FAQ Number 06-0022 **FAQ Revision** 3

FAQ Title Acceptable Electrical Cable Construction Tests

Plant: Arkansas Nuclear One Date: March 16, 2009

Contact: Ronnie Hendrix Phone: 479-858-5552

Email: rhendri@entergy.com

Distribution: *(NEI Internal Use)*

☒ 805 TF ☐ FPWG ☐ RATF ☐ RIRWG ☐ BWROG ☐ PWROG

Purpose of FAQ:

To provide a list of flame propagation tests for electrical cables that are acceptable to the AHJ.

Is this Interpretation of guidance? Yes / No

Proposed new guidance not in NEI 04-02? Yes / No

Details:

NEI 04-02 guidance needing interpretation (include section, paragraph, and line numbers as applicable):

NEI 04-02, Section 4.3.1, Fundamental Fire Protection Program and Design Elements Transition Review, should refer to a new appendix which lists interpretation of specific sections of NFPA 805 Chapter 3

Circumstances requiring guidance interpretation or new guidance:

Section 3.3.5.3 of NFPA 805 requires that electric cable construction comply with a flame propagation test acceptable to the AHJ and that it be a type that has been tested using a recognized flame spread test such as IEEE 817 or IEEE 1202. The industry requires clarification as to what flame propagation tests are acceptable to the NRC.

Detail contentious points if licensee and NRC have not reached consensus on the facts and circumstances:

None

Potentially relevant existing FAQ numbers:

FAQ Number	**06-0022**	**FAQ Revision**	**3**
FAQ Title	**Acceptable Electrical Cable Construction Tests**		

None

Response Section:

Proposed resolution of FAQ and the basis for the proposal:

Based on the NRC response to Revision 1 of FAQ 06-0022 (ML072740236), the NRC's technical evaluation entitled "Response to NRR FAQ 06-0022 Guidance on Standards and Flame Propagation Tests" (ML07205022) will be incorporated into the NEI 04-02, Appendix K NFPA 805 Chapter 3 Clarifications.

Revision 2 of FAQ 06-0022 was submitted on 10/23/08 (ML083010053).

Subsequently, Revision 3 to FAQ 06-0022 is being submitted to address editorial and formatting comments relative to Revision 2.

If appropriate, provide proposed rewording of guidance for inclusion in the next Revision to NEI 04-02:

Include the following specific clarification to NFPA 805, Chapter 3.3.5.3:

Appendix K NFPA 805 Section 3.3.5.3 (FAQ 06-0022)

Purpose

The purpose of this Appendix is to evaluate currently recognized flame propagation tests to the IEEE 383-1974 Standard, the US NRC minimum test standard, and acceptance criteria for cable flame propagation tests.

References

US Nuclear Regulatory Commission Documents

1. Regulatory Guide 1.189 “Fire Protection for Nuclear Power Plants”; March 2007; Rev 1
2. NUREG-0800 “Standard Review Plan Sec 9.5.1: Fire Protection System”; October 2003; Rev 4, (Formerly NUREG-75/087 March 1979)
3. “Guidelines for Fire Protection for Nuclear Power Plants”; Branch Technical Position ASB 9.5-1; May 1976
4. “Guidelines for Fire Protection for Nuclear Power Plants”; Branch Technical Position ASB 9.5-1; Rev 1; March 1978
5. “Recommended Fire Protection Policy and Program Actions” (GL 85-01); October 26, 1984
6. “NRC Positions on Certain Requirements of Appendix R to 10CFR50” (GL 83-33); October 1983

Internet & Cable Companies Resources

7. “Anixter Wire & Cable Handbook”; Wire & Cable Group Anixter Inc; 3rd Ed; 1996
8. “Fire Tests”; Anixter File F-3; Wire & Cable Group Anixter Inc; August 2000
9. “UL Wire & Cable Flammability Testing”; Underwriters Laboratories Inc; www.ul.com/fire/wire.html
10. “Vertical Cable Tray Flame Tests”; Nexans Canada Inc; www.nexans.ca/egy/tecdoc/9.htm
11. “Belden Standards Reference Guide”; Belden Inc; www.belden.com
12. “UL Flame Test Descriptions”; Huber Suhner Group; www.hubersuhner.com
13. “Cable Flame Tests”; Houston Wire & Cable Company; www.houwire.com
14. “Cable Fire Tests”; Presentation by Marcelo M. Hirscher; GBH International; www.fire.tc.faa.gov and http://155.178.136.36/ppt/materials/CableFireTests.ppt
15. “Plenum Cable: Proven Safety & Performance”; Presentation by Carson W.G. and Zicherman J.B.; The Vinyl Institute; http://www.vinylinfo.org/

