

5-2 Toward Risk-Informed Safety Management of Nuclear Fuel Facilities

— Development of Probabilistic Safety Assessment Procedures for MOX Fuel Fabrication Facilities —

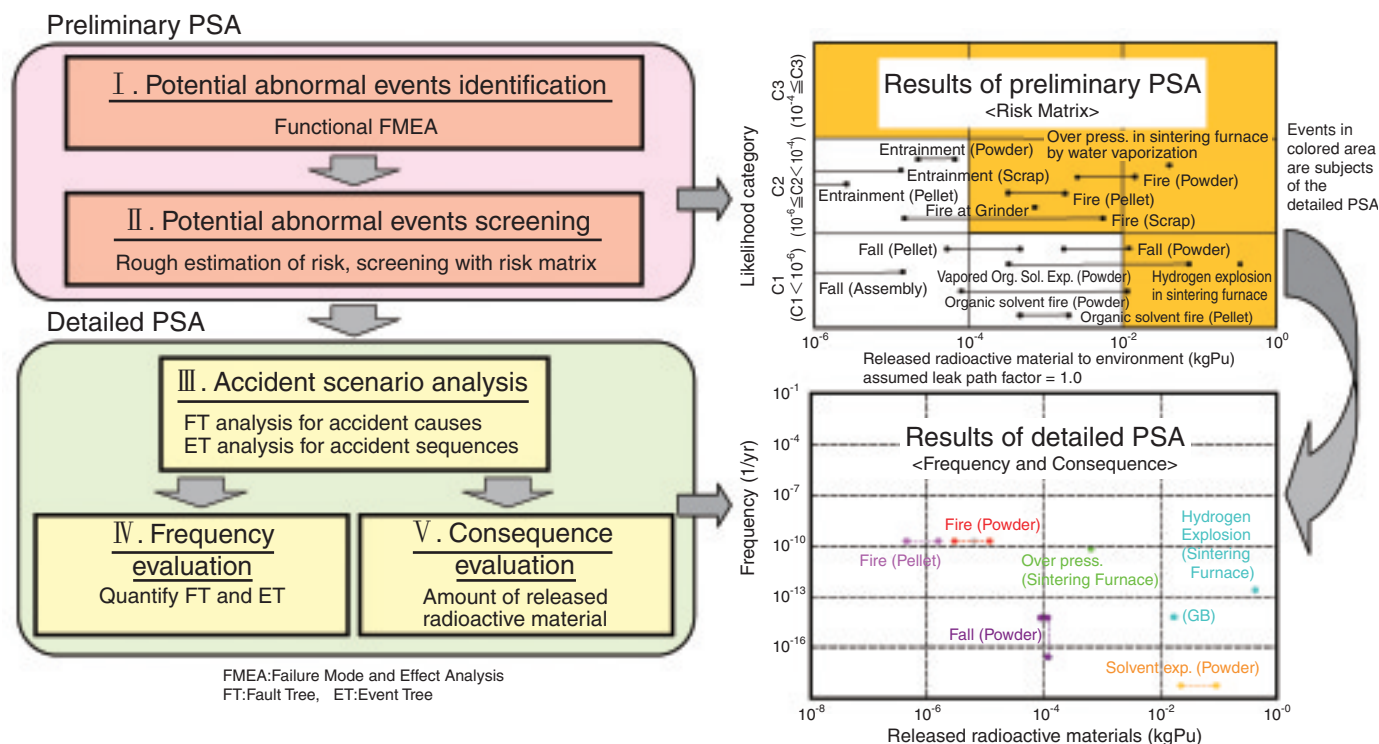


Fig.5-4 PSA procedures and analysis results of a typical MOX fuel fabrication facility

The preliminary PSA is carried out through I) exhaustive identification of potential abnormal events and II) efficient screening of those events using a risk matrix. In the detailed PSA, III) Accident scenario analysis is carried out to analyze causes and event sequences of each abnormal event by drawing a fault tree (FT) and event tree (ET) respectively. IV) Accident frequencies are evaluated by quantifying FT and ET. Finally, V) radioactive material releases to the environment are evaluated as the accident consequence using a five factor formula calculating the release amount from five material-specific factors.

Probabilistic safety assessment (PSA) has the advantage that it can give valuable information for reasonable decision-making on safety measures for nuclear installations with considering their effects and inferences that are assessed systematically and quantitatively by the PSA. Compared with the PSA for the nuclear power plant, however, the PSA for nuclear fuel facilities seems to be immature. In order to assist the regulatory review, in FY2001, a five-years research project was launched at the former JAERI to develop a PSA procedure applicable to a MOX fuel fabrication facility under the entrustment from the Ministry of Economy, Trade and Industry (METI).

One of the features of MOX fuel fabrication facilities is that nuclear materials exist in various physical forms at different areas in the facility. It is supposed that a variety of accidents may occur with different energy release at those areas. Therefore, it is important to identify potential abnormal events exhaustively and to screen those events efficiently from the point of risk significance. After

screening, detailed risk assessment is also important for frequency of occurrence and radioactive material release to environment of various accident sequences.

The developed PSA procedure consists of two stages, "Preliminary PSA" and "Detailed PSA" which include five major analysis steps as shown in Fig.5-4. In the Preliminary PSA, the screening of the potential abnormal events identified by the hazard analysis is carried out by using a two dimensional matrix (called as risk matrix) based on the rough estimation of likelihood and unmitigated release of radioactive material. The selected events are the subjects of the Detailed PSA in which major procedures are as same as for the nuclear power plant PSA.

The applicability of proposed PSA procedure was demonstrated through a trial PSA for a model MOX plant in which risk-significant accident scenarios, systems and components were identified with risk profile derived from the results of accident frequency and amount of released radioactive materials.

Reference

Tamaki, H., Yoshida, K. et al., Development of Probabilistic Safety Assessment Method for Mixed Oxide Fuel Fabrication Facilities, Nippon Genshiryoku Gakkai Wabun Ronbunshi, vol.5, no.2, 2006, p.125-135 (in Japanese).