



XA04C1703

IGORR-IV

WORKSHOP ON R&D NEEDS

Klaus Böning

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As in recent IGORR meetings, the goal of this workshop on R&D Needs was to bring together those groups of research reactor operators and designers, who need answers to particular R&D problems they have, and those groups of research reactor operators and designers, who plan to perform or have already performed R&D investigations on problems they have. As could be expected — and as the former IGORR meetings have demonstrated — there is a considerable range of overlap in the interests and needs of various groups in the same R&D topics.

During IGORR-I and IGORR-II, a matrix was set up — see Table 1 — connecting numerous R&D topics (vertical) and groups interested (horizontal). Results have been reported on some of these R&D topics during IGORR-II (*italicized texts*) while other problems still had to remain open — these have been labeled by 2a—2f in Table 1. Further R&D needs have been identified at IGORR-III: these are shown in Table 2, labeled by 3a—3g.

R&D needs identified at IGORR-I and IGORR-II

| Topics | ANS | BERLIN | BNL | FRM-II | JAERI | JÜLICH | MAPLE | MIT | MURRI | ORPHEE | PETTEN | RISO |
|---|-----|--------|-----|--------|-------|--------|-------|-----|-------|--------|--------|------|
| ▶ <i>Thermal-hydraulic tests and correlations</i> | ● | | ○ | ○ | ● | | | | ● | | | |
| ▶ <i>Corrosion tests and analytical models</i> | ● | | | ○ | | | | ○ | ○ | | | |
| ▶ <i>Multidimensional kinetic analysis for small cores</i> | ○ | | | ● | | | ● | | | | | |
| ▶ <i>Fuel plate fabrication</i> | ● | | | ● | | | | | | | | |
| ▶ <i>Fuel plate stability</i> | ● | | | ● | | | | | ○ | | | |
| ▶ <i>Fuel irradiation</i> | ● | | | ○ | ● | ○ | | | ● | | | |
| ▶ <i>Burnable poison irradiation</i> | ● | | | ● | | | | | | | | |
| ▶ <i>Structural materials irradiation</i> | ● | ○ | ● | ○ | | | ● | | ● | ● | ● | |
| ▶ <i>Neutron guides irradiation</i> | ○ | | | ○ | ● | | | | | | | |
| ▶ <i>Cold source materials irradiation</i> | ○ | ○ | | ○ | | | | | | ● | | ● |
| ▶ <i>Cold source LN₂ test</i> | ● | | | | | | | | | | | |
| ▶ <i>Cold source ¹H₂-²H₂O Reaction (H or D)</i> | ○ | | ● | ○ | ● | | | | | | | |
| ▶ <i>Instrumentation upgrading and digital control system</i> | ● | | ○ | | | | | ● | ○ | ● | ● | |
| ▶ <i>Man-machine interface</i> | ○ | | | ○ | | | | ● | | | | |

2a

2b

2c

2d

2e

2f

↑

Still open at IGORR-II

● Results needed and work already underway or planned
 ○ Results needed but work not already planned
 Note: *Italicized text* — results to be reported at IGORR-II

Table 1. (from IGORR-II Proceedings)

Further R&D needs identified at IGORR-III

| New Open: | Topic | Notes |
|--------------|---|---|
| 3a | Accident and safety analysis codes and benchmarks | IGORR members will be asked to supply and share information on the methods they use |
| 3b | Thermophysical properties of D ₂ O liquid and vapor | Risoe has prepared a report on this, with 150 references and will publish a heavy water handbook in about six months. IGORR members will be informed. |
| 3c | Chemical and other energy release from core melt events | Need better estimates of steam production for containment and design (Lee/AECL) |
| 3d | Fission product release from a molten MTR core | |
| 3e | Thermal conductivity of irradiated fuel meat | Analytical, or better still experimental, data are needed (West/ANS) |
| 3f | Tests of cryogenic circulators for single-phase forced-convection cold source | |
| 3g | Flow blockage tests | ANS will measure flow and heat transfer effects in the wake of a partial blockage and will use the results to benchmark a computational fluid dynamics model. Results will be reported. |

394

Table 2. (from IGORR-III Proceedings)

