February 13, 2003

NOTE TO: File

FROM: Paul Lain, Plant Systems Branch, NRR **/RA/**

SUBJECT: FIRE PROTECTION SDP REVISION TASK GROUP CONFERENCE CALL
TEAM B: FIRE SCENARIO DEVELOPMENT

TEAM B MEMBERS:
Paul Lain, NRC
Roy Fuhrmeister, RI
Bijan Najafi, EPRI
Robert Ladd, NMC
William Stillwell, STP
Dennis Henneke, Duke Power (not in attendance)

ADDITIONAL ATTENDEES:
Dan Frumkin, NRC
Steve Nowlen, SNL

On January 17, 2003, e-mailed the team members with draft SDP revision, team assignments, and a list of team members. On February 6, 2003, a conference call was held to discuss the team assignment. The author of the draft SDP revision, Steve Nowlen, provided a discussion of the new SDP structure and team assignments.

The fire protection SDP revision task group has seven teams working on separate Phase 2 issues. Team B is assigned to develop fire scenarios that start with an ignition sources and calculate various times to Fire Damage States (FDS) and also, the time to self extinguishment. It is limited to the fire area of fire origin and does not consider suppression efforts. This approximation will provide a baseline time for which other mitigation efforts will effect. The team will interface mainly with the Fire Ignition Frequency Team, providing them with a list of fire ignition sources.

Team B's effort is divided into four sections: (1) develop a list of ignition sources such as electrical panels, motors, and transformers, (2) define for each ignition source, an average Heat Release Rate (HRR) and a maximum credible HRR, (3) develop a fire growth methodology utilizing the ignition source HRR and site specific data such as configuration of combustible loading to calculate a time temperature curve, and finally, (4) develop component damage thresholds, such as IEEE-383 cabling fails at 500^{o}C, to predict the time to FDS 1 and 2. These times will be used to evaluate the Probability of Non-Suppression (PNS). The time to self extinguishment will be used to evaluate barrier effectiveness and fire propagation into adjacent areas.

The team divided the effort in two, with Roy and Bijan working to develop the list of ignition sources with HRRs, and Paul and Robert to review existing approaches to calculate time temperature curves and component damage temperatures. A meeting is scheduled for February 20, 2003, in Rockville to assemble our efforts. Each member should review the team assignments (attached) to prepare for the next meeting. The target completion for a draft resolution to the team assignment is March 7th, with submission to SPSB on March 14th.

CONTACT: Paul Lain, NRR/DSSA/SPLB
415-2346

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ATTACHMENT: Team Assignment

Team Assignments
Team B: Fire Scenario Development Team
1/14/03

Lead Coordinator: Paul Lain, 301-415-2346, pwl@nrc.gov

Overview of Assignment

The fire development team has several key assignments. This team needs to develop guidance on how fire scenarios are going to be defined. This includes the following activities:

1. Define the fire ignition source bins to be used in analysis - the binning of fire ignition source scenarios.
2. Define the characteristics of the fires involving each fire ignition source scenario.
3. Develop an approach to quantify fire growth and damage scenarios - time to fire damage.
4. Define an appropriate fire severity factor for fire ignition source scenarios that involve the maximum anticipated/credible fire severity.

The fire scenario development team activities involve interactions with the following teams:

5. Fire Ignition Frequency Team:
    a. The binning of fire ignition sources to be defined by the fire scenario team must be provided to the fire ignition frequency team.
    b. The fire event database may provide some relevant insights relative to fire severity factors.

Special Note: The term “fire scenario” as used in the SDP document is defined in a PRA context. Hence, a fire scenario involves several stages, some of which are not included in the common fire protection engineering application of this term. Fire scenarios are defined in terms of the fire ignition source scenario, the fire growth and damage scenario, and the fire suppression scenario, and the plant SSD response. The Fire Scenario Development Team is responsible only for the fire ignition source and fire growth and damage portions.

