



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

OFFICE OF THE
INSPECTOR GENERAL

January 22, 2008

MEMORANDUM TO: Chairman Klein

FROM:


Hubert T. Bell
Inspector General

SUBJECT: NRC'S OVERSIGHT OF HEMYC FIRE BARRIERS

Attached is an Office of the Inspector General Special Inquiry that addresses NRC's handling of concerns pertaining to the performance of Hemyc fire barriers that are installed at a number of nuclear power plants.

Please call me if you have any questions regarding the Special Inquiry. This report is furnished for whatever action you deem appropriate. Please notify this office within 120 days of what action, if any, you take based on the results of this Special Inquiry.

Attachment: As stated

cc w/attachment: Commissioner Jaczko
Commissioner Lyons
L. Reyes, EDO

CONTACT: George A. Mulley, OIG
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**Office of the Inspector General
Special Inquiry**

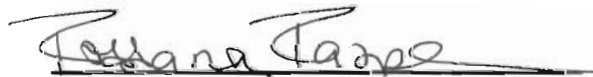


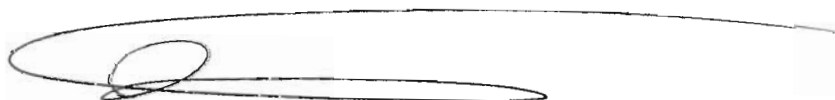
"NRC's Oversight of Hemyc Fire Barriers"

Case No. 05-46


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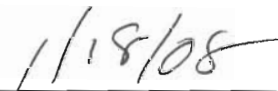

Date

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BASIS AND SCOPE

The Office of the Inspector General (OIG), U.S. Nuclear Regulatory Commission (NRC), initiated this special inquiry in response to concerns pertaining to Hemyc fire barriers. Hemyc is a fire barrier manufactured by Promatec, Inc., that has been installed in operating nuclear power plants (NPPs) since the 1980s. The recent concerns focused on the failure of Hemyc to provide the level of protection expected for a 1-hour rated fire barrier during confirmatory testing sponsored by the NRC in 2005. Also, there were concerns regarding whether the NRC staff was aware of problems with Hemyc prior to 2005 and whether the NRC staff acted to address these problems.

In the early 1990s, problems were identified with fire testing for Thermo-Lag, another fire barrier material commonly used at NPPs. As a result of the Thermo-Lag experience, NRC developed an action plan to assess the adequacy of other fire barrier materials, including Hemyc, which were used at power plants.

Although other fire barriers are in use at NPPs, this inquiry was limited to the Hemyc fire barrier. OIG examined the NRC staff's oversight of Hemyc fire barriers subsequent to the first indication that the barriers did not provide the required level of protection.

BACKGROUND

Hemyc

Hemyc is a fire barrier material that is wrapped around cable trays, junction boxes, and other equipment so that the underlying equipment is protected from fire damage. Hemyc is constructed from an inner core of ceramic fiber covered with a fabric capable of withstanding high temperatures. The inner core is the main thermal insulating component of the Hemyc system. The primary purpose of the cover material is to protect the ceramic fiber core from physical damage.

According to NRC records, Hemyc is currently installed at 15 nuclear reactors in the United States. This represents approximately 15 percent of the nation's operating reactor fleet.

Browns Ferry Nuclear Power Plant Fire and New Regulations

In March 1975, a fire at the Browns Ferry NPP adversely impacted a number of the plant's safety systems. Consequently, Congress conducted an inquiry into the sufficiency of NRC's oversight of fire protection in NPPs.

NRC subsequently formed a special review group that concluded improvements in fire prevention and control were needed and proposed a number of recommendations. One recommendation identified the need to protect redundant electrical cables in NPPs that were needed to achieve and maintain safe shutdown of the nuclear reactor in the event of a fire.

The Browns Ferry fire also resulted in NRC publishing new fire protection regulations in 1980.¹ The new regulations included specific requirements for protecting NPP safe shutdown systems. Safe shutdown systems are those necessary to achieve and maintain the reactor in a shutdown condition with adequate core cooling. The new regulations prescribed fire barriers as a means of protecting electrical cables from fire damage.

