UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
WASHINGTON D.C. 20555-0001

April 1, 2005

INFORMATION NOTICE 2005-07: RESULTS OF HEMYC ELECTRICAL RACEWAY FIRE BARRIER SYSTEM FULL SCALE FIRE TESTING

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel, and fuel facilities licensees.

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of the results of Hemyc electrical raceway fire barrier system (ERFBS) full-scale fire tests. The Hemyc ERFBS did not perform for one hour as designed because shrinkage of the Hemyc ERFBS occurred during the testing. It is expected that recipients will review the information for applicability to their facilities and consider actions as appropriate to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

BACKGROUND

The Hemyc ERFBS, manufactured by Promatec, Inc., has been installed at nuclear power plants (NPPs) to protect circuits in accordance with regulatory requirements (Reference 1) and plant-specific commitments.

As a result of fire protection inspections, unresolved items (URIs) were opened at some nuclear power stations due to questions raised regarding the fire resistance capability of the Hemyc ERFBS (Reference 2). The Office of Nuclear Reactor Regulation (NRR) performed a review of the Hemyc ERFBS (Reference 3) and requested the NRC's Office of Nuclear Regulatory Research (RES) to perform confirmatory testing of this ERFBS. RES performed the testing at the Omega Point Laboratories in Elmendorf, Texas.

DISCUSSION

This information notice describes the results of the investigation of the fire resistance capability of the Hemyc ERFBS (Attachment 1). The NRC performed two ASTM E 119 furnace tests on a number of cable raceway types that are protected by the Hemyc ERFBS (with and without air gaps) in accordance with the Hemyc ERFBS test plan (see ADAMS Accession No. ML043210141 for a preliminary version of the test plan). The test plan provides

a detailed discussion of the assemblies and the thermocouple positions. The Hemyc ERFBS tests were performed for a period of 60-minutes each, followed by a hose stream test and post-test visual inspection of the ERFBS.

A bare No. 8 stranded copper conductor, instrumented with thermocouples every 6 inches along its length, was routed through each of the conduit and cable tray test specimens. Additional thermocouples were mechanically attached to the outer surfaces of the conduit test specimens and along the length of both side rails of the cable tray test specimens at 6-inch intervals. All results in Attachment 1 refer to the additional thermocouples attached to the outer surfaces of the conduits and cable trays unless otherwise stated.

Shrinkage of the Outer Covering

The Hemyc ERFBS is constructed of Hemyc mats consisting of Kaowool insulation inside an outer covering of Siltemp high-temperature fabric. The mats are machine-stitched at the factory to fit each electrical raceway installation. Hemyc mats that are directly wrapped around the electrical raceway use 2-inch-thick Kaowool. Hemyc mats that are installed over spaced frames to provide a 2-inch air gap between the Hemyc and the electrical raceway (for cable tray protection) use 1½-inch-thick Kaowool.

While Siltemp is a frequently used descriptor for the outer covering, and thus is used generically in this information notice, the material originally known as Siltemp is not now available commercially. The Promatec vendor manual references either Siltemp, Refrasil, or Alpha 600 as equivalent materials for the outer covering of the Hemyc ERFBS mats. This testing used the Refrasil brand fabric. The term “Siltemp” is most commonly used in the nuclear industry to describe the outer covering fabric of the Hemyc ERFBS mats. The NRC’s preliminary testing indicates that the material density, thickness, and fabric weave are identical for both Siltemp and Refrasil.

During the fire testing, the outer layer of Siltemp consistently showed thermal shrinkage and change of color from tan to white. This shrinkage led to some gaps opening between the Hemyc ERFBS mats. NRC’s preliminary findings indicate that the color change and shrinkage of both Siltemp and Refrasil materials are spatially uniform. Based on preliminary testing both Siltemp and Refrasil shrink approximately 8 percent during the ASTM E 119 furnace exposure.

Opening of the Joints

This testing examined the four most common methods of joining the Hemyc material into a complete ERFBS: (1) using stitched joints, (2) using minimum 6-inch collars over a joint, (3) using minimum 2-inch overlapping of the mats, and (4) using through bolts with fender washers. The Siltemp shrinkage led to the opening of each of the joint systems, which exposed the assembly (conduit, cable tray, junction box, air drop cable) to the furnace environment. For method (1), the shrinkage led to the seams being torn open. For method (2), the mats also experienced shrinkage, causing openings in the Hemyc ERFBS. It appeared that the 6-inch collar contracted and moved with one side of the material. For method (3), the 2-inch overlapping joints also opened. For method (4), the through-bolting of the Hemyc mats on the cable tray designs using the 2-inch air gap appeared to provide the most robust resistance to Siltemp shrinkage. However, due to this rigid fixed mounting of the Hemyc mats, the Siltemp

experienced tearing of the machine sewn seams and tearing of the Siltemp fabric. All but one assembly (conduit or cable tray) experienced temperatures capable of damaging plant cables (Reference 4).

Supports and Intervening Item Protection

With only the 3-inch thick Kaowool protection on supports as required by the vendor manual, the single point temperature rise of 325 °F was exceeded in 13 to 32 minutes. To prevent corruption of the thermal measurement data for the raceways because of potential thermal short-circuiting from structural supports, this program did not test the raceway and the structural supports together. Intervening metallic items would also be expected to permit the same temperature rise.

