INDUSTRIAL STRUCTURE AT RESEARCH REACTOR SUPPLIERS

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1. Introduction

Mostly the question: 'What is a research reactor?' is answered by a definition similar to: 'A research reactor is a neutron source, which provides free neutrons by fission reactions for various applications'.

For the industry that is asked to offer or to supply a research reactor that same question is answered quite differently, since it is asked by the tasks that have to be solved by the industry when designing and constructing a new research reactor. That answer may be about: A research reactor is a

- a big piece of engineering
  - in many fields of engineering
  - with strong input from physics
  - with hundreds/thousands of given rules
  - with extreme demands on qualify and proofs
- a plant for research
  - with mostly clear actual tasks
  - with unknown future tasks
- a plant for production
  - with effective processes
  - with quasi-industrial equipment
- a big task in licensing
  - safety issues and proofs
  - legal issues and evidences
- a plant to promote/defend in the public
  - nuclear technology is not generally accepted
  - the rather high cost need to be justified
  - the competition of the SNS is a growing issue
- a wide variety of hardware
  - mechanics
  - electrics/electronics
  - systems composed from catalogue hardware & special components
  - high demands on quality and proofs
- a major management challenge to fulfil the above tasks within the time period and the budget limits set by a contract with the supplier.

This list of tasks and issues has even prolonged by those installations which are enabling a research reactor to perform the research it is constructed for:

- Hot Cells, Shielded Boxes, Glove Boxes
- Conveyors (Gas, Water), NAA
- HNSs, CNSs
- Pressurised Loops incl. Ramp Test Facilities

- Plant-internal Laboratories & Equipment
- NTD-Facilities
- Manual Handling (Devices, Procedures & Tools)
- n-Radiography Facilities
- n-Converters, Medical Treatment Facilities
- Special Experiments/Beams (Fission Product Generator, Inclined and Vertical Beams)
- n-Guide Systems

2. Reasons for the Analysis

Due to the recent joining of the forces of Framatome S. A. from France and the Nuclear Division of Siemens AG Power Generation (KWU) from Germany to a Joint Venture named Framatome Advanced Nuclear Power S.A.S., the issue of the necessary and of the optimal industrial structure for nuclear projects as a research reactor is, was discussed internally often and intensively. That discussion took place also in the other technical fields such as

- Services for NPPs
- New NPPs
- Fuel Elements
- Instrumentation & Control

but also in the field of interest here, i. e.

- Research Reactors.

Opposite to the situation within the Joint Venture for nuclear power plant issues as mentioned above, in the field of research reactors the Joint Venture did not give rise to a unification of 2 branches dealing with about the same subject, but saw a branch at the former Siemens side, which was capable of designing, constructing and commissioning complete research reactor plants and a limited background in that very field at the former Framatome S.A. In their limited history on research reactors, Framatome S.A. had mainly concentrated on BOP-issues, and the projects worked on were proposals and design studies by today.

3. Today's Situation at Framatome ANP

However, together the former Siemens Nuclear Power GmbH and the former Framatome S.A. provide a comprehensive know how and an extremely experienced team for the entire field of research reactor issues. The same staff is available which has already worked for the various predecessors, such as Siemens AG - Power Generation (KWU) and Interatom GmbH (see Table 1), which had worked on projects, which were realized during the last 3 decades nearly continuously. Such major projects are compiled in Table 2, Part 1, for the erected plants and for the further projects applying research reactor technologies and know how.

Table 1: The RR-Team with its homes during the march through the institutions

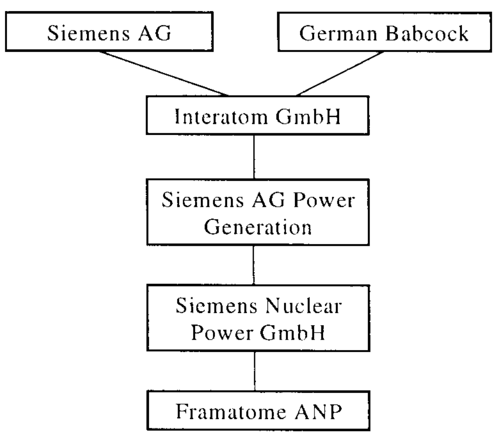


Table 2, Part 1: Main Reference Projects, National & International Plant Erections

