# Module 5: Phase 2 Details

## Steps 2.1-2.4

# Module 5: Phase 2 Details

- We will cover each step and task in Phase 2:
  - Purpose/objective
  - What, why, how
  - Input/output
  - Supporting guidance
  - Some Examples – focus on a step/task

# Step 2.1: SSD path first check

- This step involves a course assessment of the designated post-fire safe shutdown path
  - Can we credit SSD path prior to development of scenarios
  - If so, what is appropriate screening CCDP value
- If we can show that the path is independent of any fire scenarios we might develop, we will credit that path right away and for all scenarios
  - Often, we may "attack" the redundant SSD path in one or more scenarios, so we won't give credit yet
- SSD credit/analysis gets refined after development of scenarios in Step 2.4 and again in Step 2.8
  - This is just a first rough cut

# Task 2.1.1: Identify SSD Path

- Path should be documented:
  - Designated SSD path under fire protection program
  - Must have supporting post-fire SSD analysis
  - Must be covered by procedures
- BTW: If the answer to any one of these is no, then you may well have a SSD finding to deal with

# Task 2.1.2 – SSD nominal unavailability

- SSD path is assigned a nominal unavailability factor
  - Possible values are limited to:
    - 1.0, 0.1, or 0.01
- 1.0 means no credit – appropriate if there are questions as to adequacy of SSD
  - e.g., given a SSD finding
- Other cases, guidance on Pg F-11

# Unavailability factors (cont.)

- Automatic steam-driven (ASD) train … including a single turbine-driven component to provide 100% of a specified function…
  - $CCDP_{2.1} = 0.1$
- One train made up of a collection of equipment that together provide 100% of a specified function…
  - $CCDP_{2.1} = 0.01$
- Major operator actions required to support SSD…
  - $CCDP_{2.1}$ = 1.0, 0.1, OR 0.01 depending on actions (complexity, feasibility, etc.)

# Task 2.1.3 – SSD path independence

- Independence has special context here:
  - SSD path should not be lost in <u>any</u> of the fire scenarios we might later develop
    - SSD path components/cables are not included in the target set for <u>any</u> of our possible fire scenarios
  - Fire scenarios definition comes later, so this requires a bit of foresight
- If path might be compromised in any one fire scenario, we don't credit the path yet
  - We still want unavailability, because later we may credit for those scenarios where the path does survive
- List of criteria on Pg F-11-13

# Independence Criteria:

- These should be assured by virtue of Appendix R compliance:
  - The licensee has identified and analyzed the SSD SSCs required to support successful operation of the SSD path.
  - The licensee has identified and analyzed SSCs that may cause mal-operation of the SSD path (e.g., the required and associated circuits).
  - The licensee has evaluated any manual actions required to support successful operation of the SSD path and has determined that the actions are feasible.

# Independence Criteria (cont.)

- This criteria might be an issue for plants taking credit for long term actions after the fire is out:
  - All manual actions take place outside the fire area under analysis
- Implication of this criterion:
  - No operator actions that take place within the fire-affected area will be credited in Phase 2
  - Feasibility of actions will be reconsidered during Phase 3 so make a note of these in your documentation

# Independence Criteria (cont.)

- These three relate to circuit analysis:
  - The licensee has conducted an acceptable circuit analysis
    - Should be a given
  - Any known unresolved circuit analysis issues that could adversely impact the operability of the designated SSD path are identified.
  - No known circuit analysis issues (e.g., a known spurious operation issue) for <u>exposed cables</u> should hold the potential to compromise operability of the identified SSD path.

# Independence Criteria (cont.)

- "Exposed cables" guidance:
  - Cables within the fire area under analysis <u>are not</u> considered exposed <u>if</u>
    - they are protected by a non-degraded raceway fire barrier with a minimum 3-hour fire endurance rating.

    OR

    - they are protected by a raceway fire barrier with a minimum one-hour fire endurance rating, the area is provided with automatic detection and suppression capability, and none of these elements is found to be degraded.

# Independence Criteria (cont.)

- "Exposed cables" guidance (cont.)
  - Cables in an adjoining fire area are not considered exposed if the fire barrier separating adjoining fire area from the fire area under analysis is not degraded.
  - If the finding category assigned in Step 1.1 was "Fire Confinement," cables located in the adjacent fire area are considered exposed unless they are protected by a non-degraded localized fire barrier with a minimum 1-hour fire endurance rating.

