

FAQ Number: 12-0064

FAQ Revision: 0

FAQ Title: Hot work/transient fire frequency: influence factors

Plant: N/A

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Purpose of FAQ:

Provide revision to Chapter 6 of NUREG/CR-6850, with the primary purpose to update and clarify the treatment of influence factors for hot work and transient fire frequency and to incorporate the consideration of floor area.

Interpretation of guidance? Yes. New guidance for this area has been developed as well.

Proposed new guidance not in NEI 04-02? Yes

Details:

NEI 04-02 guidance needing interpretation (include section, paragraph, and line numbers as applicable):

N/A

Circumstances requiring guidance interpretation or new guidance:

NRC reviewed the current guidance in NUREG/CR-6850 based on information provided in several NFPA 805 applications to calculate hot work and transient fire frequency. Several of these applications have utilized values for influence factors beyond those identified in NUREG/CR-6850, and thus constitute deviations from NUREG/CR-6850. Another issue is the fact the existing guidance in NUREG/CR-6850 yields transient fire frequency values that are independent of the size of the plant location. This could result in under-estimating the fire frequency for larger plant locations.

Detail contentious points if licensee and NRC have not reached consensus on the facts and circumstances:

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. The extent of the values used for influence factors may be a contentious point, as a broad range of influence factors less than 1 have been applied in the NFPA 805 applications.

Potentially relevant existing FAQ numbers:

None.

Background

Comment [vka1]: This FAQ is suggesting a revision to the text of NUREG/CR-6850 guidance. However, the FAQ process is to be used to clarify and add detail to the NRC approved guidance in NEI 04-02 and NUREG 1.205. This is therefore not an appropriate FAQ topic. The method should instead be sent to the EPRI-led review panel for appropriate technical assessment and consensus.

NRC reviewed the current guidance in NUREG/CR-6850 based on information provided to calculate hot work and transient fire frequency 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 staff is requesting sensitivity studies to evaluate the significance of these deviations from NUREG/CR-6850 documented influence factors.

Response Section:

Proposed resolution of FAQ and the basis for the proposal:

NRC has provided additional explanation on the use of influence factors and an expanded set of influence factors for the calculation of hot work and transient fire frequency. Particular fractional values have been proposed, under certain limited conditions, for influence factors for both hot work and transient fires. Other minor clarifications of Chapter 6 in NUREG/CR-6850 related to fire frequency with respect to component bins are made as well. In addition, the process of allocating the transient fire frequency is modified to include the consideration of the floor area associated with the plant locations.

If appropriate, provide proposed rewording of guidance for inclusion in the next Revision:

See below

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FIRE IGNITION FREQUENCIES (TASK 6)

[NO CHANGES PRIOR TO SECTION 6.5.7.2]

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) may be mapped as a Main Control Board. 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.

**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: <ul style="list-style-type: none"> • 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.
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.

**Table 6-2
Generic Plant Location Descriptions and Weighting Factor W_L (Continued)**

Plant Location	Description/Clarification	Weighting Factor (WL)
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 any components of the relevant type (e.g., air compressors, battery charges, etc.) 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 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~~ any item treated as MCB 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.

Comment [vka2]: The proposed wording change conflicts with existing guidance in NUREG/CR-6850 for bins 9, 10, and 14. The reference to these bins should be removed and addressed in the second bulleted discussion. Components associated with Bins 9 and 10 that are dedicated to a plant EDG would be excluded. In the case of Bin 14, although the existing guidance is less ambiguous, the term “any” could inadvertently lead a user to treat the motor in a pump application separately.

Comment [vka3]: Note the existing NUREG/CR-6850 guidance would allow any other large control panel to be designated as a MCB even if it is not actually in the MCR – from Section 6.5.4, “It is important to note that large control panels other than those in the Main Control Room (e.g., Radwaste Control Panel) may be mapped as a Main Control Board.”

