# Development of Approach to Establishment of Risk Informed Accident Management Class in Severe Accident（#21）

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# Severe Accident Management Subcommittee

- The Great East Japan Earthquake of a magnitude 9.0 occurred on March 11, 2011.
- The SAM Subcommittee was set up under the System Safety Technical Committee （STC） for the Standard Committee （SC） of Atomic Energy Society of Japan (AESJ） in order to establish the Severe Accident Management（SAM）standard.
- The SAM standard provides technical requirements and satisfactory methods concerning maintenance and update of severe accidents management strategies for existing nuclear plants.
- The SAM standard was established on March 2014.
- The SAM Subcommittee resumed to revise the standard on Sep. 2015.
- The first revision of the standard was established on June 2018 after about three years of discussion and reviews in AESJ.

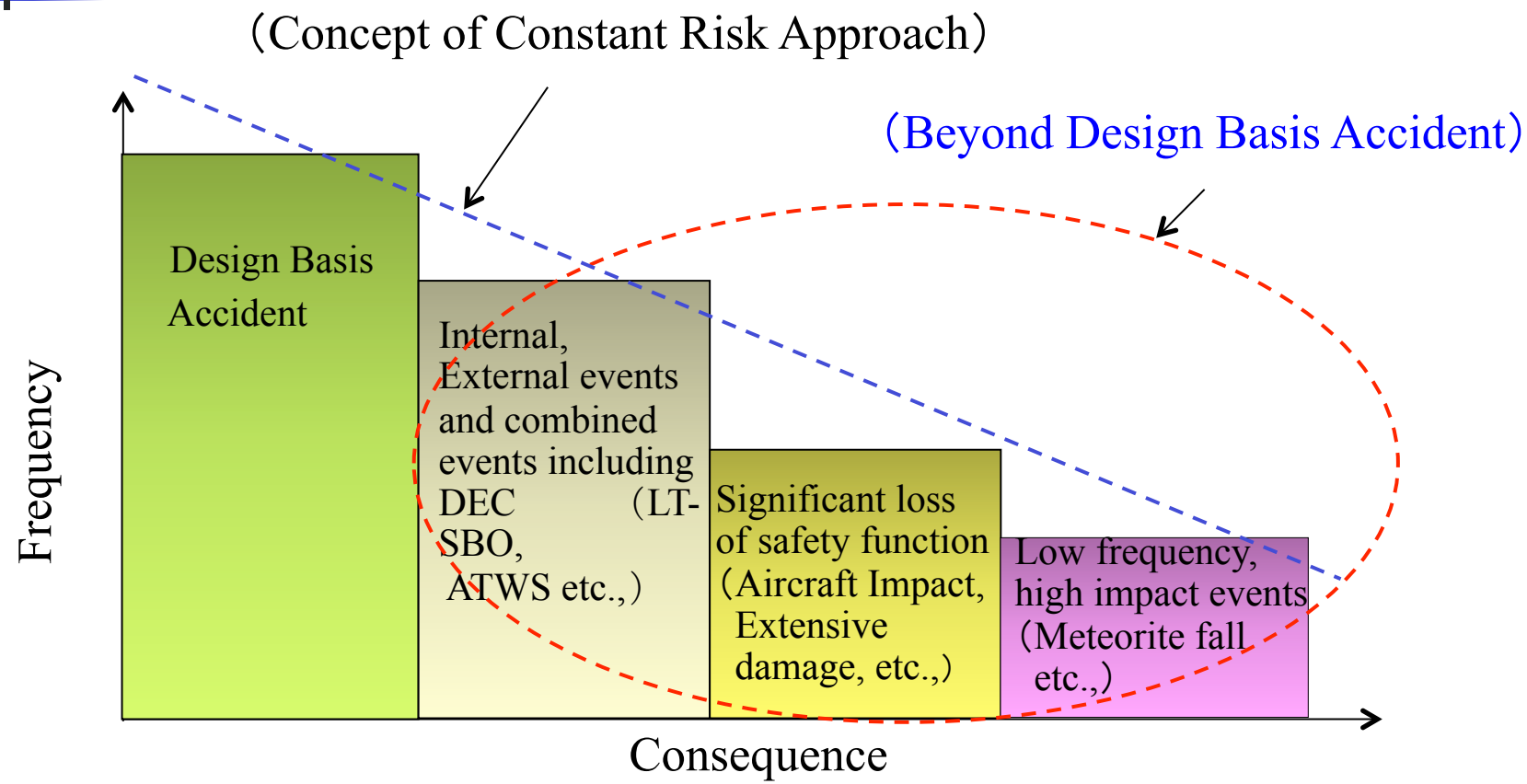
# Target of Revision for SAM standard（Rev.1）

- Accident management and management classification should be established based on plant vulnerability and latent risk including external events unique to each NPP.