# Independence Criteria (cont.)

- The features discussed in previous two slides relate directly to Appendix R III.G.2 Separation strategies
- Basically, when we decide if cables are exposed or not exposed for purposes of SDP fire scenarios:
  - We do credit 3 hour separation as long as barrier is not degraded
  - We do credit 1 hour separation with auto detection and suppression as long as these features/systems are not degraded
  - We do <u>not</u> credit spatial separation within the same fire area
  - We do <u>not</u> credit exemptions or remote shutdown at this stage of analysis

# Task 2.1.4 – Screening check

- $\Delta CDF_{2.1} = DF \times (F_{Area}) \times CCDP_{2.1}$

| Table A1.2 - Phase 2 Screening Step 1 Quantitative Screening Criteria | | |
|---|---|---|
| **Assigned Finding Category (from Step 1.1):** | **$\Delta$ $CDF_{21}$ Screening Value** | |
| | **Moderate Degradation** | **High Degradation** |
| Fire Prevention and Administrative Controls | N/A | 1E-6 |
| Fixed Fire Protection Systems | 1E-5 | |
| Fire Confinement | 1E-5 | |
| Localized Cable or Component Protection | 1E-5 | |
| Post-fire SSD | 1E-6 | |

- $\Delta$ $CDF_{21}$ is lower than the corresponding value in Table A1.2 - the finding screens to Green and the analysis is complete.
- $\Delta$ $CDF_{21}$ is greater than or equal to the corresponding value in Table A1.2. The analysis continues to Step 2.2

# Step 2.2 – FDS determination

- The nature of the finding determines which types of fire scenarios MAY be relevant to risk <u>change</u>
  - If nothing about a scenario changes as a result of the degradation, then the scenario is not relevant
- This step is a quick decision process to decide which FDS's need to be considered as you develop fire scenarios
- The most complex part of this step is Task 2.2.2, FDS3 screening

# Task 2.2.1: Initial FDS Assignment

- Simple look up table:

| FDS/Finding Category Matrix | | | |
|---|---|---|---|
| **Finding Type or Category:** | **FDS1** | **FDS2** | **FDS3** |
| Fire Prevention and Administrative Controls | Yes | Yes | Yes |
| Fixed Fire Protection Systems | Yes | Yes | Yes |
| Fire Confinement | No | No | Yes |
| Localized Cable or Component Protection | | | |
| Given a High degradation | Yes[1] | Yes | Yes |
| Given a Moderate degradation | No | Yes | Yes |
| Post-fire SSD | Yes | Yes | Yes |

Note 1: For a highly degraded local barrier, the protected components/cables are treated as fully exposed and may be assumed damaged in FDS1 scenarios, depending on their proximity to the fire ignition source.

# Task 2.2.2 – FDS3 screening

- We would really like to drop FDS3 if we can – most of the time you will
  - Multi-area scenarios are rarely risk important so long as the barriers are intact
  - FDS3 is the equivalent of the "multi-room" term in the old SDP
- If the inter-area barrier is degraded, you're stuck
  - This screening task only applies to findings that are not Fire Confinement category
  - We already did an equivalent screening for the Fire Confinement case in Phase 1 (Step 1.3.2) so we do not repeat

# FDS3 screening (cont.): Exposing and Exposed areas

- Given that the finding is anything other than fire confinement, the fire area you are inspecting is always the exposing fire area
  - The fire always starts somewhere in the exposing fire area
- The exposed fire area may be any adjacent fire area – up, down, sideways
  - You will be evaluating the potential risk due to fire spread to an exposed fire area
- You are going to look for a fire in the exposing fire area that is substantial enough to challenge the fire area's boundaries and spread to the exposed fire area causing additional unique damage there

# FDS3 screening (cont.): How it works

- Series of yes/no questions
  - You start in the Exposing fire area – where the finding is
  - Apply the questions looking at each adjacent fire area as a potential Exposed fire area
  - Look for any one area pair that might give you a credible scenario
  - If FDS3 scenarios do not screen out, you will ultimately identify one area to act as the representative exposed fire area
    - Pick the worst case and go with it – usually based on interesting targets (e.g., redundant safe shutdown path)
    - You won't analyze all combinations in detail
- Questions are virtually identical to those in Task 1.3.2
  - Same general intent and basis
  - Only difference is we assume the barrier between the fire areas is not degraded
  - Words relating to fire endurance rating of the barrier "in it's degraded condition" are dropped

