January 17, 2013

MEMORANDUM TO: AFPB Files

FROM: Alexander R. Klein, Branch Chief ***/RA/***
Fire Protection Branch
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: CLOSE-OUT OF NATIONAL FIRE PROTECTION ASSOCIATION 805 FREQUENTLY ASKED QUESTION 12-0064 ON HOT WORK/TRANSIENT FIRE FREQUENCY INFLUENCE FACTORS

Frequently Asked Question (FAQ) 12-0064 was proposed by the U. S. Nuclear Regulatory Commission (NRC) staff through the Nuclear Energy Institute (NEI) National Fire Protection Association (NFPA) 805 Task Force to develop guidance for licensees transitioning to a risk-informed, performance-based fire protection program under Title 10 of the *Code of Federal Regulations* (10 CFR) 50.48(c).

Background

NRC staff reviewed the current guidance in NUREG/CR-6850 used to calculate hot work and transient fire frequencies by licensees as a part of several NFPA 805 applications. Several of these applications have utilized values for influence factors beyond those identified in NUREG/CR-6850. In particular, fractional values less than 1 have been applied for those influence factors which determine the hot work and transient fire frequencies in the plant. Licensees have indicated that these adjustments to NUREG/CR-6850 are necessary to produce the appropriate range of the frequencies for their fire PRA plant model. Of particular interest in these applications are influence factors formed from small fractions for areas of the plant with administrative controls on transient combustibles or hot work activities. As a part of its NFPA 805 review, the NRC staff is requesting sensitivity studies to evaluate the significance of these deviations from NUREG/CR-6850 documented influence factors.

Conclusion

Technical exchange between the NRC staff and the NEI Task Force has led to the clarification documented in Revision 1 to this FAQ which follows. The solution attached to this memorandum is the technical content of FAQ 12-0064, Revision 1, as referenced in the References section, below, with all comments accepted.

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The NRC staff finds that nothing in this FAQ would prevent continued endorsement of NEI 04-02. In accordance with RIS 2007-19, "Process for Communicating Clarifications of Staff Positions Provided in Regulatory Guide 1.205 Concerning Issues Identified during the Pilot Application of NFPA Standard 805," the guidance in this FAQ is acceptable for use by licensees in transition. The final endorsement of this FAQ will be addressed by a revision to Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

<u>References:</u>

For details regarding this FAQ, please see the following:

- FAQ 12-0064, Revision 0 (Agency-wide Documents Access and Management System (ADAMS) Accession Number ML121780013)
- Industry Response to FAQ 12-0064, Revision 0 (ADAMS Accession Number ML12216A142)
- FAQ 12-0064, Revision 1 (ADAMS Accession Number ML122550050)
- NEI 04-02, Revision 2 (ADAMS Accession Number ML081130188)
- NFPA 805, 2001 Edition (available through the Public Document Room or NFPA)
- Regulatory Guide 1.205, Revision 1 (ADAMS Accession Number ML092730314)
- NFPA 805 FAQ Process Document, Revision 1 (ADAMS Accession Number ML061660105)
- RIS 2007-19 (ADAMS Accession Number ML071590227)

Enclosure:
As stated

The NRC staff finds that nothing in this FAQ would prevent continued endorsement of NEI 04-02. In accordance with RIS 2007-19, "Process for Communicating Clarifications of Staff Positions Provided in Regulatory Guide 1.205 Concerning Issues Identified during the Pilot Application of NFPA Standard 805," the guidance in this FAQ is acceptable for use by licensees in transition. The final endorsement of this FAQ will be addressed by a revision to Regulatory Guide 1.205, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants."

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Enclosure:
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[NO CHANGES PRIOR TO SECTION 6.5.4]

6.5.4 Step 4: Mapping Plant-Specific Locations to Generic Locations

Fire ignition source bin definition, in addition to equipment type, includes a plant location (see Table 6-1). This step maps plant-specific locations to generic locations. The following set of generic plant locations is used in defining ignition source bins:

- Battery Room,
- Containment (PWR),
- Control Room,
- Control/Auxiliary/Reactor Building,
- Diesel Generator Room,
- Plant-Wide Components,
- Transformer Yard, and
- Turbine Building.

These generic plant locations are derived based on variety of plant constructions and naming practices. In order to use the generic frequency model, the analyst should assign various plant locations to one of the above-listed generic locations. The ultimate goal of this effort is to map the compartments defined in Task 1 (and not screened in Task 4) to one of the above listed generic locations. Therefore, the final outcome of this task is a list of plant locations and their respective generic locations. Table 6-2 provides a description of each generic location category to facilitate the mapping process described in this step. Note that location weighting factor, W_L, is addressed in Step 3, below.

Generic mapping of areas raises a number of questions about the process, since plants are generally configured differently. The primary criterion used in mapping deals with the location of equipment that serve the same or similar function(s) as the one in the generic database. The premise here is that all plants (per unit) are made up of the same general components that perform the same functions, i.e., power control, inventory control, decay heat removal, on-site AC and DC power, etc. Some of these components are housed in similar locations in different plants (e.g., turbine generator in the turbine building); these are separated in the generic plant locations. Other components vary in their location from one plant to another, e.g., battery chargers and air compressors; these are grouped in a category called “Plant-Wide Components.”

