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MEMORANDUM FOR: Leland C. Rouse, Chief
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety

FROM: John P. Roberts, Section Leader
Irradiated Fuel Section
Fuel Cycle Safety Branch
Division of Industrial and
Medical Nuclear Safety
Office of Nuclear Material Safety
and Safeguards

SUBJECT: MEETING OF THE NUCLEAR ENERGY AGENCY/COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS (NEA/CSNI) FUEL CYCLE SAFETY WORKING GROUP (FCSWG)

DATE/TIME: September 11-12, 1989; 10 a.m

LOCATION: NEA Headquarters, 2 Rue Andre, Paris, France

ATTENDEES: See Enclosure 1

PURPOSE: Regular meeting of the FCSWG to discuss fuel cycle development

SUMMARY:

The working group members introduced themselves, adopted the meeting agenda and approved the summary record of the group's 1987 meeting. Members from each country discussed evolution of, and operating experience and incidents in their fuel cycle facilities. The Chairman and Secretary discussed their participation in the International Symposium on Fire Protection and Fire Fighting in Nuclear Installations. I then made a presentation on the Nuclear Fuel Cycle Facility Accident Analysis Handbook (NUREG-1320)--noting the additional work continuing on UF_6 release and transmission, which will be published as a supplement to NUREG-1320.

There was a general discussion on containment in fuel cycle facilities. The Japanese are active in experimental work on filter response in accidents and in calculational modeling. Their work is associated with reprocessing and enrichment facilities proposed for the Rokkasho-mura site in Aomori Prefecture.

The working group proceeded to discuss the effort needed to revise the report on the Safety of the Nuclear Fuel Cycle (CSNI-SOAR No. 3) published in 1981. The members agreed on the need for a full revision of the report. Comments on needed areas of revision (including additions) were requested to be sent to the Secretariat by December 15, 1989. A group of consultants will then proceed to work on revising the report. The Federal Republic of Germany, France, the United Kingdom, and Japan will supply consultants. The Nuclear Energy Agency

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will cover travel and hotel expenses for the consultants during meetings at NEA headquarters in Paris. NEA will also supply facilities, typing, reproduction, etc., to the consultants.

The FCSWG discussed topics for a specialists meeting. The topic selected was Safety and Risk Assessment in Fuel Cycle Facilities. Japan has offered to host the meeting in September or October 1991 at a site accessible to the planned Rokkasho-mura facilities' site.

The next regular meeting was discussed. Emphasis will be on the drafted revision to the Safety of the Nuclear Fuel Cycle report. The next FCSWG meeting will be held in September 1990.

DISCUSSION:

After initial introduction of working group members (see Enclosure 1), The meeting was opened by the Chairman Dr. Baetsle with the proposal that the agenda for the meeting be adopted unless modifications were requested. The group agreed to adopt the agenda without change. The summary record of the working group's 1987 meeting was also adopted without objection. The group then moved on to new business addressing as its next item, presentations by the representatives of the various countries present. The representative of the Federal Republic of Germany (FRG) led off with a frank discussion of the impacts of the termination of the Wachersdorf reprocessing plant, the status in the FRG of the NUKEM and Transnuklear firms, the shutdown of all reprocessing including demonstration activities, and the lack of new nuclear reactor plant orders in the FRG. The impacts of these various actions have resulted in the movement of personnel to other work (in some cases of a non-nuclear nature); employment termination; and, for areas affected, plans for new efforts to restore local economies. Reprocessing of FRG spent fuel will be performed by COGEMA in France. Radioactive waste transportation will be handled by the German railway companies. The most highly qualified staff will be retained and diverted to new reactor design work by Siemens. The Karlsruhe Research Institute is expected to keep 100-150 people. At the Julich Research Institute, some staff will be included in high level waste repository work.

One incident concerning a minor UO_2 release (one-sixth the licensed amount) at the Hanau fuel fabrication facility was mentioned. A combination of unusually high ambient temperature and humidity conditions led to condensation of water in filters which reduced filter decontamination factors. Measures taken to avoid this in the future involved installation of humidity sensors.

Two Belgian representatives spoke. The first, Henri Meyers, discussed the activities of Deutsche Gesellschaft fur Wiederaufarbeitung von Kernbrennstoffen, mbH, (DWK) and Eurochemique in completing processing of high-and intermediate-level wastes from reprocessing. Some 2,000 drums of vitrified, high-level waste and 12,000 drums of intermediate-bituminized waste exist, along with about 30 canisters of concrete incorporated with solid, intermediate level (filters, resins) waste. This activity is expected to be completed in 1993 or 1994. One incident of a fire in bituminized, intermediate level waste occurred in 1981. This was due to an exothermic reaction when the liquified waste was converted to salts in the bitumin. A temperature of more than 300°C was reached initiating a fire. Procedures including sampling were introduced to eliminate this problem.