- Optimized accident management and management classification can be determined based on integrated risk informed decision making process using key element such as risk reduction, safety margin and Defense-in-Depth （DiD）.

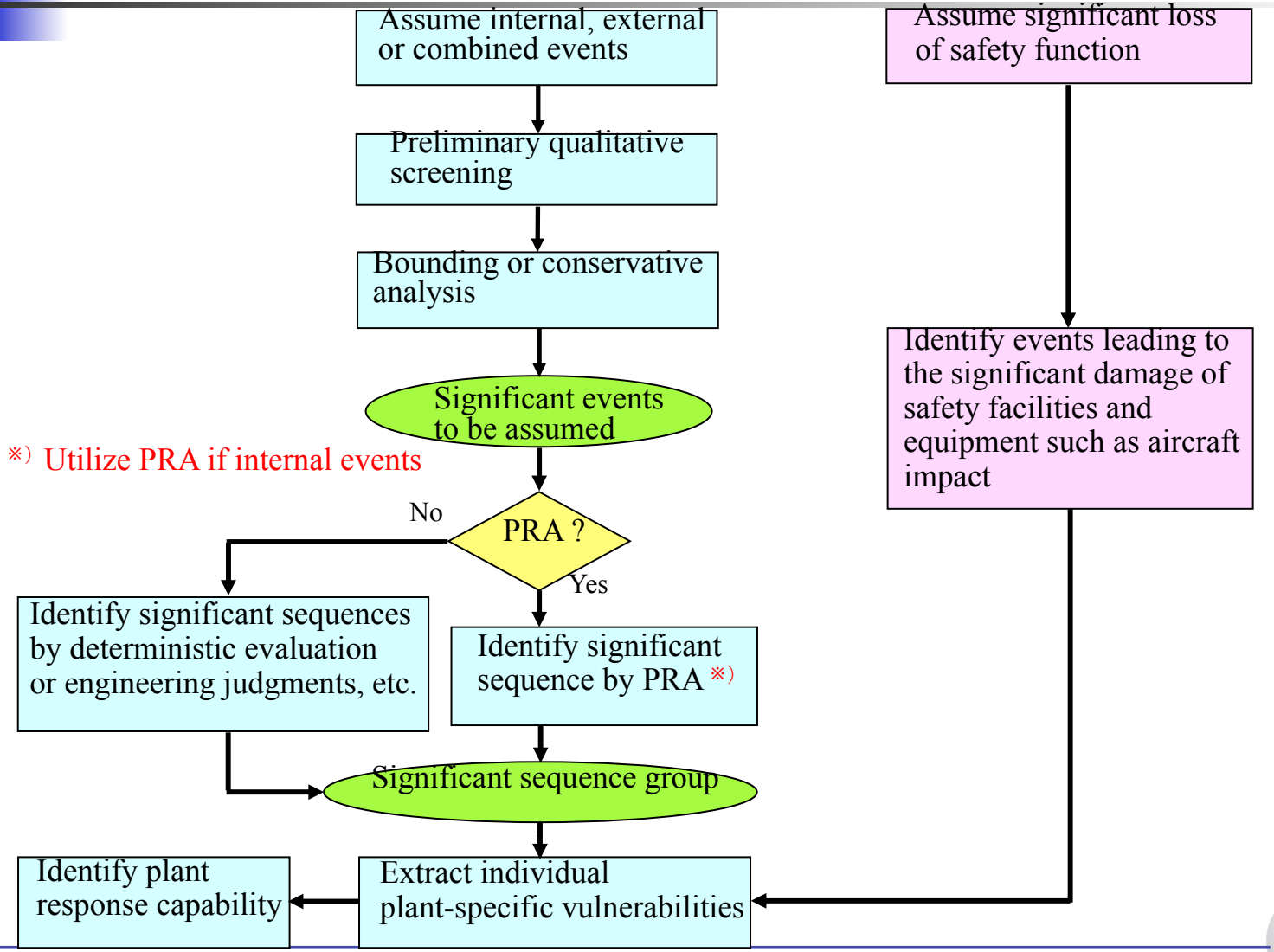
- Most recent findings including revised IAEA NS-G-2.15, regulatory progressions in the U.S. NRC and other overseas regulators should be taken into the main text and appendices.