Industry Standards

16. “NFPA 805: Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants”; 2001 Edition

Abbreviations & Definitions:

AHJ: Authority Having Jurisdiction

ASTM: American Society for Testing and Materials

CSA: Canadian Standards Association

ICEA: Insulated Cable Engineers Association

IEC: International Electrotechnical Commission

IEEE: Institute of Electrical and Electronics Engineers

FM: Factory Mutual Global

NFPA: National Fire Protection Association

TC: Thermocouple

UL: Underwriters Laboratories

US NRC: United States Nuclear Regulatory Commission

Heat exposure or burner heat output: Theoretical heat release rate of the burner.

Heat exposed time (het): Total time the flame is applied to the sample

Max average damage length (adl): Max or acceptable damage length of the test

Discussion & Analysis

Several NRC documents cited in this section include the requirements for flame propagation for existing or new electrical cables. In general, these documents refer to the IEEE 383-1974 and/or IEEE 1202-1991 flame tests as the NRC accepted test standards for flame propagation. Below is a list of NRC related documents that cite IEEE 383-1974 test as minimum acceptance requirements for flame propagation. Even though these documents may apply to Nuclear Power Plants constructed during different time periods, the standard flame propagation tests accepted to the US NRC are still basically the same.

NFPA 805, 2001 Edition, Section 3.3.5.3 states that "*electric cable construction shall comply with a flame propagation test as acceptable to the AHJ (Authority Having Jurisdiction)",* which in the US Nuclear Industry is the United States Nuclear Regulatory Commission (US NRC). Below are the US NRC documents which refer to the flame propagation test acceptable to the AHJ.

NUREG-0800, Rev 4, Oct 2003, states that "*Electrical cables should meet flame test criteria of IEEE 383 or 1202, or be provided with alternative protection as allowed by the specific plant licensing and/or design basis (See Regulatory Guide 1.189)".*

Appendix A to Branch Technical Position (BTP) APCSB 9.5-1 states that "*electric cable constructions should, as a minimum, pass the flame test in the current IEEE 383*". It also states that "*for cable installation in operating plants and plants under construction that do not meet the IEEE 383 flame test requirements, all cables must be covered with an approved flame retardant coating and properly derated*".

Reg Guide 1.189, Rev 1, Mar 2007, states that *"Electric cable construction should pass the flame test in IEEE Standard 383, "IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations" (Ref. 109), or IEEE Standard 1202, "IEEE Standard for Flame Testing of Cables for Use in Cable Trays in Industrial and Commercial Occupancies" (Ref. 110). (This does not imply that cables passing either test will not require additional fire protection.) For cable installations in operating plants and plants under construction before July 1, 1976 that do not meet the IEEE Standard 383 flame test requirements, all cables should be covered with an approved flame-retardant coating and properly derated or be protected by automatic suppression. Although cable coatings have been shown to reduce flame spread, coated cables are considered intervening combustibles when determining the protection requirements of Section III.G.2 of Appendix R to 10 CFR Part 50. Coated cables do not have higher damage thresholds and, therefore, are not equivalent to IEEE 383 or IEEE 1202 cables. In addition, coated cables can and do ignite in fires*".

The data and discussion presented in this report on flame propagation tests compare theoretical burner heat output, heat exposure time, and pass/fail criteria to determine the relative severity of the test standards. Each test was reviewed and compared to the vertical flame propagation test in the IEEE 383-1974 as a baseline to determine if testing conditions and/or passing criteria are comparable. Tests with lower burner heat outputs than the IEEE 383-1974 standard are very difficult to compare due to the difference in test sample size. These low heat exposure tests will be discussed but will not be directly compared to IEEE 383-1974. Below is a brief discussion of each flame test starting with the IEEE 383-1974 Flame Propagation Test (Baseline test) and followed by flame spread tests ranked in decreasing order of severity.

