Session 3. 10

Handling of Fuel Flasks in German NPP- Safety Aspects

Klaus-Dieter Nerlich
TÜV Süddeutschland
Westendstraße 199
D 80686 München, Germany

Summary

Handling and transport of Flasks for irradiated Fuel Elements are necessary and important for the operation of a nuclear power plant (NPP). They belong to the design conditions of a nuclear power plant and must therefore fulfil all relevant safety requirements. To get an approval for the handling and transport in Germany an expert opinion with a positive result of evaluation of the handling and transport procedures and equipment is necessary: Each step must be analysed for evaluation. TÜV Süddeutschland has performed a lot of such safety evaluations in order of the competent authorities. For handling inside the NPP-area the atom act and the traffic act come together. Procedures have proved worthwile: Up to now no heavy accident happened during handling and transport inside the NPP-area. The fixed requirements are suitable to assure safe handling now and in future.

Introduction

To run a transport with spent fuel elements in Germany you need a lot of approvals. Outside the plant the regulations of the traffic act and the international guidelines are valid. National and international regulations - as it was explained in many sessions of different PATRAM-conferences - must be observed. The flask for spent fuel must have an approval of the country of origin and a national validation.

For handling and transport of a flask within the area of a nuclear power plant a special approval of the competent authority is necessary. Figure 1 shows a simplified description of the correlations between the different authorities and groups.

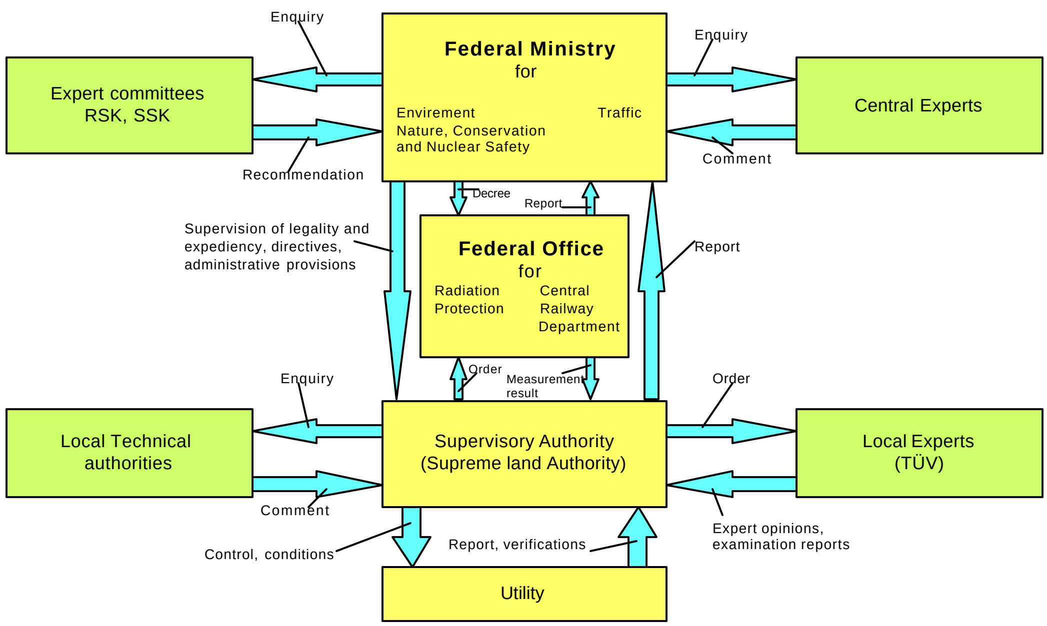

FIG. 1. Approval Structure for Nuclear Transports

The safety standard of German NPP as the technical basis of the different necessary approvals is defined by a hierarchy of technical requirements as are presented in Figure 2.

