

# APPENDIX D

## CABLE FIRE TEST DATA LEGEND

NRC staff in collaboration with an NRC contractor reviewed and analyzed the test data to support the PIRT and fire PRA expert elicitation panels. Much of this work is documented in NUREG-2128, "Electrical Cable Test Results and Analysis during Fire Exposure (ELECTRA-FIRE), A consolidation of three major fire-induced circuit and cable failure experiments performed between 2001 and 2011." Subsequent to the completion of that work, the fire PRA expert elicitation panel requested access to the Microsoft Excel® database containing the consolidate test data information, to support their evaluation. That Excel database is contained on the CD included in the back cover of this report. This appendix provides the legend to that Excel file to enable the user to better understand the database. Sections D.1 and D.2 of this appendix preset the AC and DC Master tabs in the excel spreadsheet, respectively.

### D.1 AC Data File Spreadsheet Legend

AC Data Column	Column Identifier	Description	Variables
A	Test Identifier	Test identification parameters  <u>Example</u> <i>C-IT-IP-3-CK1</i> CAROLFIRE, Intermediate scale test, Preliminary Setup, test 3, circuit 1	C - CAROLFIRE E - EPRI/NEI D – DESIREE-FIRE IP- Preliminary Test IT – Intermediate-Scale P - Penlight CK - Circuit JPN- Japanese Cable
B	Conductor Count	Number of conductors within the multi-conductor cable tested	Variable  3, 5, 6, 7, 8, 9, or 10 conductors  MC represents multiple cables connected to a single circuit. This configuration was typically used to evaluate inter-cable failure modes.
C	Conductor Size (AWG)	Size of conductors in each multi-conductor cable. Units expressed in American Wire Gauge (AWG)	Variable  6, 12, or 14 AWG
D	Insulation Type	Classification of polymer type used in the cable to insulate the individual conductors.	TS-Thermoset TP-Thermoplastic

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
E	Insulation Material	Conductor insulation polymeric material (the insulation over each individual conductor)	EPR-Ethylene propylene rubber FR Kerite-unknown polymer HTK Kerite-unknown polymer PE-polyethylene (Not cross-linked) PVC-polyvinyl chloride SR-silicone-rubber SR-V-silicone-rubber Vitalink® TEF-Tefzel® DuPont Chemical XLPE-cross-linked polyethylene XLPO-cross-linked Polyolefin
F	Insulation Thickness	Cable Insulation thickness (mm)	Variable 0.410mm to 1.540mm
G	Jacket Type	Classification of polymer type used in the cable jacket.	TS-Thermoset TP-Thermoplastic
H	Jacket Material	Cable jacket polymer material	Braid-fiberglass braid sheath CP or CPE-chlorinated polyethylene CSPE- chlorosulfanated polyethylene FR-Kerite-unknown polymer PE-(Non-cross-linked) polyethylene SR-V-Silicone-Rubber Vitalink® TEF-Tefzel® Insulation DuPont Chemical XLPO-Cross-linked Polyolefin
I	Jacket Thickness	Jacket insulation thickness (mm)	Variable 0.510mm – 2.030mm
J	Cable Shield	Cable included a metal foil shield. This designation represents a rugged metal foil shield such as a spiral wound copper or lead/tin shield. Mylar wraps <u>do not</u> represent a rugged metal foil shield and are not included in this designation.	Yes or No