Note: A flame propagation test procedure in one Standard could be included or referenced in another standard. This does not mean the two standards are the same; it means that the standard uses the same testing procedure for flame propagation testing. A standard might have other sections which have nothing to do with flame propagation like smoke and aging test procedures, materials of construction, markings, or other procedures and requirements. For this reason, the data was organized in terms of flame tests instead of individual Standards.

Test Ranking and Description

IEEE 383-1974 is the baseline test to which the other tests will be compared. It is a 20 kW (70000 BTU/hr) heat exposure, vertical test considered the minimum requirement of the US NRC to pass flame propagation criteria. As in all the 20 kW (70000 BTU/hr) tests discussed below, it has a 20 minute exposure time. This test requires cables to self extinguish before reaching top of the tray (8 ft, 2.44 m) to pass the test.

One of the most severe flame tests is the FT-6 Horizontal Flame Test included in the NFPA 262 and CSA C22.2 No. 0.3 standards. It is a horizontal flame test used for cables in plenum applications and uses a burner heat output of 86 kW (294000 BTU/hr). This test has one of the lowest acceptable damage lengths, the second highest heat output, and uses high air flow in its chamber during testing to increase flame spread. This combination of variables makes it one of the most rigorous tests for a sample to pass. This is currently considered the most severe flame test.

The UL1666 Fire Riser Test is another of the more severe flame tests. It is a vertical test used for cables in riser shaft applications. It has the highest heat output of all the tests (154.5 kW, 527500 Btu/hr), second highest exposure time (30 minutes) and high air flow in its chamber during testing. This test has an acceptable cable damage length of 12 ft (3.66 m). Even though the damage criteria is less severe than the IEEE 383-1974 (12 ft vs. 8 ft), the higher exposed heat and time makes this test more severe.

The FT-4/Vertical Flame Test, included in standards IEEE 1202-1991, CSA C22.2 No. 0.3, UL 1685, and referenced in UL 1581, UL 44, and UL 83, is the most rigorous of the 20 kW (70000 BTU/hr) tests. The testing conditions and equipment in all of the 20 kW (70000 BTU/hr) tests are essentially the same. What makes this test the most difficult to pass of the 20 kW (70000 BTU/hr) tests is its low acceptable damage length of 4.9 ft (1.5 m).

The IEEE 383-2003 standard Flame Test qualification cites: "*Cable shall be flame retardant in accordance with the requirements of IEEE Std 1202-1991 or NFPA 262-2002. Switchboard cables, coaxial, twinaxial, and triaxial cables shall as a minimum pass the UL VW-1 flame test.*" This citation is the only direction the IEEE 383-2003 standard gives on cable flame propagation testing. The IEEE organization superseded the IEEE 383-1974 standard with IEEE 383-2003 in 2003. Still, the US NRC standards on flame propagation tests are IEEE 383-1974 or IEEE 1202-1991 as cited on the NRC documents previously discussed.

The ICEA T-29-520 standard is essentially the same as the 20 kW (70000 BTU/hr) IEEE 383-1974 tests except with a burner heat output of 62kW. In this test the distance acceptance criteria is the same as IEEE 383-1974: 8 ft (2.44 m). Cables tested using this test will meet or exceed performance of IEEE 383-1974 tested cables, and could have similar cable performance to tests like the FT-4/Vertical Flame Test.