# Events as Object of Accident Management

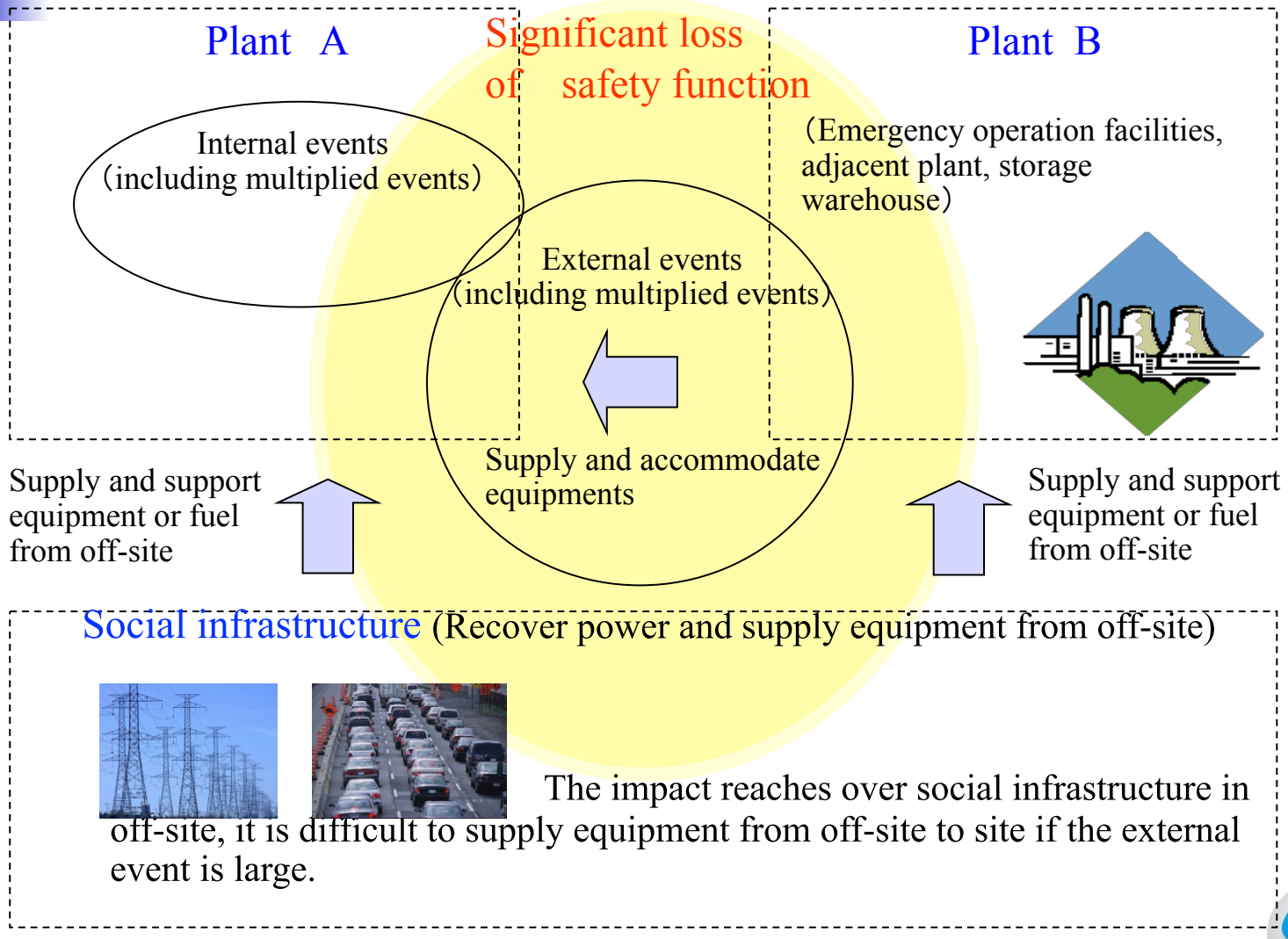



Category of Events and Extent of Accident Management

# AM Optimization and Establishment Block-Chart（1/2）

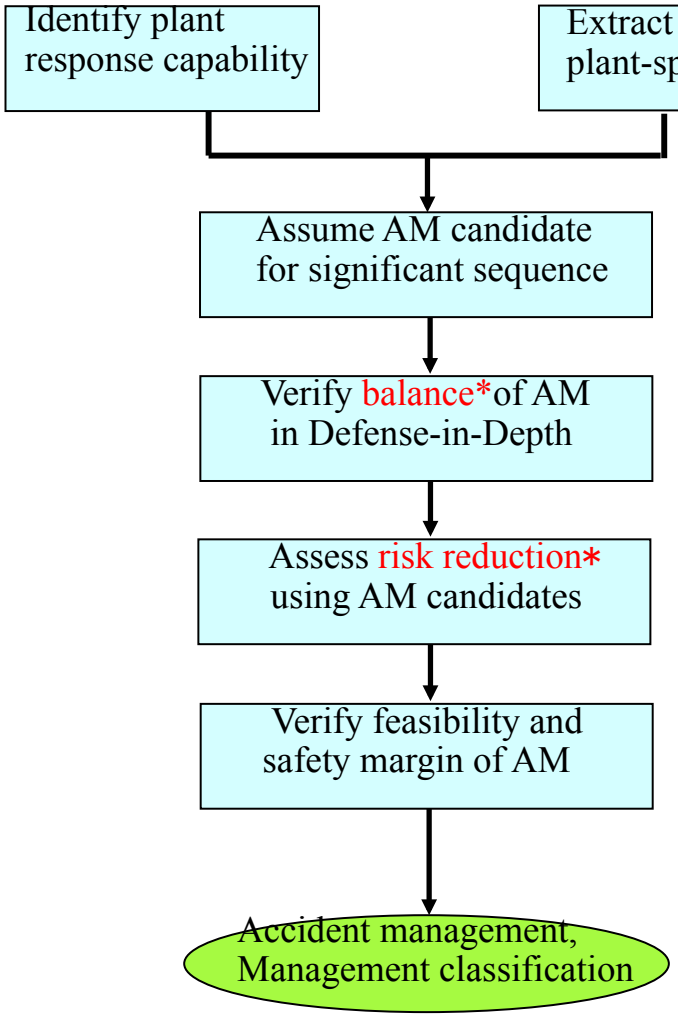


# Impact Propagation Extent by Initiating Events




The impact reaches over social infrastructure in off-site, it is difficult to supply equipment from off-site to site if the external event is large.

