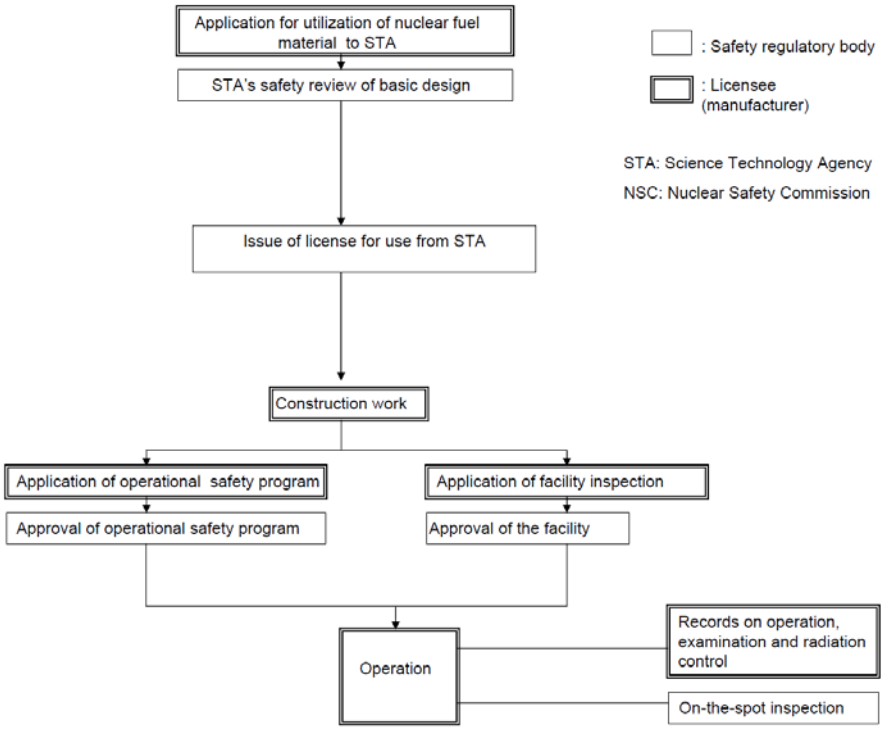

Figure 2.1. License flow for "use" of nuclear material.

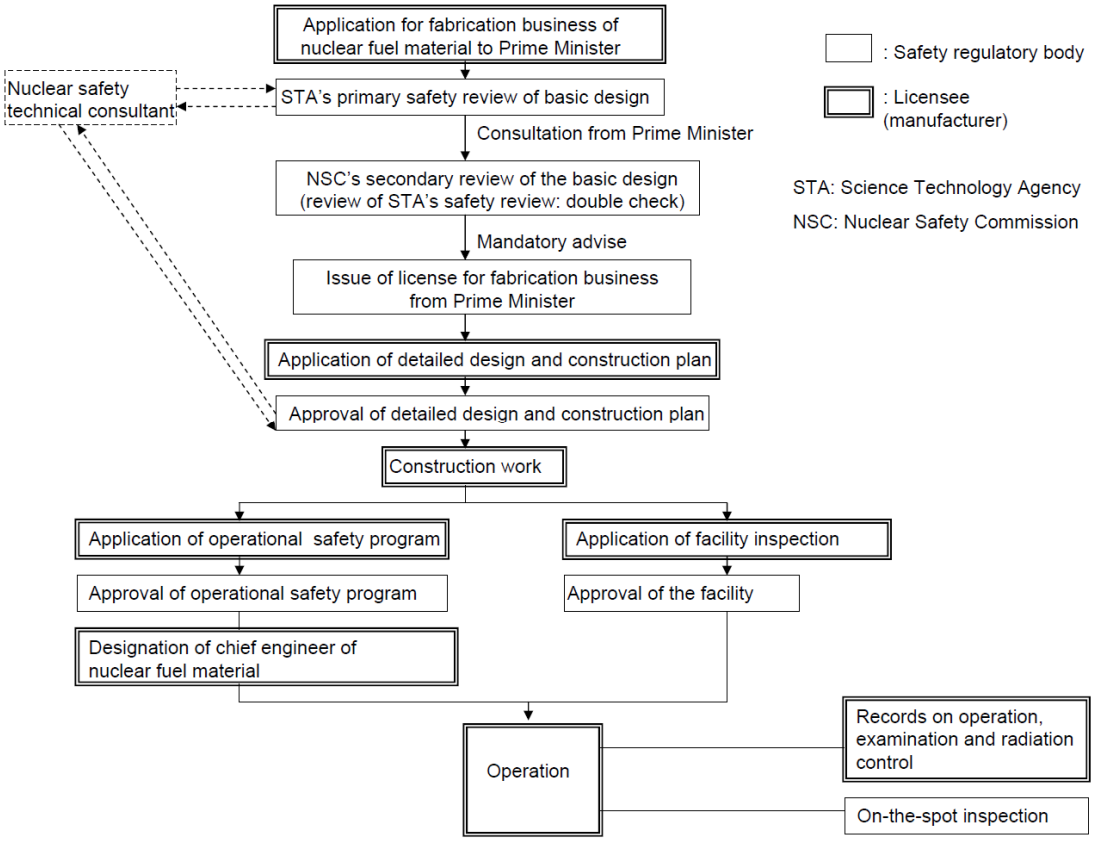

Figure 2.2. License flow for the manufacturing business.

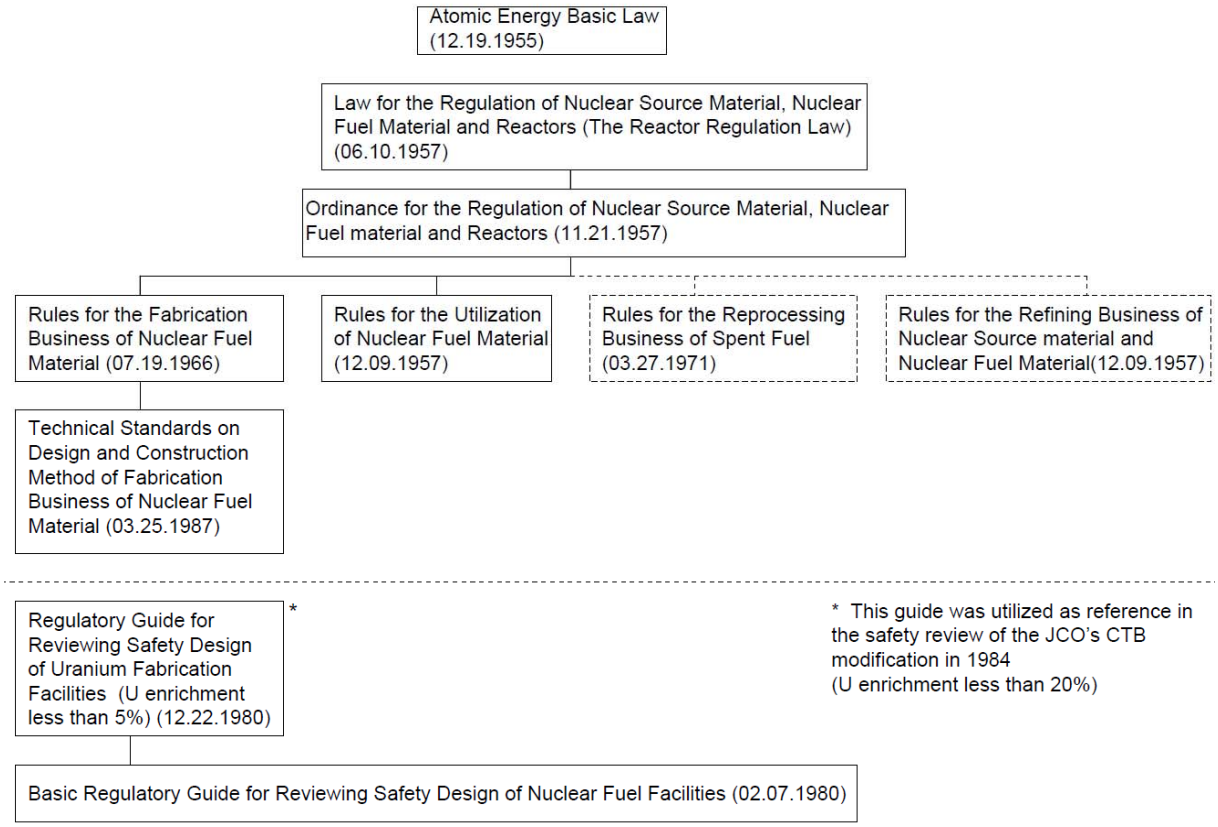

Figure 2.3. Major legislations and guides governing the safety regulation of fabrication business or utilization of nuclear fuel material

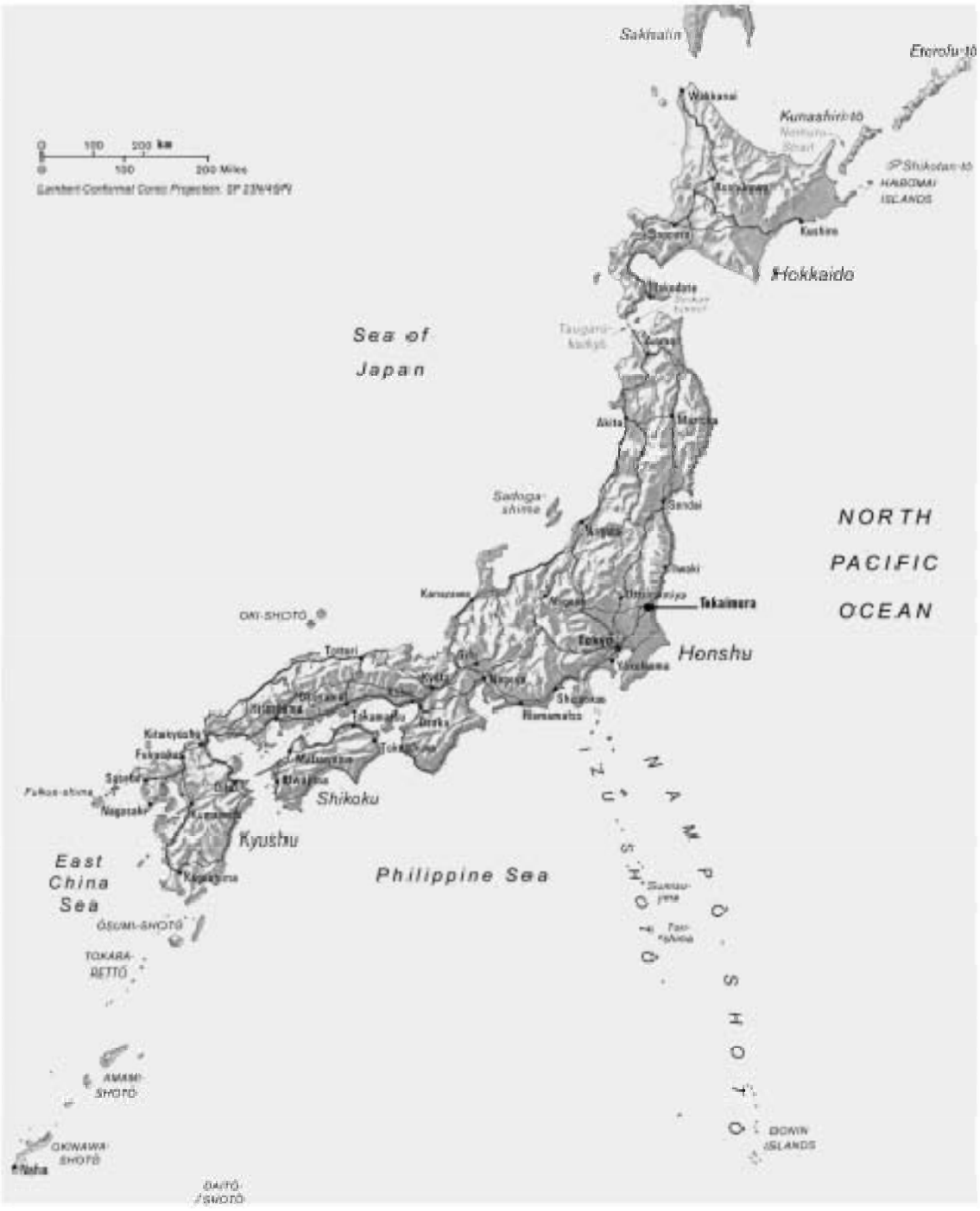

Figure 3.1. General map of Japan

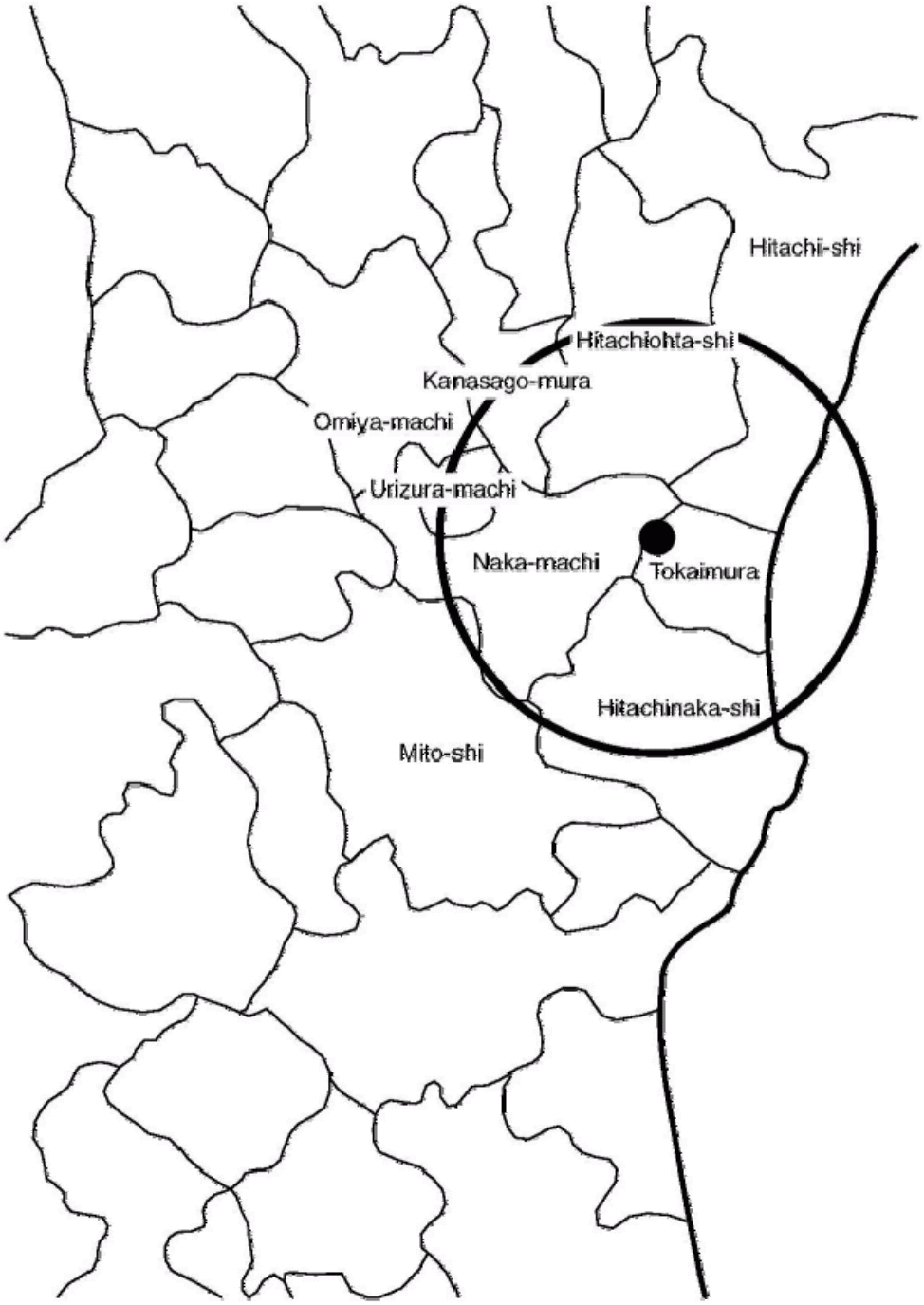

Figure 3.2. Regional map of Ibaraki Prefecture. The circle represents the 10 km area within which about 310,000 people were recommended to stay indoors.

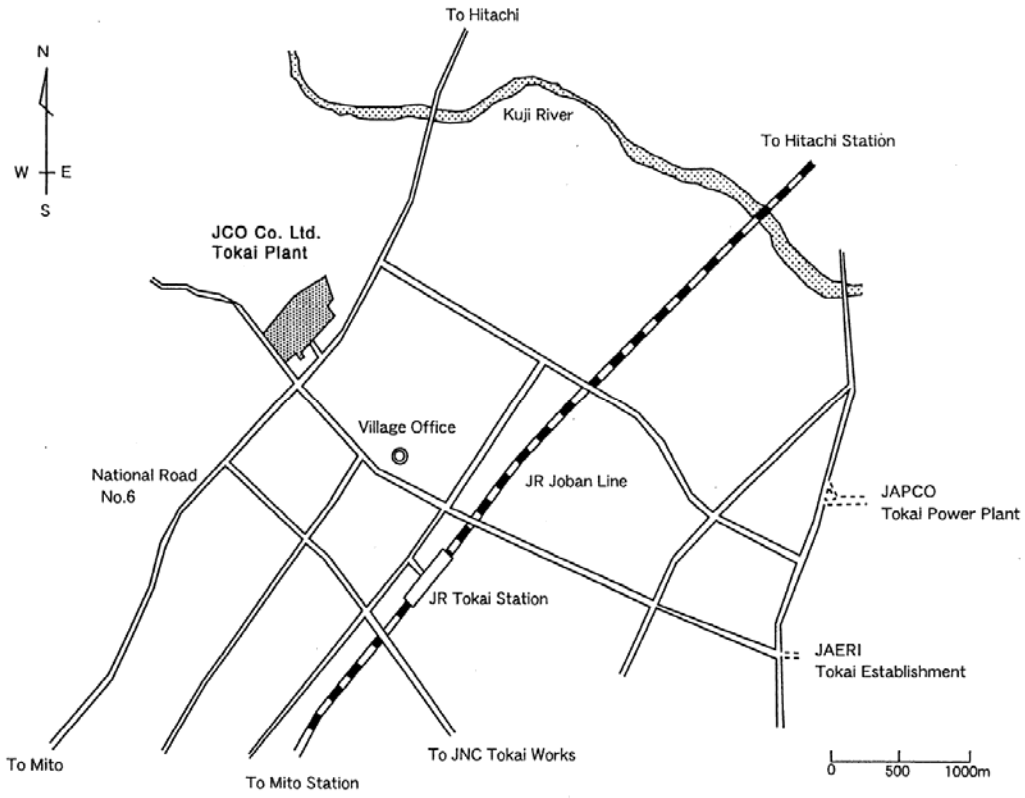

Figure 3.3. Location of JCO site (JCO Tokai Plant).