- FMRB - Brunswick
- SURs - 12 different locations
- MZFR - Karlsruhe
- TRIGA-HD - Heidelberg
- BER-II, 5 MW - Berlin
- RHF (as consortium leader) - Grenoble
- MPR30 - Serpong
- RP10 (core) - Hurangal
- BER-II, 10 MW - Berlin
- CNS of BER-II - Berlin
- CNS of FRG1 - Geesthacht
- HOR (upgrading + conversion) - Delft
- RML - Serpong
- FRM-II - Garching
- SHESTCO - Sheda

Table 2, Part 2: Main Reference Projects, National & International Other Supplies & Services

- Participation at the SNQ-design for KFA Jülich
- Comprehensive participation for the RERTR-program on behalf of the Federal Republic of Germany, especially in terms of the conversion of all German MTR-type research reactors
- Feasibility study for the erection of an ORPHEE-type research reactor at Jülich (with TA)
- Exchange of the RHF-tank (in a consortium with TA, AEA/T) at the ILL, Grenoble
- Licensing rules as basis for re-licensing of HFR-Petten
- Consultancy services for the TRR-II project at Lungtan
- etc.

That background led to a proven structure for the related branch and a team of very experienced staff plus a solid and wide know-how basis, especially as the projects stretch by today from rather simple reactors to the most complex examples of that technology, such as RHF and FRM-II. As elaborated above, the projects comprise standard technology, such as civil or cooling loops, same way as nuclear technologies as core design or reactivity accidents plus legal issues in the more and more complex world of licensing plus the management of complex projects, too.

4. The Structure in Detail

During the project which is finished these days, i.e. the erection of the new and ambitious high flux neutron source FRM-II at Garching, nearly all these issues had to be tackled by an adequate organisational structure, which is comprised in Table 3. This was the team which worked for and finished what is shown in Fig. 1. This team and its structure demonstrate the completeness of the approach, but also shows some exceptions, which are mostly in the very wide-ranged field of the experimental equipment and research facilities linked to a modern neutron source. Here Framatome ANP concentrates on the interfaces between the neutron source and the experimental set up predominantly. The related experimental equipment will be mostly dealt with by one of the experienced sub-suppliers, which are on that market. This is one of the issues where all research reactor suppliers have about the same philosophy. But such tasks can also taken on as an integrated task of a research reactor construction or upgrading as demonstrated by the list of Table 2, Part 2, which composes the related background at Framatome ANP.

Fig. 1: Pool Internals of FRM-II

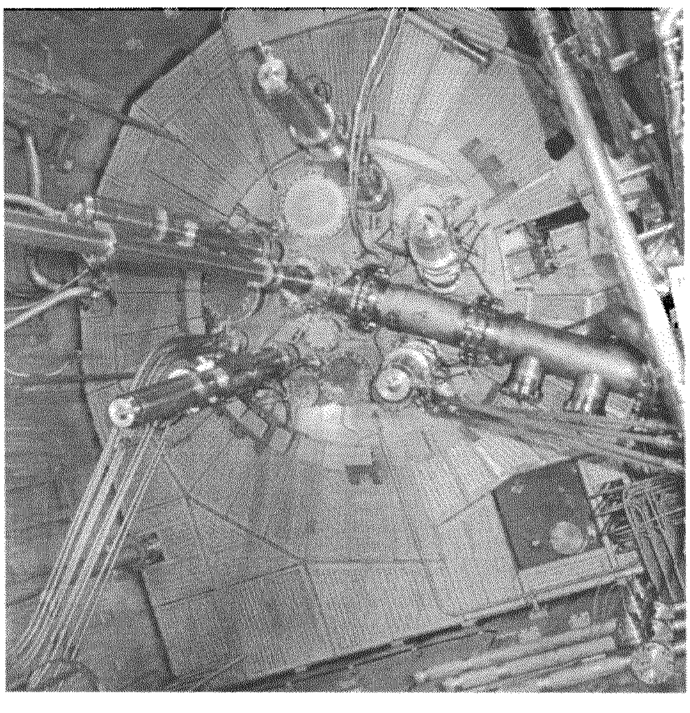
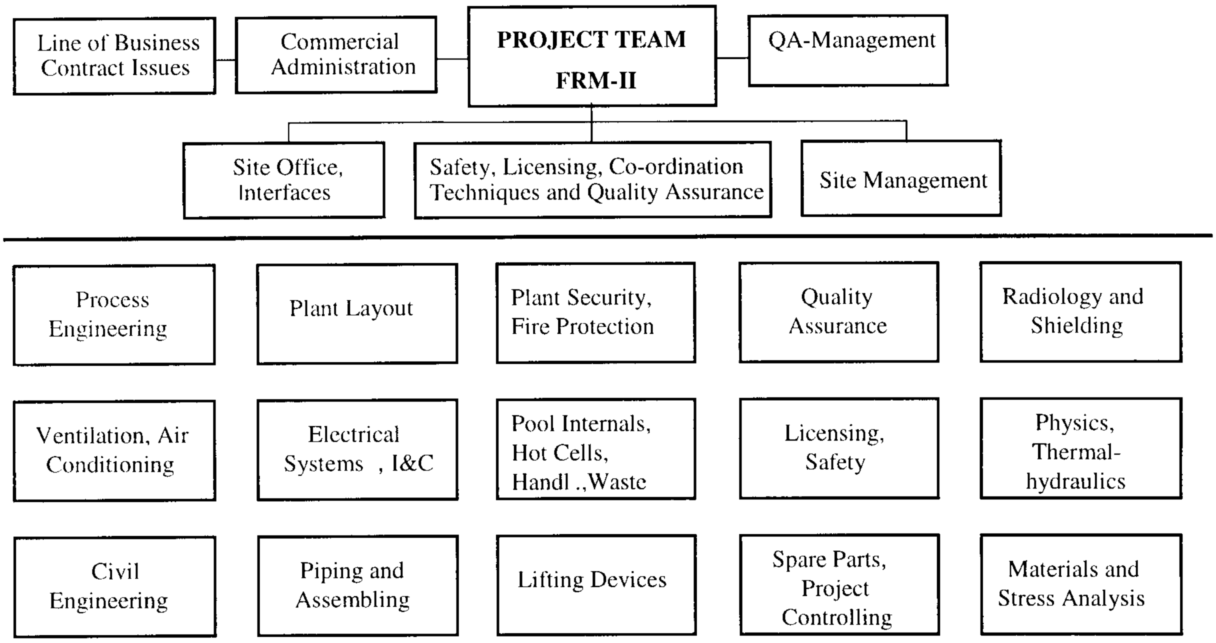


