe. For this case, the CIPP is considered to be a circular flat plate fixed at the edge and subjected to the full internal differential pressure. The maximum diameter hole (*d*) in the existing pipe for which the flat plate loading case remains applicable is:

$$\frac{d}{20.875} \leq 1.83 \left( \frac{0.450}{20.875} \right)^{0.5}$$

Therefore, the maximum hole diameter for flat plate loading (*d<sub>MAX</sub>*) is:

$$d_{MAX} = 20.875 * 1.83 \left( \frac{0.450}{20.875} \right)^{0.5} = 5.609"$$

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For the design case, the allowable hole diameter ( $d$ ) corresponding to an internal pressure of 30 PSIG with flat plate loading is found to be 5.000" as follows:

$$P_1 = \frac{5.33}{(46.4-1)^2} * \left(\frac{20.875}{5.000}\right)^2 * \frac{1,333}{2} = 30 \text{ PSIG}$$

For smaller hole sizes, the CIPP liner remains within design for higher internal pressures. The highest design pressure anywhere in the SSW system is 100 PSIG. The allowable hole diameter ( $d$ ) corresponding to an internal pressure of 100 PSIG with flat plate loading is found to be 2.740" as follows:

$$P_1 = \frac{5.33}{(46.4-1)^2} * \left(\frac{20.875}{2.740}\right)^2 * \frac{1,333}{2} = 100 \text{ PSIG}$$

The calculations above determine that the appropriate value for the CIPP minimum required wall thickness ( $t_{MN}$ ) is 0.450", which is then increased by 10% to give the final CIPP nominal design wall thickness:

$$t_{NOM} = 0.450 * 1.10 = 0.495"$$

The next standard CIPP millimeter (mm) thickness greater than the nominal design wall thickness is 13.5 mm:

$$\frac{13.5 \text{ mm}}{25.4 \frac{\text{mm}}{\text{inch}}} = 0.531"$$

The percent difference between the 13.5 mm standard CIPP thickness and the minimum required thickness ( $t_{MN}$ ) is:

$$\left(\left(\frac{0.531"}{0.450"}\right) - 1\right) * 100 = +18\%$$

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Calculation of Design External Pressure Value

The design value for external pressure is based on the SSW hydraulic analysis in Calculation M-630 [Ref. 8]. The SSW discharge piping downstream of the system RBCCW and TBCCW heat exchangers operates at negative pressure under certain flow conditions due to a "siphon" effect based on the piping elevations and flow rates. The lowest absolute pressure occurs at equivalent piping nodes in Loop "A" and Loop "B" that are at the highest elevation of the discharge piping in the Auxiliary Bay vault flanges at EL (+)15.6 ft. The limiting case for lowest absolute pressure occurs for emergency operation at the design low tide level. The piping negative pressure is combined with potential external hydrostatic pressure due to a groundwater 5 foot static head to give an equivalent total external pressure acting on the pipe.

Atmospheric Pressure =	14.70	PSIA
Absolute Pressure @ Node (+)EL 15.6 ft =	(-) 6.00	PSIA
Convert to External Static Head =	(x) 2.31	ft w.g./PSI
Add 5 ft External Groundwater Head =	(+) 5.00	ft w.g.
-----		
Equivalent Total External Static Head =	25.10	ft w.g.
Convert to External Pressure =	(x) 0.433	PSI/ft w.g.
-----		
Equivalent Total External Pressure =	10.90	PSIG

This confirms the design value given in Specification M-624 for equivalent negative pressure acting on the pipe of -11 PSIG internal pressure. The CIPP liner is designed based on the equivalent external hydrostatic pressure.

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CIPP Pipe Stress Analysis

To confirm the adequacy of the CIPP design for all imposed loads and conditions, the following analysis is performed. This additional analysis considers the effects of other sustained and occasional pressure, mechanical, and thermal expansion loads. To perform a rational analysis that explicitly accounts for both primary and secondary stresses and their effects, the methodology used is based on ASME B&PV Code Section III [Ref. 6] Subsections NB-3200 "Design by Analysis" and NB-3650 "Analysis of Piping Products" as shown below.

The following correlations are based on the general relationship that  $S_M$  (membrane stress) is equal to the lesser of  $(2/3)S_Y$  or  $(1/3)S_U$ .

The combination of primary membrane plus bending stress intensity has an allowable stress intensity of  $1.5S_M$  as follows:

$$P_L + P_B \leq 1.5S_M \approx S_Y \approx 0.5S_U$$

The combination of primary membrane plus secondary bending and thermal expansion stress intensity has an allowable stress intensity of  $3.0S_M$  as follows:

$$P_L + P_B + \sigma_E \leq 3.0S_M \approx 2S_Y \approx S_U$$

High strength epoxy compounds do not exhibit a true yield point in their stress-strain curves. The elongation at break for the epoxy-felt composite being used is 1.5%. Using the rated short term tensile strength and linear modulus of elasticity, the elongation at break is:

$$\epsilon = \frac{S_{TS}}{E_{TS}} = \frac{4,000}{300,000} = 0.0133 = 1.33\% \text{ versus } 1.5\% \text{ at break}$$

This shows that there is very little yielding before reaching the tensile strength. Therefore, the definition that  $S_M$  is equal to  $(1/3)S_U$  is applicable.

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The CIPP liner is encased within the original steel SSW pipe, which remains the structural component of the discharge line. The design calculations above ensure that the CIPP can withstand the internal design pressure hoop stress and the external design pressure buckling loads. There are other loads that may be imposed on the CIPP directly from the structural steel pipe due to the strain ( $\epsilon$ ) experienced from the loads imposed on the steel pipe. These piping strains, i.e., displacements, will then be imposed on the CIPP liner within the steel pipe. To account for all the potential loads, whether their origin be weight, overburden, or seismic, and to use an intensified stress that includes the effects of discontinuities and concentration effects, it will be assumed that the steel pipe is at the yield stress  $S_y$  value of 30,000 PSI and calculate the resulting strain:

$$\epsilon = \frac{\sigma}{E_T} = \frac{30,000}{30 \times 10^6} = 0.0010 \text{ inch/inch}$$

The CIPP is then subjected to the same localized strain value, with the resulting stress:

$$\sigma_T = E_T(\epsilon) = 300,000(0.0010) = 300 \text{ PSI}$$

This tensile stress value will be used to account for all imposed loads from the steel pipe to the CIPP whether due to bending or axial loads. This stress is of the type due to a strain-controlled load application, i.e., the steel pipe will be at the strain corresponding to its yield point regardless of the stress in the CIPP. A strain-controlled load has the self-limiting characteristic of a secondary stress, and the same value will be used for all imposed loads in the following equations. This tensile stress value will be substituted for the expression in each equation that represents the resultant stress caused by the sustained and occasional mechanical moment loading on the discharge line. The appropriate stress indices will be applied to the pressure and thermal loading terms but the above tensile stress ( $\sigma_T$ ) will be used directly in all cases for the mechanical moment loading term since it includes stress intensification effects.

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The primary stress intensity is evaluated at design conditions for pressure and bending loads as follows:

$$B_1 \left( \frac{P_1 D_O}{2t_{NOM}} \right) + B_2 \left( \frac{D_O}{2I} \right) M_i \leq 0.5S_{TL} \quad \text{EQ 9}$$

where:  $B_1 = 0.5$

$$B_2 \left( \frac{D_O}{2I} \right) M_i = \sigma_T = 300 \text{ PSI}$$

substituting:

$$0.5 \left( \frac{30 * 20.875}{2 * 0.495} \right) + 300 \leq 0.5(1,333)$$

$$616 \leq 667 \text{ PSI} \quad \therefore \text{OK}$$

The  $B_1$  and  $B_2$  stress indices in the above case are applicable to both straight pipe sections and elbows.

The primary plus secondary stress intensity is evaluated for the maximum range of pressure, temperature, and bending moment that can occur as the system goes from one load set to any other load set that may follow it in time. This maximum range is analyzed as follows:

$$C_1 \left( \frac{P_{MAX} D_O}{2t_{NOM}} \right) + C_2 \left( \frac{D_O}{2I} \right) M_i + C_3 E_{TS} \alpha (\Delta T) \leq S_{TL} \quad \text{EQ 10}$$

where:  $P_{MAX} = 9.0 \text{ PSI Max Pressure Range}$

*This is the maximum operating pressure range from the SSW hydraulic analysis [Ref. 8] occurring as either a -9.0 PSIG to zero at the discharge pipe inlet or zero to +9.0 PSIG at the discharge pipe outlet end.*

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First case is for straight pipe sections:

where:  $C_1 = 1.0$

$$C_2 \left( \frac{D_0}{2I} \right) M_i = \sigma_T = 300 \text{ PSI}$$

$C_3 = 1.0$

substituting:

$$1.0 \left( \frac{9.0 * 20.875}{2 * 0.495} \right) + 300 + 1.0(300,000)(4.0 \times 10^{-5})(100-30) \leq 1,333$$

$$1,330 \leq 1,333 \text{ PSI} \quad \therefore \text{OK}$$

Second case is for elbows:

where:  $C_1 = \frac{(2R - r_m)}{2(R - r_m)} = \frac{(2 * 31.3) - 10.2}{2(31.3 - 10.2)} = 1.2$  EQ 11

$$C_2 \left( \frac{D_0}{2I} \right) M_i = \sigma_T = 300 \text{ PSI}$$

$C_3 = 1.0$

substituting:

$$1.2 \left( \frac{9.0 * 20.875}{2 * 0.495} \right) + 300 + 1.0(300,000)(4.0 \times 10^{-5})(100-30) \leq 1,333$$

$$1,368 > 1,333 \text{ PSI} \quad \therefore \text{calculated stress exceeds criteria}$$

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For this type of secondary stress range analysis, this is not an unacceptable result but requires that further analysis of the particular load case be performed as follows:

1. The primary stress case (EQ 9) is satisfactory, this confirms that gross failure will not occur since the secondary stresses are self-limiting, i.e., the loads imposed from the steel pipe to the CIPP (second term in EQ 10) act as a strain-controlled secondary stress within the CIPP that cannot cause failure. However, distortion and thermal ratcheting must also be considered (below) when EQ 10 exceeds the allowable.
2. The thermal expansion stress alone (third term in EQ 10), as calculated below, is within an allowable stress of  $2/3(S_U)$ . Therefore, thermal stress ratcheting will not occur from thermal stress alone, and the bending stresses that are superimposed upon this stress (second term in EQ 10) to exceed the criteria are due to occasional loads representative of the faulted case seismic loads.
3. Any distortion that does occur from the worst case loading combination would be localized at the elbow and would be self-relieving.
4. This primary and secondary stress intensity range equation maximizes the stress intensity (i.e., twice the maximum shear stress) by combining the pressure stress in the hoop direction, which is either a tensile or compressive stress, with the longitudinal stresses. A Mohr's circle diagram analysis on the following pages shows the worst case stress combination where the longitudinal stresses are also in tension and the stress intensity is maximized.

