P-111 INTEGRATED WORKSHOP #1

PLANNING AND PRIORITIZING INSPECTION ACTIVITIES

Objective: The student will learn how to extract risk insights from a PRA and SDP Notebook for use in planning and prioritizing inspection activities.

Method: Students will be given the North Anna SDP Notebook and material from the North Anna IPE Submittal to be used as an illustration of PRA information for carrying out this workshop. Only portions of that submittal useful for performing the workshop will be provided to the students in order to avoid ineffectual time looking through a large volume of material. Completion of this workshop should be expected to take approximately ½ day and will be given at the end of the P-111 course after all course modules have been presented.

Materials:
1) North Anna SDP Notebook
2) Summary of Major Findings from the IPE
3) Functional failure summary information from the IPE
4) List of Initiating Events from the IPE
5) Success Criteria information from the IPE
6) Event tree information from the IPE
7) Plant design and Safety Injection System information from the IPE
8) Core damage (and dominant cut sets) results information from the IPE
9) Risk importance information from the IPE
10) List of basic events and descriptions
11) Information regarding one Human Error modeled in the IPE

Instructions: By using the material provided and answering the questions in this workshop, arrive at an inspection plan to investigate aspects of the plant design and operation based on the insights gained from the IPE while performing this workshop.

Questions:

(Questions 1 – 6 illustrate how an inspector might begin to investigate "what is dominating risk at this plant." Getting "acquainted" with the dominant results and basic terminology, at least at a high level, is an important first step in gaining risk insights from a PRA. Part of this is "learning" what initiators, functional failures, systems, etc. are important to the results.)

1. Based on a review of the major findings for the IPE,
   a) What is the total plant core damage frequency (CDF) from internal events?
   b) What percentage of this total comes from LOCA-type initiators? (Note: it may be helpful to look at the initiating event list to know which designators are LOCAs – treat "R" (such as in RX sequences) as a LOCA but neglect "V" (such as in VX sequences) since this is a special class of LOCA that is not being considered here).
   c) As a class, are LOCAs among the more dominant contributing initiators to CDF?

2. Determine the following:
   a) What are the respective percent contributions to the total CDF from the following LOCA initiators: A, S1, S2?
   b) Which one of these initiator types contributes the most and what is the corresponding contribution?

3. From the summary of results for the PRA (see Section 3.4.1.2 and Table 3.4.1-8),
   a) Which functional failure (i.e., what group of functional failures) contributes most to the CDF?
   b) What is the percentage contribution?

4. Based on information in Table 3.4.1-3 in the "Core Damage Results" portion of the material provided,
   a) What are the functional failure designation and the sequence designation for the core damage sequence that contributes the most to CDF?
   b) What is the percentage contribution of this one sequence to the total CDF?
   c) What is the corresponding CDF value?
   d) Using the event tree that depicts the sequence identified in 4.a above, and the event tree designator table that describes the nomenclature, describe in general terms what initiator has occurred, what has failed in the sequence, and what is successful in the sequence?
   e) Locate this sequence on the small LOCA event tree in the SDP Notebook. Estimate the frequency of the sequence using the small LOCA worksheet table in the SDP Notebook. Is this value larger or smaller than the value for this sequence in the PRA? Explain why this should be so.

5. Using the same table as above (Table 3.4.1-3), and with help from the designators shown on the Functional Failure Table 3.4.1-8,
   a) List all the sequences (by functional failure designation and by sequence designation) with the same initiator as that for the sequence in question 4.a and identify which of

those are "injection-type" failure sequences. Identify these sequences in the SDP Notebook.

b) List all the sequences with the same initiator as the sequence in question 4.a and identify which of those are "recirculation-type failure sequences. Identify these sequences in the SDP Notebook.

6. Based on the information from question 5,
   a) What is the total percentage contribution to CDF from sequences involving this same initiator and injection failures?
   b) What is the total percentage contribution to CDF from sequences involving this same initiator and recirculation failures?
   c) For this same initiator, which contributes most, injection or recirculation failures?

(Questions 7 – 12 illustrate how an inspector might further investigate more detailed aspects of certain accident sequences and/or systems found generally to be important in the PRA. Questions 7 - 12 illustrate using the PRA to obtain more detailed information than can be obtained from the SDP Notebook.)

7. By reviewing the success criteria table for the S2 initiator, and using the event tree designator table to understand the nomenclature,
   a) How many charging pumps must fail in order to fail event D1 in the S2-LOCA event tree? Is this consistent with the success criterion in the SDP Notebook?
   b) How many low head safety injection pumps must fail in order to fail event D3 in the S2-LOCA event tree? Is this consistent with the success criterion in the SDP Notebook?
   c) How many accumulators must fail in order to fail event D2 in the S2-LOCA event tree? How does the SDP Notebook model accumulator injection for small LOCA?
   d) How many auxiliary feedwater pumps must fail in order to fail event L in the S2-LOCA event tree? Is this consistent with the success criterion in the SDP Notebook?

8. Using the basic event/description list and by reviewing the dominant cut sets for the S2P35 sequence,
   a) What single component failure, along with the S2 initiator, causes this core damage sequence? (Note: ignore the C-Y02 event; "C" stands for complement and is actually the success of the "Y" event in the S2 event tree).
   b) Is the single component failure an "active" or "passive" failure?
   c) Why does this single failure cause failure of both D1 and D3? (Hint; look at simplified schematics of systems involved).
   d) What percentage of the total sequence frequency does this one cut set contribute?
   e) What one single common cause failure, along with S2, causes this core damage sequence?
   f) What percentage of the total sequence frequency does this one cut set contribute?
   g) What percentage of the sequence frequency do these two cut sets contribute together?
   h) For certain system start/run configurations, note that check valve 254 failing open is assumed to cause "short-circuiting" of the entire charging system (i.e., flow recirculates back to pump suctions rather than into the reactor). What percentage of

the sequence frequency is made up of cut sets that contain the basic event representing failure of check valve 254? How does this valve failure fail the affected system?

i) Looking at the assumptions used in modeling failure of high-head safety injection, does the system modeling with respect to check valve 254 appear reasonable?

9. To get a feeling for the overall importance of some of the basic events from the previous two questions, not just to these S2 sequences, but to total CDF from all sequences, let's examine the risk importance tables.
   a) Is there a significant difference between the importance of the single component failure and the common cause failure you found in question 8.a and 8.e above using Fussell-Veseley importance?
   b) What about from the perspective of risk achievement worth (RAW)?
   c) Would the components represented by these events be classified by the PRA as high or low risk significance for purposes of the Maintenance Rule, using the criteria in NUMARC 93-01?
   d) Looking at both Fussell-Veseley and RAW values, qualitatively how does the check valve 254 failure (see 8.h above) compare in importance with the single component and common cause failures?

10. Often, the assumptions in the analysis are just as, or more important, than some of the PRA modeling. In the cut sets that have been reviewed, plugging of the common valve at outlet of the RWST, 1-QS-38, has shown up but the human error of inadvertently leaving the valve closed after a maintenance activity requiring it to be closed has not appeared among the dominant cut sets. Safety Injection Fault Tree Modeling assumptions # 15 and #46 provide rationale for this. Do these assumptions seem reasonable?

11. This question illustrates one way in which PRA "quality" can be examined. Looking again at the cut sets for sequence S2P35, does it appear that the success criterion for low-head safety injection has been modeled correctly in generating these cut sets?

12. Use the information you have gleaned from the IPE and SDP Notebook to construct an outline of your inspection plan. Include in the outline the items you intend to examine and be prepared to defend your choices.