Herwig de Canck of Belgonucleaire then discussed the fabrication of mixed oxide (MOX) fuel in Belgium and the problems which can be expected due to increased thermal recycling of plutonium (Pu). As the isotopic compositions of Pu change, increased neutron and alpha emission and heat generation can be expected. Improved neutron shielding and dosimeters will be needed. Glove box problems have already been observed. Air in glove boxes is converted to ozone by alphas emitted. This affects neoprene in glove box gloves. Measures to address this problem include coating of gloves and use antioxidants in glove material and replacement of air by nitrogen which also aids in fire protection. Also additional gamma shielding in glove boxes is expected to be needed because of low energy gamma emission from increased isotopic presence of Am-241.

At this point, G. Donald McPherson joined the meeting. As a division director, he has responsibility for our group and two others. He recently joined NEA from the USNRC. There is now support within CSNI for a more active FCSWG. Consequently, the regular meeting schedule is being changed from once every two years to annually. CSNI would welcome proposals for new activities from the group. He suggested that one possible item for the group's consideration as a proposed activity might involve study of the recently released report by the Soviet Union on the accident at Krystym involving reprocessing wastes.

It appears that the response by NRC and other national representatives at the CSNI meeting to calls in 1987 for cutbacks (due to budgetary restrictions) on FCSWG activities has resulted in a positive attitude toward the importance of the fuel cycle and the FCSWG's role. As the NRC representative, I provided copies of the last issue of the NMSS Newsletter (June 1989). I noted the RSI capsule failure, reported and pointed out other items in the Newsletter. I also provided bilingual (French and English) copies of the summary of Cynthia Jones' Canadian presentation on thermal neutron activition device development for explosives detection for aircraft luggage, and copies of the Federal Register Notice of the environmental assessment and finding of no significant impact. I noted expected early use of the device in New York, London, and Paris airports. I briefly described the proposed rule amending Part 72 for a general license for dry spent fuel storage at reactor sites in preapproved casks, and the NRC copies of the press release and the FRN for the proposed rulemaking were distributied. I mentioned the new enrichment facility proposed to be located in Louisiana providing copies of the press release on this. Finally, I mentioned the 1990 American Society for Mechanical Engineering (ASME) Pressure Vessels and Piping Conference which will have an international technical session on storage of radioactive materials--especially spent fuel. I supplied copies of a call for papers for the conference, which is to be held in Nashville, Tennessee, June 17-21, 1990.

The French representative discussed four incidents. A forest fire occurred near the Cadarache facility this August. It threatened the facility from August 2-4th. Note the forest is cleared back from the Cadarache facility only about 15 meters. In March 1988, leakage occurred of a radioactive liquid through a ceiling into a cell below. It resulted from corrosion of a chemical reactor. No serious consequences occurred. A large number of personnel received about 8 man-rem with the maximum individual dose being 100 millrem. The chemical reactor was redesigned and then further modified to avoid future problems. The third incident in March 1989 concerned interruption of electrical power at La Hague due to water infiltration in a relay resulting in a short circuit. A design flaw was recognized in that there was not sufficient power system independence to ensure the second power line would provide continued electricity. The design has been modified to avoid a common mode failure. The fourth incident involved a hydrogen supply fire triggered by a lightening strike near a facility. Other than the fire itself, there were no consequences. However, consideration of placement of hazardous materials near a facility and design details were reconsidered.

The Italian representative indicated a general retrenchment of Italian nuclear activities. Reactor plants are being shutdown. Those in construction are being cancelled and in one case converted to fossil fuel. Research and development is being cut. Probably all laboratories doing work related to reprocessing will be closed. Environmental laboratories will likely continue to operate.

The Japanese representatives discussed a number of activities. The reprocessing plant proposed to be located at Rokkasho - mura in Amori Prefecture was discussed. A license application was filed in March 1989. The Japanese are concerned about public opinion. In this context, the German cancellation of Wachersdorf is not considered helpful. An upper house candidate for the Japanese legislature from Amori who opposes the reprocessing facility has been elected. Japanese policy on use of MOX fuel in LWRs was described as firm. However, they are sensitive to the need for public acceptance of this policy. Small demonstrations of use of MOX fuel in LWRs will be carried out before full reload of one third or one fourth of a core is attempted. A demonstration reactor near Rokkasho-mura is being planned. Siting for it is under review. The Rokkasho reprocessing plant is being designed to withstand aircraft crash. An actual test using an F4 Phantom jet at a velocity of 250 m/s against a rigid concrete block was conducted on April 8, 1988, at Sandia National Laboratory. Rokkasho plant walls will be 1-1.5 meters thick reenforced concrete.

