Emergency Response for Damaged UF_6 Cylinders During Transport or Handling Activities on Site by Developing and Updating of Patch Systems

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SUMMARY

Transportation of all goods contains the risk of an accident. Dangerous goods --like UF_6 cylinders-- are in principle not excepted from this risk.

This paper describes suitable measures of preparedness to cope with a damaged UF_6 cylinder, the development of a patch and its updating, the training of emergency personnel, and the introduction of this preparedness system into a national emergency response system in Germany. The updated repair concept will be described.

INTRODUCTION

Since the early 1970's public interest in emergency situations during transport increased considerably worldwide. Today the public reacts very sensitively when radioactive materials are involved in a transport accident, or when an incident with radioactive material occurs on site.

In response to this evolution all transport activities and emergency response measures have to be checked for completeness and for possible improvement.

One of these measures is the preparedness to repair a damaged UF_6 cylinder.

Handling, transportation, storage, testing, and maintenance of UF_6 cylinders has to take place in accordance with regulations and recommendations, e.g., IAEA Safety Series(1990), ADR(1957), RID(1980), ANSI N 14.1(1990), and USEC 651(1995), each in the latest revision.

A contribution to a practicable emergency response system can only be expected to come from UF_6 handling experience.

Within the URENCO Group the Dutch-German pilot plant at Almelo (The

Netherlands), in the 1970's was involved in intensive public discussion, --particularly in connection with nuclear licensing-- on the safety of cylinders during transportation and storage, because the question had been raised of how UF_6 cylinders could be sealed off in case of a leak occurring during transportation or handling activities on site.

Moreover, in the early 1980's transport activities became more important for the URENCO Group, as the number of transports to and from their sites in Capenhurst (UK), Almelo (The Netherlands), and Gronau (Germany) increased, because of growing enrichment capacity of the URENCO plants, which is still increasing (see Figure 1).

PREVIOUS PATRAM SYMPOSIA

Ideas on UF_6 cylinder repair were discussed at previous PATRAM Symposia:

At PATRAM '78 J.C. Taylor presented some impressive pictures of accident scenes where UF_6 cylinders were involved (Taylor 1978). Although no leakage or loss of material occurred, possibilities to repair a leak were discussed. One proposal was to cover cylinder punctures or cracks with preformed metal sheets and sealing rings.

At PATRAM '80 H. Beyen described a rescue container which included an installation for emptying the defective UF_6 cylinder into an undamaged cylinder on the spot or after transport to another site (Beyen 1980). Rescue containers had to be developed, because the licensing authorities for UF_6 storage facilities in Germany required this mandatorily, and usually a storage facility will have neither experience nor equipment for UF_6 handling in case of an incident.

During discussion of both proposals mentioned above, the author questioned the practicability and effectiveness of these emergency measures.

BASIC CRITERIA FOR A PATCH AND FIRST PATCH CONCEPT

One accident is not like the other. Accidents can only be compared or analyzed in retrospect. How to minimize risks of an accident can only be decided on the basis of a given real situation.

The essential requirement of a systems's universal applicability led URENCO's thinking to a highly malleable, quick sealing patch, which had to fulfil all basic criteria of flexibility, e.g.

- within minutes of arrival, an expert team must be able to seal off a leak, regardless of size, shape or kind, or how it was caused,
- the seal must allow transport of the cylinder to a plant with UF_6 handling expertise, so that the remaining UF_6 can be removed.

This could be realized using a double glassfibre patch, one (quick) being coated with polyester mixture and the other (strong) with epoxy resin.

