

Development of Fire PRA Guide for Japanese NPPs

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2. Overview of Methodology
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1. Introduction

- ◆ Japan Nuclear Regulation Authority requires continuous safety upgrade and evaluation after restart of Japanese NPPs:
 - Safety evaluation by licensees for safety upgrade beyond regulatory requirements
 - PRA for various hazards as a part of continuous safety evaluation
 - ✓ Scope of PRA should be expanded according to maturity of methodology in step by step manner.
 - ✓ The regulatory guide for continuous safety evaluation identifies internal fire PRA as an example of scope expansion of PRA
- ◆ Japanese utilities intend to use internal fire PRA in RIDM

 NRRC, cooperating with Japanese vendors and US experts, is developing Fire PRA Guide around next year, as a common technical basis to assist Japanese utilities' fire PRA by themselves

1. Introduction (cont'd)

◆ Fire PRA Guide for Japanese NPPs:

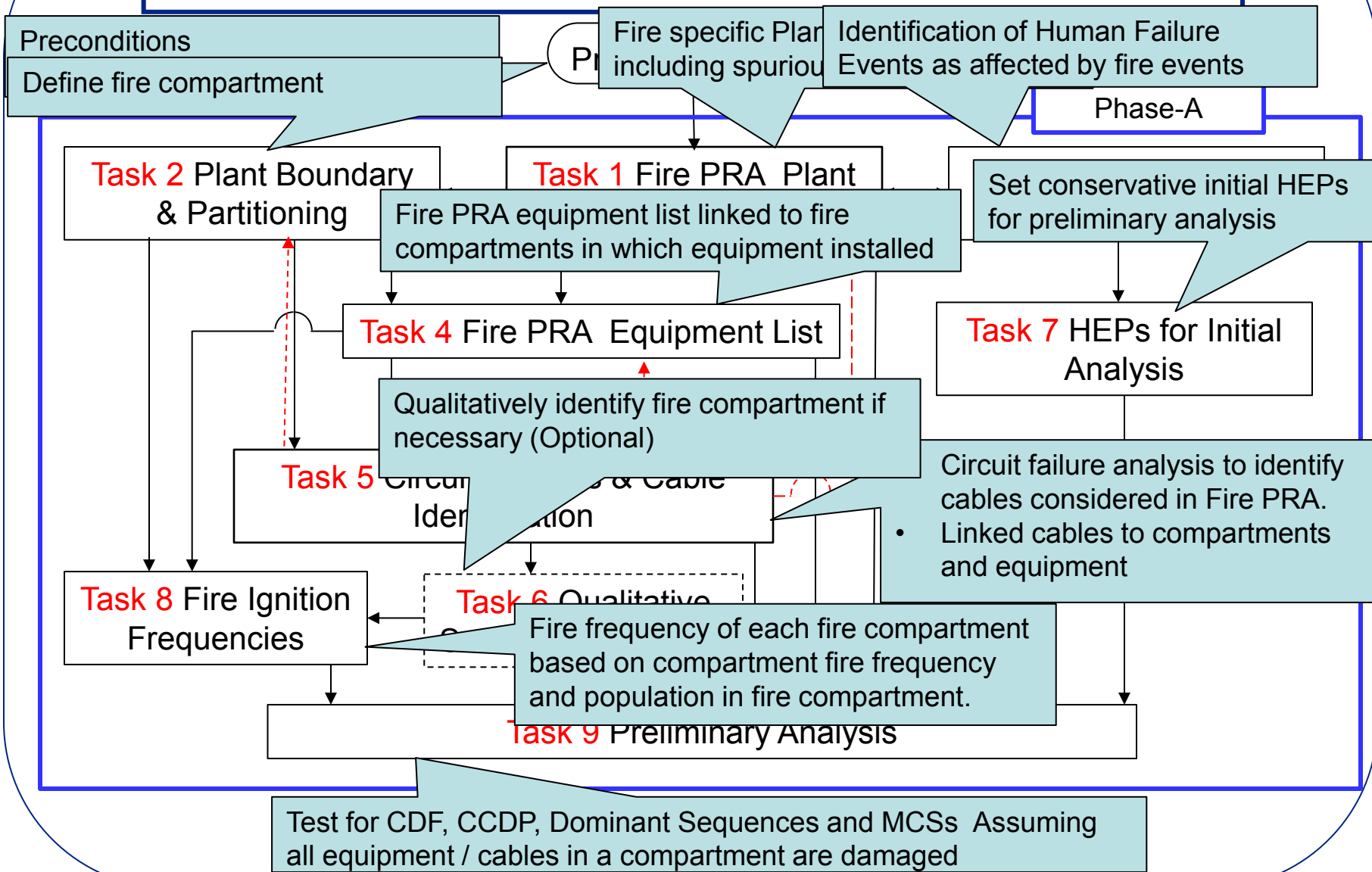
- Should be practical and realistic
- Use NUREG/CR-6850 as starting point
- Take advantage of the U.S. experience in applying NUREG/CR-6850
- Take advantage of research subsequent to NUREG/CR-6850
- Develop fire ignition frequency based on Japanese NPPs' experiences

