quality assurance programme for fuel fabrication; (4) establishment of a central information service to assist utility groups in preparing documents and procedures to be used in quality assurance activities.

REPORT ON AN INTERNATIONAL SYMPOSIUM, OTANIEMI, FINLAND, 2–6 AUGUST 1976

The Symposium was attended by 140 participants from 32 countries and 3 international organizations. Forty-five papers were presented during 8 technical sessions.

# The Design of Hot Laboratories

The need for specialized laboratories to handle radioactive substances of high activity has increased greatly due to the expansion of the nuclear power industry and the widespread use of radioisotopes in scientific research and technology.

Such laboratories, which are called hot laboratories, are specially designed and equipped to handle radioactive materials of high activity, including plutonium and transplutonium elements. The handling of plutonium and transplutonium elements presents special radiation-protection and safety problems because of their high specific activity and high radiotoxicity. Therefore, the planning, design, construction and operation of hot laboratories must meet the stringent safety, containment, ventilation, shielding, criticality control and fire-protection requirements.

The IAEA has published two manuals in its Safety Series, one on the safety aspects of design and equipment of hot laboratories (SS No.30) and the other on the safe handling of plutonium (SS No.39).

The purpose of the symposium in Otaniemi was to collect information on recent developments in the safety features of hot laboratories and to review the present state of knowledge. A number of new developments have taken place as the result of growing sophistication in the philosophy of radiation protection as given in the ICRP recommendations (Report No.22) and in the Agency's basic safety standards (No.9). The topics discussed were safety features of planning and design, air cleaning, transfer and transport systems, criticality control, fire protection, radiological protection, waste management, administrative arrangements and operating experience.

Four of the eight sessions of the programme were devoted to the planning, design and construction of the hot laboratory buildings, hot cells, glove boxes, fume hoods and systems of ventilation, fire protection, transfer, transport and criticality control and other ancilliary systems, together with the discussion of safety features in each case.

The effects of earthquakes, tornadoes and even the impact of light aircraft on the laboratory buildings were discussed. It was stressed that the design of laboratory buildings should ensure that all internal facilities would remain functional in the event of such catastrophes. The advantages of compartmentalization of hot facilities in order to isolate high risk areas to minimize productivity and financial loss in case of accidents were also discussed.

The requirements of safety-analysis reports on hot laboratories were reviewed. Safety-analysis reports should contain the safety principles, detailed description of technical, organizational and operational matters, critical analysis of the safety principles and other related matters, and should be examined and approved by competent authorities.

Some papers dealt with the standardization of components of hot laboratories and automation of operations using computer control or servocontrol systems. The advantages of standardization are its flexibility of use and the interchangeability of components.

Automation improves remote control operations and increases the quality of results, since personal factors are eliminated. Some participants, however, expressed the view that standardization should not become a deterrent to future basic research and engineering aimed at improving the state of the art. One paper discussed the design of hot laboratories to handle plutonium when it is in a form that is pyrophoric. In such facilities, special attention is required to prevent fire or explosion, and criticality incidents.

The conversion of a $\beta$–$\gamma$ laboratory into an $\alpha$–$\beta$–$\gamma$ laboratory to handle limited amounts of plutonium was described by an author from France. It was noted that the former $\beta$–$\gamma$ laboratories in France are now being gradually converted for experimental operations with plutonium-containing elements.

Remote and semi-remote handling systems, including new master-slave manipulator designs, were discussed. Servocontrol and forced feed back systems used in master-slave manipulators were also described. Especially for plutonium and transplutonium work, the hand and forearm dose rates during "hands on" glove-box work may be significant. Experience at the Institute of Transuranium Elements (EURATOM) shows that handling of gram amounts of americium-241 leads to a rather high irradiation dose to personnel despite lead or steel glove-box shielding and shielding within glove boxes. This suggests that routine handling of americium and curium should be done with master-slave manipulators behind gamma and neutron shielding, and direct contact between the glovehand and americium should be avoided.

Many papers dealt with the transfer and transport systems used in hot laboratories. A new lifting-arm overhead crane to service hot cells has been developed in Japan. New improvements were reported from France on the double-port transfer system.

A good ventilation system is a significant factor in achieving safety in hot laboratories. The basic principle in the design of ventilation systems is more or less the same in all hot facilities. Negative pressure is maintained in hot laboratories; the highest contamination zones are maintained at the lowest level, so that the flow of ventilation air is unidirectional from the low to the high radioactive work-areas.

The general principle of prevention of criticality is to guarantee sub-criticality at all times. Development of new criticality probes and their testing under real accident conditions, as well as precaution for preventing criticality at plutonium fuel facilities, were discussed.

Fire prevention, fire surveillance and fire fighting systems were reviewed. An automatic carbon-dioxide fire extinguisher in a plutonium laboratory in Switzerland was described.

With the growing amounts of radioactivity handled in hot laboratories, the requirements for improved and standardized equipment for radiation protection are also increasing. There is, therefore, a great need for quality control, greater reliability and efficiency. Many participants expressed the view that an increase in initial cost for equipment often results in an overall saving during operation; such increase in cost may be negligible compared with the cost of an accident.