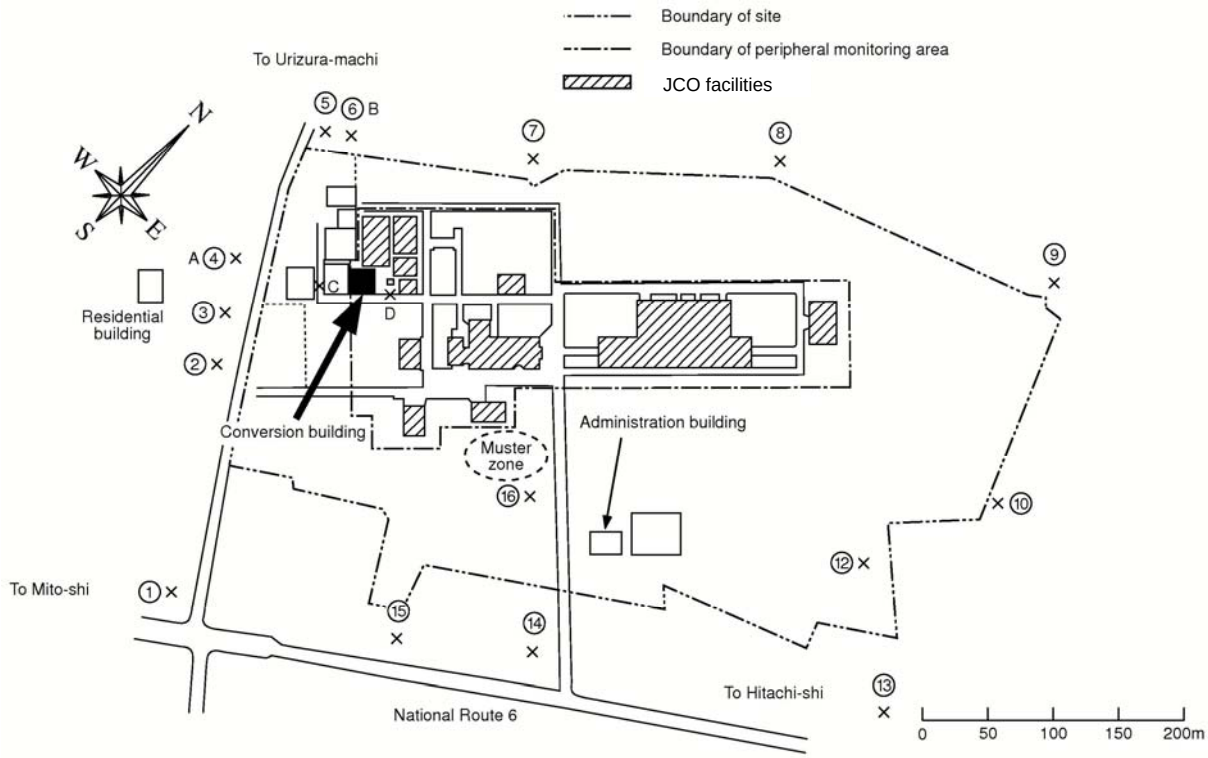

Figure 3.4. Plan of the JCO site with location of monitoring points (circled numbers)

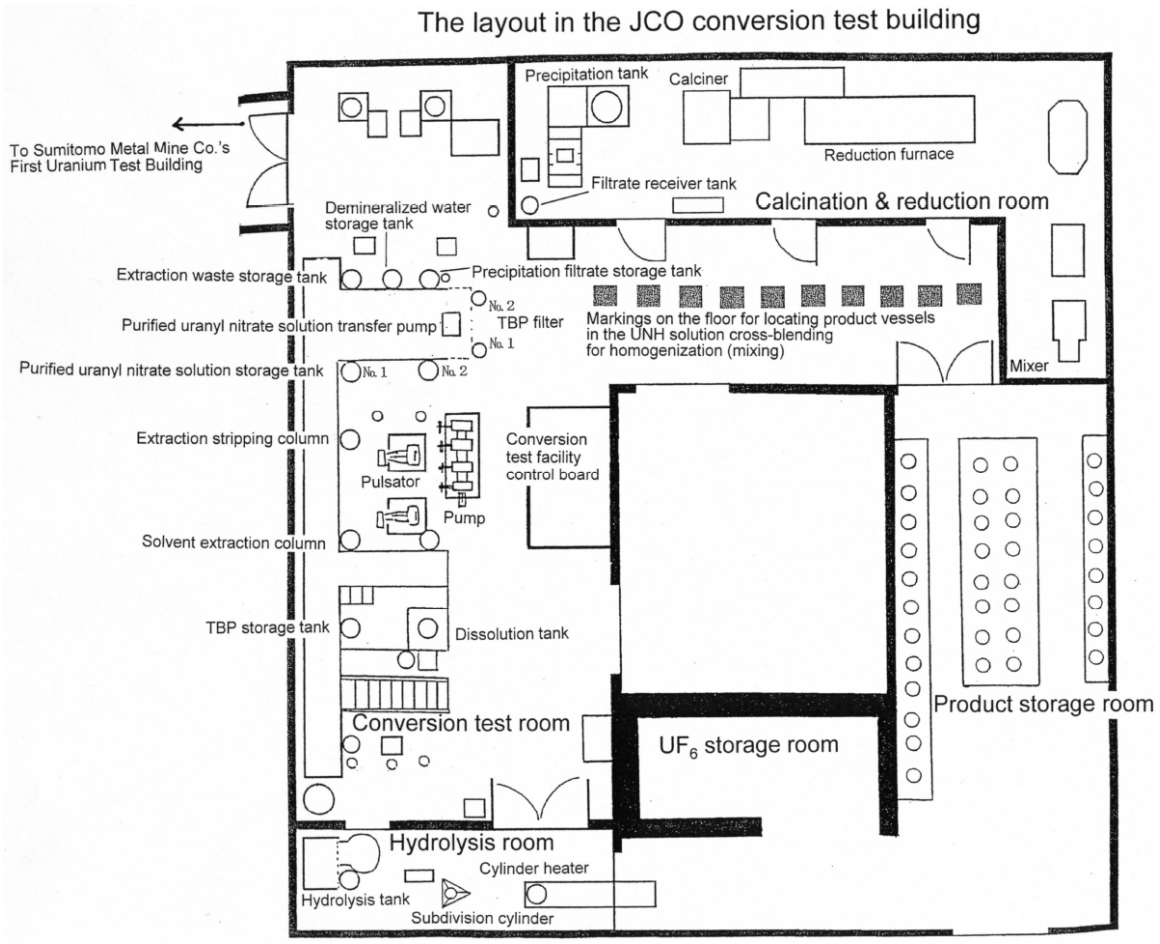

Figure 3.5. Layout in the JCO conversion test building where the accident took place.

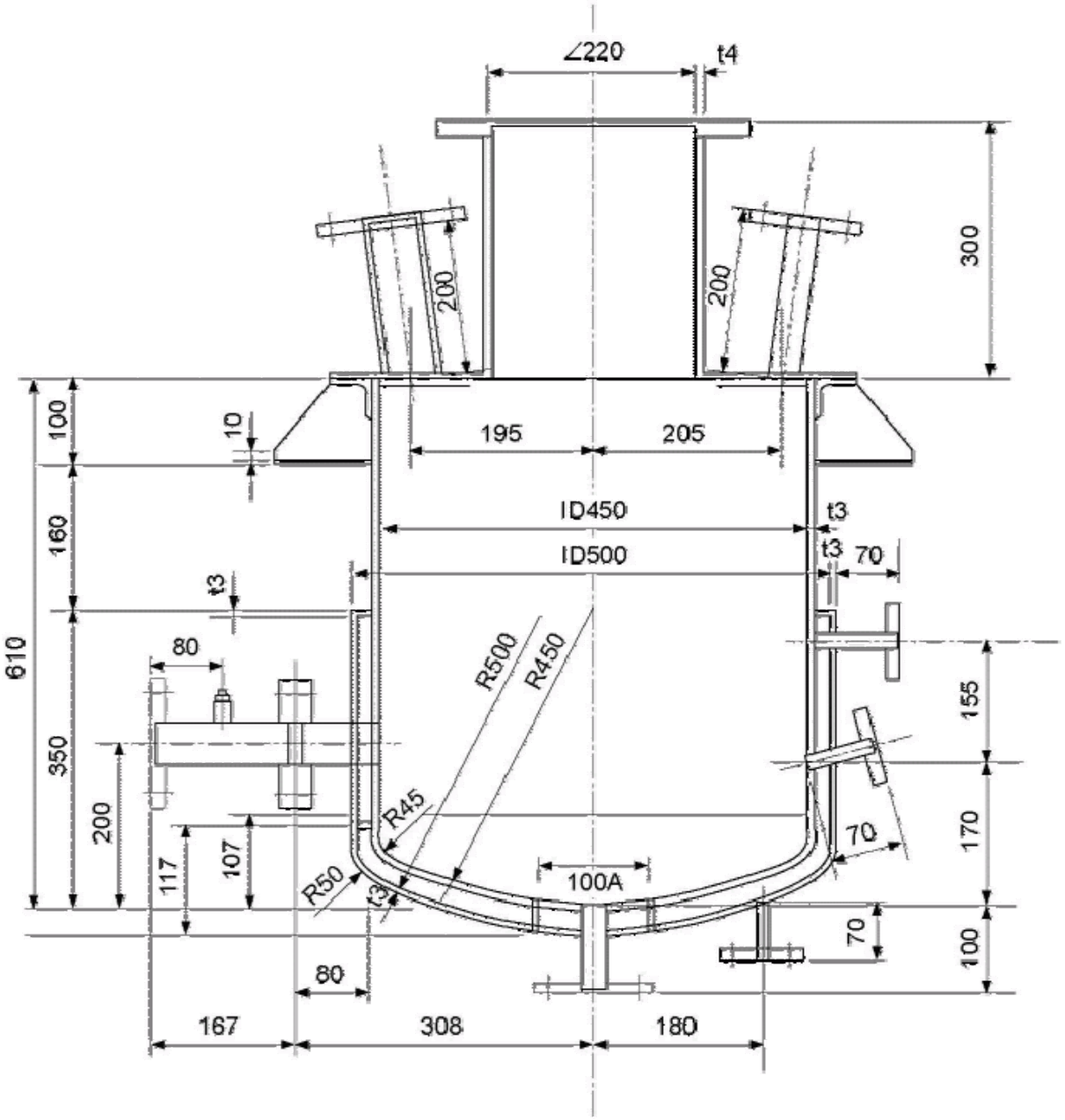

Figure 3.6. Cross-section of the precipitation tank indicating dimensions (in mm).

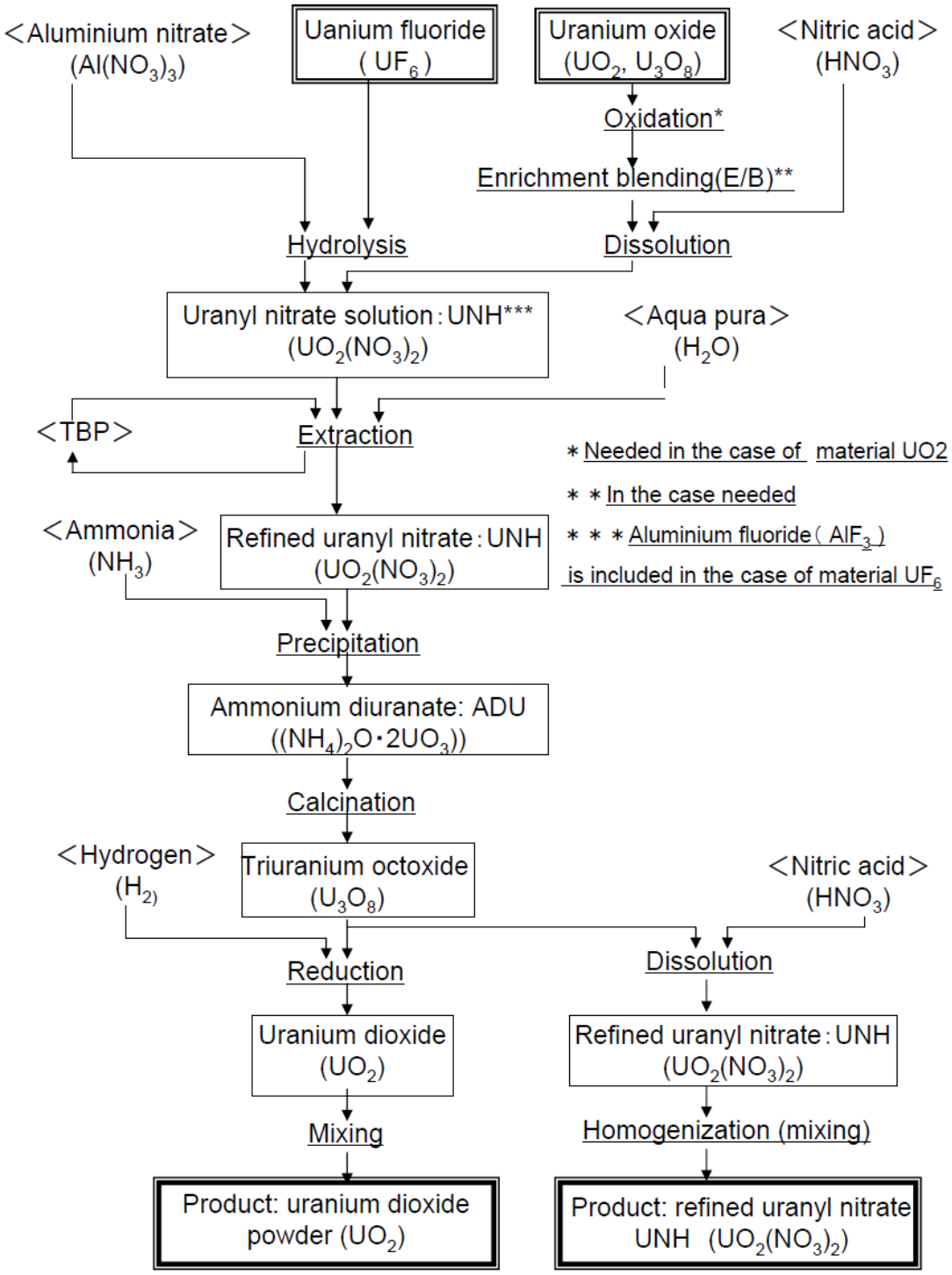

Figure 3.7. Process flow of producing uranium dioxide or UNH in the CTB.

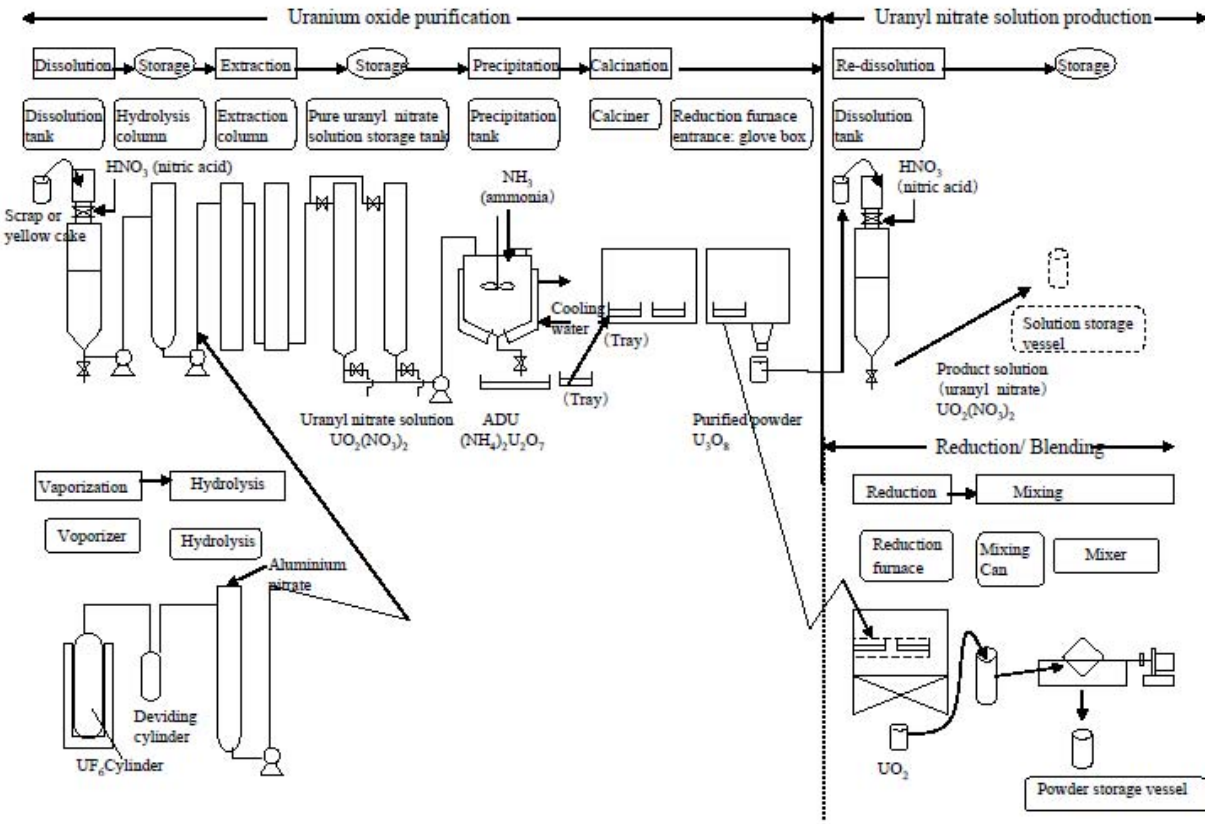

Figure 3.8. Production system licensed in 1984 for UO_2 and UNH in the CTB.

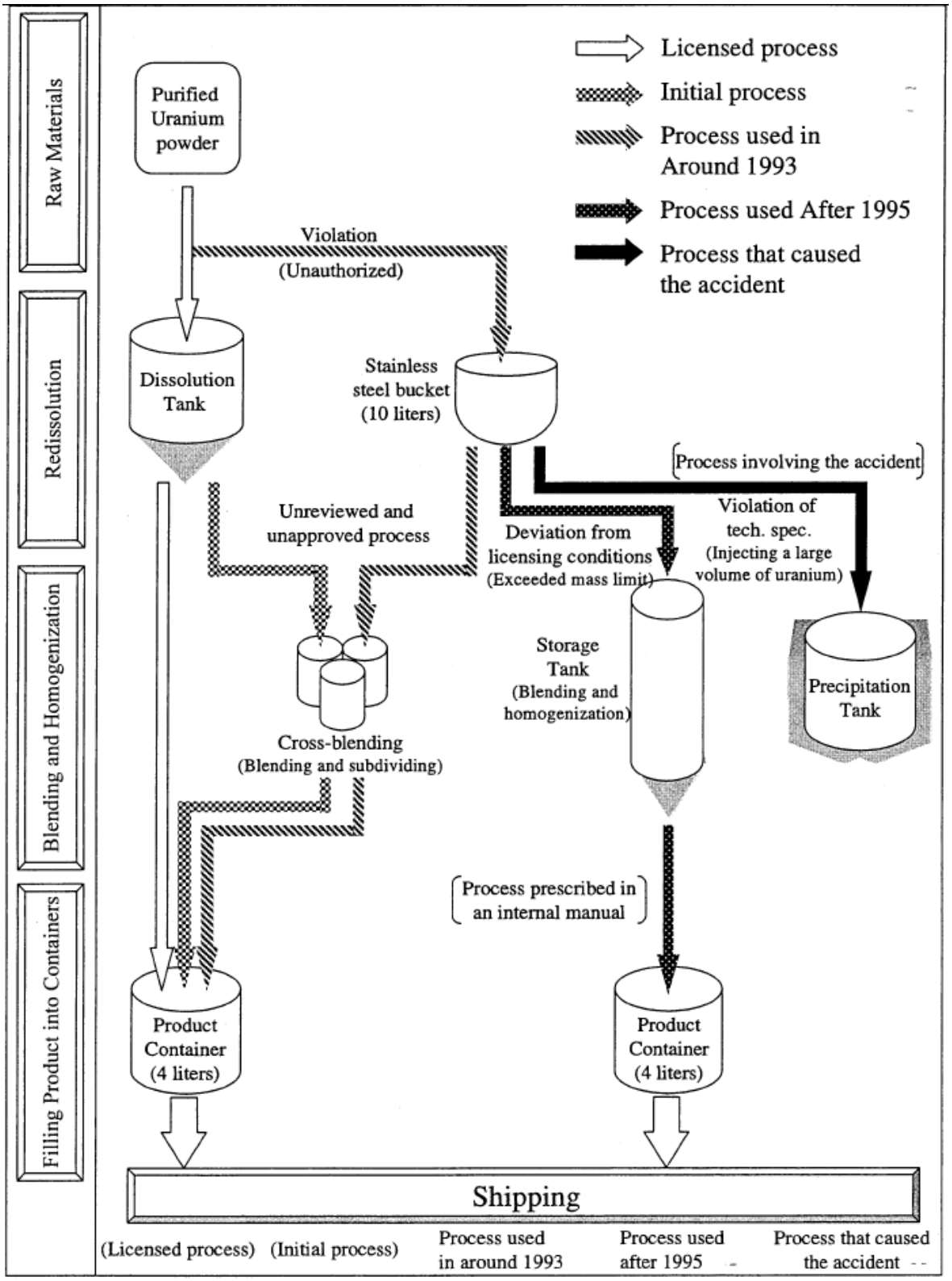

Figure 4.1. Changes of the production process of UNH solution in the CTB.