# AM Optimization and Establishment Block-Chart（2/2）

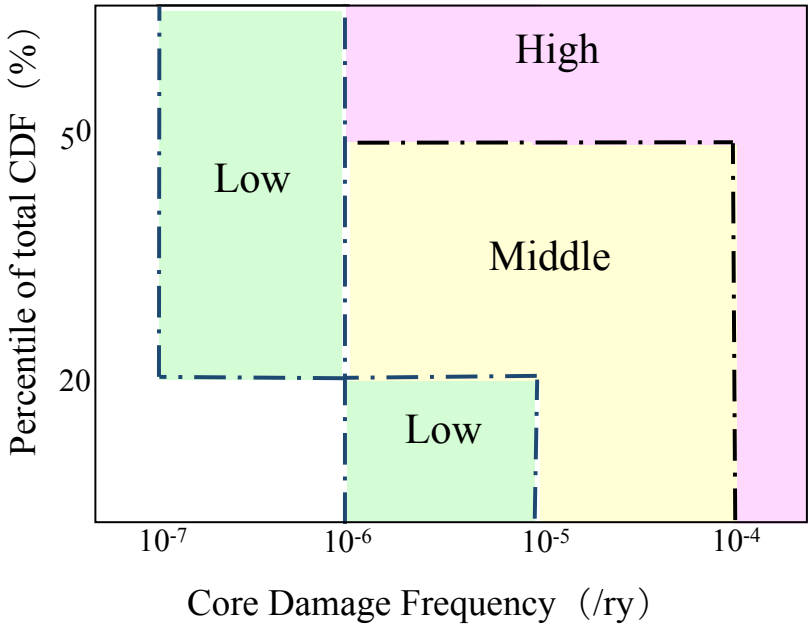



balance*
Assignment of AM in SA progression phases

risk reduction*
PRA, NEI 16-06

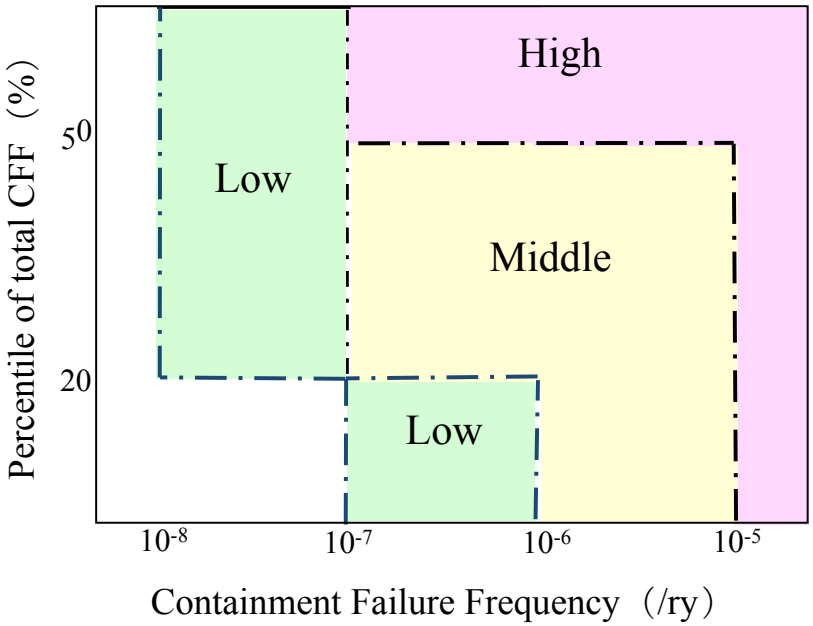
# Classification of Risk Significance using CDF, CFF

- Perform risk assessment using IPE or an alternative method for relevant plant and identify vulnerability in the plant.




※「CDF≧$10^{-6}$/ry」 or
「CDF≧$10^{-7}$/ry and CDF≧Total CDF 20％」
Significant accident sequence group

- Classify the sequence groups into three graded risk significance based on the criteria of NEI 91-04（Rev.1）

