ASPECTS OF SAFETY TRANSPORTING LIQUID HIGH ACTIVE WASTE

Martin Lietz
Technischer Ueberwachungsverein Suedwest e.V.
Dept. KS
Dudenstr. 28
D-6800 Mannheim, Germany

ABSTRACT

Aspects of safety and risks in transportation of liquid high active waste concentrate (HAWC) are discussed on the bases of:

- the actual transportation rules in the Federal Republic of Germany
- a comparison between safety systems of stationary stored HAWC and transported HAWC
- a comparison between transportation of spent fuel (solid phase) and of high active waste (liquid phase)
- transports of other radioactive liquids
- the present waste management conceptions.

INTRODUCTION

In 1989 the Federal Republic of Germany has renounced its own way of reprocessing nuclear fuel. As a consequence, the pilot plant for reprocessing nuclear fuel at Karlsruhe Germany (WAK), operating for approximately twenty years, was shut down in 1990. The fission products, as a result of reprocessing are now stored in liquid form in tanks at the WAK. In the process of decommissioning the WAK completely the high active waste concentrate, the so called HAWC, has to be transformed into a nondispersible condition for final disposal, that is vitrification. As there is no vitrification plant at the WAK site it is planned to transport approx. 100 m^3 HAWC to the vitrification plant PAMELA at the Mol site in Belgium. The distance from the WAK to Mol is nearly 500 km.

Our organization, the TUEV-SW, an Association for Technical Supervisory, has to advice the authorities in nuclear affairs safety. As we know no comparable project to that of HAWC-transportation, that means, there is no background experience to set requirements to HAWC-transport. We therefore apply the experience we have made with the storage of HAWC, the transportation of reactor fuel elements and the transport of other liquid radioactive materials.

LAWS AND REGULATIONS

In the Federal Republic of Germany as in other countries all nuclear matters are governed by the atomic energy laws (1) and by the subordinated radiation protection ordinance (2). The aim of the atomic energy laws is to protect life and environment against the dangers of radioactivity, whereby the steps to protection must fulfil the state of arts. The transportation of radioactive materials is especially ruled by the ordinances on dangerous cargo on roads, GGVS (3), or railways, GGVE (4), which are also subordinated to the atomic energy laws. GGVS and GGVE for radioactive materials are based on IAEO's "Regulations for Safe Transport of Radioactive Materials".

CHARACTERISTICS OF HAWC

The liquid high active waste concentrate contains more than 90% of the fission products, which were accumulated by reprocessing about 200 t of UO_2 elements with a maximum burn-up of 40,000 MWd/t heavy metal. Quantities of important fission product nuclides such as Sr-90, Ru-106, Cs-134, Cs-137, etc. depending on burn-up and decaytime are listed up in (5). Beside this HAWC contains approx. 0.2 g/l Pu and more than 10 g/l solids. Planning and designing a new HAWC project with the aim of ensuring no significant activity releases into the environment, the following summarized HAWC characteristics have to be considered:

- High concentration of fission products activity (approx. 1.8E13 Bq/l) with high radiotoxic and long lived nuclides (At the surface of the HAWC in a storage tank there is an estimated dose rate of approx. 200,000 rem/h)
- Decay-heat of fission products
- Corrosion, because of the nitrates and the nitric acid
- Generation of gas by radiolysis
- HAWC may become heterogeneous (the solids deposit when not stirred)
- And nevertheless, HAWC is a liquid (suspension) with all its typical properties. If the cask has a leak, the liquid disperses, due to gravity in contrary to a solid.

SAFETY REQUIREMENTS FOR THE PACKAGING TO TRANSPORT HAWC

Applying the regulations GGVS/GGVE with its basic aims:

- sufficient shielding against radiation,
- sufficient cooling of the fission product decay heat,
- to ensure criticality safety in all stages of transportation,
- to prevent an accidental release of activity,

and taking the characteristics of HAWC into consideration, a possible cask for transporting HAWC could be of type B(U).