Team Task: Fire Ignition Source Binning

Develop a list that define the fire ignition sources among broad categories. Typical fire source binning categories include the following:

6. low energy electrical panels
7. high energy electrical panels
8. batteries
9. pumps
10. motor

11. turbine generator sets
12. diesel generators
13. dry transformers
14. oil-filled transformers
15. transients (trash and other)
16. welding/cutting operations
17. self-ignited cable fires

More detailed lists can be developed (see FIVE for example), but for the SDP a relatively simple list will likely suffice.

Team Task: Fire Ignition Source Characterization

For each fire ignition source category, the team needs to define a set of fire characteristics. The approach presented in the text of Step 2.2 assumes that the team will define a mean and maximum heat release rate for each fire ignition source scenario. The idea would be to analyze the mean value and if damage/spread occurs, then you are done. If no damage/spread occurs given the mean fire, then check the maximum case. We will then visit the question of fire severity in Step 2.5. Key questions/issues:

18. Is the two-stage mean/maximum fire characteristics approach viable?
19. Define what we mean by maximum fire characteristics (e.g., do we use the 805 approach of the "maximum expected fire scenario").
20. Define fire characteristics for each fire ignition source bin (fire intensity, size, guidance on location/placement of the fire).

An alternate that gets a bit more complicated would be to look for the smallest fire that leads me to the FDS of interest. We use Step 2.2 to define the min/max range, then explore a bit with that range. We then balance the intensity leading to damage against likelihood with the severity factors in Step 2.5.

Team Task: Fire Growth and Damage Scenarios

This is one of the more challenging task areas - how to estimate fire growth and damage times. Recall that the key answer required is the time needed to reach a given fire damage state (FDS). This is the most complex part of the fire scenario problem, especially given the target audience. Key questions/issues:

21. Define information gathering needs (e.g., passive fire protection features, basic compartment geometry (height and floor space estimates), identification of fire PRA component and cable targets, and information on detection and suppression).
22. Define an approach to predict the ignition of secondary combustible fuels
23. Define an approach to deal with fires involving secondary combustible fuels.

24. Define criteria for component and cable damage. We can likely use fairly generic values such as the following: 250C for non-qualified cables, 350C for qualified cables, 100C for electronic equipment, and 200C other types of electro-mechanical components.
25. Define an approach to predict the time to damage for discrete sets of components as defined by the FDS scenario of interest.

Team Task: Fire Severity Factors

As written, the Phase 2 analysis currently includes a severity factor review step (Step 2.5). The intent of this step is to apply a severity factor to the quantification if the inspector determines that only a very large fire (e.g., the maximum expected fire) can lead to fire damage. Guidance to match this approach is needed. Key questions/issues:

26. Is the proposed severity factor review approach viable?
27. Tie the fire characteristics for each fire ignition source to a corresponding severity factor.

Note that Step 2.5 has wide implications. We have recommended a cautious approach to severity in estimating fire frequency - e.g., the fire frequency would include any event that <u>had the potential</u> to become a threatening fire. As a result we have, in effect, deferred the question of likelihood versus fire intensity to Step 2.5. If we eliminate step 2.5, then we have to whatever severity factor credit we want to allow directly into the fire frequencies and we lose the ability to tie severity factor to the scenario fire intensity. This will leave us to decide what is an appropriate fire intensity for a given fire ignition source.

Under the proposed approach, we would tie the severity factor directly to the fire intensity leading to damage once we know that answer (i.e., we have completed step 2.4). If a small fire leads to damage, then no additional severity factor. If only a really big fire leads to damage, then an additional severity factor is appropriate.

Consider panel fires as an example: we might assume all that the mean fire intensity of a panel fires is 200kW and assign a severity factor of 1.0 to this fire intensity. However, data show that panel fires as large as 1500kW are possible. We might recommend consideration of a maximum fire intensity of 1000 kW panel fire, and assume that this is a 1-in-100 fire (assign a 0.01 severity factor to this fire intensity).

The challenge will be to establish the fire intensity ranges in Step 2.2 and at the same time establish corresponding likelihood/severity factor estimates for use in Step 2.5. We need the two to line up exactly, or it won't work. In this case we are focused entirely on the fire ignition source. Subsequent fire spread (e.g., to overhead cable trays) does not effect the severity factor, this is simply the consequences of a severe fire.