- 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 6.5.7.2]

6.5.7.2 Transients

A relative ranking scheme is described here for estimating the ignition source weighting factors for ignition frequency bins involving transient combustibles or activities. 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 (0.5)**
3. Low (1)
4. Medium (3)
5. High (10)

Additional rating levels of Extremely Low (0.2) 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)

Comment [vka4]: A new weighting factor of .5 is added without explanation of why it is a .5. The existing weighting factors are relative, and form a geometric progression of 1, 3, and 10. If an additional factor between 0 and 1 is chosen, it should be .3 unless there is a basis to make it .5. The .5 is an average between 0 and 1, while the other weighting factors are in geometric progression. We believe the .5 should be a .3, unless there is a basis from historical data to make it a .5.

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 may occur at all areas of a plant unless precluded by design and/or operation, such as inside an inerted BWR containment during power operation. 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. 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

Comment [vka5]: I. We agree with this statement, but there needs to be more discussion of when/what is precluded. The words “design and/or operation” are included here, but in other places, it is just precluded by design. There needs to be some distinction in weighting factors for the following cases:

a. A key-carded door provides little interference with access. However, a locked door which can only be opened with a work permit, and a health physics or radiation protection technician in attendance provides a much greater interference with access. There needs to be a special category of access (i.e., weighting factor) which cannot be done casually, but needs permission and coordination with other plant departments.

Examples:

- i. If entrance into a room requires deactivation of a halon/CO2 system which then requires a fire watch to be posted, this is more severe than simply a locked door or a key-card.
- ii. If entrance into a high radiation room requires consultation with health physics or radiation protection, access must have a reason and is more restrictive than “casual”
- iii. In a PWR, entrance into containment is an involved process and would not be done casually.
- iv. If a room is physically uncomfortable (for example a normal temperature of 115F or cramped such as a cable tunnel), access is possible, but not likely.
- v. If a room (such as a cable vault) is only accessible through the control room, then entrance into the cable vault is difficult and limited.

b. We believe there needs to be an enhanced discussion of “design and/or operation” to indicate what types of impediments to access provide a deterrent to occupancy and storage, and specifically to address the following cases.

- i. Key carded door
- ii. Locked door with limited access to keys
- iii. Prohibited without radiation worker training
- iv. Prohibited without health physics or radiation protection technician present
- v. Prohibited without a fire watch
- vi. Prohibited without permission from shift supervisor

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) By and large, a ranking value of 3 is considered “normal” for all four ranking factors. **Hence, 3 should nominally be the most commonly applied ranking value.** 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

Comment [vka6]:) We suggest the words “average”, “most common”, “normal” not be used.

Comment [vka7]: Even if “3” represents an average room, it does not mean it is the most commonly applied ranking, or that the average of all rooms will be 3.

-If rooms within an area are sorted 33% for 1, 33% for 3 and 33% for 10, “3” is then normal, but not the average or the most common.

-It is possible that the work orders for maintenance show the following relative ranking—50% are low, 35% are medium and 15 % are high. The “average” rank is 3, but the most common ranking is 1.

-For maintenance, the weighting factors should be based on historical work order frequency. This may or may not show a normal distribution around the “3”.

-Storage and occupancy are subjective rankings and could be made to fit a normal curve.

-Since the weighting factor are set up in a geometric progression, the numerical average over a plant area for a given factor, has no intrinsic meaning and may or may not be “3”.

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.

~~(5)(6) The process for allocating the fire frequency includes the consideration of floor area as a separate variable in the methodology. Therefore, the size of the plant location should not be used as an attribute when determining the ranking value to be assigned.~~

The method as written potentially allows for roughly two orders of magnitude difference between the aggregate hot work induced ranking value ~~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 the aggregate general transients ranking value 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.

Also note that the hot work influence factor acts in a somewhat different manner than do the other influence factors. In particular, the likelihood of fire involving transient combustibles ignited by hot work activities is a function of both the frequency of hot work activities and the likelihood that transient fuels will be present. Similarly, cable fires ignited by hot work are based on both the frequency of hot work and the quantity of cables present in the location. Hence, the hot work influence factor acts as a multiplier on the other influence factors. The other influence factors (general maintenance, storage, and occupancy) generally act in summation.

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 weighing 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.