The design dose limit used in this hypothetical crash is 500 mrem. Under questioning, the Japanese indicated that this was not the usual facility accident dose requirement. Construction cost for the reprocessing plant is projected at 800 billion yen (about $3.3 billion). There is litigation in the Rokkasho facility license application case.

Associated with Rokkasho will be a uranium enrichment facility with a final capacity of 1500 SWU and a low level waste burial facility with a final capacity of $6X10^5m^3$. Applications were made for these facilities in 1988. Along with discussion of fuel cycle activities and public perception concerns, the Japanese noted that they are attempting to develop and maintain a comprehensive data base on accidents and failure occurrences for nuclear fuel cycle facilities and to explain to the public the relative seriousness of such. The French are also trying to educate the public on occurrences and their relative severity also. Beyond this work, the Japanese discussed efforts relative to radioactive material confinement, ventilation, HEPA filter integrity during fires, and experiment versus modeling of filter efficiency in a fire event. There was general discussion of modeling using the FIRIN and FIRAC codes and filter decontamination factors in laboratory experiments versus in-plant.

The representative from Holland had little to report noting that a new government was coming to power and policy directions were unclear.

The representatives from the United Kingdom (UK) were from the Atomic Energy Authority (AEA) and the Nuclear Installations Inspectorate (NII). The AEA member spoke first, noting the upcoming privatization of electric power in the UK. Under this program, at least 20 percent of power generated will continue to be nuclear. However, the future of fast breeder reactor (FBR) development is uncertain, and it seems likely to be terminated for lack of private utility funding. The Dounreay FBR is expected to shutdown in 1994-1995.

He also discussed the need for correct training, noting two minor incidents, fuel and cask drops, which resulted in no releases but showed failures in training. In February 1989, a major power failure at Dounreay (14-hours length) led to the fuel cycle plant's going on emergency power. Nothing occurred, that is, no releases, but again lessons were learned. Battery power backup for stack monitors was unsatisfactory. In analytical laboratories and glove boxes, pressure differentials were not maintained. Pressures came to equilibration points with, in at least one box, slight positive pressure observed.

The NII member also discussed the privatization process noting uncertainty on who will get and operate older MAGNOX plants. On the other hand, the privitization initiative has resulted in provision of funds for decommissioning. Decommissioning of older areas of Sellafield has started. Another result of privatization is that AEA sites will be licensed by NII. NII is expanding rapidly to meet new tasks. From a staff of 100 two years ago, it is up to a staff of 160.

Auditing of activities at British Nuclear Fuels Limited (BNFL) Sellafield was discussed. For this complex of plants, BNFL has produced safety cases (safety analysis reports). BNFL has expended 60 man-years/year to produced its safety cases (398 man-years in total). Plant drawings have been updated and risks quantified. Nothing of great safety significance has been discovered. However, there is a firmer basis for safety, and improved plant personnel concern for safety. Completion of all safety cases by BNFL is scheduled by 1991. Actinide content of sea discharges is to be reduced by 1992.

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Future activities at Dounreay and Sellafield may involve high-level waste disposal. Six-inch diameter holes are being drilled at both sites to obtain geological data to determine if they would be suitable sites for a high level waste repository.

The Swedish representative discussed fuel fabrication plant failures, which resulted in material spills in the plant, and reassessment and redesign of parts of the plant.

The International Symposium on Fire Protection and Fire Fighting was discussed by Chairman Baetsle and the FCSWG Secretary George Ishack, both of whom presented papers at the symposium. There were 175 attendees at the Symposium (February 27-March 3, 1989), and a book of the 50 papers presented has been published by the International Atomic Energy Agency.

I made a presentation (see Enclosure 2) on the Nuclear Fuel Cycle Facility Accident Analysis Handbook (NUREG-1320) (AAH). I also discussed work involving UF_6 releases nearing completion to supplement the handbook. This effort, which is being managed by Peter Loysen, will result in publication in 1989 of two NUREG reports, Calculational Measures for the Analysis of UF_6 Releases, Supplement 1 (NUREG/CR-4360, Supp.1) and the AAH Supplement 1 (NUREG-1320, Supp. 1). The AAH supplement is formatted in the same manner as the AAH with discussion of the codes available for UF_6 release and transmission and sample problems. The codes which can be run on a personal computer, are being made generally available through the National Energy Software Center at Argonne National Laboratory.