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
K	Armor	The cable construction includes an interlocked steel armor over the insulated conductors. The armor is typically grounded. The cable may or may not have a polymeric jacket surrounding the armor. (The armor is similar in appearance to flexible metal conduit.)	Yes or No
L	Dain Wire	Cable included an un-insulated drain wire.	Yes or No
M	Exposure Location	<p>Physical location of exposure; CAROLFIRE test locations correspond with Figure 3.6 “Schematic representation of the CAROLFIRE intermediate-scale test structure” in NUREG/CR-6931, Vol. 1</p> <p>DESIREE-FIRE test locations correspond with Figure 3-2 “Schematic representation of the DESIREE-Fire intermediate-scale teststructure” in NUREG/CR-7100.</p> <p>EPRI test locations correspond with height of horizontal cable tray above ground per individual test setup</p>	<p>5- EPRI Test Location 5ft above ground</p> <p>6- EPRI Test Location 6ft above ground</p> <p>7- EPRI Test Location 7ft above ground</p> <p>A- CAROLFIRE Location A or DESSIRE-FIRE Location A</p> <p>B- CAROLFIRE Location B or DESSIRE-FIRE Location B</p> <p>C- CAROLFIRE Location C or DESSIRE-FIRE Location C</p> <p>D- CAROLFIRE Location D or DESSIRE-FIRE Location D</p> <p>E- CAROLFIRE Location E or DESSIRE-FIRE Location E</p> <p>F- CAROLFIRE Location F</p> <p>G- CAROLFIRE Location G</p> <p>P- Test performed with Penlight apparatus</p> <p>V- Vertical Arrangement</p>
N	Exposure Condition	General fire exposure condition of cables during each test. This parameter could vary at a given exposure location based on individual test specifications depending on flame height and heat release rate.	<p>F- Flame exposure</p> <p>F-P - Flame/Plume region exposure</p> <p>H- Hot gas layer exposure</p> <p>P- Plume exposure</p>

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
O	Raceway type	Type of cable raceway. A small number of tests were conducted with no raceway support (i.e., a simulated air-drop). Most tests involved cables in either a cable tray or a conduit.	A- Air Drop C- Conduit T- Tray
P	Cable Orientation	Orientation of cable	H- Horizontal V- Vertical
Q	Raceway fill	Specific raceway fill characteristic per test	1-row- 1 row of cables 2-row- 2 row of cables 3-row- 3 row of cables B-4- Bundled configuration; 4 Cables B-6- Bundled configuration; 6 Cables B-12- Bundled configuration; 12 Cables F- Full cable tray S- Single Cable
R	Control Power Transformer (VA)	Control power transformers (CPTs) and CPT power rating [volt-ampere (VA)]	75- 75 volt-ampere (VA) 100- 75 volt-ampere (VA) 150- 75 volt-ampere (VA) 200- 75 volt-ampere (VA) None- No CPT present
S	Circuit Grounding	Grounding configuration of the circuit. Testing used either a solid ground or an ungrounded configuration.	Yes or No
T	# Total Sources	Total number of available source conductors present in the cable	1, 2, or 5
U	# Active (SA) Targets	Number of active target conductors present in the cable. Active target conductors represent a conductor where a hot short would result in a physical change in state of the devices under consideration (i.e., spurious operation)	2 or 5
V	# Passive (HS) Targets	Number of passive target conductors present in the cable. Passive targets had no ability to have a physical change in state when energized from a source conductor (i.e. hot short, but not spurious event)	0 or 1

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
W	# Grounds	Number of ground conductors contained within the circuit	0, 1, or Drain Drain = Circuit contained a drain wire in place of a ground conductor
X	# Neutrals	Number of common return (neutral) conductors contained within the cable.	0 or 1
Y	# Spares	Number of spare conductors contained within the circuit. Spares were not grounded.	0, 1, or 2
Z	Circuit Type	Type of diagnostic circuit used during testing	AC-1- Actuation circuit 1 IC – Inter-cable configuration MOV – Typical MOV surrogate circuit MOV+ - configuration used to evaluate a 3/C Kerite HTK power cable MOV-5 – monitored cable only had 5 conductors MOV-SA+ - Cable contained only source and target cables. This configuration was used to determine cable failure time for several Kerite-FR tests.
AA	Wiring Configuration	Indicates wiring configuration patterns that correspond with the EPRI 1003326 report; Figure 4-7 Conductor Connection Patterns	AB- Actuation Biased Alt (s/t) – Alternating source and target conductors CG- Center Ground IC – Inter-cable configuration NAB-Non-Actuation Biased SC- Source Centered SC-1 – variation on SC
AB	Single Failure (only one hot short/SA per circuit)	*Place holder column*	Information in the next 5 columns was evaluated circuits on the global approach. That is, the circuit was counted if any cable experienced at least one fault
AC	# Hot Shorts (including Spurious Actuations)	Any hot short occurred within the circuit (Active and Passive targets included)	0 or 1 (0 = No, 1 = Yes)

