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TRANSPORT OF LARGE OBJECTS – AN INDUSTRY PERSPECTIVE

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ABSTRACT

The transport of large objects are becoming of major interest for the nuclear fuel cycle industry and the utilities world-wide. Successful transports of steam generators in the US and in France are some recent examples. Also, new waste streams from dismantling activities come into existence on a regular basis.

Current transport regulations have yet to take fully into account these evolutions. The fact that the International Atomic Energy Agency (IAEA) Transport Safety Standards Committee has accepted “large object transport” as a topic in the current review cycle of the SSR-6 Transport Regulations is [1] welcomed by industry. While some progress has been made, notably on fissile exceptions in the new SSR-6, some issues need further consideration.

The proposed paper will describe, from an industry perspective:

- the need for industry to transport large objects safely, efficiently and cost-effectively,
- the current status of the Regulations, taking into account recent progress,
- the difficulties in applying the current Regulations will be high-lighted and proposals made on the following points :
  - The classification of SCO-1 objects;
  - LSA-1 fissile material;
  - Drop testing of Industrial Packages
  - The special arrangement procedure
- Some recent examples will be used as an illustration.

Finally, a new approach will be presented for consideration on a long-term perspective. The current IAEA philosophy is based on **packaging** performance. The packaging has to meet all of the safety requirements (structural resistance, thermal protection, shielding, criticality, confinement, etc). A recent development in France is that the various safety requirements need not necessarily be attached to a packaging only, but could be assured by what can be called a **"transport system"**. Transport systems are interesting in particular when packagings are no longer possible because of the size or weight of the radioactive objects.

BACKGROUND

The transport of large objects are becoming of major interest for the nuclear fuel cycle industry and the utilities world-wide. Recently, the transport of the large objects is increasing steadily because of the decommissioning of nuclear power stations or replacing equipment for the extension of their operational life. For example, in Southern California, Edison transported used steam generators to the disposal site in Utah in August 2011 [2] and three steam generators from Sweden's Ringhals nuclear power plant were transported to Studsvik's plant for decommissioning and recycling in January 2012 [3].

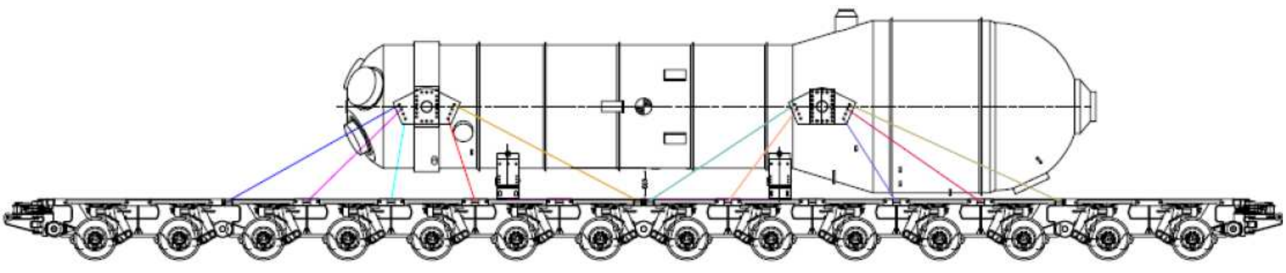
Figure 1. Edison's steam generator transport

In the U.K. two used boilers (21 meters long, 5 meters wide and weighing in at 310 metric tons) from the Berkeley Magnox power plant were transported to Sweden for decommissioning and recycling in March 2012 [4].

Figure 2. Magnox boilers on their way through Berkeley

Similarly, at the end of 2012 and early 2013, steam generators from the Chooz A nuclear power plant in France were transported to the French national waste disposal facility.

Figure 3. Chooz A steam generator on special trailer



Furthermore, it is predicted that the demand to transport large objects from various nuclear fuel cycle facilities for equipment replacement, decommissioning, disposal or recycling will increase.