Note that naming schemes varies from plant to plant for rooms and buildings containing similar components. For example, the room(s) where service water pumps are housed are referred to as the service building, service water pump house, pump building, intake structure, etc. It is important to note that large control panels other than those in the Main Control Room (e.g., Radwaste Control Panel), as a surrogate, may be mapped as a Main Control Board type panel for the purposes of fire frequency estimation. In other words, the same frequency as that used for the Main Control Board of the Main Control Room may be assigned to those other large control panels as well. This is not to say that these other panels will be treated as if they were an extension of the Main Control Board in the Main Control Room. Rather, the intent is that an analyst may assume that the fire frequency for such cabinets would be the same as the value cited in Table 6-1 for the Main Control Board. This approach would be expected to yield a conservative frequency estimate. The alternative is to assign a portion of the plant-wide electrical cabinet fire bin (Bin 15) to such cabinets. Cabinets that are much larger than a typical plant electrical cabinet should be treated as an outlier and rules for fire frequency assignment to outlier cabinets established. For further information on this subject, refer to NFPA 805 FAQ 06-0016 (ADAMS Accession Number ML072700475).

Table 6-2
Generic Plant Location Descriptions and Weighting Factor W_L

Plant Location	Description/Clarification	Weighting Factor (W_L)
Battery Room	Plant location(s) where station batteries are located. Does not include other permanent or temporary batteries.	The number of site units that share a common set of batteries.
Containment (PWR)	PWR–The building that houses the reactor core and the rest of the primary system. Refueling floor may be part of this location in many U.S. plants.	The number of units in the site divided by the number of containment buildings.
Control Room	Plant location(s) where controls for normal and emergency plant operations are located. The control room envelope may include additional locations typically referred to as: • Auxiliary Electrical Room or Relay Room, where all plant relay logic circuits are located, • Computer room(s), and • Recreation room or kitchen connected to the control room.	The number of units in the site divided by the number of control rooms per site.

Table 6-2
Generic Plant Location Descriptions and Weighting Factor W_L

Plant Location	Description/Clarification	Weighting Factor (W_L)
Control/Auxiliary /Reactor Building	The combination of typically contiguous buildings that contain the emergency core cooling, auxiliary feedwater, emergency electrical distribution system, emergency control circuits, and other safe shutdown related systems. It would include the cable spreading room, emergency or safety related switchgear room, relay room, etc. It would not specifically include the containment where main reactor vessel is located and the fuel handling areas of the plant. Note: in BWRs, this location combination is typically referred to as the Reactor Building.	The number of units in the site divided by the number of shared control/auxiliary/reactor building considered as one structure.
Diesel Generator Rooms	Plant location where emergency diesel generators are located. This does not include temporary diesel generators.	The number of units in the site that share a common set of diesel generators.
Plant-Wide Components	All plant locations inside the global analysis boundary other than: those locations or equipment items already covered explicitly by another corresponding frequency bin or locations of no at-power fire risk significance such as the fuel handling building, office buildings, maintenance yard, maintenance shop, warehouses, security/access buildings, temporary buildings, etc.	The number of units per site.
Transformer Yard	The area of the yard where station, service, and auxiliary transformers and related items are located. This may also be referred to as the Switchyard.	The number of units in the site that share a common set of switchyards.
Turbine Building	Plant building that house turbine-generators, its auxiliary systems, and power conversion systems, such as main feedwater, condensate and other systems. Building generally consists of several elevations, including, basement, mezzanine, and turbine deck.	The number of units in the site divided by the number of turbine buildings.

Note that some care is needed in the treatment of the various “plant wide components” frequency bins (9-26). The following provides specific guidance for apportioning the frequency of these bins to specific ignition sources or locations:

- For bins 9, 10, 12-14, 16-20, 22 and 26 the fire frequency will be apportioned to components of the relevant type (e.g., air compressors, battery charges, etc.) that are counted as fire ignition sources (see Step 6) as those items are located throughout the plant. That is, for these fire frequency bins there are no other overlapping frequency bins to consider and no risk-relevant locations are excluded.
- For bins 15, 21, 23a and 23b the plant wide fire frequency is apportioned to components of the relevant type (i.e., electrical cabinets, pumps, and transformers) that are counted as fire ignition sources (see Step 6) and that are not already covered by another more specific frequency bin. That is, in these cases there are overlapping fire frequency bins that need to be considered and, in particular, the following exclusions apply:
    - In the case of electrical cabinets, plant-wide bin 15 *excludes* the MCB in the MCR which is covered by bin 4. Bin 15 *includes* any other main control room electrical cabinets not part of the MCB (see Appendix L for further discussion of the MCB). Bin 15 also *excludes* battery chargers which are covered by bin 10.
    - In the case of pumps, plant-wide bin 21 *excludes* the reactor coolant pumps and main feedwater pumps which are covered by bins 2 and 32 respectively.
    - In the case of transformers, plant-wide bins 23a and 23b *exclude* transformers in the transformer yard which are covered by bins 27-29.
- Bins 11, 24 and 25 are the plant-wide fire frequency bins for general transients and transient activities (e.g., hot work). For these bins the frequency is apportioned to all *plant locations* not already covered by the more specific transient and hot work related fire frequency bins. In particular, plant-wide bins 11, 24 and 25 *exclude* locations associated with the turbine building (covered by bins 31, 36 and 37), the control/aux/reactor building complex (covered by bins 5, 6 and 7) and containment (covered by bin 3). For example, the frequency of general transient fires for locations within the turbine building is based on apportioning bin 37, and bin 37 *only*. There is no contribution from the corresponding plant-wide bin 25 to turbine building locations.