The fire protection regulations included requirements for 1-hour fire barriers to be installed in areas of the plant with fire detection and automatic suppression (e.g., sprinkler systems) and 3-hour fire barriers to be installed in areas without fire detection or suppression capabilities. These time durations indicate the number of hours a fire barrier protects equipment from fire damage. Specific fire testing methods are used to qualify fire barriers for these durations. NRC regulatory documents specify that fire barrier ratings be based on testing by nationally recognized testing laboratories.

¹ 10 Code of Federal Regulation (CFR) 50.48 and 10 CFR 50 Appendix R – Fire Protection Requirements for Nuclear Power Facilities Operating Prior to January 1, 1979.

A method of testing accepted by the NRC included monitoring temperature increases inside a cable tray containing electrical cables that are protected by the fire barrier being tested. The testing protocol typically involved heating cable trays and conduits which are covered by the fire barrier under evaluation. The fire barrier sample is heated in a furnace where the temperature increase can be controlled at a rate prescribed in the American Society of Testing and Materials (ASTM) standard E-119. The effectiveness of the fire barrier is evaluated by measuring the effect the fire has on electrical cables located inside the cable trays and conduit. NRC accepted the ASTM E-119 criteria that transmission of heat through the barrier could not raise the temperature inside the barrier more than 250 degrees Fahrenheit above its initial ambient temperature of 75 degrees Fahrenheit (i.e., 325 degrees Fahrenheit).

Another testing protocol for fire barriers is based on circuit integrity. The testing protocol used to monitor circuit integrity looks for whether an electrical cable can still conduct an electrical current even though the cable had sustained some fire damage. The NRC staff did not consider circuit integrity testing to be an approved method for demonstrating that safe shutdown cables can perform their function during fire testing.

Following the Browns Ferry fire, manufacturers and suppliers worked with NRC licensees to install fire barriers in NPPs as needed to meet the new regulatory requirements. Manufacturers of fire barriers performed or sponsored fire endurance tests to establish that their fire barrier materials met either the 1-hour or 3-hour rating period. This testing is referred to as manufacturer fire qualification testing.

OIG reviewed NRC records which included licensee submittals, and found that the NRC approved the use of Hemyc as a fire barrier as early as 1983. OIG found an NRC Safety Evaluation Report (SER) approving the use of Hemyc fire barriers for Waterford NPP.² According to the SER and supporting correspondence, the Waterford licensee provided NRC a manufacturer fire qualification test report performed by Central Nuclear de Asco, Spain (CTP 1026, dated June 1, 1982) for Hemyc. The SER indicated that the test described in the report demonstrated that Hemyc was able to adequately protect cables from a 1-hour fire.

Thermo-Lag Fire Barrier Found to be Defective

Beginning in 1989, a number of concerns were brought to the attention of the NRC regarding performance of the fire barrier material Thermo-Lag and the legitimacy of the qualification tests performed by or sponsored by Thermal Sciences, Inc., the manufacturer of Thermo-Lag. At that time, Thermo-Lag was the most common fire barrier installed in NPPs. In 1991, in response to these concerns, the NRC reviewed the performance issues related to Thermo-Lag. The NRC ultimately concluded that the testing conducted by the manufacturer of Thermo-Lag was inadequate and that the fire barrier resistance ratings for Thermo-Lag fire barrier systems were indeterminate.

² Safety Evaluation Report, NUREG-0787, Supplement No.5, dated June 1983

In August 1992, an OIG investigation determined that the NRC staff had accepted manufacturer fire qualification test results for Thermo-Lag that were reported to have met required standards but later were found to have been falsified.

On February 27, 1993, an NRC staff report addressed concerns pertaining to Thermo-Lag performance and testing issues and recommended that the staff reassess the NRC reviews done for other fire barrier materials.³

NRC Communicates Fire Barrier Assessment Plans to Congress

On March 3, 1993, the U.S. House of Representatives, Subcommittee on Oversight and Investigations, conducted an oversight hearing concerning deficiencies in Thermo-Lag fire barriers. In testimony before the Subcommittee, chaired by Congressman John Dingell of Michigan, then NRC Chairman Ivan Selin quoted from the February 1993 NRC staff report that addressed the Thermo-Lag problems:

“In the area of follow up of indications of problems, the staff’s performance has not been adequate. In some cases there appears to be reluctance on the part of the staff because of the general view that fire protection concerns were rarely serious safety concerns. Most telling of all, these failures have resulted in at least a 3 to 5 year delay in addressing the issues of fire endurance

Chairman Selin’s written statement to the Subcommittee described NRC activities to assess other fire barriers and included a copy of the February 1993 NRC staff report as Attachment 3 of the written submission. The Chairman’s statement included the following passage:

“The NRC will evaluate the resistive performance of other raceway fire barrier materials . . . and the NRC will assess the current capabilities of fire barriers, particularly Thermo-Lag, both on a generic basis and in plant specific installation, to determine what improvements in fire barrier systems will be needed in order to meet NRC requirements.”