Thermal expansion stress evaluated separately:

$$\sigma_F = C_3 E_{TS} \alpha (\Delta T) \leq \left(\frac{2}{3}\right) S_{TL} \quad \text{EQ 12}$$

substituting:

$$1.0(300,000)(4.0 \times 10^{-5})(100-30) \leq \left(\frac{2}{3}\right)(1,333)$$

$$840 \leq 889 \text{ PSI} \quad \therefore \text{OK}$$

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Evaluate Maximum Primary & Secondary Stress Intensity (Mohr's Circle Analysis):

The stress intensity equation has three components in this application as follows:

1. Pressure stress range in the hoop direction for max/min operating pressures.
2. Longitudinal bending stress range, this is taken to be the maximum stress that can be created in the CIPP due to the steel pipe stress range being equal to the yield stress due to all the combined sustained and occasional loads acting on the steel pipe, including faulted case seismic loads.
3. Longitudinal restrained thermal expansion stress range. The worst case for the CIPP is the restrained contraction that occurs where the temperature change is the design range of 100°F decreasing to 30°F. Since the CIPP is cured at greater than 100°F and is maintained in a state of conformance to the original pipe ID at 100°F prior to releasing the curing hydrostatic pressure and temperature, there is no case where restrained thermal expansion will create greater stress than the restrained thermal contraction load case combination.

The Mohr's circle analyses of these load cases is as shown on the following page. It is seen that the maximum possible load combination value of 1,368 PSI requires the longitudinal stresses to be tensile with hoop stress simultaneously compressive. For this CIPP installation, this corresponds to a thermal expansion stress due to restraint of thermal contraction (tensile stress) together with the negative pressure case.

It is concluded that the CIPP stress analysis is acceptable, based on the considerations above, and that the CIPP installation will operate within allowable stress limits.

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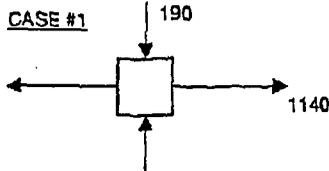
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MOHR'S CIRCLE ANALYSIS

**PRIMARY + SECONDARY STRESS INTENSITY RANGE  
STRAIGHT PIPE CASE**

This analysis shows that the code stress equation is a worst case load combination that applies for the case where the maximum thermal expansion stress is in the tension direction and hoop stress is compressive as shown in Case #1 below versus the Case #2 combination with thermal compression that will not occur.



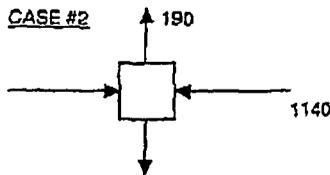
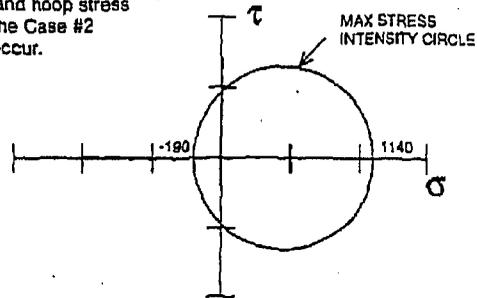
$\sigma_P$  HOOP = (-)190 PSI

$\sigma_P$  LONG = 0 PSI

$\sigma_T$  BENDING = (+)300 PSI

$\sigma_E$  THERMAL = (+)840 PSI

MAX STRESS INTENSITY RANGE = 190 + 1140 = 1330 PSI



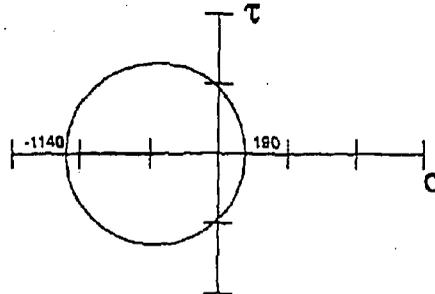
$\sigma_P$  HOOP = (+)190 PSI

$\sigma_P$  LONG = (+)95 PSI OR 0 PSI

$\sigma_T$  BENDING = (-)300 PSI

$\sigma_E$  THERMAL = (-)840 PSI

MAX STRESS INTENSITY RANGE = 1140 + 190 = 1330 PSI



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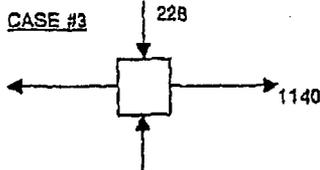
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MOHR'S CIRCLE ANALYSIS (continued)

**PRIMARY + SECONDARY STRESS INTENSITY RANGE  
PIPE ELBOW CASE ( $C_1 = 1.2$ )**

This analysis shows that the code stress equation is a worst case load combination that applies for the case where the maximum thermal expansion stress is in the tension direction and hoop stress is compressive as shown in Case #3 below versus the Case #4 combination with thermal compression that will not occur.



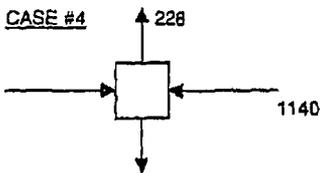
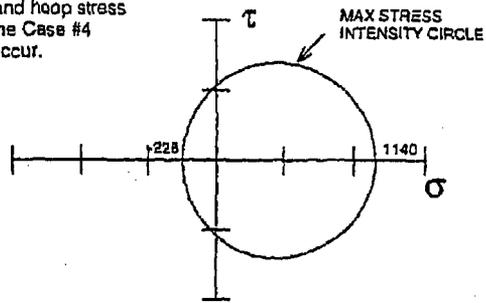
$\sigma_P$  HOOP =  $1.2 \times 190 = (-)228$  PSI

$\sigma_P$  LONG = 0 PSI

$\sigma_T$  BENDING =  $(+)300$  PSI

$\sigma_E$  THERMAL =  $(+)840$  PSI

MAX STRESS INTENSITY RANGE =  $228 + 1140 = 1368$  PSI



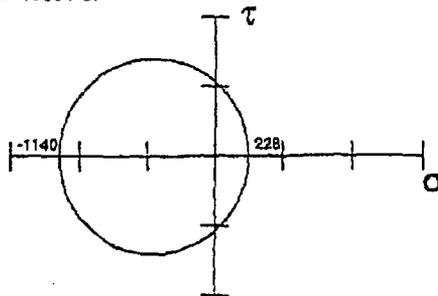
$\sigma_P$  HOOP =  $1.2 \times 190 = (+)228$  PSI

$\sigma_P$  LONG =  $(+)114$  PSI OR 0 PSI

$\sigma_T$  BENDING =  $(-)300$  PSI

$\sigma_E$  THERMAL =  $(-)840$  PSI

MAX STRESS INTENSITY RANGE =  $1140 + 228 = 1368$  PSI



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F. References

1. PNPS Specification M-624 "Specification for Cured-In-Place-Pipe (CIPP) Lining for SSW Discharge Piping"
2. Piping Isometric Drawing M100-7253 Buried Discharge Piping Salt Service Water "A" Loop
3. Piping Isometric Drawing M100-7255 Buried Discharge Piping Salt Service Water "B" Loop
4. CGI-860 "SSW Cured-In-Place-Pipe (CIPP) per Specification M-624"
5. ASTM F1216 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube"
6. ASME Boiler and Pressure Vessel Code - Section III "Rules for Construction of Nuclear Power Plant Components", 1986 Edition.
7. PNPS Specification M-300 "Piping"
8. PNPS Calculation M-630 Rev. 3 "SSW System Hydraulic Analysis"
9. PNPS Calculation M-976 Rev. 0 "Buried Piping Evaluation Salt Service Water Discharge Piping"
10. Shell EPON Resin Systems for Pipe Rehabilitation Information (see attached)
11. AOC Viprel L704-Series Polyester Resin Product Information (see attached)
12. Belzona 1311 Product Specification Sheet (see attached)
13. PDC 01-09 "SSW Discharge Piping Cured-In-Place-Pipe (CIPP) Lining"
14. FRN 01-09-02 "SSW CIPP Liner Epoxy Repair"
15. FRN 01-09-04 "SSW CIPP Liner Stress Relieving Process"
16. FRN 01-09-06 "SSW Loop "A" CIPP Liner"
17. NCR 01-038 Nonconformance Report - Loop-B Liner Separated in Three Locations
18. NCR 01-048 Nonconformance Report - Loop-B Material Test Results
19. NCR 03-027 Nonconformance Report - Loop-A Liner Thickness Readings
20. NCR 03-039 Nonconformance Report - Loop-A Material Test Results
21. CGI-861 "Belzona 1311 Ceramic R-Metal"

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- 22. ASTM Standard D638 "Standard Test Method for Tensile Properties of Plastics"
  - 23. ASTM Standard D790 "Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials"
  - 24. CR-PNP-2001-02301 "Prior to installation of the SSW Cured In Place Pipe liner, the mixed resin/curing agent prematurely reacted due to the high ambient temperature."

G. List of Attachments

- Attachment 1 = Shell EPON Resin Systems for Pipe Rehabilitation Information
- Attachment 2 = Test Results for Loop-B CIPP Installed in RFO-13
- Attachment 3 = AOC Viprel L704-Series Polyester Resin Product Information
- Attachment 4 = Belzona 1311 Product Specification Sheet
- Attachment 5 = Test Results for Loop-A CIPP Installed in RFO-14
- Attachment 6 = Independent Verification Statement Record

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SHELL EPON® RESIN SYSTEMS FOR PIPE REHABILITATION

We recommend the use of one of the six Shell EPON® Resin/EPON CURING AGENT® systems for the repair of pipe in place. Each of these systems has been designed to do a specific job and provide long term integrity and durability. A brief guide to selecting the right system is given below.

EPON® Resin 9210 & EPON CURING AGENT® 9270

This system is designed to rehabilitate pipes carrying potable water at temperatures up to about 30° C. This system provides a tough, flexible barrier to inhibit corrosion and is recommended for repairing pipe with minor leaks. The maximum operating pressure depends on the size of cracks and condition of the original pipe. While the system can easily span small cracks, it tends to creep and is not suitable as a long term "stand alone" pipe under pressure. The use of KEVLAR® reinforcement with this system greatly improves its ability to withstand pressure.

EPON Resin 9215 & EPON CURING AGENT 9270

This system is designed for general purpose use at temperatures up to about 50° C and is very similar to the EPON 9210/9270 system. It provides a tough, flexible barrier which inhibits corrosion and is recommended for repairing pipe with minor leaks. It is resistant to hydrocarbons and caustics. The maximum operating pressure depends on the size of cracks and condition of the original pipe. While the system can easily span small cracks, it tends to creep and is not suitable as a long term "stand alone" pipe under pressure. The use of KEVLAR reinforcement with this system greatly improves its ability to withstand pressure.

EPON Resin 9215 & EPON CURING AGENT 9264

The resin and curing agent mix of this system has a long working life of all of 17 hours. It is recommended for repairs where a "stand alone" pipe is needed with long term physical integrity, durability and resistance to chemical attack. The system exhibits low creep and can be used to repair pipe where large sections of the old pipe are missing. Pipe prepared with this system is resistant to acids, bases and hydrocarbon solvents and can operate in continuous service at temperatures of up to 65° C.

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EPON Resin 9215 & EPON CURING AGENT 9269

The properties of this system are very similar to that of the EPON 9215/9264 system. The resin and curing agent mix is designed to be less sensitive to water and to begin curing at a lower temperature, thus producing better laminates in the presence of water. This system is also recommended for repairs where a "stand alone" pipe is needed with long term physical integrity, durability and resistance to chemical attack. The system exhibits low creep and can be used to repair pipe where large sections of the old pipe are missing. Pipe prepared with this system is resistant to acids, bases and hydrocarbon solvents and can operate in continuous service at temperatures of up to 65° C.

EPON Resin 9220 & EPON CURING AGENT 9264

This is the newest addition to our family of pipe repair systems, hence, not all of the data is available for this system which you will find for other systems in this brochure.