A discussion on containment in nuclear fuel cycle facilities proceeded with comparison of fuel cycle facilities versus reactor facilities. Japanese representatives discussed experiments and calculational modeling work related to HEPA filters in fire accidents. There was discussion on the conditions of experiments and HEPA filter decontamination factors observed versus in-plant conditions and experience. Codes development and existing codes used in modeling were also discussed.

The next item on the working group's agenda was the update of the 1981 report, Safety of the Nuclear Fuel Cycle (CSNI -SOAR No. 3), the Red Book. Support was strong in the group for a general rewrite of the report to reflect significant developments in the fuel cycle over the last decade. Chairman Baetsle provided a set of comments on sections of the report requiring changes (see Enclosure 3). The group agreed that each member would provide similar comment to the Secretariat by December 15, 1989. A small group of consultants will then meet to plan and subsequently execute the revision of the report. Japan, the UK, the FRG, and France agreed to participate in the process by supplying consultants. Japan indicated that its support would be by long-distance for the most part through correspondence. The schedule for the revision is 3-6 months to agree on revisions, 2 months to rewrite with a new report for the working group's consideration by next year's meeting. United States participation in this work would also be welcome (In some areas, such as

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dry spent fuel storage and possibly enrichment, we may wish to provide some material). Don McPherson noted that NEA, while it cannot cover consultant fees for this effort, will cover travel and hotel costs. George Ishack, the FCSWG Secretary, stated that facilities and typing, reproduction, etc., would be supplied by NEA at headquarters for consultants meetings.

The group chose Safety and Risk Assessment in Fuel Cycle Facilities as the Topic of the next Specialists' Meeting. Japan volunteered to host the meeting in 1991. It will be held in a site accessible to the planned Rokkasho-mura reprocessing facility in September or October 1991.

Planning for the next regular working meeting in September 1990 was discussed. Emphasis will be on the revision of Safety of the Nuclear Fuel Cycle report which is to be available for review by then.

The meeting adjourned.

Original Signed by
John P. Roberts

John P. Roberts, Section Leader
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Fuel Cycle Safety Branch
Division of Industrial and
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Office of Nuclear Material Safety
and Safeguards

Enclosures:
1) Attendance List
2) AAH Presentation
3) Suggestions for Updating

cc: R. Bernero
G. Arlotto
R. Cunningham
G. Sjoblom
R. Hauber

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ATTENDANCE LISTING

SEPTEMBER 11-12, 1989, FUEL CYCLE SAFETY WORKING GROUP MEETING

NAME	ORGANIZATION
Richard Olsson	Swedish Nuclear Power Inspectorate
Brian Spoonley	HM Nuclear Installation Inspectorate
Mike Brown	SRD, UKAEA
Adrian Van Dalen	ECN Research Center
Masahi Kanamori	Safety Division, PNC
Katsuyoshi Omori	Nuclear Fuel Material Regulation Division, of Science & Technology Agency
Takeshi Tsuiino	Office of Planning, JAERI
Tadamasa Yamazaki	Technical Administration Dept. Japan Nuclear Fuel Service Co. Ltd.
Mario Guidotti	ENEA, Fuel Cycle Department
Hubert Bastien Tuiry	Cogema Reprocessing Branch
Jacques Prospert	Service Central de Surete de Installation
Hugues Auchere	CEA/IPSN Fontenay Aux-Roses (FRANCE)
John P. Roberts	U.S. Nuclear Regulatory Commission Fuel Cycle Safety Branch
G. Donald McPherson	NEA, Nuclear Safety Division
Herwig De Canck	Belgonucleaire
Henri Meyers	Belgoprocess
Lothar Sutterlin	Gesellschaft fur Reaktorsicherheit

ENCLOSURE 1

NUCLEAR FUEL CYCLE FACILITY ACCIDENT ANALYSIS HANDBOOK (NUREG-1320)

ENCLOSURE 2

PURPOSE:

To Develop Improved Methods of Evaluating the Consequences of Major Accidents in Fuel Cycle Facilities

SCOPE:

COVERS 4 GENERIC FACILITIES:

- Fuel Manufacturing
- Fuel Reprocessing
- Waste Storage/Solidification
- Spent Fuel Storage

SCOPE:

COVERS 6 ACCIDENT TYPES:

- Fire
- Explosion
- Tornado
- Criticality
- Spill
- Equipment Failure

RANGE:

Accident Types Considered to Make Major Contributions to Radiological Risks from Accidents in Nuclear Fuel Cycle Facility Operations

USEFULNESS:

Enables User to Calculate Source Term Releases from Accident Scenarios Manually or by Computer Accident Sample Problems (Chapters 2 & 3) Source Term Analysis Methods (Chapter 4) Transport Computer Codes (Chapter 5)

APPLICATION:

Facility Description (Chapter 2)

Processes (Chapter 3)

Scenario and Radioactive Source Terms (Chapter 4)

Mass, Energy and Material Transport Calculation (Chapter 5)

RESULTS:

DETERMINATION OF RELEASES FROM FACILITIES

Limitations:

- No Transport Beyond Facility
- No Health Physics Calculation for Population
- No Probalistic Risk Assessment

S.C.K./C.E.N.