[NO FURTHER CHANGES UNTIL: Section 6.5.6]

[THE CHANGES TO SECTION 6.5.6 HAVE INCOPORATED FAQ 07-0031 (CLARIFICATION OF MISCELLANEOUS IGNITION SOURCE BINNING ISSUES). THEY DO NOT, HOWEVER, INCLUDE THE ELECTRICAL CABINET COUNTING EXAMPLES PROVIDED IN FAQ 06-0016 OR THE HEAF GUIDANCE FROM FAQ 06-0017.]

6.5.6 Step 6: Fixed Fire Ignition Source Counts

[CHANGES TO SECTION 6.5.6 ARE LIMITED TO CLARIFIED COUNTING GUIDANCE FOR IGNITION SOURCE BINS: 1, 9, 10, 14, 21, 23 AND 26.]

- *Bin 1– Batteries (Battery Room):* Each bank of interconnected sets of batteries located in one place (often referred to as Battery Room) should be counted as one battery set. Cells may not be counted individually.
  - Bin 1 *excludes* small batteries that may be associated with items such as emergency lighting, backup power supplies for individual instruments, and those associated with the starting system for an engine (e.g., such as a diesel driven fire pump).

[NO CHANGES TO BINS 2 THROUGH 8]

- *Bin 9– Air Compressors (Plant-Wide Components):* This bin covers the large air compressors that provide plant instrument air included in the Internal Events PRA Model. These compressors are generally well-defined devices. They may include an air receiver, air dryer, and control panel attached to the compressor. These items should be considered part of the air compressor. If portable compressors are part of the model, those compressors should also be included in the equipment count for this bin. Note that compressors associated with the ventilation systems are not part of this bin. Small air compressors used for specialized functions are also not part of this bin.
  - Bin 9 *excludes* air compressors that are an integral part of a self-contained (e.g., skid-mounted) diesel generator set. For these types of generator sets the compressor is considered a part of the generator set and the entire unit is counted as one diesel generator set. However, Bin 9 includes air compressors associated with other diesel generator sets that may be permanently installed in the plant but mounted separately from the diesel generator itself.
- *Bin 10– Battery Chargers (Plant-Wide Components):* These are generally well defined items associated with DC buses. Each charger should be counted separately.
  - Bin 10 excludes any small battery chargers that may be associated with, for example, emergency lighting or a small engine (e.g., for an engine driven pump or portable generator) that includes a small battery (or battery set) for engine starting. Battery chargers to be counted are those associated with the battery banks counted in ignition source Bin 1.

[NO CHANGES TO BINS 11 THROUGH 13]

- *Bin 14– Electric Motors (Plant-Wide Components):* The electrical motors with power rating greater than 5hp associated with various devices, not including those counted in other bins, are included in this bin. This may include elevator motors, valve motors, etc, with the following clarifications:
  - This bin includes any electric motor with a rating greater than 5 hp unless the motor meets one (or both) of the two exclusionary provisions immediately below. The bin excludes motors with a rating of 5 hp or less regardless of motor application.
  - This bin excludes electric motors that are attached to equipment already identified and counted in other bins (i.e., reactor coolant pumps, air compressors, dryers, pumps, RPS MG sets, and ventilation subsystems). That is, motors associated with a piece of equipment counted as a part of another ignition source bin are not counted separately as motors, but rather, are considered an integral part of the larger equipment item (the pump, the compressor, etc.).
  - This bin *excludes* any motors, including MOV drive motors, which are totally enclosed regardless of the motor size. A totally enclosed motor is defined by the National Electrical Manufacturers Association (NEMA) as "a motor designed without air openings so there is no free exchange of air between the inside and outside of the enclosure but not necessarily air or water tight" (Reference: NEMA MG 2-201, Rev. 1, 2007, "Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators"). Specifically, motors meeting the following NEMA classifications are *excluded* from the motor counting process and are not considered as ignition sources: totally enclosed machines; totally enclosed nonventilated; totally enclosed fan-cooled; totally enclosed pipe-ventilated; totally enclosed water-cooled; and explosion-proof.

[NO CHANGES TO BINS 15 THROUGH 20]

- Bin 21– Pumps (Plant-Wide Components) and large hydraulic valves: For this methodology, it is assumed that above a certain size, fire ignition is the same for all pumps. Pumps with a rating of 5 hp or less are assumed to have little or no significant contribution to risk. The number of larger pumps (>5 hp) in all plant locations defined as "Plant-Wide" should be estimated.
  - This bin excludes small sampling pumps.
  - This bin excludes pumps with a rating of 5 hp or less. This bin includes pumps rated greater than 5 hp.
  - This bin excludes pumps associated with hydraulic actuators where the pump is rated 5 hp or less. The bin includes pumps associated with larger hydraulic actuators where the pump is rated greater than 5 hp.