Assessments Reveal Problems with Other Fire Barriers

As part of its review of the performance of Thermo-Lag, NRC developed a Fire Protection Task Action Plan (FP-TAP) that included a recommendation to assess other fire barrier materials. The FP-TAP was also contained in Attachment 3 of Chairman Selin’s congressional testimony. The FP-TAP prescribed two activities to satisfy the fire barrier assessment recommendation. First, NRC would sponsor new tests to evaluate the fire endurance characteristics of other fire barriers. Second, NRC would review the original fire qualification test reports from fire barrier manufacturers.

³ Report on the Reassessment of the NRC Fire Protection Program, dated February 27, 1993.

DETAILS

I. ASSESSMENTS OF HEMYC FIRE BARRIERS IN 1993

Testing by the National Institute of Standards and Technology

In accordance with the FP-TAP, the NRC selected the National Institute of Standards and Technology (NIST), a nationally recognized testing facility, to conduct tests to evaluate the fire endurance characteristics of fire barriers. OIG reviewed a NIST test report (FR 3994), dated March 31, 1994, filed at the NRC, which concerned tests conducted on several fire barriers, including Hemyc. The report contained the results of a test performed by NIST on Hemyc on September 17, 1993, and noted that NRC staff were present to observe this test. The report stated that the Hemyc test sample failed to meet a 1-hour duration period and included the following statement in bold: “fire endurance period was 1390 seconds (23.2) minutes.” This statement indicated that the test sample had a measured endurance period of less than half of the expected 1-hour endurance period.

Manufacturer Fire Qualification Reports

Additionally, as part of the FP-TAP, the NRC sent a letter in 1993 to several manufacturers of fire barriers, including Promatec the manufacturer of Hemyc, requesting information regarding the Hemyc fire barrier. The letter included a questionnaire about fire barrier qualifications and requested specific manufacturer information, including qualification test reports. On July 27, 1993, Promatec responded to NRC’s questionnaire and provided a copy of a qualification test conducted by Central Nuclear de Asco (CTP 1026) on June 1, 1982, and two qualification tests conducted by the Southwest Research Institute (SWRI) on January 6, 1986 (CTP 1071) and June 4, 1986 (CTP 1100A). According to these test reports, cables were not functionally damaged during the furnace fire endurance tests and the cables maintained sufficient insulation and continuity at all times.

OIG learned that in May 1993, the NRC issued Information Notices 93-40⁴ and 93-41.⁵ The information notices identified problems with a number of manufacturer fire qualification test reports. Both information notices stated that “suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.” The information notices made no mention of Hemyc.

⁴ 93-40: Fire Endurance Test Results for Thermal Ceramics FP-60 Fire Barrier Material, May 26, 1993.

⁵ 93-41: One Hour Fire Endurance Test Results for Thermal Ceramics Kaowool, 3M Company FS-195, and 3M Company “” E-50 Fire Barrier Systems, May 28, 1993.

OIG Review of Documents

OIG reviewed documents available through the Agencywide Document Access and Management System, agency microfiche documents, and fire protection file archives stored in the fire protection branch, Office of Nuclear Reactor Regulation (NRR). The review revealed that a February 13, 1995, Executive Director for Operations (EDO) status update report to the Commission described progress on both the NIST testing and the staff's review of manufacturer fire qualification tests. According to the status update, NIST tests for several fire barrier materials, including Hemyc, were completed and documented in a NIST report (FR 3994). The update stated that the NIST report was still under review and that preliminary reviews of the data and staff observations during the tests had not revealed performance problems similar to those associated with Thermo-Lag.