The Vertical Flame Spread test (IEC 60332-3-21, IEC 60332-3-22 and IEC 60332-3-23) uses a burner of 20 kW (70000 BTU/hr) heat output. In these tests, the recommended acceptance length of damage is 10.2 ft (3.1 m) which is less rigorous than the 8 ft (2.44 m) of acceptable damage of the IEEE 383-1974 standard, but the heat exposure time is 40 minutes which is twice the time exposed in IEEE 383-1974. In order to compare the severity of these IEC's tests with the IEEE 383-1974 test, the maximum average damage length (adl) per heat exposed time (het) was calculated. Assuming most of the damage will occur during flame application times, an average adl/het was calculated of 0.4 ft of damage/minute during the 20 minutes of flame application for the IEEE 383-1974 test and an average adl/het of 0.255 ft of damage/minute during the 40 minutes of flame application for the IEC tests. If these two values are compared, any sample which has an average adl/het during flame application greater than the calculated should fail the test. In this case, the IEC test will be more rigorous than the IEEE 383-1974.

The Vertical Tray Flame Test (UL 1581, 1685, 83, and 44) and Vertical Cable Tray Flame Test (ICEA T-30-520) both use a burner with a 20 kW (70000 BTU/hr) heat output. These two tests are very similar to the IEEE 383-1974. The three have the same acceptable damage length of 8 ft (2.44 m) and require cables to self extinguish before reaching the top of the tray. Also, the heat exposure time is 20 minutes. These tests have minor variations in procedure and equipment used. IEEE 817-1993 Flame Test is mainly used to determine whether cables need to be coated or not and does not have pass/fail criteria. If cable damage reaches the top of the tray, the cable is recommended to be coated.

The IEC 60332-3-24 standard is very similar to IEEE 383-1974 but has less strict acceptance criteria. This test has the same burner heat output and exposure time as IEEE 383-1974, but has an acceptable damage length of 10.2 ft (3.1 m) making the test less severe.

Note that the IEC 60332-3-10 standard is the description of the apparatus used in the IEC 60332-3-21, IEC 60332-3-22, IEC 60332-3-23, and IEC 60332-3-24 standards discussed above and is not an actual test.

Low Intensity Test Methods

The tests discussed below have burner heat outputs equal to or lower than 1 kW (3400 BTU/hr). A comparison of these methods to IEEE 383-1974 is not prudent due to the vast difference in test samples and burner heat outputs. These low heat exposure tests will be discussed for completeness of this report, but will not be directly compared to the IEEE 383-1974 baseline Standard.

Vertical Flame Propagation Tests (IEC 60332-1-2 and IEC 60332-1-3) are both 1 kW (3400 BTU/hr) of heat exposure Burner Heat Output tests. Both exposure times vary from 1-8 minutes depending on the sample diameter. IEC 60332-1-2 requires more than 50 mm (1.97 in) of distance between the lower edge of the top support and the onset of charring and less than 540 mm (21.26 in) from the lower edge to the top support. IEC 60332-1-3 requires that the filter paper used as indicator does not ignite during the test.

The four 500 W (1700 BTU/hr) tests are very similar in terms of heat exposure time and passing criteria. These tests are the VW-1 Vertical Wire Flame Test (UL 1581 and CSA C22.2 No. 0.3, and referenced in UL 83 and UL 44), the FT-1 Vertical Flame Test (UL 1581 and CSA 22.2 No. 0.3 and referenced in UL 83 and UL 44), Flame Test (ICEA S-61-402), and the FT-2 Horizontal Flame Test (UL 1581, CSA 22.2 No. 0.3, and referenced in UL 83 and UL 44). The first three are vertical flame tests and have exposure times of 75 seconds total with different time intervals between heat applications. These three are very similar and require that samples do not burn more than 60 seconds or burn less than 25% of the indicator and/or cotton batting. The FT-2 test is a horizontal test with a heat exposure time of 30 seconds and requires that the cable self-extinguishes and that no flaming particles ignite cotton under specimen.

The ASTM D5537-03 *Standard Test Method for Flame Spread* is used to determine the heat release rate by measuring gas concentrations and flow. It also measures Flame Propagation by blistering and char length. This test does not have acceptance criteria.

The FM 3972 *Test Standard for Cable Fire Propagation* is used to calculate a Fire Propagation Index to classify cable fire propagation characteristics. In the test procedure, a pilot flame is used to ignite the cables. After that, the flame is extinguished and heaters are used until the cable self-extinguishes. Measurements of the combustion gas concentrations and flow, time and heat release rate are used to calculate the Fire Propagation Index. This test does not have acceptance criteria.

