



ONET TECHNOLOGIES UK



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The Transport of Uranium Swarf Immersed in Oil



Introduction

- Uranium swarf is considered to be a pyrophoric material liable to spontaneous combustion and is immersed in oil for transport.
- Does this payload constitute a pyrophoric material?
- If not is there any other hazard that should be considered?
- This presentation reviews the requirements of the various Dangerous Goods Transport Regulations to determine a suitable packaging for uranium swarf immersed in oil.



Introduction

- Uranium swarf is a radioactive material so transport is subject to the IAEA Regulations for the Safe Transport of Radioactive Material (TS-R-1).
- It is classified as LSA-I and may be transported in a Type IP-1 Package.
- Type IP-1 Packaging does not require testing under the Radioactive Material Transport Regulations.



Introduction

TS-R-1 Paragraph 507

“In addition to the radioactive and fissile properties, any other dangerous properties of the contents of the *package*, such as explosiveness, flammability, pyrophoricity, chemical toxicity and corrosiveness, shall be taken into account in the packing, labelling, marking, placarding, storage and transport in order to be in compliance with the relevant transport regulations for dangerous goods of each of the countries through or into which the materials will be transported, and, where applicable, with the regulations of the cognizant transport organizations, as well as these Regulations.”



Introduction

ADR Paragraph 4.1.9.1.5

“Radioactive material with a subsidiary risk shall be carried in packagings, IBCs or tanks fully complying with the requirements of the relevant chapters of Part 6 as appropriate, as well as applicable requirements of Chapters 4.1, 4.2 or 4.3 for that subsidiary risk.”

Part 6: Requirements for the Construction and Testing of Packagings, IBCs, Large Packagings, Tanks and Bulk Containers.

Part 4: Packing and Tank Provisions.



Classification

- The Package Design must comply with the appropriate Dangerous Goods Transport Regulations
- The classification of a payload comprising of uranium swarf immersed in oil must be determined

Classification

United Nations Recommendations on the Transport of Dangerous Goods.

- Class 4: Flammable Solids
- Division 4.2: Substances liable to spontaneous combustion
 - a) Pyrophoric substance: ignites within 5 minutes of contact with air
 - b) Self-heating substance



Classification

Is Uranium Swarf pyrophoric?

- United States Department of Labor
Occupational Safety and Health Guideline

The ignition temperature of uranium metal is 170°C.
Finely divided uranium metal (dust) ignites at room temperature (20°C).

- United States Environmental Protection Agency
Depleted Uranium Technical Brief

Uranium metal powder or chips will ignite spontaneously in air at ambient temperature.



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Depleted Uranium Technical Brief

Uranium metal powder or chips will ignite spontaneously in air at ambient temperature.

YES



Classification

Is a payload comprising Uranium Swarf immersed in oil pyrophoric?

Pyrophoric substances ignite within 5 minutes of contact with air.

If the payload escaped from a package carrying uranium swarf immersed in oil the material would not ignite for a considerable period due to the coating of oil remaining on the uranium (certainly not within 5 minutes).



Classification

Is a payload comprising Uranium Swarf immersed in oil pyrophoric?

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If the payload escaped from a package carrying uranium swarf immersed in oil the material would not ignite for a considerable period due to the coating of oil remaining on the uranium (certainly not within 5 minutes).

NO



Classification

Is a payload comprising Uranium Swarf immersed in oil a self-heating substance?

The UN test for a self-heating substance involves heating the substance for 24 hours. We are not aware that such a test has been performed but it is probable that the oil coating would evaporate over such a period and the uranium swarf may ignite.



Classification

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The UN test for a self-heating substance involves heating the substance for 24 hours. We are not aware that such a test has been performed but it is probable that the oil coating would evaporate over such a period and the uranium swarf may ignite.