Except for the EDO status update, OIG was unable to locate any documentation of an NRC review of the September 1993 NIST test for Hemyc. OIG was also unable to locate any documentation of an NRC review of the original Hemyc manufacturer fire qualification tests as recommended by the FP-TAP. In addition, a review of generic communications issued by NRC between 1993 and 2004 did not identify any generic communications to NRC licensees regarding Hemyc fire endurance tests.⁶

OIG Interviews with Staff

An NRC fire protection engineer and a senior manager, who formerly had supervisory responsibility for the NRR fire protection branch from 1992 to 2000, told OIG that the 1993 NIST tests were referred to as small-scale or screening tests, and they were not sufficient to make a final determination regarding the capability of fire barriers. According to the engineer and the senior manager, these screening tests should have been used to determine whether additional testing or review was necessary. They both said that the September 1993 NIST test results should have led to further action, for example, additional testing of Hemyc.

The senior manager said that he could not recall whether the NRC evaluated the original manufacturer fire qualification tests at the time they were provided to NRC in 1993. Also, although his name was listed on the NIST report as having observed the NIST test of Hemyc in September 1993, the senior manager did not have specific recollection of the Hemyc test. He said that NRC should have documented its review of the NIST test and communicated the test results to licensees. However, he did not recall NRC publicly disseminating the NIST test results or communicating test results to licensees via an information notice or any other method. He could not explain why NRC did not release the results of the Hemyc test.

The fire protection engineer said he was not aware of any NRC follow-up to the NIST small-scale test. The fire protection engineer told OIG that in 2005 when he reviewed the manufacturer fire qualification test reports he noted they reflected significant

⁶ OIG reviewed the Generic Communications Web postings for the period 1993 to 2004.

problems and did not “pass the smell test.” For example, he said that the test data contained inconsistent temperature profiles that showed some test specimen temperatures decreasing as the test furnace heated the specimen.

According to the senior manager, although the NRC Thermo-Lag follow-up action plan called for the review of fire barrier materials other than Thermo-Lag, the NRC was focused on resolving problems with Thermo-Lag because it was installed in a large number of NPPs, while Hemyc was installed in relatively few facilities.⁷ Consequently, NRC resources were devoted to resolving problems identified with Thermo-Lag. Testing of other fire barrier materials was viewed as something that needed to be accomplished, but this testing did not receive the same level of attention as Thermo-Lag.

The senior manager told OIG that given all the activities the NRC staff was working on, which included resolving the Thermo-Lag problems as well as developing a new fire protection inspection program, he was comfortable with the work accomplished. He acknowledged that if the NRC staff could have done something differently, it would have been to review other fire barrier materials in a more timely manner.

II. CONCERNS REGARDING HEMYC RAISED BY NRC INSPECTORS IN 1999

Shearon Harris Nuclear Power Plant Inspection

In November 1999, NRC Region II conducted a fire protection program inspection at the Shearon Harris NPP as part of a pilot program for the new reactor oversight process. The NRC inspection report documented unresolved questions raised by inspectors regarding the manufacturer fire qualification tests for the Hemyc fire barriers at Shearon Harris. As a result of the inspection, Region II requested that NRR review three manufacturer qualification test reports provided to the inspectors by the Shearon Harris licensee. These were the same three test reports provided by Promatec to the NRC in 1993.

An NRC inspector involved with the Shearon Harris inspection told OIG that there were a number of reasons why the inspectors questioned these qualification tests, including the use of “a small-scale furnace test” and that the tests were not conducted by a nationally recognized testing laboratory. The inspector also stated that during the tests, “circuit integrity and not the actual temperature rise inside the barrier itself” was monitored.

⁷ NRC does not maintain specific records on how many nuclear plants had Hemyc originally installed or how many plants contained Hemyc at any particular point in time. Current records indicate that 15 nuclear reactors currently have Hemyc fire barriers installed (see Figure 1).

NRR Determination Regarding Hemyc Manufacturer Fire Qualification Testing

In August 2000, NRR staff responded to the Region II request to review three Hemyc manufacturer fire qualification test reports.⁸ The first report described the 1-hour Hemyc fire barrier testing that was performed by Central Nuclear de Asco, Spain. The results were reported in CTP 1026. This is the same fire test report accepted by the NRC in 1983 in approving the use of Hemyc at the Waterford NPP.⁹ Based on its August 2000 review, NRR concluded that the test results in CTP 1026 were “inconclusive to qualify” Hemyc as a 1-hour rated fire barrier.

