

## 5.1. RESEARCH REACTOR PROGRAMMES AT THE IAEA, H. Reijonen (Vienna, Austria)

### 1. Introduction

The Agency's programmes on research reactors are set up according to the established structure of similar technical activities consisting of basically the following components.

- Collection of various data on research reactors and their utilization and the dissemination of this information
- Organization of meetings and the publishing of the proceedings and recommendations
- Publishing of various review papers and technical documents on the operation and use of research reactors
- Execution of Technical Assistance and United Nations Development Programme projects.

These activities will be discussed in the following chapters emphasizing the services that are provided for developing countries. It is intended that the programme on research reactors should be flexible and respond to the actual needs of the countries receiving assistance. In this sense, the Agency would be grateful for any useful suggestions that this presentation would generate among the users of TRIGA reactors.

### 2. Data Bank on Research Reactors

For several years the Agency has compiled data on research reactors in its Member States. The data was published in the "Directory of Nuclear Reactors", Vols. II, III, V, VI, VIII and X and also in the periodic issues of "Power and Research Reactors in Member States", the latest edition of which was published in 1974.

Following the requests from the Member States, a data collection effort on research reactors and critical facilities was initiated in June 1977 with a letter from the Director General and attached questionnaire addressed to all the Member States. The questionnaire was set up to consist of the following parts:

- General information (address, telephone, telex, contact persons)
- Facility data, including technology transfer aspects
- Fuel data (origin of U, Pu, enrichment, type of fuel, spent fuel, plans for new acquisitions)

- Safeguards
- Facility history and status
- Facility utilization
- Costs
- Future plans

Although the data requested is of a relatively basic nature, the time and effort involved in developing a sufficiently complete and correct data base are considerable. As a matter of fact, in June 1978, a reminder was sent to Member States who had not yet responded. It is foreseen that during the autumn of 1978 the remaining data will be submitted to the Agency. All the data will be stored in the computer, thus making various information, processing operations including continuous updating practicable. The publishing of the data early in 1979 is planned to have a computer print-out type of format that is already used in the Agency's publication "Power Reactors in Member States".

When the data base is being updated, it is intended to include more detailed technical data on the reactor design replacing the somewhat outdated information that has been previously published. It is understood that this kind of new data on the core physics, operating arrangements, grid plate size etc. could well be needed for example to help introducing the various new research reactor fuel designs with a high uranium density to the market. Concrete suggestions from the users of research reactors on what kind of additional technical data should be requested, would be welcomed and taken into account.

### 3. Recent Meetings on Research Reactors

In this connection it may be mentioned that the recent discussions on research reactors have centred on the question of the use of highly enriched uranium in the fuel. Therefore research reactors are also included in the International Nuclear Fuel Cycle Evaluation (INFCE) in the Working Group 8 "Advanced Fuel Cycle and Reactor Concepts", sub-group C. The Agency's input to the WGS, sub-group C, essentially consists of the findings of an Advisory Group Meeting on Research Reactor Renewal and Upgrading Programmes, held in Vienna on 23 - 26 May 1978. The basic understanding of the fuel enrichment questions seems to be that it is clear that uranium enriched to 93% <sup>235</sup>U gives the best balance between reactivity requirements, fuel cycle cost and the thermohydraulic performance of fuel assemblies for

research reactors. However, the enrichment reductions from 93% are technically and economically feasible for most reactor designs to the extent that the <sup>235</sup>U in the fuel element may be kept the same ( increased) by utilizing increased uranium density fuel technologies and/or increased fuel "meat" volume.

Following the Advisory Group's recommendations, it is pointed out that if reductions in enrichment are to be implemented, it is desirable that:

- Fuel element fabricators should be encouraged to undertake further development of low and medium-enriched research and test reactor fuels and to offer those fuels commercially.
- It should be agreed as quickly as possible on a single intermediate enrichment in the 35% to 45% U-235 range for universal application to such medium-enriched fuel.
- Developers of these new fuels should make available the results of their efforts, recognizing their right to proprietary technology.
- Licensing of these new fuels should be accomplished as expeditiously as possible.
- Early demonstrations of the feasibility and in pile testing of full assembly should be encouraged for those low or medium-enriched fuels for which they do not already exist.

The Agency's role here is to closely follow the developments on new fuel, so as to be in a position to respond to requests by Member States for information on technical assistance. For further information on this subject, it is referred to the proceedings of the Advisory Group Meeting which will be published /1/.

Another item brought to the Agency's attention by the Advisory Group Meeting and which will be reflected in our programme are the safety and licensing questions. It can be said that in general, the licensing climate has become more demanding. Cases have been mentioned that backfitting has been demanded by the licensing authorities as a result of small changes in the reactor system. This could result in the loss of the operating license even when the change was small, until the necessary work has been carried out. In the absence of generally accepted licensing criteria, the licensing authorities may request to bring the reactor safety systems up to the "state

of the art" of the technology, which obviously leaves a lot of room for interpretation. Another approach could be to impose power reactor standards which are not suitable for research equipment demanding the maximum flexibility in their operation. The Agency has published in 1971 a Safety Series Handbook /2/ on this topic. This is a very general publication which outlines all aspects of research reactor designs, licensing, operation, maintenance and inspection. The updating of this Handbook in a suitable form is therefore being considered. The preparation of more detailed basic criteria prepared by an international body and applicable to standard type research reactors, hopefully should be:

- acceptable to many countries, and
- to serve as an encouragement for many organizations who had not upgraded outdated systems to do so because a set of guidelines would be available.

