D.6.4. ADS PROGRAM IN THE CZECH REPUBLIC

D.6.4.1 APPROACHES TO A NATIONAL ADS PROGRAM IN THE CZECH REPUBLIC

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D.6.4.1.1. NUCLEAR ENERGY IN THE CZECH REPUBLIC

The Czech Republic is a highly developed industrial country with a dense population.The country is very poor in conventional energy resources: hydroenergy - fully exploited - provides less than 3% of the total electricity production; fossil reserves are reduced to coal only, most of it being low quality and sulphur rich brown coal and lignites. Its use for electricity production caused, and still causes, heavy environmental damage especially in the northern part of the Czech republic which is internationally declared to be an ecological disaster region. The atmospheric pollution caused by coal power stations is causing grave concerns even in the neighboring countries. At the end of the eighties, Czechoslovakia, having a population of about 0.3% of the total world population, was burning app.10% of the total world production of lignites. At the beginning of the nineties, about 90% of Czechoslovakia's oil and natural gas were imported from the former USSR i.e. from abroad, making the country's economics very vulnerable and dependent.

The Czech republic had considerable reserves of Uranium ores. Although a large part of it was exploited between 1945 and the seventies, a reasonable amount of Uranium ore is still available.

These are the main reasons why the Czech Republic decided to build several nuclear power stations. Four of them, Russian designed VVER-440 (V-213) reactors have been in operation at Dukovany since the middle of eighties. Two additional reactors, VVER-1000, are near to completion in Temelín, South Bohemia.

The completion of the Temelín nuclear power plant initiated hectic discussions both at the national and international levels. Although the VVER-1000 is the most modern russian designed NPP, provided with a very solid containment, additional significant steps were undertaken to increase its safety standards. The American company Westinghouse is in charge of further modernization the NPP, providing modern instrumentation and control system and newly designed fuel elements.

D.6.4.1.2. SPENT FUEL MANAGEMENT

Until 1986 the spent fuel did not present any problems since the country manufacturing the fuel - i.e. the USSR - had a contract obligation to take care of it. Since the end of 1991a Russian Federation law prohibits the acceptance of spent fuel from abroad, so the Soviet/Russian option for handling of the spent fuel has been out of the question.

This is why the Czech Republic since 1992 has had to reconsider the whole problem of the spent fuel waste. The Czech energy board tried unsuccessfully to negotiate the storage of spent fuel abroad in Germany, Italy, Finland, Belgium and Sweden - i.e. in countries with spare storage capacity. After rejecting

the reprocessing option, the only remaining solution was to build both an interim and a final repository in the Czech republic. Due to considerable public opposition, spent fuel management has become a serious political problem in the Czech republic during the last couple of years. According to present political plans, the final underground repository should not be opened before 2050-2070; therefore enough time exists for a thorough investigation of alternative solutions.

D.6.4.1.3. THE 1994 AND 1995 LIBLICE SYMPOSIUM

The above are, in brief the reasons why the new ideas presented on the Los Alamos ATW project and by the Rubbia energy amplifier project met a positive response not only in political quarters but also in the nuclear power industry and utilities. Even the mass-media reacted positively and published several reports about the Los Alamos project.

In 1994 the Ministry of Industry and Commerce asked a group of Czech scientists to prepare a preliminary study on projects dealing with accelerator driven nuclear reactors and nuclear waste transmutation. The study has been completed in the spring of 1994 and published in Czech [1].

The Initiative Group for the accelerator driven transmutation of waste was set up in September 1993. Its activities were financially supported by the Czech Energy Board (ČEZ), Czech Ministry of Industry and Commerce and the ŠKoda industrial group.

This financial support has allowed small symposiums to be convened on June 27-29, 1994 and then on September 1995 at the Liblice castle near Prague on accelerator driven reactors and nuclear waste management projects in the Czech Republic [2].

The symposiums met with a considerable interest from Czech scientists and nuclear engineers. Over 40 people, including several scientists from Sweden, the U.S., Slovakia and Russia, took part in its work and around 20 papers, covering different aspects of this problem and reporting related activities in the Czech republic were presented. The participation of a group of engineers from ŠKODA NM Ltd who presented several papers was encouriging, showing that these new ideas are seriously discussed and studied in the industry.

The Liblice symposiums reviewed the competencies of Czech scientists and engineers in the field of accelerator driven reactor and transmuters. Many interesting proposals and topics were presented at the symposium [3].

In the spring of 1995, the Iniative Group presented another more detailed and complex study to the Czech Ministry of Industry and Commerce under the title "Possibilities of incineration of spent fuel and radioactive wastes by new methods" [4].

The nuclear program was initiated in the former Czechoslovakia in the late fifties. Since then Czech and Slovak scientists and engineers and the nuclear industry gained considerable experience in nuclear science and technology:

(1) several accelerators, research and experimental reactors were successfully operated for several decades;

(2) considerable experience was also gained in the field of hot chemistry - separation, partitioning and solidification;

(3) jointly with Russian specialists, a new type of nuclear power reactor was designed, constructed and operated between 1972-1977. The nuclear power station, called A1, had a graphite moderated gas-cooled (CO_2) reactor using natural Uranium with a designed net electrical output of 150 MW_e;

(4) the Škoda nuclear engineering factory produced 14 NPP, twelve of them with VVER 440 power reactor units with modernized design and two with VVER-1000 reactors.

The Liblice symposiums allowed assessment of both the interest and the competences available in the Czech republic for the transmutation projects. The main centers in the Czech Republic which possess

know-how and competence for the future accelerator driven systems and transmutation studies are described here:

Nuclear Research Institute, Řež [1]:

Two research reactors (LVR-15 for material testing and LR-0 developed for testing cores of the VVER reactors)

Research reactor department.