YES (probably)



Classification

Summary

- Dry uranium swarf should be classified as a pyrophoric substance



Classification

Summary

- Dry uranium swarf should be classified as a pyrophoric substance
- Uranium swarf immersed in oil should be classified as a self-heating substance

Regulatory Requirements

The proposed package comprises an HDPE plastic inner drum within a steel outer drum





Regulatory Requirements

The Package must comply with the requirements for a self-heating substance.

If not radioactive classification under ADR would be:

- UN3190 SELF-HEATING SOLID, INORGANIC, N.O.S
- Packing Instruction P410 applies



Regulatory Requirements

- Packing Instruction P410 permits the use of removable head UN approved plastic drums as single packagings up to a mass of 400kg.
- The inner HDPE drum is a UN approved packaging complying with the requirements of the ADR regulations.
- The inner drum alone therefore complies with the requirements for self-heating substances.
- A filtered vent is fitted to allow the release of any hydrogen that may be produced by corrosion or radiolysis of the oil.



Regulatory Requirements

- The proposed packaging complies with the regulatory requirements applicable to a self-heating substance.
- The proposed packaging can be shown to comply with the General Requirements for All Packagings and Packages in the IAEA Regulations and may therefore be approved as a Type IP-1 Package for the transport of uranium swarf immersed in oil.



Retention of Oil

- We rely on the oil to prevent the swarf drying out and igniting so the plastic inner drum must retain oil.
- Open head plastic drums are typically UN approved for the transport of solids so not guaranteed to retain liquids.
- Testing of similar packages at Gravatom has demonstrated that the inner drum remains leak tight following drop testing.

Requirements for Pyrophoric Materials

What if the payload is conservatively considered to be pyrophoric? Does this make any difference?

The Package must comply with the requirements for a pyrophoric substance.

If not radioactive classification under ADR would be:

- UN1383 PYROPHORIC METAL N.O.S
- Packing Instruction P404 applies

Requirements for Pyrophoric Materials

- Packing Instruction P404 permits the use of:
 - 1) Combination packaging comprising an outer packaging with a hermetically sealed metal inner packaging up to 15kg capacity.
 - 2) Metal packaging (drum or jerrican). Maximum mass 150kg.
 - 3) Composite packaging comprising plastic receptacle with outer steel or aluminium drum. Maximum mass 150kg.



Requirements for Pyrophoric Materials

- A Composite Packaging consists of an outer packaging and an inner receptacle so constructed that the inner receptacle and the outer packaging form an integral packaging. Once assembled, it remains thereafter an inseparable unit.
- The use of a standard plastic drum within a standard steel drum as proposed would not constitute a Composite Packaging.
- Plastic packagings are not permitted.
- The proposed packaging would not be suitable for a pyrophoric material.

Conclusions

- Uranium swarf is classified as LSA-I radioactive material (Class 7) and should be transported in a Type IP-1 package.
- The package design must take account of any other dangerous properties of the material.
- Uranium swarf is considered pyrophoric in its clean (oil free) and dry state.
- A payload of uranium swarf immersed in oil is not pyrophoric. It is classified as a self-heating substance (Class 4.2).



Conclusions

- The packaging must comply with the requirements for a self-heating substance. These are more stringent than IP-1 requirements.
- Uranium swarf immersed in oil can be transported in a Type IP-1 Package comprising of a UN approved plastic inner drum in a steel outer drum.
- The UN approved plastic inner drum satisfies the requirements for transporting a self-heating substance.
- Testing has demonstrated that this design will retain oil under normal conditions of transport.



Conclusions

- This raises a more general question.
- Do radioactive material packages carrying materials with subsidiary risks need to comply with all the requirements applicable to the subsidiary risk?
- Typically this requires a UN tested package having Competent Authority approval.
- Is the radioactive material package testing sufficient?
- That is a subject for another paper.

And Finally ...



- Stacking test on UN tested drum – similar test load.
- UN testing – drum is full of sand.
- Tested in accordance with Radioactive Transport Regulations to carry a number of plastic jerricans.