Status of ARIES-IFE Safety and Environmental Activities

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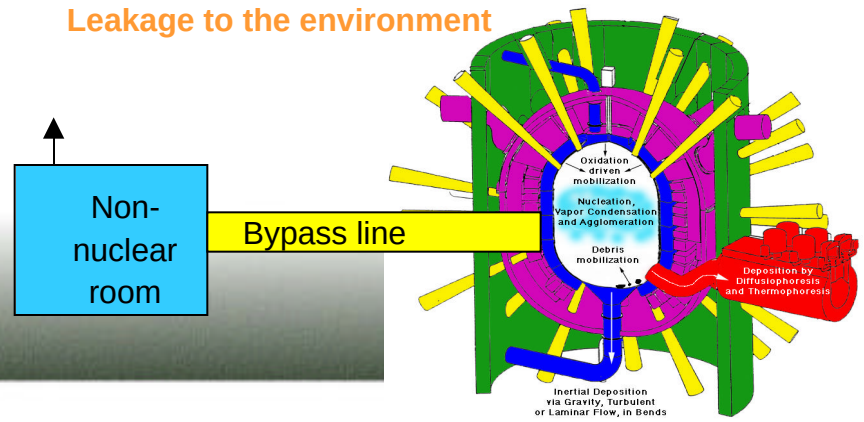
Overview of Safety and Environmental Activities

- Minimization of radiological inventories through ES&H-conscious materials selection and careful design
- Implementation of radiological confinement in IFE systems recognizing the large number of penetrations in the chamber
- Identification of accident scenarios in IFE systems
- Safety analysis of some of these events based existing designs (e.g., SOMBRERO, HYLIFE-II)
- Waste management assessments of different configurations focusing on both volume and hazard of waste (e.g final focus magnets)



