Here's a copy of a summary of Thermo-Lag tests we conducted which attempted to replicate, to the extent possible, the original tests conducted by TSI in the early '80s.

They were distributed at a (public) meeting between the NRC staff and NUMARC Wednesday (2/9) afternoon. The complete data will be released soon and the NRC staff will put out an information notice on the results.

Mike C.

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February 9, 1994

TEST ARTICLE 1
FIRE ENDURANCE TEST SUMMARY

TEST DATE:	December 8, 1993
TEST SPONSOR:	U.S. Nuclear Regulatory Commission
TECH ASSISTANCE:	Sandia National Laboratories
TEST FACILITY:	Underwriters Laboratories, Incorporated Northbrook, Illinois
TEST ARTICLE:	1 (TSI Procedure 20684, Rev V based barrier installation)
DESCRIPTION:	U-shaped 6-inch-wide steel solid bottom cable tray with light cable loading. The test article components and configuration duplicated a test article from TSI Report 82-5-3558. The barrier installation, however, was performed in accordance with TSI Technical Note 20684, Revision V. 3-hour fire rated barrier. Two layers of ½-inch thick panels with prebuttered joints.
AMBIENT TEMP:	19 °C [66 °F]
TEST PROFILE:	Standard 3-hour ASTM E-119 time-temperature curve.
FAILURE CRITERIA:	Single thermocouple temperature > 200 °C [391 °F][1] Average thermocouple temperature > 158 °C [316 °F][2] Loss of circuit integrity
SUMMARY RESULTS:	1:05 Single point temperature criterion exceeded. 1:16 Dead short circuit integrity failure. 1:20 Average temperature criterion exceeded. 2:30 Test terminated. The Thermo-Lag had fallen away from upper leg and upper elbow sections of the cable tray. Little virgin material remained on the test article. All of the cable jacket and conductor insulation was consumed by the fire, only bare copper conductors remained.
HOSE STREAM TEST:	Not conducted due to extensive failure of test assembly during fire exposure.

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[1] Maximum allowable single point temperature rise is 30 percent above the allowable average temperature rise (1.30 x 139 °C = 181 °C [1.30 x 250 °F = 325 °F]) plus ambient temperature at the start of the test (181 °C + 19 °C = 200 °C [325 °F + 66 °F = 391 °F]).

[2] Allowable average temperature rise is 139 °C [250 °F] above ambient temperature at the start of the test (139 °C + 19 °C = 158 °C [66 °F + 250 °F = 316 °F]).

February 9, 1994

TEST ARTICLE 2
FIRE ENDURANCE TEST SUMMARY

TEST DATE:	December 7, 1993
TEST SPONSOR:	U.S. Nuclear Regulatory Commission
TECH ASSISTANCE:	Sandia National Laboratories
TEST FACILITY:	Underwriters Laboratories, Incorporated Northbrook, Illinois
TEST ARTICLE:	2 (TSI Procedure 20684, Rev V based barrier installation)
DESCRIPTION:	U-shaped 12-inch-wide steel ladderback cable tray with light cable loading. The test article components and configuration duplicated Test Article 4 of TSI Report 82-11-81. The barrier installation was performed in accordance with TSI Technical Note 20684, Revision V. 3-hour fire rated barrier. Two layers of ½-inch thick panels with prebuttered joints.
AMBIENT TEMP:	19 °C [66 °F]
TEST PROFILE:	Standard 3-hour ASTM E-119 time-temperature curve.
FAILURE CRITERIA:	Single thermocouple temperature > 200 °C [391 °F][1] Average thermocouple temperature > 158 °C [316 °F][2] Loss of circuit integrity
SUMMARY RESULTS:	0:55 Single point temperature criterion exceeded. 0:59 Dead short circuit integrity failure. 1:03 Average temperature criterion exceeded. 2:00 Test terminated. The Thermo-Lag had fallen away from upper sections of the cable tray. Little virgin material remained on the test article. All of the cable jacket and conductor insulation was consumed by the fire, only bare copper conductors remained.
HOSE STREAM TEST:	Not conducted due to extensive failure of test assembly during fire exposure.

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[1] Maximum allowable single point temperature rise is 30 percent above the allowable average temperature rise (1.30 x 139 °C = 181 °C [1.30 x 250 °F = 325 °F]) plus ambient temperature at the start of the test (181 °C + 19 °C = 200 °C [325 °F + 66 °F = 391 °F]).