The second report reviewed by NRR described 3-hour MT/Hemyc conduit fire barrier testing which was performed by SWRI.¹⁰ The results were reported in CTP 1071. NRR concluded that the test results in CTP 1071 were “inconclusive to qualify” MT/Hemyc as a 3-hour rated fire barrier.

The third report reviewed by NRR described 3-hour MT/Hemyc cable tray fire barrier testing which was also performed by SWRI. The results were reported in CTP 1100A. NRR concluded that the test results in CTP 1100A could be used to qualify MT/Hemyc as a 3-hour rated fire barrier only if the specific configuration of MT/Hemyc installed in NPPs met the criteria (i.e., cable tray sizes and cable masses) in CTP 1100A.

OIG Review of Documents

An OIG review of NRC generic communications revealed that the NRC did not issue any generic communication requiring licensees to take corrective action following NRR’s determination in August 2000 that the manufacturer fire qualification tests for Hemyc were not sufficient to qualify Hemyc for use as a fire barrier in NPPs.

OIG Interviews with Staff

The senior manager, who had supervisory responsibility for the NRR fire protection branch from 1992 to 2000, told OIG that in hindsight, whether the staff did all it could to test other fire barrier materials could be questioned. The senior manager said that NRC staff held numerous discussions on whether the NRC should sponsor further testing. He recalled that the consensus of the staff was that industry should take the lead in demonstrating that materials installed at NPPs complied with NRC requirements.

An NRC fire protection engineer told OIG that subsequent to the August 2000 determination by NRR that Hemyc was not qualified for use as a fire barrier in NPPs, the staff requested that licensees address Hemyc concerns as a voluntary initiative and that the Nuclear Energy Institute (NEI) assist with coordinating that initiative. The

⁸ NRR Response to Task Interface Agreement TIA 99-028, August 1, 2000, Suzanne Black to Loren Plisco.

⁹ NRC review documented in SER, NUREG-0787, Supp. No. 5, dated June 1983.

¹⁰ MT/Hemyc consists of Hemyc blankets wrapped around layers of other materials.

engineer said that the industry later decided not to pursue a voluntary initiative which stalled the NRC's progress on resolving Hemyc issues. OIG learned that in February 2001, NEI advised the NRC that there was insufficient evidence to indicate a safety concern that would warrant an industry initiative. In August 2001, NEI informed the NRC that it was the position of the nuclear industry that licensees were in compliance with NRC requirements based on the fact that the NRC had previously accepted the original Hemyc manufacturer fire qualification tests.

III. ADDITIONAL NRC TESTING OF HEMYC AND FOLLOW-UP ACTIONS

Hemyc Test Plans

As a result of industry's decision not to conduct any tests, NRR requested that the NRC Office of Nuclear Regulatory Research (RES) perform confirmatory testing of the Hemyc fire barriers.¹¹ It should be noted that NRC does not conduct tests to qualify commercial products for use in NPPs; therefore, NRC confirmatory fire testing could only be used to identify potential problems with fire barriers. NRC fire protection status reports prepared by NRR in June 2001, January 2002, and August 2002, indicated that efforts were underway in 2001 to complete the confirmatory testing of Hemyc by 2002. The January 2002 status report stated, "It is hoped that a portion of the testing will be performed this year with the balance of the testing in the 2003 fiscal year." The August 2002 status report stated that a test plan will be complete in 2002 with testing to be performed in 2003, "contingent on funding," and any necessary follow-up testing will be performed in 2004, once again, "contingent on funding."

Hemyc Fails During 2005 NRC Testing

OIG learned that on March 25, 2005, a confirmatory test of Hemyc was conducted for the NRC by Sandia National Laboratories at Omega Point Laboratories. The results of the test were documented in NRC Information Notice 2005-07, *Results of Hemyc Electrical Raceway Fire Barrier System Full Scale Fire Testing*. The information notice, dated April 1, 2005, concluded that the Hemyc fire barrier failed to perform for 1 hour as designed. Specifically, the report stated that Hemyc exceeded the temperature limit of 325 degrees Fahrenheit between 13 and 42 minutes, depending on where the temperature was measured on the test assembly (see Figure 2). In describing the significance of the tests results, Information Notice 2005-07 stated that Hemyc fire barriers "do not provide the level of protection expected for a rated 1-hour fire barrier." Although the information notice stated that the NRC expected recipients to review the information for applicability to their facilities and to consider appropriate actions, the information notice did not require NRC licensees to take any specific action or to provide a written response.