This system was designed especially for making thick walled Insitupipe™, i.e., 15mm or thicker. Desirable features are low viscosity to speed wetout and the longest working life of any of our systems - 19 hours. It is recommended for repairs where a "stand alone" pipe is needed with long term physical integrity, durability and resistance to chemical attack. The system exhibits low creep and can be used to repair pipe where large sections of the old pipe are missing. Pipe prepared with this system is resistant to acids, bases and hydrocarbon solvents and can operate in continuous service at temperatures of up to 65° C.

EPON Resin 9225 & EPON CURING AGENT 9290

Pipe prepared with this system can operate in continuous service at temperatures up to 90° C. This system produces pipe with low creep giving long term physical integrity and the ability to operate as a stand alone pipe. This system also exhibits the best resistance to attack by acids, bases and solvents compared to the other EPON Resin systems.

TYPES OF CURING AGENTS AND CROSSLINKING REACTIONS

The EPON CURING AGENT 9270 is a proprietary mixture of amines. These amines undergo addition polymerization with epoxy resin resulting in a three dimensional, insoluble, infusible, crosslinked polymer network. The molecular structure of the polymer network formed is composed of about 30% of the curing agents.

The EPON CURING AGENTS 9264, 9269 and 9290 are proprietary mixtures of amines which causes the epoxy resin to undergo catalytic homopolymerization resulting in a three dimensional, insoluble, infusible, crosslinked polymer network. The molecular structure of the polymer network formed is composed of less than 10% of the curing agents.

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PROPERTIES	EPOX RESIN / EPOX RESIN CURING AGENT					
	9210/9270	9215/9270	9215/9264	9215/9269	9220/9264	9225/9290
<b>CASTINGS</b>						
Tensile Strength, psi	7,500	7,500	9,000	9,300	8,425	8,000
MPa	51.7	51.7	62.1	64.8	58.1	55.2
Tensile Modulus, psi	480,000	386,000	415,000	420,000	506,000	450,000
MPa	2,758	2,661	2,999	2,896	3,489	3,103
Tensile elongation, %	11.5	11.5	3.0	4.6		4.1
Flexural strength, psi	12,600	12,600	18,000	15,600	15,400	17,500
MPa	86.9	86.9	124.1	107.6	106.2	120.7
Flexural modulus, psi	415,000	415,000	480,000	470,000	506,000	500,000
MPa	2861	2999	3310	3241	3489	3447
Heat deflection, deg C	50	50	69	93	101	130
Glass transition, deg C				120	130	143
<b>VELT COMPOSITES</b>						
Tensile Strength, psi	5,100	5,100	5,000	5,200	6910	5,000
MPa	35.2	35.2	34.5	35.9	47.6	34.5
Tensile Modulus, psi	390,000	390,000	560,000	490,000	502,000	500,000
MPa	2689	2689	3792	3378	3461	3447
Tensile elongation, %	2.3	2.3	1.5	1.5		1.5
Flexural strength, psi	10,300	10,300	9,000	8,000	9,390	8,500
MPa	71.0	71.0	62.1	55.2	64.7	58.6
Flexural modulus, psi	420,000	420,000	490,000	475,000	552,000	490,000
MPa	2896	2896	3378	3275	3806	3378

CALC M-1031 Rev 01  
Attachment 1  
Page 3 of 5

1 0 3 0 8 0 6 1 5

SHELL RESINS AND CURING AGENTS FOR INSITU PIPE REPAIR

ETON RESIN / ETON RESIN CURING AGENT

END USES	9210/9270	9215/9270	9215/9264	9215/9269	9220/9264	9225/9290
Potable Water	X	--	--	--	--	--
Thick Walled Pipe	--	--	--	--	X	--
Inhibit Corrosion	X	X	X	X	X	X
Seal Pinholes	X	X	X	X	X	X
Seal Larger Holes	--	--	X	X	X	X
Pressure Systems	X	X	X	X	X	X
Stand Alone Pipe	--	--	X	X	X	X
Chemical Resistance	--	--	X	X	X	X
Max. Service Temperature	30 deg. C	30 deg. C	65 deg. C	65 deg. C	65 deg. C	90 deg. C
Working Life, Eres, mixed system, 1 gal @ 25C	2.3	2.3	17	6.5	19	7.5
CURE SCHEDULE	2 hr @ 60 C 3 hr @ 70 C (See Brochure)	3 hr @ 70 C	3 hr @ 60 C 1 hr @ 70 C	3 hr @ 60 C 1 hr @ 70 C	3 hr @ 60 C 1 hr @ 70 C	1 hr @ 50 C 2 hr @ 60 C 6.5 hr @ 82 C

CALC M-1031 Rev 04  
Attachment 1  
Page 4 of 5

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EPOX RESIN / EPOX RESIN CURING AGENT

	9210/9210	9215/9210	9215/9264	9215/9269	9218/9264	9225/9290
<b>COEF. OF EXPANSION</b>						
<i>1/1/deg C x 10<sup>-5</sup></i>						
10 to 50 deg C	8.9	8.9	7.2	7.3	—	—
10 to 75 deg C	—	—	—	—	5.8	6.6
50 to 70 deg C	—	—	—	8.8	—	—
75 to 95 deg C	—	—	—	—	11.7	8.9

**CHEMICAL RESISTANCE**  
AT 25 DEG C

DIST. WATER	R	R	R	R	R	R
20% SULFURIC ACID	NR	NR	R	R	R	R
20% ACETIC ACID	NR	NR	R	R	R	R
20% SODIUM HYDROX.	R	R	R	R	R	R
CHLORIN	R	R	R	R	R	R
ACETONE	NR	NR	NR	NR	NR	R
TOLUENE	NR	NR	R	R	R	R

R-RESISTANT  
NR-NOT RESISTANT

A-PROPTA.M21 LOTUS 123 DISK GDE VOL. 059

CALC.M-1031 Rev 04  
Attachment 1  
Page 5 of 5



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## Massachusetts Materials Research, Inc.

P.O. BOX 810 • 241 WEST BOYLSTON STREET • WEST BOYLSTON, MA 01583 • TEL. 508-835-8282 • FAX 508-835-0025

Entergy Nuclear Generating Co.  
Pilgrim Nuclear Power Station  
600 Rocky Hill Road  
Plymouth, Ma. 02360-5599

DATE: May 2, 2001

P.O. NO.: PS01-10803

MMR NO.: F4-23

MMR ID #: B Loop In & Out  
And Belzona Mtl.

PAGE #: 1

ATTENTION: Mr. Phillip Harizi

**SAMPLE IDENTIFICATION:** Cured in place (CIPP) Liner samples from;  
1) B loop In  
2) B Loop Out  
And  
3) Belzona 1311, Ceramic R-Metal Material

MMR has completed the required testing on the three types of material received from Entergy. The samples received from the B Loop In and B Loop Out were sectioned and machined into tensile and flexural strength test samples per ASTM D 638 and D 790, respectively.

The Tensile Test Results are as follows:

Test No.	Sample No. Loop	Width in.	Depth in.	Area sq in	Ultimate Load lb.	Ultimate Stress PSI	Remarks
1	B-OUT 1	.7465	.419	.3128	960	3069	
2	B-OUT 2	.744	.368	.2738	978	3562	
3	B-OUT 3	.738	.332	.245	813	3318	Ave. 3316 PSI
4	B-IN 1	.7685	.4965	.3816	988	2589	
5	B-IN 2	.660	.446	.294	825	2806	
6	B-IN 3	.753	.480	.3614	990	2739	Ave. 2711 PSI

MASSACHUSETTS MATERIALS RESEARCH, INC.

Richard C. Greeno

Manager of Fatigue and Simulated Service Testing

The results reported above apply only to the test samples(s) provided. We believe the above test to be reliable and correct. Inaccuracies or errors, if they occur, will be corrected free of charge. In no event shall Massachusetts Materials Research, Inc. be liable for any special, consequential or other damages. The above testing was conducted in accordance with MMR's Quality Control Manual, Revision #15A, dated 31 August, and your purchase order requirements. This material is controlled under the United States Nuclear Regulatory Commission Rules and Regulations, Title , Chapter 1, Code of Federal Regulations -Energy, Part #21.

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**Massachusetts Materials Research, Inc.**

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DATE: May 2, 2001

P.O. NO.:

MMR NO.: F4-23

MMR ID #:

PAGE #: 2

ATTENTION:

SAMPLE IDENTIFICATION:

103000618

Flexural Test Results

Test No.	Sample No. Loop	Width in.	Depth in.	Span in.	Load lb.	Stress psi	Tangent moduls psi	Remark
1	B-Out 1	.57	.530	8	115	4219	384,000	
2	B-Out 2	.565	.570	8	125	4087	371,965	
3	B-Out 3	.530	.550	8	115	4212	370,909	
4	B-IN 1	.560	.575	8	169	5469	410,566	
5	B-IN 2	.573	.590	8	175	5263	371,965	
6	B-IN 3	.510	.580	8	175	6122	439,595	

MASSACHUSETTS MATERIALS RESEARCH, INC.

Richard C. Greeno

Manager of Fatigue and Simulated Service Testing

The results reported above apply only to the test samples(s) provided. We believe the above test to be reliable and correct. Inaccuracies or errors, if they occur, will be corrected free of charge. In no event shall Massachusetts Materials Research, Inc. be liable for any special, consequential or other damages. The above testing was conducted in accordance with MMR's Quality Control Manual, Revision #15A, dated 31 August, and your purchase order requirements. This material is controlled under the United States Nuclear Regulatory Commission Rules and Regulations, Title 10, Chapter 1, Code of Federal Regulations - Energy, Part #21.



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DATE: May 2, 2001

P.O. NO.:

MMR NO.: F4-23

MMR ID #:

PAGE #: 3

ATTENTION:

SAMPLE IDENTIFICATION:

A Belzona kit was received, mixed per the enclosed instructions and spread onto a flat plate treated with a release compound. The sample was put into an environmental chamber set at 85 degrees F. for 16 hours to cure. Flexural and tensile samples were then rough cut and machined from the cured Belzona and tested per ASTM D 790 and D 638, the test results are listed in the following tables.

Belzona 1311, ceramic R-Material Tensile Test results

Test No.	Sample Type	Width in.	Depth in.	Area sq in.	Ultimate Load lb.	Ultimate Stress psi	Remarks
1	Belzona	.689	.377	.2598	1538	5921	
2	"	.712	.430	.3062	1935	6320	
3	"	.711	.338	.2403	1130	4702	

All three specimens broke at voids in the material.

Belzona 1311, ceramic R-Material Flexural Strength Tests Results

Test no.	Material Type	Width in.	Depth in.	Span in.	Load lb.	Stress psi	Tangent modulus	Remark
1	Belzona 1	.501	.387	6	180	10,795	1.67 <sup>^</sup> 6 psi	
2	2	.507	.375	6	125	7890	1.68 <sup>^</sup> 6 psi	
3	3	.506	.202	4	68	14,820	5.4 <sup>^</sup> 6 psi	

MASSACHUSETTS MATERIALS RESEARCH, INC.

*RCG*  
 Richard C. Greeno

Manager of Fatigue and Simulated Service Testing

The results reported above apply only to the test samples(s) provided. We believe the above test to be reliable and correct. Inaccuracies or errors, if they occur, will be corrected free of charge. In no event shall Massachusetts Materials Research, Inc. be liable for any special, consequential or other damages. The above testing was conducted in accordance with MMR's Quality Control Manual, Revision #15A, dated 31 August, and your purchase order requirements. This material is controlled under the United States Nuclear Regulatory Commission Rules and Regulations, Title , Chapter 1, Code of Federal Regulations -Energy, Part #21.