[2] Allowable average temperature rise is 139 °C [250 °F] above ambient temperature at the start of the test (139 °C + 19 °C = 158 °C [66 °F + 250 °F = 316 °F]).

February 9, 1994

TEST ARTICLE 3
FIRE ENDURANCE TEST SUMMARY

TEST DATE:	December 6, 1993
TEST SPONSOR:	U.S. Nuclear Regulatory Commission
TECH ASSISTANCE:	Sandia National Laboratories
TEST FACILITY:	Underwriters Laboratories, Incorporated Northbrook, Illinois
TEST ARTICLE:	3 (TSI Test report-based barrier installation)
DESCRIPTION:	U-shaped 12-inch-wide steel ladderback cable tray with light cable loading. The test article components and configuration were identical to Test Article 2. The barrier installation, however, duplicated as closely as possible the barrier design and installation documented in TSI Report 82-11-81. Upgraded 3-hour fire rated barrier. Two layers of ½-inch thick panels with prebuttered joints. All inner and outer joints and seams reinforced with wire stitching. Outer joints also secured with machine nuts and bolts. Skim coat of trowel-grade applied over assembly.
AMBIENT TEMP:	20 °C [68 °F]
TEST PROFILE:	Standard 3-hour ASTM E-119 time-temperature curve.
FAILURE CRITERIA:	Single thermocouple temperature > 201 °C [393 °F][1] Average thermocouple temperature > 159 °C [318 °F][2] Loss of circuit integrity
SUMMARY RESULTS:	1:50 Single point temperature criterion exceeded. 1:58 Average temperature criterion exceeded. 1:59 Dead short circuit integrity failure. 3:00 Thermo-Lag covering the bottom of the upper cable tray section completely burned away, only stress skin remained. The cable tray was fully exposed. Very little virgin material remained on the test article. All of the cable jacket and conductor insulation was consumed by the fire, only bare copper conductors remained.
HOSE STREAM TEST:	Not conducted due to failure during fire exposure.

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[1] Maximum allowable single point temperature rise is 30 percent above the allowable average temperature rise (1.30 x 139 °C = 181 °C [1.30 x 250 °F = 325 °F]) plus ambient temperature at the start of the test (181 °C + 20 °C = 201 °C [325 °F + 68 °F = 393 °F]).

[2] Allowable average temperature rise is 139 °C [250 °F] above ambient temperature at the start of the test (139 °C + 20 °C = 159 °C [68 °F + 250 °F = 318 °F]).

February 9, 1994

TEST ARTICLE 4
AMPACITY DERATING TEST SUMMARY

TEST DATE: October 14-15, 1993 (baseline, tray without barrier)
December 9-10, 1993 (protected, tray with barrier)

TEST SPONSOR: U.S. Nuclear Regulatory Commission

TECH ASSISTANCE: Sandia National Laboratories

TEST FACILITY: Underwriters Laboratories, Incorporated
Northbrook, Illinois

TEST ARTICLE: 4 (TSI Procedure 20684, Rev V based barrier installation)

DESCRIPTION: U-shaped 12-inch-wide steel ladderback cable tray with 50 percent cable loading (8 AWG, 4 AWG, and 2/0 cables). Test article components and configuration duplicated TSI Report 82-5-355F. Barrier installation in accordance with TSI Technical Note 20684, Revision V. 3-hour fire rated barrier. Two layers of ½-inch thick panels with prebuttered joints.

AMPACITY DERATING FACTORS

Cable Size	Data Source	Baseline Ampacity (Amps)	Protected Ampacity (Amps)	Derating Factor (%)
8 AWG	SNL	23.7	12.7	46.4
	TSI[1]	17.46	14.64	16.15
	TSI[2]	20.38	13.89	31.84
	TSI[3]	23.96	14.83	38.10
4 AWG	SNL	37.8	24.1	36.2
	TSI[1]	35.77	29.74	16.86
	TSI[2]	41.75	28.21	32.43
	TSI[3]	41.75	28.21	32.43
2/0	SNL	114.00	73.40	35.6
	TSI[1]	105.91	87.18	17.68
	TSI[2]	123.60	82.69	33.10
	TSI[3]	131.60	84.82	35.55

[1] Reported in TSI Report 82-5-355F.
[2] TSI calculation error associated with inverting the ICEA adjustment factor corrected.
[3] Actual individual conductor temperatures used to calculate individual ampacity adjustment factors for each cable independently rather than using the hottest single cable temperature for each cable.