[NO CHANGES TO BIN 22]

- *Bin 23– Transformers (Plant-Wide Components):* This bin nominally includes any indoor transformer that is not an integral part of a larger component. In particular, all dry-type transformers with a rating greater than 45 kVA and all oil-filled transformers are included in this bin. Examples of transformers accounted for in this bin include: 4160V/480V station service transformers attached to AC load centers; low-voltage regulators; and 480V/208-120V auxiliary service transformers. The large yard transformers are not part of this bin. The number of indoor transformers should be estimated with the following clarifications:
  - This bin excludes control power transformers and other small transformers, which are subcomponents in electrical equipment. These small transformers are assumed to be an integral part of the larger component.
  - This bin includes all indoor, oil-filled transformers regardless of size.
  - This bin excludes dry-type transformers with a rating of 45 kVA or less. The bin includes all indoor dry-type transformers with a rating greater than 45 kVA.
  - This bin includes wall-mounted transformers, unless they satisfy the 45 kVA exclusionary criteria immediately above.

[NO CHANGES TO BINS 24 OR 25]

- *Bin 26 – Ventilation Subsystems (Plant-Wide Components):* This bin includes components such as air conditioning units, chillers, fan motors, air filters, dampers, etc. A fan motor and compressor housed in the same component are counted as one component. The total number of ventilation subsystems should be estimated with the following clarification:
  - This bin excludes ventilation subsystems (e.g., fans, filter banks, or compressors) driven by an electric motor rated 5 hp or less. The bin includes any ventilation subsystem with an electric motor greater than 5 hp.

[NO CHANGES TO BINS 27 THROUGH 37]

[NO FURTHER CHANGES UNTIL: Section 6.5.7.2]

6.5.7.2 Transient Combustibles and Activities

A relative ranking scheme is described here for estimating the ignition source weighting factors for ignition frequency bins involving transient combustibles or activities (i.e., hot work and general maintenance). This scheme applies to all transient fire related bins defined in Table 6-1; that is Bins 3, 5, 6, 7, 11, 24, 25, 31, 36 and 37. Note that a separate relative ranking analysis should be conducted for each bin. Occupancy level, storage of flammable materials, type and frequency of hot work type activities, and type and frequency of other general maintenance activities in a compartment are the four most important influencing factors of the likelihood of fire ignition involving a transient combustible or activity.

The following rating levels apply to all influence factors:

1. No (0)
2. Very Low (0.3)
3. Low (1)
4. Medium (3)
5. High (10)

Additional rating levels of Extremely Low (0.1) and Very High (50) are available for special cases as discussed in Table 6-3, where all the rating levels are defined within the specific context of their corresponding influence factors.

For each of the frequency bins, a set of applicable plant locations (a location set) is defined as discussed in Section 6.5.4. For general transient combustibles and transient activities (hot work) there are four location sets to be defined; namely: containment, the turbine building, the control/aux/reactor building complex, and the set made up of all other plant locations. Taken together the four location sets encompass all risk-relevant plant locations with no overlap and no exclusions. The weighting factor approach is then applied within each of these four location sets. That is, each compartment is ranked relative to the other compartments within their own location set. Compartments of one location set are not compared to compartments assigned to any other location set.

It is assumed that transient fires, consisting of fire from transient combustible and hot work, may occur at all areas of a plant unless precluded by design and/or operation. Design factors that would preclude transient fires would be features that physically prevent access to a location even if those features might be overcome by extraordinary actions (e.g., by breaching a physical barrier or through use of a cutting torch). Operational factors that would preclude transients would be features that make a location essentially uninhabitable by personnel. Examples of areas where transient fires may be excluded from the analysis include the following:

- inerted locations such as inside an inerted BWR containment during power operation,
- very high radiation areas such as a traversing in-core probe (TIP) room (or equivalent) for a BWR,

- permanently sealed cable tunnels such as poured concrete cable ways without access or cable tunnels where access ways have been closed by mortared block,
- cable tunnels with manhole or hatch access where the manholes/hatches are welded shut,
- areas physically too small to allow personnel access under any conditions (e.g., an underground cable chase), and
- areas with extreme thermal environment beyond human tolerance such as the main steam tunnel in a BWR.

In the specific case of hot work and general maintenance, the analyst must also consider the possibility that workers might undertake welding/maintenance in a location in an urgent situation. In other words, the activity could introduce hot work or general maintenance in an area otherwise precluded by the factors above. For example, a welded access cover to a cable tunnel might be cut free if urgent work was needed to avoid a shutdown. If these conditions do exist, then a minimum 0.3 (very low) ranking factor should be applied rather than assuming hot work or general maintenance would never be undertaken (None – 0.0).

A final example of design factor that would preclude transient combustibles is a location where the equipment present occupies all of the available space such that the storage or placement of transient materials would be physically impossible. One example that has been encountered here is an alternate shutdown panel room with a roll-up door that was just large enough to house the required control panels. Based on the argument that there was simply nowhere to place a transient fuel package or to store any materials, transients were assumed to be precluded from the location.

