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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

EXEMPTION RELATED TO 10 CFR PART 50, APPENDIX R, SECTION III.G.2.c

FIRE PROTECTION OF SAFE-SHUTDOWN CAPABILITY

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

DOCKET NO. 50-271

1.0 INTRODUCTION

By letter dated May 28, 1996, as supplemented by letters dated July 26 and November 15, 1996, Vermont Yankee Nuclear Power Corporation (the licensee) requested exemption from the requirements of Section III.G of Appendix R to 10 CFR Part 50 to the extent that it specifies the separation of certain redundant safe-shutdown circuits with fire-rated barriers. Alternatively, the licensee proposes to use Rockbestos Firezone R Appendix R cables in the cable vault area of the Reactor Building (elevation 280 feet).

2.0 DISCUSSION

2.1 Exemption Request

2.1.1 Licensee's Basis for Requesting the Exemption

Paragraph 2.c of Section III.G, "Fire Protection of Safe Shutdown Capability," of Appendix R to 10 CFR Part 50 requires the following:

> Enclosure of cable and equipment and associated non-safety circuits of one redundant train in a fire barrier having a 1-hour fire rating. In addition, fire detectors and an automatic fire suppression system shall be installed in the fire area.

The licensee requested an exemption from these requirements to allow the use of fire-resistant cables instead of enclosing the cables in fire barriers having a 1-hour fire resistance rating. The licensee proposed to use Rockbestos Firezone R Appendix R fireproof cable to control equipment that is necessary to ensure cooling of the corner room of the Reactor Building in the event of a fire in the cable vault. An exemption is needed because the Firezone R cables do not meet the literal requirements of the regulation.

2.1.2 Evaluation

The cable vault and the control room constitute a separate fire area contained within the control building. The cable vault contains instrumentation, control, and power cables in cable trays and conduits that are relied upon for safe shutdown of the plant. The fire loading consists predominantly of cable insulation in cable trays. Alternative shutdown capability is provided to ensure safe shutdown in the event of a fire in the cable vault.

Access to the cable vault is controlled by key card, and the cable vault is not part of a normal travel route to any other plant location. The cable vault is designated a Fire Control Area in accordance with the licensee's administrative procedures. A Fire Control Area requires a Fire Protection Control Permit for introduction of significant quantities of combustible or flammable materials into the area. A Fire Control Area also requires a Hot Work Control Permit for any hot work activity in the area.

Fire protection features in the cable vault are provided in accordance with defense-in-depth principles and Section III.G of Appendix R. The cable vault is provided with full area detection system coverage (27 ionization detectors mounted at ceiling level) that would detect a postulated fire in its incipient stages. Activation of a single detector transmits an alarm to the control room and sounds an alarm outside the cable vault. Activation of a second detector initiates an evacuation alarm inside the cable vault and a 75-second timer before discharge of the total flooding CO_2 extinguishing system. The CO_2 system can be manually activated from outside the main entrance door to the cable vault. A manually activated 100-percent reserve capability is also provided through a cross-connect with the west switchgear room system. Control room alarms resulting from automatic or manual detection or activation of the CO_2 suppression system will result in a fire brigade response. Portable extinguishers are located in the cable vault, and a hose station is located outside the northwest entrance door to the cable vault, for manual fire-fighting purposes.

The cables of concern consist of four stainless steel sheathed cables. The cables, which are grouped together throughout their run in the cable vault, enter through the floor of the cable vault along the east wall. The cables rise vertically about 6 feet, travel 45 feet horizontally to the south wall of the cable vault, and enter the Reactor Building through a block-out. The cables are located between 16 and 30 inches below the ceiling throughout the horizontal run. The cables are attached to 12-gauge light metal framing members and associated hardware (i.e., unistrut type). Two supports, bolted directly to the east wall of the cable vault, are used in the vertical portion of the cable run. Eleven supports, spaced about 4 to 5 feet apart, are used in the horizontal portion of the run, with the cables attached to the top of short, horizontal members. The horizontal sections are bolted to vertical framing members that are attached to the floor, ceiling, or overhead conduits. Three of the vertical supports are bolted directly to the ceiling above. Four of the vertical supports are attached to conduits, and the conduits are attached to the ceiling by 3/8 inch (minimum) diameter threaded rods and concrete inserts. Three of the vertical supports also form part of the support system for the floor-to-ceiling cable trays that run parallel to and below the fire-resistant cables. The three vertical supports that form the part of the cable tray support system (described below) are bolted to the floor, with one of the supports also bolted to the ceiling. One support is framed into the block-out where the cables penetrate through the south wall of the cable vault.

The floor-to-ceiling cable tray system running parallel to and under the fire-resistant cables is supported by a total of nine vertical 12-gauge light metal framing members, spaced about 4 feet to 5 feet apart, on both sides of the tray system. Horizontal supports, provided underneath each cable tray, are bolted to the vertical members. The vertical members are all bolted to the floor and most are bolted to the ceiling. Fire-rated barriers are not required for any of the cables in the cable trays running parallel to the fire-resistant cables.