¹¹Confirmatory testing is conducted in a manner similar to manufacturer qualification testing. Testing includes full-scale mockups of various configurations of protected equipment (e.g., cable trays, conduit) wrapped in fire barrier. Equipment is exposed to temperatures in a furnace while it is protected in the fire barrier, and instruments monitor temperature in the equipment mockups.

NRC Issues Generic Letter in 2006

Following Information Notice 2005-07, the NRC met with industry groups and licensees to discuss Hemyc fire barrier issues. On April 10, 2006, the NRC issued Generic Letter 2006-03, *Potentially Nonconforming Hemyc and MT Fire Barrier Configurations*. Generic Letter 2006-03 gave licensees until December 1, 2007, to provide a description of actions taken to resolve problems with Hemyc and MT/Hemyc fire barriers. The generic letter stated that based on the results of the confirmatory test conducted for the NRC, the NRC was concerned that Hemyc fire barriers may not provide the level of fire endurance intended by licensees and licensees that use Hemyc may not be conforming with their licensing basis. The generic letter also requested that all licensees review their fire protection programs in light of the information contained in Information Notice 2005-07 and the generic letter. The letter asked licensees to implement appropriate compensatory measures and develop plans to resolve any nonconformances.

Current Status of Hemyc Fire Barriers

OIG learned that by September 1, 2007, all NRC licensees, including the licensees of the 15 reactors with Hemyc, had responded to Generic Letter 2006-03. Also, as of that date the NRC had replied to all but three licensees. The NRC accepted licensees' responses to the generic letter based on information provided such as whether a plant used Hemyc or MT/Hemyc and the proposed licensee action plans to resolve problems associated with the deficient fire barrier materials. The licensees' proposed resolution for the problems associated with Hemyc ranged from replacing Hemyc with another fire barrier material to requesting exemptions from NRC fire protection regulations. NRC advised licensees that the responses provided to the NRC were subject to future inspection. However, OIG noted that NRC has not scheduled or budgeted for any inspections to conduct independent reviews of licensees' claims that Hemyc barrier issues are being resolved.

OIG Interviews with NRC Managers

A Division Director with NRR, who had management responsibility over the NRR fire protection branch between 1990 and 2003, told OIG that he was familiar with the 1993 Thermo-Lag action plan requirements to test other fire barriers and to review manufacturer fire qualification test reports. He could not recall specific circumstances to explain why, when problems with Hemyc were again identified in 1999, it took the agency from 2000 to 2005 to conduct testing of Hemyc, but he said that it is not unusual for planning for this type of testing to take 2 to 4 years. He said a complicating factor was an ongoing dialogue between NRC and NEI about who would finance the testing. As to the circumstances surrounding the NRC's lack of action regarding Hemyc between 1993 and 2000, the NRR Division Director said that he knew that some fire barrier testing was being conducted during that period, but he could not recall anything specific regarding testing Hemyc fire barriers.

The NRR Office Director told OIG that NRR staff briefed him on Hemyc after he assumed his position in September 2003. The staff informed him that industry believed Hemyc was safe when viewed from a risk-informed perspective even if Hemyc did not meet NRC's requirements. The Office Director recalled that following the staff's review of the manufacturer fire qualification tests in August 2000, industry did not agree with the NRC's concerns regarding Hemyc. The NRC attempted to get industry to conduct tests of Hemyc fire barriers; however, industry felt that the original manufacturer fire qualification tests were adequate for fire barriers installed in NPPs. After a few years of inaction on industry's part, the NRC allocated funds in its budget to test Hemyc. He said that the NRC was making progress on fire barrier issues but he conceded that NRC may not have acted quickly enough to resolve fire barrier testing issues.

OIG Interviews with Congressional Staff Members

The former NRC Chairman's 1993 testimony to the House Subcommittee on Oversight and Investigations included a commitment to conduct future assessments of fire barrier materials to ensure they met NRC requirements. In light of this testimony, OIG coordinated this special inquiry with staff from the House Committee on Energy and Commerce. OIG met with a majority and a minority staff member from the House Committee on Energy and Commerce which is chaired by Congressman John Dingell. Neither congressional staffer was aware of any NRC reports to Congress detailing the status of NRC assessments of fire barriers following the 1993 Congressional Testimony.