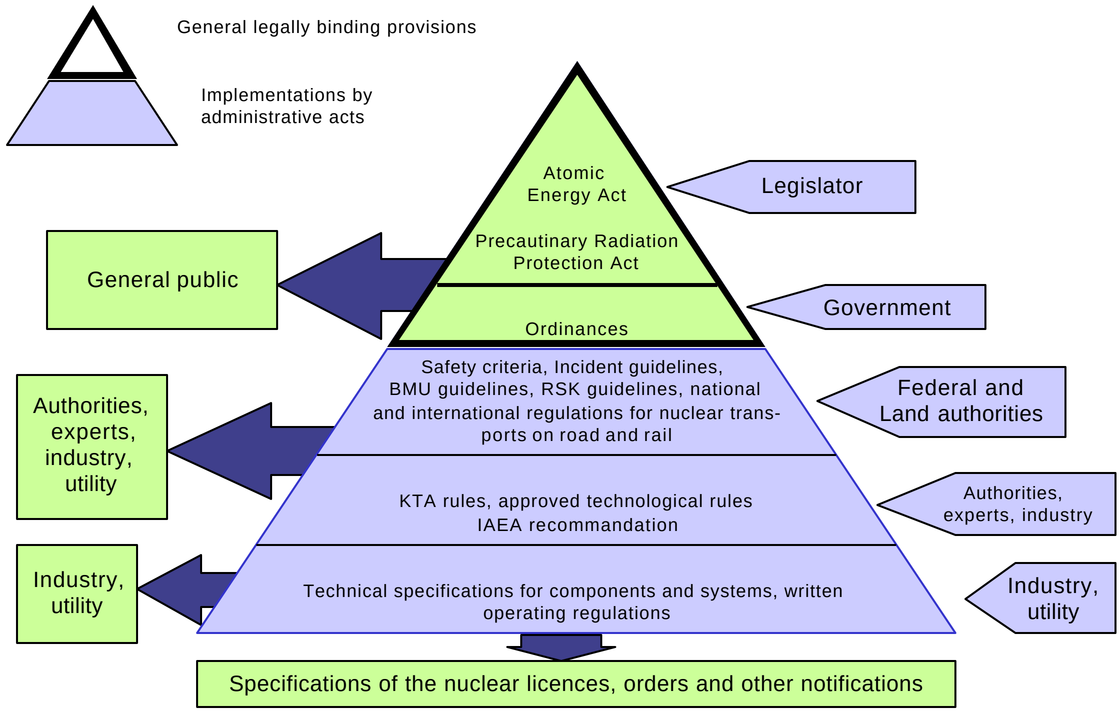

FIG. 2 Hierarchy of legal nuclear provisions.

For all design and accident conditions it must be assured that the four higher safety goals are fulfilled:

- reactivity control (1)
- enclosure of radioactive substances (2)
- residual heat removal (3)
- subcriticality (4)

For handling and transport the requirements (2), (3) and (4) are fulfilled by the design of the flask.

Handling Steps

One prerequisite for an approval to handle a flask in the plant consists of the positive result of an analysis of all safety important steps. These steps can be subdivided in :

1. Lift of the empty flask

After arriving the empty flask is lifted from a lorry or a railway wagon under the gantry to the height of the rails leading into the material lock (see Figure 3) of a pressure water reactor (PWR) or up to the height of the reactor floor (see Figure 4) of a boiling water reactor (BWR).