If maintenance activity of a compartment includes liquid combustible/flammable material (e.g., diesel fuel, lubricating oil), the compartment should be rated as “high.” 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.

Comment [vka8]: This is not consistent with the fire events database or industry experience. The mere allowance for the use of flammable combustible liquids in an area should not merit a “high” rating. There are tight controls placed on the use of flammable /combustible liquids including container types and liquid amounts.

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 dosimetry 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), ~~all four influence factors are evaluated including only~~ the hot work factor ~~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.

Comment [vka9]: Please provide clarification on the usage of this term, for example, does this mean:
-Access into a Radiation Controlled Area or a potentially contaminated area?
-All personnel must wear dosimeters, but are free to go in by themselves?
-An independent health physics or radiation protection technician must accompany the work crew?

Comment [vka10]: Only the hot work influence factor should be considered for the reasons described above. Hot work transients are those associated with the hot work job not typically separate activities.

**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.
	Very Low (0.5)	A “0.5” 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. Special considerations for applying this rating may be applied to the CSR and to cable vault and tunnel areas necessitate that provided that (1) access to the location is strictly controlled (e.g., controls that go beyond simple key-card type access or security notification on entry, access limited to a specialized subset of plant personnel, special entry permitting procedures, etc.), (2) the location contains no plant equipment or components other than cables, fire detectors, and junction boxes. Application 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.
	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 “0.5” (very low) rating factor. Application 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).
	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.
Hot work	No (0)	Hot work activities during power operation are precluded by design.
	Extremely Low (0.2)	This specialized Hot Work factor of 0.2 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,

Comment [vka11]: Is this design, or design and operation? For example: If a cable vault is accessible only through the control room; and permission to enter the control room must be granted by the shift supervisor; and in order to perform hot work in the cable vault, personnel must carry equipment through the control room – does this constitute “precluded by design”?

Comment [vka12]: Areas that meet this description should be considered a (0). Strict administrative controls, training, plant labeling and signage above and beyond the typical program transient controls are sufficient to justify a reduced factor over the “typical” (1.0) area.

Comment [vka13]: The wording also needs to be clarified. It can easily be interpreted to mean that it can only be credited for the CSR, and cable vault and tunnel locations. It is the intent that this only be applied in these location or any location that satisfies the criteria that is stated.

Comment [vka14]: The requirements associated with this classification of “strictly controlled” vary depending on the weighting factor being considered. Is that the intent of the updated guidance?

Comment [vka15]: This wording is too broad and subjective. In the absence of a clarification, the presence of plant paging equipment (speakers, phone), lighting, or other largely benign “plant equipment” could be taken by a user to prohibit the assigned of this ranking.

Comment [vka16]: Small and infrequent violations indicate that the administrative programs are effective at detecting and correcting issues in the benign phase. “No violations” is an inappropriate criterion.

Influencing Factor	Ranking value	Where Applicable
		or exceptions to, the MCR hot work restrictions while at power have been recorded over some reasonable prior time period (i.e., five ten years).
	Very Low (0.5)	May be applied to the CSR and to cable vault and tunnel areas provided that (1) access to the location is <u>strictly controlled</u> (e.g., controls that go beyond simple key-card type access such as special permissions, limited access lists, extra security controls, verbal notification of entry and exit, personnel safety tagouts required for automatic suppression systems, etc.), (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 0.5 ranking may also be applied to the MCR if the previous conditions for an extremely low ranking of 0.2 are satisfied, except that the review confirms no violations or exceptions over only a five-year period.
	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 no violations of the controls associated with transient combustibles and activities have occurred in the specific location or in other similar locations over a reasonable prior time period (i.e., five years).
	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.
	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.
	Very Low (0.5)	Compartment is bounded on all sides by controlled physical barriers and is normally un-occupied during plant operations. The

Comment [vka17]: The time period for historical record review should be 5 years for both Very Low and Low. Five years is typical for data sampling for many aspects of the PRA and should be sufficient for Fire PRA.

Comment [vka18]: The requirements associated with this classification of "strictly controlled" vary depending on the weighting factor being considered. Is that the intent of the updated guidance?