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ASTM D 638  
TENSILE PROPERTIES OF PLASTICS

ASTM D638 (TYPE III)

Test type: Tensile

Instron Corporation  
Series IX Automated Materials Testing System 5.05  
Test Date: 01 May 2001

Operator name: I. PRODANGSAVANE

Sample Type: ASTM

Sample Identification: 1P25-1T1  
Interface Type: 42/43/4400 Series

Machine Parameters of test:  
Sample Rate (pts/sec): 10.000  
Crosshead Speed (in/min): .2000

Humidity (%): 50  
Temperature (deg. F): 71

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Dimensions:	Spec. 1	Spec. 2	Spec. 3
Width (in)	.71500	.74400	.73300
Thickness (in)	.45000	.46600	.43800
Spec gauge len (in)	2.0000	2.0000	2.0000
Grip distance (in)	4.5000	4.5000	4.5000

Out of 3 specimens, 0 excluded.  
Sample comments: LOOP B TN

Specimen Number	ROGL DIS.	Tensile Strength (psi)	Elongation (%)
1		3655.	9.950
2		3663.	12.050
3		3568.	12.300
Mean:		3629.	11.430
Standard Deviation:		53.	1.251
Minimum:		3568.	9.950
Maximum:		3663.	12.300



FLEXURAL PROPERTIES OF PLASTIC  
ASTM D 790

CALC M-1031 Rev 01  
Attachment 2  
Page 5 of 5

SUPPORT SPAN = 6"

Flexural 1 point bend

Operator name: B.C

Sample Identification: 1F18-1-A  
Instron Type: 42/43/4400 Series  
Machine Parameters of Test:

Sample Rate (pts/sec): 10.000  
Crosshead Speed (in/min): .1600

Instron Corporation  
Series IX Automated Materials Testing System 6.02  
Test Date: 01 May 2001

Sample Type: ASTM

Humidity (%): 50  
Temperature (deg. F): 71

Dimensions:

	Spec. 1	Spec. 2	Spec. 3
Width (in)	.53800	.53400	.53300
Depth (in)	.46800	.48000	.48100
Span (in)	6.0000	6.0000	6.0000

Out of 3 specimens, 0 excluded.  
Sample comments: LGOP "H" IN

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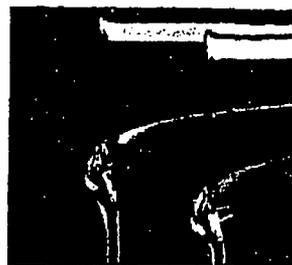
Specimen Number	Displacement	Strain	Load	Stress	Modulus
	at Yield (in)	at Yield (in/in)	at Yield (lbs)	at Yield (psi)	of Elasticity (psi)
1	.2661	.0200	81.4	6219.7	202865
2	.2738	.0213	87.1	6366.6	215860
3	.2539	.0192	87.8	6407.2	246320
Mean:	.2665	.0204	85.4	6325.4	227995
Standard Deviation:	.0168	.0014	2.5	96.7	19420
Minimum:	.2300	.0192	81.4	6216.7	215860
Maximum:	.2738	.0213	87.8	6407.2	252865



VipeI™ L704-AAP Series Polyester Resin

Product Information

VipeI™ Isophthalic Based Resin for Underground Sewer Pipe Liners



TYPICAL LIQUID RESIN PROPERTIES\* (1) VipeI™ L704-AAP-12 see back page

	Nominal	Test Method
Viscosity @ 77°F/25°C, RVF Brookfield Spline #4 @ 20 RPM, cps.	5,000	QI-003
Thin Index 2/30	4	QI-003
Color	Opaque	
Specific Gravity @ 77°F/25°C	1.11	QI-004
Non-Volatiles, %	60	QI-005
Gel Time @ 140°F with (1.0% Di-(4-tert-butyl-cyclohexyl) peroxydicarbonate and 0.5% Trigonox® 42S), minutes	12	Q-008
Pot Life @ 77°F/25°C (1% Di-(4-tert-butyl-cyclohexyl) peroxydicarbonate and +0.5% Trigonox® 42S), hours	48	Q-026

Trigonox is a trademark of Akzo Nobel Chemicals

TYPICAL CAST MECHANICAL PROPERTIES\* (2) see back page

Tensile Strength, PSI/MPa	15,500/93.1	ASTM D-638
Tensile Modulus, PSI/GPa	600,000/4.1	ASTM D-638
Tensile Elongation, %	3.0	ASTM D-638
Flexural Strength, PSI/MPa	23,300/161	ASTM D-790
Flexural Modulus, PSI/GPa	630,000/4.3	ASTM D-790
Heat Distortion Temperature, °F/°C @ 264 psi	212/100	ASTM D-648
Barcol Hardness	40	ASTM D-2583

\*Typical properties are not to be construed as specifications.

DESCRIPTION

The VipeI™ L704-AAP Series is a high molecular weight isophthalic/unsaturated polyester resin. VipeI™ L704-AAP Series provides the corrosion resistance, durability and toughness that is required for cured in place pipe applications. Refer to the AOC Corrosion Resistant Resin Guide for corrosion resistance information listed under F701. A typical resin in this series is VipeI™ L704-AAP-12.

FEATURES

- Excellent catalyzed pot life
- Superior mechanical properties
- Excellent wet-out properties
- Excellent curing properties

BENEFITS

**Adaptability**  
AOC's VipeI™ L704-AAP Series molecular architecture provides an excellent balance of corrosion and physical properties.

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ASTM F1216 TEST RESULTS ON L704  
 6 mm Applied Felt  
 ONE MONTH RESULTS AT 77°F

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	L704 (Isophthalic)	REQUIREMENTS %	PASS OR FAIL
<b>CONTROL SAMPLE</b>			
FLEXURAL STRENGTH, psi	9.544		
STANDARD DEVIATION	2.52		
FLEXURAL MODULUS, psi	564.989		
STANDARD DEVIATION	15.329		
<b>TAP WATER</b>			
FLEXURAL STRENGTH, psi	10.915		
STANDARD DEVIATION	431		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	563.496		
STANDARD DEVIATION	10.993		
% FLEXUARAL MODULUS RETENTION	100	>80	PASS
<b>5% NITRIC ACID</b>			
FLEXURAL STRENGTH, psi	10.672		
STANDARD DEVIATION	894		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	528.173		
STANDARD DEVIATION	13.842		
% FLEXUARAL MODULUS RETENTION	100	>80	PASS
<b>10% PHOSPHORIC ACID</b>			
FLEXURAL STRENGTH, psi	10.301		
STANDARD DEVIATION	1.439		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	552.544		
STANDARD DEVIATION	9.333		
% FLEXUARAL MODULUS RETENTION	98	>80	PASS
<b>10% SULFURIC ACID</b>			
FLEXURAL STRENGTH, psi	12.438		
STANDARD DEVIATION	620		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	545.889		
STANDARD DEVIATION	6.319		
% FLEXUARAL MODULUS RETENTION	97	>80	PASS
<b>AMOCO GASOLINE</b>			
FLEXURAL STRENGTH, psi	9.209		
STANDARD DEVIATION	1278		
% FLEXURAL STRENGTH, psi RETENTION	97	>80	PASS
FLEXURAL MODULUS, psi	567.531		
STANDARD DEVIATION	4.611		

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% FLEXURAL MODULUS RETENTION	100	>80	PASS
<b>VEGETABLE OIL</b>			
FLEXURAL STRENGTH, psi	11,809		
STANDARD DEVIATION	2,484		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	549,755		
STANDARD DEVIATION	27,235		
% FLEXURAL MODULUS RETENTION	97	>80	PASS
<b>0.1% DETERGENT</b>			
FLEXURAL STRENGTH, psi	8,073		
STANDARD DEVIATION	1,732		
% FLEXURAL STRENGTH, psi RETENTION	85	>80	PASS
FLEXURAL MODULUS, psi	511,284		
STANDARD DEVIATION	15,837		
% FLEXURAL MODULUS RETENTION	91	>80	PASS
<b>0.1% SOAP</b>			
FLEXURAL STRENGTH, psi	11,756		
STANDARD DEVIATION	325		
% FLEXURAL STRENGTH, psi RETENTION	100	>80	PASS
FLEXURAL MODULUS, psi	549,192		
STANDARD DEVIATION	11,869		
% FLEXURAL MODULUS RETENTION	97	>80	PASS

August 1, 1999

The information contained in this data sheet is based on laboratory data and field experience. We believe this information to be reliable, but do not guarantee its applicability to the user's process or assume any liability for occurrence arising out of its use. The user, by accepting the products described herein, agrees to be responsible for thoroughly testing any application before committing to production. Our recommendation should not be taken as endorsement to infringe any patent or violate any law, safety code or insurance regulation.



February 28, 2001

ASTM D696-98

Coefficient of Linear Thermal Expansion of L-704 Series in a clear casting.

The samples were scanned from 20°C to 100°C at 10°C per minute. The COE was evaluated from 25°C to 80°C.

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<u>Sample</u>	<u>COE (25° to 80°C)</u>
L704 Series	60.45 e-06 / °C (mm/mm/°C)
	61.11 e-06 / °C (mm/mm/°C)
	<u>62.28 e-06 / °C (mm/mm/°C)</u>
	61.28 e-06 / °C (mm/mm/°C) Average



World leaders in the conservation of man-made resources and the environment

**PRODUCT SPECIFICATION SHEET**  
**BELZONA® 1311**

1 0 3 0 8 0 6 2 6

**1. PRODUCT NAME**  
BELZONA® 1311  
(Ceramic R-Metal)  
Repair system designed for rebuilding metals damaged by erosion-corrosion.

**2. MANUFACTURER**  
Belzona Inc.,  
America's Gateway Park,  
2000 N.W. 88th Court  
Miami, Florida 33172  
Belzona Polymerics Ltd.,  
Claro Road,  
Harrogate, North Yorkshire  
HG7 4AY, England.

**3. PRODUCT DESCRIPTION**  
A two-component, non-machinable grade material based on a silicon-steel alloy blended within high molecular weight reactive polymers and oligomers, the system is designed for rebuilding metals and offers protection against the effects of erosion-corrosion. Ideally suited to be overcoated with Belzona® 1321 (Ceramic S-Metal).

**Applications**  
Centrifugal and turbine pumps.  
Heat exchangers, water box ends,  
division bars and tube sheets.  
Butterfly and gate valves.  
Propellers.  
Kort nozzles.  
Bow thrusters.  
Pipe elbows.  
T-pieces.

**4. TECHNICAL DATA**

**Base Component**  
Appearance Paste  
Color Very dark gray  
Gel strength at 77°F (25°C) 150 - 350 g/cm HF  
Density 2.8 - 2.8 g/cm<sup>3</sup>

**Solidifier Component**  
Appearance Paste  
Color Gray  
Gel strength at 77°F (25°C) 70 - 150 g/cm OY  
Density 1.63 - 1.69 g/cm<sup>3</sup>

**Mixed Properties**  
Mixing Ratio by Weight (Base : Solidifier) 5 : 1  
Mixing Ratio by Volume (Base : Solidifier) 3 : 1  
Mixed Form Paste  
Peak Exotherm Temperature 239 - 284°F (115 - 140°C)  
Time to Peak Exotherm 25 - 42 mins.  
Slump Resistance nil at 0.5 inch (1.27 cm)  
Mixed Density 2.35-2.52 g/cm<sup>3</sup>

**Shelf Life:**  
Separate base and solidifier components shall have a 5 year shelf life when stored between 32°F (0°C) and 86°F (30°C).

