R&D LMFRS KNOWLEDGE PRESERVATION FRENCH PROJECT: APPLICATION TO THE SODIUM COOLANT AND COVER GAS

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Abstract

In the frame of Liquid Metal Fast reactors knowledge preservation French project, CEA has separated the field of this subject in several items and has designed several experts to treat specific areas. Thus, this paper presents how this study was made dealing with the following item: sodium coolant and cover gas. This paper explains what were the main difficulties by making this study and how they can be solved.

1. INTRODUCTION

Development of R&D linked to Liquid Metal Fast Reactors had an important stop in France since the decision of the final shutdown of Superphénix in 1998. From the very beginning of this technology until now with the decommissioning aspects, France have accumulated a huge knowledge in this field mainly shared by three companies: CEA, EDF and FRAMATOME ANP.

In 2000, it has been decided to create an everlasting data base of documentation with easy access for consulting, in order to keep knowledge an experience acquired through the development, design, construction and operation of the French LMFR plants (RAPSODIE, Phénix, Superphénix, and EFR projects).

This database was considered to be important in order to perpetuate the knowledge on LMFRs for the following decades. The absence of French and European future project on this subject highlighted the risk of loss of knowledge in various field (excepted maybe decommissioning aspects), and expresses the need to drive as soon as possible such a project.

2. GENERAL PRESENTATION OF THE PROJECT

The R&D LMFRs preservation knowledge French project started in 2000. CEA is the leader project. The aim of this data base project is to include:

- Synthesis of history, concept approach, evolution and supporting R&D of French LMFRs;
- 22 R&D topics and 41 SUPERPHÉNIX plant systems;
- Description of the main common CEA, EDF and FRAMATOME ANP realizations;
- More than 1500 documents (papers and CD Rom medium);
- RCC MR 2000 version (updates of the mechanical analysis rules);
- Database of all the measurement recorded and obtained from SUPERPHÉNIX exploitation.

From the R&D part, the most important items are the following:

- Neutronic;
- Fuel;
- Fuel rupture;
- Sodium cooling and argon gas;
- Sodium technology;
- In sodium mechanics;

- Safety and operation;
- Thermohydraulic;
- In sodium inspection;
- Sodium fires;
- Material codes and standards;
- Decommissioning;

This paper deals with the treatment of the “sodium coolant and cover gas” item.

3. THE ITEM ‘SODIUM COOLANT AND COVER GAS’

3.1. Work asked

To treat this item (as every other items), it was given the following constraints:

- It was necessary to write a small presentation text to present the context of this item and some very general information.
- It was necessary to select a limited number of references considered to cover the whole subject of the item. The number of 150 references was given as an upper limit.
- This study as the whole project must be done in a limited time (from 2000 to mid 2002) and will not continue after. Thus the given list of referenced papers will not have any reevaluation with time.

These constraints and specifically the limited number of referenced papers were the major difficulty to deal with such a wide item. Thus, to try to solve these difficulties, the first operation was to divide this subject into several sub items.

3.2. Description of the sub items

In order to be more precise in the definition of the indispensable knowledge on sodium coolant and cover gas, it was decided to define several sub items. Eight sub items were selected and even in these sub items, another division was made. At the end this strategy leads to the following list:

1) General knowledge on sodium
   - Physical properties;
   - Chemical properties;
   - Thermal properties.

This sub item deals with all the properties of metallic sodium that is necessary to know to have a good knowledge of how the metallic sodium behaves.

2) Primary sodium
   - Specifications for primary sodium;
   - Pollution monitoring;
   - Activation;
   - Measurement techniques;
   - Purification techniques.

The most important operations dealing with the primary sodium are covered by this sub-item.

3) Secondary sodium
   - Specifications for secondary sodium;
   - Pollution monitoring;
   - Measurement techniques;
   - Purification techniques;
   - Specifications for secondary sodium.

The most important operations dealing with the secondary sodium are covered by this sub-item.

4) Experimental feedback from PHÉNIX and SUPERPHÉNIX
   - Recall of the experimental feedback gained from the main incident occurred in PHÉNIX plant in operation;
   - Recall of the experimental feedback gained from the main incident occurred in SUPERPHÉNIX plant in operation.

This sub item is covering the major experimental feedback gained by some incidents encountered on French fast operators in operation. That is to say for example several sodium/water reactions on Phénix Steam Generators, pollution of the primary sodium by air ingress on Superphénix reactor, etc…

5) Argon cover gas
   - Physical and chemical properties;
   - Behavior with sodium – aerosols;
   - Specifications for fast reactors;
   - Measurement techniques;
   - Physical and chemical properties.