Administrative controls significantly impact the characteristics and likelihood of transient fires, but they do not preclude their occurrence, since there is industry evidence of failure to follow administrative control procedures. A range of administrative controls are credited in the weighting factor approach but are not assumed to preclude transients. It is also assumed that all areas of the plant are subject to some minimal set of administrative controls including access controls, transient combustible material controls, hot work controls, and various activity specific permitting processes. Hence, the existence of administrative controls in and of itself is not a compelling basis for exclusion of transient combustibles or transient activities (hot work). The weighting methodology *is* intended to provide additional fire frequency reduction credits to locations that are under the strictest of administrative controls.

Some areas of the plant, such as office areas (computers, cubicles, etc) and chemistry labs may have safe-shutdown cables. The fire frequency for these areas may be underestimated if the analysis consists mainly of counting plant components like electrical cabinets, pumps, etc., because these rooms do not contain plant-type sources. High-transient fire “influence factors” may be assigned to these areas in order to properly capture the fire risk.

Conversely, there may also be plant locations with strict controls on, up to and including prohibitions of, personnel access, transient combustibles, maintenance and/or hot work type activities. Such controls are expected to reduce the frequency of transient and hot work related fires in comparison to other plant locations and are credited via the location weighting factor approach. There is, however, some potential for the violation of even the strictest administrative controls; hence, there is always some potential for transient fires to occur. In many cases locations subject to very strict administrative controls also house important plant equipment or cables. Hence, there may be significant safety implications if a fire were to occur. In such areas, the lowest value transient ranking factors may be assigned to capture the reduced, albeit non-zero, likelihood of transient fires in comparison to other plant locations.

The overall intent of the weighting factor method is to reflect real differences in the relative likelihood of transient fires in various locations while at the same time preserving the overall plant-wide fire frequency for each ignition source bin. In application the analyst should consider the following points relative to the intent of the transient location factor ranking method:

1. The ranking factor numerical values assigned to each location should reflect *relative weighting values within each applicable frequency bin location set*. The relative rankings should *not* look across location sets. For example, when addressing bins 36 and 37 the analyst should not compare locations of the turbine building (the location set for these two bins) to other non-turbine building locations (e.g., to areas of the control building which is covered by bin 25 and 26).
2. The full range of the numerical ranking values is available to the analyst and should, at least nominally, be exercised for each location set. If the full range of the ranking factor values is not exercised, then fire frequency will be distributed more evenly to the applicable fire compartments. If the analyst concludes that a relatively even distribution is the correct answer for the plant and location set, then it is recommended that an explanation should be provided in the PRA documentation. It was the intent of the method that the analyst exercise the range of the ranking values within each location set to reflect their qualitative assessment of fire frequency differences. For example:
    - Bin 3 is apportioned to locations within non-inerted containment structures. The weighting factor approach is applied to any and all accessible locations within containment. Locations that are not accessible during power operations (e.g., extreme radiation areas or areas not physically accessible) may be excluded. (NOTE: The containment may represent an exception to the expectation that the full range of influence factors be exercised. In the containment, the hot work and transient frequency may be more uniformly distributed.)
    - Bins 5 and 6 represent transient fuel fires occurring within the control/aux/reactor building complex. For these two bins, the applicable locations within this complex are weighed against each other. Within this set of locations, the full range of weighting factors may, and likely will, be used in the ranking process because this complex likely contains at least some, if not all, of the locations subject to the strictest of administrative controls.

- Bins 36 and 37 are the corresponding frequency bins assigned to the turbine building. Again, the set of locations making up the turbine building are ranked relative to each other with the full range of numerical values potentially available to the analyst. In the case of the turbine building, some plants may find that no locations meet the criteria for assignment of the zero or fractional ranking values.
- Bins 24 and 25 are corresponding bins assigned to "plant-wide components." In the case of transients and transient activities, as discussed above, all those locations not already included in the prior analyses are analyzed as a set and assigned their own relative ranking values with the full range of ranking values again available.

3. The ranking value of 3 for all four ranking factors is, in a sense, the calibrating or normative value. That is, a ranking value of 3 should be assigned to locations that represent an average condition within a location set. The use of the term "average" here (including Table 6-3) does not imply a mathematically calculated mean value; rather, it implies a qualitative assessment of location set conditions and the identification of an intermediate condition (an average condition) falling between those locations that will receive the higher ranking values and those that will receive the lower ranking values. All locations within a location set are then weighed against the established intermediate normative condition. If the ranking values are assigned with a bias towards lower numerical values (e.g., many 1's and no 10's or 50's) then the methodology will provide limited analysis benefit and frequency will be distributed more or less evenly across all locations. There should be no perception of a stigma associated with an assignment of 10 or 50 to a particular location. The activities being ranked will vary between plant areas and that variation should be reflected in the analysis.
4. The descriptions of various ranking levels are intended to provide a general context for the ranking approach. The broad descriptions of what is considered low, normal, high or very high should *not* be viewed as absolute descriptors, but rather, should be viewed as broad descriptors that should be tailored to the specific application. Again, the overall intent is that 3 represent the typical or average location.
5. The effect of the ranking approach that will most profoundly impact the risk results is the reduction of fire frequencies assigned to tightly controlled and/or largely inaccessible plant locations. The converse effect is that, because plant wide frequency is preserved, some other plant locations will see an increased fire frequency. The intent is that both increased and decreased assignments of relative fire frequency should reflect plant conditions, plant practices and administrative controls.