That means, for instance, a modified cask for reactor fuel elements could be used for the HAWC-transport. There are no special requirements for the number of barriers enclosing the activity-inventory during transport. A possible HAWC-cask could consist of a one-wall containment, which is surrounded by an adequate shielding. The shielding itself does not have to be HAWC resistable.

REQUIREMENTS FOR THE SAFE STORAGE OF HAWC

To fulfil the requirements of the atomic energy laws and its subordinated regulations and under consideration of the special characteristics of HAWC the following safety concept for the storage of HAWC was developed and put into effect.

HAWC is stored in tanks with a volume of 70 m^3 consisting of a corrosion resisting material with a suitable thickness. A storage tank stands in a fully lined storage room with appropriate shielding walls, a so called cell. Any leakage of HAWC will be contained. A leak can be detected by a leakage control system and the released solution can be transferred into an empty reserve storage tank. The reserve tanks fulfil the same requirements to safety as the main storage tanks do. All tanks are equipped with cooling systems to keep the waste temperature below 65°C and ballast tubes to keep the HAWC suspension homogeneous. Offgas from the storage tanks and exhausted aerial effluents of the cell are cleaned in separate systems and sampled before they are released into the environment. The state of the HAWC has to be controlled by measuring level, temperature, density, activities, solids and other important storage-parameters. The cooling systems are controlled too. All safety systems have redundancies. Building and systems are designed against earthquakes and aircraft crashes, although the probabilities for such events are very small at the plant site.

COMPARISON BETWEEN STATIONARY STORED AND TRANSPORTED HAWC

A comparison of safety requirements/-conditions for stationary stored and transported HAWC in a cask of type B(U) shows differences. While the stationary stored HAWC is surrounded in at least two controlled enclosures, the transported HAWC needs only one enclosure, as regulations demand. The cask body itself has to be only designed against radiation shielding and mechanical impacts and has not to be resistent against HAWC. In case of a leak of the first barrier, there could be a chemical reaction between HAWC and the shielding material.

In case of a leak in a storage tank the leaking HAWC can be detected and transferred immediately into an intact storage tank. Because of the HAWC-characteristics a leak of the containment with any release of activity into the environment must be prevented in all cases. For this reason a second enclosure consisting of a HAWC-resisting material (liner) together with a leakage control system could make a HAWC-cask safer. But the advantage of the stationary storing system is that the leaking solution can be transferred into an intact reserve tank without delay, while during a transportation there is no possibility to take such a step.

Another difference between stationary stored and transported HAWC is that the storage tank is connected with an offgas cleaning system at nearly atmospheric pressure. A HAWC-cask is completely sealed. In case of an accident the normal transportation time may get longer. Radiolytic generated gas will built up the pressure in the cask, so that possibly the transportation time must be limited, as an exceeding of the pressure limit must be prevented. Another possibility would be to give the cask a design pressure that there is no need for time limiting.

COMPARISON OF A REACTOR FUEL ELEMENT TRANSPORT WITH A HAWC TRANSPORT

Reactor fuel elements could be transported as well as HAWC in casks of type B(U) according to regulations. Though there is the same type for both transports, there is a difference in the safety assesses, as can be shown easily. As a consequence of a potential cask leak, the massive escape of activity into the environment is prevented by two more barriers, the cladding and the fuel matrix itself in case of the reactor fuel elements, while the HAWC with a behavior of a liquid runs out of the cask, disperses and seeps away, depending on the soil quality. The impacts of a HAWC-leakage into the environment could be serious, while the impacts of a reactor fuel element leakage is limited, because of the two more barriers a fuel element has.

OTHER TRANSPORTS OF LIQUID RADIOACTIVE MATERIALS

Reprocessing of spent nuclear fuel yields liquid waste of middle and low active quality beside HAWC, but also the products plutonium nitrate and uranyl nitrate. Transports of all these species were carried out in our country. But only the transport of a plutonium nitrate solution is comparable to a HAWC-transport, because of its potential radiological impact. Plutonium nitrate solution is transported only in small quantities considering especially aspects of criticality safety. But there is a difference between the transportation of HAWC and the transportation of a plutonium nitrate solution. In case of a leakage the plutonium nitrate solution could be handled under adequate conditions to health physics, while there is no sufficient shielding against radiation in case of a HAWC leakage.

