SAFIR2022 – Supplement to the Framework Plan for Call 2022

Summary based on the minutes of the SAFIR2022 Management Board meeting on 16.6.2021.

Infrastructure issues

Overview of existing infrastructure

The research infrastructure in the Finnish nuclear safety research field can be seen in the wide sense consisting of all human and material capital, as well as of the official and unofficial organisational structures in the use of the field. However, in the narrow sense, the research infrastructure should be understood to mean those physical and logical structures and equipment that are exceptionally costly and cannot be easily repurposed for other uses.

The most visible parts of the current Finnish nuclear infrastructure are the laboratories of VTT at Otaniemi and LUT in Lappeenranta. The VTT laboratory consists of a state-of-the-art hot cell laboratory that is capable of handling extremely radioactive sources, and processing these to get samples that can be researched with a wide array of technical laboratory equipment that mostly allows work on material science, chemistry and aerosol science issues. The laboratory is integrated to an office complex that houses the VTT nuclear science staff.

The LUT laboratory is a dedicated thermal hydraulics laboratory that is designed to work with non-radioactive materials. Its major facilities consists of PACTEL (a PWR/VVER integral effects facility), PPOOLEX (a containment effects facility) and MOTEL (an SMR integral effects facility). PACTEL has been noted by OECD/NEA as globally significant research facility. In addition to these, LUT has a set of smaller separate effects facilities and good capabilities to design and construct new ones when necessary.

In the corporate side of the field, the most important pieces of infrastructure are the simulators, which encompass all plant types in Finnish use. The use of this equipment for research purposes is always subordinate to the needs of the utilities in the training of their personnel, validation of procedures and engineering work. However, as Olkiluoto 3 enters commercial operation in 2022, the demands on its simulators become less intensive, and Loviisa I&C modernisation which has also placed a great burden on simulators, has already been finalised. With proper collaboration with utilities, this may open new routes for human factors and organisational psychology research.

The nuclear reactors in Finland are power reactors and not suitable for research. However, in some limited cases, these have been utilised. For example, the 2009 experiments on Olkiluoto BWRs yielded important information on thermal stratification in containment wet well. Similar experiments are possible, with good utility cooperation, if they are planned carefully, don't endanger nuclear safety and availability of the plants, and their actual usefulness is readily apparent. Even more importantly, the plant behaviour in actual transients can be used for primary validation of analysis codes and models. For this purpose, the nuclear commissioning of Olkiluoto 3, and to lesser extent, the commissioning of Olkiluoto EDGs, will produce a storehouse of primary plant data for future research.

Finland lacks a laboratory suited for irradiation of samples. Should such needs arise, the vast materials of radioactive material stored in Olkiluoto and Loviisa offer a wide selection of different radiation levels, although sample holders need to be improvised. The highest levels are inside the spent fuel pools and in the reactor pits. Locating samples to these would require careful planning and cooperation with the plants

but locating samples to the lower radiation fields present in waste facilities is easier, although even that requires cooperation with power plants or Posiva. Emplacing samples in the reactor vessels proper, on the other hand, is not technically feasible.

For long-term material science experiments, the facilities built in solid rock provide areas that are at very constant temperature and humidity. In addition to the Posiva final disposal facility, there are plenty of similar rock environments elsewhere in Finland.

Development needs

The task of the VYR funding is to preserve the capability of Finnish nuclear safety research to answer swiftly to situations that arise unexpectedly. This requires the maintenance of a material sciences laboratory and a thermal hydraulics laboratory. As the actual research questions that may arise are unknown, the most important feature of the facilities is their flexibility. This was shown very well in the case of Olkiluoto 3 primary circuit vibrations, when LUT laboratory could improvise a facility for studying the complex phenomena around post-accident behaviour of the proposed dampers. This leads to considerable time savings, better engineering solutions from nuclear safety point of view, and benefits to the national economy. Thus, all facilities should be designed to allow connection of new equipment.

During the period 2023–28, the physical infrastructure needs both maintenance and upgrades. Both major Finnish nuclear science laboratories should be maintained as viable research groups, which requires a certain personnel level. However, if a research group from another organisation makes a proposal for entering the nuclear safety research, such proposal needs to be considered seriously and without prejudice. The thermal hydraulic facilities PACTEL and PPOOLEX are approaching the end of their useful lives, and also the exhaustion of useful research vistas. New approaches are needed either for their revitalisation or for development of facilities for new research topic. This opens possibilities also for new candidates, though naturally, the established laboratories have a strong basis also for future development.

When developing new or existing facilities, care should be taken not to rely altogether too much on outside supplier of research equipment. When possible, the infrastructure development should be research in itself, and the aim should be to develop new measurement devices in-house, or at the very least, modify existing equipment in novel ways, as usually, advances in measurement technology also allow novel results in the issues being researched. The innovativeness in measurement technologies should be prioritised over getting short-term results or lower cost of equipment.

In addition to these physical facilities, the Finnish infrastructure consists of data storage of previous experiments, and computational facilities. Computational facilities consist of each research group's normal workstations, which are financed as general overhead costs of the projects, while mainframe-level scientific computing is done mainly with the resources of CSC, without SAFIR involvement in financing. This situation shall remain also during the years 2023–28. However, if good proposals for use and better archiving of the existing research data appear, they may be financed separately, either as infrastructural projects or as work packages of discipline-specific projects. Yet, all archival projects should also aim to have an actual use case for the materials being used. Simply archiving for its own sake is often fruitless.

Software issues are described with each research field separately.