Summary of Results

Tables 1 and 2 below provide a summary of the testing methods that are more severe than IEEE 1202-1991 (Table 1) or more severe than IEEE 383-1974 (Table 2). Note that all test standards in Table 1 are also included in Table 2, since IEEE 1202-1991 is a more rigorous test method than IEEE 383-1974.

Table 1
More Severe Tests (Standards) than IEEE 1202-1991

Test Name (Test Type)	Cable Standard
FT-6/Flame Travel Test (horizontal)	NFPA 262 CSA 22.2 No. 0.3
Fire Test (riser/vertical)	UL 1666
FT-4/Vertical Flame Test (vertical)	UL 1581 UL 1685 UL 83 UL 44 CSA22.2 No. 0/3 IEEE 1202-1991
Flame test Qualification (vertical)	IEEE 383-2003

Table 2
More Severe Tests (Standards) than IEEE 383-1974

Test Name (Test Type)	Cable Standard
FT-6/Flame Travel Test (horizontal)	NFPA 262 CSA 22.2 No. 0.3
Fire Test (riser/vertical)	UL 1666
FT-4/Vertical Flame Test (vertical)	UL 1581 UL 1685 UL 83 UL 44 CSA 22.2 No. 0.3 IEEE 1202-1991
Flame Test Qualification (vertical)	IEEE 383-2003
Vertical Cable Tray Flame Test (vertical)	ICEA T-29-520
Vertical Flame Spread (vertical)	IEC 60332-3-21 IEC 60332-3-22 IEC 60332-3-23
Vertical Tray Flame Test (vertical)	UL 1581 UL 1685 UL 83 UL 44
Vertical Cable Tray Flame Test (vertical)	ICEA T-30-520
Flame Test (vertical)	IEEE 383-1974

Conclusion

Electrical cables tested in accordance with the flame propagation acceptance criteria of one or more of the Test Standards listed in Table 2 should be considered to perform equal to or better than if they were tested to IEEE 383-1974. Low burner heat output tests discussed in this report are not recommended to be accepted due to the impractical nature of comparing these small scale screening test requirements (e.g. low thermal exposure, sample size, time exposure and acceptance criteria) to the US NRC minimum accepted test methods and acceptance criteria of larger scale IEEE 383-1974.

Attachment 1:
Cable Standards and Respective Flame Tests

Test Title (Test Type)	Standard	Standard Title
FT-6/Flame Travel Test (horizontal)	NFPA 262	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling spaces (2007 Ed)
	CSA 22.2 No. 0.3	Test Methods for Electrical Wires and Cables (Jan 2005)
Fire Test (riser/vertical)	UL 1666	Test for Flame Propagation Height of Electrical and Optical Fiber Cables Installed Vertically in Shafts (4th Ed Nov 2000 Revisions thru Jul 2002)
FT-4/Vertical Flame Test (vertical)	UL 1581	Reference Standard for Electrical Wires, Cables and Flexible Cords (4th Ed Oct 2001 Revisions thru Aug 2006)
	UL 1685	Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Fiber Optical-Fiber Cables (2nd Ed Feb 1997 Revisions thru Nov 2000)
	UL 83	Thermoplastic-Insulated Wires and Cables (13th Ed Nov 2003 Revisions thru Apr 2006)
	UL 44	Thermo set-Insulated Wires and Cables (16th Ed Jul 2005 Revisions thru Nov 2005)
	CSA 22.2 No. 0.3	Test Methods for Electrical Wires and Cables (Jan 2005)
	IEEE 1202-1991	IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies (1991)
Flame Test qualification (vertical)	IEEE 383-2003	IEEE Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations (2003; Revision of IEEE 383-1974)
Vertical Cable Tray Flame Test (vertical)	ICEA T-29-520	Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input Rate of 210000 Btu/hr (Sep 1986)
Vertical Flame Spread (vertical)	IEC 60332-3-21 IEC 60332-3-22 IEC 60332-3-23	Tests on Electric Cables Under Fire Conditions Parts 3-21 to 23: Test for Vertical Flame Spread of Vertically-Mounted Bunched Wires or Cables: Category A (F/R), A&B (Oct 2000)
Vertical Tray Flame Test (vertical)	UL 1581	Reference Standard for Electrical Wires, Cables and Flexible Cords (4th Ed Oct 2001 Revisions thru Aug 2006)
	UL 83	Thermoplastic-Insulated Wires and Cables (13th Ed Nov 2003 Revisions thru Apr 2006)
	UL 44	Thermo set-Insulated Wires and Cables (16th Ed Jul 2005 Revisions thru Nov 2005)
	UL 1685	Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Fiber Optical-Fiber Cables (2nd Ed Feb 1997 Revisions thru Nov 2000)