FINDINGS

1. In 1983, the NRC approved the installation of Hemyc at Waterford NPP based on a finding by the NRC that a fire qualification test report provided by the manufacturer demonstrated that Hemyc was able to adequately protect electrical cables from a 1-hour fire. Subsequently, Hemyc has been used in a number of NPPs to provide protection of electrical cables. In 1994, the NRC received information indicating problems with the length of fire endurance of Hemyc as the result of a small-scale fire endurance test by NIST. Although rated as a 1-hour barrier, during the NIST test the fire endurance was 23.2 minutes. Although the NIST test was a small-scale test and was not sufficient to make a final determination regarding the capabilities of the Hemyc fire barrier, the test results should have led to further action, e.g., additional tests of Hemyc fire endurance. However, the NRC did not communicate the results of the NIST test to licensees, nor did the NRC conduct any follow up to the NIST small-scale test of Hemyc.
2. In November 1999, an NRC inspection identified potential problems with Hemyc fire barriers at Shearon Harris NPP. Consequently, the NRC reviewed three manufacturer fire qualification test reports that were provided to the NRC by the Shearon Harris licensee. One of the test reports was the same report that had been accepted by the NRC in 1983 to support installation of Hemyc at Waterford NPP, and had been provided to the NRC for review in 1993. However, in August 2000, the NRC concluded that the results of that test were inconclusive to qualify Hemyc as a 1-hour fire rated barrier. With respect to the two remaining manufacturer test reports provided by the Shearon Harris licensee, NRC determined that one report provided test results that were inconclusive to qualify Hemyc as a 3-hour fire barrier, and the other report provided results that could be used to qualify Hemyc as a 3-hour barrier only in specific installed configurations. Following the August 2000 determinations regarding the qualifications of Hemyc, the NRC did not require NRC licensees to take corrective action.
3. Following the August 2000 determination by the NRC that the manufacturer qualification tests for Hemyc were not sufficient to qualify Hemyc for use as a fire barrier in NPPs, the NRC initiated a program to perform NRC sponsored confirmatory testing of the Hemyc fire barriers. Efforts began in 2001 to complete confirmatory testing of Hemyc by 2002. It was not until March 25, 2005, that a confirmatory test of Hemyc was conducted by NRC. The test resulted in a finding that the Hemyc fire barrier failed to perform for 1 hour as designed. In April 2005, the NRC published the results of the tests in an NRC information notice to all licensees. The notice described problems observed with Hemyc during the testing, and the report stated that Hemyc fire barriers do not provide the level of protection expected for a 1-hour rated fire barrier. The notice did not require licensees to take any action or to provide a written response.

4. On April 10, 2006, the NRC issued a generic letter to all NPPs regarding the potentially nonconforming Hemyc fire barriers. The generic letter gave licensees until December 1, 2007, to provide a description of actions taken to resolve problems with Hemyc fire barriers. All licensees that installed Hemyc responded to the generic letter by September 1, 2007. The NRC accepted responses to the generic letter which discussed licensee plans to resolve problems with the Hemyc fire barriers which ranged from replacing Hemyc with other fire barriers to requesting exemptions from NRC fire protection regulations. While NRC advised licensees that responses to the generic letter were subject to future inspection, OIG noted that NRC has not scheduled or budgeted for any inspections to review licensees' resolution of the Hemyc fire barrier issues.

5. In 1980, the NRC established fire protection regulations which included specific requirements for protecting NPP safe shutdown electrical cables with either a 1-hour or 3-hour fire barrier. Beginning in the early 1980s, to comply with these regulations, Hemyc was installed in a number of NPPs. In March 1993, after problems with Thermo-Lag fire barriers were identified, a former NRC Chairman provided testimony to the House of Representatives Subcommittee on Oversight and Investigations. His testimony included a commitment to conduct assessments of all fire barriers used to protect electrical cables in NPPs to identify what improvements were needed to have these fire barriers meet NRC requirements. Although the NRC staff has made progress in addressing Hemyc fire barrier problems, it was not until April 2005 that the NRC first informed licensees of the failure of Hemyc to perform as an NRC qualified fire barrier, and not until April 2006 that the NRC first requested licensees to take actions to resolve problems with Hemyc fire barriers installed at their facilities. As of December 2007, no fire endurance tests have been conducted to qualify Hemyc as an NRC approved 1-hour or 3-hour fire barrier for installation at NPPs.