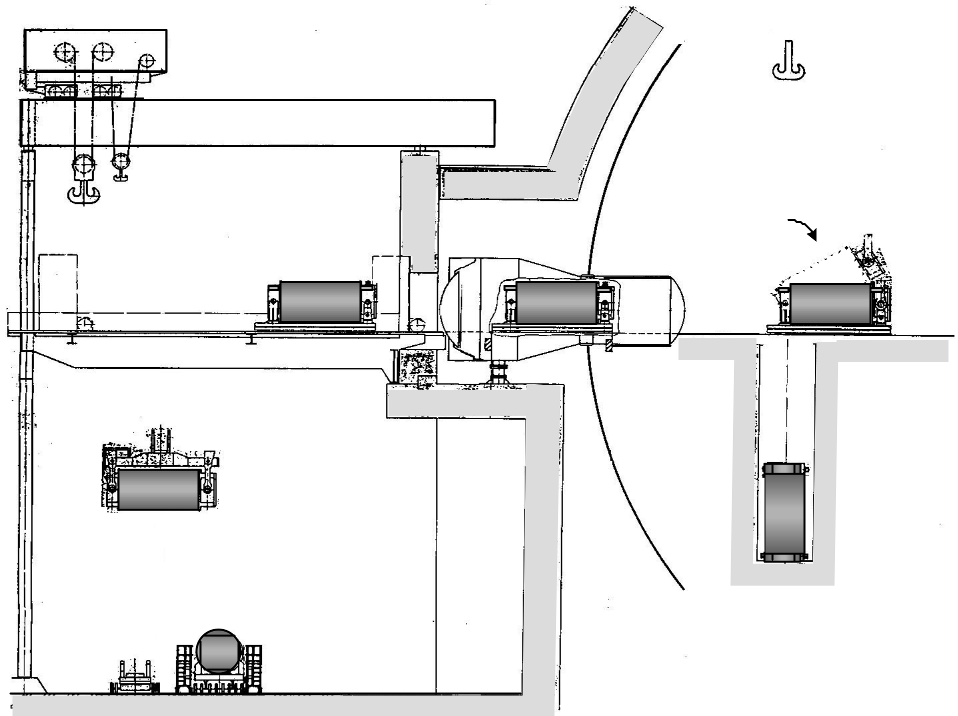

FIG. 3. Flask Positions in a PWR

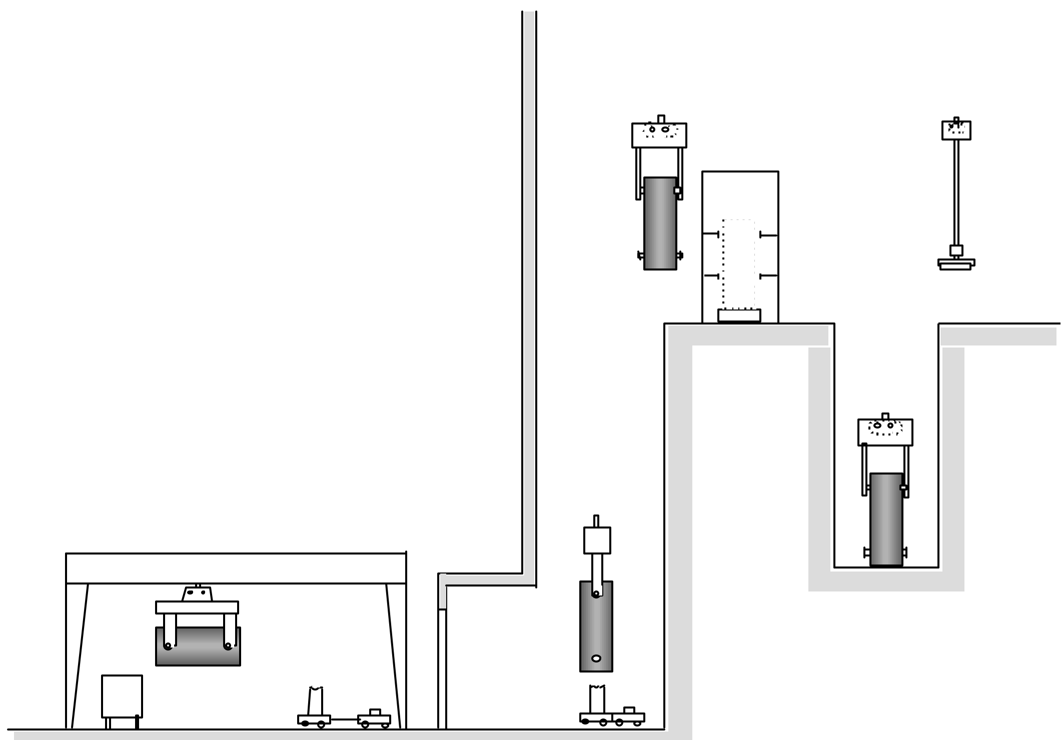

FIG. 4. Flask Positions in a BWR.