Each of the four cables involved in the exemption request is a two-conductor (2/C) #14 American Wire Gauge (AWG) Firezone R cable with a stainless steel sheath and is used for connecting an electrical load requiring a nominal 120 Vac with a nominal current of between 0 and 1.3 amperes. The Firezone cables addressed in the test report by Underwriters Laboratories, Inc. (UL), included a three-conductor (3/C) #14 AWG cable. The 2/C cable is identical to the 3/C cable in critical fire protection attributes. Cable jacket construction for the 2/C and 3/C #14 AWG cables is the same, including flame-retardant binder tape, glass braid covering, and a continuously welded corrugated stainless steel sheath. Conductor construction for the two cables is the same, including conductor size, composite inorganic layer fire barrier, silicone rubber insulation, mica tape and glass braid conductor covering with a high-temperature finish, conductor-to-conductor spacing, and conductor-to-cable jacket spacing. In order for the licensee to come into compliance with the regulations, the cables in question would have to be provided with a 1-hour fire barrier for their entire run, a distance of 51 feet. The fire-resistant cable is already installed in the cable vault, thus, the licensee wishes to take credit for the cable.

The Rockbestos Firezone R Appendix R fireproof cable has been tested by UL in order to provide data on the electrical characteristics of the fire-resistant cable under controlled fire exposure conditions and during an extended cool down period. The testing program, which is documented in the UL Report on Fire Resistant Cables, File R10925-1, dated April 10, 1984, investigated fire-resistant electrical cables installed in trays, conduits, and air drops beneath a floor/ceiling assembly. The 3/C #14 AWG tested cable was subjected to a 1-hour fire endurance test, with the furnace temperature controlled in accordance with the American Society for Testing and Materials (ASTM) Standard E-119, "Standard Test Methods for Fire Tests of Building Construction and Materials." Immediately before beginning this test, the 3/C #14 AWG tested cable was connected to a three-phase power supply adjusted to provide three-phase wye voltages of 480/277 Vac. Each conductor in the cable remained energized with a steady-state current of about 4 amperes throughout the fire endurance test, except for a 10-second period immediately preceding an inrush current test of approximately 17 amperes. Following the endurance test, the 3/C tested cable was de-energized and subjected to a water hose stream test. This test was followed by re-energizing with steady-state electrical currents throughout a 93-hour cooldown period, except for a 10-second period just before the application of four supplemental inrush current tests. Subsequently, the 3/C tested cable was subjected to a second hose stream test, followed by a final inrush current test. The 3/C #14 AWG tested cable was monitored continuously for electrical faults during the endurance test and an automatic data logger scanned each circuit and provided a printed record to show electrical faults. Analysis of this printed record concluded that no electrical faults occurred. Furthermore, analyses of the measured values recorded for electrical currents, insulation resistances, and dielectric withstand voltages provide additional evidence that the 3/C #14 AWG tested cable remained electrically functional during the 1-hour fire endurance test and during the extended cooldown period.

The tested configuration for the 3/C #14 AWG tested cable is as severe as the installed 2/C #14 AWG cables at Vermont Yankee since the installed 2/C cables are routed outside of cable trays away from non-fire-resistant electrical cables. The tested 3/C cable was placed in a cable tray assembly to simulate the fire loading of an actual installation and was therefore subjected to additional exposure of ignited non-fire-resistant cables. As previously noted, the tested configuration remained functional throughout the test in that the electrical current values were maintained.

The staff was concerned that a fire could directly damage the cables or damage structures surrounding and/or supporting the cables, which could possibly damage the cables themselves. This occurrence could affect the licensee's ability to achieve and maintain a post-fire safe shutdown capability.

Postulated fires in the cable vault would involve cable insulation in the cable tray system. Such a fire would develop slowly and generate a significant amount of smoke in the early stages of the fire. Reasonable assurance is therefore provided that postulated fires in the cable vault would be detected in the incipient stages, with actuation of the total flooding CO_2 suppression system to extinguish the fire. The fire brigade would respond to the cable vault upon receipt of an alarm in the control room to begin manual fire fighting activities as required. On the basis of the automatic detection and suppression systems provided for the area, and fire brigade response for manual fire-fighting activities, there is reasonable assurance that postulated fires in the cable vault would be detected, controlled, and extinguished before temperatures would rise to a level that could challenge the structural support capabilities of the fire-resistant cables, the cable tray network, or the overhead conduit. In addition, the staff questioned whether the cables as they were installed were bounded by the UL fire test, which was used to justify the 1-hour rating of the cables. Pursuant to this discussion and on the bases of the same cable construction for the tested and installed cables, the ASTM E119 test results for the 3/C #14 AWG Firezone R cable as contained in the UL report, and the installed and tested configurations for the cables, the staff concludes that the electrical functionality of the installed 2/C Firezone R cables is equivalent to that functionality tested in the UL fire test. Further, the staff concludes that the installed Firezone R cables provide an electrical functionality equivalent to that provided by enclosing cables in a 1-hour fire-rated barrier in the licensee's specific application.

As part of its evaluation, the staff reviewed similar exemption and deviation requests and found that it had previously approved the use of Firezone R cable by a licensee in lieu of 1-hour fire-rated barriers at other facilities.

On the basis of its evaluation, the staff concluded that the Firezone R cables proposed by the licensee will remain functional during postulated fires at Vermont Yankee and, therefore, postulated fires would not prevent plant operators from achieving and maintaining safe shutdown. The staff concluded, therefore, that the use of the Firezone R cables at Vermont Yankee in lieu of a 1-hour fire-rated barrier satisfies the underlying purpose of Section III.G.2.c of Appendix R to 10 CFR Part 50, which is to establish fire protection features such that the plant will maintain the ability to perform safe shutdown functions in the event of a fire.

3.0 CONCLUSION

The staff concludes that the requested exemption from the requirements of 10 CFR Part 50, Appendix R, Section III.G.2.c, is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Application of the regulation in these circumstances is not necessary to achieve the underlying purpose of the rule. Therefore the exemption is approved.

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Date: June 9, 1997