Figure 1
Fire Barriers in US Nuclear Plants
Based on Best Available Information

| Plant Name | Hemyc | List of Other Barriers | Plant Name | Hemyc | List of Other Barriers |
|------------------------|-------|---|--------------------|-------|---|
| Arkansas Nuclear (1,2) | Yes | Thermo-Lag (T-L), and Versa wrap. | H. B. Robinson | Yes | 3M |
| Beaver Valley | No | T-L, 3M Interam System (3M), Darmatt. | Edwin Hatch | No | Promat-H board. |
| Braidwood | No | 3M Interam. | Hope Creek | No | |
| Browns Ferry | No | T-L. | Indian Point (2,3) | Yes | Hemyc and 3M. |
| Brunswick | No | 3M | Kewaunee | No | 3m |
| Byron | No | Rely on Darmatt. | LaSalle County | No | Rely on Darmatt, |
| Callaway | No | Rely on Darmatt. | Limerick | No | Rely on Darmatt and TL, |
| Calvert Cliffs | No | | McGuire (1,2) | Yes | |
| Catawba (1,2) | Yes | | Millstone | No | |
| Clinton | No | Rely on T-L and 3M | Monticello | No | |
| Columbia | No | 3M and T-L. Darmat | Nine Mile Pt | No | |
| Comanche Peak | Yes | T-L | North Anna | No | 3M |
| Cooper Station | No | | Oconee | No | |
| Crystal River | No | Rely on T-L and Mecatiss fire barriers. | Oyster Creek | No | T-L and Mecatiss, |
| Davis-Besse | No | 3M, | Palisades | No | Concrete is used for separation. |
| Diablo Canyon | No | 3M, Pyrocrete. | Palo Verde | No | T-L. |
| Donald C. Cook | No | Darmatt, Mecatiss, T-L. | Peach Bottom | No | Darmat and T-L. |
| Dresden | No | Rely on 3M. | Perry | No | 3M, |
| Duane Arnold | No | Darmat | Pilgrim | No | Mecatiss and 3M. |
| Enrico Fermi | No | 3M, | Point Beach | No | 3M. |
| Farley | No | Promat, 3M | Prairie Island | No | Darmatt, and 3M. |
| Fitzpatrick | Yes | Other barriers all approved by exemption May 29, 2001 | Quad Cities | No | 3M, Darmat, Versawrap. |
| Fort Calhoun | No | 3M, Pyrocrete, Pabco | River Bend | No | Only rely on Thermo-Lag 330. |
| Grand Gulf | No | T-L and 3M Interam | Robert E Ginna | Yes | Hemyc and MT. Hemyc will be evaluated as part of 805 transition. MT installed as 1 hour barrier |

Figure 1
Fire Barriers in US Nuclear Plants
Based on Best Available Information

| Plant Name | Hemyc | List of Other Barriers | Plant Name | Hemyc | List of Other Barriers |
|---------------------|-------|--|-------------------|-------|--|
| Salem | No | 3M | Susquehanna | No | Other barriers (not listed) meet Supp 1. |
| San Onofre | No | Rely on Cerablanket. 3M Interam, | Three Mile Island | No | T-L, T-L/Mecatiss, Mecatiss. |
| Seabrook | No | 3M | Turkey Point | No | T-L, |
| St. Lucie | Yes | Hemyc as Radiant Energy Shield only - TL, Mecatiss | Vermont Yankee | No | 3M, |
| Sequoyah | No | T-L. | Vogtle | No | 3M, cementitious material. |
| Shearon Harris | Yes | Hemyc, T-L and 3M. | Waterford | Yes | 3M. |
| South Texas Project | No | T-L. | Watts Bar | No | T-L. |
| Virgil C. Summer | No | Kaowool 3M installed, | Wolf Creek | No | Rely on Darmatt and T-L. |
| Surry | No | Pyrocrete | | | |

Figure 2 Hemyc Full Scale Test Assembly

Pre Fire Test



Post Fire Test (Note Change in Color of Outer Wrap)



Failed Joint

(From Sandia National Laboratories Report No. 14790-123264 Page 511 & 519)

Figure 3
Hemyc Fire Barrier Issues Timeline

