Moving Towards more Realistic Cabinet Damage

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Potential Realism Improvement

All trains and functions that can be affected by a fire are assumed to occur at the cabinet ignition frequency.

For most cabinets, this is a mildly conservative assumption (e.g. breaker goes open/breaker goes closed).

For cabinets that control multiple trains from different power supplies, this can be overly conservative.

Industry events of cabinets with multiple trains do not show the loss of all trains (e.g. single alarm card damaged others functional, single HS malfunction, etc.).

Identification of Relevant Guidance

NUREG/CR-6850 Section 8.5.1.2 (pg. 8-10)

- In identifying damage targets, do not include components directly within or associated with the fire ignition source itself. The fire ignition source will be assumed to be damaged given any fire involving itself as the source, so further evaluation of the components as damage targets is unnecessary.

Example: for an electrical panel fire, all equipment and components within the panel will be assumed to fail. Per the definitions for the counting process, a panel will be defined as a distinct vertical section in this context.

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Proposed Approach to Enhance Realism

Use a 25% chance all functions in a cabinet are lost and a 75% chance a single function is lost. This is based on a review of the sixteen control cabinet scenarios in the Fire Events Database (FEDB) only three are considered to represent broad damage to the cabinet.

A train is defined as any equipment in the cabinet powered from the same ultimate external power supply to the cabinet. If all equipment in the cabinet is powered from the same external source, then this method cannot be applied.

This would only apply to scenarios with NO EXTERNAL damage. If the fire is large enough to damage external equipment, then larger internal losses are expected.

Data for Proposed Approach to Enhance Realism

Data (3-of-16 is wide spread damage):

FireID	Specific Component	Challenging Determination	Event Date	Fire Characterization	Fire Characterization Type	Extent Source Damage	Power Effect
69	Control Cabinet	4 U(NC-PC)	8/29/1994	Fire damaged cables in control cabinet (located in the Switchyard). Fire caused by breakdown of insulation in a control cable. The insulation breakdown was located where the insulation came in contact with a protruding tap of a wire wound power resistor. Insulation breakdown due to aging (25 years) and water intrusion.	Other (specify)	Unknown	Scram
98	Control Cabinet	2-PC	10/8/1998	During a 24 hour post maintenance run of the EDG	Smoldering combustion – internal to component	Confined to the object of origin	Entered an LCO
187	Control Cabinet	2-PC	8/16/1999	thick grey smoke observed	Flaming combustion – internal to component	Confined to the object of origin (broad/extensive damage)	None
303	Control Cabinet	2-PC	3/1/2000	Electrical short resulting in burning insulation and paint in Plant Heating Boiler Control Cabinet.	Flaming combustion – external to component	Confined to the object of origin (broad/extensive damage)	None
20272	Relay Rack	4 U(NC-PC)	9/10/1990	Unknown	Other (specify)	Confined to the object of origin	Unknown
30276	Other	2-PC	7/24/2006	Lighting battery box smoking, flames observed coming out near transformer	Flaming combustion – internal to component	Confined to the object of origin	None
30281	Relay Rack	1-CH	6/5/2008	Failed relay in controm room cabinet due to overheating. Evidence of smoke, opened panel and saw relay with failed insulation. No flaming observed.	Smoldering combustion – external to component	Confined to the object of origin (localized/single subcomponent)	None
30338	Control Cabinet	2-PC	3/30/2006	Discovered fire in blower. Extinguished using CO2. Contacted electricians to investigate problem. Electricians disconnected the blower from its power source and removed the blower from the cabinet. Blower found to be full of dust and dirt. Smoke detecter in cabinet did not alarm while the area inside the panel was hazy with smoke.	Flaming combustion – internal to component	Confined to the object of origin (localized/single subcomponent)	None
30478	Control Cabinet	2-PC	9/9/2005	Source of fire a bunch of relays, wiring sustained significant damage to insulation	Flaming combustion – internal to component	Confined to the object of origin (broad/extensive damage)	None
30513	Control Cabinet	2-PC	5/27/2008	Voltage transformer overheated and ignited combustible material located inside transformer housing	Flaming combustion – internal to component	Confined to the object of origin	None
30522	Control Cabinet	2-PC	9/12/2000	fire kept to electrical cabinet. Damage to internals with noticable charring and smoke damage, external box had some heat and smoke damage.	Flaming combustion – internal to component	Confined to the object of origin	None
50473	Wall Mounted	2-PC	6/26/2000	small flames from relay with smoke, water intrusion, sparking and smoke before power removed	Flaming combustion – internal to component	Confined to the object of origin	None
50784	Relay Rack	2-PC	11/20/2005	Testing relay, started to smoke - fuses pulled and shot with extinguisher	Flaming combustion – external to component	Confined to the object of origin (localized/single subcomponent)	None
50811	Control Cabinet	2-PC	1/9/2001	relay burning, found extinguisher and put out	Flaming combustion – internal to component	Confined to the object of origin (localized/single subcomponent)	None
83-1	Wall Mounted	2-PC	4/4/1996	Smoke was discovered in the back boards area of the control room by a security offer who was performing an hourly fire watch. Smoke was emitting from the emergency lightning UPS. Damage limited to cabinet involved and adjoining cables	Flaming combustion – internal to component	Confined to the object of origin (localized/single subcomponent)	None
83-2	Wall Mounted	2-PC	4/4/1996	DC EQUP room fire - fire limited to transformer enclosure and involved only internals.	Flaming combustion – internal to component	Confined to the object of origin (localized/single subcomponent)	None

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Example

Flow controllers for Pump A and B are in Cabinet X.

Given a per panel ignition frequency of 1E-4, the conservative and more realistic results are:

Case	Description	Impact	Conservative full Cabinet Loss Frequency	Improved Cabinet Modeling Frequency
X1	Fire within Cabinet	Both FC A and B Lost	7.00E-05	1.75E-05
X2	Fire within Cabinet	FC A lost; FC B functional	N/A	2.63E-05
X3	Fire within Cabinet	FC B lost; FC A functional	N/A	2.63E-05
X4	Fire Damages cabinet and Target	FCs A and B Lost and 1st Target	2.80E-05	2.80E-05
X5	Fire Damages whole room	Whole Room Lost	2.00E-06	2.00E-06
		Sum Check	1.00E-04	1.00E-04

Only benefit is in the Fire within a cabinet region

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Industry Benefit

Maximum site benefit is 20% CDF reduction. The average industry benefit is 2%.

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Questions