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TYPE B PACKAGE RADIOACTIVE MATERIAL CONTENTS COMPLIANCE

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ABSTRACT

Implementation of packaging and transportation requirements can be subdivided into three categories; contents compliance, packaging closure, and transportation or logistical compliance. This paper addresses the area of contents compliance within the context of regulations, DOE Orders, and appropriate standards. Common practices and current pitfalls are also discussed.

I. BACKGROUND

The failure to adequately characterize the contents of shipments and adequately prepare packages for shipment has resulted in unwanted contamination of receiving facilities with consequent adverse and sensational reporting by news media, References 1 - 4. This paper reviews the contents compliance issues associated with packaging and transportation of radioactive materials.

II. REGULATIONS

The Code of Federal Regulations (CFR) provides many detailed requirements pertinent to the design, fabrication, testing, and use of radioactive material packagings. Contents compliance is discussed in only a few instances in both the Department of Transportation (DOT) regulations in Title 49 of the CFR and the Energy regulations in Title 10 of the CFR.

A. Transportation

The DOT regulations discuss contents compliance in 49 CFR 173.24 General requirements for packagings and packages and 49 CFR 173.475 Quality control requirements prior to each shipment of Class 7 (radioactive) materials.

The General requirements section identifies four high level concerns about contents and the packaging: no identifiable (without the use of instruments) release of hazardous materials, effectiveness of the package will not be substantially reduced for minimum and maximum temperatures encountered during transportation, no mixture of gases or vapors which through any credible spontaneous increase of heat or pressure significantly reduces the effectiveness of the packaging, and no significant chemical or galvanic reaction between package materials and contents of the package.

The Quality control requirements section identifies specific areas of concern pertinent to radioactive materials. These include a generic requirement that the packaging is proper for the contents to be shipped. More specifically, the quality concerns address the following: packaging is in unimpaired physical condition, each closure device is properly installed, moderator and neutron absorber is present and in proper condition, special instructions for filling, closing, and preparation of packaging for shipment have been followed, each closure is properly closed, and internal pressure of the containment system will not exceed the design pressure during transportation. Ensuring radiation and contamination limits are satisfied is also addressed.

The intent of the DOT regulations appears to ensure that the proper package is used, it is in a working condition, it is properly closed and provides necessary containment, it will not significantly degrade during transport, and credited criticality controls are in place. Internal package temperatures, pressures and potential chemical reactions must be considered.

B. Energy

The Energy regulations in 10 CFR 71.83 and 10 CFR 71.87 provide requirements that apply to Type B fissile packages. Specifically, 10 CFR 71.83 addresses assumptions for unknown properties important to criticality safety. The regulation states that the licensee shall package fissile material as if unknown properties have credible values that cause maximum neutron multiplication. The severe consequences of a criticality event justify the conservative treatment of unknown content properties.

The regulations called out in 10 CFR 71.87, Routine determinations, are very similar to the ones in 49 CFR 173.475. Additional requirements are accessible package surface temperatures must not exceed limits in 10 CFR 71.43(g) and any structural part of the package not designed for lifting or tie down must be rendered inoperable (i.e., unusable for tie down). The general package performance requirements to withstand temperatures and any potential chemical reactions are addressed elsewhere in 10 CFR 71.

In general, there is little regulation regarding content compliance other than the general statement in 10 CFR 71.87 (a) that "The package is proper for the contents to be shipped". The only specific technical guidance applies to criticality safety where there is a requirement to conservatively estimate unknown quantities.

III. ORDERS AND REGULATORY GUIDES

A. DOE Orders

The primary DOE Order of interest is 460.1B Packaging and Transportation Safety. This high level order establishes the mechanism for DOE certification of packages. Compliance with package certificates are addressed in the Requirements portion of the order. As such, contents compliance is addressed as the content restrictions are routinely called out in specific detail. The Order does not provide guidance as to how much detail should go into a DOE package certificate.

B. Regulatory Guides

The Nuclear Regulatory Commission drafted Reg. Guide 7.7 in 1977 titled: Administrative Guide For Verifying Compliance With Packaging Requirements For Shipments Of Radioactive Materials. The Regulatory Guide points to ANSI N 14.10.3-1975 to provide specific techniques and methods for verifying compliance.

IV. STANDARDS AND PRACTICES

A. ANSI N14.10.3-1975

This standard provides a method whereby compliance with packaging requirements may be obtained and documented. The standard emphasizes protection against contamination and radiation exposure incidents. Although much of the standard deals with requirements other than contents compliance, a checklist is provided to address contents issues.

The checklist addresses package degradation due to internal reactions (galvanic or otherwise), content decomposition, criticality, and additional shielding for radiation exposure. The checklist follows many of the requirements for a radioactive materials package as addressed in 49 CFR 173.475.

B. DOE Implementation Guides

The Radioactive Material Transportation Practices Manual (DOE M 460.2-1) establishes a set of standard transportation practices for DOE programs. Section 2.2.1 states the following:

Characterization and classification of the material to be shipped are necessary to ensure that the material is shipped safely and in compliance with applicable regulations and that the material is compatible with the packaging selected for shipment. DOE is responsible for properly characterizing and classifying the material in accordance with DOT requirements and in sufficient *detail to permit identification of appropriate packaging. Material characterization and classification are performed by DOE or contractor technical staff who possess detailed knowledge of the material and who have been properly trained on the DOT regulations pertaining to classification.*

The emphasis is on knowing the material well enough to select the proper package and ensure regulations are adhered to. Section 2.2.3 addresses packaging selection.