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
AD	# Hot Shorts Possible (including Spurious Actuations)	Number of hot shorts possible within the circuit (counted as one (1) for this section regardless of how many active and passive targets were present)	1
AE	# Spurious Actuations	Number of spurious operations that occurred per test (counted as one (1) if at least one spurious activation of an active target occurred)	0 or 1
AF	# Spurious Actuations Possible	Number of spurious operations possible within the circuit (Counted as one (1) for this section regardless of how many active targets were present)	1
AG	Ground Fault	Indicated the test circuit faulted to ground (1) resulting in a fuse clear without any other failure modes occurring	0 or 1
AH	Multiple Failure	*Place holder column*	Information in the next 5 columns was evaluated circuits on the target approach. That is, each target cable was evaluated separately for hot shorts and spurious activations
AI	# Total Hot Shorts (including Spurious Actuations)	Number of hot shorts that occurred within the circuit (Active and Passive targets included)	0, 1, 2, 3, or 4
AJ	# Hot Shorts Possible (including Spurious Actuations)	Number of hot shorts possible within the circuit (active and passive targets included)	2, 3, 4, or 5
AK	# Spurious Actuations	Number of spurious operations that occurred per test (active targets included only)	0, 1, or 2
AL	# Spurious Actuations Possible	Number of spurious operations possible (active targets included only)	2 or 5
AM	Ground Fault	Indicated the test circuit faulted to ground (1) resulting in a fuse clear failure without any other failure modes occurring	0 or 1

CABLE FIRE TEST DATA LEGEND

AC Data Column	Column Identifier	Description	Variables
AN	*Place holder column*	*Place holder column*	Information in the next 4 columns evaluated the circuit results using the target approach and the values represent the duration of the hot short and/or spurious operation.
AO	C4 total (HS)	Total duration of hot short on circuit C4	Variable (seconds)
AP	C8/3 total (HS)	Total duration of hot short on circuit C8/3	Variable (seconds)
AQ	C5 total (SA)	Total duration of spurious operation on circuit C5	Variable (seconds)
AR	C6 total (SA)	Total duration of spurious operation on circuit C6	Variable (seconds)

CABLE FIRE TEST DATA LEGEND

**D.2 DC Data File Spreadsheet Legend**

DC Data Column	Column Identifier	Description	Variables
A	Test Identifier	<p>Test identification parameters</p> <p><u>Example</u>  <i>D-P-7-MOV1</i>                      DESIREE-FIRE, Penlight, Test 7, Motor Operated Valve Circuit 1</p>	D – DESIREE-FIRE P- Penlight IP- Preliminary Test IT - Intermediate P - Penlight MOV- Motor Operated Valve SOV- Solenoid Operated Valve 1" Vlv- 1 Inch Valve PORV- Power-operated relief valve Trp- Trip Circuit Breaker Cls- Close Circuit Breaker
B	Conductor Count	Number of conductors within the multi-conductor cable tested	6, 7, 8, 9, 10, or 15 conductors
C	Conductor Size (AWG)	Size of conductors in each multi-conductor cable. Units expressed in American Wire Gauge (AWG)	12 or 14 AWG
D	Insulation Type	Classification of polymer type used in the cable to insulate the individual conductors.	TS-Thermoset TP-Thermoplastic Unknown
E	Insulation Material	Conductor insulation polymeric material (the insulation over each individual conductor)	EPR-Ethylene propylene rubber FR Kerite- PE-(Non-cross-linked) polyethylene PVC-XLPE insulated polyvinyl chloride SR-Silicone-Rubber TEF-Tefzel® Insulation DuPont Chemical XLPE-Cross-linked polyethylene XLPO-Cross-linked Polyolefin Unknown
F	Insulation Thickness	Cable Insulation thickness (mm)	Variable  0.410mm to 1.524mm
G	Jacket Type	Classification of polymer type used in the cable jacket.	TS-Thermoset TP-Thermoplastic  Unknown TBD – CPE can be a TS or TP it is unclear the classification of the cable tested