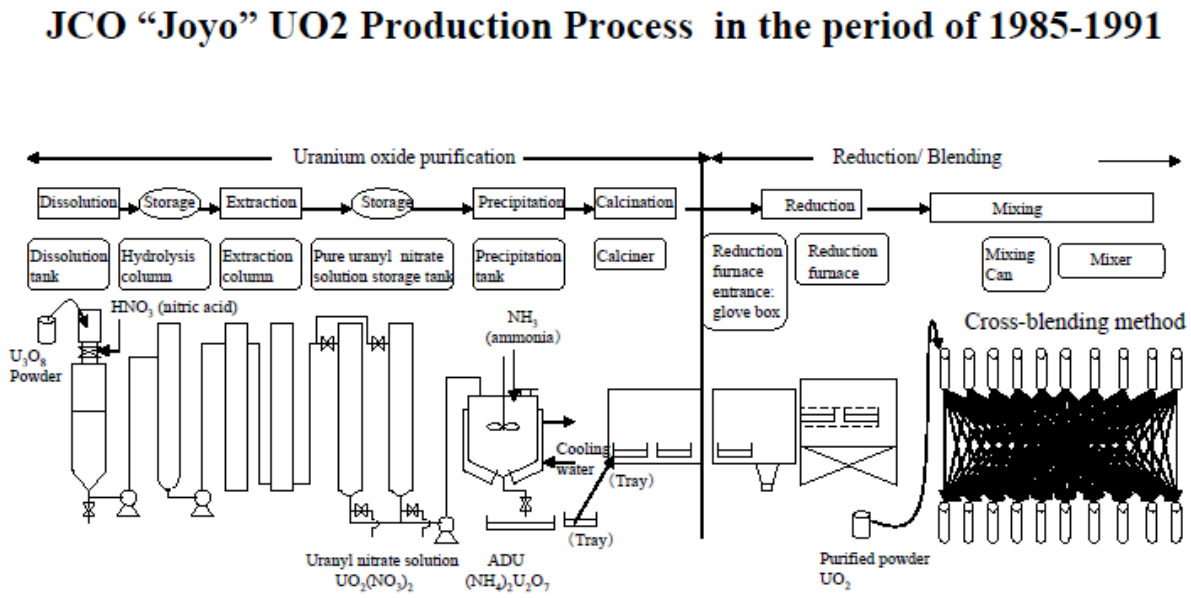

Figure 4.2. Production system of JOYO UO_2 in the period of 1985-1991.

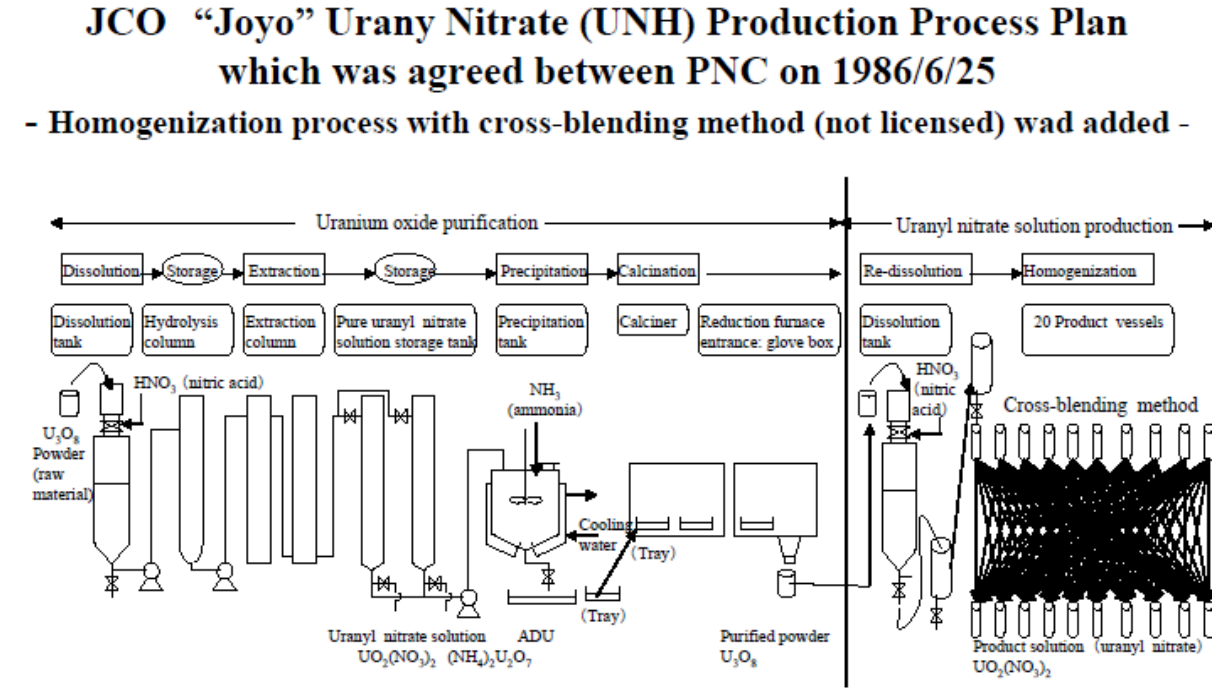

Figure 4.3. Production system plan of JOYO UNH which was agreed between PNC and JCO on June 25, 1986.

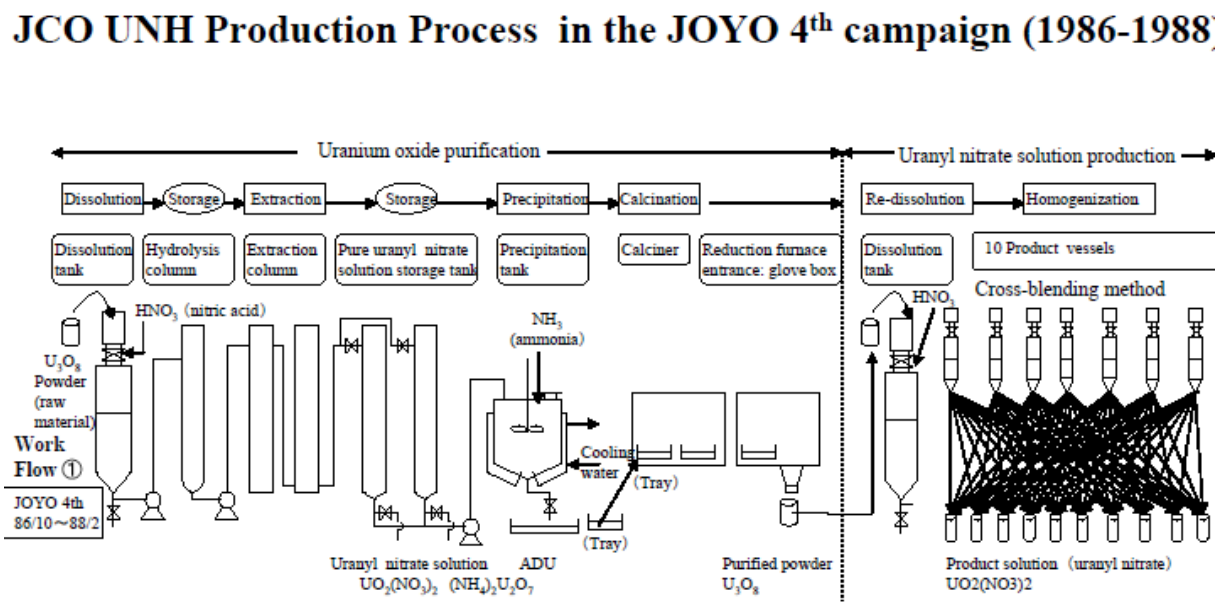

Figure 4.4. Production system of UNH in the Joyo 4th Campaign (1986-1988).

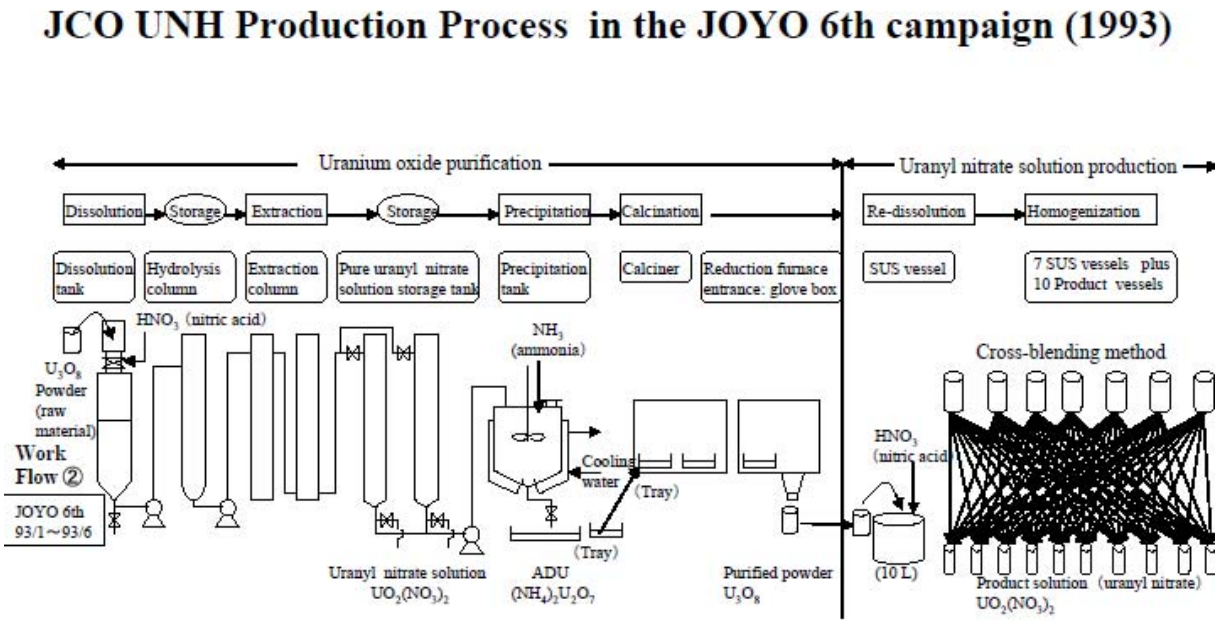

Figure 4.5. Production system of UNH in the JOYO 6th Campaign (1993).

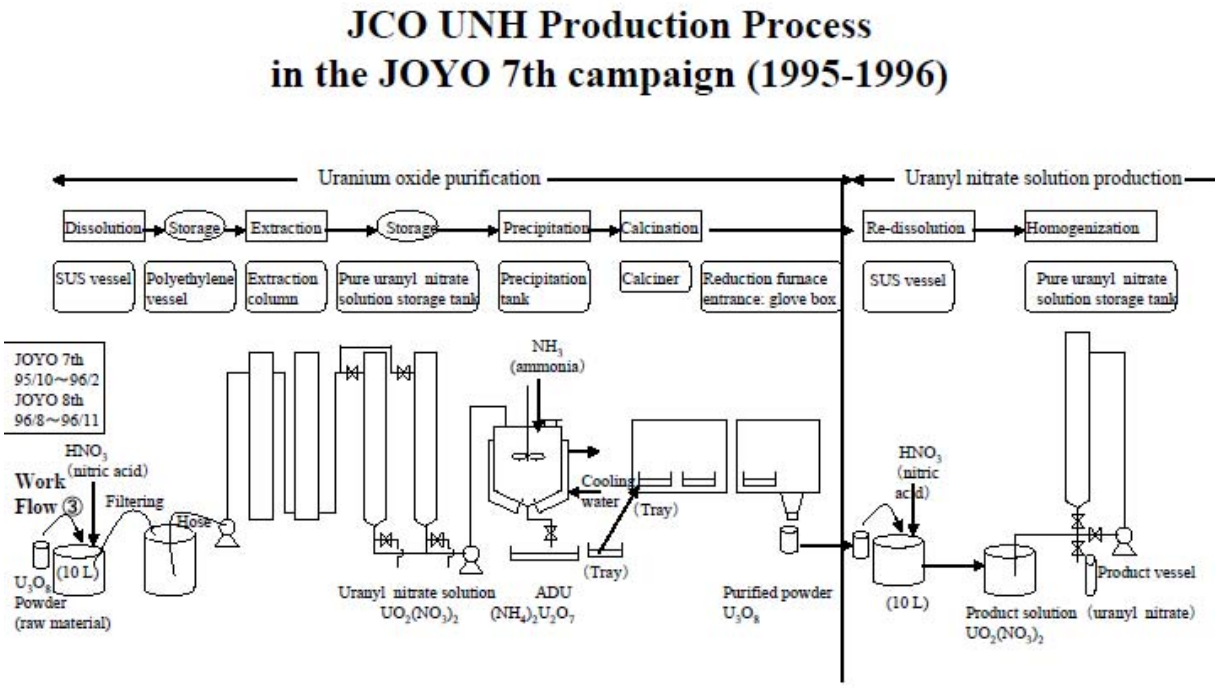

Figure 4.6. Production system of UNH in the JOYO 7th Campaign (1995-1996).

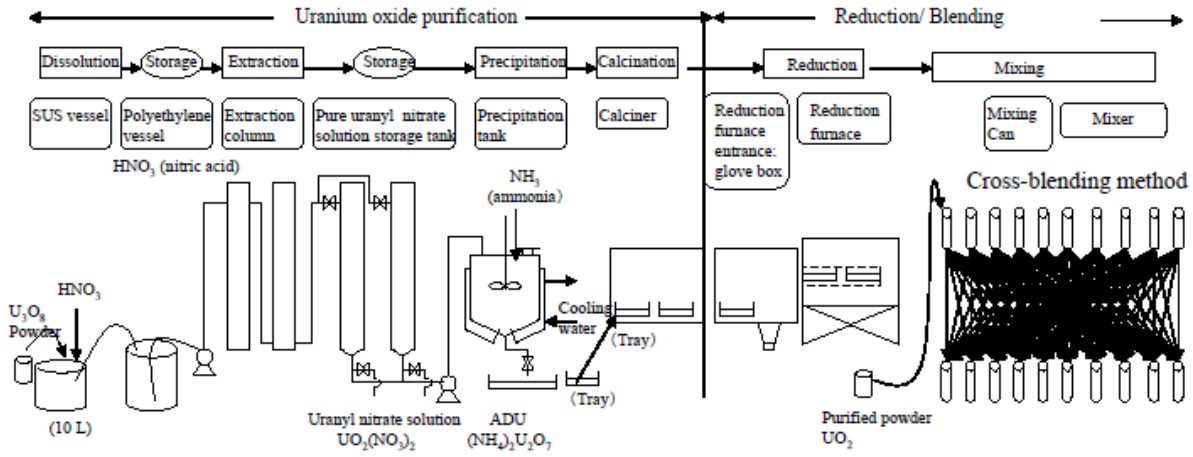

Figure 4.7. Production system of JOYO UO_2 in the period of 1996-1998.

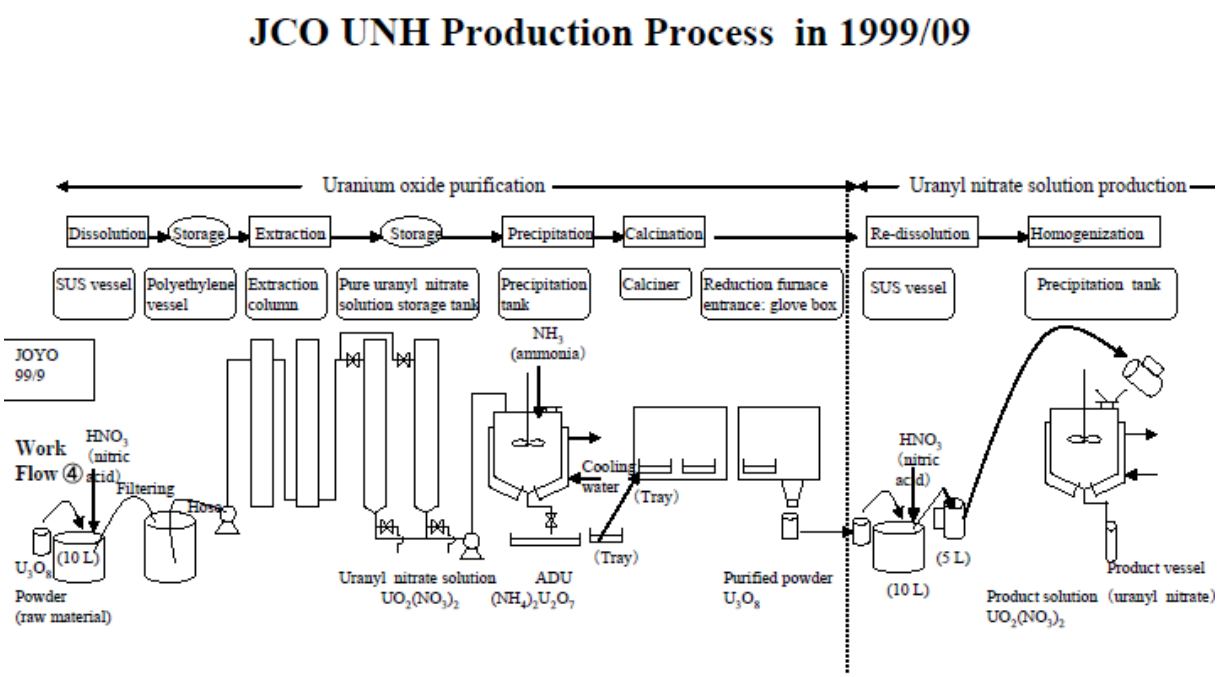

Figure 4.8. Production system of UNH in September 1999.

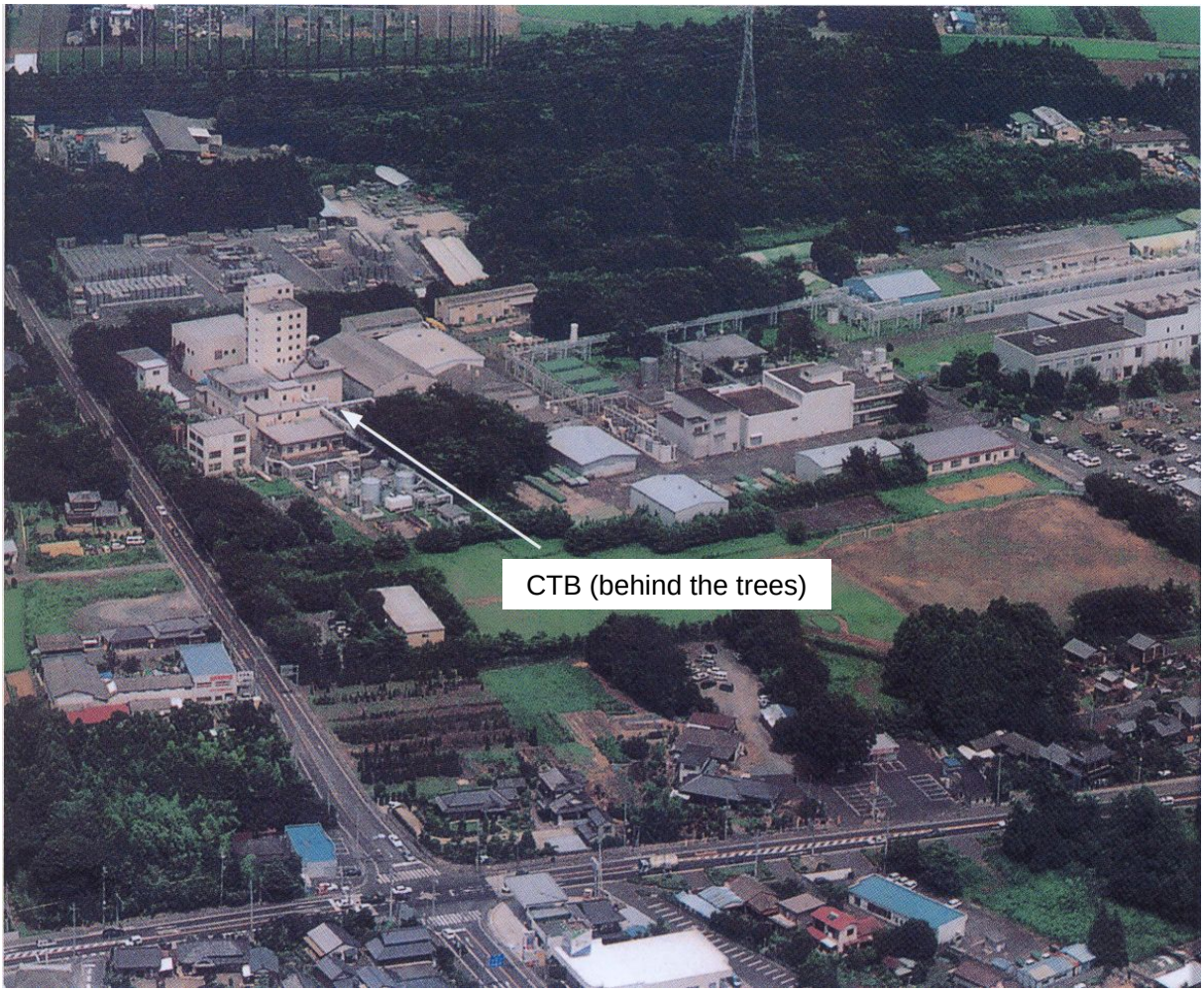

Photo 5.1. Bird eye view of near the JCO site in Tokaimura, Ibaraki.