**Working Life:**  
Will vary according to temperature. At 77°F (25°C) the usable life of mixed material is 15 minutes.

**Volume Capacity:**  
The volume capacity of a 1 kg. unit of mixed Belzona® 1311 is 25.2 in.<sup>3</sup> (413 cm<sup>3</sup>).

**Cure Time:**  
Allow to solidify for the times shown in the chart below before subjecting it to the conditions indicated.

**5. PHYSICAL / MECHANICAL PROPERTIES**

Determined after 7 days cure at 77°F (25°C). Post curing the material with heat

results in a more highly cross-linked polymer. For enhanced performance this material may be post-cured by heating to 212°F (100°C) for a period of up to 24 hours. This should be carried out following an initial cure period of 24 hours at ambient temperature.

**Abrasion Resistance:**

Taber  
The Taber abrasion resistance with 1 kg load is typically:  
H10 Wheels (Wet) 125 mm<sup>3</sup>  
CS17 Wheels (Dry) 48 mm<sup>3</sup>  
loss per 1000 cycles

**Adhesion:**

Tensile Shear  
When tested in accordance with ASTM D1002, using degreased substrates which have been grit blasted to a 3-4 mil profile, typical values will be:  
Mild steel 2,700 psi (190 kgs/cm<sup>2</sup>)  
Brass 2,270 psi (160 kgs/cm<sup>2</sup>)  
Copper 2,200 psi (155 kgs/cm<sup>2</sup>)  
Stainless steel 2,800 psi (195 kgs/cm<sup>2</sup>)  
Aluminium 2,000 psi (140 kgs/cm<sup>2</sup>)

**Chemical Resistance:**

Once fully cured, the material will demonstrate excellent resistance to the following chemicals:  
carbonic acid  
10% hydrobromic acid  
10% hydrochloric acid  
10% nitric acid  
20% nitrous acid  
5% phosphoric acid  
10% sulfuric acid  
20% ammonia solution  
lime water  
20% potassium hydroxide  
20% sodium hydroxide  
propanol  
butanol  
ethylene glycol  
diethanolamine

Continued...

CURE TIMES	TEMPERATURE					
	41°F (5°C)	50°F (10°C)	59°F (15°C)	68°F (20°C)	77°F (25°C)	86°F (30°C)
Movement or use involving no loading or immersion	4 hrs	3 hrs	2 1/4 hrs	1 3/4 hrs	1 hr	3/4 hr
Machining and/or light loading	6 hrs	4 hrs	3 hrs	2 hrs	1 1/2 hrs	1 hr
Full electrical, mechanical or thermal loading	4 days	2 days	1 1/2 day	1 day	20 hrs	16 hrs
Immersion in chemicals	5 days	4 days	3 days	2 days	1 1/2 days	1 day

methylamine (25% in water)  
hydrocarbons  
mineral oils  
inorganic salts

\* For a more detailed description of chemical resistance properties, refer to Product Data M501.

**Compressive Strength:**  
When tested in accordance with ASTM D695, typical values obtained will be 13,000 psi (914 kgs/cm<sup>2</sup>).

**Corrosion Resistance:**  
Once fully cured, will show no visible signs of corrosion after 5,000 hours exposure in the ASTM B117-73 salt spray cabinet.

**Electrical Properties:**  
**Dielectric Constant**  
Tested to ASTM D150 is typically 3.29 at 1000Hz

**Dielectric Strength**  
Tested to ASTM D149 is typically 32 volts/mil (1280 volts/mm).

**Dissipation Factor**  
Tested to ASTM D150 is typically < 0.0005 at 1 MHz

**Surface Resistivity**  
Tested to ASTM D257 is typically 5.76 x 10<sup>11</sup> ohm.

**Volume Resistivity**  
Tested to ASTM D257 is typically 1.03 x 10<sup>19</sup> ohm cm.

**Flexural Strength:**  
When tested to ASTM D780, typical values obtained will be 10,000 psi (703 kgs/cm<sup>2</sup>).

**Hardness:**  
The hardness of the material when tested to ASTM D785 is typically Rockwell R104.

**Heat Distortion Temperature:**  
Tested to ASTM D648 (284 psi fiber stress), typical values obtained will be 130°F (56°C).

**Heat Resistance:**  
For many typical applications, the product is thermally stable to 450°F (200°C) dry and 140°F (60°C) wet.

**Impact Strength:**  
Reverse notched impact strength is typically 0.93 ft.-lb./in. or 50 J/m.

**Shrinkage:**  
0.0% minimum  
0.005% maximum

**Thermal Expansion:**  
Tested to ASTM E228 the coefficient of thermal expansion is typically 35.5 ppm/°C.

**6. SURFACE PREPARATION AND APPLICATION PROCEDURES**

For proper technique, refer to the Belzona Instructions for Use leaflet which is enclosed with each packaged product. Areas rebuilt with Belzona® 1311 may be overcoated with Belzona® 1321 (Ceramic S-Metal)

**7. AVAILABILITY AND COST**

Belzona® 1311 is available from a network of Belzona® Distributors throughout the world for prompt delivery to the application site. For information, consult the Belzona® Distributor in your area.

**B. WARRANTY**

Belzona® guarantees this product will meet the performance claims stated herein when material is stored and used as instructed in the Belzona® Instructions for Use leaflet. Belzona® further guarantees that all its products are carefully manufactured to ensure the highest quality possible and tested strictly in accordance with universally recognised standards (ASTM, ANSI, BS, DIN, etc.). Since Belzona® has no control over the use of the product described herein, no warranty for any application can be given.

**9. TECHNICAL SERVICES**

Complete technical assistance is available and includes fully trained Technical Consultants, technical service personnel and fully staffed research, development and quality control laboratories.

**10. HEALTH AND SAFETY**

Prior to using this material, please consult the Material Safety Data Sheet provided with each packaged product.

**11. APPROVALS/ ACCEPTANCES**

- U.S.D.A.
- ASS
- BUREAU VERITAS
- CATERPILLAR
- NATO
- GENERAL MOTORS
- TOYOTA
- YORK INTERNATIONAL
- FORD
- RUSSIAN REGISTER OF SHIPPING

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World leaders in the conservation of man-made resources and the environment

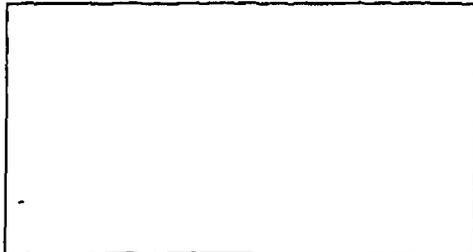
Belzona Inc.,  
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U.S.A.  
Tel: +1 (305) 594 4284  
Fax: +1 (305) 539 1140



BS EN ISO 9002:1994  
Certificate No. Q106335

Belzona Polymers Ltd.,  
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Tel: +44 (0) 1423 567841  
Fax: +44 (0) 1423 505987

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Belzona® is a registered trademark



Belzona®1311-Product Specification Sheet (Page 2)

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THE MEP LAB  
THE MEP LAB

"We help you see the whole picture."  
net: www.the-mep-lab.com e-mail: info@the-mep-lab.com  
2210 Technology Drive PO Box 724  
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fax: 518-382-1182

481 Garlington Rd., Suite L  
Greenville, SC 29615  
phone: 864-297-4417  
fax: 864-297-4517  
Page 1 of 4  
REPORT

LAB NO.: NR-0559  
DATE RECEIVED: April 18, 2003  
REQUESTED BY: Philip Harizi  
COMPANY: Entergy Nuclear Generation Co.  
Pilgrim Nuclear Power Station  
STREET ADDRESS: 600 Rocky Hill Road  
CITY: Plymouth, MA 02360

PHONE: (508) 830-7726 COPIES: N.V. Gजा  
PURCHASE ORDER NO.: PS02-10876  
CUSTOMER REQUEST NO.: N.A.

DESCRIPTION OF MATERIAL AND WORK REQUESTED:  
Received materials as described in the document "Testing Requirements for PNPS SSW Discharge Piping Cured-In-Place-Pipe (CIPP) Lining and Belzona 1311 Ceramic R-Metal Samples for PDC 01-09, Specification Number M-624, CGI Evaluation No. 860, and CGI Evaluation No. 861", Rev. 1, dated 02-MAY-2003.  
WORK BY: James F. Getman, Robert F. Kraus

RESULTS SOURCE NO.: N.A. DATE REP.: May 9, 2003

The two material samples were identified as (1) Belzona 1311, and (2) CIPP lining material. Flexural Modulus of Elasticity, Flexural Strength and Tensile Strength tests were requested.

(Continued on page 2)

Reviewed by: Dale L. Purvis Robert F. Kraus  
Dale L. Purvis Robert F. Kraus

I HEREBY CERTIFY THAT THE DATA CONTAINED IN THIS REPORT HAVE BEEN GENERATED IN ACCORDANCE WITH AND MEET THE REQUIREMENTS OF THE ABOVE PURCHASE ORDER.  
James F. Getman 13 May 2003  
Quality Assurance Administrator

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Philip Harizi

Sample Identifications

Two Belzona 1311 kits (Ceramic R-Metal) were received. Each kit consisted of a base and a solidifier.

1) PIL-84240, PIL Lot 6508,  
PO No. PS01-10981, Received 02-May-2001  
Belzona 1311 Base Lot# 49036B1,  
Belzona 1311 Solidifier Lot# 49040B1.

2) PIL-84112, PIL Lot "none",  
PO No. PS01-11474, Received 28-Aug-2001  
Belzona 1311 Base Lot# 49697E1,  
Belzona 1311 Solidifier Lot# 49893E1.

Item 1 in the list, above, was identified in the test results as "Lot 1". Item 2 was identified as "Lot 2".

Six CIPP quarter-pipe segments were received. They were uniquely labeled as follows.

- 1) Loop-A-In #1, 4/27/03.
- 2) Loop-A-In #2, 4/27/03.
- 3) Loop-A-In #3, 4/27/03.
- 4) Loop-A-Out #1, 4/27/03.
- 5) Loop-A-Out #2, 4/27/03.
- 6) Loop-A-Out #3, 4/27/03.

Items 1, 2 and 3, in the list above, were identified in the test results as "IN". Items 4, 5 and 6 were identified as "OUT".

Test Results

The results of each test are listed in Table 1.

Flexural Strength and Modulus of Elasticity Tests

The Belzona 1311 material was cured at The M&P Lab. A total of six specimens (three from Lot 1 and three from Lot 2), each of a nominal size of 0.5 in. by 0.1 in. by 2.5 in., were fabricated for the measurement of Flexural Strength and Modulus. Flexural strength and modulus were measured at room temperature in 3-Point bending in accordance with ASTM D790-02. The specimen preparation was performed at The M&P Lab.