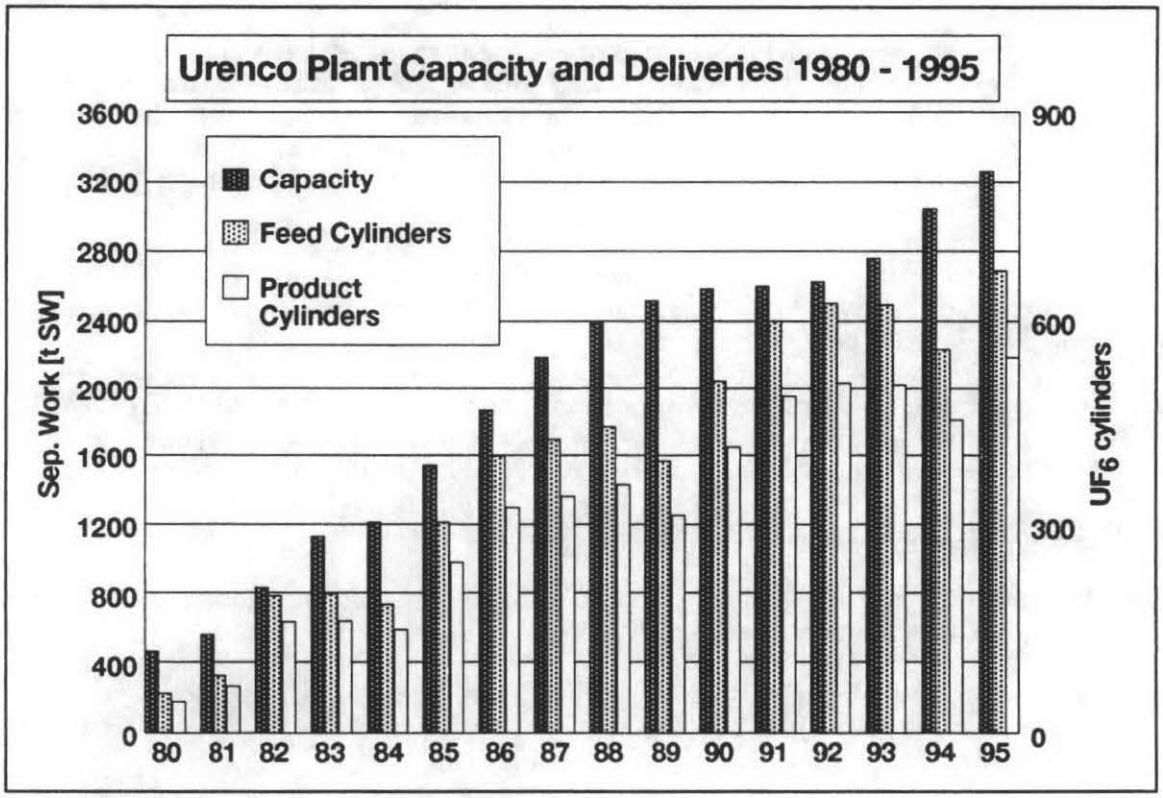

Fig. 1 Urenco's Transport Numbers of UF_6 Cylinders

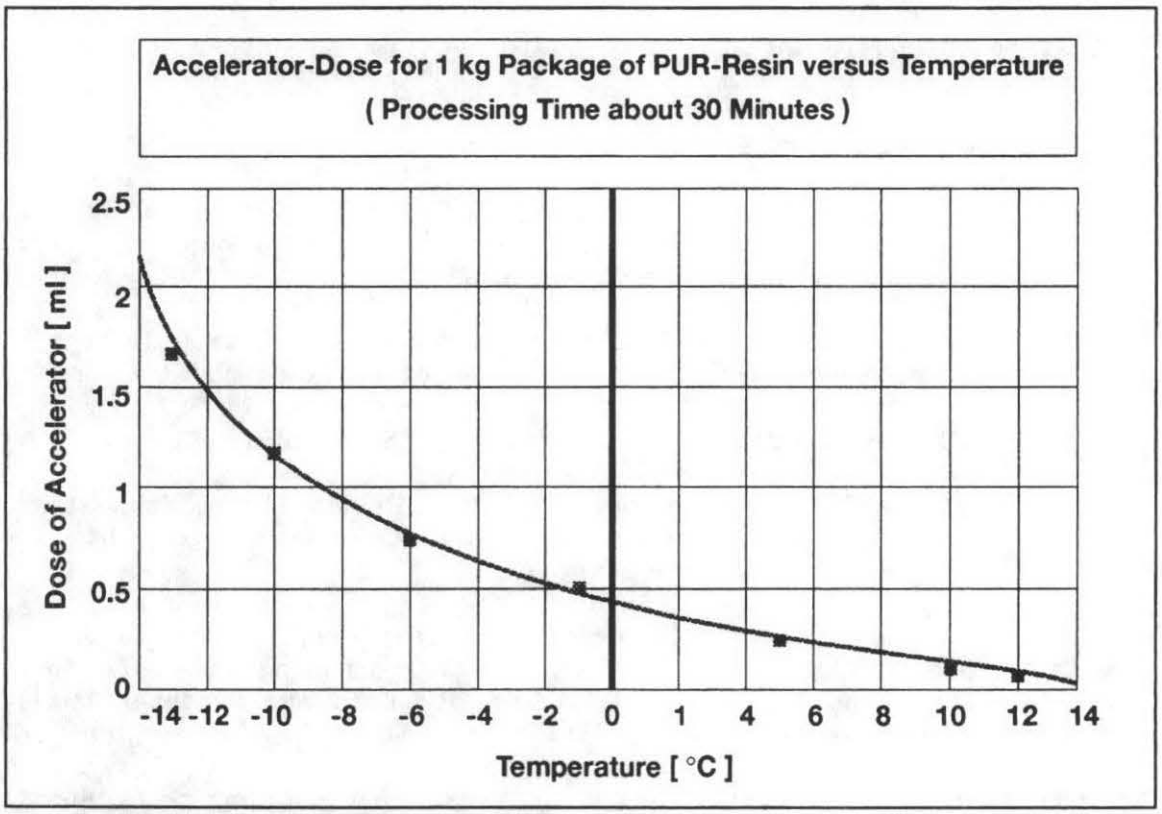

Fig. 2 PUR-Accelerator Dose versus Temperature

Series of experiments under laboratory conditions using a small 15-litre cylinder were started at URENCO NL, leading to a practicable patching concept. At PATRAM '83 the first results were presented by the author (Steinebach 1983), and at PATRAM '86 an improved solution of a cost reducing rescue container in combination with the patching concept was reported (Pfeifer and Steinebach 1986).

The weak point of this first repair concept was, that it only worked at temperatures above +10°C and that colder cylinders had to be warmed up around the leak before patching.

In the meantime, modern chemistry has made resins and foils available which can be used down to about -15°C. Consequently, this repair concept was further developed by the author at URENCO D.

QUALITY TEST OF PATCH MATERIAL

New foils and resins were tested to achieve good outgassing behaviour and good resistance against UF_6.

Starting with tests under vacuum conditions from 0.1 Torr down to 0.01 Torr at a temperature of 113°C, a test followed under UF_6 conditions: 80 Torr gaseous UF_6 at temperatures of 40°C up to 50°C.

The test time for the different materials was chosen between 2 and 28 days. The loss of mass of the best-tested foils and resins was between 0.48% and 4.4%.

The best foils and resins were also inspected visually after the tests; they looked nearly unchanged.

So a suitable foil and resin could be found:

The foil: Polyvinyl chloride (PVC) with 25% dioctyl phthalate as a softening agent, 1 mm thick (well known and often used as pond foils in gardens).

The resin: Two-component polyurethane (PUR) adhesive, with diphenylmethane-4.4-diisocyanate as accelerator agent.

DETERMINATION OF ACCELERATOR DOSE AND TEST RESULTS

The normal applicability of the chosen PUR resin was limited to a temperature of +15°C. At lower temperatures an accelerator agent has to be added to the resin and hardener mixture.

The accelerator dose had to be determined carefully on the basis of a suitable processing time of the resin. A processing time of about 30 minutes (from the beginning of mixing of resin and hardener until patch application) seems to be a suitable time.