Test Title (Test Type)	Standard	Standard Title
Vertical Cable Tray Flame Test (vertical)	ICEA T-30-520	Guide for Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 70000 Btu/hr (Sep 1986)
Flame Test (vertical)	IEEE 383-1974	IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations (1974)
Flame Test (vertical)	IEEE 817-1993	IEEE Standard Test Procedure for Flame-Retardant Coatings Applied to Insulated Cables in Cable Trays (1993)
Vertical Flame Spread (vertical)	IEC 60332-3-24	Tests on Electric Cables Under Fire Conditions Parts 3-21 thru 23: Test for Vertical Flame Spread of Vertically-Mounted Bunched Wires or Cables: Category C (Oct 2000)
Vertical Flame Propagation (vertical)	IEC 60332-1-2	Test for Vertical Flame Propagation for a Single Insulated Wire or Cable – Procedure for 1 kW pre-mixed (2004-07)
Vertical Flame Propagation (vertical)	IEC 60332-1-3	Test for Vertical Flame Propagation for a Single Insulated Wire or Cable – Procedure for determination of flaming droplets/particles (2004-07)
VW-1 Vertical Wire Flame Test (vertical)	UL 1581	Reference Standard for Electrical Wires, Cables and Flexible Cords (4th Ed Oct 2001 Revisions thru Aug 2006)
	UL 83	Thermoplastic-Insulated Wires and Cables (13th Ed Nov 2003 Revisions thru Apr 2006)
	UL 44	Thermo set-Insulated Wires and Cables (16th Ed Jul 2005 Revisions thru Nov 2005)
	CSA 22.2 No. 0.3	Test Methods for Electrical Wires and Cables (Jan 2005)
FT-1 Vertical Flame Test (vertical)	UL 1581	Reference Standard for Electrical Wires, Cables and Flexible Cords (4th Ed Oct 2001 Revisions thru Aug 2006)
	UL 83	Thermoplastic-Insulated Wires and Cables (13th Ed Nov 2003 Revisions thru Apr 2006)
	UL 44	Thermo set-Insulated Wires and Cables (16th Ed Jul 2005 Revisions thru Nov 2005)
	CSA 22.2 No. 0.3	Test Methods for Electrical Wires and Cables (Jan 2005)
Flame Test (vertical)	IPCEA S-61-402	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (Oct 1994)

Test Title (Test Type)	Standard	Standard Title
FT-2 Horizontal Flame Test (horizontal)	UL 1581	Reference Standard for Electrical Wires, Cables and Flexible Cords (4th Ed Oct 2001 Revisions thru Aug 2006)
	UL 83	Thermoplastic-Insulated Wires and Cables (13th Ed Nov 2003 Revisions thru Apr 2006)
	UL 44	Thermo set-Insulated Wires and Cables (16th Ed Jul 2005 Revisions thru Nov 2005)
	CSA 22.2 No. 0.3	Test Methods for Electrical Wires and Cables (Jan 2005)
Standard Test Method for flame Spread (vertical)	ASTM D5537-03	Standard Test Method for Heat Release, Flame Spread Smoke Obscuration, and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration (Dec 2003)
Fire Propagation Test	FM 3972	Test Standard for Cable Fire Propagation (Mar 1994)