Table 3: The FRM-II Project Team



5. The Supporters

Another important part of the know-how-basis is a deep and actual knowledge of those companies, which are capable and ready to supply components and hardware of that quality, as we have to request for nuclear facilities, even though they are 'only' research reactors. This is the more true, the more ambitious such facilities are designed. In brief, two statements can be made in this context:

- No Turnkey-Supplier without experienced sub-suppliers.
- No Engineering-Architect without knowledge of experienced hardware suppliers.

In brief this means: The turnkey-contractor as well a the engineering-architect have to know and to have experience with partners and have on that basis established partnerships to a basket of experienced suppliers. This does not automatically mean that a country building or renewing a research reactor cannot involve its local industry. Of course it can, especially in the field of components/systems outside the nuclear island and its specific requests and necessarily with the proper guidance of either the reactor supplier or by a partnership with an experienced hardware supplier.

The community of sub-suppliers can be divided into two major parts: Those which are well-known due to their very specific supplies for research reactors and other nuclear installations (Table 4 names such products) and those which are less known but have the references in experience and in quality which make them a specialist in this field (Table 5 names their specialties).

Table 4: Well-known subsuppliers for hardware exist for:

- hot cells manipulators
- fuel assemblies (incl. transport)
- I&C-systems
- uranium supplies
- n-guides
- radiation monitors
- conveyor systems
- lead glass windows
- cryo-generators
- Beryllium

Table 5: Less-known specialists for essential subsupplies with experience in technology plus reputation in quality

- pool liners
- large Al-alloy structures as
  - core shrouds
  - beam tubes
  - CNS-structures
- very heavy concrete
- beam shutter
- Be- & Hf-manufacturing
- pumps, armatures

6. Summary

In summarizing the statements made above one can about state:

- RRs are easier to build than NPPs, but not standardised
- RRs need a wide spectrum of skills + experiences
- to design and build RRs needs an experienced team, esp. in terms of management and interfaces
- RRs need background from erected reference plants more than from operating plants
- RRs need knowledge of suitable experienced subsuppliers
  (after hot operation repairs are a major issue)

Drawing 2 more essential conclusions as industry involved in constructing and upgrading research reactors, these are:

- RRs by far are more than a suitable core that generates a high neutron flux
- Every institution that designs and builds a RR with quality lacks or that causes safety problems, damages the reputation of the entire community.