For accelerator dose determination, patches were applied to a dummy cylinder, shown in Figure 4, at temperatures down to -13°C. This temper-

ature was limited by winter conditions in Gronau, Germany. The results of accelerator dose versus temperature are shown in Figure 2.

If under certain patching conditions at the scene of an accident the processing time is found to be too short or too long, the accelerator dose should be corrected by a factor of 1.5.

For accelerator application common insulin injections were tested successfully.

Finally, some patches applied to the dummy cylinder were tested on leakage and pressure. The patches showed no leakage during helium leak test and pressures up to 2 bar above the atmosphere, based on a punctured area of 13 cm^2 (2 sq.in).

APPLICATION OF PATCH

Two persons of the specially trained team, equipped with breathing apparatus and protective clothing, will care for the preparatory work and the application of the patch.

URENCO D uses aluminum suitcases containing all materials and tools necessary for the application of these patches. The necessary equipment is shown in Figure 3.

The preparatory work includes:

- All necessary activities of health physics, e.g., determination of dose rate and radioactive contamination and all other protective measures according to the situation at the scene of accident, e.g., close off activities by a barrier;

- depending on the scene of accident: provisional patching with adhesive tape or change of the cylinder position in order to have access to the damaged cylinder area;

- depending on the weather conditions, e.g., rain or fog: to set up a protective tent; and

- depending on the temperature at the scene of the accident (only if temperature is below +15°C): expose all adhesive material to ambient temperature, in order to reach the temperature of the cylinder.

The patch is applied as follows:

- The area around the leak is mechanically cleaned (wire brush) and carefully degreased (solvent).

- A suitable piece of PVC foil (1 mm thick) is cut out.

- The temperatures of PUR resin and cylinder surface are measured.

- Resin and hardener are intensively mixed with a suitable power tool.