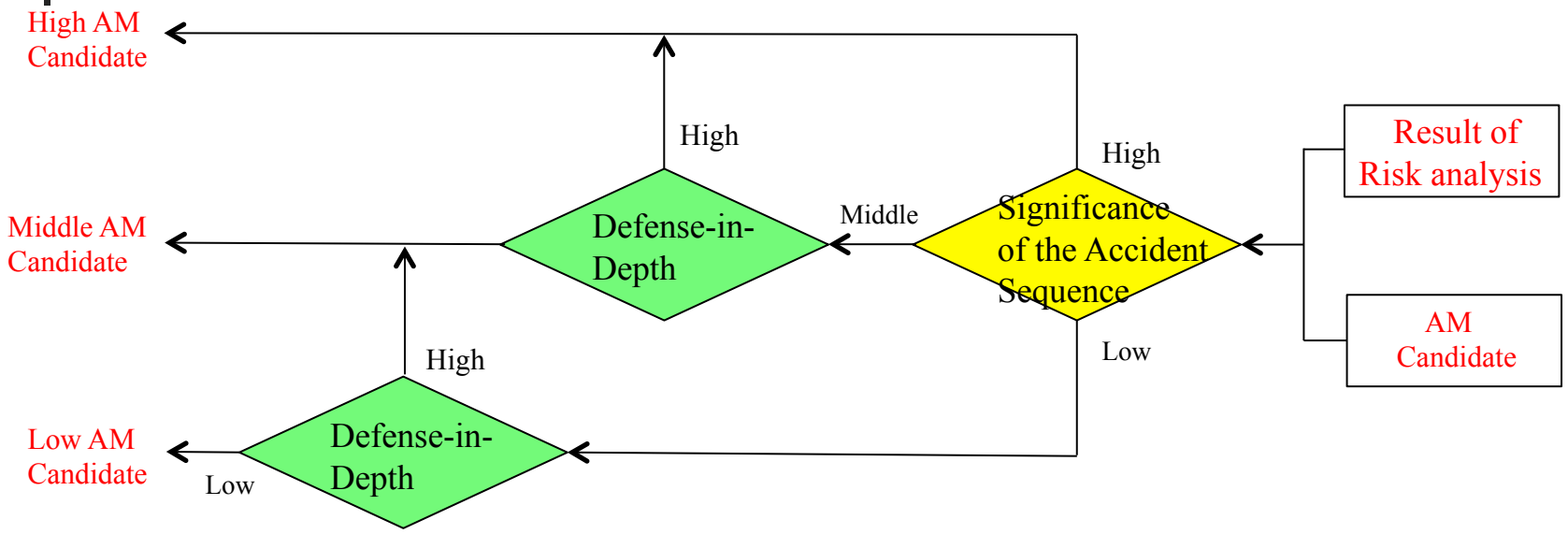


# Establishment of AM Candidates in SA Progression Phases

（Example using PRA results of Internal and Seismic event for BWR）

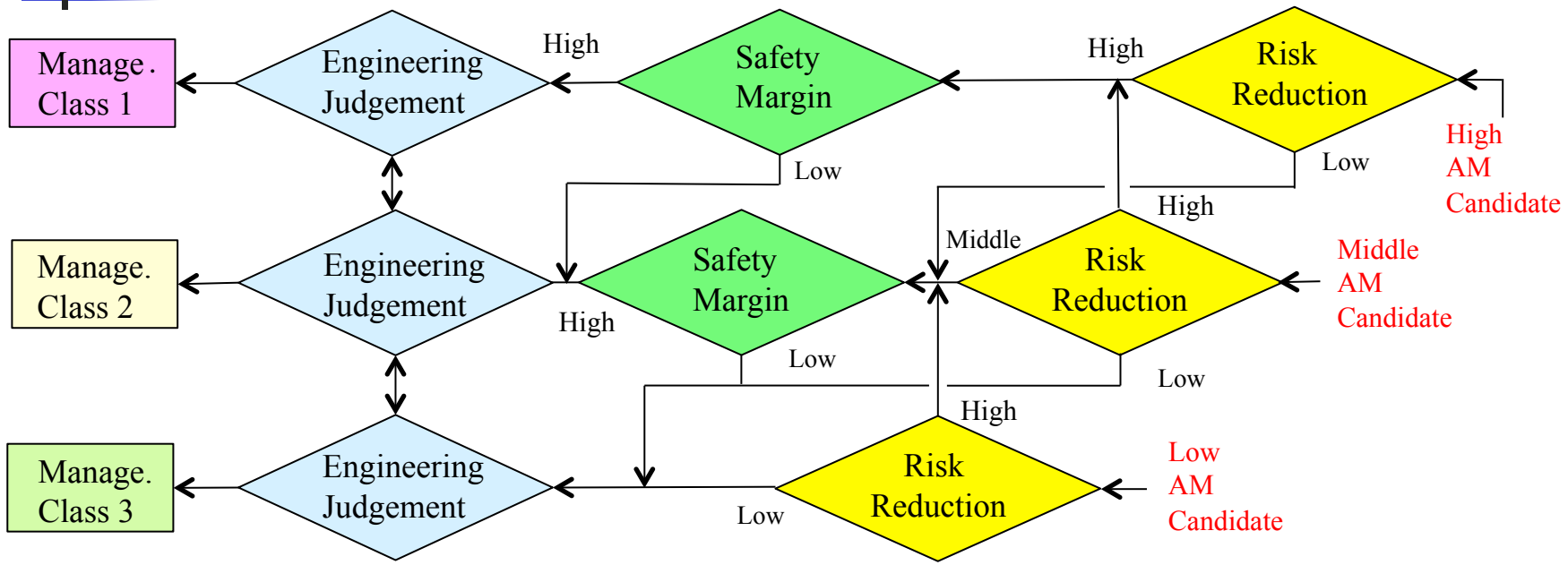
| AM Candidates \ SA Progression Phases in 4th layer | Prevent Core Damage | Terminate SA progress. | Maintain CV Integrity | Minimize FP Release | Achieve long term stable st. |
|---|---|---|---|---|---|
| Alternative high pressure injection | Middle | | | | |
| RCIC black start | Middle | Effective | | | |
| Alternative high voltage AC power sources | High | | | | |
| Enhancement of battery capacity | Middle | Effective | | | |
| High voltage AC power from neighboring plant | Low | | | | |
| Low voltage AC power from neighboring plant | Low | | | | |
| Mobile power sources | High | | | | |
| Alternative low pressure injection | Low | Effective | Middle | | |
| Alternative mobile injection | High | Effective | Middle | | |
| PCV venting | High | | Middle | Effective | |

# Example of the Management Classification flow（1/2）




- Assume the AM candidates as measure according to each accident sequence group.
- With regard to the AM candidates, verify from the point of view of securing defense-in-depth whether they are appropriately assigned to each level, or not.

