UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

May 26, 1993

NRC INFORMATION NOTICE 93-40: FIRE ENDURANCE TEST RESULTS FOR THERMAL CERAMICS FP-60 FIRE BARRIER MATERIAL

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to results of fire endurance and ampacity derating test reports submitted by Thermal Ceramics on the FireMaster FP-60 fire barrier system and the results of NRC staff reviews. 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.

Description of Circumstances

In Generic Letter (GL) 92-08, "Thermo-Lag 330-1 Fire Barriers," the staff stated it would evaluate other known fire barrier materials and systems that are used by licensees to fulfill NRC fire protection requirements. The staff is now evaluating fire barriers manufactured by other vendors to verify the ability of the barriers to adequately perform their 1-hour or 3-hour fire resistive functions and to meet stated ampacity derating values. Thermal Ceramics, Inc., formerly the Insulating Products Division of Babcock and Wilcox, Inc., of Augusta, Georgia, manufactures the FP-60 fire barrier system and submitted reports on two fire endurance tests and one ampacity derating test to the NRC in a letter of February 23, 1993.

Discussion

In its review of the Thermal Ceramics reports, the staff identified the following information.

In its product literature, Thermal Ceramics states that the FP-60 product is manufactured for use on cable trays, conduits, junction boxes, and other cable raceways. The primary component, the FireMaster FP-60 blanket, is a ceramic fiber blanket with thicknesses varying from 2.5 cm [1 inch] to 7.6 cm [3 inches]. Optional aluminum or stainless steel foil, Kao-Tex (woven cloth), or other cloth facings are provided for physical protection of the blanket. The vendor claims that the material, when installed according to the instructions, is qualified for up to a 1½-hour fire rating using the American

Society for Testing and Materials (ASTM) Standard E-119, "Standard Test Methods for Fire Tests of Building Construction and Materials."

FIRE ENDURANCE TESTS

According to one report submitted by Thermal Ceramics, a 1-hour fire endurance test of the FP-60 fire barrier in various configurations was performed at Underwriters Laboratories, Inc. (UL File R11044-1, Project 84NK8356, March 22, 1985). The test followed UL Subject 1724, "Outline of Investigation, Fire Tests for Electrical Circuit Protective Systems," May 1984. According to the report, the furnace temperatures followed the ASTM E-119 standard time-temperature curve for fire exposure, and the barriers were subjected to a solid hose stream test. The report also states that circuit integrity was monitored.

Documented test configurations included 91.4 cm [36 inch] wide open-ladder and solid-back steel cable trays, an air drop assembly, 12.7 cm [5 inch] diameter steel conduits, and a 30.5x15.2 cm [12x6 inch] steel junction box. All configurations contained cables. Two hundred fifty thermocouples were reportedly used to measure temperatures of cables, cable trays, junction boxes, conduits and electrical circuit protective systems on the unexposed side of the assembly.

According to the report, within 30 seconds of the start of the test, the filament tape around the blanket wrap ignited. At 5 minutes, flames reportedly issued from seams and butt joints. The report also states that at 20 minutes, some of the wrap slipped out of position resulting in an opening in the barrier, and at 60 minutes, there was a 8.9 cm [3½ inch] opening in the barrier. Some thermocouple measurements reportedly ranged from 204 °C [400 °F] to 260 °C [500 °F] at the end of the fire test.

After the test, some cables were documented to be fused together, and cable jackets were melted and blistered. The hose stream eroded the bottom surface of the cable tray barrier so that the tray was exposed.

The UL report concluded that the tested fire barrier had a 1-hour fire rating because circuit integrity was maintained during the fire exposure and hose stream test. However, it appears that the UL approval is limited to minimum 91.4 cm [36 inch] wide cable trays and 12.7 cm [5 inch] or larger-diameter conduits with minimum No. 16 AWG jacketed multi-conductor cables or minimum No. 300 MCM jacketed copper single conductor power cables with polyvinyl chloride jackets.

The second fire endurance test report submitted by Thermal Ceramics documented a Southwest Research Institute small-scale test, "One Hour Fire Qualification Test of a Protective Envelope for Class 1E Electrical Conduit Circuits," (SwRI Project 01-8305-053, February 1986). According to this report, the test employed the ASTM E-119 standard time-temperature curve for fire exposure and a subsequent solid hose stream test. The report also states that circuit integrity was monitored. SwRI documented the use of a small-scale furnace (maximum test specimen of 425.8 square cm [66 square inches]) to test a 2.5 cm [1 inch] diameter conduit with a pull box, a 5.1 cm [2 inch] diameter conduit with a junction box, and an air drop. According to the report, these

test assemblies each contained a single-conductor power cable and two control cables, all with PVC jackets.

Recorded cable temperatures (measured at the cable jackets) at the end of the fire exposure ranged from 146.5 °C [296 °F] to 164 °C [327 °F]. According to the report, circuit integrity was maintained during the fire exposure and hose stream tests.

The barrier and cable conditions after the fire exposure were not reported. The test report suggests that the hose stream test caused some barrier damage, although the test report did not clearly report the extent of damage. SwRI did not report a conclusion as to the acceptability of the fire barrier system.