Mol, August 29, 1989
LB/jv-N.89.53

SAFETY OF THE FUEL CYCLE

Suggestions for updating of the May 1981 document

I. Introduction

Purpose

4 * Addition of recent developments in the field of risk assessment and external hazards.

* Inclusion of specific safety aspects related to the construction of large industrial plants (FR, UK, JAP).

Scope and content

7 * Information resulting from recent public inquiries and/or governmental hearings have to be included in the report to provide an up to date picture of the situation in the nuclear fuel cycle.

* Safety aspects associated with the handling of Waste materials during the processing steps, the interim storage and the disposal operations.

II. Nuclear Fuel Cycle

Introduction

8 * Description of alternative fuel cycles is limited to a sketchy treatment for reasons of lack of industrial maturity.

9 * Addition for long term spent fuel storage.

* Radioactive waste management (limited to operational safety considerations).

14 * Would it be appropriate to add a more extended discussion on the fuel cycle aspects of the Gas Cooled Reactor and Advanced Gas Cooled Reactor ?

ENCLOSURE 3

Status of various fuel cycle segments :

16 * Uranium mining and milling.
The problem of ^{222}Rn has drawn the attention on all sources of this radioactive gas and mill tailings are increasingly subject to public inquiries and criticism (CN, US).

18 * Recovery of U from phosphate fertilizer production entered into an early industrial practice (B).

19 * Making of this paragraph up to date with regard to its technology is commendable.

20 * EURODIF is now a mature processer of enriched U.

21 * Gascentrifuge process : Almelo, Winfrith,... (UK, FRG, USA, NL).

23 * Laser enrichment of U and Pu to be mentioned as a new venture with great future (USA).

Status of Chemical enrichment (FR, JAP).

24 * World capacity in the different technologies to be reassessed.

26 * Metal fuelled reactors - (MTR's ?).
- Gaz graphite.

28-30
* On fig. II4 There is no mention of Dirty Reject Oxides which are nonetheless important waste materials to be stored for long periods.

35 * Carbo-nitride fuel to be mentioned.

38 * The use of neutron absorbing racks to increase storage capacity is to be mentioned.

39-40
* Amplification of the wet and dry storage facilities during the last decade and its expected upscaling should be reflected in the text.

Head end processes

42 * Adaptation to present French/UK/JAP technology

- mechanical cutting
- dissolver
- clarification

43 * Alternative methods have only a historical significance.

45 * Additional efforts have been made to reduce the salt content in the waste solutions by using salt free reagents. (These products display a certain chemical instability which can lead to local explosion or pressure excursions). (FRG, FR).

* Adaptation of PUREX flowsheet if necessary.

46 * No further comments (drop).

Uranium and Plutonium concentration and storage

Radioactive Waste Management

- HLW
- Hulls
- Lower activity wastes stored or discharged into the enviroment. Review of validity of Table 3 Annex I (p. 109).

54 * The reversal in the expected trend concerning the release of gaseous fission products must be explained as a consequence of global dose calculation which showed that only ^{129}I has to be retained. The capture of ^{85}Kr has been abandoned in France and UK and the ^{3}T retention has not been considered as a necessity because all reprocessing plants discharge into sea bodies.

55 * High level liquid waste vitrification has shown important developments.

- industrialisation of the vitrification process according to the french process
- development on pilot scale and exploitation of hot pilots (PAMELA & BATTELLE N.W.) using the Joule heating process
- SYNROC stayed as a laboratory option.

56 * Transportation takes place as well as liquids or as solids.

* Safety measures are taken to avoid accidental dispersion of radioactivity during road transport (container development). World wide shipping of fuel elements has entered into industrial practice (JAP, UK).

* The construction of geologic disposal facilities which are not situated at the reprocessing site require extensive transport activities. The shipping of waste materials from a central reprocessing plant (UP3, THORP,...) to different client countries necessitate also extensive transportation activities.