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Philip Harizi

TABLE 1  
ROOM TEMPERATURE TEST RESULTS FOR PNPS SSW DISCHARGE PIPING CIPP  
LINING AND BELZONA 1311 CERAMIC R-METAL FOR PDC 01-09, SPEC M-624,  
CGI EVALUATION 860 & CGI EVALUATION 861

Sample Label	Specimen Label	Flexural Modulus of Elasticity (psi)	Flexural Strength (psi)	Tensile Strength (psi)	Acceptance Criteria
Belzona 1311 Lot 1	1	1.10 x 10 <sup>9</sup>	8570	4096	Flexural Modulus of Elasticity ≥ 300,000 psi
	2	1.21 x 10 <sup>9</sup>	9020	4586	
	3	1.20 x 10 <sup>9</sup>	7470	5432	
Belzona 1311 Lot 2	1	1.21 x 10 <sup>9</sup>	9890	5401	Flexural Strength ≥ 4,000 psi
	2	1.22 x 10 <sup>9</sup>	9880	5304	
	3	1.36 x 10 <sup>9</sup>	7530	4250	
CIPP IN	1	467 x 10 <sup>7</sup>	4410	2368	Tensile Strength ≥ 4,000 psi
	2	469 x 10 <sup>7</sup>	3850	2848	
	3	479 x 10 <sup>7</sup>	4450	2958	
CIPP OUT	1	392 x 10 <sup>7</sup>	5510	3918	
	2	425 x 10 <sup>7</sup>	5610	4026	
	3	415 x 10 <sup>7</sup>	5790	3927	

- Notes: 1. The CIPP IN material specimen #2 did not meet the acceptance criteria for flexural strength.  
2. None of the three CIPP IN specimens met the acceptance criteria for tensile strength.  
3. The CIPP OUT specimens #1 and #3 did not meet the acceptance criteria for tensile strength.  
4. The acceptance criteria were documented in "Testing Requirements for PNPS SSW Discharge Piping Cured-In-Place-Pipe (CIPP) Lining and Belzona 1311 Ceramic R-Metal Samples for PDC 01-09, Specification Number M-624, CGI Evaluation No. 860, and CGI Evaluation No. 861", Rev. 1, dated 02-MAY-2003.

The CIPP material was cured by the client. A total of six specimens (three labeled IN and three labeled OUT), each of a nominal size of 0.7 in. by 0.3 in. by 7 in., were fabricated for the measurement of Flexural Strength and Modulus. Flexural Strength and Modulus were measured at room temperature in 3-Point bending in accordance with ASTM D790-02. The specimen preparation was performed at The M&P Lab.

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Philip Harizi

Flexural Modulus was calculated from the cross-sectional dimensions and the slope of the steepest tangent line to a test specimen plot of stress as a function of strain. A result was expressed in psi (pounds per square inch).

Flexural Strength was calculated from the cross-sectional dimensions and the maximum sustained test load. Each result was expressed in psi units.

#### Tensile Strength

The Belzona 1311 material was cured at The M&P Lab. A total of six specimens (three from Lot 1 and three from Lot 2), each with the nominal shape of ASTM D638-02 Type I specimens, were fabricated for the measurement of Tensile Strength. Tensile Strength was measured at room temperature in accordance with ASTM D638-02. The specimen preparation was performed at The M&P Lab.

The CIPP material was cured by the client. A total of six specimens (three labeled IN and three labeled OUT), each with the nominal shape of ASTM D638-02 Type I specimens, were fabricated for the measurement of Tensile Strength. Tensile Strength was measured at room temperature in accordance with ASTM D638-02. The specimens were removed from the pipe wall along the longitudinal direction by personnel at The M&P Lab. All sides of each specimen were machined to remove effects from external membranes or the host pipe.

Prior to each test, the actual cross-sectional dimensions were measured, and a specimen's initial area was calculated. This area was used as the denominator in a fraction with the corresponding specimen maximum sustained load in the numerator to calculate the Tensile Strength in psi.

Testing applicable to supplied items was performed in accordance with 10CFR50 Appendix B, 10CFR Part 21 and revision 4 of The M&P Lab's quality program manual, dated 30 November 1999.

#### Material Disposition

The specimens will be retained at The M&P Lab for six months and then discarded.

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<p>2. Assumptions – Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>No necessary assumptions used.</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u> Sect. D.</u></p>
<p>3. Quality Assurance – Are the appropriate quality and quality assurance requirements specified?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: <u>N/A</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>4. Codes, Standards and Regulatory Requirements – Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>NONE</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u> Sect. C + F</u></p>

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<p>5. Construction and Operating Experience - Have applicable construction and operating experience been considered?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>Considered from RFO #13</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Set B</u></p>
<p>6. Interfaces - Have the design interface requirements been satisfied and documented?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: <u>N/A</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>7. Methods - Was an appropriate analytical method used?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>NONE</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Set C</u></p>

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<p>8. Design Outputs - Is the output reasonable compared to the inputs?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>NONE</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Set B+E</u></p>
<p>9. Acceptance Criteria - Are the acceptance criteria incorporated in the calculation sufficient to allow verification that design requirements have been satisfactorily accomplished?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>NONE</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Set C+E</u></p>
<p>10. Records and Documentation - Are requirements for record preparation, review, approval, retention, etc., adequately specified?</p> <p>Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>NONE</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>



# **Attachment B**

Safety-Related     Non-Safety-Related     "Q"-List Item     Non-"Q"    RTYPE B5.21

PILGRIM NUCLEAR POWER STATION  
 SPECIFICATION  
 FOR  
 CURED-IN-PLACE-PIPE (CIPP) LINING  
 FOR SSW DISCHARGE PIPING

SPECIFICATION NUMBER M-624

BID Addendum No. \_\_\_\_\_  PURCHASE    DATE: 12-MAR-2003

ASME B&PV CODE CERTIFICATION:  REQ'D     NOT REQ'D

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E1	<i>P.D. Harizi</i>	<i>03/17/03</i>	<i>[Signature]</i>	<i>3/19/03</i>	<i>[Signature]</i>	<i>3/17/03</i>	<i>[Signature]</i>	<i>3/17/03</i>
E0	P.D. Harizi	04/02/01	S.P. Woods	04/02/01	R.P. Murray	04/02/01	R.M. Pace	04/02/01
REV	PREPARED BY	DATE	VERIFIED BY	DATE	SCM REVIEW	DATE	APPROVED BY	DATE

ENERGY NUCLEAR GENERATING COMPANY  
 PILGRIM NUCLEAR POWER STATION  
 600 ROCKY HILL ROAD  
 PLYMOUTH, MA 02360

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1.0 SCOPE

- (1) This specification provides the requirements for the design, materials, installation, inspections, and testing of a Cured-In-Place-Pipe (CIPP) lining for the Salt Service Water (SSW) discharge piping at Pilgrim Nuclear Power Station (PNPS). The purpose of the CIPP is to provide a new protective lining for the existing steel pipe that maintains the structural integrity of the discharge pipe for soil, overburden, seismic, and live loads.
- (2) The SSW piping to receive the CIPP is the discharge piping for Loop "A" and Loop "B" from the last flange connection in the Auxiliary Building piping vault to the end of the discharge pipe at the Seal Well opening.
- (3) The SSW discharge piping is 22" nominal diameter standard weight carbon steel pipe (0.375" wall thickness) with a 3/16" natural rubber lining thickness. Flange connections are rubber-lined Pressure Class 150 flat-faced slip-on flanges. Existing rubber lining and coatings that are intact will remain in place for the CIPP installation.
- (4) The Loop "A" discharge piping is approximately 240 ft (total length to be lined) with three(3) 45-degree elbows and one(1) 90-degree long radius elbow.
- (5) The Loop "B" discharge piping is approximately 225 ft (total length to be lined) with four(4) 45-degree elbows and one(1) 90-degree long radius elbow.
- (6) As a result of pipe spool replacements performed in 1999, there is a 40'-0" spool in Loop "A" and a 40'-3" spool in Loop "B" that are 22" nominal diameter standard weight carbon steel pipe (0.375" wall thickness) coated with Duromar EAC-FE epoxy with a minimum 1/32" (0.031") thickness, and include "WEKO" elastomeric expansion seals on both end flange joints of the replacement spool, which are to be removed before the CIPP installation.
- (7) This specification provides the requirements for the CIPP design, materials, installation, inspections, testing, and Supplier documentation.
- (8) The SSW discharge piping is part of a "Q", Safety-Related, PNPS Class I system. The CIPP design, materials, installation, inspections, testing, and documentation are to be performed and/or accepted under the PNPS Nuclear Quality Assurance program in accordance with Appendix B to Part 50 of Title 10 of the Code of Federal Regulations (10CFR50 Appendix B).

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**2.0 EQUIPMENT OR SERVICES REQUIRED**

- (1) The Supplier shall perform the cleaning, examination, and as-needed coating/lining preparations for the existing steel pipe prior to installing the CIPP liner.
- (2) The Supplier shall provide sufficient number of workers and resources to perform work on a continuous 24 hour/day basis in accordance with the Owner's schedule.
- (3) The Supplier shall provide all CIPP liner materials and end seals.
- (4) The Supplier shall be responsible for installing the CIPP liner and for the curing process.
- (5) The Supplier shall provide the necessary equipment and shall perform the monitoring and controlling of all CIPP liner curing parameters.
- (6) The Owner shall provide all necessary access to the SSW discharge piping including the opening of the Auxiliary Building piping vaults, removal of piping spools, and installation of outlet cofferdams.
- (7) The Owner shall be responsible for the required inspections and tests and performing examinations or verifying that all examinations have been performed and that the applicable criteria have been met.
- (8) The Owner shall perform any necessary weld repairs of the existing steel pipe.
- (9) The Owner shall provide all necessary staging and work platforms.
- (10) The Owner shall provide the necessary ventilation, air quality monitoring, and confined-space safety training for all workers.
- (11) The Owner shall provide all clean water required and shall dispose of waste water from curing the CIPP liner.
- (12) The Owner shall provide all necessary security personnel and radiological monitoring during the work.

**3.0 APPLICABLE DOCUMENTS**

- (1) ASTM F1216 "Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of Resin-Impregnated Tube"
- (2) ASTM D638 "Standard Test Methods for Tensile Properties of Plastics"
- (3) ASTM D790 "Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials"

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4.0 DESIGN REQUIREMENTS

- [1] The preparation, verification, and independent review of a safety-related design calculation for the CIPP installation will be the responsibility of the Owner.
- [2] The CIPP minimum required thickness ( $t_{min}$ ) shall be the larger of that required by either the external load or internal pressure analysis. The final CIPP nominal design thickness ( $t_{nom}$ ) shall be based on the minimum required thickness increased by 10% to account for thickness variations in the actual installation. The actual thickness used shall be rounded to the next standard millimeter thickness greater than the nominal design thickness.
- [3] The maximum allowable stress for the external load and internal pressure analyses shall be equal to one-half the long-term (time-temperature corrected) flexural and tensile strengths, that is, a Factor of Safety ( $N$ ) equal to 2 shall be used in the design equations.
- [4] For the external load analysis, the design shall be based on the Partially Deteriorated Gravity Pipe Condition. For the negative pressure (vacuum) design condition, the CIPP shall be designed as a gravity pipe with the external hydrostatic pressure increased by an amount equal to the negative pressure. The long-term (time-temperature corrected) Flexural Modulus of Elasticity ( $E_L$ ) shall be equal to one-half the short-term value. An Enhancement Factor ( $K$ ) value of 7.0 shall be used. An Ovality Reduction Factor ( $C$ ) of 0.80 shall be used, based on a 0.250 inch maximum to mean inside diameter differential.
- [5] For the internal pressure analysis, the design shall be based on the Fully Deteriorated Pressure Pipe Condition. The design shall use long-term flexural strength ( $\sigma_L$ ) and tensile strength ( $\sigma_{TL}$ ) equal to one-third the rated short-term strength values listed below.
- [6] The short-term design values to be used, and verified by testing in Section 7.0 below, shall be as follows:

Physical Property	Rated Short-Term Value
Flexural Modulus =	300,000 PSI
Flexural Strength =	4,000 PSI
Tensile Strength =	4,000 PSI

- [7] The design loadings shall be as follows:

Design Parameter	Design Value
Maximum Internal Pressure/Temperature =	30 PSIG @ 100°F
Minimum Operating Temperature =	30°F
Maximum External Differential Pressure (Minimum Internal Pressure) =	25 ft w.g. (-11 PSIG Internal)

Portions of the SSW discharge piping are normally operating at negative pressure. The Maximum External Differential Pressure of 25 ft w.g. is based on the highest negative operating pressure for the discharge piping plus an accounting for groundwater pressure acting externally. External soil, overburden, seismic, and live loads do not act upon the CIPP liner because the steel pipe will remain the structural component.