All the basic knowledge of the argon cover gas and its behavior in contact with liquid sodium are gathered in this sub item.

6) Narrow items
   - Corrosion in sodium;
   - Sodium compatibility;
   - Sodium potassium alloy (NaK alloy);
   - Cleaning – Decontamination – Re-qualification for the reuse of the components.

This sub item covers all the subjects where there was a fear that they will not be properly treated in another item because they are at the borderline between two fields of knowledge.

7) Further or other coolants – Comparison with sodium

It was found necessary to define this sub item in order to remind for the future what were in the past the reasons to select sodium as coolant for fast reactors and not another coolant (such as gas or lead or whatever). And also to remind what were the comparisons between sodium and other coolants with the choice criteria.

8) Books, technical documents and general conferences on sodium technology

Because this subject: sodium coolant, was too wide, and because it was really difficult to select a limited number of document when several thousand have been written on this subject, it was decided to define a sub items where unavoidable referenced documents must be conserved. These document are not concerned to only one sub item but they generally treats all of them. Thus the general international conference on liquid metal technology (LIMET) or some Handbook on liquid sodium was selected in this sub item.

4. DIFFICULTIES IN DOING THIS SELECTION

Several sorts of difficulties arose when time is arrived to select the final papers. These difficulties can be sum up in four questions:

- Am I the best person chosen to select the best document?
- It is of course difficult to identify the right person that knows every about sodium coolant. This question means that even if I have been chosen, my own knowledge is only partial and mainly focused on my field of competence. So, it is necessary to keep in mind that all the field of the subject must be covered and not only what I know the most.
- How can I be sure that I will not miss something important (one paper or worst one part of the field of this item) ?
- How it is possible to select around 150 documents when several thousand were produced all over the world ?
- Of course to solve this problem it should be argued that now we can store everything on computer. There is no more a limitation of space memory. But by selecting everything it is not possible to let to the future generation the experimental feedback of what it is useful to know and what is not (or far less). By storing everything, we let to the future a huge amount of data and documents with no hierarchy between themselves. We are not in a knowledge preservation attitude but in a general archive strategy with no increase in value by French experts. It is not the aim of this project.

To answer as much as possible to these previous questions, the following recommendations happened to be very useful:

- Try to choose only the papers written as synthesis.
- Try to ask to every specialists: “What are the five documents that summarize your field of speciality the best?”
- Try to keep the same importance in every subject and not only in the field of your speciality.
- Try to see abroad if the field of interests is the same or not.
- And finally keep in mind that your selection is maybe not the best but it is better than nothing (!).

5. SYNTHESIS OF THIS STUDY

The selection of all the documents designed to cover this subject is now over. One-hundred-one documents were selected: 92 French documents coming from CEA, EDF and FRAMATOME and 29 foreign documents coming from all the countries that have worked or are still working in fast reactors. Ten general books were selected (sodium handbooks, IAEA conferences on liquid metal technology or specialist meetings, IAEA technical documents). Moreover all the up to date courses given at sodium school were selected because they were easily available and they were a good synthesis of every specific subject (i.e. corrosion, purification, sodium monitoring, cleaning, etc…). The compilation of all the sodium school courses was counted as only one reference but in fact it gathers more than 70 courses.

6. CONCLUSIONS

The list to treat about 'sodium coolant and argon cover gas' is now finished and considered as definitively complete. After doing this kind of work there is still a feeling that nonetheless a

lot a knowledge is lost or difficult to maintain through the ages: principally the knowledge of retired experts.

It was possible to notice also that the field of interest in one particular subject in sodium coolant depends strongly on what happens during the LMFRs life. For example for French part, it was mainly sodium pollution and purification consequence of the air ingress in Superphénix and also materials and corrosion as a consequence of the intermediate fuel sodium storage leak. In Great Britain, a lot of documents were focused on sodium/oil interaction due to the oil ingress in PFR. This field of interest is also linked to the questions of the national safety authorities. As an example studies on In Service Inspection and Repair started in a lot of countries in the 90's after questions of safety authorities on this subject. Before, nothing was asked and as a consequence the development in this field was no so important. The trouble is that it is not possible or obvious to predict what will be the field of questions coming from the safety authorities in thirty years.

It can be said as a final conclusion that this selection on sodium coolant is now ready for the future, so the knowledge preservation is on the way. This list of document is also very useful for the present time.

REFERENCES

[1] BAQUE, F., R&D LMFRs Knowledge Preservation French Project, paper presented in the IAEA Technical Meeting on Operational and Decommissioning Experience with Fast Reactors, Cadarache, France, 11–15 March 2002, to be published as IAEA-TECDOC.