2. Horizontal Transport

The flask is set down on the transfer carriage and is driven on it into the material lock. After closing the outer door and opening the inner door of the lock the horizontal transport into the containment on the so called reactor floor can be performed (only in PWR).

3. Vertical transport into the storage pool or into a separate flask pool

From its horizontal position on the transfer carriage the flask is turned into a vertical position by the reactor building crane, lifted up from the transfer carriage and set down on the service-place on the reactor floor. After removing the lid the flask it is prepared for the next handling steps - contamination-checks and equipping with a metallic or plastic contamination protection skirt. With this equipment the flask is lifted, transported to the pool and lowered down to the ground of the pool.

4. Loading the flask with fuel elements

In the station under water - either in the storage pool or in the separate flask pool - the flask will be loaded with the selected irradiated fuel elements by the reactor building crane or the refuelling machine in accordance with a specific loading plan.

5. Way back

After loading the lid is set down under water and the flask is removed by the reactor building crane onto the reactor floor. The flask is got ready (fixing the lid, drying, leak tightness test). The remaining steps are performed as the steps 1 - 3 only in the reverse order - with additional quality assurance - and measurement steps.

Safety requirements / evaluation standard

All handling and transport steps with a flask in a NPP are to be performed in the way that no risk is induced for the plant, for the staff and for the environment. For all the handling and transport steps and for all the equipment the fulfilment of the state of the art concerned to the atomic act is necessary. At all situations keeping the higher safety goals must be guaranteed at anytime:
The state of the art is fixed generally by

- relevant acts
- ordinances
- safety criteria and guide lines

and especially by

- KTA-rules (3902, 3903, 3905 and 3602)
- national and international transport guidelines.

Fulfilling of the safety requirements

1. Lift of empty flasks and lowering of loaded flasks

When the empty flask is lifted up to a height of approximately 20 m above ground floor or the loaded flask is lowered from this height, it must not damage any important system of the NPP - for the case of a fall. This requirement can be fulfilled by the arrangement of important systems out of the area or by mastering of such an accident by design or protection of the system or by exclusion of such an accident by design of the complete load chain.

To master the accident fall of a loaded flask from the gantry there are two ways.

a) Exclusion of such an accident by design of the complete load chain (crane, lifting equipment and trunnions) due to the increased requirements of the KTA 3902, 3903 and 3905). In figure 5 there is an overall view of the different principles of crane design.