Regarding research reactor renewal programmes, it is noted that a rather large number of facilities are already some 15 to 20 years old, and in need of a thorough replacement of components and systems if the reactor is going to be operated still another 20 years or so. Replacement or renewal of almost all components of existing research reactors is technically feasible, including such major and radioactive components as core structures or reactor tanks. In the interests of enhanced reactor safety, the Agency will investigate the possibilities of formulating quality assurance standards to which components and systems should conform. It may also be mentioned that in the various technical assistance projects related to this topic, quality assurance principles have been included whenever possible.

#### 4. Publishing activities

The publishing policy has been to provide support for the utilization of medium flux facilities, and to encourage various practical applications. The topics that have recently been covered include neutron radiography /3/ and neutron scattering in applied research /4, 5/.

#### 5. Technical Assistance

A country wishing to obtain its first research reactor often wishes to have the Agency involved in the various stages of such an enterprise. The first question to be clarified is the actual justification for obtaining a research reactor in view of the overall scientific and technical development

of the country, and the plans to embark on a nuclear power programme. Without attempting any rigorous cost-benefit analysis, the Agency generally does not encourage the acquisition of new research reactors in developing countries because of the following reasons:

- The possibilities of performing original research with a medium flux facility are usually very limited.
- The realistic demand for short lived radioisotopes that should be locally produced in a poorly industrialized environment is only sporadic, or not existing at all. Furthermore, for the medical uses,  $^{99m}\text{Tc}$  which can be produced locally from imported generators has such a dominating position that there is not much room, if any for the other locally produced short lived isotopes.
- The development of other analytical techniques such as energy-dispersive X-ray fluorescence spectrometry and atomic absorption spectrophotometry put the uniqueness of neutron activation analysis (NAA) open for arguments, considering the popular claim of its high sensitivity and relative freedom from interference for the determination of elements at concentrations below those detectable by most other techniques. For this reason, it is not recommended that any developing country should invest heavily on a central laboratory on NAA. Rather, attempts should be directed towards setting up a central laboratory for analytical chemistry, where balanced efforts should be spent developing the capability, not only for activation analysis, but also for other nuclear-based techniques (particularly X-ray fluorescence analysis) and at least a few non-nuclear techniques, such as atomic absorption spectrophotometry and conventional chemical analysis. This statement should not be understood to downgrade the value of NAA; obviously the choice of an analytical technique should depend on the nature of existing and anticipated problems. However, when NAA is to be included in the analytical techniques, the possibilities offered by  $^{252}\text{Cf}$  isotope sources and neutron generators are very favourable when their costs are compared to those associated with research reactors.

On the other hand, if the country plans to embark on a nuclear power programme in the foreseeable future, new considerations must be taken into account. The development of the local competent manpower and administrative structures are difficult to carry out without the practical experience that a successful construction and operation of a research reactor facility gives.

Once the decision to obtain a research reactor has been made, the Agency has over the years provided assistance in the various phases of implementing the project including:

- bid specifications and bid evaluations
- contract negotiations
- supervision of construction works
- training of staff
- start-up tests
- advice on setting up the research programmes.

As already indicated in Chapter 3, one major field of activity in the coming years where project applications are encouraged by the Agency, will be the renewal and upgrading of old research reactors. It is understood that the problems which may arise in component replacement, back-fitting or upgrading of existing research reactors, cannot be realized by means of generalised guidelines. Rather such problems are specific to the particular reactor and the particular degree of modification being undertaken.

One way to enhance these activities is to compile actual case histories that can be made available by the Agency to those planning such projects. It would be appreciated if suitable case histories could be obtained from the large TRIGA users' community.

An aspect that is recommended to be included in the project applications, whenever applicable, is the review of safety status of ageing research reactors. In particular reactivity and coolant related accidents should be analyzed to establish that the safety systems, when renewed, would conform to the modern standards.

#### References

- /1/ Research Reactor Renewal and Upgrading Programmes, IAEA Technical Document 214.

- /2/ Safe Operation of Critical Assemblies and Research Reactors, IAEA Safety Series No. 35 (1971)
- /3/ Atomic Energy Review, 15 2(1977). (Special issue on neutron radiography)
- /4/ Reijonen, H. (Compiler), Neutron Scattering in Applied Research: Possibilities for Medium-Flux Research Reactors, Atomic Energy Review, 15 (1977) 755.
- /5/ Neutron Scattering in Applied Research, IAEA, Technical Document 204 (1977).