Division of reactor physics.

Division of radiation chemistry (hot cells).,

Division of fuel cycle.

Division of metallurgy of Uranium and of reactor materials, .

Institute of Nuclear Physics, Řež near Prague:

Cyclotron (U120M, energy for protons 36 MeV, alpha-particles 40 MeV)

Van de Graaf (protons 2-5 MeV).

Accelerator department.

Department of Nuclear reactions.

Department of Nuclear spectroscopy.

Collaboration with the Joint Institute for Nuclear studies in Dubna, Russia and access to its facilities.

Institute of Special Inorganic Chemistry, Řež

Partition, extraction, solidification etc.

Institute of Physics, Czech Academy of Sciences, Prague

High Energy physics, detectors.

Collaboration with CERN.

Faculty of Mathematics and Physics and Faculty of Nuclear Physics and Engineering, Prague

Experimental reactor VR-1

Nuclear Physics

High Energy Physics

Dosimetry

Nuclear Chemistry

Neutron Physics,

Reactor Engineering.

Reactor Safety.

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[1] Nuclear Research Institute originally belonged to the Czechoslovak Academy of Sciences, and later to the Czechoslovak Atomic Energy Commission. It was privatized in 1993.

Škoda Nuclear Machinery Co, Plzeň.

This company has built 14 reactors (12 VVER 440, 2 VVER 1000), many testing loops, transport and storage casks for spent fuel and performed reactor safety studies.

Institute of Thermomechanics, Czech Academy of Sciences, Prague:

Fluid dynamics

Thermodynamics

Dynamic fracture and impact problems

Vibrations

Institute of Nuclear Fuel, Zbraslav

Encapsulation of nuclear fuel

The Liblice symposiums and numerous discussions after it concluded that the Czech ADS program will deal with the following topics:

- Review of the present knowledge on feasibility of transmutation of actinides and fission products
- Investigation of nuclear processes in a spallation target hit by a high energy particle beam. Determination of optimal target-projectile combination(s).
- Specific problems of transmutation of long-living nuclides and neutron economics. Photonuclear reactions.
- Studies of subcritical systems, their geometry and their static and dynamic behaviour. Control of such systems.
- Trends in development of separation techniques. Dicarbollides Extraction and Sorption. Assessment of approaches developed in other countries.
- Studies on technical and economical efficiency of subcritical systems.
- Studies of thermodynamical processes in subcritical systems.
- Studies of suitable materials for the most exposed parts of subcritical systems.
- Feasibility studies of the application of an ADS in the framework of the national nuclear power program conditions and Škoda's own nuclear power technology manufacturing tradition.

The 1994 and 1995 Liblice symposiums concluded that the Czech Republic has significant theoretical, experimental and engineering potential and know-how in several fields important for the rapid development at accelerator driven systems.

Reflecting the strong interest of Czech scientists and engineers and the favorable attitude of Czech industry and Czech policy makers it was decided to establish an information and coordination center, based at the Institute of Nuclear Physics in Prague. The main task of this Center will be the formulation and coordination of national policy in this field. The center will also collect information about the development of transmutation technologies and assist in establishing contacts and collaboration with similar centres abroad.

The interest and financial support for this initiative group both from the Czech Energy Board and Škoda company and the interest shown to these programs by the Ministry of Industry and Commerce is noted as positive and promising.

6.3.1.4. INDUSTRIAL PARTNERSHIP

Being one of the first European industrial companies traditionally involved in nuclear power technology manufacturing, Škoda Nuclear Machinery (NM), Ltd. started the first feasibility studies of the application of an ADS in the framework of the national nuclear power program conditions and its own nuclear power technology manufacturing tradition [3,5-8].

Škoda NM decided to concentrate on the LANL liquid fuel (molten salt) concept of the blanket with an accelerator concept adjusted to the applicability of the redundance principle (modular system). For example: Several accelerators of lower power could be employed. The use of their integrated proton beams to bombard the lead target will not only raise the strength of the neutron source but will play one of the most significant roles of the above mentioned modular systems:

One of the accelerators can be used as a spare in case of e.g. malfunction of one of the other machines, periodic maintenance and inspection, etc. A concept that assumes accelerated proton beams bombarding several different targets in various reactor/blanket units also seems to be feasible for the Škoda NM designers.

The first results of the study mention a series of engineering problems in the area of materials and their degradation in the fields of intensive high energy particles, both charged and neutrons. The problem of the window and its life time, the problem of the target and others are proposed to be solved by the already mentioned modular system principle. The proton channel section, including the window, will be designed as remotely replaceable, by a vacuum preservation at an optimal level and by a proton channel contamination prevention. A replaceable window design solution has been proposed as well with the design of a proton channel closing valve and a quick-operating valve for a window break emergency event.

The obviously high level of complexity, and thus also the price, of such systems produces a need to accelerate the procedure to reduce the number of options and to go rather into more detailed system design and engineering in order to reach a realistic technological and economical image of the concept and project itself.

D.6.4.1.5. CONCLUSIONS

Czech scientists and engineers are fully aware of the fact that the accelerator driven transmutation and reactors are projects which are too large to be handled individually by small European nations. Scientists and engineers from the Czech republic consider therefore that a large scale international collaboration is an essential condition for further progress in this important and promising project and would welcome a creation of an international coordination body as the first step. In a more - but not too - distant perspective also the creation of an international institute, laboratory or center specializing in accelerator driven transmutation and energy production is desirable and will be supported by Czech specialists.

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