Significance of Results

The significance of the test results is that the Hemyc ERFBS did not perform for one hour as designed. Observations made during the testing, such as mat shrinkage and thermal shorts through the support protection, were not identified during previous testing of the material. Consequently, the Hemyc ERFBS does not provide the level of protection expected for a rated 1-hour fire barrier.

CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contact(s) listed below or the appropriate NRR project manager.

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Attachment 1: Hemyc 1-Hour Fire-Rated Test Results

Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under Electronic Reading Room/Document Collections.

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References:

1. Title 10 of the Code of Federal Regulations, Part 50, Appendix R, Section III.G.2

2. NRC Inspection Report 50-400/1999-13 (ADAMS Accession No. ML003685341); NRC Inspection Reports 50-369/2000-09 and 50-370/2000-09 (ADAMS Accession No. ML003778709)

3. NRR Response to Task Interface Agreement (TIA) 99-028, “Shearon Harris Nuclear Power Plant, Unit 1 - Resolution of Pilot Fire Protection Inspection Fire Barrier Qualification Issues,” dated August 1, 2000 (ADAMS Accession No. ML003736721)

4. Inspection Manual Chapter 0609, Appendix F, Fire Protection Significance Determination Process, Attachment 7, page F7-2

Hemyc 1-Hour Fire-Rated Test Results
Conduit , Supports & Junction Box

Raceway	Time to $\Delta T_{ave} \geq 250^{o}F$ (minutes)	Time to Single Point $\Delta T > 325^{o}F$ (minutes)	Max. Temp. Bare #8 @ 1 hour[1] (^{o}F)	Joint Opening[2] Yes/No
1" Conduit (1E) (Empty)	46	42	1013	Yes
1" Conduit (1F) 1.02 lb./linear foot (lin.ft.) Cable Fill	44	34	1177	Yes
2 ½ " Conduit (1C) (Empty)	48	41	709	Yes
2 ½ " Conduit (1D) 5.85 lb./lin.ft. Cable Fill	51	38	446	Yes
4" Conduit (1A) (Empty)	49	33	865	Yes
4" Conduit (1B) 14.84 lb./lin.ft. Cable Fill	57	43	199	Yes
Junction Box 18” x 24” x 8”	17	15	NA	Yes
Unistrut Support[3]	NA	22 - 32	NA	NA
2" Tube Steel Support[3]	NA	13 - 25	NA	NA

Hemyc 1-Hour Fire-Rated Test Results
Cable Tray, Junction Box, & Airdrop

Raceway	Right Side Tray Rail $\Delta T_{ave} \geq 250^{o}F$ (minutes)	Right Side Tray Rail Single Point $\Delta T > 325^{o}F$ (minutes)	Left Side Tray Rail $\Delta T_{ave} \geq 250^{o}F$ (minutes)	Left Side Tray Rail Single Point $\Delta T > 325^{o}F$ (minutes)	Bare #8 $\Delta T_{ave} \geq 250^{o}F$ (minutes)	Bare #8 Single Point $\Delta T > 325^{o}F$ (minutes)	Bare #8 Max. Temp. @ 1 hour (^{o}F)	Joint Opening[2] Yes/No
12" Cable Tray Empty, (2A) Direct Attachment	36	34	27	18	32	32	1260	Yes
12" Cable Tray Empty, (2B) 2" Air Gap	37	35	38	35	33	34	1002	Yes
36" Cable Tray Empty, (2C) Direct Attachment	41	39	34	33	35	35	1330	Yes
36" Cable Tray Empty, (2D) 2" Air Gap	32	31	33	32	28	27	1117	Yes
Air Drop, (2E) Direct Attachment	NA	NA	NA	NA	35	32	1712	Yes
Air Drop, (2F) 2" Air Gap	NA	NA	NA	NA	32	28	1411	Yes
18” x24” x 8”Junction Box,(2G) Direct Attachment with Bands[4]	31	32	NA	NA	NA	NA	NA	Yes

Notes:

1. The temperatures recorded on the Bare No. 8 conductor may not be indicative of the actual temperature inside the assembly for two reasons. First, to insure the integrity of the thermocouple's jacket and insulation during installation, the instrumented Bare No. 8 conductor was located in the center of the cable; therefore it may not have been exposed to the highest temperature within the conduit. The second reason was that the joints opened during the testing, producing local hot spots on the interior of the raceway that may or may not have been picked up by the Bare No. 8 conductor.

2. All Hemyc ERFBSs experienced some thermal shrinkage of the outer Siltemp covering. As a result, some joints opened and exposed the conduits or cable trays to the furnace environment at various points during the test.

3. The time provided for the structural supports was determined to be the time when the single point temperature rise (ΔT) exceeded 325 ^{o}F at a distance 3 inches into the Hemyc insulation protecting the structural steel. Three inches is the minimum structural support protection recommended in the vendor manual.

4. The junction box average temperature is the average across all thermocouples mounted on the outside of the box's surface. The single-point temperature is also measured on the external surface of the junction box.