The method as written potentially allows for roughly two orders of magnitude difference between the hot work induced transient fire frequencies ultimately assigned to the highest and lowest ranked locations within each location set, with a larger potential range assigned to the MCR under certain conditions. The magnitude difference for general transients is about a factor of 2 less. The range for hot work induced cable fires cannot be determined by influence factor ratings alone since the frequency is dependent on cable loading. The method is intended to ensure that no area is assigned a zero combined fire frequency for transient combustibles and activities except under extraordinary conditions (e.g., locations that are physically inaccessible during power operations). At the same time, the method is intended to reflect the benefits gained from administrative controls including access controls, hot work control programs, transient combustible control programs, and general maintenance controls and procedures.

The four influencing factors are described below:

1. Hot work – The frequency and nature of hot work (welding, cutting and grinding) activities in a compartment will impact the likelihood of hot-work related activities. The number of hot work permits issued during power operation for different compartments during a specific time period can be used to establish a relative ranking associated with these activities. Administrative controls, and in particular, cases where hot work is prohibited during power operations, can also be considered. Special consideration is also given to specific plant locations including the MCR as well as the CSR and cable vault and tunnel areas that meet certain characteristics relative to the limits and controls placed hot work activities.
2. General Electro-Mechanical (E/M) Maintenance – The frequency and the nature of maintenance activities (preventive and/or corrective) in a compartment can impact the likelihood and characteristics of transient fires. Maintenance activities will lead to introduction of transient combustible materials and transient ignition sources increasing the likelihood of fires involving transient combustibles. This includes an increased potential for hot work initiated transient fuel fires depending on the nature and frequency of hot work maintenance activities. The general maintenance weighting factor depends in part on the type of equipment in the compartment, maintenance procedures, and housekeeping practices. The number of general work orders issued during power operation for different compartments of the plant during a specific time period can be used to establish the relative ranking associated with maintenance activities.

   The analyst should use engineering judgment to determine the maintenance factor of compartments with no work orders in the selected period of time. The judgment can be based on the characteristics of the compartment relative to compartments with work orders. If the work orders cannot be collected easily, the analyst may use engineering judgment based on personal experience or information gathered from the maintenance personnel of the plant. In this case, the analyst may ask the maintenance personnel to assign a rating number between 0 and 10 in terms of frequency of maintenance at a compartment and to identify the two or three most typical maintenance activities undertaken (e.g., pump overhaul or electrical device replacement).

   The type of maintenance undertaken is also a relevant consideration when ranking locations. For example, an oil change on a large pump or motor is quite different from switching out a modular instrument device. The relative likelihood that the types of maintenance activities undertaken might lead to a fire, the quantity and nature of transient combustible materials associated with the activities, the nature and types of ignition sources (e.g., tools) used in the activity and other factors associated with the fire potential can also be considered when assigning the weighting factors.

3. Occupancy – Occupancy level, which includes traffic, of a compartment impacts both the likelihood of transient combustibles (within the limits specified by plant housekeeping program) present in the compartment and the likelihood of ignition. Engineering judgment may be used to determine the occupancy factor.
4. Storage – Temporary or permanent storage of combustible/flammable materials in racks, cabinets, and other forms can impact the frequency and characteristics of transient fires initiated in compartments where such storage racks/cabinets are placed. The amount, type, and frequency of the use of stored materials should be taken into account. Engineering judgment augmented with plant walkdowns may be used to determine the storage factor.

Table 6-3 provides a description of these levels for each influencing factor. The following additional comments are noted.

- The influencing factors for hot work and general maintenance should be based on the frequency and type of activities. The information obtained from work order counts or maintenance staff should be translated to the levels defined here.
- This exercise should consider all compartments affected by the maintenance activity. For example, if lube oil is staged in the turbine building for diesel generator oil change, both the turbine building and diesel generator room are considered affected by this maintenance activity.
- A low rating should be assigned to those compartments where administrative procedures prohibit welding and cutting, maintenance, or the storage of combustible materials (as applicable to the rating factor) during power operation but do not meet the criteria for the very low or extremely low ranking values.
- Areas requiring special dose rate monitoring (i.e., high radiation areas or greater where monitoring is required beyond that routinely required for general plant personnel) may be assigned a low occupancy level, unless personnel need to walk through these areas to access other areas of the plant.

Since the different transient fire bins address different plant locations and activities, the influencing factors should be evaluated separately for each case. The following notes are provided for the various bins:

- For general transient fires (i.e., Bins 3, 7, 25 and 37), the influence factors associated with general maintenance, occupancy and storage should be evaluated.
- For transient fires caused by welding and cutting (i.e., Bins 6, 24, and 36), only the hot work factor is applied and should be evaluated.
- For cable fires caused by welding and cutting (i.e., Bins 5, 11, and 31), only the hot work influencing factor should be evaluated. The hot work factor is then weighed in combination with a relative numerical estimate of the quantity of cables in the

location to the total quantity of cables in the entire location set to generate the final location weighting factor.

