Attachment 4

Fire Ignition Source Mapping Information: Fire Frequency, Counting Instructions, Applicable Fire Severity Characteristics, and Applicable Manual Fire Suppression Curves

Fire Ignition Source Mapping Table:
See additional counting instructions at end of table.

A4.1 - Mapping Fire Ignition Source Scenarios to Fire Frequency, the Fire Severity Characteristics, and the Applicable Manual Fire Suppression Curve				
Ignition Source Bin	**Counting Unit**	**Fire Frequency per Counting Unit (/ry)**	**Use These Fire Severity Characteristics**	**Use This Manual Fire Suppression Curve**
Cables – Non-Qualified:				
Low Loading	per fire area	1.6E-05	Self-Ignited Cable Fire	Cable Fires
Medium Loading		4.8E-04		
High Loading		1.4E-03		
Electrical Cabinets:				
Switchgear Cabinets	per distinct vertical section	5.5E-05	Small Electrical Fire	Electrical Fires
		4.7E-06	Energetic Faults	Energetic Faults
General Electrical Cabinets		6.0E-05	Small Electrical Fire	Electrical Fires
General Control Cabinets		6.0E-05	Large Electrical Fire	Electrical Fires
MCR and MCR Service Cabinets	per unit control room	4.8E-03	Large Electrical Fire	Main Control Room
Electric Motors:				
Electric Motors – (< 100HP)	per motor	6.5E-04	Small Electrical Fire	Electrical Fires
Electric Motors – (≥ 100HP)		6.5E-04	Large Electrical Fire	Electrical Fires
Generators – General:				
Diesel Generators	per generator	5.6E-03	Engines and Heaters	All Events
Gas Turbine Generators		3.2E-04		
Reactor Protection System MG Sets		6.7E-04		
Hydrogen Sources:				
H2 Recombiner (BWR)	per recombiner	5.5E-03	Gas Fire	All Events
H2 Storage Tanks	per H2 tanks	6.5E-04	Gas Fire	All Events
H2 - Normally Charged Piping	per fire area with charged piping	9.7E-04	Gas Fire	All Events
Hot Work:				
Hot Work – Low	per fire area	2.3E-05	Self-ignited cable, transient, or other (see text)	Hot Work / Welding
Hot Work – Medium		6.9E-05		
Hot Work – High		6.9E-04		
Main Turbine-Generator Set:				
TG Exciter Fire	per exciter	1.4E-03	Small Electrical Fire	Turbine Generator
TG Oil Fires	per lube oil system	1.7E-03	Oil Fire	
TG Hydrogen Fires	per H2 system	1.4E-03	Gas Fire	

A4.1 - Mapping Fire Ignition Source Scenarios to Fire Frequency, the Fire Severity Characteristics, and the Applicable Manual Fire Suppression Curve				
Ignition Source Bin	**Counting Unit**	**Fire Frequency per Counting Unit (/ry)**	**Use These Fire Severity Characteristics**	**Use This Manual Fire Suppression Curve**
Miscellaneous Components:				
Air Compressors (< 100HP)	per compressor	1.6E-04	Small Electrical Fire	Electrical Fires
		1.0E-04	Oil Fire	All Events
Air Compressors (≥ 100HP)		1.6E-04	Large Electrical Fire	Electrical Fires
		1.0E-04	Oil Fire	All Events
Battery Banks	per interconnected battery set	1.9E-04	Small Electrical Fire	Electrical Fires
Boiler Heating Units	per boiler	9.7E-04	Engines and Heaters	All Events
Electric Dryers	per dryer	5.4E-04	Small Electrical Fire	Electrical Fires
Ventilation Subsystems	per major ventilation system	6.0E-05	Small Electrical Fire	Electrical Fires
Pumps:				
Reactor Coolant Pump (PWR)	per reactor coolant pump	6.2E-04	Large Electrical Fire	Electrical Fires
		3.1E-04	Oil Fire	All Events
Reactor Feed Pump (BWR)	per reactor feed pump	8.4E-05	Large Electrical Fire	Electrical Fires
		8.4E-04	Oil Fire	All Events
Main Feedwater Pumps	per main feedwater pump	2.7E-04	Large Electrical Fire	Electrical Fires
		2.7E-03	Oil Fire	All Events
Other Pumps (< 100HP)	per pump	5.0E-05	Small Electrical Fire	Electrical Fires
		5.0E-05	Oil Fire	All Events
Other Pumps (≥ 100HP)		5.0E-05	Large Electrical Fire	Electrical Fires
		5.0E-05	Oil Fire	All Events
Transformers:				
Outdoor/Yard	per transformer	4.2E-03	Very Large Fire Source	Switchyard
Indoor Dry		1.1E-04	Small Electrical Fire	Electrical Fires
Indoor Oil-Filled		1.1E-04	Indoor Oil-Filled Transformers	All Events
Transient Fuels:				
Transients – Low	per fire area	5.5E-05	Solids and Transient Combustibles	Transients
Transients – Medium		1.7E-04		
Transients – High		1.7E-03		

Additional Counting Instructions:

Electrical Cabinets - All types:

- Count distinct vertical sections
- Do not individual cubicles for devices such as breakers and MCCs - count vertical sections.
- Do not count fully enclosed wall-mounted electrical panels and junction boxes.

