
Support of the Russian Nuclear Safety Authority Developing the regulatory basis for dealing with ex-Weapons Plutonium

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** GRS: Gesellschaft für Anlagen und Reaktorsicherheit mbH (Germany)

***IRSN: Institut de Radioprotection et de Sûreté Nucléaire (France)

****RISKAUDIT: European Economic Interest Grouping (EEIG) founded by GRS and IRSN

*****EC: European Commission

*****CEA: Commissariat à l'Energie Atomique (France)

*****DGSNR: Direction Générale de la Sûreté Nucléaire et de la Radioprotection (France)

Abstract:

In line with the framework of the AIDA/MOX program for utilizing excess Russian Weapons Plutonium in Russian reactors (WWER or fast-breeder reactor) under the form of MOX fuel, a collaboration has been launched under the leadership of the nuclear safety authority of Russia (Rostechndzor) to develop a set of state regulation documents. Several organizations are involved in this project: ROSATOM, the SEC NRS, RAS IBRAE on the Russian side, the DOE, PNNL and the NRC for the USA, the European Commission, the French regulatory body (DGSNR), the CEA and a team of RISKAUDIT safety experts (coming from AVN, GRS and IRSN) on the European side. This collaboration started in 2001, and 42 documents have to be developed to give safety standards, rules, principles and requirements. They cover all safety issues (siting, content of the safety reports, waste management, radiation protection, internal and external hazards, transportation, emergency planning) for the fuel cycle and also for the MOX fuel to be used in Russian reactors. The US DOE (National Nuclear Security Administration - NNSA) and the European Commission (EU Joint Action Russia) have co-financed the writing of 31 documents in Russia and their review by western safety experts. The list of documents and their topics, the work plan and the main results of the collaboration between European experts and the Rostechndzor are described in this presentation.

I. INTRODUCTION

The objective of this international cooperation is to develop the regulatory basis for implementing the Russian program to dispose of excess weapons plutonium (W-Pu). The newly developed regulations had to be harmonically incorporated into the already existing system of regulatory documents and to take into consideration the internationally accepted safety principles, criteria and requirements. This is very important to take into account the worldwide tendency toward the harmonization of regulatory requirements. In collaboration with other Russian departments involved, the Russian Nuclear Safety Authority (the Federal Environmental, Industrial and Nuclear Supervision Service of Russia called Rostechndzor) drew up a list of regulation documents to be developed. This list, at first containing 39 documents, was recently extended to 42. Following negotiations among representatives from Rostechndzor, the U. S. Department of Energy (US/DOE), the European Commission (EC), the French Atomic Energy Commission (CEA) and the French regulatory body (DGSNR), an agreement was reached to finance the development of these regulatory documents.

II. THE AIDA MOX PROJECT

A reference process to convert the W-Pu into MOX fuel was defined. It includes the following different stages (see figure 1):

- the dissolution of the plutonium alloy into a mixture composed of nitric and fluorhydric acid,
- the purification of the Pu nitrate obtained by solvent extraction (PUREX process),
- the production of Pu dioxide by oxalate precipitation and calcination,
- the fuel manufacturing by two processes :
 - o "Russian COCA" process for the fast breeder reactor fuel,
 - o "Russian MIMAS" process for the WWER reactor fuel.

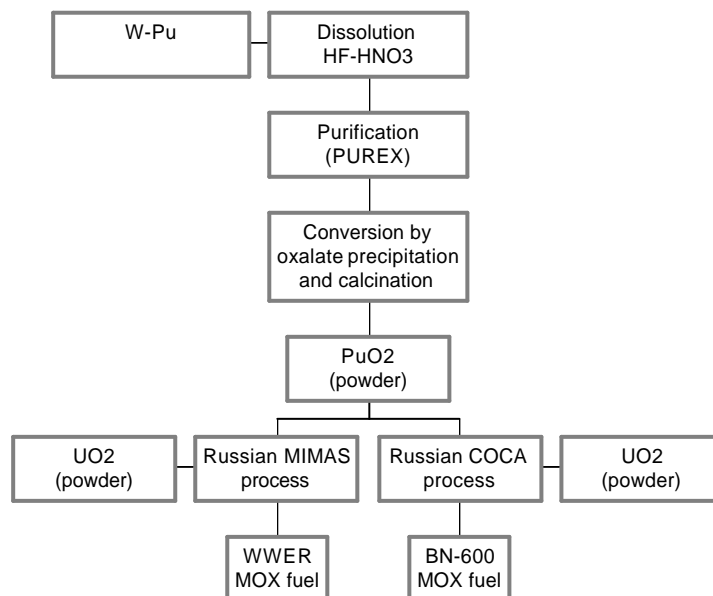


Figure 1: Process to convert the W-Pu in MOX fuel

The plant capacity will be near 60 tons of MOX fuel per year, containing around 2.2 tons of W-Pu. Four WWER reactors of the Balakovo site and three of the Kalinine site have been chosen to burn around 270 kg of Pu each year. The BN-600 fast breeder reactor is also an option to burn around 280 kg of Pu each year.