Attachment 2
Testing Conditions and Acceptance Criteria

Test Name (Test Type)	Test Standard	Acceptance Criteria		Test Exposure Conditions	
		Acceptable Damage Length	Other Acceptance Criteria	Burner Heat Output	Exposure time
FT-6/Flame Travel Test (horizontal)	NFPA 262 CSA 22.2 No. 0.3	5 ft (1.5 m)	Max temperature shall be 542° F (267° C)	86 kW (294000 Btu/hr)	20 min
Fire Test (riser/vertical)	UL 1666	12 ft (3.66 m)	Any TC shall not exceed 850° F (454.4° C)	154.5 kW (527500 Btu/hr)	30 min
FT-4/Vertical Flame Test (vertical)	UL 1581 UL 1685 UL 83 UL 44 CSA 22.2 No. 0.3 IEEE 1202-1991	4.9 ft (1.5 m)	N/A	20 kW (70000 Btu/hr)	20 min
Flame test qualification (vertical)	IEEE 383-2003	Refers user to IEEE 1202-1991 or NFPA 262 flame propagation test procedure.			
Vertical Cable Tray Flame Test (vertical)	ICEA T-29-520	8 ft (2.44 m)	Cables that self extinguish pass the test; fail if the flame propagates to the total height of the tray (8 ft, 2.44 m)	62 kW (210000 Btu/hr)	20 min
Vertical Flame Spread (vertical)	IEC 60332-3-21 IEC 60332-3-22 IEC 60332-3-23	10.2 ft (3.1 m)	N/A	20 kW (70000 Btu/hr)	40 min
Vertical Tray Flame Test (vertical)	UL 1581 UL 83 UL 44 UL 1685	8 ft (2.44 m)	Requires cable to self extinguish before reaching top of the tray.	20 kW (70000 Btu/hr)	20 min
Vertical Cable Tray Flame Test (vertical)	ICEA T-30-520	8 ft (2.44 m)	Cable damage shall not extend to the top of the tray (8 ft, 2.44m)	20 kW (70000 Btu/hr)	20 min
Flame test (vertical)	IEEE 383-1974	8 ft (2.44 m)	Cables that self extinguish pass the test; fail if the flame propagates to the total height of the tray (8 ft, 2.44 m)	20 kW (70000 Btu/hr)	20 min
Flame test (vertical)	IEEE 817-1993	N/A	When flame is removed the cable needs to self-extinguish. Uncoated cables that burn to the top of the tray are suitable for testing coatings.	20 kW (70000 Btu/hr)	20 min
Vertical Flame Spread (vertical)	IEC 60332-3-24	10.2 ft (3.1 m)	N/A	20 kW (70000 Btu/hr)	20 min
Vertical Flame Propagation (vertical)	IEC 60332-1-2	N/A	Requires more than 50 mm (1.97 in) of distance between the lower edge of the top support and the onset of charring and less than 540 mm (21.26 in) from the lower edge to the top support	1 kW (3400 Btu/hr)	1-8 min (depends on sample diameter)
Vertical Flame Propagation (vertical)	IEC 60332-1-3	N/A	Requires that the filter paper does not ignite during the test.	1 kW (3400 Btu/hr)	1-8 min (depends on sample diameter)

Test Name (Test Type)	Test Standard	Acceptance Criteria		Test Exposure Conditions	
		Acceptable Damage Length	Other Acceptance Criteria	Burner Heat Output	Exposure time
VW-1 Vertical Wire Flame Test (vertical)	UL 1581 UL 83 UL 44 CSA 22.2 No. 0.3	N/A	If sample burns for more than 60 sec the sample fails the test. If 25% or more of the cotton batting or indicator flag burns the cable fails test.	500 W (1700 Btu/hr)	75 sec (flame applied 5 times of 15 sec with time intervals of no more than 60 sec)
FT-1 Vertical Flame Test (vertical)	UL 1581 UL 83 UL 44 CSA 22.2 No. 0.3	N/A	If sample burns for more than 60 sec the sample fails the test. If 25% or more of the cotton batting or indicator flag burns the cable fails test.	500 W (1700 Btu/hr)	75 sec (flame applied 5 times of 15 sec with time intervals of no more than 60 sec)
Flame Test (vertical)	IPCEA S-61-402	N/A	If sample burns for more than 60 sec the sample fails the test. If 25% or more of the cotton batting or indicator flag burns the cable fails test.	500 W (1700 Btu/hr)	75 sec (flame applied 5 times for 15 sec with time intervals between applications)
FT-2 Horizontal Flame Test (horizontal)	UL 1581 UL 83 UL 44 CSA 22.2 No. 0.3	N/A	No flaming particles shall drop from the specimen causing the cotton under the specimen to ignite and the cable should self-extinguish.	500 W (1700 Btu/hr)	30 sec
Standard Test Method for Flame spread (vertical)	ASTM D5537-03	N/A	N/A	20 kW (70000 Btu/hr)	20 min
Fire Propagation Test (vertical)	FM 3972	N/A	Until cable self-extinguishes	50 kW (175000 Btu/hr) *(heater output)	