- General electrical cabinets include MCCs, load centers, breakers, electrical distribution cabinets, battery chargers, inverters, and all other similar cabinets generally associated with power distribution and/or power switching.
- General control cabinets include relay cabinets, signal conditioning cabinets, signal multiplexing cabinets, cabinets provided for local control of systems and components such as the diesel generator, remote shutdown panels, and all other similar cabinets generally associated with plant instrumentation and control functions.

Electrical Cabinets - MCR and MCR Service Cabinets:

- "MCR service cabinets" refers to cabinets located in an area immediately adjacent to the main control room that might be located in the main control room at another plant. Such areas are often referred to as an "auxiliary electrical equipment area", "relay room", or "relay rack room". Other names may be applied on a plant-specific basis. Not all plants will have such fire areas, in which case, these cabinets are located in the MCR itself.

Electric Motors:

- Do not count motors that are 5 HP or less.
- Do not count any motor already included as a part of another fire ignition source:
  - Pump motors are counted as part of the pump.
  - Ventilation fan/blower motors are counted as a part of a ventilation subsystem.

Miscellaneous Components - Air Compressors:

- Do not count air compressors if the drive motor is 5 HP or less.

Miscellaneous Components - Batteries:

- Count interconnected banks of batteries.
- Do not count small batteries (e.g., individual battery cells) associated with back-up power to a small component
- Do not count emergency lighting batteries.

Miscellaneous Components - Ventilation Subsystems:

- Do not count wall mounted ventilation fans if the drive motor is 5 HP or less.

Pumps - Other Pumps:

- Do not count small sampling pumps.
- Do not count pumps if the drive motor is 5HP or less.

Transformers - Indoor Dry Transformers:

- Count only transformers that are at least 1 cubic foot in size.
- Count wall-mounted transformers if they do satisfy other counting criteria.
- Do not count lighting transformers.
- Do not count control power transformers.
- Do not count small transformers integrated as an individual component within a larger electrical panel - these are included as a part of the panel.
- Battery chargers and inverters are counted as general electrical cabinets.

Likelihood Ratings for Non-qualified Cables:

- **Low** - used for areas that have a few cable trays that are generally less than half full. For example, this level may be used for a fire area where there are four vertical cables attached to one wall and each cable tray carries no more than 10 cables. Areas that will typically be assigned a low cable loading include pump rooms.

- **Medium** - used for areas that have several cable trays that are generally more than half full. For example, this level may be used for a fire area where there are four vertical cable trays attached to one wall and all four trays carry large number of cables. Typical rooms that will likely be assigned a medium cable load are areas such as a switchgear room.

- **High** - used for areas that have a large concentration of cable trays (e.g., the cable spreading room, cable vaults, cable tunnels, other areas used for general routing of cables).

For those plant areas where the only cables that are not enclosed are small sections of cables (i.e., a few feet long) that provide the power to the electrical equipment in the plant area, it may be assumed that cables have no contribution to the fire frequency of the area. For example, the room where a residual heat removal pump is located may contain no cables except for a 3 feet length of a power cable between the pump motor and the floor.

Most cable trays have ladder-type construction and are therefore open on both sides. Some trays may have a solid bottom or a sheet metal cover on top or both (i.e., solid bottom and sheet metal cover). In the latter case, the trays are not hermetically sealed. Therefore, a fire inside the cable tray may impact other adjacent cables. The analyst may elect to include such fully enclosed cable trays in the fire frequency calculation. However, some cable trays may be fully wrapped or boxed in a fire retardant material and construction. For such cases, the analyst may ignore the influence of those cable trays on the fire frequency.

Likelihood Ratings for Transients:
Criteria for assigning a relative transient fire likelihood rating focus on the following factors:

- Extent of general plant personnel traffic passing through an area - higher traffic tends to be indicative of a higher likelihood rating.
    - Exception: a roving fire watch or routine security patrols passing through an area will not be taken as indicative of a higher transient fire likelihood.
- Normal occupancy during at-power operations - higher occupancy levels and rates is taken as indicative of a higher likelihood rating.
    - Exception: continuous occupancy of the main control room will not be taken as indicative of a higher transient fire likelihood because extraordinary vigilance is expected for this fire area.
    - Exception: a continuous fire watch in a fire area will not be taken as indicative of a higher transient fire likelihood.
- The frequency of maintenance activities undertaken in the area - maintenance activities may introduce transient fuels and/or ignition sources and increases the likelihood rating.
- Storage practices for transient materials - areas will be assigned a higher likelihood rating if, by plant practice, they are use to store transient materials such as trash, maintenance materials, flammable liquids, packing materials, etc., or to stage materials in anticipation of an outage or other maintenance activity. Storage may be occasional and temporary (generally indicative of a medium rating) or continuous (generally indicative of a high rating).
- Restrictions imposed by administrative controls - less restrictive combustible materials and/or activity-related administrative controls are taken as indicative of a higher transient fire likelihood.