# You are going to drop FDS3 if:

- Fire area boundaries for the exposing fire area have minimum 2 hour fire performance
  - You may have a mixed bag of barriers – some 2-hour, some not
  - Drop any room combinations that are separated by a 2-hour barrier
  - For the rest of the questions, focus only on those combinations that don't have 2-hour separation
- The exposing fire area has:
  - Non-degraded gaseous suppression, OR
  - No more than moderately degraded full coverage water suppression, OR
  - Partial coverage water system that covers all in-situ fire ignition sources

(Meeting any one of these conditions is enough)

# You will drop FDS3 if (cont):

For these three conditions, remember to focus on specific combinations of fire areas that lack 2-hour separation:

- There are no unique targets in any exposed compartment
- Targets in any exposed compartment are at least 20 feet from the separating fire barrier and/or have passive protection with a one-hour fire endurance
- The fire barrier between fire area has at least 20 minutes fire endurance, AND in situ material won't subject barrier to direct flame impingement
  - i.e., Fire ignition sources are well away from the barrier

(Meeting any one of these conditions is enough)

# If you end up retaining FDS3 you must have found:

- A somewhat weak barrier to at least one adjacent fire area (less than 2 hours)
- Questionable or non-existent fixed suppression capability in exposing compartment
- Unique and exposed targets in the adjoining exposed fire area
- The potential for fire that can directly challenge that fire barrier element

It's not hard to develop a fire scenario out of that situation!

# Step 2.2 – Summary

- At the end of this step you will be left with one, two, or three FDS's to <u>consider</u> in the development of fire scenarios
  - We still need to develop credible fire scenarios, but this step says we will at least look for scenarios corresponding to each retained FDS
- If you drop one or more FDS's, they never come back

# Step 2.2 – One Last Point

- Step 2.2 only tells you that you need to consider the possibility of one or more fire scenarios for each FDS retained
- It does NOT say you MUST develop at lease one fire scenario for each FDS
  - Some FDS states may simply not be credible
  - e.g., FDS2 in a fire area with inadequate combustibles to create a hot gas layer
- It also does not say every fire ignition source will lead to at least one scenario for each FDS retained
  - Some fire ignition sources might contribute to only one FDS and not to other FDS's even though the other FDS's were retained

# Illustrative Example

**Finding:** A cable tray associated with the Designated Train B SSD path should have been wrapped but was not (licensee wrapped the wrong tray)

- Finding Category: Localized Cable and Component Protection
- Degradation: High
- Task 2.2.1 says nominally retain FDS1, FDS2, FDS3

- To fill out example, let's assume:
  - We know exactly where the train B tray is
  - The train B tray is routed in the first (lowest) tray among a stack of trays directly above a bank of electrical panels
  - There are various other panels and equipment in the fire area, and many train A cable trays
  - FDS3 screened out in 2.2.2

# Illustrative Example (cont.)

So lets develop scenarios!

- General Observations: Fire Sources
  - We have several fire sources around the room
  - The row of electrical panels directly below the train B tray are of particular interest, but other more remote sources may also be important

# Illustrative Example (cont.)

Scenario development (cont.)

- Second key factor in scenario development it target sets:
- Targets of interest are:
  - Train A cables throughout the room
    - Specifics lacking so we assume they are everywhere
    - Loss of any exposed tray causes loss of Train A
  - The cables in the un-wrapped Train B tray
    - Can cause loss of the post-fire SSD capability
- Implies we might have two target sets:
  - Target set 1: Loss of Train A cables only
  - Target set 2: Loss of both Train A and Train B cables
- Why not target set 3: Train B only?

