

of normal operations of a nuclear ship may be discharged into the open sea without undue risk to man. Harbours, estuaries and other inshore areas appear unsuitable for the discharge of wastes of intermediate activity, but many harbours could receive the low level liquid effluent without any unacceptable hazard. The continental shelf and coastal area can safely receive the low level liquid wastes but cannot be recommended as suitable for the release of wastes of intermediate activity.

The Panel has recommended that the disposals from a nuclear ship should be entered in a record maintained on the ship and available for inspection by port authorities. An abstract of the record could be

transmitted to the Intergovernmental Maritime Consultative Organization which, jointly with IAEA, should work out an effective registration and compilation of disposals from nuclear ships.

All disposals from ships in harbours and national waters should be in conformity with conditions laid down by the local authority. Disposals in international waters should conform to conditions specified in the licensing of the vessel or by the appropriate international authority.

Finally, the Panel has recommended that IAEA, in collaboration with other international organizations concerned, should review all these problems at appropriate intervals.

FABRICATION OF FUEL ELEMENTS

The prospects of economic nuclear power depend to a large extent on the lowering of fuel costs by achieving the maximum yield of acceptable fuel elements during the fabrication process and by a more effective utilization of the fuel in the reactor system. In fact, the efficiency of a reactor during operation is in a significant measure a function of fuel technology and is dependent upon the form and arrangement in which the fuel elements are placed in the reactor system.

The primary consideration, of course, is a self-sustaining, controlled fission chain reaction, and the fabricated elements must contain right amounts of fuel and be placed in a geometry within the reactor that would facilitate such a reaction. Usually these elements are in the form of rods, plates or other structures of fissile material "clad" or closely sheathed in metal containers. The metal cladding or can protects the fuel element from damage by other substances in the reactor system: it prevents the fuel from coming in contact with water or other moderator materials with which it reacts vigorously whenever a fuel element failure occurs. Such a failure in most cases requires the reactor to be shut down to remove the defective fuel element. The canning also serves to contain the fission products and facilitates the handling of irradiated fuel during chemical reprocessing.

These requirements demand complex techniques of fabrication and cladding, and considerable research has been going on in a number of countries with the object of improving these techniques. Many of them were discussed in detail at an international symposium held by IAEA in Vienna last May. The symposium, which was in session from 10 May to 13 May 1960, was attended by nearly 200 experts from 23 countries. Representatives of the OEEC and the Euratom also took part in the meeting.

In his opening speech at the symposium, the IAEA Director General, Mr. Sterling Cole, stressed the importance and complexity of development of fuel element fabrication techniques and especially the role of cladding materials in lowering fuel costs. He explained that for the efficient and economic operation of a power reactor the fabricated and clad fuel elements must be able to stand up to high temperatures and also contain the fission products within themselves. Furthermore, the capture of neutrons by the cladding materials must be sufficiently low not to affect the conversion of fertile into fissile material. (By neutron irradiation, fertile material, such as uranium 238 or thorium, is converted into plutonium or uranium 233 which are fissile materials.)

Cladding Materials

The special emphasis at the symposium was on cladding materials and the first two sessions were devoted to a discussion of the characteristics of materials that can be used for canning. A number of papers were presented and discussed on different aspects of the principal cladding materials, such as aluminium, zirconium, zirconium alloys and graphite. The views expressed were supported by practical experience, and several suggestions were made for improvements in the use of these materials.

At the next two sessions, some of the technical problems of fuel fabrication were taken up, and the papers presented contained accounts of fuel fabrication facilities and methods employed in several countries. This was followed by a session on quality control and inspection; the topics discussed included tightness control, production control and the applications of microradiography for inspection. Problems raised by corrosion and radiation damage of cladding materials were considered at the following session, and

the discussions covered not only the radiation effects on cladding materials in general but also the effects of irradiation and oxidation on specific canning substances.



Symposium on fuel element fabrication at the Hofburg, Vienna

The last two sessions of the symposium were devoted to discussions on the economics and general trends of development of fuel element fabrication, on which several papers were presented. The subjects considered included the relationship between a reduction in fabrication costs and the price of nuclear power, economic consequences of variations in fuel element designs as well as some problems connected with particular reactor types. Attention was also drawn to the significant trends in current research in some of the advanced countries, and the likely developments were appraised in broad terms.

The following scientists, all of whom are eminent specialists in the field, served as discussion leaders: Mr. Alfred Boettcher (Germany), Mr. Spencer H. Bush (USA), Mr. Jacques Huri (France), Mr. Alexander B. MacIntosh (UK) and Mr. Shuichiro Takahashi (Japan).

The proceedings of the symposium will be published later this year.