2. Overview of Methodology

◆ Overall Task Flow

- Divide the tasks into two phases:
 - Phase-A: Setup and test run underlying model and data
 - Phase-B: Detailed analyses

2. Overview of Methodology – Phase A



2 Overview of Methodology – Phase B

Risk ranking of fire compartments assuming damage of all equipment / cables in a fire compartment

Phase-A]

Phase-B

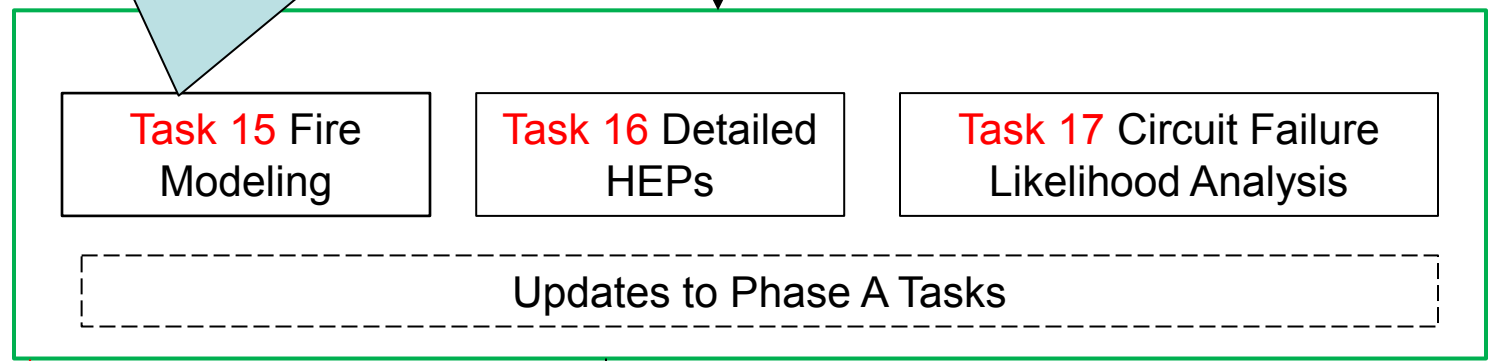
Detailed Analysis: Define fire scenarios in increasing levels of detail



Detailed fire modeling

- Fire growth and propagation analysis
- Detection / suppression analysis

System Fire
Initiation



Task 18 Quantitative Analysis

Task 19 Final Risk Quantification

Task 20 Uncertainty & Sensitivity Analysis

Task 21 Documentation

2. Overview of Methodology

◆ Overall Task Flow

- Streamline fire PRA
 - Combine some of the tasks to gain efficiency
 - Divide some of the tasks into better defined activities
 - Modularize tasks based on contents
 - Clarification of relationships among tasks

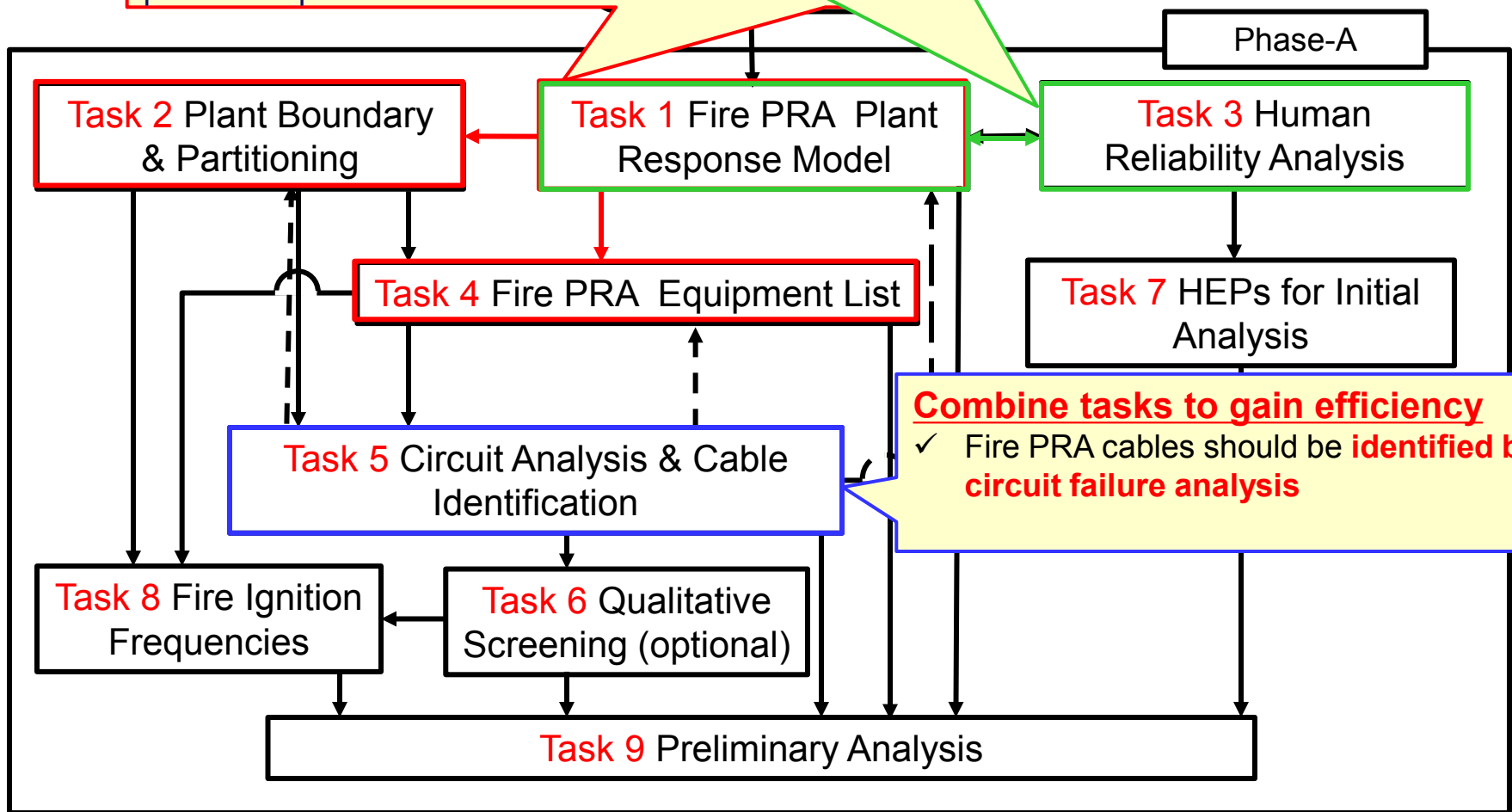
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Clarifi

Fire PRA PRM (task 1) is addressed as to provides inputs or reference to Task-4 and Task

Clarification of relationship among tasks

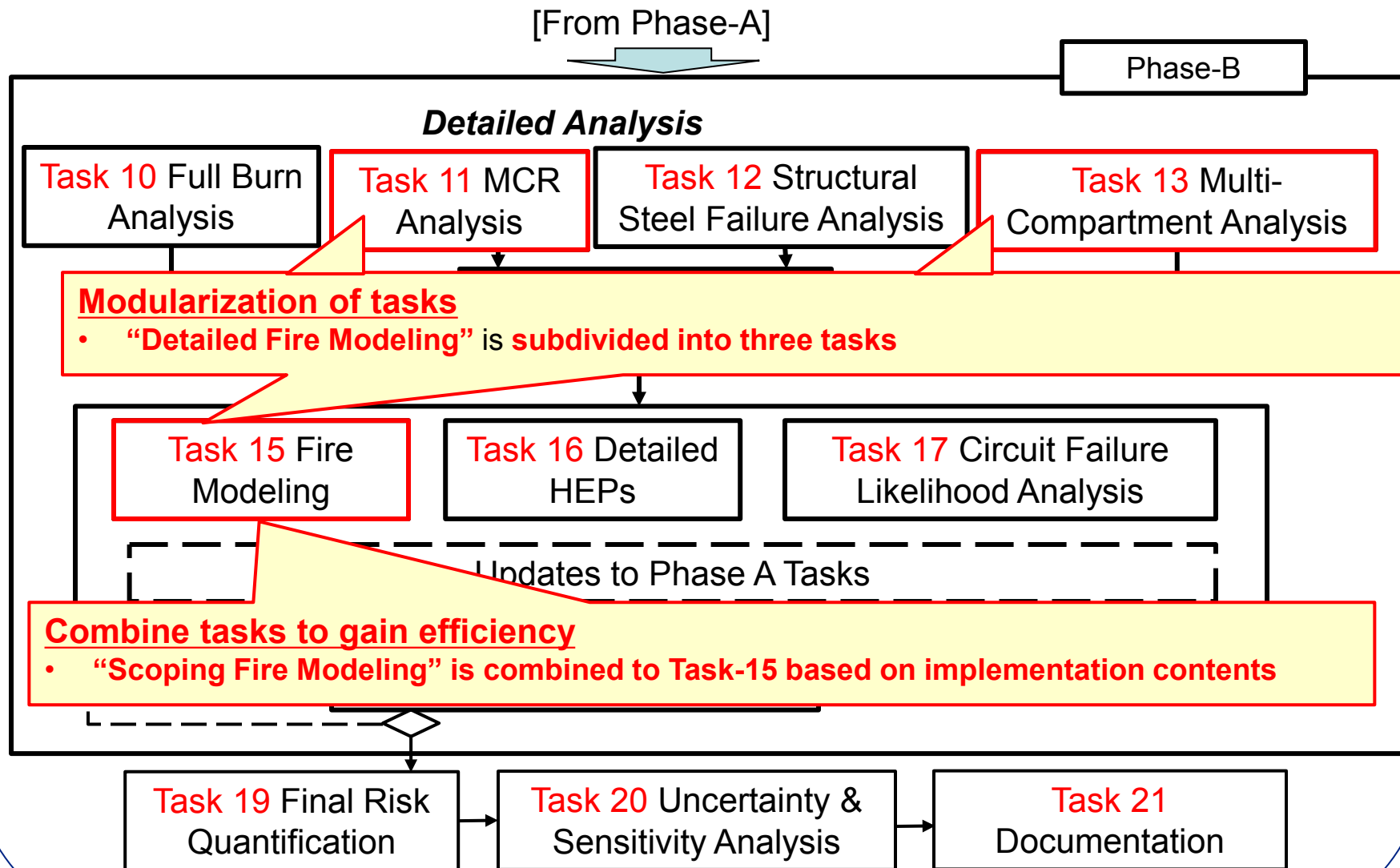
Identification of human failure event and Fire PRA PRM has interaction each other



Combine tasks to gain efficiency
 ✓ Fire PRA cables should be **identified by circuit failure analysis**

[To Phase-B]

2. Overview of Methodology



3. Structure of Fire PRA Guide

Volume-1

- ◆ Introduction & Background
- ◆ Fire PRA methodology overview including overall task flow
- ◆ Methodological & Technical updates from NUREG/CR-6850 (2005)

Volume-2

- ◆ Develop “modular style guide”, guidance for individual tasks independently with interfaces.