# Illustrative Example (cont.)

- For the bank of electrical panels directly below the unwrapped Train B tray:
  - First exposed cable tray has Train B
  - Any tray gives us loss of Train A
  - FDS1 scenarios get us loss of both Train A and B – Target set 2
  - Do we need FDS2?? Answer: NO
    - FDS2 scenarios can't add anything new
    - We already lost both trains including the SSD train
  - For these sources, FDS1 scenarios are enough to characterize the risk change – Target set 2 applies

# Illustrative Example (cont.)

- What about fire sources remote from un-wrapped tray?
  - FDS1 scenarios will not damage train B cables – Target set 1 applies - Train A only
    - Question to ask yourself: Does the lack of a wrap on the train B cable tray change these FDS1 scenarios in any way?
    - Answer in this case: NO – FDS1 is not attacking the train B tray, so lack of thermal protection is irrelevant.
    - Result: Fires leading to loss of train A only are not relevant to the finding against the train B wrap - FDS1 scenarios need not be pursued for these fire ignition sources

# Illustrative Example (cont.)

- The remote fire ignition sources (cont.)
  - FDS2 scenarios – fire spreads to overhead cables causing a damaging hot gas layer
    - These scenarios can damage both the Train A and Train B cables
  - Are these scenarios relevant?? ASOLUTELY!
  - For the remote fire ignition sources the FDS2 scenarios characterize risk change relevant to the finding
    - We don't need to analyze the FDS1 scenarios in detail for the remote fire ignition sources

# Illustrative Example (cont.)

- To summarize:
  - Risk change will be characterized by a combination of FDS1 and FDS2 scenarios
  - For the panels directly under the train B tray, we analyze FDS1 scenarios only
  - For the other remote fire ignition sources, we analyze FDS2 scenarios only
  - For this case, we probably can characterize risk with just two fire scenarios by appropriately grouping the fire ignition sources!

# Step 2.3 – Scenario and Ignition Sources

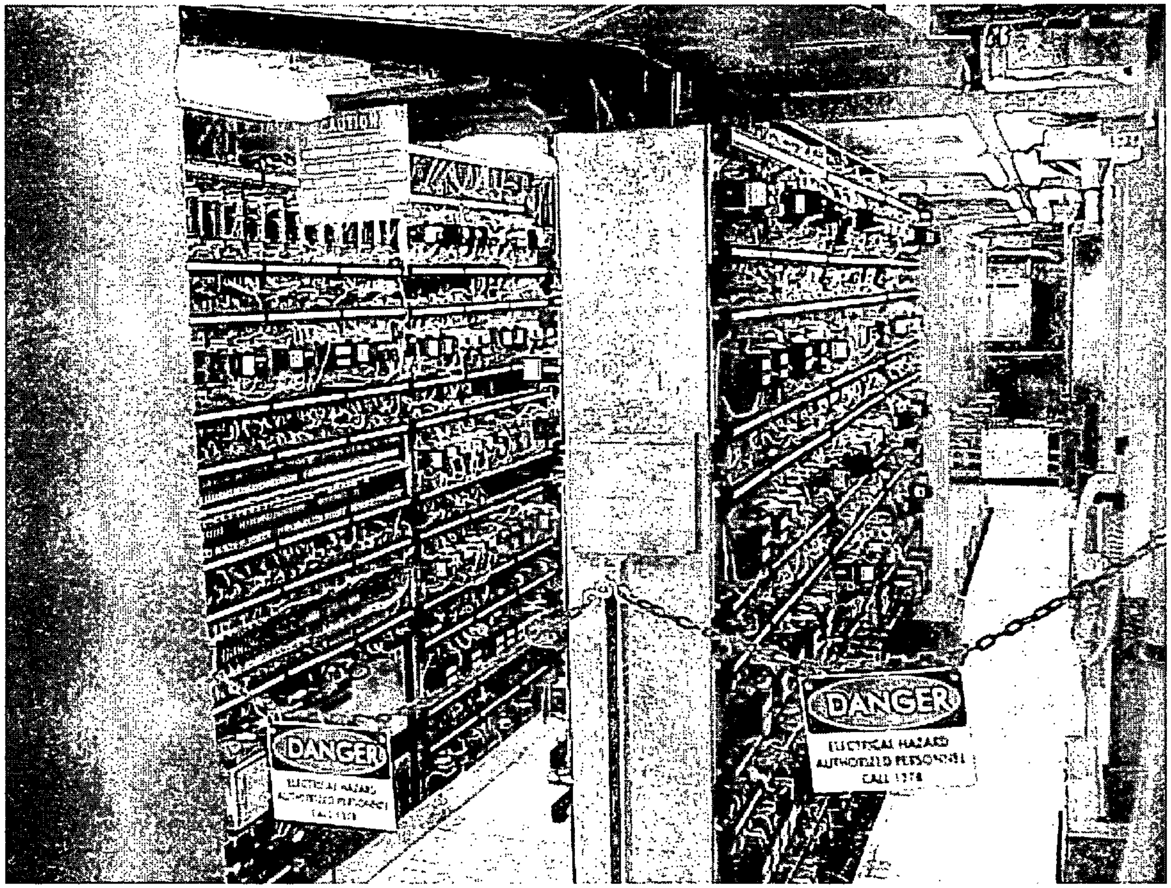
- Purpose of this step is to begin defining fire scenarios
  - That last illustrative example started us on this path!
- First point of focus is to identify fire ignition sources to be retained for further analysis
  - Identify and count fire ignition sources
  - Screen out non-threatening fire ignition sources
  - Revised room fire frequency based on retained fire ignition sources
  - Screening check using new room fire frequency

# Task 2.3.1 – Count Sources

- For most cases, we use a component-based fire frequency so first task is to count fire ignition sources
  - If you use spreadsheet, entering counting results automatically updates the fire frequency
- For transients, cables, and hot work fires, the area is ranked as High – Moderate – Low
  - There is ranking guidance provided
  - Intent is to do a relative ranking – how does this fire area compare to other fire areas in the plant?
- Any questions on counting/ranking guidance??

# There will be counting challenges

- How many "distinct vertical sections" do you see?



# Counting

- Use your judgment!
- Goal is to get a reasonable estimate of the fire frequency
  - Avoid optimism but also avoid gross conservatism
- For the illustrated relay racks, two possible options are:
  - There are some distinct divisions between sections visible that could be counted as panel divisions
    - Q: how would this weigh against general plant practice and other electrical panels? Does it seem reasonable?
  - You could assume a "typical" panel is about 3 feet wide, and assign the relay racks an equivalent panel count based on the total linear feet of racks

# Task 2.3.1 – Special cases

- For some findings, only a specific subset of potential fire ignition sources are considered
  - High degradation finding against combustible material controls – only transient fire ignition sources are relevant
  - High degradation finding against hot work fire watch – only hot work fires are relevant

# Focus on what changes

- You want to focus on fire ignition sources where a scenario will change given the finding – example:
  - If a portion of a fire sprinkler is out of service, focus on sources that would normally be covered but now are not
  - Given a lack of detection within a beam pocket, focus on fire ignition sources that are also within/under that same beam pocket
- Use your judgment and limit your search as appropriate
  - No different than what you are already doing

# Focus on what might prove to be credible

- Don't waste time worrying about fire ignition sources that will clearly not yield a credible fire scenario – Example:
  - If you have an issue in one corner of a reactor building, and there is a small fire source isolated at the opposite end of the building, Don't waste time worrying about that source
    - If it's obvious that the fire cannot spread enough to create a damaging hot gas layer, then you have no FDS2 and the scenario is not going to be credible
- Document your logic and move on.

# Task 2.3.2: Characterize Sources

- We talk about simple and non-simple fire ignition sources
  - Simple: panels, other electrical fires, transformers, engines, heaters, transients
  - Non-simple: self-ignited cable fires, energetic arcing faults, transients that exceed nominal size, hot work fires, liquids, hydrogen
- We are going to talk about simple sources now, we will cover non-simple sources in Module 6 (with examples)

# Task 2.3.2 – Simple sources

- For simple sources, pull HRR values from the lookup table for each fire ignition source
- Two values for each source:
  - Lower value represents 90% of fires – the "expected value"
  - Higher value represents upper 10% of fires – the "high confidence value"
- There is some inconsistent terminology here:
  - SDP calls the "expected value" the "$50^{th}$ percentile"
  - Fire Risk Requantification Study uses the exact same "expected value" but calls it the "$75^{th}$ percentile"
  - High confidence value: SDP says "$95^{th}$ percentile", FRRS says "$98^{th}$ percentile"
  - The HRR values are right, FRRS probably has percentiles right.