TRANSPORT REGULATIONS FOR LARGE OBJETS – STATUS AND RECENT DEVELOPMENTS

The transport of radioactive material is regulated by national and international modal regulations based on the IAEA Transport Safety Regulations SSR-6 [1]. Generally, radioactive material is packed inside a packaging (e.g. ISO drum, freight container or cask) which satisfies the requirements of the SSR-6 according to their radioactivity and their chemical and physical properties. Previously, used radioactive large objects were usually treated and their size reduced into smaller pieces, packed into a number of packagings onsite (at the nuclear power plants or the fuel cycle facilities), then transported off site to disposal or recycling facilities. However, this size reduction and packing may increase exposure of workers and risk of radioactivity release. Thus, from an overall health and safety perspective, it is often interesting to transport large objects to disposal or recycling facilities without onsite dismantling or size reduction.

Intensive discussion on such transport had been conducted in the last review cycle of the IAEA Transport Regulations in which the World Nuclear Transport Institute (WNTI) actively contributed. A new “Guidance for Transport of Large Components under Special Arrangements” was added as Appendix VII in the revised advisory material TS-G-1.1 [5]. Its purpose is to assist consignors and Competent Authorities in preparing and assessing applications for Special Arrangement for the transport of large objects. While this guidance is very useful with the introduction of a road map to obtain a special arrangement, it is limited in scope and does not address a number of issues. No new concepts or ideas are introduced and the basic philosophy behind the regulations remains the same.

This paper addresses some of these issues, such as classification, drop testing and Special Arrangements. It tries to show the way forward, by promoting technological progress and new concepts. The WNTI, which promotes the safe, reliable and efficient transport of radioactive materials, is currently preparing a fact sheet for publication on the transport of large objects which provides a clear overview of the current situation [6].

CLASSIFICATION OF LARGE OBJECTS

Large objects are usually classified as Surface Contaminated Objects. <u>Activated</u> large objects, such as reactor vessels, are not within the scope of this paper because of their additional complexity.

A Surface Contaminated Object (SCO) is defined as a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces, and also has limits for the radiation level and total radioactivity. This means SCO is essentially a very limited risk, and is further classified as SCO-I or SCO-II according to the surface contamination level.

Surface Contaminated Objects

Many large objects have a complicated and inaccessible inner structure. By all practical means it is impossible to realize a physical examination of the interior so as to determine the thickness of the deposits or to find any potential accumulation of material. The consequence is that the regulatory requirements for SCO objects are impossible to demonstrate, since surface contamination measurements of inaccessible areas cannot be realized.

Where an internal physical examination of a large object is not possible, a new external dose rate measurement is proposed. This measurement uses a scanning method covering the complete outer surface. After careful calibration of the tool, any accumulation of radioactive material or non-distributed activity in the component (i.e. a hotspot) can be detected. Obviously, the aim is to show the absence of material accumulation and hotspots in order to allow a characterization as SCO.

Fissile Material

The inner surface which has been in contact with the radioactive material can become very large. So even relatively thin surface deposits can lead to enormous quantities of radioactive material. In many cases the limit for fissile excepted material is reached and the surface contaminated object has to be characterized as being fissile.