III. REGULATORY DOCUMENTS

The Russian system of legal and regulatory documents applied to the nuclear energy is organized in the form of a pyramid (figure 2), on the top of which are Federal Laws and International Treaties (Conventions, Agreements). Then there are executive legal documents of the President and Government of the Russian Federation. The next level is represented by Federal Standards and Rules applied to the nuclear energy use. Almost all documents to be developed within the frame of this international cooperation belong to this level. Then follows a level of documents issued by the State Regulatory Authorities (Safety Guides, Guidelines) and at the bottom level there are operational documents.

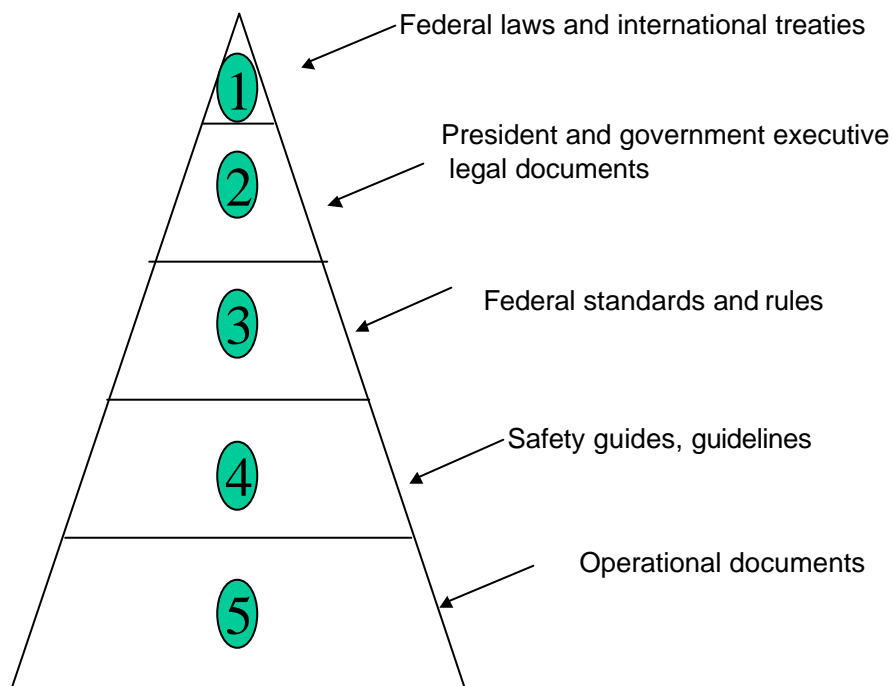


Figure 2 : Pyramidal organization of regulatory documents

The list of documents included in this project is given in Appendix n° 1.

IV. PROCESS FOR DOCUMENT ELABORATION

Among the 42 documents, the US/DOE finances 13 documents and the European Commission (EC) 18. For each document, a contract was concluded between US/DOE or CEA and one of the organisations providing technical support to Rostechnadzor. The

contracts are based on the technical description of the document content. Rostechnadzor controls the quality of the developed drafts.

For the documents financed by the EC, the CEA concluded several contracts with RISKAUDIT to review the documents written by the Russian organisations. A team of experts belonging to AVN, GRS and IRSN was created to do this work.

Talking about the documents financed by the US/DOE, experts of the US NRC and US National Laboratories (mainly PNNL) review the drafts and provide their comments.

The work is being carried out in two principal phases.

The first one is the review of the first draft of a regulatory document established by Rostechnadzor. For the documents financed by the EC, RISKAUDIT's comments (a synthesis of the comments elaborated by the AVN, GRS and IRSN experts) are submitted to the CEA, which sends this review report to Rostechnadzor and to the US/DOE. Rostechnadzor collects all the comments, including those from Russian departments, and draws up a general list. These comments are sent to all the organisations involved, with the writer's answers on the way each remark is taken into account. A meeting is then organized to discuss this comment review. Rostechnadzor, the Russian organisation in charge of writing, the EC representatives, the DGSNR representative, the RISKAUDIT team, and the US/DOE accompanied by NRC representatives all attend this meeting, where the comments and the Russian answers are explained and discussed. The experience feedback shows that these meetings are very useful and efficient. In particular, they allow a quick solution of misunderstandings arising from translation difficulties.