# Fire Characteristics Table

| Mapping of General Fire Scenario Characterization Type Bins to Fire Intensity Characteristics | | | | | | |
|---|---|---|---|---|---|---|
| **Fire Size Bins** | **Generic Fire Type Bins with Simple Predefined Fire Characteristics** | | | | | |
| | **Small Electrical Fire** | **Large Electrical Fire** | **Indoor Oil-Filled Transformers** | **Very Large Fire Sources** | **Engines and Heaters** | **Solid and Transient Combustibles** |
| 70 kW | 50th Percentile Fire | | | | 50th Percentile Fire | 50th Percentile Fire |
| 200 kW | 95th Percentile Fire | 50th Percentile Fire | | | 95th Percentile Fire | 95th Percentile Fire |
| 650 kW | | 95th Percentile Fire | 50th Percentile Fire | 50th Percentile Fire | | |
| 2 MW | | | 95th Percentile Fire | | | |
| 10 MW | | | | 95th Percentile Fire | | |

# Task 2.3.2 – Simple Sources (cont.)

- Assign a location for the fire origin
  - For general fire ignition sources, place origin on top of the fire source
    - e.g., a motor, transformer, etc.
  - Exceptions:
    - Cabinets/Panels: 1 foot below the top of the panel
    - Pool fires: on floor at center of pool
    - Transients: 2 feet above the floor at desired location
    - Hydrogen fires: at the point of gas release

# Tasks 2.3.3 and 2.3.4

- We need to screen ignition sources:
  - If we can ignite or damage any secondary target, we keep the ignition source
  - If we cannot damage/ignite nearest target, we drop that ignition source
- Three considerations:
  - Plume exposure
  - Radiant heating
  - Hot gas layer
- Screening is done in two tasks…

# Task 2.3.3 – Nearest target

- In this task you identify the nearest and/or most vulnerable target to each fire source
  - Don't need to define a full target set (yet), just find the one most likely to fail/ignite
- Target can be either a damage or ignition target – it's all the same to this step
  - Target's function does not matter – does not need to be a SSD component for example
- For now, we just want to know if the fire ignition source is capable of either spreading fire to secondary combustibles OR damaging one or more potential targets

# Task 2.3.3 – Nearest target (cont.)

- Look for targets directly above fire
  - Plume heating
- Look for targets off to the side
  - Radiant heating target
- If nothing else, you will have some target for hot gas layer exposure
- If you can't find a target, you should not be in that room

# Task 2.3.3 (cont.)

- Note target location relative to fire ignition source
  - Height above source
  - Horizontal distance
- Targets are almost always cables
  - For most equipment, cables are the weak spot
    - e.g., A motor will likely fail because the fire damages it's power and/or control cables, not because the fire overheats the motor itself
  - Find out if you are dealing with thermoplastic or thermoset cables
- Integrated circuit components also valid targets
  - IC components are weaker than their cables

# Task 2.3.4 – Screening sources

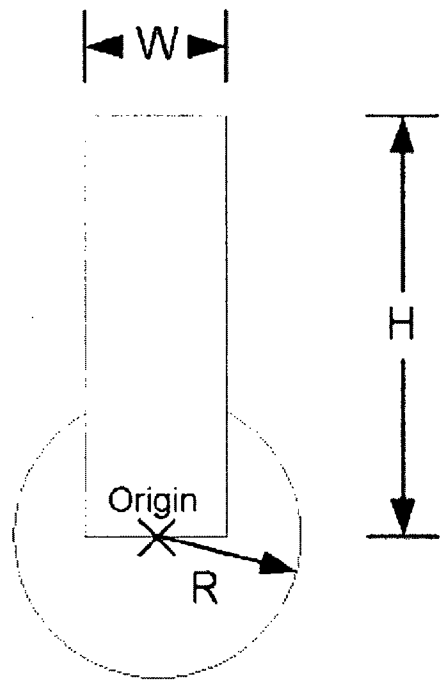
- This task decides if a given fire ignition source can spread fire and/or damage the most vulnerable target
- We do two types of check:
  - Zone of Influence (or Ball and Column)
    - Column = Plume
    - Ball = Radiant heating
  - Hot gas layer temperature

# Fire Ignitions Sources and HRR

- You must consider both the expected and high confidence HRR values for each source
  - Check the (lower) expected HRR value first
    - If you retain a source at the expected value, then you clearly keep it at the high confidence value also!
  - If expected value is not enough to retain, then check the (higher) high confidence HRR value
  - If a fire ignition source screens at both HRR values, then it drops out of the analysis entirely
    - No need to track this fire ignition source any further
  - You may retain a source at it's high confidence HRR, and screen it out the expected value
    - That's OK (more later) and probably will be pretty common

# Zone of Influence Chart

- Graphical zone of influence chart
  - Height (H) and radius (R) are from look up tables
  - Width (W) corresponds to footprint of the source