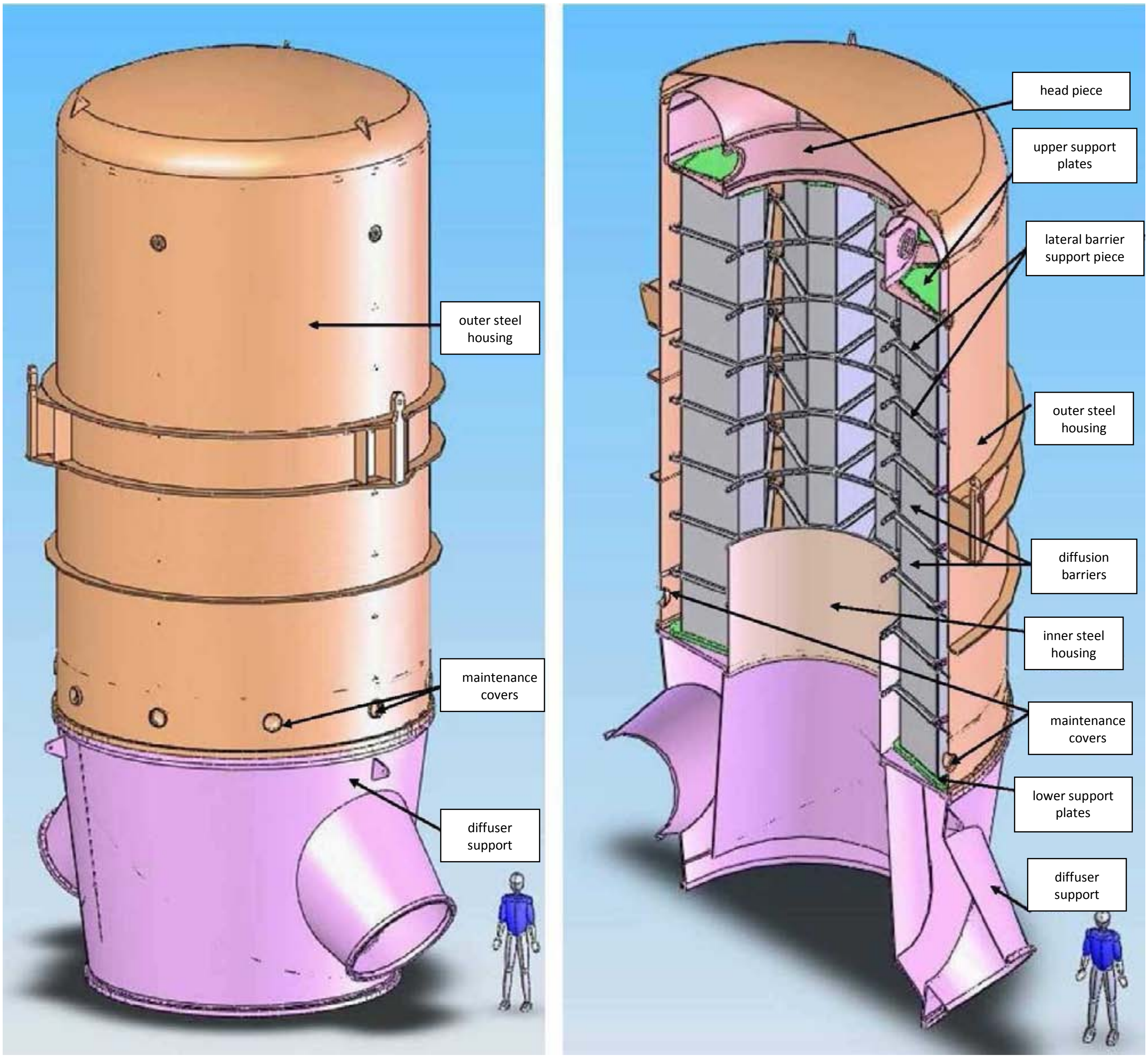
Table 1 gives an example of the large object to be transported at AREVA's Georges Besse enrichment plant in France

Table 1. Large objects at the Georges Besse plant

	Diffuser "UFE" with its support	Diffuser "UTG" with its support	Diffuser "USG" with its support
Quantity	280	400	720
Length	3 730 mm	5 000 mm	6 900 mm
Width	3 000 mm	3 830 mm	6 102 mm
Height	9 900 mm	11 100 mm	12 440 mm
Total volume	110 781 dm^3	212 565 dm^3	523 771 dm^3
Total mass	18 110 kg	40 000 kg	87 000 kg
Surface in contact with uranium	133 m^2	225 m^2	358 m^2
Estimated uranium mass after rinsing	4.5 kg	10 kg	19 kg
Estimated fissile mass (U-235)	225 g	320 g	475 g

Figure 4 shows an illustration of a diffuser. It is interesting to compare its size to the individual next to it.

Figure 4. USG



The contamination consists of non irradiated Uranium enriched to less than 5%. Since the A2 value is unlimited it can be classified as LSA-I material. Thus, the corresponding packaging type would be an “IP-1”. Even “unpacked” transport would be possible under certain conditions.

However, since the fissile material exceeds the limits for fissile exception, the appropriate packaging type is “IP-2 fissile”. The requirements for IP-2 fissile packagings are much higher than for an IP-1 packaging, since the packaging must resist under Normal Conditions of Transport and must fulfill the additional requirements for fissile packagings. This example clearly shows the need for a LSA-1 fissile classification of radioactive materials which does not exist in the current SSR-6 regulations [1]. Also it is obvious that a packaging for fissile material is not required.

This example shows that the Transport Regulation needs to adapt to newly emerging transport flows in order to avoid over-classification, which puts an undue burden on the nuclear industry because fissile packagings have to be developed and used. In the case of large objects this becomes even unfeasible, or, at least, it is not cost-effective.