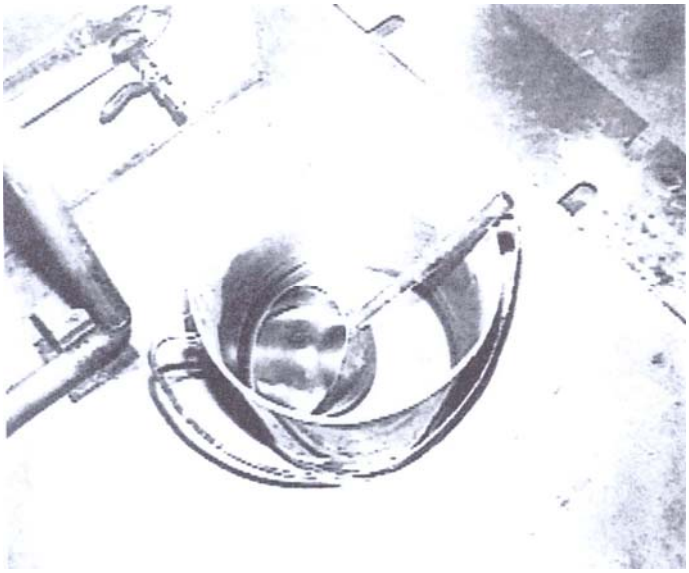

Photo 5.2. Stainless steel beaker.

Photo 5.3. Precipitation tank

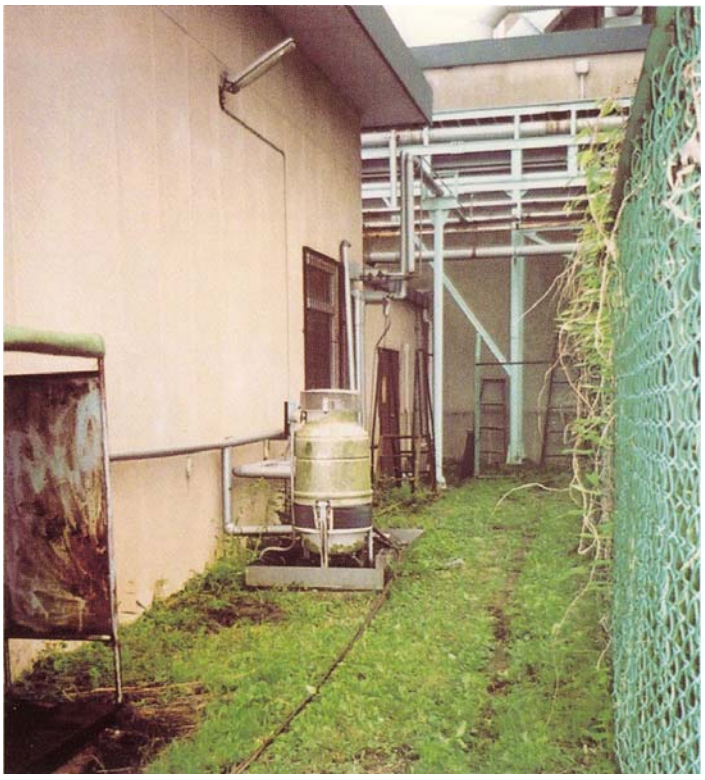

Photo 5.4. The CTB and the cooling tower for the precipitation tank.

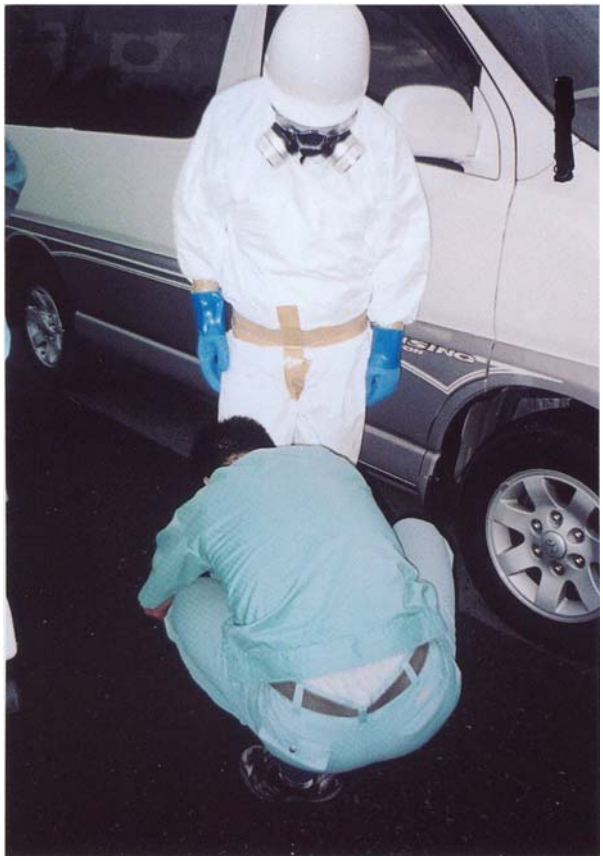

Photo 5.5. Working clothes for water draining.

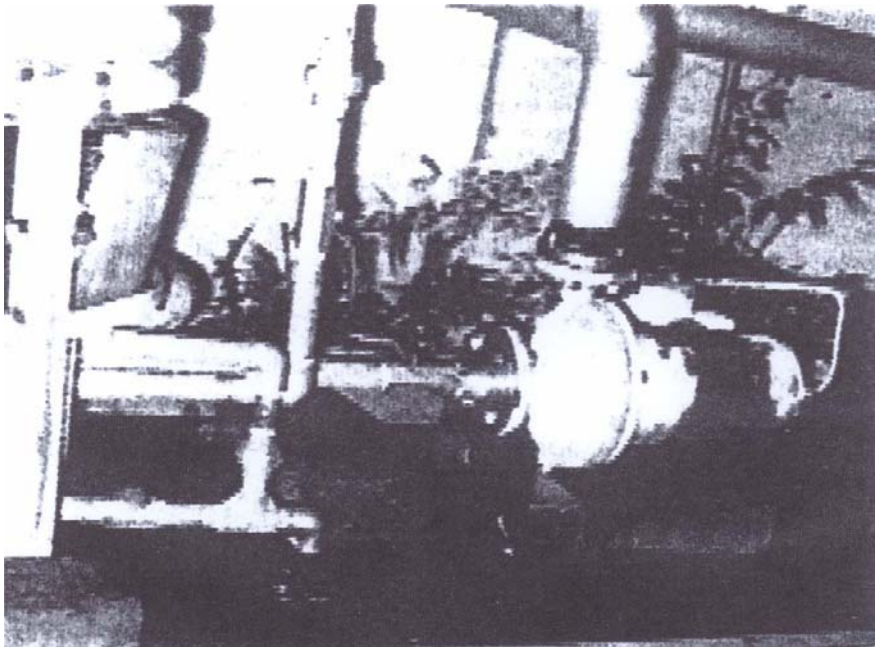

Photo 5.6. Pipe connection to be broken (a snap shot).

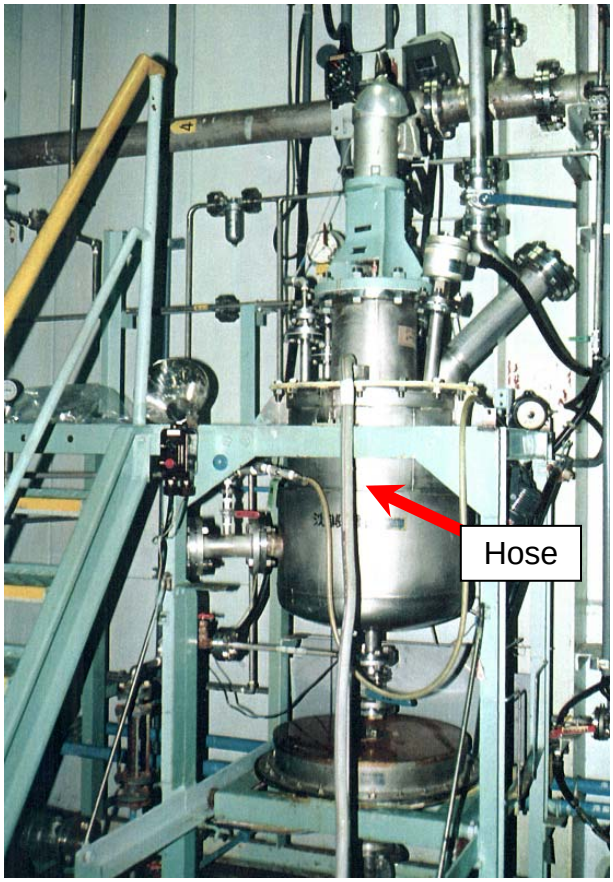

Photo 5.7. The precipitation tank with a hose for injection of boric acid.

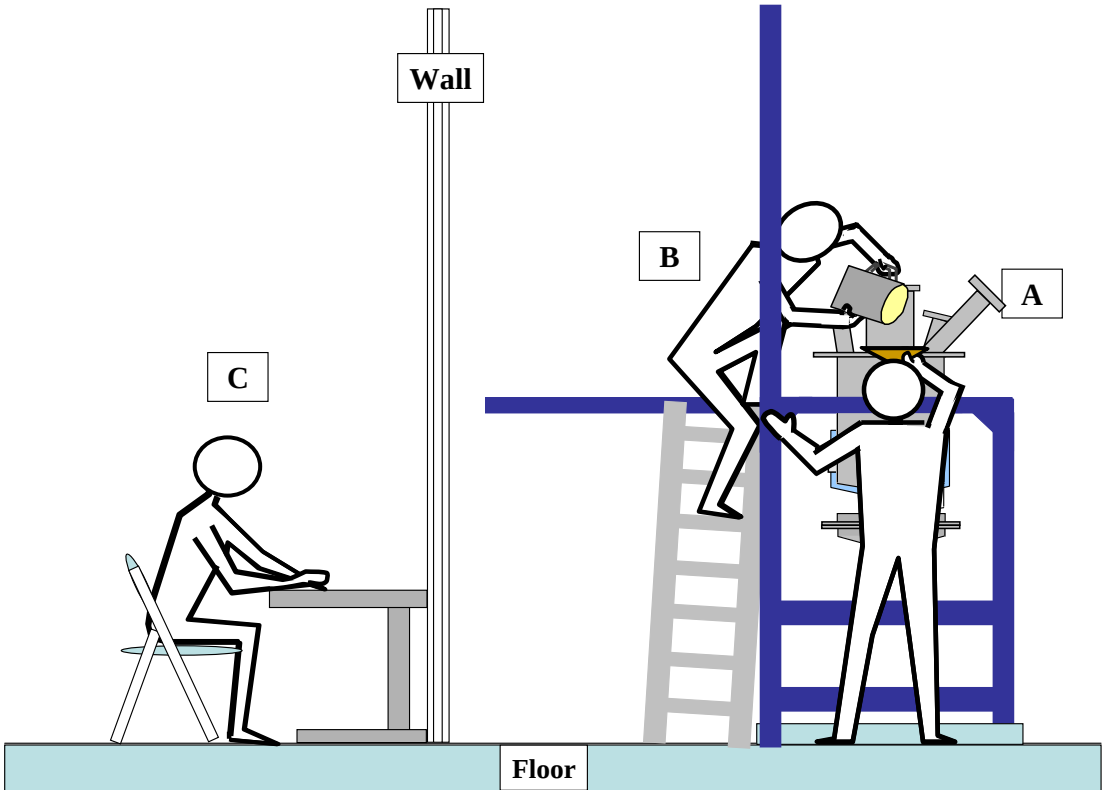

Figure 5.1 Working situation of severely exposed three workers in the criticality accident.

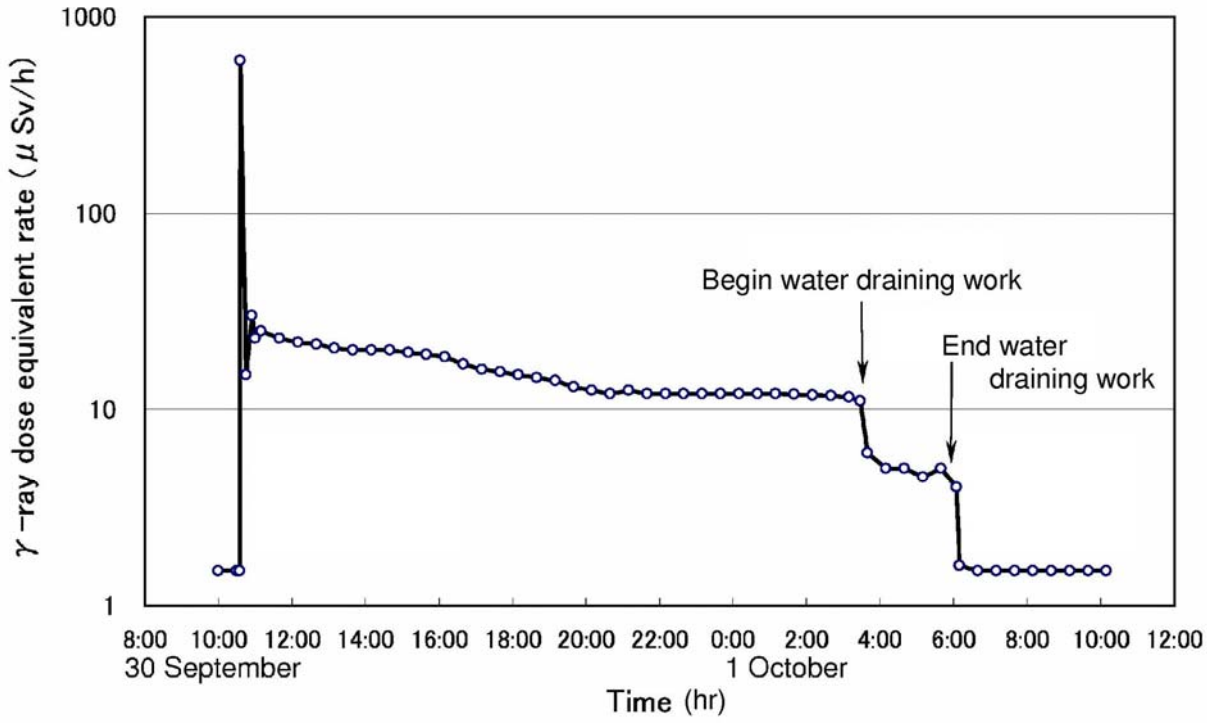

Figure 5.2. Records of a gamma-ray monitor in the JCO facility.

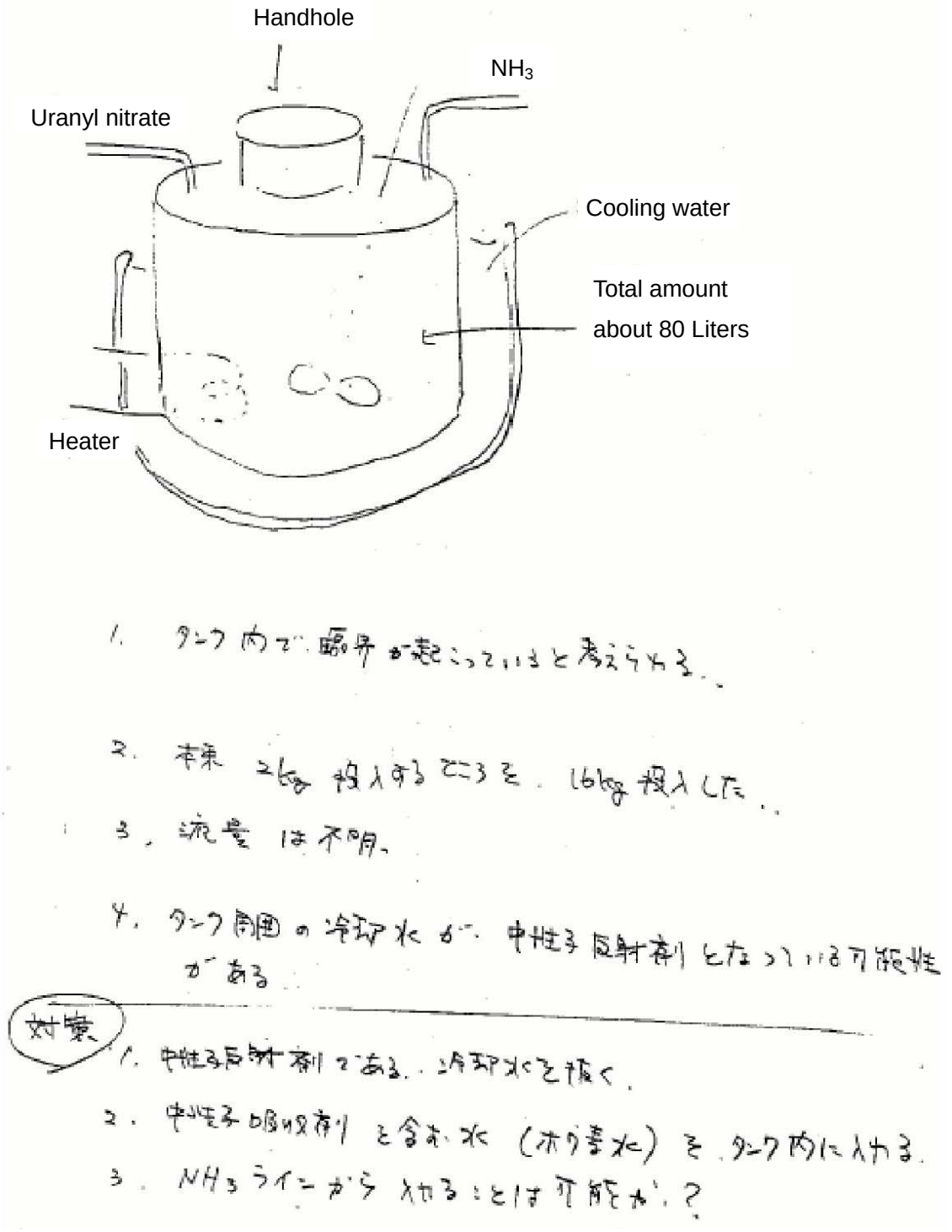

Figure 5.3. Sketch of the precipitation tank for discussion on the criticality provided by JCO.

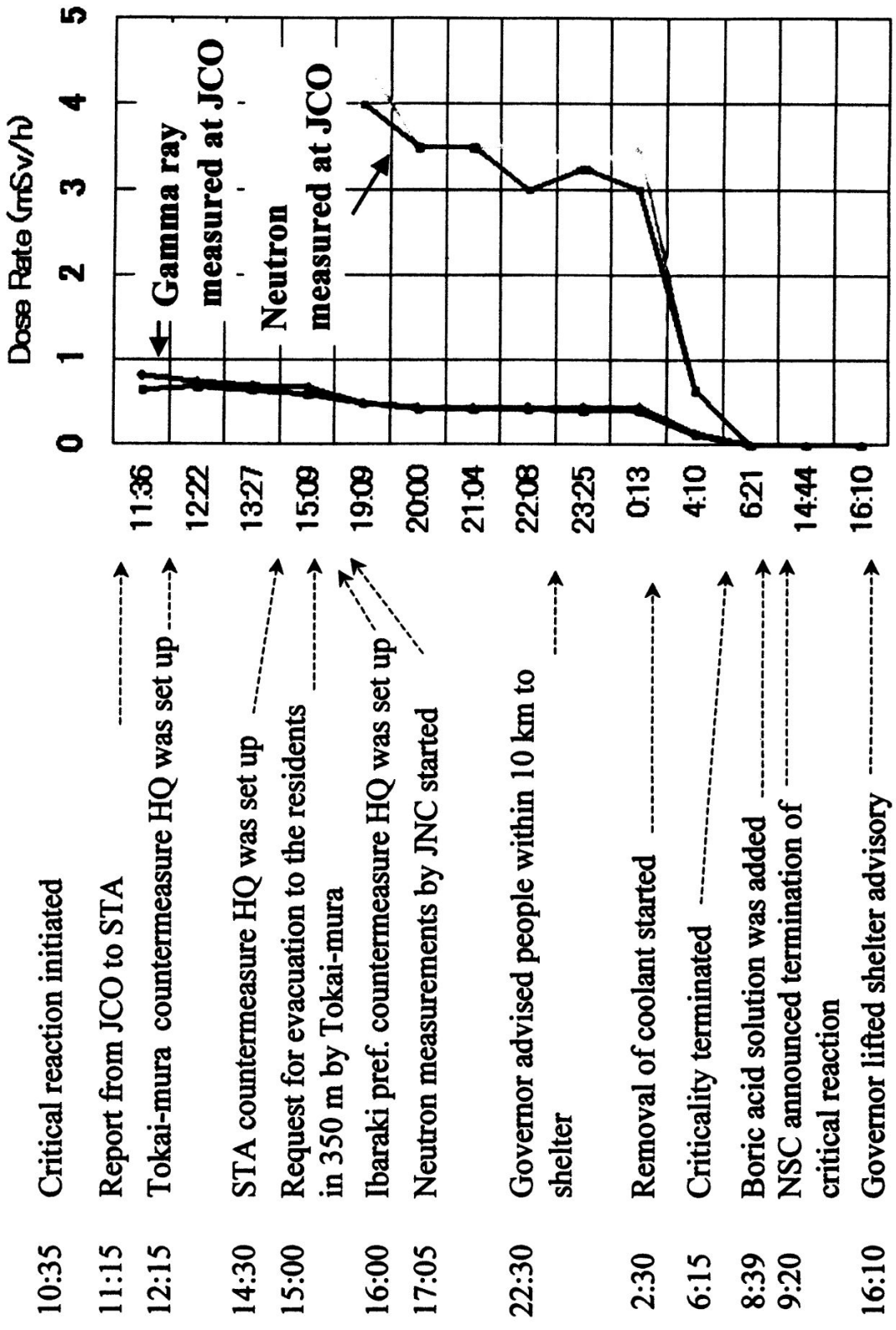

Figure 5.4. Chronological record of various meetings and centers and gamma-ray dose indication.