Packaging selection depends on the DOT material classification and the chemical and physical characteristics of the material. The shipper is responsible for identifying the proper packaging and taking steps to ensure that the packagings are available when needed for shipment. For Type B packagings, the appropriate certificate of compliance must be checked to ensure that it is current and that the proposed contents have been approved. Packaging selection is performed by the shipper's or contractor's technical staff who have been properly trained on DOT and/or international packaging regulations.

The emphasis is on the shipper's responsibility for content compliance with the certificate.

C. <u>FIELD EXPERIENCES</u>

The fundamental safety issues for transport of Type B packages includes subcriticality, radioactive material containment, and radiation shielding. Fundamental content characteristics such as chemical and physical form, fissile mass, total mass, heat generation, quantities of predominant isotopes, curies, A_2's, and neutron and gamma radiation source are in general reasonably well known prior to package loading. Relatively accurate measurements can be made using radiation measuring equipment (gamma spectroscopy, neutron multiplicity counter, active well counter, ion chambers, neutron counters) and calorimeters when plutonium is being measured. In addition, very accurate balances are often used to measure nuclear material mass prior to confinement packaging. Additional measurements are sometimes made of the total content mass and even the loaded package mass. Thus, primary characteristics such as mass, isotopic distribution or enrichment, heat generation and dose rates of the product containers are typically reasonably well known. However, the complex analyses performed in order to rigorously and unequivocally evaluate package performance inherently lead to detailed specification of what was once considered to be a minor content characteristic such as non-radioactive impurities and presence of very small quantities of radioactive impurities. These detailed specifications of relatively minor constituents are often copied directly into the package certificate. Accurate measurement of such constituents on an individual content or package basis is often not practical and in some cases violates ALARA radiation protection principles. As such, process knowledge is widely used to justify minor constituent compliance. This can lead to inconsistent application of "process history" where some package users approach is "prove me wrong" while others approach it as "we must prove it is compliant".

V. OBSERVATIONS

Although the regulations provide some high level guidance with respect to contents compliance, there is minimal guidance outside of the Safety Analysis Report (SARP) for a particular package. The Certificate for each package provides the absolute minimum in terms of requirements for package compliance. This can lead to inconsistencies and an uneven application of rigor to widely varied requirements. Relatively benign requirements such as non-radioactive constituent mass limits (e.g limit for iron in the contents) are often captured within the content tables which are then pasted into the certificate.

One specific area of concern where small quantities of highly radioactive materials and even particular non-radioactive impurities can theoretically impact package safety is radiation exposure. Almost endless permutations of simulations can be performed varying and optimizing these impurities. In some cases the models used to predict radiation exposure from these mixtures are inherently flawed [Ref. 8]. One approach would be to limit the content surface dose rate of the item to be packaged based upon the shielding protection provided by the package. A nominally bounding shielding analysis would be provided in the SARP with a content verification measurement required prior to placement into the containment vessel. The regulations already require a final post load radiation measurement as an additional verification.

Consider the graded approach used to control packaging designs for comparison. Components important to safety are designated as "A" or "B" on the "Q" list. Specific features of such items are controlled (e.g. thickness of lead shielding, thickness of containment vessel body, gage of drum, etc.). Such components and features are often specifically called out in the Certificate. As such, they can not be re-designed without a formal review from the certifying official. Design components and features not called out in the Certificate may often be re-designed by the package designer provided the change does not adversely impact package performance, as determined by the package designer.

The content descriptions, which are often provided in Chapter 1 of a SARP, should include a listing of content "safety limits". Examples of such limits would be fissile mass, isotopic restrictions (e.g. enrichment), physical form, total heat generation, gross content mass, and moderator mass (where appropriate). Secondary content features such as packaging configuration (e.g. types of cans), non-radioactive constituents, and relatively small quantities of radioactive constituents (e.g. Cs-137 impurity within a uranium content) should be generally described, but establishing limits and proving compliance is often problematic for shippers. As such, the package designer could evaluate and approve minor content deviations as is already done to control packaging designs, provided the deviation is not prohibited per the package Certificate. This approach, in general, would satisfy DOE Order 460.1B, and it would allow the package designer to exercise more authority than is typically allowed. This is justified given the extraordinary transportation safety record in the US.

VI. CONCLUSIONS

Packaging Certificates should specify content parameters important to safety, especially in the criticality area. However, parameters which are not important to safety should not be specified as limits. Instead, bounding assumptions used in the SARP should be identified with allowance for revision with approval from the package designer.

Shippers must establish internal procedures for confirming and documenting the contents they plan to ship.

Strict knowledge of the contents is necessary to select the appropriate package for transport of radioactive materials. Inadequate contents definition can result in a violation of the transportation regulations.

The failure to insure that the contents conforms to the packaging requirements can result in imposition of additional requirements by regulatory bodies with resulting increased operational costs.

All violations of the transportation regulations attract media attention which compromises the efforts of the nuclear industry to build public support and understanding for licensing of long term repositories and resumption of power plant construction.

VII. ACKNOWLEDGMENTS

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VIII. DISCLAIMER

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