Given these factors, the relative transient fire likelihood rating is assigned as follows:

- **Low** - applies to fire areas that are normally closed for any type of traffic, are not visited often (no more than once per week), are not occupied during normal plant operations, and where maintenance activities would generally be disallowed during normal at-power plant operations. Furthermore, the fire area is subject to administrative controls that disallow leaving transient fuel sources unattended in the area (e.g.: no storage of transient materials is allowed; maintenance materials may not be left unattended). Examples:
    - Pipe tunnels that contain nothing but pipes, that are accessible but are not generally visited by plant personnel can be regarded as "low" transient combustible level areas.

- Low can also be assigned to a cable spreading room with cables only assuming that access to the room is strictly controlled and administrative controls are in place as described above. Low may also apply to other similar areas such as cable vault and tunnel areas.
- Low will generally apply to main control rooms.
- Low will generally apply to the containment structure.

- **Medium** - used for areas that either have occasional to frequent foot traffic (no more than once per shift and the area is not a regular access/transit pathway) or are occasionally, but not continuously, occupied during normal plant operations. Modest storage of transients may be allowed. Medium would also apply to a fire area where maintenance activities are allowed during at-power plant operation, but these activities are subject to strict administrative controls such as activity-specific permit and/or combustible controls program, and are a relatively rare occurrence (e.g., not more than once per operating year). Examples:
  - A fire area that is not normally locked but is not used as a passage to other parts of the plant may be regarded as "medium" transient combustible level area. A DC Power distribution panel room at the end of a corridor can be regarded as such a room.
  - The room is not locked, but only a few plant personnel may enter the room once or twice per shift.
  - Normal plant operations may, infrequently, involve plant personnel occupying the area for up to several hours.
  - Medium can also be assigned to a cable spreading room that contains components other than cables.
  - Items may be stored in the room on a temporary basis, for example, to conduct repair work on equipment nearby. Such storage should be infrequent rather than routine.
  - Repair/maintenance work that may result in introduction of transient fuels or ignition sources (e.g., pump oil change-out activities or routine maintenance on motor bearings) is relatively common (e.g., two or more times per year) while the plant is at power.
  - Most pump rooms and areas within the Reactor Building or Auxiliary Building would likely fall into this category (case specific exceptions are possible).
  - Most switchgear rooms would typically be ranked medium.
  - Batteries rooms would generally be ranked medium depending on the frequency of battery maintenance activities.

- **High** - used for areas that have heavy foot traffic, are frequently or continuously occupied, where transient items are typically stored, where plant refuse is routinely gathered in substantive quantities for eventual collection, where ignition sources are often brought into the area, and/or where maintenance activities during normal operation are relatively common. Examples:
  - Those parts of a power plant with characteristics similar to an office can be regarded as "high". In such an area, personnel are present for a large fraction of the time. Paper based items (i.e., letters, reports, computer printouts, etc.) are brought in and maintained in the area. Small electrical tools or appliances (e.g., hot plates, portable heaters, microwave ovens, coffee pots) may be used in the area once every few weeks or more frequently. Health physics access control areas, break room areas, any area used for food preparation, and security stations are examples. Note that this category is not intended to apply to the main control room itself, but may apply to kitchen or security areas associated with or adjacent to the main control room.
  - Any area where smoking is not prohibited or where there is evidence of smoking.
  - An area with an open trash can that routinely contains substantive quantities of general trash.
  - An area where rad protection gear (e.g., jump suits, gloves, boots, etc.) are stored or collected including turn-out/change-out areas.
  - Any area used for the storage (permanent or temporary) of flammable or combustible fluids.
  - A staging area where items are repaired or constructed before they are taken to other parts of the plant for installation.
  - An area where materials are pre-staged in anticipation of a planned outage.

- A truck loading and unloading bay.
- An area where hot work is relatively common during at-power plant operations.
- For most plants, areas within the turbine building, service building, diesel generator rooms, intake structure, and rad waste areas would typically be categorized as high for transient combustible fire potential.

Likelihood Ratings for Hot Work:
As a starting point, the same likelihood rating assigned to the fire area for transient fires is also used as the hot work fire likelihood rating. However, plant specific conditions may be considered if such information is readily available, and an alternate hot work likelihood rating may assigned as appropriate.

The hot work fire likelihood ratings are representative of the following conditions:

- **Low** - fire areas where hot work is precluded during at-power plant operations.
- **Medium** - fire areas where hot work activities might be undertaken during at-power operation, but would only be expected to occur only rarely (e.g., on the order of once per operating year).
- **High** - fire areas where hot work activities are allowed and likely to occur during at-power operation (e.g., on the order of two or more times per operating year).

Note that the above rating categories presume that all hot work activities within the plant would be subject to administrative controls (e.g., hot work permit programs and fire watches) regardless of their location.