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0 5 9 1

5.0 MATERIALS

- [1] The CIPP liner material shall consist of a felt tube composed of woven or non-woven material capable of carrying resin and withstanding the installation pressures, and curing temperatures, and shall be compatible with the resin system used. Either an epoxy resin and hardener (curing agent) system, or a polyester resin using polymerization initiators (catalysts) system shall be used.
- [2] The CIPP system shall achieve the physical strength properties in accordance with this specification. To confirm the actual short-term strength properties, test samples of the CIPP shall be taken at the final installation after the curing is completed. The samples shall be cut from a section of CIPP that has been cured within the SSW pipe or within a like diameter pipe provided for this purpose at the entrance and termination point as described in Section 6.0 below.
- [3] The cured specimens taken at the time of final installation shall meet or exceed the following minimum values, which correspond to the short-term values described in Section 4.0:

Physical Property	Minimum Measured Value
Flexural Modulus =	300,000 PSI
Flexural Strength =	4,000 PSI
Tensile Strength =	4,000 PSI

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- [4] The liner tube shall have a uniform thickness that when compressed at installation pressures will equal or exceed the specified nominal design thickness as measured at the test sample locations.
- [5] The liner shall be fabricated using a fiber base material capable of expanding to the size that when installed will cure while in contact with the existing pipe, lining, or coating.
- [6] The average inside diameter of the existing rubber-lined pipe is 20.875" except for the 40 foot epoxy-coated spool section in each line that is 21.188" inside diameter.
- [7] The outside surface of the liner tube (before wetout) shall be encapsulated within a translucent flexible membrane that allows observation of the resin impregnation (wetout) procedure.
- [8] The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color that enhances final visual examination.
- [9] Any lubricant used in the inversion water shall be a nontoxic biodegradable oil of vegetable origin.
- [10] The end seals to be used at the entrance and termination point of the CIPP shall be expanding type seals with an EPDM elastomer element and AL6XN alloy retaining bands. Alternative materials may be used if approved by the Owner.
- [11] Material Safety Data Sheets (MSDS) shall be submitted to the Owner prior to delivery of any chemical materials to PNPS.

6.0 FABRICATION AND INSTALLATION REQUIREMENTS

- [1] CIPP installation shall be by the liner inversion process with the following specific requirements.
- [2] The SSW discharge lines shall be cleaned of all debris, foreign material, and biological matter and inspected as described in Section 7.0 prior to the CIPP installation.
- [3] The existing "WEKO" seals installed at flange joints in the piping shall be removed.
- [4] The existing rubber lining and other urethane and epoxy compound coatings and previous lining repairs shall be visually examined. Loose or damaged lining or coatings shall be removed and the underlying steel pipe examined as described in Section 7.0 below. It is not necessary to repair the rubber lining or coatings.
- [5] The CIPP installation shall not begin until the Owner has inspected and reviewed the final examination results and any measurements, preparations, or repairs performed on the existing pipe, lining, or coatings.
- [6] The felt liner tube wetout process shall be conducted so as to produce a uniform distribution of the epoxy or polyester resin mixture throughout the tube.
- [7] The wetout process shall not begin until the Owner has inspected and reviewed the processing equipment to be used for the wetout, inversion, and curing process.
- [8] The CIPP installation shall be performed by the inversion process. The inversion pressure shall be sufficient to cause the impregnated tube to invert from the point of inversion to the point of termination and hold the tube tight to the pipe wall during the curing process.
- [9] A pull tape may be used to augment the inversion process and shall be kept under tension throughout the inversion process to prevent it from getting trapped under the liner.
- [10] Provision shall be made to produce test samples of the CIPP at the entrance and termination point for each inversion length of tubing installed. The sample material shall be cut from a section of CIPP that has been cured within the SSW pipe or within a like diameter pipe provided at the entrance and termination of the SSW pipe for this purpose. Additional plate test samples may be made using a clamped mold for a section of saturated felt. The axial length required for the sample material and the handling of the samples is described in Section 7.0 below.
- [11] Curing shall be accomplished using circulated heated water, steam, or pressurized heated air. The heated air/water should be circulated the length of pipe to uniformly raise the temperature to effect a cure of the resin. The temperature of the hot supply and return water, steam, or air shall be monitored during the actual curing conditions. The Supplier shall determine the appropriate curing times and temperatures and is responsible for providing all monitoring and control of the curing parameters.

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- [12] The required pressure to hold the flexible tube tight against the existing pipe shall be maintained until the cure has been substantially completed. The Supplier shall determine the appropriate pressure to be maintained during the curing process and is responsible for providing all monitoring and control of the curing parameters.
- [13] The CIPP shall be cooled to a temperature below 100°F before relieving pressure used during curing.
- [14] End seals shall be installed at the entrance and termination point of the CIPP of the type described in Section 5.0.

7.0 INSPECTION, EXAMINATION, AND TEST REQUIREMENTS

- [1] The existing rubber lining and other coatings and previous lining repairs shall be visually examined. Loose or damaged lining or coatings shall be removed and the underlying steel pipe examined. Any significant corrosion shall be removed and the steel pipe thickness confirmed to be greater than the minimum required thickness to be provided by the Owner. Steel pipe wall thickness shall be determined either by direct measurement of the depth of wall loss due to corrosion (measured as a gap between the lowest point of the pit and a prolongation of the original contour of the pipe) or by ultrasonic measurement of the remaining wall thickness.
- [2] The Owner shall provide an inspection and review of the initial examination results and approve the method and materials to be used for any repairs or preparations performed on the existing pipe, lining, or coatings.
- [3] The CIPP installation shall not begin until the Owner has inspected and reviewed the final examination results and any measurements, preparations, or repairs performed on the existing pipe, lining, or coatings.
- [4] Prior to beginning the wetout processing of each tube, the Owner representative(s) shall verify that the equipment setup is capable of ensuring a thorough and uniform wetout and impregnation of the felt tube with the epoxy or polyester resin mixture. The Supplier shall demonstrate the handling and processing of the liner from the wetout through the complete inversion and curing process. The wetout process shall not begin before the successful completion of this Owner verification. The Supplier shall demonstrate the methods of operation for the equipment to the satisfaction of the Owner representative(s). After acceptance of the setup, the Owner representative(s) shall witness the wetout, inversion, and curing process.

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- (5) The liner felt tube material shall have a reasonably uniform thickness with variations not greater than  $\pm 10\%$  of the average flattened tube total thickness with the exception of localized areas that may have a lesser or greater thickness over a width at the surface that is less than the nominal tube thickness and for any length. The felt tube shall be visually examined with thickness measurements required only for areas that are identified visually or by tactile means as varying significantly from the average thickness. Uniformity of thickness for the liner felt tube material is a critical characteristic that, together with the physical property tests described below, provides the basis for acceptance of the CIPP installation.
- (6) The following physical properties defined in Section 5.0, as measured for the test specimens described below, are critical characteristics that provide the basis for acceptance of the CIPP installation:
  - Average Thickness
  - Flexural Modulus of Elasticity
  - Flexural Strength
  - Tensile Strength
- (7) Test samples of the CIPP shall be taken at both the entrance and termination point after the curling is completed for each inversion length of tubing installed as described in Section 6.0. An amount of sample material suitable for the preparation of a minimum of six specimens with a minimum axial length of 10" as described below shall be collected at both the entrance and termination point sample locations.
- (8) Additional plate test samples may be included using a clamped mold for a section of saturated felt. The plate specimens will be tested in addition to the samples described above.
- (9) Test sample material shall be immediately marked with identification for traceability and prepared for shipment to a testing laboratory previously agreed to by the Owner.
- (10) The thickness of the cured samples shall be measured with a caliper or similar device prior to shipment. Thickness measurements are only required for the cured test samples taken from the entrance and termination points. The average thickness of the cured samples shall be equal to or greater than the nominal design thickness ( $t_{nom}$ ) determined in the Section 4.0 analysis.
- (11) Test specimens shall be prepared from axially oriented sample material with a minimum length of 10" and an individual specimen width of 1-1/2" each unless otherwise agreed to by the Owner.
- (12) Flexural testing shall be performed on at least three specimens taken at both the entrance and termination point (total six specimens) to determine the Flexural Modulus of Elasticity and the Flexural Strength in accordance with ASTM Standard D790. Testing is required only for the flatwise orientation of the specimens.

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- [13] Tensile testing shall be performed on at least three specimens taken at both the entrance and termination point (total six specimens) to determine the Tensile Strength in accordance with ASTM Standard D638.
- [14] Test specimens may be prepared by machining the samples. It is not required that the original inside or outside surfaces be retained in the test specimens if machining is performed.
- [15] The finished CIPP shall be inspected by visual examination over the entire length and shall be free of significant voids (air bubbles), dry spots, pits, and cracks.
- [16] Any significant imperfections found shall be reported to the Owner to be dispositioned.
- [17] Voids (air bubbles), dry spots, and pits shall preferably be repaired with Belzona 1811 Ceramic R-Metal epoxy compound. The inside surface membrane may be removed as needed to make repairs. As an alternative, other epoxy or urethane repair compounds may be used if approved by the Owner. Repairs shall be allowed to cure sufficiently long at ambient temperature or curing may be accelerated by heating.
- [18] Cracks are not permitted and any affected areas of CIPP shall be removed by cutting or excavating to completely remove the crack. The area shall preferably be repaired with Belzona 1311 Ceramic R-Metal epoxy compound. Alternative repairs may be approved by the Owner.
- [19] The CIPP inversion around bends may result in wrinkles or fins due to material bunching of the tube along the inner radius of the bend and thinning of the tube around the outer radius of the bend. The wrinkles, fins, or thinning are not considered to be imperfections or defects and are accounted for by the design analysis.

8.0 HANDLING, CLEANING, SHIPPING, AND STORAGE REQUIREMENTS

- [1] The Supplier shall be responsible for all shipping and handling of the CIPP materials and supplies. The Owner will provide a suitable area at or in close proximity to the installation work site for the Supplier to set up the work vehicles or temporary structures necessary for the storage, handling, and wetout process for the CIPP materials. The work area will be available to the Supplier for the duration of the installation project.