PRESENT WASTE MANAGEMENT CONCEPTIONS

HAWC in liquid condition does not fulfil the requirements for final disposal. That is why the liquid is transformed into a solid. The solidified HAWC is bound in a glass matrix to optimize immobilization of activity. This shows that the liquid condition is the more unfavorable one compared with the solid one under aspects of safety. The present reprocessing plant conceptions in Britain and France follow the principle to condition the waste where it arises, so that there is no need of transportation of liquid HAWC outside the plant. (6,7).

The concept of the nuclear fuel cycle in the Federal Republic of Germany followed also this principle as can be seen from the design of the reprocessing plant at Wackersdorf. Spent reactor fuel elements should be transported to the reprocessing plant and the vitrified fission products should be transported to final disposal.

CONCLUSION

The comparison of safety measures between HAWC storage as well as HAWC transport and spent reactor fuel elements transport shows several differences.

- The number of barriers including the HAWC during the transport in a cask of for instance type B(U) package is different from HAWC storage and is also different from that of a compatible transport of spent fuel elements.
- Under safety consideration the liquid condition is the more unfavorable one, compared to the solid. Thus a HAWC-cask leakage during transportation could have serious impacts and therefore must be prevented.
- A HAWC-cask is completely sealed, while the HAWC is stored nearly at atmospheric pressure.
- The transportation of plutonium nitrate solution is not comparable to that of HAWC, as a leakage of plutonium nitrate solution could be handled under adequate conditions of health physics.

Present reprocessing plant conceptions avoid HAWC transports.

Regulations demand that a leakage of dangerous goods transported must be prevented. The HAWC-cask concept could be improved in view to the characteristics of the HAWC and all loads resulting from the transport.

REFERENCES

1. Gesetz ueber die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz-AtG) vom 23. Dezember 1959 (BGBl. I S. 814) in der Fassung der Bekanntmachung vom 15. Juli 1985 (BGBl I S. 1565).
2. Verordnung ueber den Schutz vor Schaeden durch ionisierende Strahlen (Strahlenschutzverordnung - StrlSchV) vom 13. Oktober 1976 (BGBl. I S. 2905, 1977 S. 184, 269) in der Fassung der Bekanntmachung vom 30. Juni 1989 (BGBl. I S. 1321, 1926).
3. Verordnung ueber die innerstaatliche und grenzueberschreitende Befoerderung gefaehrlicher Gueter auf Strassen (Gefahrgutverordnung Strasse - GGVS) vom 22.Juli 1985 (BGBl. I S. 1550) (BGBl. III 9241-23-9).
4. Verordnung ueber die innerstaatliche und grenzueberschreitende Befoerderung gefaehrlicher Gueter mit der Eisenbahn (Gefahrgutverordnung Eisenbahn - GGVE) vom 22.Juli 1985 (BGBl. I S. 1560) (BGBl. I S. III 9241-23-10).
5. H. ESCHRICH, 19. Lagerung und Verfestigung fluessiger hochaktiver Abfaelle, Chemie der nuklearen Entsorgung II, herausgegeben von F. Baumgaertner, Thiemig-Taschenbuecher-Band 66, Verlag Karl Thiemig , Muenchen, 1978.
6. JEAN-LOUIS RICAUD, The Start-up of UP3 Processing Plant, Spectrum 90, Nuclear an Hazardous Waste Management, International Topical Meeting, September 30 - October 4, 1990 Knoxville, Tennessee.
7. A.D. ELSDEN, Management of Radioactive Waste from Reprocessing Operations, Spectrum '90, Nuclear and Hazardous Waste Management, International Topical Meeting, September 30 - October 4, 1990 Knoxville, Tennessee.