CABLE FIRE TEST DATA LEGEND

DC Data Column	Column Identifier	Description	Variables
H	Jacket Material	Cable jacket polymer material	Braid-fiberglass braid sheath CPE-Chlorinated Polyethylene CSPE-Chloro-Sulfanated Polyethylene FR-Kerite-unknown polymer PVC-XLPE insulated polyvinyl chloride TEF-Tefzel® Insulation DuPont Chemical XLPO-Cross-linked Polyolefin Unknown
I	Jacket Thickness	Jacket insulation thickness (mm)	Variable  0.510mm to 2.030mm
J	Cable Shield	Cable included a metal foil shield. This designation represents a rugged metal foil shield such as a spiral wound copper or lead/tin shield. Mylar wraps <u>do not</u> represent a rugged metal foil shield and are not included in this designation.	Yes No Unknown
K	Armor	The cable construction includes an interlocked steel armor over the insulated conductors. The armor is typically grounded. The cable may or may not have a polymeric jacket surrounding the armor. (The armor is similar in appearance to flexible metal conduit.)	Yes No Unknown
L	Exposure Location	Physical location of exposure;  Figure 3-2 Schematic representation of the DESIREE-Fire intermediate-scale test structure. NUREG/CR-7100	A-DESSIRE-FIRE Location A B-DESSIRE-FIRE Location B C-DESSIRE-FIRE Location C D-DESSIRE-FIRE Location D E-DESSIRE-FIRE Location E P- Test performed with Penlight apparatus
M	Exposure Condition	General fire exposure condition of cables during each test. This parameter could vary at a given exposure location based on individual test specifications depending on flame height and heat release rate.	F- Flame exposure H- Hot gas layer exposure P- Plume exposure

CABLE FIRE TEST DATA LEGEND

DC Data Column	Column Identifier	Description	Variables
N	Raceway type	Type of cable raceway. Most tests involved cables in either a cable tray or a conduit.	C- Conduit T- Tray
O	Cable Orientation	Orientation of cable	H- Horizontal V- Vertical
P	Raceway fill	Specific raceway fill characteristic per test	B-Bundle M-Medium S- Single
Q	Fuse Size (A)	Rated Fuse Size; Expressed in units of Amperes (A)	5- 5 amps 10- 10 amps 15- 15 amps 35- 35 amps
R	Circuit Grounding	Grounding configuration of the circuit. All DC circuits were tested in the ungrounded configuration.	No
S	# Total Sources	Total number of available source conductors present in the cable	1, 2, or 3
T	# Active (SA) Targets	Number of active target conductors present in the cable. Active target conductors represent a conductor where a hot short would result in a physical change in state of the devices under consideration (i.e., spurious operation)	1 or 2
U	# Passive (HS) Targets	Number of passive target conductors present in the cable. Passive targets had no ability to have a physical change in state when energized from a source conductor (i.e. hot short, but not spurious event)	1 or 2
V	# Grounds	Number of ground conductors contained within the circuit	0
W	# Neutrals	Number of common return (neutral) conductors contained within the cable. In the DC circuits this designation represents any conductor connected to the negative of the power supply	1 or 2