Influencing Factor	Ranking value	Where Applicable
		compartment is not used as an access pathway for any other plant location. Entrance to the compartment is strictly controlled (e.g., locked rooms with special access controls). 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.
	Very Low (0.5)	Both long-term and temporary storage of combustible materials is prohibited by administrative controls. Temporary structures (e.g. scaffolding) are not built 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.”
	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.
	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.

Comment [vka19]: The requirements associated with this classification of “strictly controlled” vary depending on the weighting factor being considered. Is that the intent of the updated guidance?

Comment [vka20]: How are combustibles inadvertently left from the last refueling accounted for?

Comment [vka21]: As worded, if a scaffold or any other feature that could be described as a temporary structure, regardless of the materials used (all aluminum), would preclude the use of this ranking regardless of any compensatory measure that may have been imposed. It is also noted that this weighing approach significantly reduces the risk benefit of designating and controlling a location as a transient combustible free zone.

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 and multiplied by the associated floor area. The floor area should be readily available from the plant Fire Hazards Analysis. If the floor area is not readily available, then general plant arrangement drawings should be used to develop a estimate of the floor area. The floor area determination should be based on the space as defined by the boundaries for the location. The presence of fixed items within the location need not be specifically subtracted from the floor area determination unless a substantial fraction of that space involves a single object – such as a single large tank.

For these cases the following equation should be used to establish the ignition source weighting factor:

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

where $A_{J,L}$ is the floor area of compartment J of location set L.

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

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

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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:

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

$$N_{WC} = \sum n_{h,i} A_i$$

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

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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:

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

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

(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. For the purposes of this example, this first compartment has a floor area of 10,000 ft². 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. This second compartment has a floor area of 500 ft².

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

$$\text{Compartment 1: Rating} = 10+3+10 = 23 \quad \text{Normalized grade} = 23/(23+3) = 0.88$$

$$\underline{0.88 \times 10,000 = 8,800}$$

$$\text{Compartment 2: Rating} = 1+1+1 = 3 \quad \text{Normalized grade} = 3/(23+3) = 0.12$$

$$\underline{0.12 \times 500 = 60}$$

This result will generate an aggregate transient fire ranking value for Compartment 1 that is nearly eight times higher than the aggregate ranking value for Compartment 2. When this combined with the floor area, the resulting transient fire frequency for Compartment 1 is almost 150 times higher than the transient fire frequency for Compartment 2.

Comment [vka22]: The proposed guidance remains silent on the issue of floor area. The existing guidance was presented in NUREG/CR-6850 would have nonsensical results if plant modifications involving the addition or removal of fire rated walls were to occur. Take for example a case where a very large portion of a building floor exists (assume its 10,000 ft²) as a common open space. Then assume that along one of the walls, an alcove happens to be separated from the remainder of the space by fire rated walls forming a small 100 ft² space. The transient fire frequency assigned to that alcove space would have some value based on the proposed weighting factor scheme. If the walls that form this alcove space were to be removed, then the new transient fire frequency would then be partitioned based on the ratio of floor area resulting in a nominal fire frequency reduction by a factor of 100. This example can also be described in reverse where a plant modification to 'protect' this alcove area by installing fire rated walls would have the opposite impact – the fire frequency would increase nominally by a factor of 100. It would seem if this FAQ, in its attempt to improve the treatment of this aspect of a fire PRA, should include an improved treatment. A proposed scheme would involve a multi-step process. The first step would be as currently described in the FAQ. However, the aggregate weighting factor would then be multiplied by floor area to create a floor space adjusted weighting factor. This floor space adjusted weighting factor would then be used in the partitioning of the fire frequency. In this fashion, two plant locations with equal characterizations for occupancy, storage, and maintenance, but have a 2:1 ratio in floor area would have that same ratio in their fire frequency. A modification of this construct wherein an exponent is applied to the floor area could also be explored to achieve varying influences associated with floor area. As proposed, a simple proportional scheme is suggested. If the exponent is reduced to a value less than 1, then floor area would have a lesser influence. Use of an exponent greater than 1 would increase the effect.

[END OF CHANGES]