In a letter of April 27, 1993 to Thermal Ceramics, Inc., the staff expressed concerns regarding the ability of the FP-60 system to meet existing NRC fire barrier acceptance criteria.

AMPACITY DERATING TEST

The ampacity derating test report submitted by Thermal Ceramics was SwRI Project 01-8818-210, "Ampacity Derating of Fire-Protected Cables in Conduit and Cable Trays Using Babcock & Wilcox, Incorporated's Passive Fire Protection System," issued by SwRI on July 8, 1986. According to the report, a 1-hour fire barrier was used in the test. Three-conductor XLPE-insulated 6 AWG cables with Hypalon protective wraps were reportedly installed in a 61 cm [24 inch] wide by 10.2 cm [4 inch] deep cable tray, and 3-conductor XLPE-insulated 3 AWG cables with Hypalon protective wraps were installed in a 10.2 cm [4 inch] diameter conduit. Both assemblies were reported to be 3.7 m [12 feet] long and completely filled. The report stated that thermocouples were installed in slits in the cable insulation.

According to the report, a steady-state temperature of 90 °C (194 °F) at the hottest single thermocouple was monitored. Equilibrium temperature was reportedly established when a steady-state condition ($\pm$1 °C per hour [$\pm$1.8 °F per hour]) was achieved for 3 hours without any perturbation to the system.

The ampacity derating for the cable tray and conduit was estimated to be 62.4 and 41.4 percent, respectively, based on the test results.

Some licensees use the FP-60 fire barrier system to achieve physical independence of electrical systems in accordance with Regulatory Guide 1.75, "Physical Independence of Electrical Systems." Ampacity derating in fire barrier systems installed to achieve physical independence of electric systems is a consideration in the design of such systems as well as in those installed to protect safe shutdown capability from a fire.

Cables enclosed in electrical raceways protected with fire barrier materials are derated to ensure that systems have sufficient capacity and capability to perform their intended safety functions. These cables are derated because of the insulating effect of the fire barrier material. Other factors that affect ampacity derating include cable fill, cable loading, cable type, raceway construction, and ambient temperature.

Cable derating calculations that are based on inaccurate or nonconservative derating factors could result in installation of undersized cables or raceway overfilling. This could cause operating temperatures to exceed design limits within the raceways thereby reducing the expected design life of the cables.

In the letter to Thermal Ceramics, Inc., of April 27, 1993, the staff requested additional information on ampacity derating.

The National Electrical Code, Insulated Cable Engineers Association (ICEA) publications, and other industry standards provide general ampacity derating factors for open-air installations but do not include derating factors for fire barrier systems. The Insulated Conductors Committee of the IEEE Power Engineering Society, Task Force 12-45, has been developing IEEE Standard Procedure P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables," for use as an industry standard. The industry consensus standard development process may formulate an appropriate technical approach to the determination of ampacity derating factors for cables enclosed by fire barrier systems.

The staff is continuing to review this product for its ability to perform its fire resistive function and will evaluate whether further generic communications are needed to address the issues discussed above.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contact: Isabel M. Miller, NRR
(301) 504-2852

Attachment:
List of Recently Issued Information Notices

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Original signed by
Brian K. Grimes

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*See previous concurrence

*SPLB:DSSA IMiller 05/06/93	*SPLB:DSSA SWest 05/06/93	*TechEd DGable 05/10/93
*SPLB:DSSA CMcCracken 5/20/93	*OGC JGoldberg 5/20/93	*DE:EELB CBerlinger 05/25/93
*DD:DSSA MVirgilio 05/25/93	*D:DSSA AThadani 05/25/93	*OGCB:DORS GMarcus 05/25/93

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BGrimes
5/26/93

DOCUMENT NAME: 93-40.IN

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Originator: Isabel Miller

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This information notice requires no specific action or written response. The staff is continuing to review this product for its ability to perform its fire resistive function and will take further action if appropriate. Licensees are advised to consider this information when contemplating any changes to their current fire protection program. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Originator: Isabel Miller

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Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contact: K. Steven West, NRR
(301) 504-1220

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SPLB:DSSA IMiller / /93	SPLB:DSSA SWest / /93	TechEd D Hall ~~RSanders~~ 5/10/93	
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Technical contact: K. Steven West, NRR
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LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
93-39	Radiation Beams from Power Reactor Biological Shields	05/25/93	All holders of OLs or CPs for nuclear power reactors.
93-38	Inadequate Testing of Engineered Safety Features Actuation System	05/24/93	All holders of OLs or CPs for nuclear power reactors.
93-37	Eyebolts with Indeterminate Properties Installed in Limitorque Valve Operator Housing Covers	05/19/93	All holders of OLs or CPs for nuclear power reactors.
93-36	Notifications, Reports, and Records of Misadministrations	05/07/93	All U.S. Nuclear Regulatory Commission medical licensees.
93-35	Insights from Common-Cause Failure Events	05/12/93	All holders of OLs or CPs for nuclear power plants (NPPs).
93-34, Supp. 1	Potential for Loss of Emergency Cooling Function Due to A Combination of Operational and Post-Loca Debris in Containment	05/06/93	All holders of OLs or CPs for nuclear power reactors.
93-34	Potential for Loss of Emergency Cooling Function Due to A Combination of Operational and Post-Loca Debris in Containment	04/26/93	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit