



Idaho National Laboratory

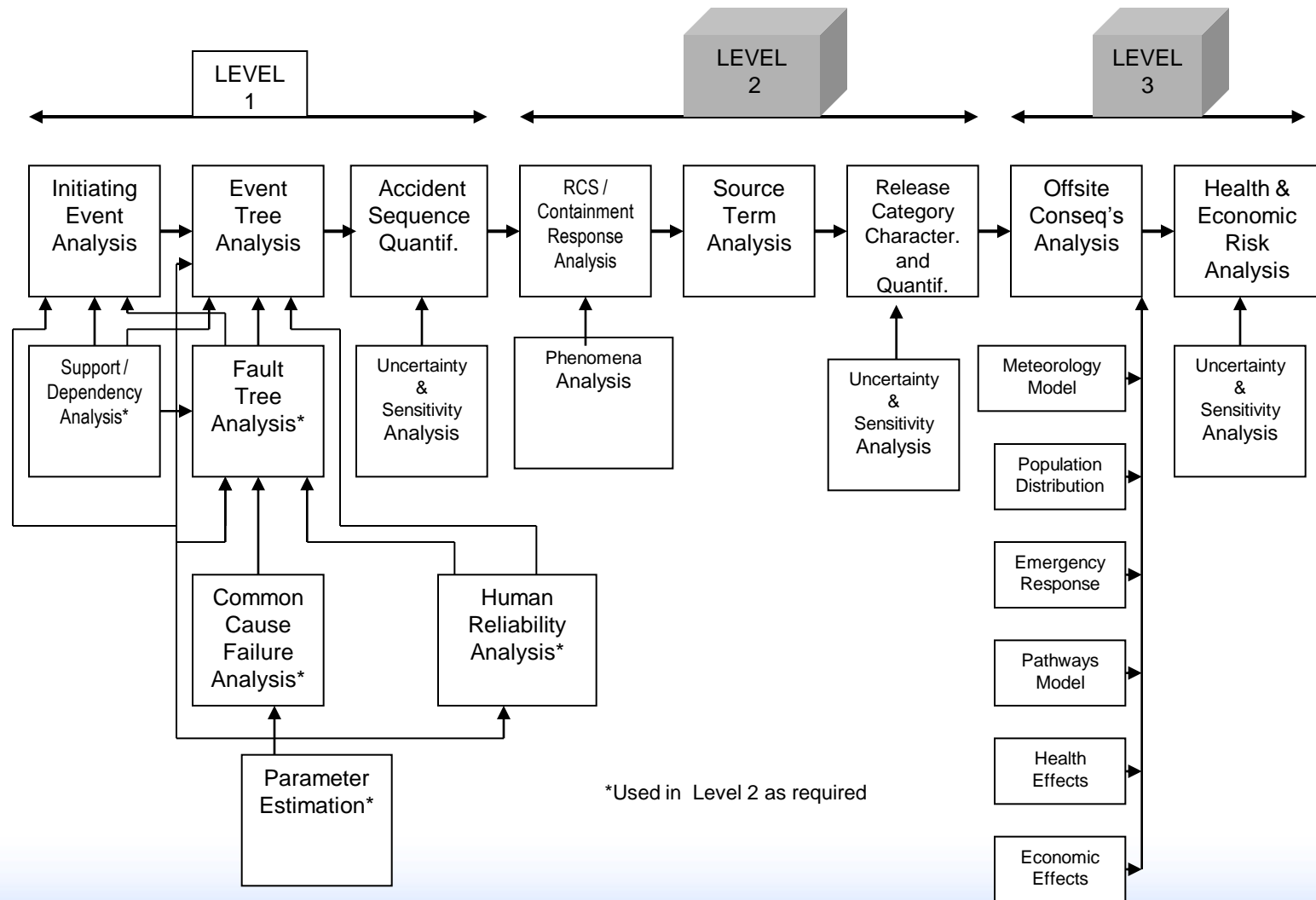
# **MODULE L**

## **LEVEL 2 & 3 ANALYSIS**

# Level 2 & 3 Analysis

- **Purpose:** Introduce the students to the purposes and scope of Level 2 (accident progression) and Level 3 (accident consequence) analyses.
- **Objectives:**
  - Describe the general purpose of Level 2 and 3 analyses
  - List typical types of consequences from a Level 3 PRA
- **References:** NUREG/CR-2300

# Principal Steps in PRA



# Purpose of Level 2 & 3 Analyses

- **Level 2 & 3 analyses bridge the gap between the engineering and operations associated with a reactor and the potential risk that it presents to the public**
  - **Level 2 (Containment) Analysis starts with the Level 1 plant damage states and calculates a set of radionuclide source terms released to the environment**
  - **Level 3 (Consequence) Analysis calculates potential ranges (probability of occurrence and magnitude) of adverse impacts (consequences) of an accidental release of radionuclides**

# Level 2 Analysis Overview

- **A Level 2 Analysis evaluates the radionuclide releases from accidents that result in a severely damaged core. It considers the following elements:**
  - fission product transportation, deposition, and release in the reactor coolant system,
  - fission product transportation, deposition, and release in the containment.
  - determining source terms from the containment

# Plant Damage State Binning

- **Plant-damage states are groups of accident sequences with certain similarities regarding plant response, timing, and equipment status.**
- **The containment analyst provides guidance as to which types of sequences are aggregated into which plant- damage states.**

# **Transportation, Deposition, and Release in the Reactor Coolant System**

- **The following issues concerning the transportation through, deposition in, and release of radionuclides from the reactor coolant system needed to be considered in the level 2 analysis:**
  - **vessel pressure and inventory,**
  - **recovery of injection prior to or after vessel breach,**
  - **hydrogen released prior to or after vessel breach, and**
  - **hydrogen burn prior to or after vessel breach.**

# Transportation, Deposition, and Release in the Containment

- The following issues concerning the transportation through, deposition in, and release of radionuclides from the containment needed to be considered in the level 2 analysis:
  - Debris coolability
  - Pressure increase due to hydrogen burn
  - Interactions between molten fuel and water
  - Debris-concrete interaction
  - Containment pressure



# Source Term from the Containment

- **The release of radionuclides from the containment is dependent upon:**
  - radionuclide chemistry,
  - the physical form of the fuel, and
  - the environment into which it is released.
- **The source term specification should include:**
  - the magnitude of the release,
  - the release rate, and
  - the chemical and physical forms of the release material.

# Source Term from the Containment (cont.)

- **The following potential release processes need to be considered:**
  - **Cladding-rupture release**
  - **diffusion release**
  - **Leach release**
  - **Melt release**
  - **Melt/concrete release**
  - **Fragmentation release**

# Level 3 Analysis Overview

- **A Level 3 Analysis evaluates the effects of the release of radioactive materials on the surrounding population and environment. It can consider the following adverse impacts (commonly referred to as "public risk"):**
  - **Early and long-term deaths**
  - **Early and long-term injuries**
  - **Contamination of property, land, or water**
  - **Economic impacts**

# Major Areas of a Level 3 Analysis

- The following areas are the major considerations that must be taken into account during a level 3 analysis: atmospheric transportation and deposition model, including meteorology
  - Pathways model
  - Dosimetry model
  - Health effects model
  - Population distribution model
  - Emergency response model
  - Economic effects model

# **Dominant Risk Contributors Sometimes Not Dominant With Respect to CDF**

- **For PWRs, SGTR and bypass sequences (e.g., ISLOCA) dominate LERF and therefore early fatalities**
- **SGTR and bypass not dominant contributors to core damage frequency**
  - **If SGTR or bypass occur, consequences are large**
  - **Remember: risk = frequency x consequence**

# Student Exercise

- **Answer the following for your choice of a plant's IPE:**
  - **In either the summary sections in the front of the IPE, or in the plant unique design features section (often Section 6), note any particular strengths or weaknesses cited from a containment capability perspective.**