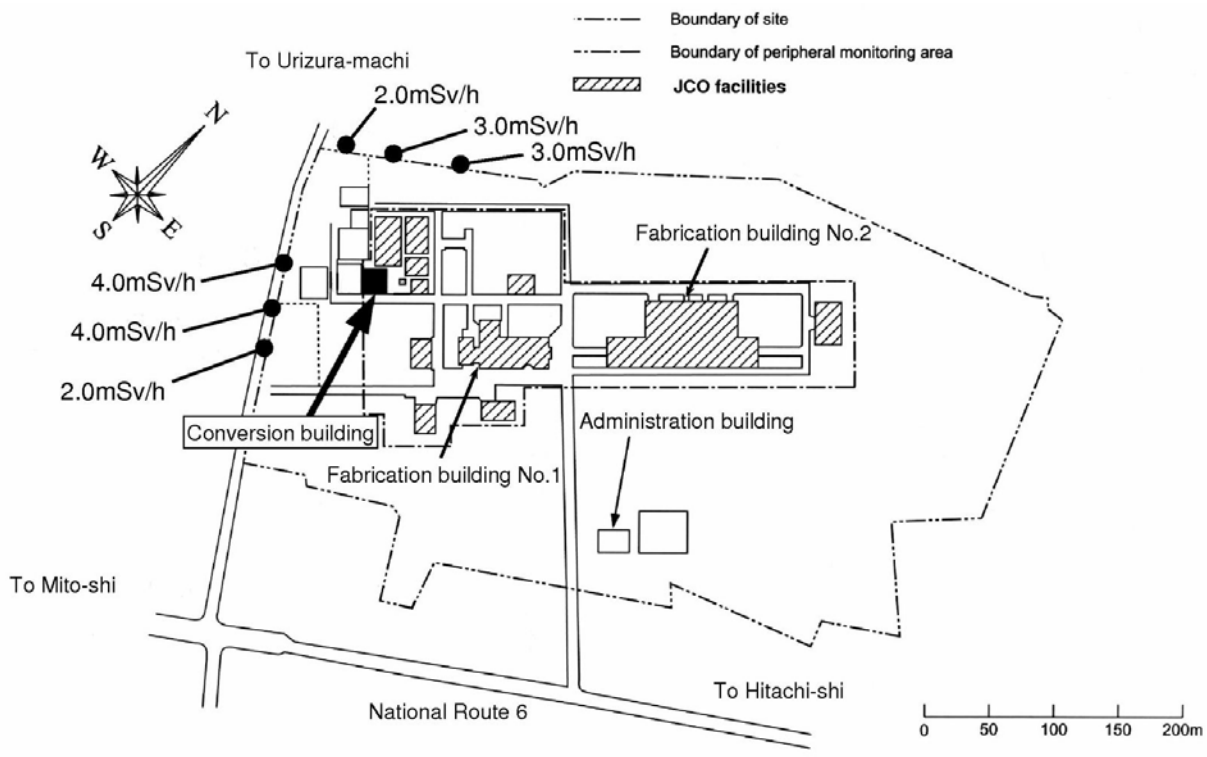

Figure 5.5. Neutron and gamma-ray dose distribution map at JCO site at around 17:00, September 30.

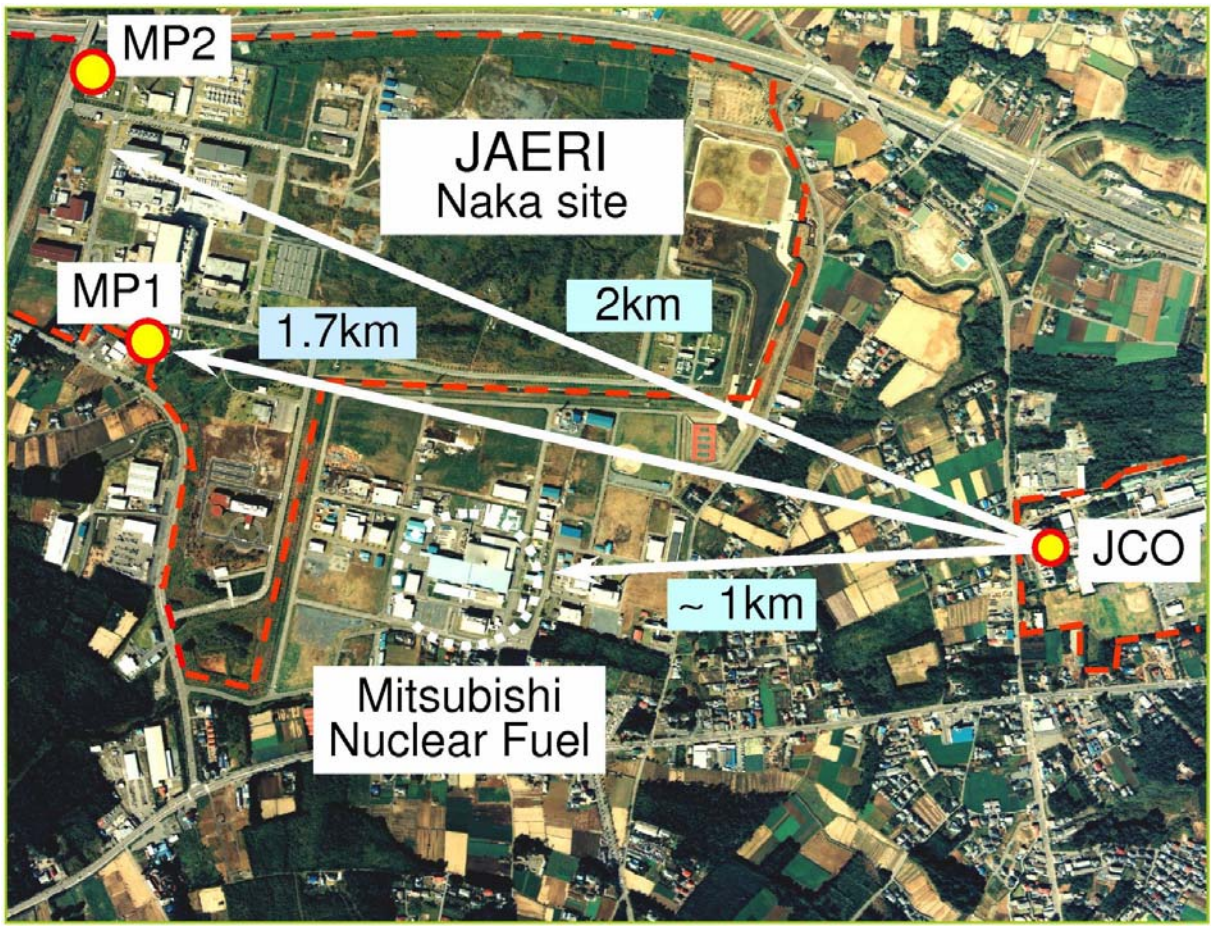

Figure 5.6. Locations of JCO, the Naka Fusion Research Establishment of JAERI (JAERI Naka) and Mitsubishi Nuclear Fuel (MNF). MP-1 and MP-2 indicate monitoring posts in the JAERI Naka.

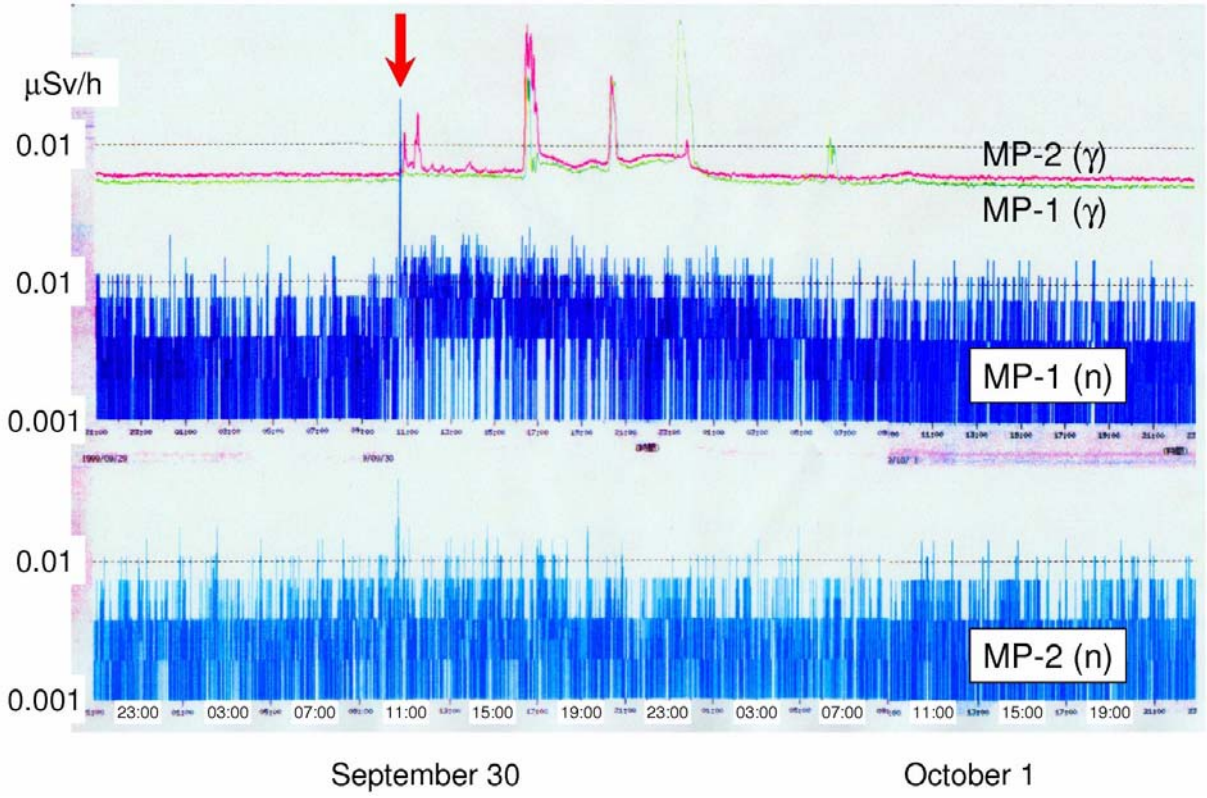

Figure 5.7. Observed data with the neutron and gamma-ray monitors in MP-1 and MP-2 at the JAERI Naka site.

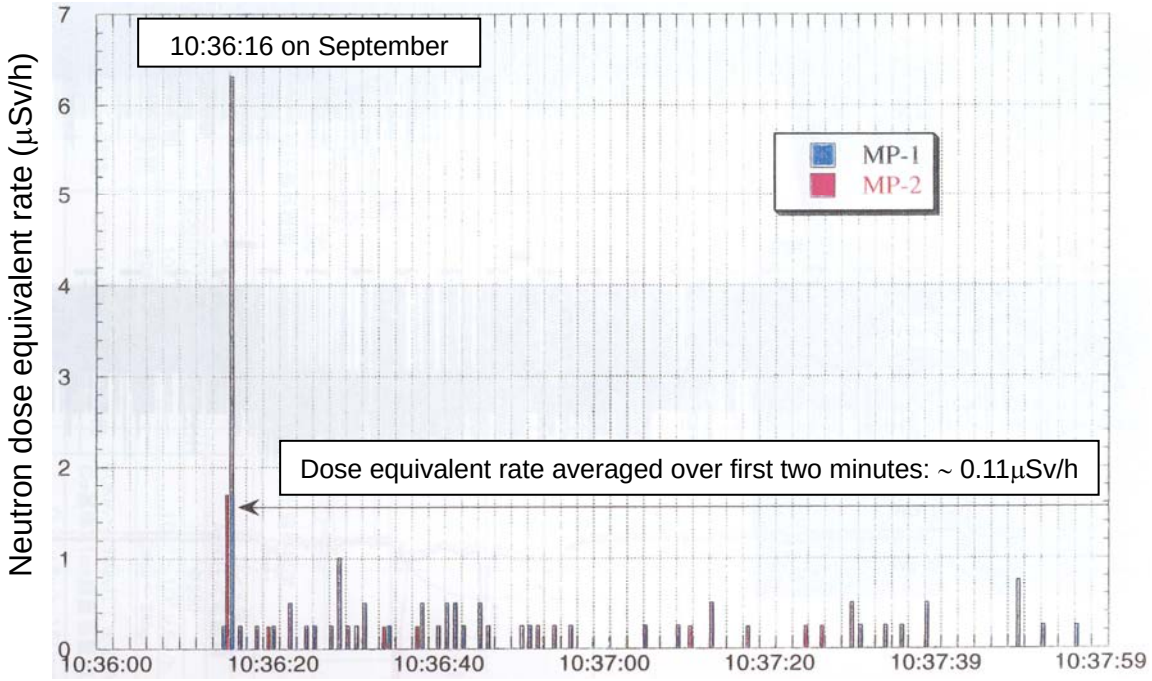

Figure 5.8. Data of the neutron monitors of MP-1 and MP-2 for every 1 second.

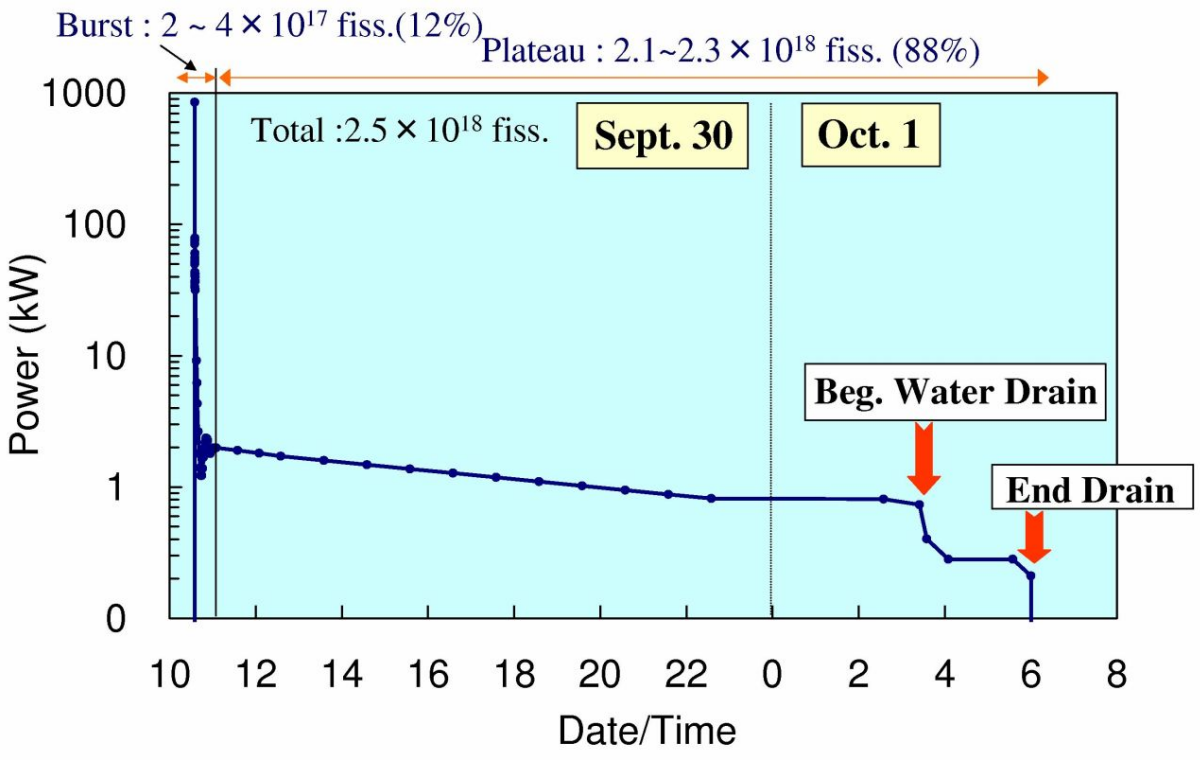

Figure 5.9. Time dependence of released fission power.

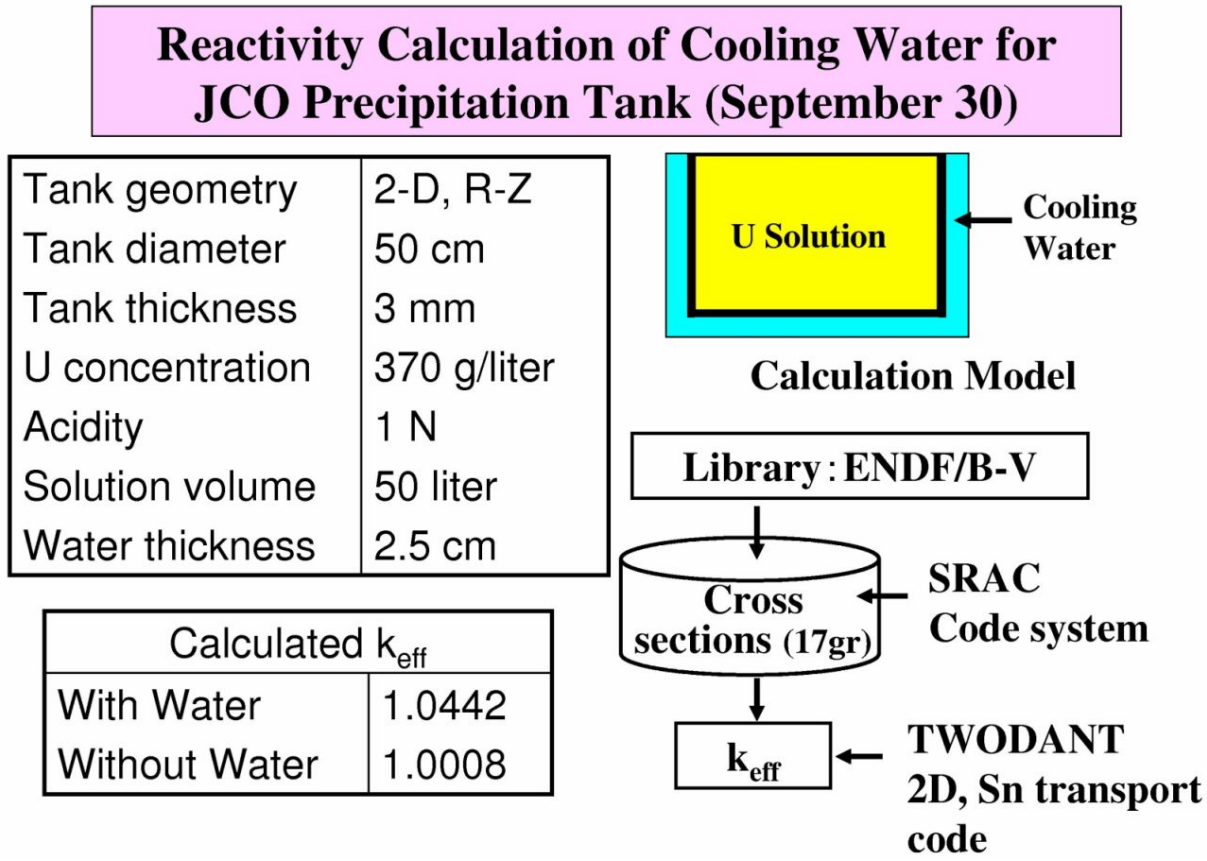

Figure 5.10. Simplified calculation model of the precipitation tank prepared in the night of accident (September 30) and balance of estimated reactivity change before and after the draining of cooling water.