Decommissioning

59 * Decommissioning of fuel cycle facilities has entered into a practical phase with the decommissioning of the EUROCHEMIC plant in Belgium and several hot activity plants throughout the world (PIVER, Marcoule. The decision of the USDoE to decommission certain large fuel cycle facilities (BATTELLE N.W., MOUND LAB.,...) will increase that venture in an accelerated fashion throughout the world. More regulations and working practices should be issued. (CEC programme) (IAEA ?).

PRESENT & PROPOSED FUEL CYCLE FACILITIES

* Prepare a comprehensive table with the existing and decided facilities :

    · Enrichment & conversion plants
    · Reprocessing plants
    · Fuel fabrication plants
    · Waste vitrification and hulls conditioning plants
    · Dry/wet storage facilities
    · Transportation park

III. Nuclear Fuel Cycle Hazards

61 * Introduction

Subdivide into * internal hazards - (fire
(explosion
(contamination - radiation
(criticality
* external hazards - seismic events
- extreme weather conditions
- flooding
- aircraft crash

Nature of Nuclear Fuel Cycle Hazards

62 * Superposition of chemical, mechanical and nuclear hazards leads to a very specific hazard potential which has to be accounted for in designing the facilities, in order to protect man and its environment. The conventional (internal as well as external) and nuclear hazards are inter related in the Nuclear Fuel Cycle. Some of them e.g. seismic events can initiate umbrella effects.

83 * Operator Error

Full automation of nuclear fuel plants has decreased the influence of operator errors drastically. But the consequences of the errors if they occur become more important due to upscaling of most fuel cycle plants.
The redundancy of monitoring equipment and the computer controlled operation have drastically improved the operational safety of fuel cycle facilities.

SAFETY PHILOSOPHY

86 * Requirements

- adequate plant design taking into account internal and external hazards, risk assessment of equipment with probabilistic and deterministic analysis
- containment systems under accidental conditions
- appropriate effluent cleanup suited for accidental operation

88 * Combination of 88 and 86 after 87 might be appropriate

97 * "A majour limitation ... is the scarcity of data relevant to conditions in nuclear fuel cycle plants ..."
This issue of the NFC safety report should emphaze the relative scarcity of incidents and explain their causes with experimental and operational data from the period 80-89 (Annex IV).

100 * Some information on assessment of radiological consequences is available - but those listed, date from 1968 - 1973. Updating is indispensable.

101 * Update computer programmes calculating the radiological consequences for the surrounding population.

Safety Assessment and Review procedure

102 - 105

The principles laid out in the document are still applicable but a general discussion should be made on the widespread validity of the described procedure among the countries having important nuclear fuel cycle facilites.

Annex III pp 127 - 131 should be reviewed and updated if necessary

IV. Safety of the Individual Stages of Nuclear Fuel Cycle

A Uranium mining and milling

* Review of Mill Tailings incidents since April 1979

* NEA - working groups on mill tailings (Results ?)
(Reports ?)

B Review of incidents with UF_6 since 1980 -
CSNI meeting 1978 and follow up

* Additional references on safety aspects of UF_5 handling, storage and transportation (1980 - 1989)

* Mont-Louis Accident

133 Updating of the knowledge with regard to reaction products from UF_6 with H_2O - Physical models. Release computer models

138 Updating of safety related work in the form of summary conclusions which have to be amended or completed

C Uranium Enrichment

139 - 141 Updating of safety record till 1989
(last reference 1978) - frequency of incidents
- consequences
- remedial actions

143 One accident took place (Pierrelate)

148 Have criticality accidents in UF_6 facilities been reported ?

D Fuel fabrication

153 UF_6 conversion (Marcoule accident)
Scrap recovery

154 Pu recycling in thermal reactors became a prototype or even an industrial task and has to be taken up in the text with an extensive coverage (< 7% Pu)

161 With the increase of the burnup it is required to have fuels with higher initial U enrichment. Influence on criticality control (U,> 5%)

166 Is there evolution in the safety assessment of fire or explosion hazards in a fuel fabrication plant

- compartimentation
- vicinity of external hazards
- air craft crash

168 The use of kerosene in the dirty scrap recovery process has to be examined from the point of view of fire hazard instead of explosion hazard

171 What additional experience can be gathered on criticality safety of U powder with enrichments higher than 5% and lower than 10%.

173 To what extent has the recycling of reprocessed U given rise to radiological problems (Pu, FP...)

175 * "Fire resistant air filtration systems" requires more elaborate treatment since it is not easy to decide to what extent a fire may coexist with ventilation

* Recent experience with fire resistent filter materials should be addressed in a generic way

176 * Is it still relevant to mention carbide fuel ?