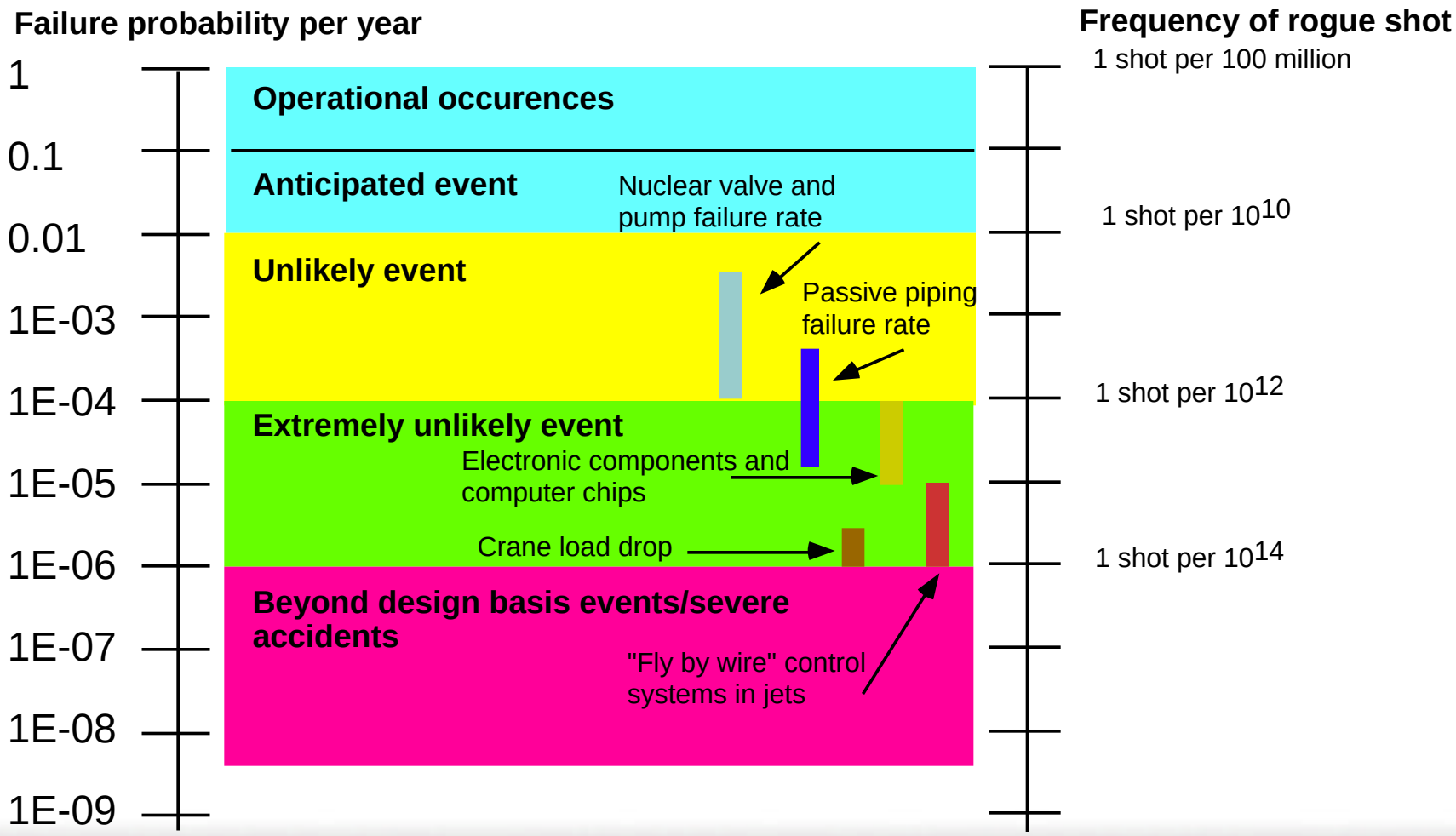
Radiological Confinement

- Need two strong/robust boundaries around radiological inventory in chamber
- Previous IFE design studies did not consider all pathways for release
- Penetrations are a key concern as release pathways
  - Where is the boundary in the penetration -- could imply a very large nuclear boundary
  - Are there natural barriers in the line that could be used?
- Could use fast-acting, redundant valves in the penetration lines
  - Will they work as expected in the environment?
  - Can such valves be put in the line given the other functional requirements of the penetration (e.g., vacuum pumping, beam propagation, shielding)
- Need to work with designers to determine optimum solution

Radiological Confinement

- Confinement buildings have been used in previous IFE studies as the second strong barrier
- There are concerns with this approach related to testing of the boundary for the appropriate leak rate
- The large size of the building could make testing even a moderate leak-rate building a costly operational burden
- Use of the building to get the needed confinement goes against conventional safety wisdom of confining the hazard as close to its source as possible

Accident Initiators - Rogue Pellets



Preliminary Initiator Frequency for IFE Rogue Shots

- Several causes have been identified for rogue shots: imperfect targets; or incorrect target injection, laser pulse actuation control, laser energy deposition
  - Imperfect targets remain in fueling stream, ~ 10 to 50/day based on 1-5% defect rate in factory (current electronic mfg data) and 0.1% failed to be rejected
  - Improper target velocity/trajectory in IFE chamber, ~ 1E-03/year based on high reliability gas injection system
  - Laser pulse actuation control fault, ~ 1E-05/year based on modern fly by wire digital control systems
  - Lasers deliver inadequate energy to target, ~ 1E-03/year based on critical nature of the component in the system
- Rogue shots should be considered “operational occurrences” until more is determined about quality control procedures and approaches for the approximately 1M targets produced per day.

Can the facility handle rogue shots that may occur during the plant lifetime?

- Impact on the chamber of such a shot
- Initiator of an accident (shrapnel possibly leading to a loss of coolant event)
- Overall reliability of the facility

Accident Identification/Analysis

- Loss of Vacuum (Air ingress event)
  - Preliminary results from LLNL for solid wall SOMBRERO design presented at last meeting
  - INEEL is re-examining those results
  - Sensitivity studies
    - Size of the hole for air ingress
    - Effect of using graphite whisker material on the first wall ---> surface area issue

Accident Identification/Analysis

- Ex-vessel events
  - Loss of power
  - Pump trip or seizure
  - Loss of coolant ex-vessel
- These events are not coupled to the implosion plasma directly (no inherent feedback as in fission systems)
- Examine response qualitatively in each system to determine consequences
- Based on examination, determine need for an active safety shutdown system
- Seismic events - is this a strong design driver as in MFE?
- Meeting in Idaho Falls with safety team in January to work through this subtask

Waste Management

- Ex-vessel activation of final focus magnets are critical
- Recent results from LLNL indicate that the magnets will not meet shallow land burial requirements (WDR ~ 13, volume of Nb in magnets ~ 0.35 m^3)
- To avoid generating a large amount of material that could not be buried as low level waste and to improve environmental attractiveness, we will have to change the material-->i.e., use high temperature superconductors
- Is this feasible?

Tritium Target Factory

- Meeting was held at LANL in mid-November to look at potential inventories for different options
- Inventories estimated by LLNL/GA and LANL using different approaches are fairly similar
- Minimum inventories for warm assembly are much higher (5 -- 50 kg?) than the current safety goal of 1 kg. Cold assembly results in an inventory between 0.8 and 1.5 kg. Release limit for no-evacuation is ~ 150 g-T as HTO
- Plan to use risk techniques to determine the degree of segmentation of the inventories that is needed to reduce the consequences of release
- Build on scoping work from LLNL/GA -- examine hydrogen deflagration issue in the tritium factory