OPERATIVE EXPERIENCE IN HANDLING ENRICHED URANIUM COMPOUNDS IN A U_3O_8 PRODUCTION PLANT

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ABSTRACT

The design of a nuclear installation associated with chemical processes depends fundamentally on the risks derived from the materials and process used. The operative experience brings useful data mainly related to the ventilation and equipment design that allow to improve the handling of operational incidents and maintenance work.

This paper presents the results extracted from a production campaign; ambient and personal monitoring results from monitorings performed routinely and during special interventions are commented.

The experience gained during the first uranium powder fabrication campaign at the U_3O_8 Production Plant was highly valuable to confront the previsions stated in the risk analysis and for improving design and operative aspects. The aspects of the installation related to the principal risks had been sufficiently taken into account and did not have to be modified; on the other hand, there were modifications derived from the operative experience and the occurrence of incidents which are the object of comment of this paper.

- Handling of the UF_6 cylinder is one of the relevant points related to safety. Replacement of an empty cylinder by a full one constitutes an operation in which there is a greater probability of UF_6 escape to the glove box, due to the fact that it is not possible to sweep away completely the UF_6 left in the connection pigtail to the gas transfer system.

- Monitoring of the empty cylinders always indicated values of background along the cylinder, and lesser than 1.5 pCi/cm^2 in the valve zone. As small UF_6 escapes to the glove box did occur, these low values are due fundamentally to have placed an outlet for the glove box air extraction close to the cylinder valve.

- The cylinder that emerges from the glove box is immediately introduced into a polyethylene bag until its separation from the heating belts, decontamination and deliverance to transit out of the controlled area. The absorbed dose measured in contact with the surface of a full cylinder is 0.3 mrad/h in the upper zone and 0.8 mrad/h in the lower one. In contact with an empty cylinder, on the other hand, the values are 0.1 mrad/h in the upper zone and 2 mrad/h in the lower one.

  The incidents of UF_6 escapes were quickly visualized and controlled; when a certain amount escapes the fire ionic detector inside the glove box is activated. UF_6 escapes came from UF_6 deposits in the connection pigtail to the transfer system and UF_6 deposits in the mouthpiece through which the gas enters to the hydrolysis vessel and the hydrolysis vessel cover; this last was evident when the cover had to be dismounted due to operative problems. In every occassion, when UF_6 escapes took place special air and surfaces monitoring was performed, including glove rings and passant holes near the escape; the values were always less than 5×10^{-2} Bq/cm^2 on surfaces and less than $2{,}6 \times 10^{-2}$ Bq/m^3 in the air, being 20 Bq/m^3 the derived air concentration.

- Along this campaign a fissure was detected in the internal sheath of the hydrolysis vessel, thus revealing that a too low probability was associated with this event in the risk analysis. This is relevant to the evaluation of critical excursion risk, as it is during the hydrolysis stage when a subcritical mass of enriched uranium is extracted from a mass greater than critical for optimal moderation in the UF_6 cylinder.

- Liquid spreadings inside the glove box were due to corrosion of the filtrate collection recipients welding, to the already mentioned fissure of the internal sheath of the hydrolysis vessel and to overflow of precipitation filter funnels used to collect ADU precipitate. The control of these incidents was simple and in no occasion there were radiological consequences. Later on it was important to get down the glove box contamination to admissible levels in order to remove the front pannels to take away components and to modify the equipment along the fabrication campaign. The risk analysis led to the conclusion that it was equally satisfactory as a respiratory protection system to operate in glove boxes or in fume hoods with air extraction system. This allowed to perform some modifications in the precipitation and powder treatment glove box lines by removing the front pannels of the glove boxes without contamination of personnel.

  During these interventions, when the glove box had to be opened, contaminated objects cleaned and removed, work was done with the maximal number of air renewals, operators dressed with suits of Tyvek Fiber and respiratory protection against fluorhydric acid and powders.

  The only occasion along this campaign when appeared results of urine uranium indicative of an incorporation of soluble compounds, was when the arrangement of the hydrolysis vessel was done; the values were less than 4 ug/l, being 6 ug/l the investigation level.

- Operative troubles that had not been foreseen appeared, consisting of

difficulties to clean up the filtration funnels and ammonia vapors emanation during the precipitation to ADU. A glove box and a small fume hood were installed; the first was a good solution for handling a moderately insoluble compound as ADU, and the second provided an outlet for the room air that did not have independent ventilation.

Important modifications to the air ventilation system in the powder treatment area were performed. All the interventions were preceded by a rigorous planification and coordination with safety personnel, as annual limits of incorporation can be easily reached handling insoluble enriched uranium compounds in case of accidental contamination. Glove boxes decontamination, dismountling, contaminated ventilation segments removal, modifications to the air injection system, were carefully outlined in advance. Originally air entered the grinding-sieving glove box, located between the glove boxes containing the calcination and thermal treatment furnaces in each of which an outlet for air extraction was situated. This disposition brought an unnecessary contamination of the glove boxes with furnaces and excessive heating of the acrylic pannels. The new design consisted of independent injection and extraction for every glove box and metallic hoods in the exhaust to the air extraction in the glove boxes containing furnaces.

- Mass control for criticality prevention was not a problem due to the simplicity of the stated standards. Mass control for a rigourous balance is a more demanding task requiring the attention of a person apart from the urgency accompanying a production. The principal difficulty lied in the control of losses.