In the second phase, Rostechnadzor sends a final draft to the CEA. The aim of the experts review is then to analyse to what extent the comments given during the first draft review have been taken into account. A synthesis of these comments is then transmitted to Rostechnadzor.

The peer review performed by the US/DOE or RISKAUDIT on the documents developed respectively under the financing of the US/DOE or the EC, and the presence of both parties in the technical meetings allow American and European experts to have a general view on the set of documents and to know the different points of view. This also leads to a better coherency in the different comments.

Parallel to this project, workshops and seminars on fabrication and use of MOX fuels are held in order to make Russian experts familiar with safety aspects and licensing practices in western countries and vice versa, to enable Russian experts to present their experiences to western experts.

V. PROGRESS AND RESULTS

At this time, we consider that this project is working well. More than 80 % of the work on the EC financed documents has been done. The second drafts of most of the documents have been written or are under preparation. Western experts have finally reviewed 11 of 18 documents; two documents were already set in force by Russian authority in 2005. And Rostechnadzor of Russia made a decision to complete development of all documents for the end of 2005.

VI. HISTORY

The set of documents was developed in the framework of the civilian use of W-plutonium. We have to keep in mind that W-grade Pu is less hazardous in terms of external exposure to the personnel than Pu from commercial LWRs, but it is more reactive in terms of criticality safety. Nevertheless, in the nuclear fuel cycle, including transportation, plutonium use leads in general to the strongest safety related constraints. Its characteristics induce all the internal origin hazards met in nuclear fuel cycle facilities:

- external and internal exposure hazard, including neutron and γ rays,
- criticality hazard,
- thermal hazard,
- radiolysis hazard,

and the most important consequences for the environment in case of accident.

So, generally speaking, though originally adapted to W-Pu process facilities, some of the documents are applicable to different types of facilities with a wide range of capacity and potential hazards (e.g. laboratories or storage facilities). This may sometimes result in overly rigid requirements for small facilities with low potential hazards. One point was underlined in the comments made on the first drafts: the regulatory documents must specify that the level of safety measures has to be adapted to the hazards. This adaptation has to be justified by the licensee.

It must be remembered that, in a general way, measures described in the documents are in line with most international practices, including decommissioning activities.

Main topics discussed:

Taking into account the document subjects' wide variety, the number of topics discussed is important. The main topics, which needed discussion and led to proposals, are developed below.

- The defence in depth concept: this concept is part of the safety approach of Rostechndzor, but it will appear more clearly in the documents defining the content of the safety justification reports. These were organized following the different safety important systems rather than according to the different hazards to be studied.
- Nuclear safety: in Russia this means criticality safety ; the permissible k_{eff} in case of normal and abnormal conditions will depend on different parameters: the nuclear material type, the calculation code qualification, etc. In general $k_{\text{eff}} < 0.95$ including uncertainties is required. Safety concepts for ensuring sub-criticality are the same as in western countries. Additionally a classification for the equipment (tanks, pipes etc.) is applied providing different safety levels, e.g. geometrically safe or not safe and equipment of higher safety margin.
- The application of the double contingency principle for criticality safety, which requires at least two unlikely, independent and concurrent failures (with particular detection conditions) in normal operation before a criticality accident is possible.
- Design basis accident (DBA) and beyond design basis accident (BDBA) ; more than the definition, it was the criteria which were discussed:
 - o what radiological consequence level could be accepted after a DBA,

- what kind of meteorological conditions have to be used for the calculation of the BDBA consequences assessment: realistic or the worst,
 - what is the criterion for the probability that a facility leads to an unacceptable release: 10^{-7} or 10^{-6} a year.
- Concerning waste management:
- the notions of near surface disposal and underground disposal will be defined more precisely. In particular, a clear link should be made between the characteristics of wastes and their final destination (landfill, near-surface disposal, sub-surface disposal, deep geological disposal),
 - it is more efficient to require that the waste package characteristics be defined on the basis of the defined storage or disposal safety case conclusions, than in a general way for all the sites and all the facility types,
 - the proposed dose limit for population of $10 \mu\text{Sv/y}$ is clearly lower than in many Western countries and may lead to difficulties in the demonstration of compliance for the safety analysis,
 - the methodology used to design disposal areas has to be better explained. Compliance with IAEA recommendations, particularly concerning institutional control should be better addressed, to remove any kind of ambiguity.

Further discussions:

As mentioned in the preceding chapter, some document drafts are still under development and the technical discussion is still carrying out or will be in the next months. For example:

- the Plutonium encapsulation in glass and the safety concerns, in particular the criticality hazard associated with the combination of Pu pellets in Pu-containing glass,
- the impact of Mox fuel use in reactors,
- the fire safety analysis in MOX fuel manufacturing plant.