* ^{241}Am should be added to the list of radionuclides increasing the radiological risk to the operating personnel

<u>E</u> Spent fuel storage

<u>179-182</u> Experience - La Hague
- Sellafield

* Storage in AFR facilities are being considered by US and Sweden

* Dry storage in CASTOR containers

191 * The presence of Cs I in irradiated fuel has changed the outlook for Zircalloy corrosion. The conclusion is still correct but it has to be rephrased because Cs and I are not present under elementary form.

<u>Additional Studies</u>

* Storage of Water Reactor Spent fuel in Water Pools
IAEA - Technical Report Series n° 218 (1982)

* * * *

204 A loss of off-site power for longer than a few hours has a very low probability (La Hague, Cadarache,...)

205 I^{129} seems not to cause any problem (15 mCi/Ton) in case of accidental release

210 Influence of loss of coolant on the mechanical stability of the pond structures. Why does the text accept boiling of the pond water as an acceptable event whereas it is admitted that mechanical damage can occur (211) under these circumstances.

F Spent fuel reprocessing

Introduction

219 - 222

* Informations on the operation records of other reprocessing plants could be advantageously added to the present introductory text referring only to BNFL.

* Operational experience in France (La Hague), Marcoule) and Japan (Tokai) ought to be described
  Reference : RECOD (1987) pp 185-203 and 1291-1311.

* Reference should be made to the new design criteria of THORP, UP3 and the Japanese plant.

224 Generally a three barrier system is adopted in the treatment facilities of high activity (equipment, confinement of cells/caves, ventilation)

225 Experience gained in France and Japan should be summarized in a paragraph on dissolver inspection, maintenance and repair

226 Additional information on the influence of external hazards and their implications on the design and construction of reprocessing plants should be developed in this section of the document :

- external hazards (Specialists Group Salamanca)
- fire hazard (Information from Vienna Meeting)

227 Subsurface connection between buildings (e.g. fission product duct between liquid extraction and liquid storage of FP) are mentioned as a weak point. Do the present new designs cope with this difficulty or has it been eliminated by a different design of the plants ?

229-231

* Noble gas removal has been abandoned in the current and newly designed reprocessing plants

* Iodine removal (I^{129}) is based on scrubber type washers and/or solid silver impregnated adsorbers
  Performance records of these systems might be incorporated in this section if it is available.

Specific Accident situations

Fire and explosion hazards :

- Pyrophoricity of Zircaloy powders
- Heating of insoluble residus
- Solvent extraction fire
- Explosion in Pu evaporators
- Use of chemically instable compounds (CH_2O, $N_2H_4^{--}$)
- Presence of hydrogen

Criticality -

Earthquake - (Umbrella effect)

Flooding -

255 Updating of industrial experience

257 Pyrophoricity of Zircalloy - add information from :

- Inst. Chem. Eng. Symp. Ser. n° 97(1987) 143-157
- EUR 11120

260 Fire risk of solvent in a reprocessing plant :

- Conf. on fire hazards Vienna 1989 pp 373-399-431-435
- Interaction of fire & explosion with ventilation in Nuclear Fuel Cycle Facilities. Proc. CSNI Spec. Mtg Los Alamos (1983)

261 Fire resistance of glove boxes for PuO_2 tail end handling

263-268 Areas for further updated
Text must be completely updated
Redefinition of main R&D areas still under investigation

FUTURE TECHNOLOGIES

269 Updating of paragraph required (period 1988-1989)

Fast reactor fuel

- Situation Dounreay
- Construction at Marcoule of pilot plant
- Development in Japan

MOX fuel

- Reprocessing prospects
- Problems associated with recycling
- gamma and neutron dose increase
- ^{241}Am ingrowth - increase of gamma dose
- ^{240}Pu increase of n dose
- ^{238}Pu increase of heat out put

272 * Undissolved residues

- Problem has been partially solved by micronisation of Pu powder and preparation of master blend UO_2 PuO_2
- By using he coprecipitation method a complete solid solution of UO_2 PuO_2 is formed and this product is soluble in HNO_3

* Third phase formation

By adapting the concentration levels of U/Pu and reducing the radiation damage by shortering the contact time red oil formation can be reduced but not eliminated. Explosion danger in evaporators

274 Fluoride Volatility maybe deleted

Plutonium storage

- see Fuel fabrication

G Radioactive Waste Management

286 Updating of HLLW storage tanks - THORP UP3 Japan

300 Follow-up of incidents reported at HLLW tanks (ANNEX IV)
Additional information with causes and remedial actions taken after the incident

301 Loss of Cooling
Alter text according to previous revisions of the text made in 1985-87. Phase 3 and 4 have been omitted

320 Further R&D

- confirmation of low level GH_2 values
- releases in abnormal situations

This area seems to be well established and may be omitted.