Drop Testing of Industrial Packages

Three types of Industrial Packages (Type IP-1, Type IP-2, Type IP-3) are defined, which differ by their capability to withstand damage as specified by the Regulations. SCO-I and SCO-II should normally be packaged in Type IP-1 and Type IP-2, respectively. It should be noted that SCO-I can be transported unpackaged under certain conditions. If an object is categorised as SCO-I, then stacking and free drop tests are not required because it is transported unpackaged. However, Type IP-2 packages are required to undergo a drop test ([1], paragraphs 624 and 722).

If an object is 20m long, vertical drop tests (an end of the object is lifted vertically and dropped from more than 20m) should be taken into account as to cause maximum damage. However, such a vertical drop with the real object or a full scale model seems unrealistic. Reduced scale models are a possible alternative. However, it is difficult to show that scale models are representative due to different materials, non-linear material behaviour, strain-rate effects etc. Alternatively, numerical analysis requires a high level of expertise and is very expensive. Competent authorities are often very reluctant to accept safety demonstrations based on these alternative methods.

Drop testing as required by the Transport Regulations [1] is not adapted to large objects. Different ways of demonstrating structural resistance should be authorized. Also, the regulations should consider accepting newly emerging techniques more readily.

FROM THE SPECIAL ARRANGEMENT TO THE TRANSPORT SYSTEM

Special Arrangements are very often used for the transport of large objects. This was notably the case for the examples mentioned above [2 - 4].

The concept of Special Arrangement is intended to give flexibility to consignors to propose alternative safety measures that are effectively equivalent to those prescribed in the SSR-6. Special Arrangement is based on the requirements that the overall level of safety resulting from additional operational controls must be shown to be at least equivalent to that which would be provided by all applicable provisions. As such, it is obvious that there is no compromise of safety in the concept. Furthermore, each Special Arrangement must be specifically approved by all Competent Authorities involved.

When the transport regulations were developed several decades ago, the need for transporting large objects did not exist. The now well established safety essentials were developed:
- Structural resistance;
- Thermal resistance;
- Confinement;
- Shielding;
- Criticality Safety;

and have to be demonstrated under routine, normal and accidental conditions. This was best achieved by using "**packagings"**, which proved to be efficient for small to medium size objects.

However, the original safety essentials are not linked to the concept of a "**packaging"**. This consideration leads to a long term proposal:

- Keep the same safety essentials
- Up to now, if you cannot use a packaging, special arrangements have to be used
- In future, a safe transport of radioactive material **without a packaging** could be called a **"transport system".**

For example, the structural resistance could be assured by the outer casing; the thermal protection by the insulation of the transport vehicle; the shielding could be completely separate, the criticality would be guaranteed by the contents themselves, etc. This new concept is already being used for some on-site transports in France.

CONCLUSIONS

Due to the increase of decommissioning and the replacement of large objects to support extended operation of nuclear power plants and nuclear fuel cycle facilities, it is expected that the transport of large objects will increase steadily. It is reasonable to transport them directly for disposal or to recycling facilities for safety reasons. However, due to the very nature of large objects they cannot be transported within the general scope of the Transport Regulations [1] and therefore these transports have to be conducted under Special Arrangement. As there are additional operational controls imposed to satisfy the safety and approval by the Competent Authorities in the transport under Special Arrangement, safety is not compromised. Furthermore, IAEA guidance has been developed for the transport of large objects under Special Arrangement in TS-G-1.1 [5]. It is expected that the guidance enhances the understanding of the transport of the large objects under Special Arrangement among all stakeholders including Competent Authorities and industry. In the future, it might be interesting to consider "transport systems" as natural evolution of Special Arrangements.

Some other issues are still a matter for ongoing discussions, such as classification of surface-contaminated objects, LSA-1 fissile and drop testing of IP-2 packages.

FUTURE WORK

A new proposal for the transport of large objects was submitted from Canada in the IAEA review cycle of the Transport Regulations [1] and the discussions on its applicability have started. The WNTI has participated in the discussion and is encouraging industry to feedback its industrial experience and expertise into the discussion either directly or through the WNTI. The new provisions may then be added to the future version of the Transport Regulations or the associated Advisory Material.

ACKNOWLEDGMENTS

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