Chapter X

Task – X Chapter Title

X.1 Purpose

X.2 Task Scope and Background

X.3 Overall Approach

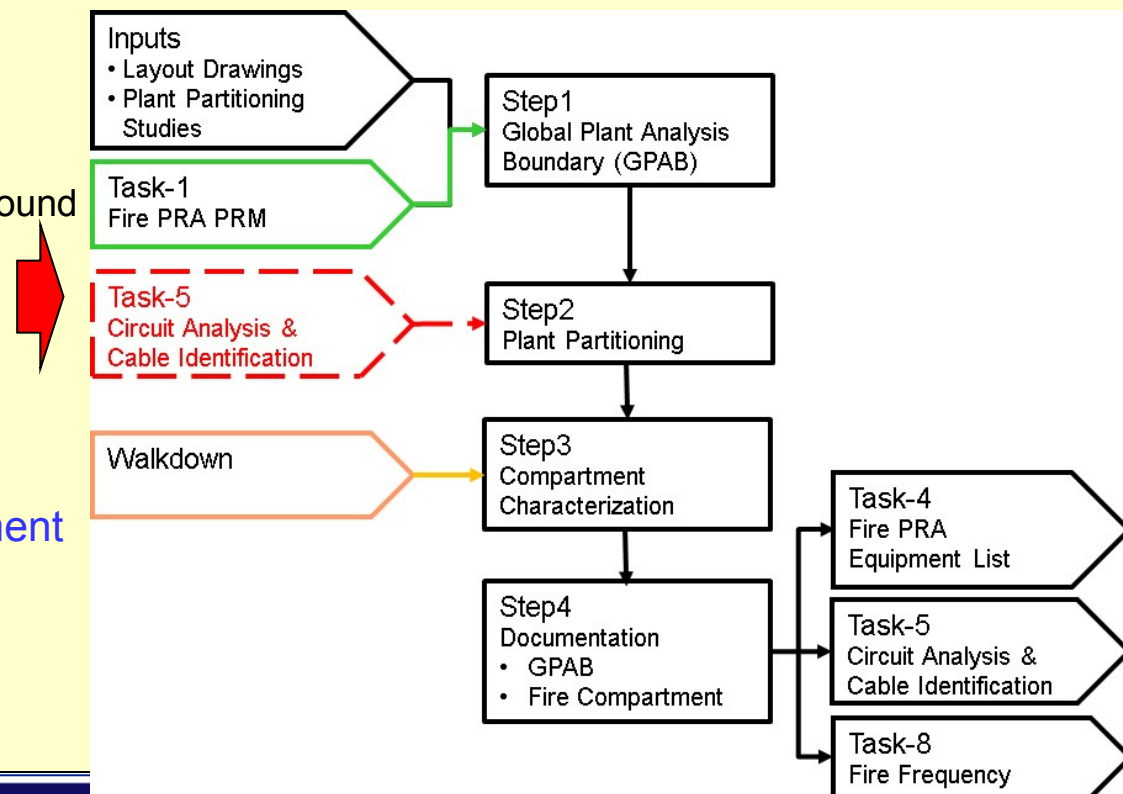
X.4 Inputs and Interfaces

X.5 Procedure

X.6 Helpful Notes

X.7 References

- ◆ Appendices to supplement main body guidance including examples for each task



4. Methodology & Technical Updates

◆ Circuit Failure Analysis

- Incorporate NUREG/CR-7150 (JACQUE-FIRE) in Task-17 Circuit Failure Likelihood Analysis
 - ✓ Credible circuit failure mode
 - ✓ Duration of hot short
 - ✓ Update probability of hot short
- Explicitly address MSO /SO modeling in Task-1 Fire PRA Plant Response Model
 - ✓ NEI00-01 MSO List
 - ✓ Guidance for MSO / SO modeling in Plant Response Model
 - ✓ Treatment of erroneous indications in HRA and PRM

4. Methodology & Technical Updates

◆ Human Reliability Analysis

- Incorporate NUREG-1921 in Tasks relevant to HRA
 - ✓ Task-3 HRA, analysis of human error events to modify of HEPs (PSFs) came from internal event PRA and to identify fire specific HFEs in consideration with fire situations.
 - ✓ Task-5 Initial HEPs for screening analysis
 - ✓ Task-16 Detailed HEPs, Detailed HRA for risk significant human errors
- Consider the impact of erroneous indications due to circuit failures

◆ Heat Release Rate

- Incorporate NUREG-2178 (RACHELL-FIRE), peak HRR data for electric cabinets, in Task-15 Fire Modeling

4. Methodology & Technical Updates

- ◆ Non detection / suppression probability
 - Incorporate non-detection / suppression factor in NUREG-2169 using latest data
 - Incorporate NUREG-2180 (Incipient fire detection modeling)
 - ✓ Some Japanese utilities have installed incipient fire detection systems in the electrical cabinets after Fukushima-Daiichi Accident.

4. Methodology & Technical Updates

◆ Fire Ignition Frequency

- Define fire ignition categories based on NUREG-2169 and Japanese NPP design features:
 - ✓ Distinguish oil fires and electrical fires for motor driven equipment
 - ✓ The fire ignition category of “Electric Cabinet Fire (non-HEAF)” break down into sub categories consistent with NUREG-2178 (HRR group)
- Collect the fire experiences in Japanese NPPs
- Classification of fire events by severity using criteria described in EPRI-1025284 (“The Updated Fire Events Database: Description of Content and Fire Event Classification Guidance”)
 - ✓ Challenging Fires
 - ✓ Potentially Challenging Fires
 - ✓ Undetermined
 - ✓ Non Challenging Fires

5. Conclusions

- ◆ NRRC, in cooperation with Japanese reactor vendors and fire PRA experts in the US, is developing a fire PRA guide in order to assist Japanese utilities in conducting fire PRA:
 - NUREG/CR-6850 as a starting point
 - Incorporate the latest data / methods modified or added subsequent to NUREG/CR-6850
 - Consider fire experience and design of Japanese NPPs
 - Develop generic fire ignition frequency distribution based on fire experience in Japanese NPPs

- ◆ This project is being conducted by the sponsorship of Japanese utilities (Tokyo, Hokkaido, Tohoku, Chubu, Hokuriku, Kansai, Chugoku, Shikoku, Kyusyu, Japan Atomic Power and Electric Power Development).