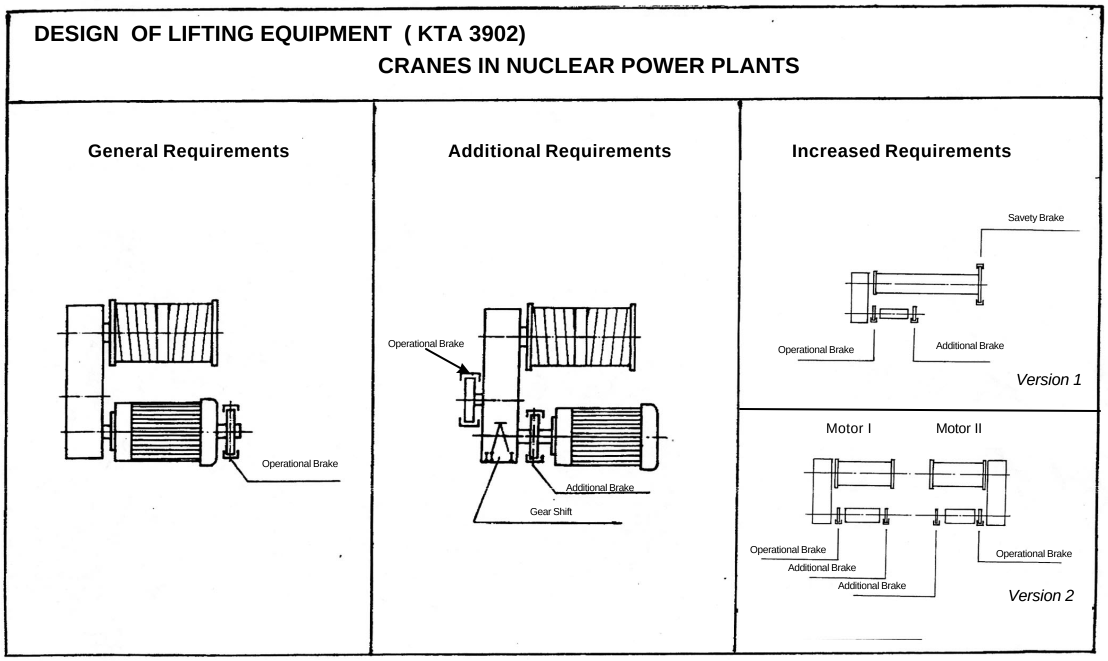

FIG. 5. Examples for Crane Design

b) Proof of the mastery of the fall. Flasks are designed by calculation and tested for a fall from a height of 9 m onto a rigid fundament. Additional results of analyses of calculations or experiments show that a fall from greater heights onto a realistic fundament can induce less uses than a fall onto a rigid fundament from a height of 9 m.

2. Horizontal transport

The lorry, the rails and the lock are designed against the load of a loaded flask. A fall from this low height would not effect unacceptable situations.

3. Transport into and out of the storage pool

This is the most safety important step for the integrity of the NPP. A drop could damage the

- spent fuel elements in their racks in the pool with the risk of
  - criticality
  - release of radioactive material
- floor of the storage pool with the risk of
  - loss of cooling and

as the additional consequence

  - loss of fuel element integrity
  - release of radioactive material.

Therefore a fall into the pool must be excluded. This aim can be reached by design of the complete load chain (reactor building crane, lifting equipment, trunnions) and fixed by administrative regulations with additional quality assurance steps. For each step there exists a procedure for the staff as part of a sequence step plan.

4. Loading

For the loading procedure it is necessary that the right irradiated fuel element is loaded into the concerned position of the flask basket. This can be guaranteed by a loading plan and quality assurance steps (4-eye-principle). A fall of an irradiated element is to be avoid. For this aspect the technical devices are designed and performed due to the increased requirements of the KTA 3902, 3903 and 3905 for all the handling equipment (crane, lifting equipment, load attachment points), the steps are fixed in a step plan with additional quality assurance measurements. Independent of the technical and administrative measurements safety analyses were performed with the result that no unacceptable release of activities into the environment can happen even in the case of a fall of an irradiated fuel element onto the ground or onto the storage racks.

Additional Safety Measurements

In addition to the above mentioned measurements especially for the safety of the NPP further steps are performed:

- Additional contamination protection by use of a complete contamination protection skirt optimised handling procedures
- Additional quality assurance steps
- Administrative steps
- Additional checks of removable contamination
- documentation and exchange of views.

Conclusion

Handling and transport of flasks for spent fuel in a NPP involve risks for the NPP. Therefore all safety important handling- and transport steps must be analysed very intensively and performed with a very high safety standard according to suitable procedures based on detailed step and quality assurance-plans. For this purpose necessary regulations to fulfil the requirements are available. In Germany the execution of the handling steps and the state of the equipment including the flask are checked by independent experts who confirm the fulfilment of the requirements as one basis for the approval of the competent authority. Good experiences up to now show the suitability of the procedures.

References:

German Atomic Act (20 th Issue)

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