# Zone of Influence
# Typical look-up table

**For fires in an open area away from walls or corners:**

| Calculated Values (in feet) for Use in the Ball and Column Zone of Influence Chart for Fires in an Open Location Away from Walls | | | | |
|---|---|---|---|---|
| **Fire HRR** | **Thermoplastic Cables** | | **Thermoset Cables** | |
| | **H** | **R** | **H** | **R** |
| 70 kW | 4.8 | 1.8 | 3.5 | 1.3 |
| 200 kW | 7.3 | 3.0 | 5.3 | 2.1 |
| 650 kW | 11.6 | 5.4 | 8.5 | 3.8 |
| 2 MW | 18.2 | 9.5 | 13.3 | 6.7 |
| 10 MW | 34.7 | 21.3 | 25.3 | 15.0 |

Calculations are based on the following damage criteria:

Thermoplastic Cables: 400°F (325°F rise above ambient) and 0.5 $BTU/ft^2sec$

Thermoset Cables: 625°F (550°F rise above ambient) and 1 $BTU/ft^2sec$

# Zone of Influence (cont.)

- Fire location can make a difference – 3 cases:
  - Fires in the open (away from walls)
  - Fires near a wall
  - Fires near a corner
- What do we mean by "near"?
  - Near = within 2 feet of the wall
  - Near a corner = within 2 feet of both walls
- When near a wall or corner, plume effect is "magnified" (2 for a wall, 4 for a corner)
  - Separate H and R lookup tables for these two cases

# Zone of Influence (cont.)

- If there is at least one target within the zone of influence, then:
  - We have the potential for fire spread and/or damage due to plume and radiant heating effects
  - The fire ignition source is retained
- If there are no targets within the zone of influence, then:
  - Fire cannot spread from that particular ignition source to any secondary fuels
  - Plume and radiant heating effect cannot cause damage to any of the potential targets in the room
  - Need to check hot gas layer to determine if source must be retained

# Zone of Influence (cont.)

- Essentially, the zone of influence chart is a visual check
  - Have your HRR and H-R lookup tables handy when you do your walkdown
  - You can quickly perform this screening check for most of the sources in the room
  - Ball-park on distances is OK
    - If it looks really close, assume you are right at the threshold and go from there

# Zone of Influence (cont.)

- If you are dealing with a HRR value not included in the tables (i.e., any one of the standard values) you will have to re-calculate the H and R values for your fire
- FDT spreadsheets can do this
  - For H – use plume correlation and look for height where plume temperature equals damage threshold
    - Unless it's a pool fire, use a standard fire surface area of 6 square feet
  - For R – use radiant heating correlation and look for distance where flux equals damage threshold
  - Recommend you seek guidance if you are not sure

# Task 2.3.4 – Hot gas layer

- If a fire source was retained based on the zone of influence, it is retained – period
  - Only need one condition met to retain
- If a source is already retained, don't bother checking hot gas layer for that source
  - Could save you some time
  - Won't hurt if you check anyway, but it is really a waste of time at this point
- If you did not retain for zone of influence, have to double-check HGL temperature before we drop that source

# Hot gas layer (cont.)

- Check the hot gas layer temperature for any fire ignition sources that had no targets within their zone of influence
  - Nothing in the zone of influence means no spread of fire beyond the fire ignition source
  - That means for damage, fire source in and of itself has to be enough to create damaging hot gas layer
- If such sources can create a hot gas layer temperature above the failure threshold of the weakest target, the source is retained
  - This will be rare!
  - Need a pretty big source in a pretty small room

# Hot gas layer: Process

- The hot gas layer check requires use of the FDT spreadsheet tool
  - Recommendation: Use the natural ventilation spreadsheet and assume an open door (standard commercial door is 36"x84")
  - Warning: Do not run a zero ventilation case using either natural or forced ventilation spreadsheet – the correlations don't work unless there is some substantial ventilation assumed
- Required inputs:
  - Room dimensions (L-W-H); ventilation conditions; fire HRR
- Record the hot gas layer temperature at 30 minutes
- Compare HGL temperature to target damage threshold
- Fire Ignition Source screens out if HGL temperature is less than damage threshold