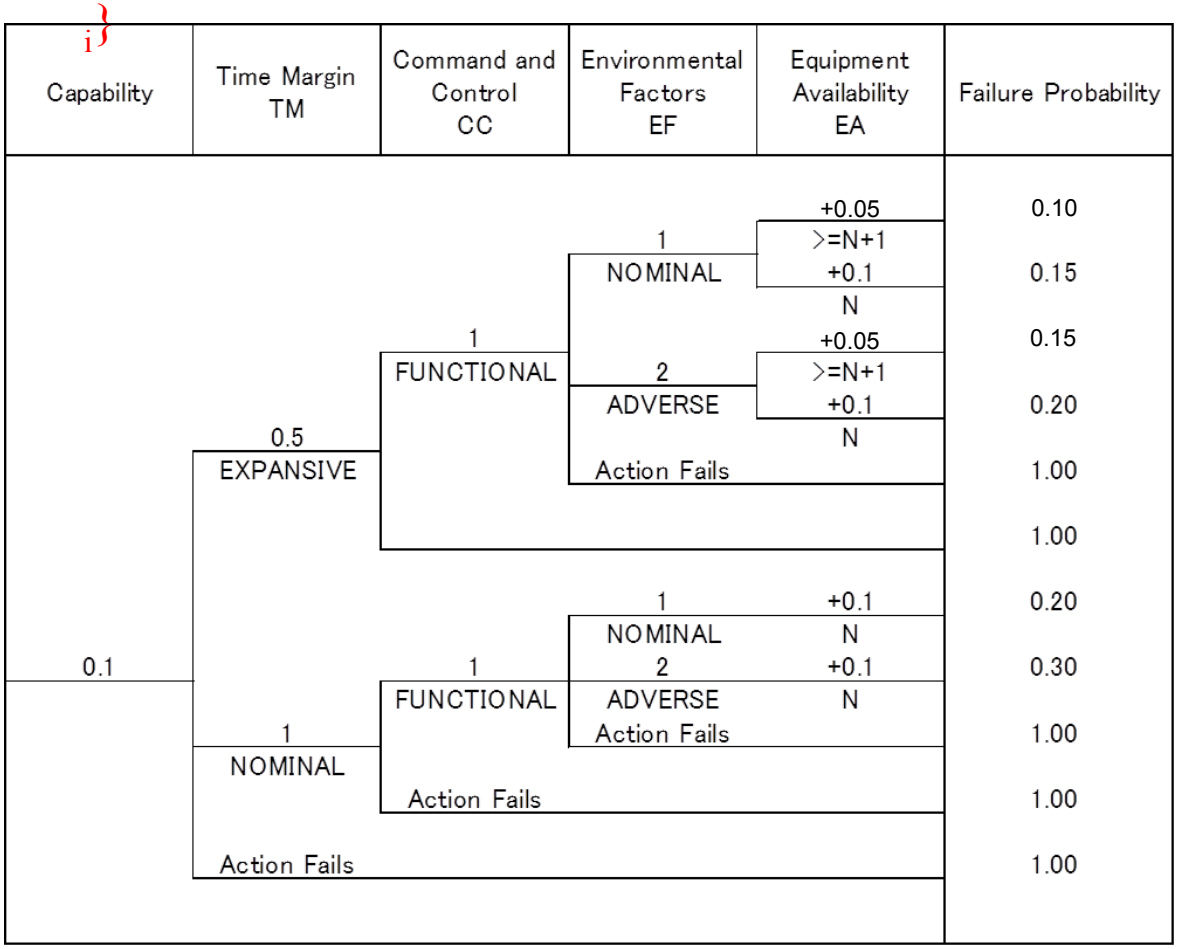
# Example of the Management Classification flow（2/2）




- Assess the risk reduction in the case of adopting the AM candidate using existing PRA results and NEI reliability method （NEI 16-06）.
- Analyze feasibility and safety margin in the AM candidate using SA analysis code.
- Determine feasible AM and management classification using integrated risk informed decision making process.

# Applicability of Semi-Quantitative Approach（NEI 16-06）

$Q_{FLEX} = Q_{HE} * TM * CC * EF + Q_{EA}$, $\Delta CDF = \Sigma_i \{CDF_{base\ i} - CDF_{base\ i} * Q_{FLEX}\}_i$