Attachment 3
Comments on Flame Propagation Tests Included in More Than One Standard

Test Name (Test Type)	Cable Standard	Comments
FT-6/Flame Travel Test (horizontal)	NFPA 262	This std includes procedure and requirements of the FT-6/Horizontal Flame Travel Test
	CSA 22.2 No. 0.3	The Std. refers (sends) user to use FT-6/Horizontal Flame Travel Test Procedure in NFPA 262 Std.
FT-4/Vertical Flame Test (vertical)	IEEE 1202-1991 CSA 22.2 No. 0.3 Section 4.11.4 & App A UL 1685 Section 12-19	These stds. Include procedure and requirements of the FT-4/Vertical Flame Test
	UL 44 Section 5.14.6 & 8.14.6 UL 83 Section 5.12.5, 5.12.6.3 & 8.12.5 UL 1581 Section 1164	These stds. Refer (send) user to use FT-4/IEEE 1202 Vertical Tray Flame Test procedure in UL 1685 or CSA 22.2 No. 0.3 Stds.
Flame Test Qualification (vertical)	IEEE 383-2003	This std. refers (sends) user to use Flame Tests procedure of NFPA 262 (horizontal flame test) or IEEE 1202-1991 (vertical flame test) stds.
Vertical Flame Spread (vertical)	IEC 60332-3-21 IEC 60332-3-22 IEC 60332-3-23	These tests follow the same procedure and apparatus in IEC 60332-3-10 Std. but the requirements apply to different category cables A (F/R), B and C.
Vertical Tray Flame Test (vertical)	UL 1685 Section 4-11 UL 44 Section 5.14.5 & 8.14.5 UL 83 Section 5.12.6.2 & 8.12.6.1	These stds. include procedure and requirements of the Vertical Tray Flame Test (also called UL Flame Exposure)
	UL 1581 Section 1160	This Std. refers (send) user to use Vertical Tray Flame Test in UL 1685. std.
VW-1 Vertical Wire Flame Test (vertical)	UL 1581 Section 1080 CSA 22.2 No. 0.3 Section 4.11.7 & App A & D	This std. includes procedure and requirements of the VW-1 Vertical Wire Flame Test
	UL 44 Section 5.14.4 & 8.14.4 UL 83 Section 8.12.1 & 8.12.3	This Std. refers (sends) user to use VW-1 Vertical Wire Flame Test in UL 1581 or CSA 22.2 No. 0.3 stds.
FT-1 Vertical Flame Test (vertical)	UL 1581 Section 1060 CSA 22.2 No. 0.3 Section 4.11.1 & App A	This std. includes procedure and requirements of the FT-1 Vertical Flame Test
	UL 44 Section 5.14.3 & 8.14.3 UL 83 Section 8.12.2	This std. refers (sends) user to use FT-1 Vertical Flame Test in UL 1581 or CSA 22.2 No. 0.3 stds.
FT-2 Horizontal Flame Test (horizontal)	UL 1581 Section 1100 CSA 22.2 No. 0.3 Section 4.11.2 & App A	This std. includes procedure and requirements of the FT-2 Horizontal Flame Test
	UL 44 Section 5.14.1 & 8.14.1 UL 83 Section 8.12.3.2	This Std. refers (sends) user to use FT-2 Horizontal Flame Test in UL 1581 or CSA 22.2 No. 0.3 stds.