2005 Asia-Pacific Conference on Risk Management and Safety

IE Analysis for ABWR on the Purpose of Risk-Informed Applications

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December 2, 2005
Kowloon Shangri-La Hotel, Hong Kong

Outline

- Introduction
- IE Identification and Grouping
- IE Frequency Estimation
- Conclusions

Introduction

- An ABWR plant with two unit is under construction in Taiwan
- INER is developing living PRA model for the ABWR plant
- Focused on Risk-Informed Application
  - Meet the ASME standard
  - Meet the criteria of PRA review guidelines by NEI
  - Split IE if possible
  - Involve operating crew for IE identification

Introduction

- PRA scope
  - Power operation (CDF and LERF)
    - Internal event
    - External event
      - Seismic
      - Fire
      - Flood
      - Typhoon
  - Refueling outage (CDF only)

IE Identification and Grouping

- Support most of the risk-informed applications in the future
- Identify every possible IE by
  - Design documents
  - Operating procedure
  - Discussions with system engineers
- Grouping IEs with care to eliminate unnecessary conservative assumption
- 24 IEs and 6 transferred events

LOCA

Initiating Event		Frequency(/yr)
A	Large LOCA	3×10^{-5}
S1	Medium LOCA	4×10^{-5}
S2	Small LOCA	3.93×10^{-3}
O1	Main steam line break outside containment	1.03×10^{-2}
O2	Feedwater line break outside containment	3.43×10^{-3}
V1	ISLOCA on LPFL Injection Train A	6.31×10^{-10}
V2	ISLOCA on LPFL Injection Train B	5.71×10^{-10}
V3	ISLOCA on LPFL Injection Train C	5.71×10^{-10}
V4	ISLOCA on RHR S/D Cooling Suction Train A	1.26×10^{-8}
V5	ISLOCA on RHR S/D Cooling Suction Train B	1.26×10^{-8}
V6	ISLOCA on RHR S/D Cooling Suction Train C	1.26×10^{-8}
R	RPV Rupture	3.2×10^{-9}

Transient and event from FMEA

Initiating Event		Frequency(/yr)
T1	MSIV closure	5.31×10^{-1}
T2A	Turbine trip	4.98×10^{-1}
T2A	General transient with PCS available	9.18×10^{-1}
T3	Loss of offsite power	2.37×10^{-2}
T3A	Loss of 345 kV Grid	1.08×10^{-1}
T4	Inadvertent open of SRV	4.6×10^{-2}
T5	Total loss of feedwater system	6.43×10^{-2}
TA3	Loss of A3 Bus (non-safety)	7.2×10^{-3}
TB3	Loss of B3 Bus (non-safety)	7.2×10^{-3}
TRBW	Total Loss of RBCW or RBSW system	1.62×10^{-4}
TTBW	Total Loss of TBCW or TBSW system	1.62×10^{-4}
TIA	Loss of instrument and control air system	1.27×10^{-2}

Transferred Event

Initiating Event		From
T3SBO	Station blackout	T3
T1CM	ATWS for T1 and T2A event	T1 and T2A
T2BCM	ATWS for T2B event	T2B
T3CM	ATWS for T3 event	T3
T3ACM	ATWS for T3A event	T3A
T5CM	ATWS for T5 event	T5

Notes for developing event tree

- O1: MSL break outside CTMT
  - break can be isolated by MSIV
- O2: FW line break outside CTMT
  - break can be isolate by check valve
- T2A: Turbine trip
  - reactor scram can be avoided by turbine bypass system
- T3, T3A: LOOP, Loss of 345 kV grid
  - reactor scram can be avoided by fast transfer to house load
- TA3, TB3: Loss of non-safety 4.16 kV bus
  - reactor scram can be avoided by starting service air and standby CRD system

Frequency Estimation

- No operating experience available
- Most were obtained from NUREG/CR-5750
- ISLOCA
  - Calculate by system design, lineup and STI
- RPV rupture
  - Considering improvements of RPV design
  - Obtained from PSAR
- Loss of 345 kV grid
  - Experiences of operating NPPs from 1994-2004
- Loss of feedwater
  - Review generic data bank and recalculate

Conclusions

- IE analysis is always a challenge for an under construction plant with new design
- Most plant staff were involved
- Neglecting or grouping IEs were carefully considered to meet the requirements of risk-informed applications
- Meet requirements of ASME standards and NEI review guidelines
- Draft event trees were developed to be a reference when grouping IE
- IE analysis will not close until system designs and operating procedures are finalized