$Q_{FLEX}$：
Unreliability for AM （FLEX）

$Q_{HE}$ ：
Failure probability for AM

TM：
Time margin for deployment
（transport, connect, initiate）

CC：
Command and Control
（Direction, Staffing for strategy）

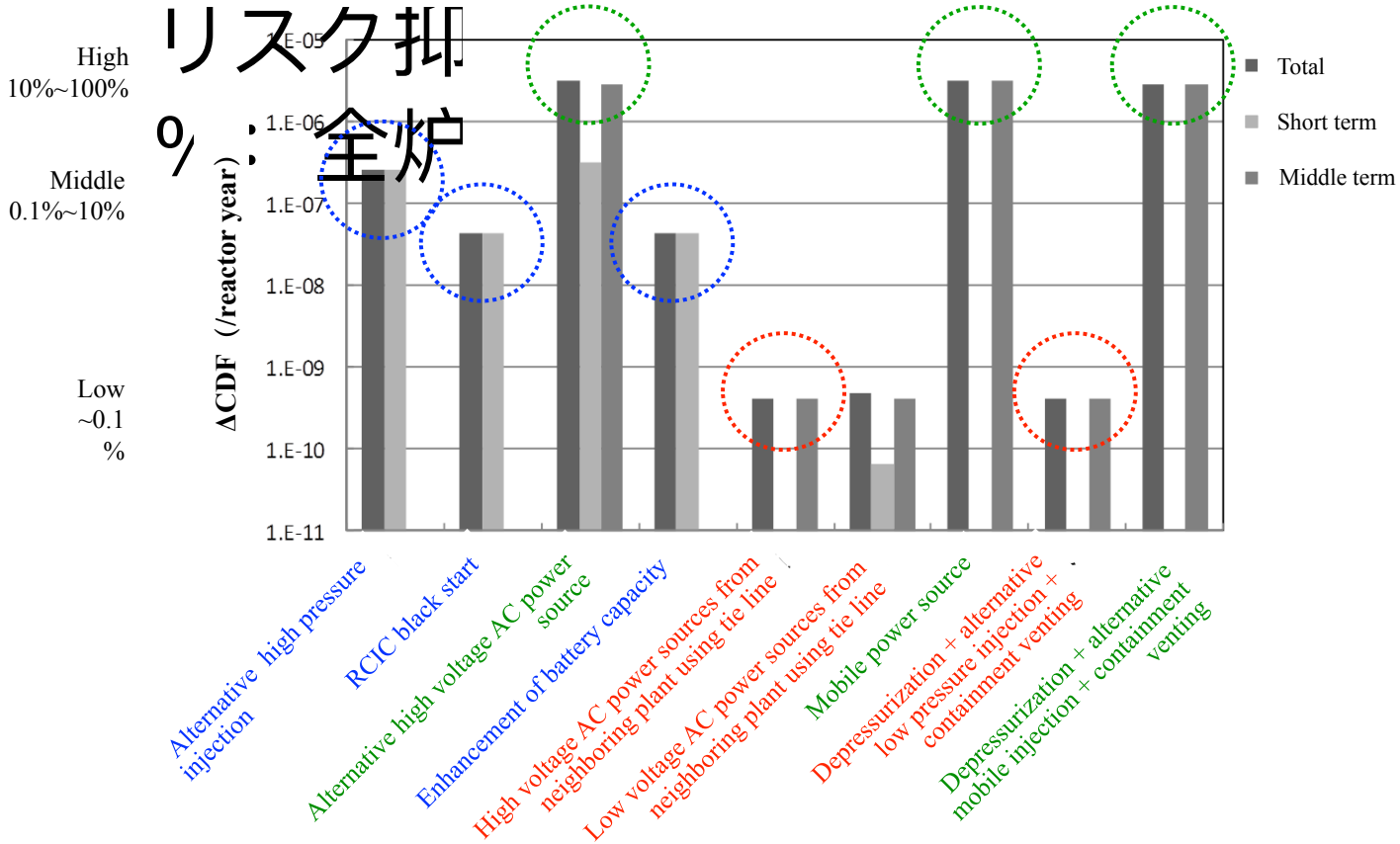
EF：
Environmental factors
（temperature, radiation）、
accessibility, operability

$Q_{EA}$：
Unavailability of equipment

# Example of Safety Classification for AM（BWR）

Risk reduction effect using NEI reliability method（%）
Contribution to the total CDF（SBO + Seismic event）

リスク抑
%：全炉



# Results of Trial Assessment for BWR

- The largest ΔCDF values are provided by mobile power sources, alternative high voltage AC power sources and alternative mobile injection which are effective against long term SBO due to the earthquake. （Management Class 1）

- The second largest ΔCDF values are provided by alternative high pressure injection, RCIC black start and alternative DC power sources which are effective against short term SBO. （Management Class 2）

- Since power sources from neighboring plant using tie line is effective against only SBO caused by internal event, CDF reduction is limited. （Management Class 3）

# Conclusion

- The trial assessment using the SAM standard shows that accident management and management classification can be established based on plant vulnerability and latent risk including external events unique to each NPP, and that the optimized program in accident management can be developed.

- It is significant to assign resources to optimized management based on classification for system modification, addition, maintenance, procedures and training as accident management.

- In near future, it is recommended that the pilot studies will be performed in the existing plant, the feasibility and optimization of the accident management will be verified with checking the applicability.

# Thank you for your kind attention !