VII CONCLUSION

In general the discussions between Russian and Western experts were very fruitful and yielded an improvement of the draft nuclear safety documents. The collaboration and the exchanges with American colleagues are also very fruitful and productive.

The way to deal with the different hazards for AVN, GRS and IRSN, parts of the RISKAUDIT team is quite similar, the safety approach also and the final objectives are coherent.

The project can be seen as a step to improve the common international understanding of safety issues for nuclear fuel cycle facilities.

Title of the document	Type	Funding source
Siting of non reactor nuclear facilities - Basic safety criteria and requirements	Federal standards and rules	DOE
Nuclear safety rules for nuclear cycle facilities	Federal standards and rules	DOE
Weapons-grade plutonium conversion facilities - Safety requirements	Federal standards and rules	DOE
Mox fuel production facilities - Safety requirements	Federal standards and rules	DOE
Basic requirements for Mox fuel	Federal standards and rules	DOE
Provisions on the procedure of investigation and accounting of operational events in nuclear fuel cycle facilities	Federal standards and rules	DOE
Requirements for the content of the safety justification report for the realization of research work in nuclear fuel cycle facilities with plutonium containing materials	Federal standards and rules	EC
Safety rules for storage and transportation of nuclear fuel in the nuclear installations	Federal standards and rules	EC
Requirements for the content of the safety justification report for non reactor nuclear installations within the nuclear fuel cycle	Federal standards and rules	EC
Safety rules in non reactor and radioactive source decommissioning	Federal standards and rules	EC
Plutonium immobilization facilities - Safety requirements	Federal standards and rules	EC
Safety insuring in nuclear material transportation	Safety guide	EC
Accounting of external impacts of natural and man-caused origin on nuclear and radiation hazardous facilities	Federal standards and rules	EC
General provisions on ensuring nuclear fuel cycle facility safety	Federal standards and rules	Russia
Safety rules for transportation of radioactive materials	Federal standards and rules	Russia
Requirements for the quality assurance program for nuclear fuel cycle facilities	Federal standards and rules	Russia
Safety in radioactive waste management- General provisions	Federal standards and rules	EC
Collection, reprocessing, conditioning and storage of liquid radioactive waste - Safety requirements	Federal standards and rules	Russia
Collection, reprocessing, conditioning and storage of solid radioactive waste - Safety requirements	Federal standards and rules	Russia
Gaseous radioactive waste management - Safety requirements	Federal standards and rules	Russia
General Safety Rules for Nuclear Fuel Cycle Facilities (revision)	Federal standards and rules	DOE
Regulations on layout and safe operation of fuel cycle facility equipment and pipelines	Federal standards and rules	DOE
Designing and manufacturing Mox fuel elements and Mox fuel assemblies	Safety guide	DOE
Requirements for the content of the safety justification report of nuclear material storage facilities	Federal standards and rules	EC
Location of storage facilities for nuclear materials, radioactive substances and radioactive waste - Safety requirements	Federal standards and rules	EC
Radioactive waste disposal - Safety requirements	Federal standards and rules	EC
Near surface disposal of radioactive waste - Safety requirements	Federal standards and rules	EC
Disposal of liquid radioactive waste in geological formations - Safety requirements	Federal standards and rules	Russia
Dry storage facilities for spent nuclear fuel - Safety requirements	Federal standards and rules	Russia
Standard plan of measures to protect workers in case of an accident at a nuclear fuel cycle facility.	Federal standards and rules	EC

Provisions on the procedure of emergency situation announcement, efficient transmission of information and emergency assistance to NPPs in case of radiation hazardous situations	Federal standards and rules	EC
Nuclear safety rules of the NPP	Federal standards and rules	DOE
Requirements for the content of the safety justification report for NPPs with WWER reactors (addition related to Mox fuel)	Federal standards and rules	EC
Requirements for the content of the safety justification report for NPPs with fast breeder reactors (addition related to Mox fuel)	Federal standards and rules	EC
Accounting for and control of nuclear materials	Federal standards and rules	Russia
Organisational requirements for material balance areas in operating organizations at nuclear installations and nuclear material storage facilities	Federal standards and rules	Russia
Physical protection regulations of the radiation sources, storage facilities, radioactive substances.	Federal standards and rules	Russia
Addition to the regulations on radiation control. Methodical instructions		DOE
Addition to sanitary rules for NPP design and operation	Federal standards and rules	DOE
Control over personnel and population exposure rates	Health standards	DOE
Fire safety of the Mox fuel fabrication processes – Technical analysis and safety criteria	Federal standards and rules	EC
Fire safety standards for design and operation of fuel cycle facilities	Federal standards and rules	EC