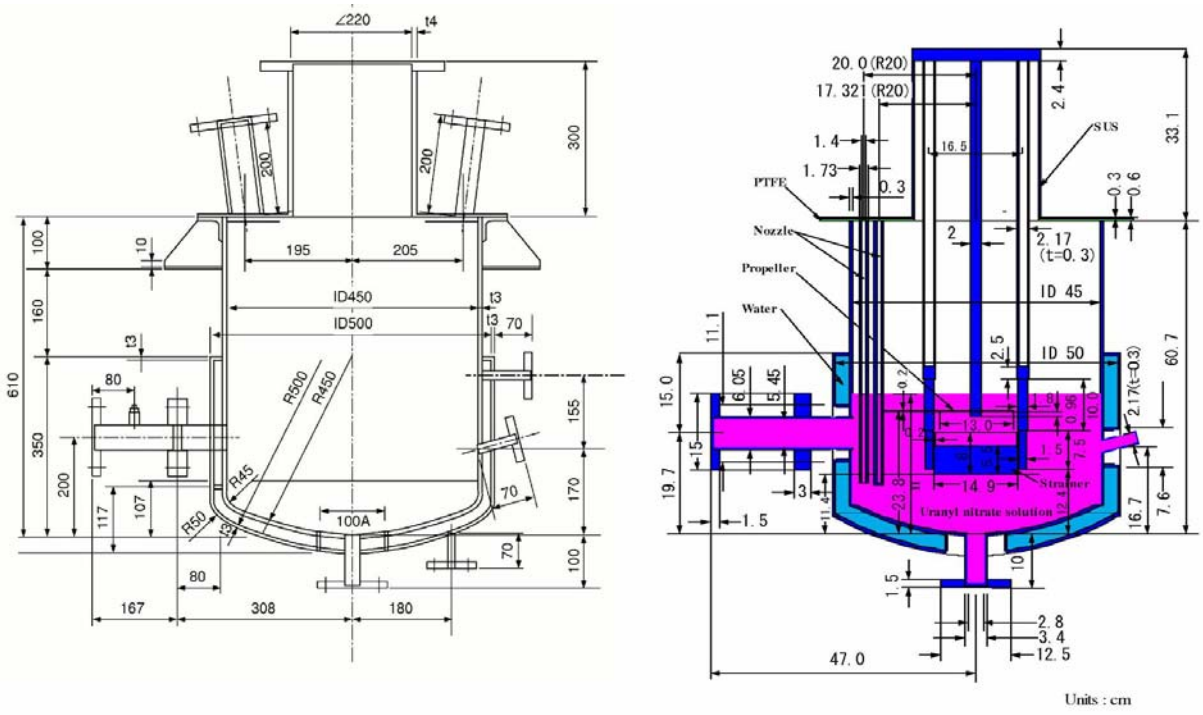

Figure 5.11. Detailed structural drawing of the precipitation tank (left) and the model prepared for calculation (right).

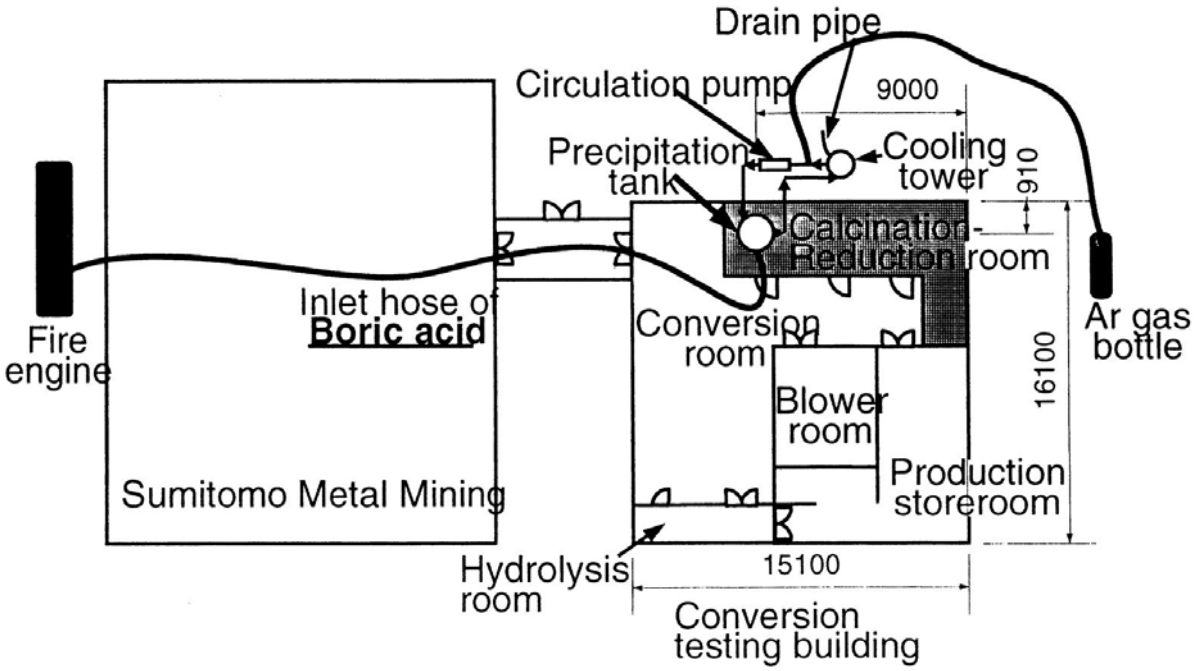

Figure 5.12. Operations of water drain and boric acid injection.

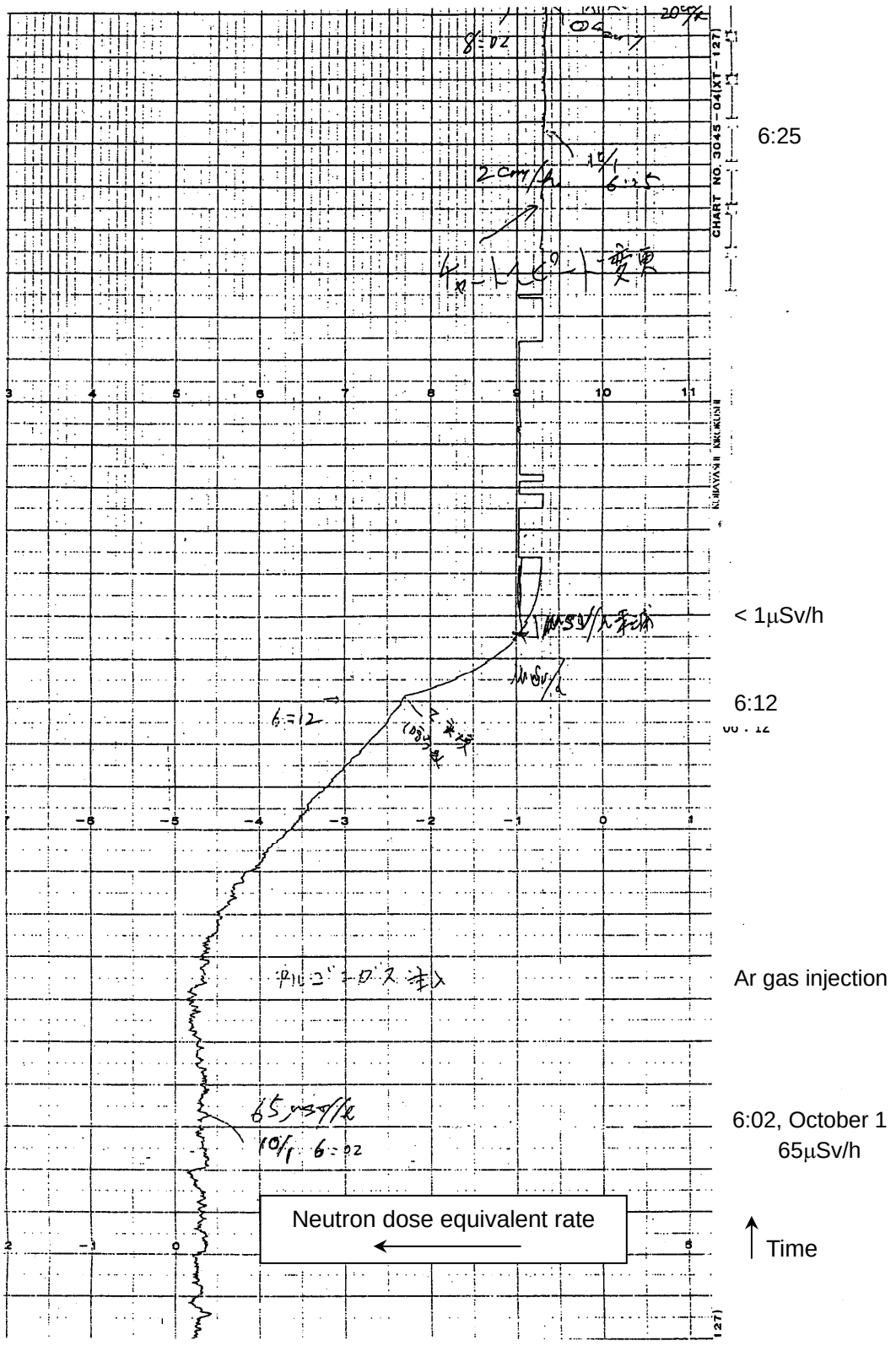

Figure 5.13. Record of decrease of neutron dose rate.

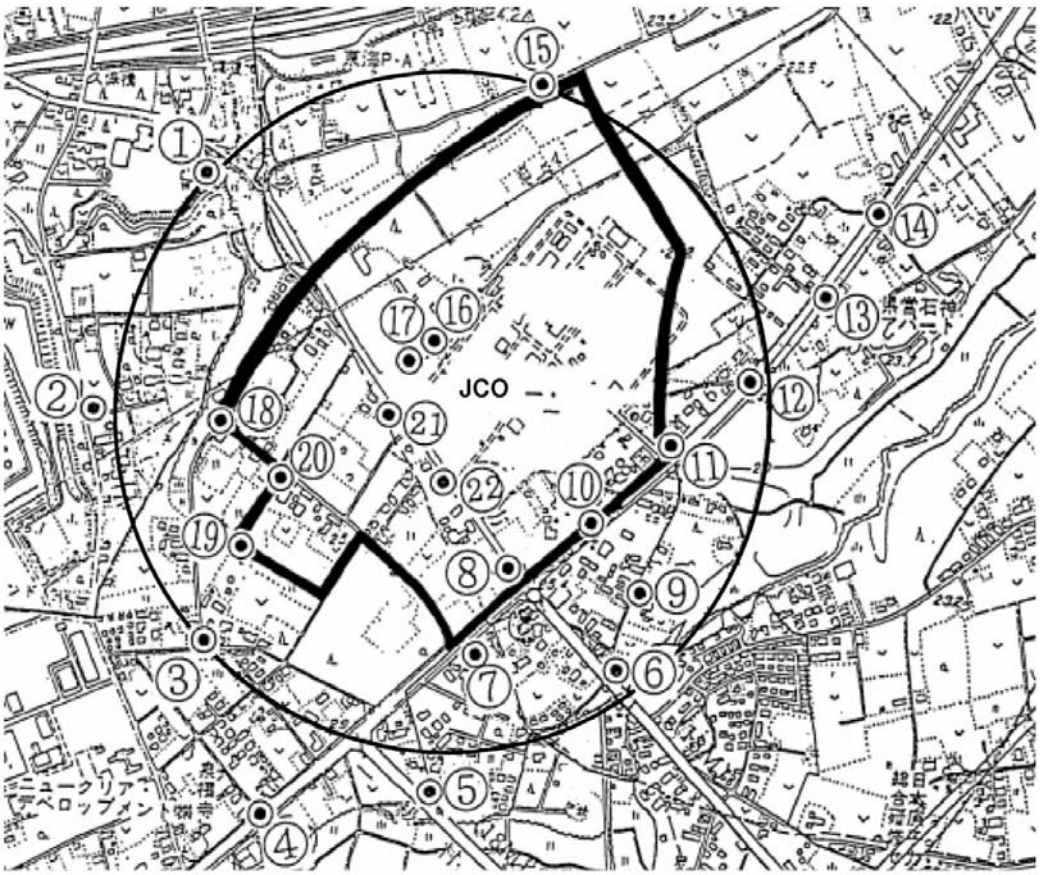

Figure 6.1. Local map indicating the area enclosed by the bold line, for which evacuation was implemented. The circle shows a 500 m radius from the CTB, and circled numbers indicate positions of radiation monitoring.

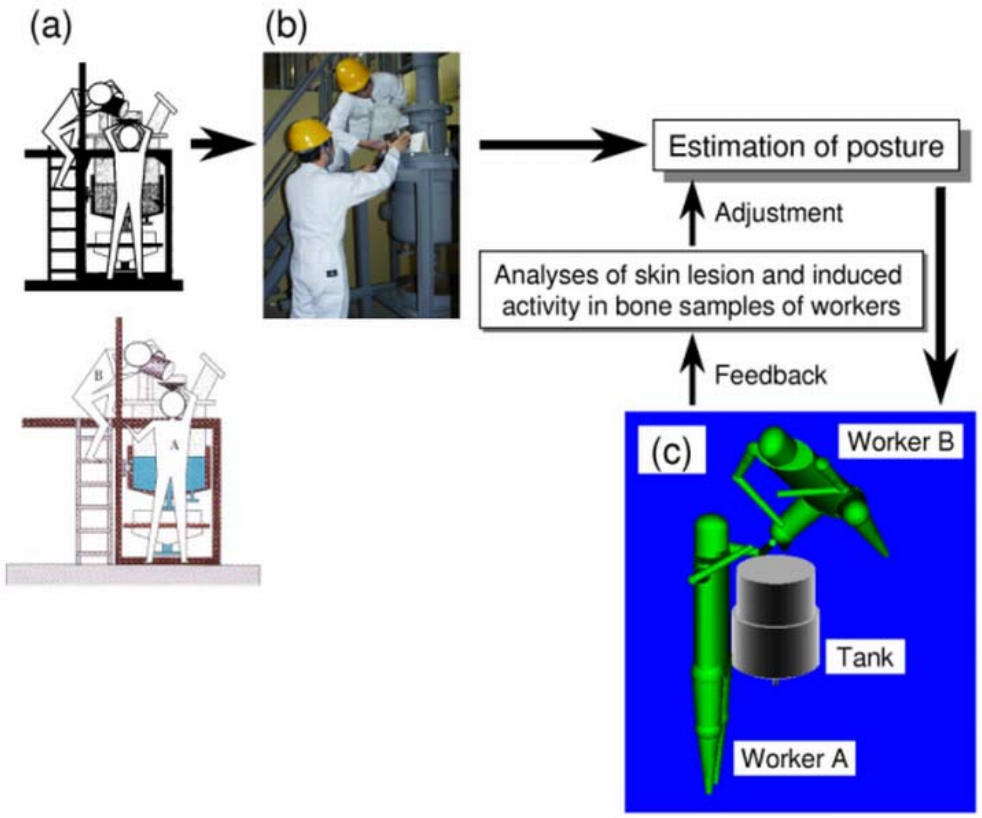

Figure 7.1. Procedures for establishing calculation geometry. (a) Upper: positions and postures recounted by the workers; lower: final estimation by NIRS. The position of left hand of Worker A is different from the upper model. (b) Behavior experiment at a mock-up facility. (c) Established geometry for computer simulation.

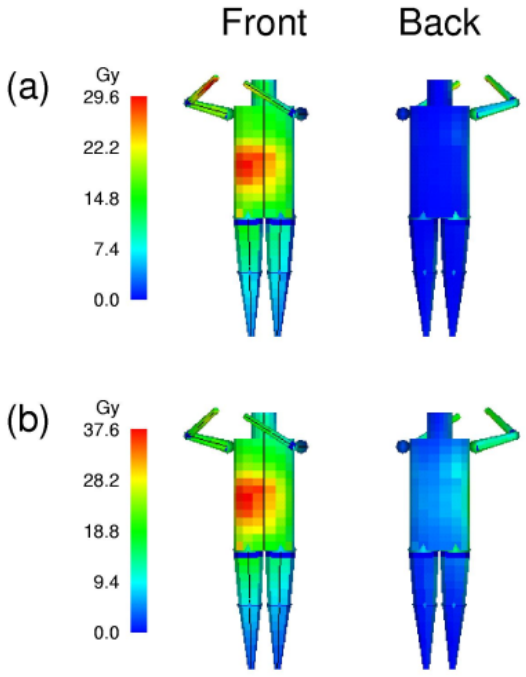

Figure 7.2. Absorbed dose distributions in the skin of Worker A. (a) Neutron dose. (b) γ-ray dose.

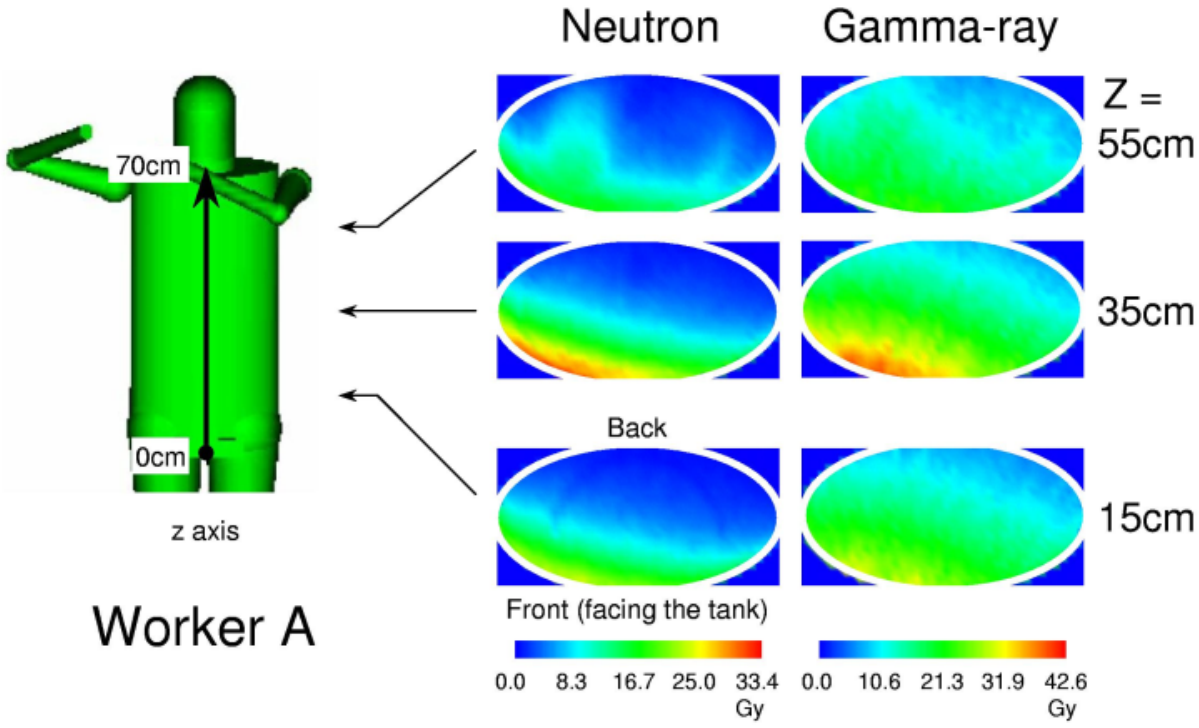

Figure 7.3. Absorbed dose distributions of neutrons and γ rays in the trunk of Worker A.

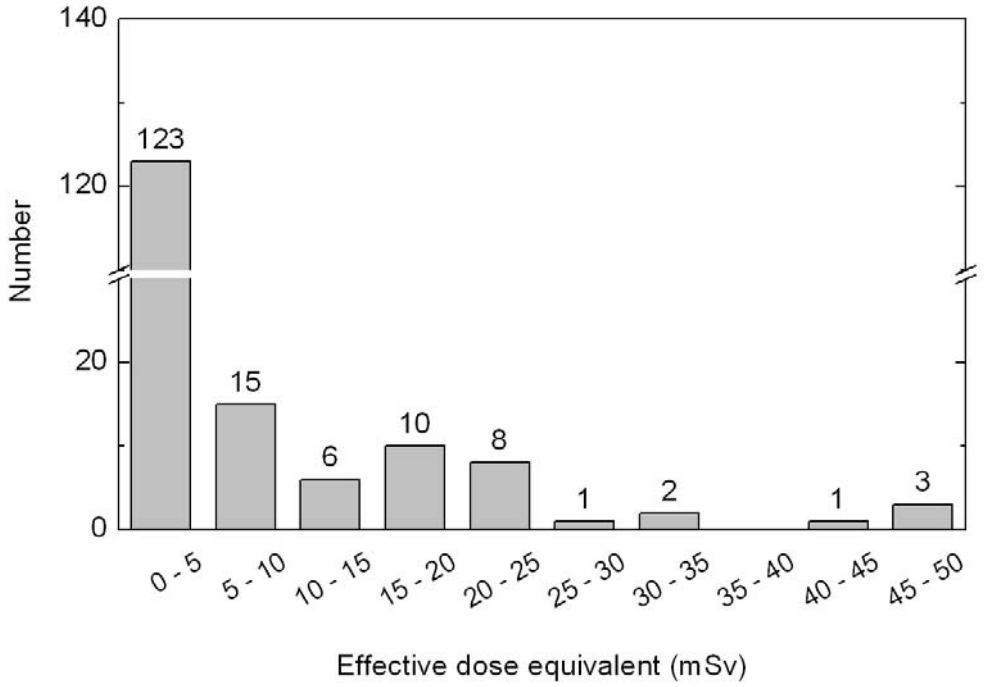

Figure 7.4. Estimates of doses for the employees of JCO and its related companies, excluding the three heavily exposed workers.