# Hot gas layer (cont.)

- Fire location makes no difference for hot gas layer
- That means you don't have to repeat the temperature analysis for each and every fire ignition source
- Do the calc once for each unique HRR
- The answer is the same for all fires sources at that particular HRR

# Task 2.3.4 – Summary

- You end up with a screening result for each fire ignition source – three outcomes possible:
  - Source may be retained at both the expected and high confidence HRR values
  - Source may be retained only at the high confidence HRR value
  - Source may screen out
- Note that if the source is retained at the expected HRR value, it is also retained (by definition) at its high confidence HRR value

# Task 2.3.5 – Screening check

- If no fire ignition sources were retained, then you failed to identify a credible fire scenario
  - In this case you are done – finding is green
- This requires that all sources screened out at both their expected and high confidence HRR values
  - If even one source at one HRR value is retained, you continue to next step

# Step 2.4 – Refined fire frequency

- In this step a new refined fire frequency for the fire area is calculated
  - We remove the contribution associated with fire ignition sources screened out in Step 2.3
  - We apply severity factor of 0.1 for those sources retained <u>only</u> at their high confidence HRR value
- Using the refined fire frequency, the quantitative screening check is repeated
  - New information (better fire frequency) may be enough to call a finding green

# Task 2.4.1 – Nominal fire freq.

- Enter the results of Task 2.3 into a fire frequency worksheet (or spreadsheet)
  - Counting results for <u>retained</u> fire ignition sources
  - Severity factors as applicable
    - Sources retained only at the high confidence HRR value get a severity factor of 0.1
    - Sources retained at both the expected and high confidence values use severity factor of 1.0 (no severity factor reduction)
  - Sources screened out in 2.3 are not included in the refined fire frequency
    - kind of like a severity factor of 0.0

# Task 2.4.2 – Findings that increase fire frequency

- Certain findings result in an increase in the fire frequency being applied
  - High degradation findings against combustible material control programs with low or medium likelihood rating – raise the likelihood rating one level
  - High degradation findings against combustible material control programs with high likelihood rating – multiply nominal transient fire frequency by 3
  - High degradation findings against hot work fire watch – set the hot work fire likelihood to high and multiply by a factor of 3

# Task 2.4.3 – Freq reductions

- Two cases where frequency may be reduced:
  - Transients
  - Hot work

# Reduction to transient freq.

- Transient fire frequency is reduced by a factor of 3 if verifiable measures are in place to promptly identify and remove transients from the area under analysis
  - If finding is against the combustible controls program this provision will not apply – do not reduce fire frequency

# Reductions to hot work freq.

- If it can be verified that no hot work was performed in the fire area during the finding exposure period, the hot work fire frequency may be set to zero
  - That means no hot work fire scenarios
  - If finding is against hot work control requirements (e.g., fire watch) this provision will not apply – do not reduce fire frequency

# Task 2.4.4 – Update frequency and screening check

- The fire frequency for the fire area is re-calculated considering
  - Elimination of fire ignition sources that were not retained in Step 2.3
  - Application of severity factors for ignition sources retained only at their higher fire HRR value
  - Adjustment factors as applicable for transients and hot work fires
- May be done using hand worksheet or using an electronic spreadsheet

# Task 2.4.4 – screening check

- Screening check is essentially identical to that from Step 2.1, but the updated fire frequency is applied

# Screening Criteria for Step 2.4

- $\Delta CDF_{2.4} = DF \times (F_{Area2.4}) \times CCDP_{2.1}$

| Table A1.6 - Phase 2, Screening Step 4 Quantitative Screening Criteria | | |
|---|---|---|
| **Assigned Finding Category (from Step 1.1):** | **$\Delta CDF_{2.4}$ screening value** | |
| | **Moderate Degradation** | **High Degradation** |
| Fire Prevention and Administrative Controls | N/A | 1E-6 |
| Fixed Fire Protection Systems | 1E-5 | |
| Fire Confinement | 1E-5[1] | |
| Localized Cable or Component Protection | 1E-5[1] | |
| Post-fire SSD | 1E-6 | |

[1] This entry applies to both 'Moderate A' and 'Moderate B' findings against a fire barrier.

- $\Delta CDF_{2.4}$ is lower than the corresponding value in Table A1.6 - the finding screens to Green and the analysis is complete.
- $\Delta CDF_{2.4}$ is greater than or equal to the corresponding value in Table A1.6. The analysis continues to Step 2.5