

the international level. The need for harmonization of the legislative systems of various countries was stressed and reference was made to an Advisory Group meeting taking place, also at Wageningen, immediately after the symposium. Results of consumer tests with irradiated onions and potatoes were reported.

Design and operation of irradiation facilities received special attention. Principles of design of a fruit and vegetable irradiation plant and a large-scale irradiation service centre were described and some new methods (lyoluminescence, biological tests, etc.) for radiation-plant dosimetry were presented.

Economics and energy aspects of food irradiation were also discussed. Disinfestation of bulk grain, of bagged flour, preservation (radurization) of packaged beef cuts and salmonella elimination from (radicidation of) poultry with electron accelerators, using electron beams or X-rays, were computed to be economically feasible and competitive. Detailed analyses of the energy requirements of food preservation by irradiation and by some conventional methods (canning, refrigeration) showed the clear advantages of the radiation treatment over the other techniques.

Detailed discussions took place at the last session of the symposium on an action plan for future activities in the field. The proceedings will be published by the IAEA.



NEA/IAEA INTERNATIONAL SYMPOSIUM, HAMBURG
5-9 DECEMBER 1977

The symposium was attended by more than 250 participants from 20 countries and 4 international organizations. Sixty-four papers were presented at 9 topical sessions.

Safety of Nuclear Ships

The great advantage in the utilization of nuclear power for ship propulsion was recognized soon after the first nuclear reactor reached criticality. The long-term self-sufficiency of a nuclear ship, which does not require frequent refuelling, puts it in a position unattainable by any conventional ship. The first two civil nuclear ships were launched in 1959, the nuclear icebreaker "LENIN" (USSR) and the commercial nuclear ship "SAVANNAH" (USA). In 1968, the "OTTO HAHN" (Federal Republic of Germany) set sail for the first time. The nuclear icebreaker "ARCTICA" (USSR) started commercial operation in 1977, and its sister ship is in the final stage of commissioning. Unfortunately, the merchant "MUISU" (Japan) has not yet been put into operation because of design engineering problems; it will begin service following partial reconstruction of the reactor radiological shield.

Interest in the utilization of nuclear steam supply systems for merchant ships and icebreakers has recently increased considerably due to the sharp rise in oil prices and the continuing trend towards larger and faster merchant ships. Canada, for example, is considering construction of an icebreaker in the near future. On the other hand, an accident which could result in serious damage to or the sinking of a nuclear ship is potentially far more dangerous to the general public than a similar accident with a conventional ship. Therefore, it was very important to evaluate in an international forum the safety of nuclear ships in the light of our contemporary safety philosophy, taking into account the results of cumulative operating experience with nuclear ships in operation.

The philosophy and safety requirement for land-based nuclear installations were outlined because of many common features for both land-based nuclear installations and nuclear ships. Nevertheless, essential specific safety requirements for nuclear ships must always be considered, and the work on safety problems for nuclear ships sponsored by the NEA was regarded as an important step towards developing an international code of practice by IMCO on the safety of nuclear merchant ships.

One session was devoted to the quantitative assessment of nuclear ship safety. The probability technique of an accident risk assessment for nuclear power plants is well known and widely used. Its modification, to make it applicable to nuclear propelled merchant ships, was discussed in some papers. Mathematical models for describing various postulated accidents with nuclear ships were developed and reported by several speakers.

Several papers discussed a loss-of-coolant accident (LOCA) with nuclear steam supply systems of nuclear ships and engineering design features to prevent a radioactive effluence after LOCA. Other types of postulated accidents with reactors and systems in static and dynamic conditions were also analysed.

Three separate sessions were devoted to legal, licensing and port entry considerations. The participants discussed the legal aspects of sailing of nuclear merchant ships. Lawyers, members of nuclear ship crews, and members of port authorities discussed their past experience with the "SAVANNAH" and "OTTO HAHN", when each port entry had had to be negotiated at a high governmental level. The urgent need for internationally acceptable documents concerning the safety of nuclear ships and legal responsibilities in the case of accidents with nuclear ships were stressed.

Great interest was expressed by participants in operating experience of nuclear ships. Description of the operation of the "LENIN", "SAVANNAH" and "OTTO HAHN" under normal and specific conditions resulted in lively discussion. Health physics experience with the nuclear ships showed there had been no radiological accident dangerous to members of the crew or the general public during the entire term of their operation. Some abnormal situations during the operation were analysed and discussed. The many questions put forward by participants reflected the interest in this topic.

An excursion on board the "OTTO HAHN" was organized for the participants by the host country. A panel discussion on some specific subjects on the safety of nuclear ships concluded the symposium. The chairmen of the sessions presented their personal opinions about the future development of the nuclear merchant fleet and the present tasks to be dealt with. The proceedings of the symposium will be published by the NEA.