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During the present IGORR-IV Meeting, numerous "Research, Development, and Analysis Results" were reported on as outlined in Chapters IV and V of these Proceedings. Some of these reports were on more detailed work referring to R&D topics which had already been raised and discussed earlier (see Table 1), but some of them also gave answers to R&D topics which were still open at that time, namely numbers 2f, 3a, 3c, 3d, 3e, and 3g. Further, R&D results have become available which have not explicitly been reported on during the meeting, i.e., neutron guide irradiation tests from ORPHEE (no. 2c) and a "Heavy Water Handbook" from Riso (no. 3b). If one also cancels R&D needs nos. 2d and 2e, which were only identified by the ANS project, the termination of which was deeply regretted by the auditory, the only open R&D topics where no answers have been given so far were those with nos. 2a, 2b, and 3f. This conclusion does, of course, not mean that all the answers given were sufficient to really solve the corresponding R&D problems, so it may well be that some of these topics will come up once again in the future.

The IGORR-IV Workshop on R&D Needs, which is the subject of this summarizing paper, provided the opportunity for the participants to report on new R&D needs they have as well as on R&D work which was going on at their home institutions and which could be of interest to other groups. As a result, Tables 3 and 4 show a compilation of these presentations concerning R&D work needed or announced, respectively. Finally, Doug Selby (ORNL) presented a list of topics of R&D investigations which have been performed (at the time being more or less completely) for the ANS project and which could be finalized and the results written down with relatively small effort if there was interest from the IGORR group members. This list is shown in Table 5 where the column on the full right-hand side demonstrates that there was a strong interest in practically all of the R&D topics by relatively large numbers of groups.

In conclusion, the present Workshop on R&D Needs (Session VI of the Agenda) together with the Sessions IV and V on R&D Results have demonstrated once again that these activities indeed serve an important

purpose of the IGORR meetings. The goal of bringing together research reactor operators and designers who have R&D needs, and those who produce R&D results, helps to save costs, improve the understanding of the ongoing processes, and so is beneficial to the safe and reliable operation of the facilities.

NEW R&D NEEDS IDENTIFIED AT IGORR-IV

| Affiliation/ Name | Topic | Comment |
|----------------------|---------------------------|---|
| 4a | AECL/Albert Lee | Requirements for the design of containment |
| | | Survey IGORR members on design basis for containment (confinement) <ul style="list-style-type: none"> — design basis events — external hazards — overpressure requirements, etc. |
| 4b | ORNL/Doug Selby | Cold neutron nuclear data |
| | | <ul style="list-style-type: none"> — Sources of data <ul style="list-style-type: none"> • LD₂ • LH₂ — Benchmarks for cold source physics analysis <ul style="list-style-type: none"> • LD₂ • LH₂ — Cold source heat loads <ul style="list-style-type: none"> • methods of analysis • benchmarks |
| 4c | TUM/ Klaus Böning | Thermal-hydraulic data (flow instability) for high cooling water velocities ($\approx 17-18$ m/s), but low system pressure (≤ 10 bars) |
| | | The recent data obtained from the ANS test loop is very very valuable, but they were all obtained for relatively high system pressures. The local TUV responsible for the assessment of the FRM-II is not fully convinced that the data obtained do not depend on pressure, although the state-of-the-art theory says they do not. |
| 4d | MURR/ Charlie McKibben | Method to calculate decay time required after full power operation before the core is safe in air. |

Table 3

NEW R&D WORK ANNOUNCED AT IGORR-IV

| Affiliation/ Name | Topic | Organizations interested |
|----------------------|---|--------------------------|
| ORNL/Doug Selby | Cold neutron beam tube guides size and geometry optimization studies | TUM, AECL |

398

4e

Table 4

POTENTIAL R&D TOPICS FROM ANS CLOSEOUT OF R&D ACTIVITIES

ORNL/Doug Selby

| | Topic | Organizations interested |
|--------|---|--------------------------------|
| 4f | HANS-3 fuel capsule irradiation (in HFIR) evaluation | GA (TRIGA); Siemens; MURR; TUM |
| 4g | Meat fabrication with spherical powder fuel | TUM |
| 4h | Centering of fuel in plate fabrication | MURR; . . . |
| 4i | Effect of flow blockage shape | KAERI; KFA; MURR; TUM; . . . |
| 399 4j | Reduced ph effects on Al corrosion | All |
| 4k | Final summation of our thermal hydraulic test program | All |
| 4l | Final results from the HANSAL aluminum irradiation tests (include BNL analysis) | All |
| 4m | Aluminum irradiation creep tests | KAERI; CERCA; . . . |

Table 5