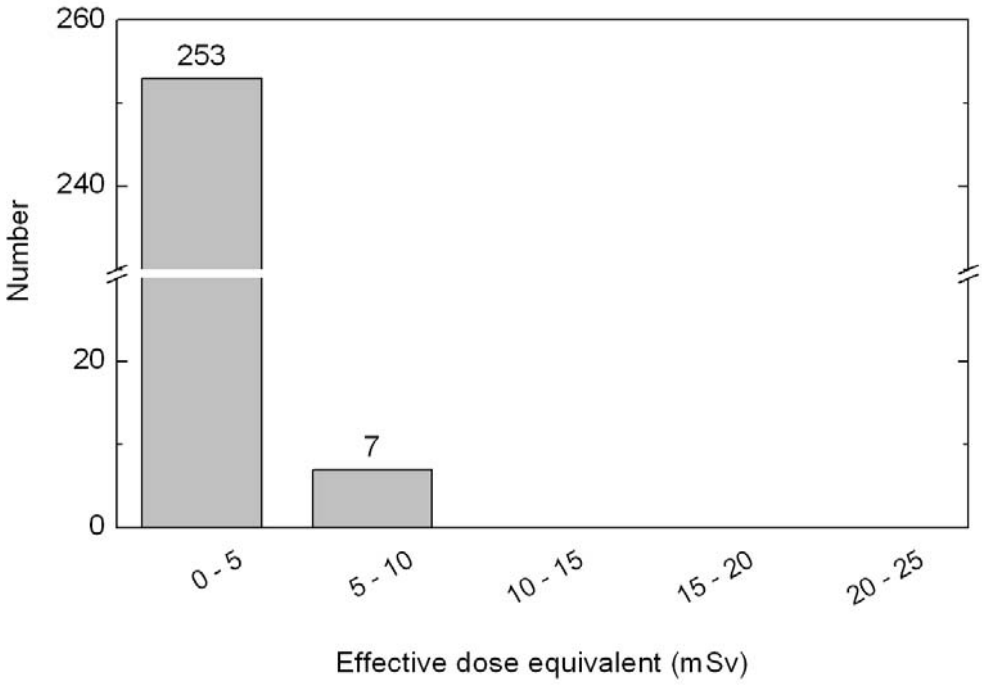

Figure 7.5. Estimates of doses for the emergency response personnel.

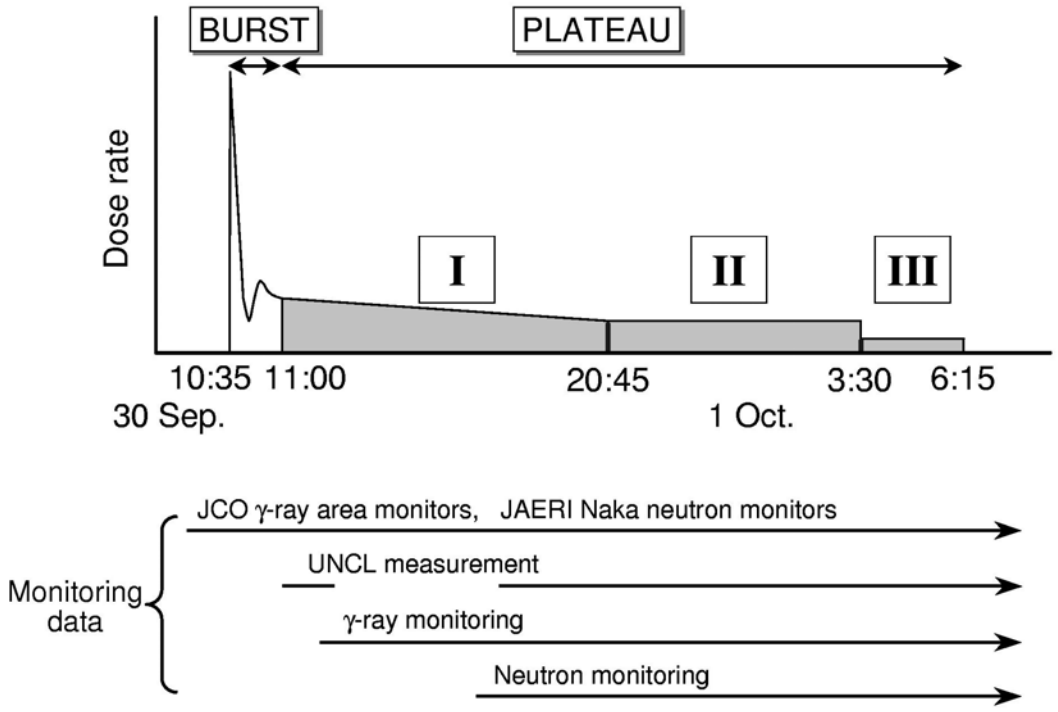

Figure 7.6. Model of the dose rate evolution.

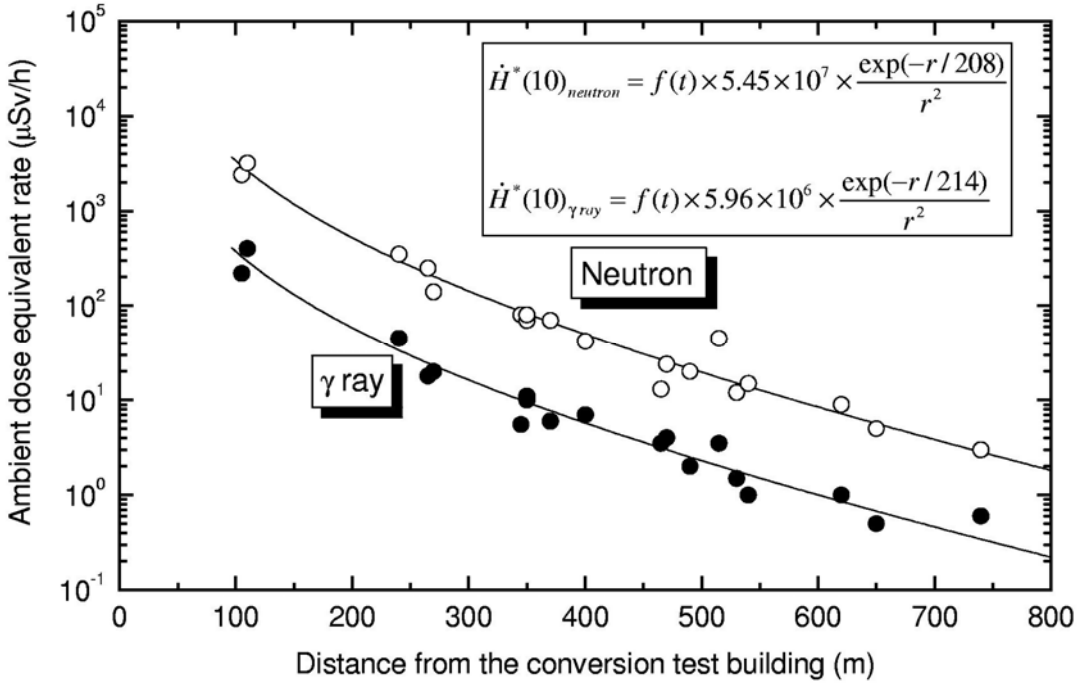

Figure 7.7. Fitting curves of the measured data.

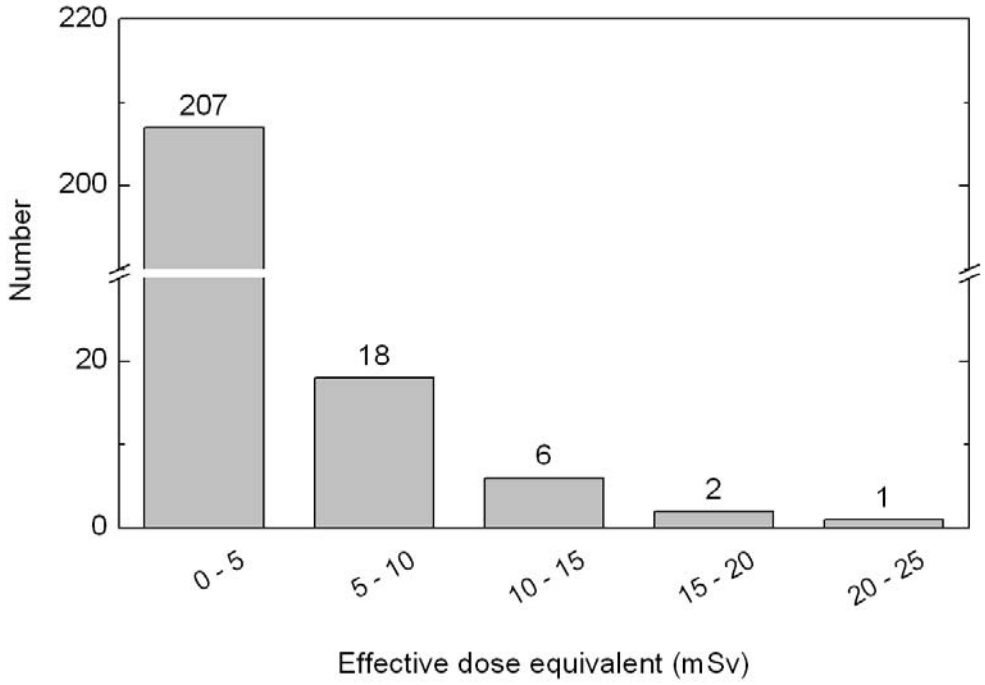

Figure 7.8. Estimates of doses for the residents.

Figure 7.9. Locations of monitoring stations (denoted by red) around the JCO site.

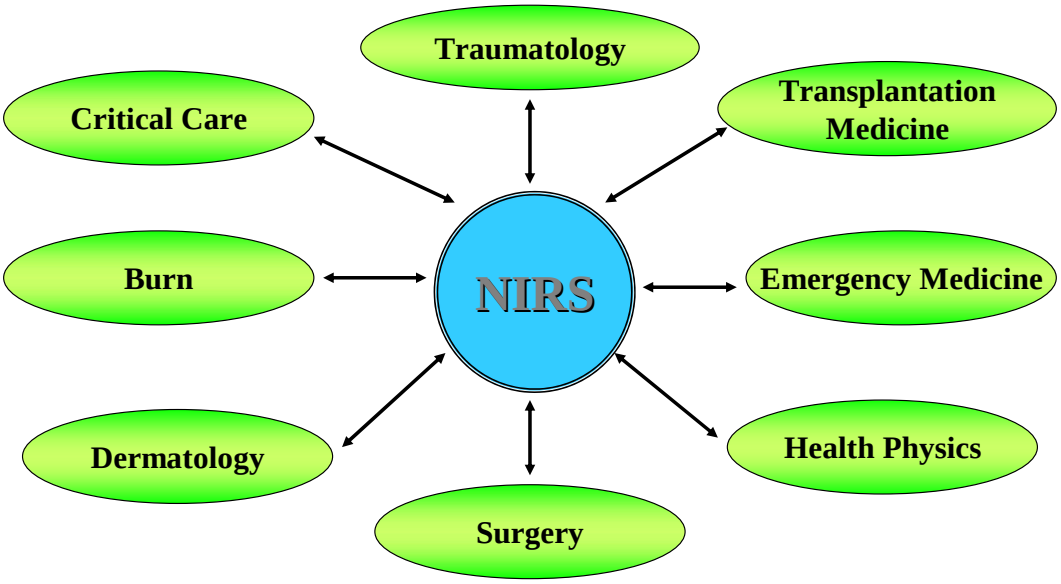

Figure 8.1. Medical Network Council for Radiation Emergency. The Medical Network Council for Radiation Emergency was established as an advisory and supporting framework complementary to the NIRS's function in July 1998.

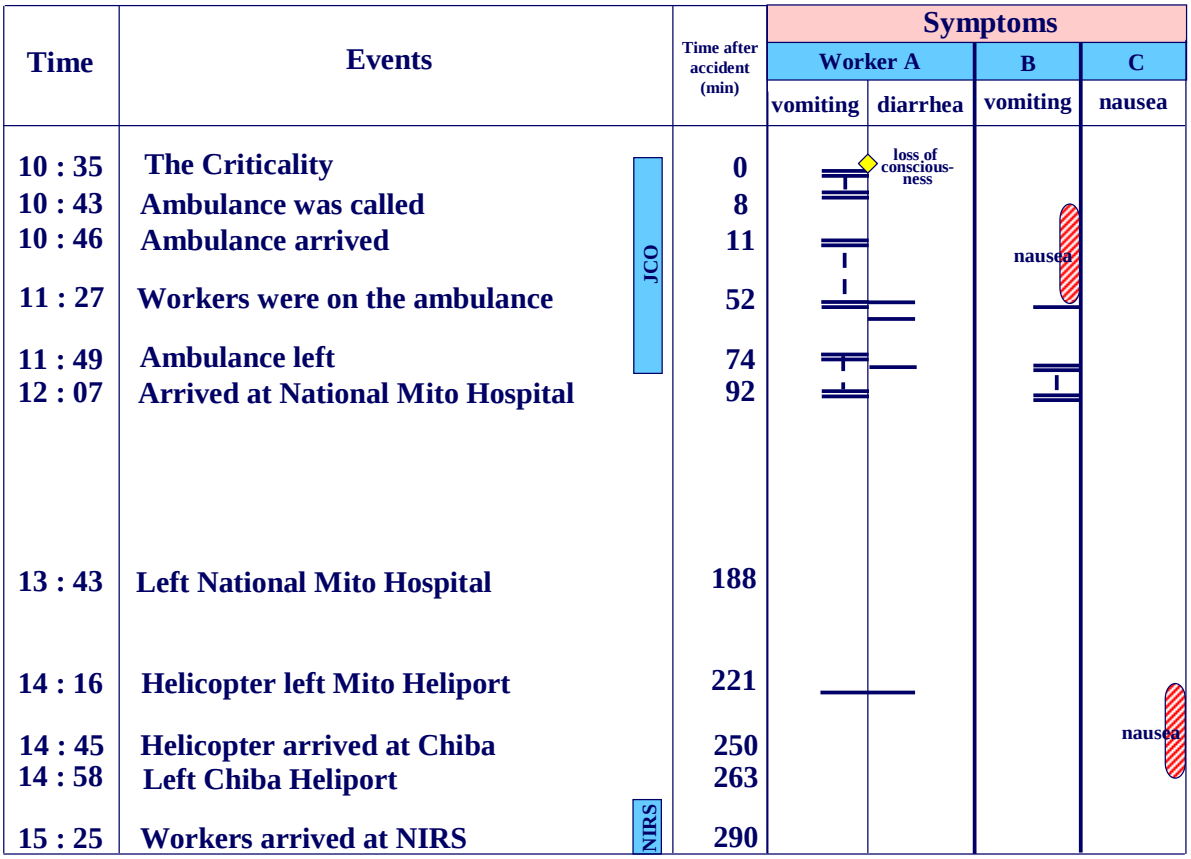

Figure 8.2. Prodromal symptoms of acute radiation syndrome in these three workers.

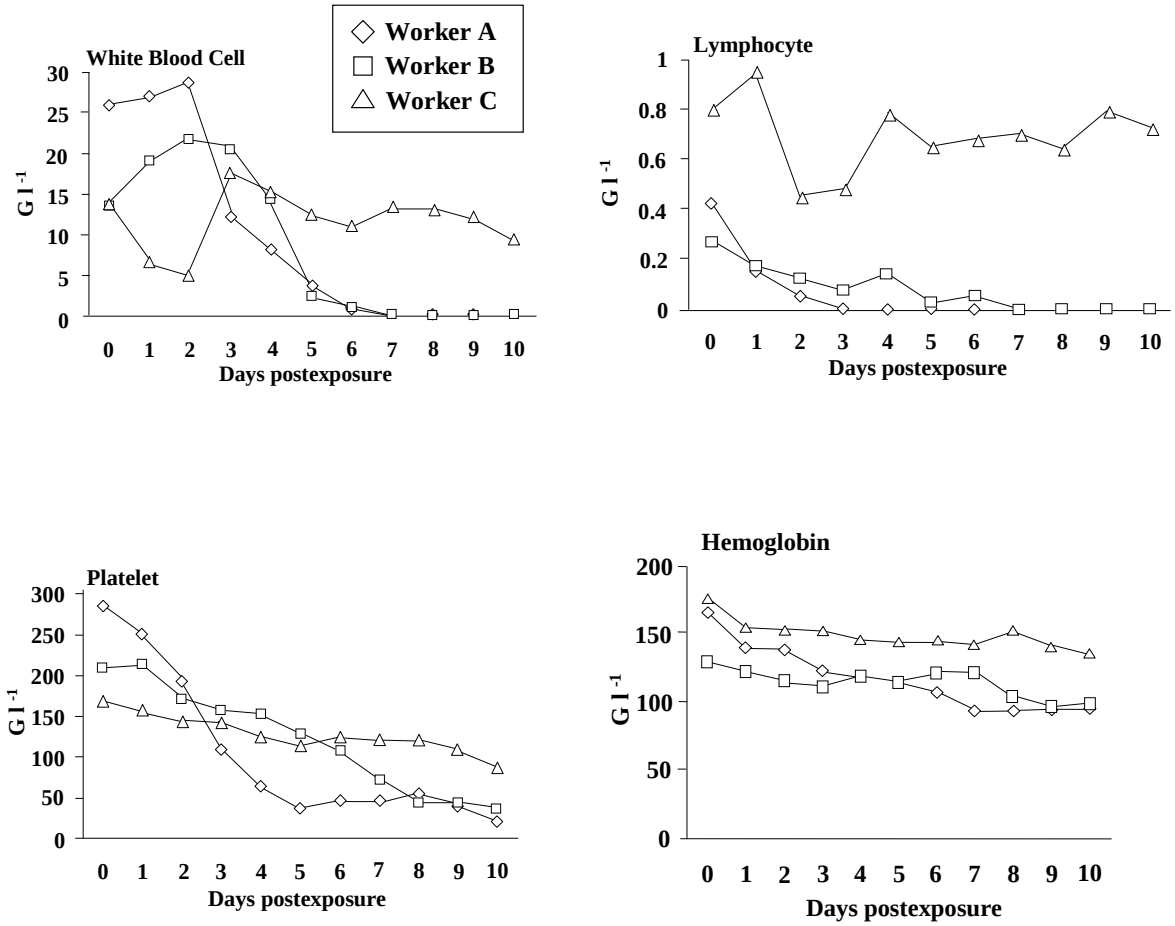

Figure 8.3. Hematologic data of the patients. (a) Peripheral blood counts of Workers A, B and C during the first 11 days are depicted with diamonds, rectangles and triangles, respectively.