- For some factors, a ranking of “very low” requires that access be “strictly controlled” which, in this context, means that location access controls go beyond simple key-card type access. Features meeting this condition would include, for example, the following:
  - special entry permitting procedures are in place (e.g., access into containment during power operations would be an involved process),
  - confined space access controls are imposed (i.e., per OSHA requirements),
  - limited personnel access lists are established,
  - extra security controls such as locked doors with limited access keys,
  - verbal notification of entry and exit to security or operations personnel is required in a specific location,
  - entry is prohibited without health physics or radiation protection technician present,
  - entry is prohibited without a fire watch, and/or
  - personnel safety tag-outs are required to lock out an automatic suppression system (e.g., Halon or CO2) prior to entry or prior to conducting a maintenance activity (note this last example may not apply equally to all factors; e.g., it may apply to hot work but not storage).

Table 6-3
Summary Description of Transient Fire Influencing Factors

Influencing Factor	**Ranking value**	**Where Applicable**
General Electro-Mechanical (E/M) Maintenance (excluding hot work)	**No (0)**	General electro-mechanical maintenance activities during power operation are precluded by design and/or operation (see discussion in Section 6.5.7.2).
	Very Low (0.3)	A “0.3” rating may be applied only to locations meeting the strictest of access controls, that are largely devoid of equipment, and that contain no equipment subject to frequent maintenance. This rating may be applied provided that (1) access to the location is strictly controlled (see discussion above), and (2) the location contains no plant equipment or components other than cables, fire detectors, junction boxes and other minor plant support equipment such as normal and emergency lighting, access control panels, plant paging or communications equipment, alarms or alarm panels, and security monitoring or support equipment. In general, the presence of any piece of equipment that was

Table 6-3
Summary Description of Transient Fire Influencing Factors

Influencing Factor	Ranking value	Where Applicable
		counted as a fire ignition source during Step 6 would preclude assignment of “very low” for this factor. Conversely, it cannot be assumed that the lack of countable fire ignition sources implies that the very low ranking factor applies. If equipment items are present that may require maintenance but do not meet the counting criteria (e.g., smaller pumps, motors or ventilation subsystems) then the very low ranking factor would not apply. Application of this ranking value requires verification that no violations of the controls associated with transient combustibles and activities have occurred over a reasonable prior time period (i.e., five years). This rating may not be applied to the MCR but may be applied to a cable spreading room (CSR) devoid of other equipment, and cable vault and tunnel areas meeting the criteria. Other plant locations may also be assigned the “very low” (0.3) ranking factor provided all of the defined criteria are met.
	Low (1)	Small number of PM/CM work orders compared to the average number of work orders for a typical compartment. A “1.0” ranking may be applied to general plant locations where strict permitting procedures are enforced, but do not meet the requirements for a “0.3” (very low) rating factor. Application requires verification that either (1) no violations of the controls associated with transient combustibles and activities have occurred over a reasonable prior time period (i.e., five years) or (2) a performance monitoring program is in place and demonstrates that the administrative control programs are meeting expectations and objectives.
	Medium (3)	Average number of PM/CM work orders.
	High (10)	Large number of PM/CM work orders compared to the average number of work orders for a typical compartment.
	Very High (50)	This specialized General E/M factor should be assigned to plant areas that may experience significantly more PM/CM work orders compared to the average number of work orders for a typical compartment.

Table 6-3
Summary Description of Transient Fire Influencing Factors

Influencing Factor	Ranking value	Where Applicable
Hot work	**No (0)**	Hot work activities during power operation are precluded by design and/or operation (see discussion in Section 6.5.7.2).
	Extremely Low (0.1)	This specialized Hot Work factor of 0.1 may be applied to the MCR provided plant procedures prohibit hot work in the MCR during power operations. Application requires that a review of plant records be performed and the review confirms that no violations of, or exceptions to, the MCR hot work restrictions while at power have been recorded over some reasonable prior time period (i.e., five years).
	Very Low (0.3)	May be applied to the CSR and to cable vault and tunnel areas provided that (1) access to the location is strictly controlled (see discussion above), (2) the location contains no plant equipment or components other than cables, fire detectors, and junction boxes, (3) hot work during power operations is prohibited by plant procedures, and (4) a review of plant records is performed and confirms that no violations of those plant procedures have been recorded over some reasonable prior time period (i.e., five years). This 0.3 ranking may also be applied to the MCR if the previous conditions for an extremely low ranking of 0.1 are not satisfied.
	Low (1)	Small number of hot work related PM/CM work orders associated with hot work compared to the average number of work orders for a typical compartment. This would include general plant locations where plant procedures generally preclude hot work activities with exceptions subject to the strictest of permitting requirements. Application requires verification that either (1) no violations of the controls associated with hot work have occurred over a reasonable prior time period (i.e., five years) or (2) a performance monitoring program is in place and demonstrates that the administrative control programs are meeting expectations and objectives.
	Medium or Average (3)	Average number of hot work related PM/CM work orders. This would be expected to be the most commonly applied rating level. All locations at the plant are assumed to be under a hot work permitting process including locations ranked as medium.