321 High Level Waste Solidification

The rather abstract scheme IV 2 might advantageously be replaced by the presently developed schemes.
In order to show the progress which has been made a summary description of the industrial projects and of the RD&D projects might advantageously replace 321-323

AVM - process - industrial experience state of the art. RECOD p 292 (1987)
- safety over the period 1980-89
- projects : construction and exploitation R7, T7

PAMELA - process - experience - state of the art
- safety record 1985-89

RD&D projects PETRA (JRC Ispra), BNWL, JAERI, UKAEA, WEST VALLEY,...

324-325 Safety problems
- Summary of informations (RECOD 87 pp 229 + additional reports)
- Release of radionuclides from AVM, PAMELA etc...
- Basic off gas purification system, DF's
- Malfunctions in design and remedial actions - AVM maintenance
  - PAMELA segregation of metals

328 Areas for further work - to be redrafted

329 Interim storage of Solid High Level Waste

- Pool storage - Dry storage

References : IAEA report TRS n° 229 (1983)
EUR 7340

332 * Maximum temperature of glass (≤ 600°C) to be rediscussed
* Prevention and remedial action to be brought up to date

341-342 Fuel Cladding Waste and Shearing and Dissolution Residues

* Conditioning of Zircalloy and Stainless Steel hulls is performed by embedding into cement - stability
  - radiolysis (H_2)
  - ^3T evolution

* Alternative conditioning methods : - High pressure compaction RECOD 799
  - Melting

Additional reference

- Conditioning and storage of Spent Fuel Elements Hulls EUR-8250(1982)
- Untersuchungen zum brand u. explosions verfahren EUR-11120(1987)
- Zircaloy hazards in nuclear fuel reprocessing Chem. Eng. Symp. Ser. n° 97 (1987) 143-157

Safety considerations

- Pyrophoricity of Zircalloy dust
- Hydrogen generation by radiolysis of concrete
- Tritium escape from compact
- Fissile material (also Pu) associated with leached hulls
- Fire hazard of alternative conditioning methods

Areas for future work

- Conditioning of dissolution residues

Plutonium Contaminated Solid Waste

343-345 Fundamental data are still correct

346 Additional references for Pu waste handling and conditioning

- Acid leaching
- Acid Digestion process   EUR R 8609
- FLK incineration

Areas for future work

* Recycling of Pu in MOX will generate more Pu contaminated materials

* Recycling operations cannot be pushed beyond 2 recycle cycles because the isotopic composition of Pu is too much shifted to higher masses. Only uptake in a fast reactor scenario allows further MOX recycling

Other radioactive wastes and future technologies

350 Low and medium wastes

* Compatibility of Waste form with ultimate disposal technology has to be mentioned as an important requirement

* Waste composition may not influence the nearfield and increase the radionuclide migration (Bitumen, NO_3^-...)

* Bacteriologic decomposition of organic matter containing waste forms, can create large quantities of CO_2 and/or complexing agents

351 The management of gaseous radionuclides has thoroughly changed in the course of the last decade
References : CEC Conference Luxembourg (1985) EUR 10580
Iodine-129 Management (1981) EUR 7953
DOE Gas cleaning conferences

The consequences of this evolution on the industrial practice at the large plants should be underlined

352 Disposal of spent fuel elements

* Extensive studies have been made in Sweden (KBS), FRG and USA. Some elements of the conclusions of each of this individual options might be described

* Several techniques e.g. mechanical dismantling, rebundling of pins, cutting of pins, have already been discussed in the chapter Reprocessing - Head End.

353 Separation of Actinides

The recent revival of this option together with conclusions of the 1980 CEC report and the CASTAING report deserve further discussion whether or not this subject has to be amplified.

354 Decommissioning

* Operating experience in the decommissioning of EUROCHEMIC and PIVER are important practical results which have been obtained.

* General information on the CEC programme on decommissioning is presented in EUR 11715 (1987)
  EUR 12338 (1988)

* Important progress have been achieved in

  - decontamination of glove boxes and concrete surfaces
  - new remotely operated cutting techniques have been developed
  - low level counting of radioactive levels in bulky materials

362 Transport

- Transport by truck
- Transport by train
- Transport by ship

Safety analysis of transportation

- Fire as a consequence of collision
- Damage as a consequence of deraillement
- Implosion of container when accidentally immersed into deep see water
- Special precautions in case of Pu transport

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