CABLE FIRE TEST DATA LEGEND

DC Data Column	Column Identifier	Description	Variables
X	# Spares	Number of spare conductors contained within the circuit.	0, 1, or 3
Y	Circuit Type	Type of circuit used during testing	1- MOV- Motor Operated Valve 2- SOV- Solenoid Operated Valve 3- 1" Vlv- 1 Inch Valve 4- PORV- Power-operated relief valve 5- Trp- Trip Circuit Breaker 6- Cls- Close Circuit Breaker
Z	Wiring Configuration (SC, AB, NAB, GC)	Indicates wiring configuration patterns that correspond with the EPRI 1003326 report; Figure 4-7 Conductor Connection Patterns	SC- Source Centered
AA	Single Failure (only one hot short/SA per circuit) Global Approach	*Place holder column*	Information in the next 5 columns was evaluated circuits on the global approach. That is, the circuit was counted if any cable experienced at least one fault
AB	# Hot Shorts (including Spurious Actuations)	Any hot short occurred within the circuit (Active and Passive targets included)	0 or 1 (0 = No, 1 = Yes)
AC	# Hot Shorts Possible (including Spurious Actuations)	Number of hot shorts possible within the circuit (counted as one (1) for this section regardless of how many active and passive targets were present)	1
AD	# Spurious Actuations	Number of spurious operations that occurred per test ( counted as one if at least one spurious activation of an active target occurred)	0 1
AE	# Spurious Actuations Possible	Number of spurious operations that occurred per test (counted as one (1) if at least one spurious activation of an active target occurred)	1

CABLE FIRE TEST DATA LEGEND

DC Data Column	Column Identifier	Description	Variables
AF	Fuse Clear	Number of spurious operations possible within the circuit (Counted as one (1) for this section regardless of how many active targets were present)	0 or 1
AG	Target Approach	*Place holder column*	Information in the next 5 columns was evaluated circuits on the target approach. That is, each target cable was evaluated separately for hot shorts and spurious activations
AH	# Hot Shorts (including Spurious Actuations)	Number of hot shorts that occurred within the circuit (Active and Passive targets included)	0, 1, 2, 3, 4, 5, 6, 7, or 8
AI	# Hot Shorts Possible (including Spurious Actuations)	Number of hot shorts possible within the circuit (active and passive targets included)	2, 3, 4, 6, or 7
AJ	# Spurious Actuations	Number of spurious operations that occurred per test (active targets included only)	0, 1, or 2
AK	# Spurious Actuations Possible	Number of spurious activations possible (active targets included only)	1 or 2
AL	Fuse Clear	Indicated the test circuit faulted in a manner to cause a fuse clear failure without any other failure modes occurring	0 or 1
AM	HS Duration Target 1	Total duration of hot short on target conductor 1	Variable (seconds)
AN	HS Duration Target 2	Total duration of hot short on target conductor 2	Variable (seconds)
AO	HS Duration Target 3	Total duration of hot short on target conductor 3	Variable (seconds)
AP	HS Duration Target 4	Total duration of hot short on target conductor 4	Variable (seconds)
AQ	HS Duration Target 5	Total duration of hot short on target conductor 5	Variable (seconds)
AR	HS Duration Target 6	Total duration of hot short on target conductor 6	Variable (seconds)
AU	HS Duration Target 7	Total duration of hot short on target conductor 7	Variable (seconds)
AV	SA Duration	Total duration of spurious	Variable (seconds)

CABLE FIRE TEST DATA LEGEND

<b>DC Data Column</b>	<b>Column Identifier</b>	<b>Description</b>	<b>Variables</b>
	Target 1	operation on target conductor 1	
AW	SA Duration Target 2	Total duration of spurious operation on target conductor 2	Variable (seconds)
AX	SA Duration Target 3	Total duration of spurious operation on target conductor 3	Variable (seconds)
AY	SA Duration Target 4	Total duration of spurious operation on target conductor 4	Variable (seconds)
AZ	SA Duration Target 5	Total duration of spurious operation on target conductor 5	Variable (seconds)
BA	SA Duration Target 6	Total duration of spurious operation on target conductor 6	Variable (seconds)
BB	SA Duration Target 7	Total duration of spurious operation on target conductor 7	Variable (seconds)