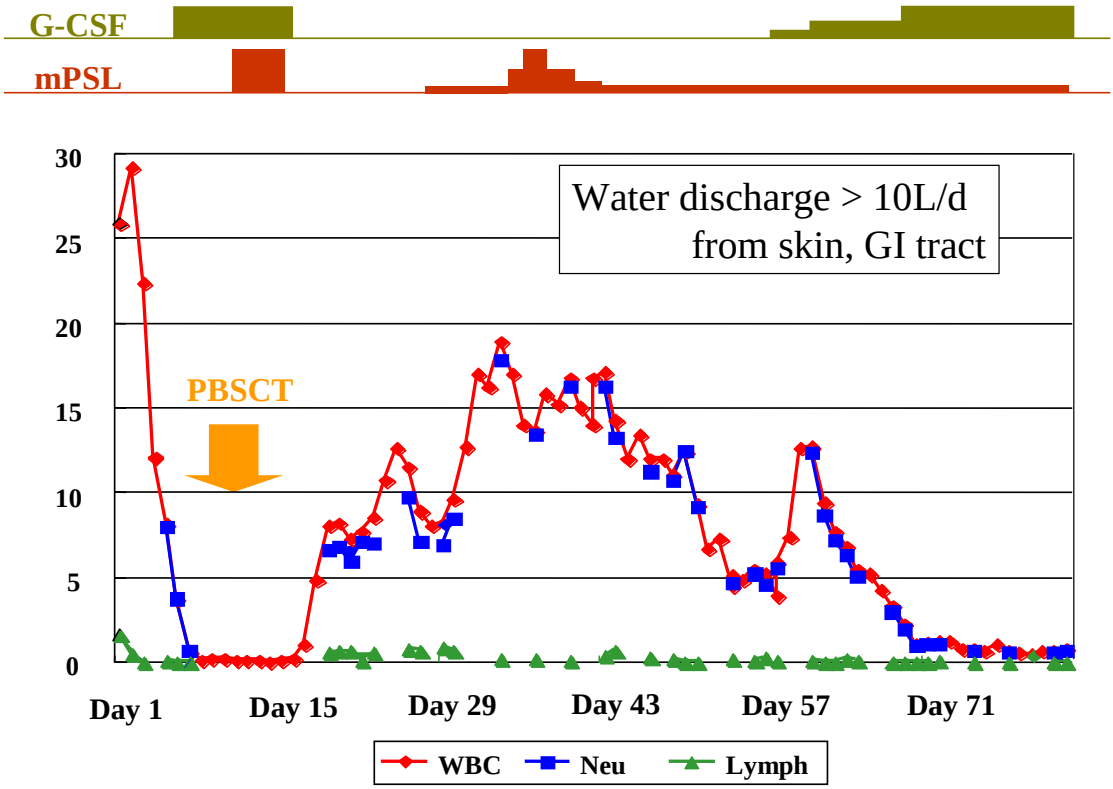

Figure 8.4. Clinical course of Worker A. G-CSF: granulocyte colony stimulating factor, mPSL: methyl prednisolone, PBSCT: peripheral blood stem cell transplantation, GI: gastrointestinal, WBC: white blood cells, Neu: neutrophils, Lymph: lymphocytes, G-CSF: granulocyte colony stimulating factor, mPSL: methyl prednisolone.
Adapted and modified from Chiba S et al. Bone Marrow Transplant. 29:935-939, 2002 and Futami S et al. pp142-153, IN: International Symposium on The Criticality Accident in Tokaimura: Medical Aspects of Radiation Emergency (Proceedings). Tsuji H and Akashi M. (Editors) NIRS-M-146, 2000

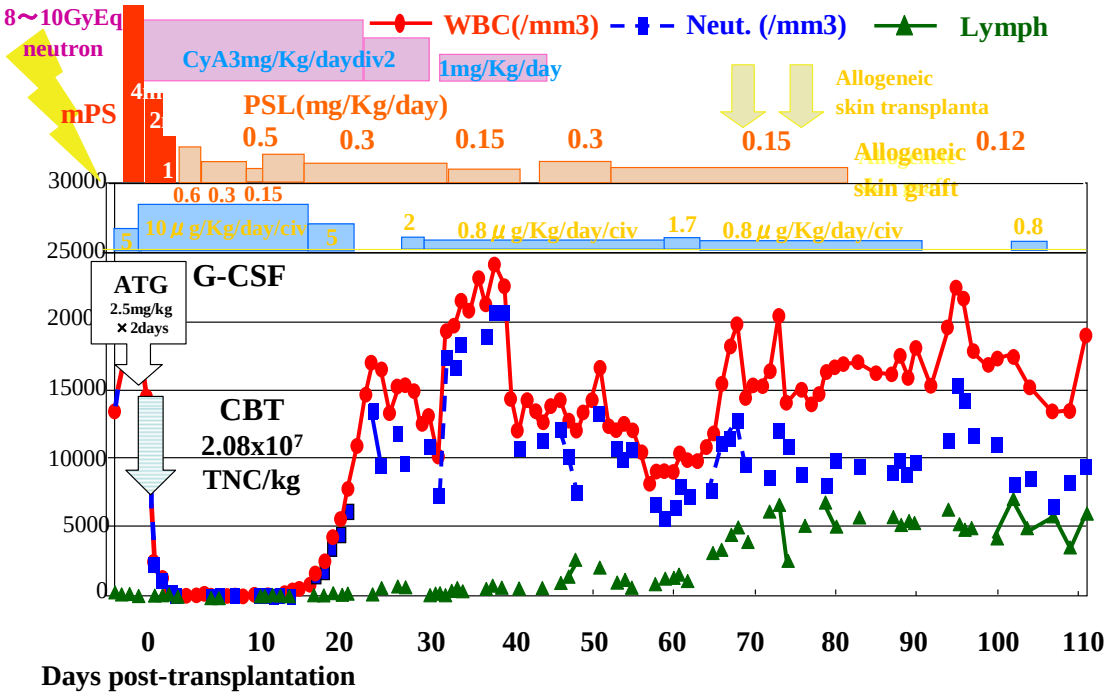

Figure 8.5. Clinical course of Worker B. G-CSF: granulocyte colony stimulating factor, mPSL: methyl prednisolone, CBT: cord blood cell transplantation, WBC: white blood cells, Neu: neutrophils, Lymph: lymphocytes Adapted and modified from Nagayama H et al. Bone Marrow Transplant. 29, 197-204, 2002.

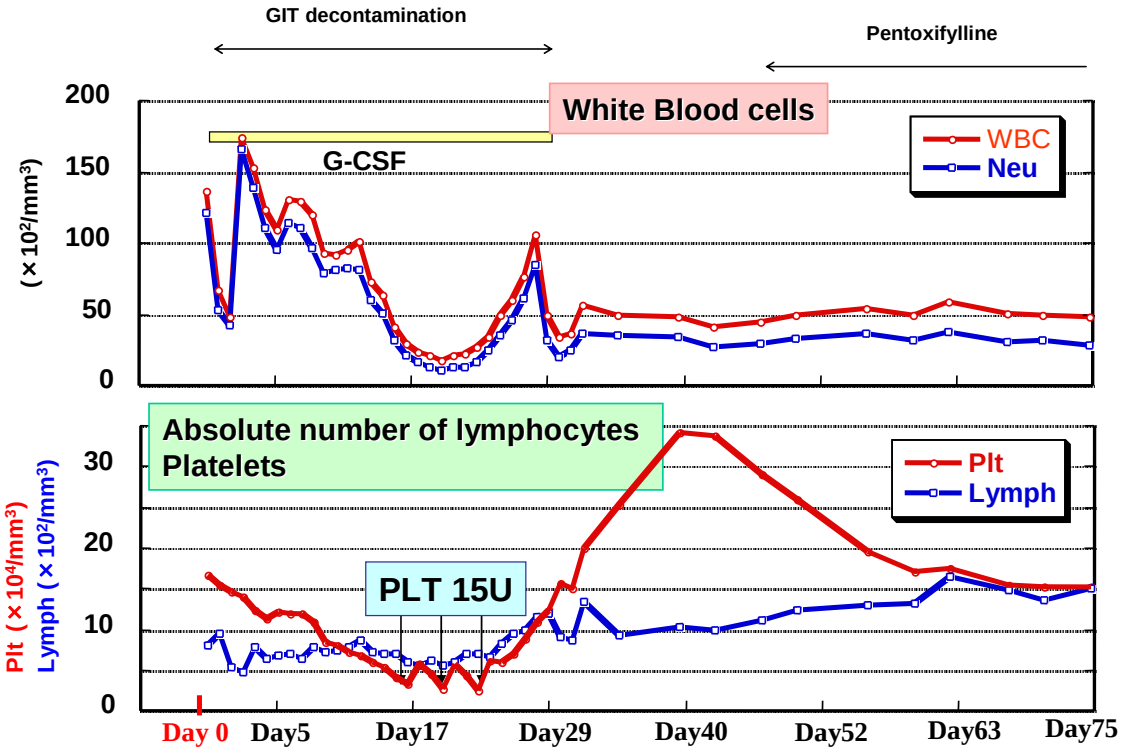

Figure 8.6. Clinical course of Worker C. GIT: gastrointestinal tract, G-CSF: granulocyte colony stimulating factor, WBC: white blood cells, Neu: neutrophils, Plt: platelet, Lymph: lymphocytes

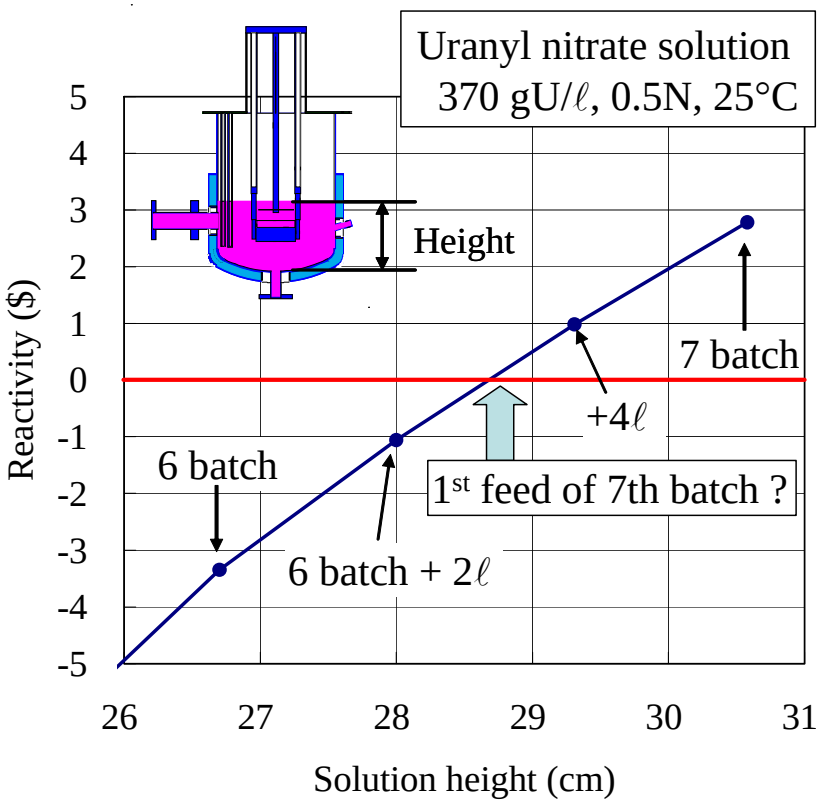

Figure A.II.1. Results of reactivity calculation.

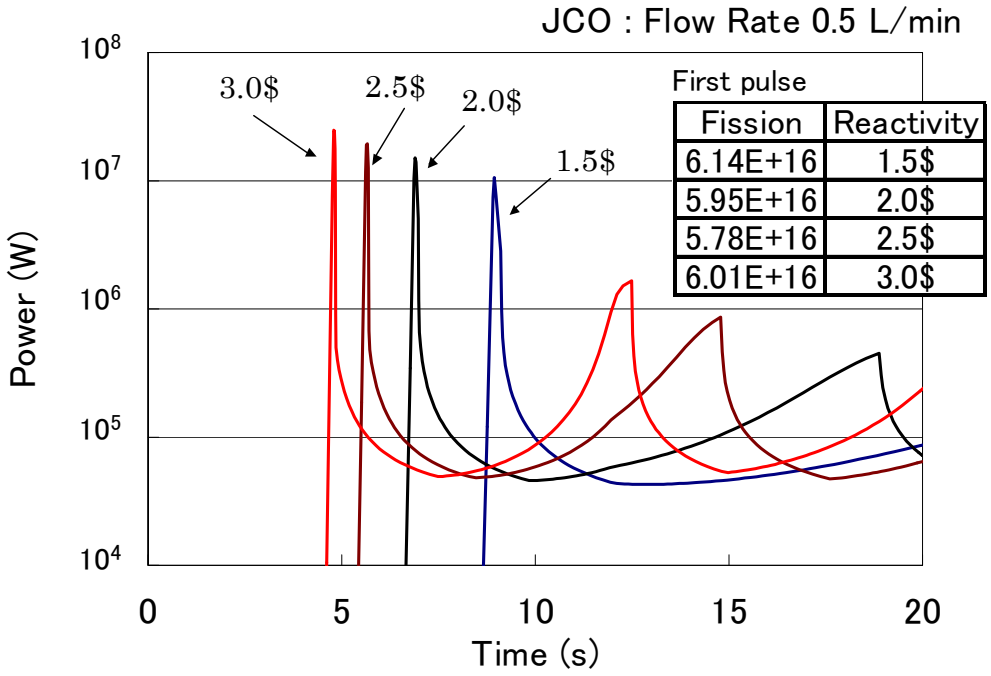

Figure A.II.2. Calculated power at the first burst.

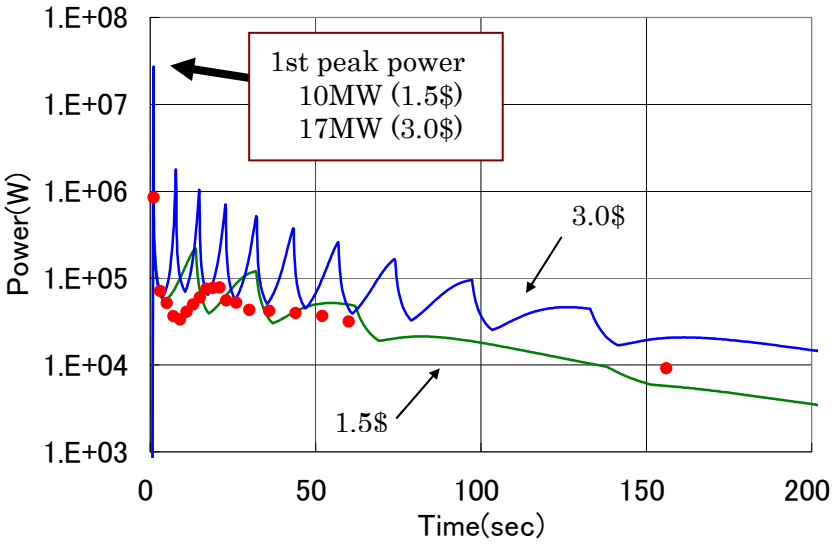

Figure A.II.3. Comparison of power profiles for different reactivity.

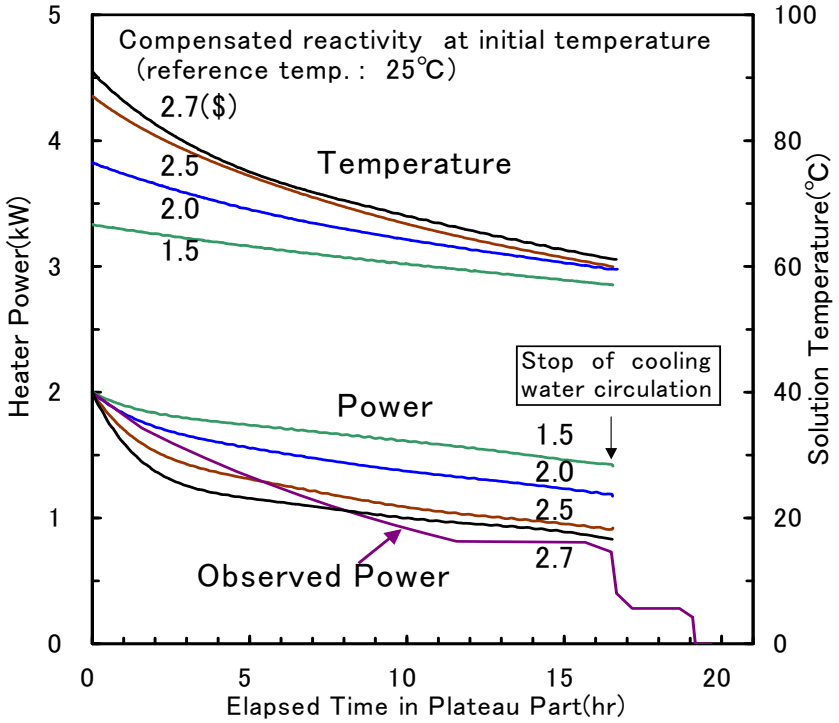

Figure A.II.4. Results of thermal simulation experiment.

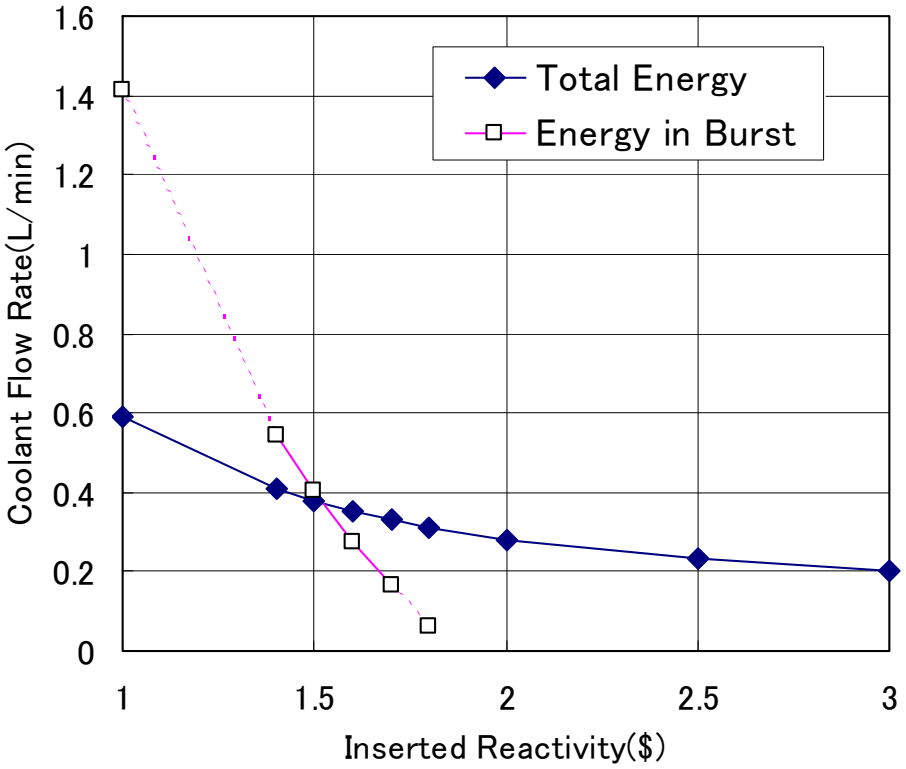

Figure A.II.5. Results of optimum parameters survey by quasi-steady state method.

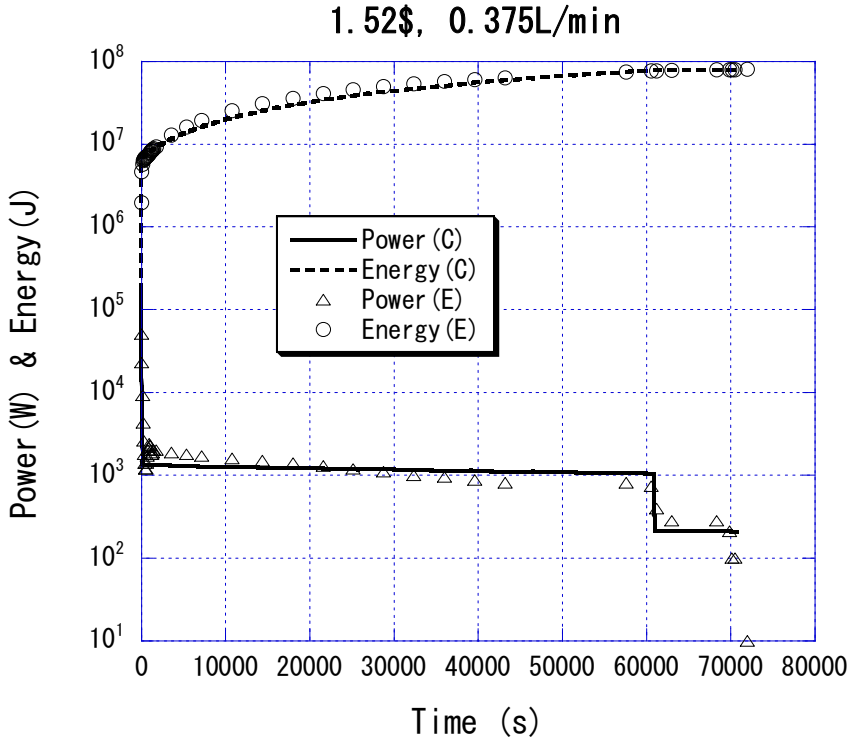

Figure A.II.6. Power profile for whole period calculated with quasi-steady state method.