Table 6-3
Summary Description of Transient Fire Influencing Factors

Influencing Factor	Ranking value	Where Applicable
	High (10)	Large number of hot work related PM/CM work orders compared to the average number of work orders for a typical compartment.
	Very High (50)	This specialized Hot Work factor should be assigned to plant areas that may experience significantly more PM/CM work orders compared to the average number of work orders for a typical compartment.
Occupancy	**No (0)**	Entrance to the compartment is not possible during plant operation and/or operation (see discussion in Section 6.5.7.2).
	Very Low (0.3)	Compartment is bounded on all sides by controlled physical barriers and is normally un-occupied during plant operations. The compartment is not used as an access pathway for any other plant location. Entrance to the compartment is strictly controlled (see discussion above). Compartment is not accessible to general plant personnel. Access requires prior approval and requires notification to on-shift operators in the main control room.
	Low (1)	Compartment with low foot traffic or out of general traffic path.
	Medium or Average (3)	Compartments not continuously occupied, but with regular foot traffic.
	High (10)	Continuously occupied compartment.
Storage	**No (0)**	Entrance to the compartment is not possible during plant operation and/or operation (see discussion in Section 6.5.7.2).
	Very Low (0.3)	Both long-term and temporary storage of combustible materials is prohibited by administrative controls. Temporary structures comprised at least in part of combustible materials (e.g. wooden scaffolding) are not built, stored or moved into the vicinity. No violations of administrative controls have been observed for a reasonable prior period (i.e., five years). This would include fire areas where the entire fire area is designated as a “combustible free zone.”

Table 6-3
Summary Description of Transient Fire Influencing Factors

Influencing Factor	Ranking value	Where Applicable
	Low (1)	Compartment where no combustible/flammable materials are stored by practice but where combustibles may be introduced subject to a permitting process. In compartments ranked as "Low" all combustible/flammable material should be stored in closed containers and/or placed in dedicated fire-safe cabinets. Application requires verification that either (1) no violations of the controls associated with storage have occurred over a reasonable prior time period (i.e., five years) or (2) a performance monitoring program is in place and demonstrates that the administrative control programs are meeting expectations and objectives.
	Medium or Average (3)	Compartments where small quantities of low-combustibility materials (e.g., solid flame retardant materials) may exist in open storage and flammable gasses or liquids may be stored in approved containers and/or flammable combustible storage cabinets.
	High (10)	Compartments where combustible/flammable materials may sometimes be brought in and left in either open containers for a short time or in a closed container, but outside a dedicated fire-safe cabinet for an extended time. Also includes areas where larger quantities of flammable materials (e.g., radiation protection clothing, packing boxes or materials, paints, flammable liquids, oils) may be stored.

The following nomenclature is used to identify the four influence factors:

$n_{h,J,L}$ = Hot work influence factor rating of compartment J of location set L,

$n_{m,J,L}$ = General electro-mechanical (E/M) maintenance influence factor rating of compartment J of location set L,

$n_{o,J,L}$ = Occupancy influence factor rating of compartment J of location set L, and

$n_{s,J,L}$ = Storage influence factor rating of compartment J of location set L.

For *general transients* (i.e., Bins 3, 7, 25, and 37), the net weighting is based on the summation of those influence factors associated with the likelihood that transient combustible and transient ignition source might be present. For these cases the following equation should be used to establish the ignition source weighting factor:

$$W_{GT,J,L} = (n_{m,J,L} + n_{o,J,L} + n_{s,J,L})/N_{GT,L}$$

$$N_{GT,L} = \Sigma\ (n_{m,i,L} + n_{o,\ i,L} + n_{s,\ i,L})$$

(summed over i, all compartments of location set L).

In the case of *transient fires caused by welding and cutting* (i.e., Bins 3, 6, 24, and 36), the following equation should be used to calculate location specific fire frequency weighting factors:

$$W_{WC,J,L} = n_{h,J}\ /N_{WC}$$

$$N_{WC} = \Sigma\ n_{h,J}$$

(summed over i, all the compartments of location set L).

For *cable fires caused by welding and cutting* (i.e., Bins 3, 5, 11, and 31), the compartment weighting factor is based on both the relative frequency of hot work activities and the relative loading of cables in the compartment. For these cases the following equation should be used:

$$W_{CF,J} = n_{h,J}\ W_{Cable,J}\ /N_{CF}$$

$$N_{CF} = \Sigma\ n_{h,i,L}\ W_{Cable,i}$$

(summed over i, all compartments of location set L),

where:

$W_{Cable,i}$ = Cable load of compartment i, based on the ratio of quantity of cables in compartment i over the total quantity of cables in the location set.

Sample calculation for general transients

Consider a plant that has two fire compartments within a generic location set in the frequency model. The first compartment is one with a significant number of components requiring maintenance (therefore rated high for general electro-mechanical [E/M] maintenance), is not continuously occupied but has regular foot traffic (rated medium for occupancy), and has permanent storage cabinets (rated high for storage). This area resembles the turbine deck area of a turbine building. The second compartment is one that has no components requiring preventive maintenance (rate low for maintenance) or is not a staging area for maintenance activity in other parts of the plant, the compartment does not have regular foot traffic or is not *en route* to other fire compartments (rated low for occupancy). There are no storage cabinets in the compartment (rates low for storage). Cable tunnels generally have such characteristics.

Using the rating system described above, the normalized rating for general transients in each compartment may be calculated as follows:

Compartment 1:	Rating = 10+3+10 = 23	Normalized grade = 23/(23+3) = 0.88
Compartment 2:	Rating = 1+1+1 = 3	Normalized grade = 3/(23+3) = 0.12

This result will generate a transient fire frequency for Compartment 1 that is nearly eight times higher than the transient fire frequency for Compartment 2.

[END OF CHANGES]