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**9.0 QUALITY ASSURANCE REQUIREMENTS**

- [1] The SSW discharge piping is part of a "Q", Safety-Related, PNPS Class I system. The CIPP design, materials, installation, inspections, testing, and documentation are to be performed and/or accepted under the PNPS Nuclear Quality Assurance (QA) program in accordance with Appendix B to Part 50 of Title 10 of the Code of Federal Regulations (10CFR60 Appendix B).
- [2] Defects or nonconformances found in the existing discharge piping or the CIPP installation shall be documented via the PNPS Nonconformance Report (NCR) process for disposition by the Owner prior to any repair work being performed.
- [3] PNPS Quality Assurance/Quality Control (QA/QC) personnel shall perform the inspection function and shall perform, review, and/or confirm examinations without restriction to ensure that the inspection objectives have been achieved. PNPS Quality Control personnel shall perform examinations directly and/or integrate Supplier examinations and/or use remote means to complete the inspection function.
- [4] The CIPP materials and installation will be controlled as a "Commercial Grade Item" (CGI) under the PNPS Quality Assurance program. This specification identifies critical characteristics that will require confirmation by the Owner to complete the acceptance of the CIPP installation. Any parameter, variable, or characteristic not identified in this specification as a "critical characteristic" shall be monitored and controlled solely by the Supplier.
- [5] Final acceptance of the CIPP installation will require the completion of the physical property testing described in Section 7.0. The installed CIPP may be released for SSW system operation immediately following the satisfactory completion of the post-installation inspection, and prior to final acceptance, for station operation in the cold condition only.

**10.0 GUARANTEE**

- [1] Completion of a CIPP installation for which the test samples adequately meet the critical characteristics defined in this Specification and for which any defects or nonconformances have been successfully dispositioned will fulfill the performance requirements for this work.

11.0 CONTROL OF INTERFACE BETWEEN SUPPLIER AND PURCHASER

- (1) All correspondence to and from the Supplier shall reference the Purchase Order number.
- (2) Supplier technical information shall be submitted to the Owner upon request. The final preparation, verification, and independent review of a safety-related design calculation for the CIPP Installation will be the responsibility of the Owner.

12.0 METHOD OF ACCEPTANCE

- (1) The CIPP Installation will be controlled as a "Commercial Grade Item" (CGI) under the PNPS Quality Assurance program.
- (2) The Inspection and testing described in Section 7.0 shall be the method of acceptance for the CIPP Installation. Inspections and testing shall be performed by PNPS Quality Control or an approved PNPS supplier.

13.0 DEFINITION OF "Q"

- (1) Quality Assurance (QA) designator that, when utilized with items or services/activities, identifies that QA Program elements are applicable in order to meet 10CFR50 Appendix B requirements.

14.0 APPLICABILITY OF 10CFR21

- (1) The Owner shall be responsible for any notifications pursuant to Part 21 of Title 10 of the Code of Federal Regulations (10CFR21) "Reporting of Defects and Noncompliance" during the CIPP installation process and at any time in the future. This does not preclude the Supplier from reporting to the NRC any known or suspected defect or failure to comply with applicable requirements for this or any other CIPP Installation.

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ENN-DC-134 REV. 0 ATTACHMENT B.1

DESIGN VERIFICATION COVER PAGE

DESIGN VERIFICATION COVER PAGE

<input type="checkbox"/> IP-2 <input type="checkbox"/> IP-3 <input type="checkbox"/> JAF <input checked="" type="checkbox"/> PNPS		
Document No. <u>Specification M-624</u>	Revision <u>E1</u>	Page 1 of <u>8</u> <u>W/CHECKLIST</u>
Title: <u>CURED-IN-PLACE-PIPE (CIPP) LINING FOR SSW DISCHARGE PIPING</u>		
<input checked="" type="checkbox"/> Quality Related <input type="checkbox"/> Non Quality Related		
DV Method: <input checked="" type="checkbox"/> Design Review <input type="checkbox"/> Alternate Calculation <input type="checkbox"/> Qualification Testing		
VERIFICATION REQUIRED	DISCIPLINE	VERIFICATION COMPLETE AND COMMENTS RESOLVED (DV print, sign, and date)
	Electrical	
✓	Mechanical	<u>S.P. Woods</u> <u>3/17/2003</u> <u>S.P. WOODS</u>
	Instrument and Control	
	Civil/Structural	
Print/Sign After Comments Have Been Resolved		
Originator: <u>PHILIP D. HARRIS</u> / <u>Philip D. Harris</u>		Date: <u>03/17/2003</u>

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ENN-DC-134 Rev. 0 ATTACHMENT B.6

DESIGN VERIFICATION CHECKLIST

<b>IDENTIFICATION:</b>		<b>DISCIPLINE:</b>	
Document Title: CURED-IN-PLACE-PIPE (CIPP) LINING FOR SSW DISCHARGE PIPING		<input type="checkbox"/> Civil/Structural	
Doc. No.: Specification M-624 Rev. E1 QA Cat. Q		<input type="checkbox"/> Electrical	
Verifier: <u>S.P. Woods</u> <u>SP/label</u> <u>3/17/03</u>		<input type="checkbox"/> I & C	
Manager authorization for supervisor performing verification. <input checked="" type="checkbox"/> N/A		<input checked="" type="checkbox"/> Mechanical	
_____ Print Sign Date		<input type="checkbox"/> Other	
<b>METHOD OF VERIFICATION:</b>			
Design Review <input checked="" type="checkbox"/>		Qualification Test <input type="checkbox"/>	
1. Design Inputs - Were the inputs correctly selected and incorporated into the design? Design inputs include design bases, plant operational conditions, performance requirements, regulatory requirements and commitments, codes, standards, field data, etc. All information used as design inputs should have been reviewed and approved by the responsible design organization, as applicable. All inputs need to be retrievable or excerpts of documents used should be attached. See site specific design input procedures for guidance in identifying inputs. Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/>		Reference Page No. _____ OR <u>sect. 1, 2 &amp; 3</u> Paragraph No. _____ Completion of the Reference Boxes is optional for all questions.	
Verifier Comments: _____ <u>SAME AS ORIGINAL ISSUE SPEC. WITH THE ADDITION OF THIS ADDITIONAL POLYESTER RESIN AND CATALYSTS.</u>			
Resolution: <u>N/A</u>			

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<p>2. Assumptions - Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent re-verification when the detailed activities are completed?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: <u>no assumptions within this document.</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>3. Quality Assurance - Are the appropriate quality and quality assurance requirements specified?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 9</u></p>
<p>4. Codes, Standards and Regulatory Requirements - Are the applicable codes, standards and regulatory requirements, including issue and addenda properly identified and are their requirements for design met?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 3</u></p>

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<p>5. Construction and Operating Experience - Have applicable construction and operating experience been considered?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____ <i>From 01-09-06 independent lessons learned from first line job.</i></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>6. Interfaces - Have the design interface requirements been satisfied and documented?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 11</u></p>
<p>7. Methods - Was an appropriate design method used?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 4</u></p>

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<p>8. Design Outputs - Is the output reasonable compared to the inputs?</p> <p>Yes <input checked="" type="checkbox"/>      No <input type="checkbox"/>      N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 4.5</u></p>
<p>9. Equipment and Processes - Are the specified parts, equipment and processes suitable for the required application?</p> <p>Yes <input checked="" type="checkbox"/>      No <input type="checkbox"/>      N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 2.6</u></p>
<p>10. Materials Compatibility - Are the specified materials compatible with each other and the design environmental conditions to which the material will be exposed?</p> <p>Yes <input checked="" type="checkbox"/>      No <input type="checkbox"/>      N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 5</u></p>

Specification M-624 Design Verification Checklist Page 5 of 7

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<p>11. Maintenance - Have adequate maintenance features and requirements been specified?</p> <p>Yes <input checked="" type="checkbox"/>      No <input type="checkbox"/>      N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p style="text-align: center;">Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 2 + 4</u></p>
<p>12. Maintenance and Repair - Are accessibility and other design provisions adequate for performance of needed maintenance and repair?</p> <p>Yes <input type="checkbox"/>      No <input type="checkbox"/>      N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: _____ <i>not applicable as liner is installed into existing pipe.</i></p> <p>Resolution: <u>N/A</u></p>	<p style="text-align: center;">Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>13. Accessibility for Inspection - Has adequate accessibility been provided to perform the in-service inspection expected to be required during the plant life?</p> <p>Yes <input type="checkbox"/>      No <input type="checkbox"/>      N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: _____ <i>not applicable as liner is installed into existing pipe.</i></p> <p>Resolution: <u>N/A</u></p>	<p style="text-align: center;">Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>

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<p>14. Radiation Exposure - Has the design properly considered radiation exposure to the public and plant personnel?</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/> N/A <input checked="" type="checkbox"/></p> <p>Verifier Comments: <u>SSW PIPE &amp; NON RADIATION AREA &amp; NON CONTAMINATED SYSTEM FLUID.</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>
<p>15. Acceptance Criteria - Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>CRITERIA ESTABLISHED TO VERIFY STRENGTH OF LWR AFTER CURS.</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 4, 5 &amp; 7</u></p>
<p>16. Testing - Have adequate pre-operational and subsequent periodic test requirements been appropriately specified?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: <u>SSW PROCEDURE FOR ULTIMATE SYSTEM PERFORMANCE TEST. VARIOUS INTRINSIC MATC TESTING THROUGHOUT LWR PROCESS.</u></p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 4, 5 &amp; 7</u></p>

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<p>17. Handling and Storage - Are adequate handling, storage, cleaning and shipping requirements specified?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 8</u></p>
<p>18. Identification - Are adequate component identification (e.g., equipment labeling) requirements specified?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. <u>Section 7</u></p>
<p>19. Records and Documentation - Are requirements for record preparation, review, approval, retention, etc., adequately specified?</p> <p>Are all documents prepared in a clear legible manner suitable for microfilming and/or other documentation storage method? Have all impacted documents been identified for update as necessary?</p> <p>Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> N/A <input type="checkbox"/></p> <p>Verifier Comments: _____</p> <p>Resolution: <u>N/A</u></p>	<p>Reference</p> <p>Page No. _____</p> <p>OR</p> <p>Paragraph No. _____</p>

Exhibit 1  
Sheet 1 of 1

RTYPE A2.20

NUCLEAR ORGANIZATION  
CONTROLLED DOCUMENT CHANGE NOTICE (CDCN)

CDCN Log No. 03-0201

MANUAL TITLE: SPECIFICATION (RTYPE B5.21)  
DOCUMENT TITLE: CURED-IN-PLACE-PIPE (CIPP) LINING FOR SSW DISCHARGE PIPING  
DOCUMENT NO.: M-624 REV. E1

NEW DOCUMENT  REVISION  RETIRE

REVISION NO.: E1  
NO. OF PAGES ATTACHED: 12-SPEC  
8-REVIEW  
SECTION(S) AFFECTED: ALL

OTHER KNOWN DOCUMENTS AFFECTED  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

GENERAL REASON FOR CHANGE  
 Change In Work Process       Change In Related Document  
 Error In Previous Revision  
 Other: FRN 01-09-06 CHANGES TO PDC 01-09

SPECIFIC PURPOSE AND SUMMARY OF CHANGES (attach additional pages if necessary)  
SPECIFICATION M-624 REV. E1 ATTACHED  
INDEPENDENT REVIEW FORMS (8 PGS) ALSO ATTACHED TO BE FILMED  
W/ SPEC BUT ARE NOT PART OF SPEC DOCUMENT.

Signature of Initiator: Philip D. Harizi      Owner: R. M. Pace  
Date Initiated: 03/18/2003      X 7726

Date Issued by Document Services 3-21-03

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