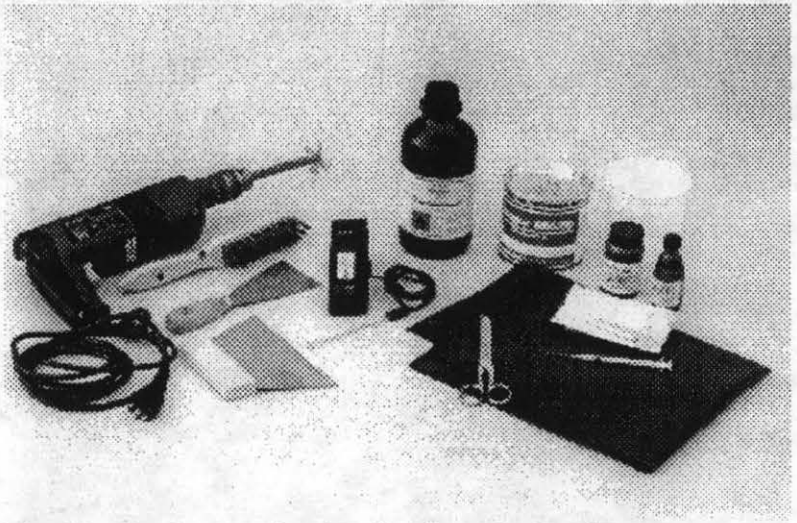

Fig. 3 Equipment for Application of a Patch

Fig. 4 30˝ B Dummy Cylinder for Training

Fig. 5 Patch Applied to the Dummy Cylinder

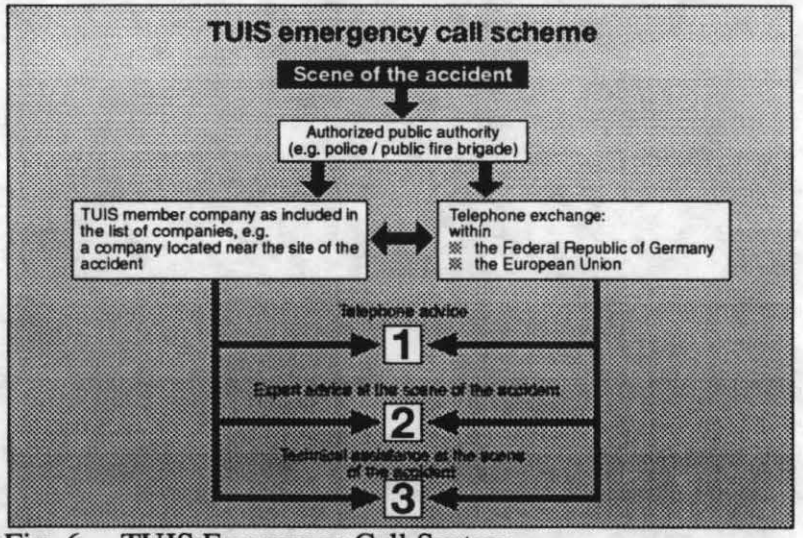

Fig. 6 TUIS Emergency Call System

- At temperatures below +15°C the accelerator agent has to be added and mixed intensively. For accelerator dose determination, the higher of the two temperatures measured before it is used and the dose diagram (shown in Figure 2) is applied.

- The adhesive is richly applied on the cleaned area and the PVC foil is firmly pressed on the adhesive.

- Finally the adhesive is also applied over the edges of the foil.

The patch is now complete, it looks as shown in Figure 5. The cylinder can be moved from the scene of accident about one hour later.

TRAINING OF EMERGENCY PERSONNEL

The updated knowledge was offered to the other URENCO plants and to interested fuel cycle companies in Germany. Schooling and training of these emergency personnel was organized and performed by URENCO D.

A dummy cylinder is used for training of the emergency personnel. The cylinder was designed for training and patch testing purposes. The cylinder is shown in Figure 4.

This cylinder is an original head of a 30" B cylinder, installed on wheels and equipped with an original 1-1/2" cylinder valve. For test purposes (leak test and pressure test of a patch) the cylinder is equipped with a realistic test puncture and test crack. On the back side a connector is fitted for pressure measurement.

The training of URENCO D emergency personnel is repeated at regular intervals.

CONCLUSIONS

It can be stated that a patch made of the chosen PUR resin and PVC foil can seal off an opening, puncture or crack, in a filled UF_6 cylinder quickly and effectively. The adhesion of the patch is adequate for subsequent transport to empty the cylinder professionally.

The improved repair concept, as described here, was included in the official operational handbook of the enrichment plant of URENCO D at Gronau, Germany.

This repair concept was also introduced into the German Emergency Response System TUIS(VCI 1992). On request TUIS offers advice or sends experts and special equipment to the scene of an accident to support the responsible public authorities (e.g., police and fire brigade).

The TUIS emergency call scheme (see Figure 6) and the TUIS manual are available to all public authorities and form the basis to call the services offered by this system.

TUIS is a German contribution to the worldwide Responsible Care Programm

of the chemical industry.

Similar emergency response systems of the chemical industry have been already established in other European countries, e.g., up to 1990 in France, Great Britain, Italy, and Switzerland.

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Session III-2: Storage Package Development and Description