SAFKEG HS Response Matrix to the Request for Supplementary Information (RSI) from the Nuclear Regulatory Commission

Docket Number 71-9338

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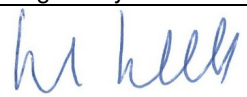
Compiled		Checked	
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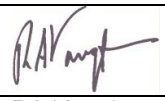
Approved		Date	20th Decmber 2012
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-		<u>General Comments on the basis of the Safkeg-HS SARP</u> The Safkeg-HS SARP is based on the Safkeg-LS SARP. The methodologies used in the Safkeg-LS SARP were discussed at several meetings with the NRC and were the reviewed and finalised in the SARP review process involving several RAIs and Croft responses. The approach of using a "back calculation" for determining the contents from the most restrictive of heat output, mass, radiation/shielding and fissile limits was both the subject of discussion and accepted in approval of the Safkeg-LS package with issue of the NRC certificate. The use of Microshield for the shielding calculations was also discussed and agreed and used in the Safkeg-LS SARP. In considering the RSI's, it is recognised that further explanation and justification is required for the Safkeg-HS SARP – we propose to add this explanation and justification rather than changing the approach from that used in the Safkeg-LS SARP. This is the approach taken is responding to the RSIs in this document. <u>Exclusive use shipping</u> The SARP has been edited to include the option of exclusive use shipping [paras 1.1 and 5.2.1]
1.1	Provide a clear and consistent definition of the package's radioactive contents throughout the application. The current definition of the proposed contents is not clear and is described inconsistently in various locations in the application. The following are specific aspects which should be addressed: a. fissile materials in contents types CT-1, 2 and 3 (information in Tables 1-3-1-3 contradicts information in Tables 1-4-1-3}, b. materials in contents types CT-1 through CT-6 may only be normal form or special form or both, c. sources in configurations such that they are	The following comments refer to the sub-paras of the RSI [a, b, etc]. a. Fissile material should not have been on the list for contents type CT1 to CT6. These nuclides have been removed from the lists. b. No account is taken off the special form however it may be carried up to the normal form limits. This has been clarified in tables 1-3-1 to 1-3-6. c. All the Microshield shielding calculations have been carried out with point sources positioned at the centre of the base of the cavity of the appropriate insert to give the worst case surface dose.

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	effectively point sources, d. complete list of all radionuclides proposed for shipment (approval will only be given for those radionuclides listed in the application), and account for daughters of radionuclides in proposed contents. A consistent and clear definition of the proposed contents is necessary for the staff to evaluate compliance with 10 CFR 71.33(b}, 71.35, 71.47 and 71.51.	d. All the radionuclides proposed for shipment are listed in the contents tables in Section 1 except for the radionuclides that arise in small quantities from activation of target materials and daughters – all of which are < A2 for each radionuclide. The radionuclides that may be present in quantities up to A2 have been added to the SARP as follows. Re radionuclides present in <A2 quantities. A new 5th para has been added to Section 1.2.2.1 for material that may be present in Type A quantities – ie <A2. This appears to be allowed by 49CFR. Re daughter radionuclides Footnotes have been added to Tables 1-4-1 to 1-4-8 as appropriate with a list of daughter radionuclides that may be present. It should be noted that the calculations for the shielding limit for each radionuclide were based upon the maximum dose rate for the listed nuclide and its daughters over a period of 1 year – thus the shielding calculations take the daughters into account. This is explained in Section 5.3.1 of the SARP.
1.2	Ensure the application is consistent in its descriptions of the proposed package and its contents. The application includes a number of apparently inconsistent and confusing statements regarding the package and the contents. As an example, within the shielding chapter, liquid contents are sometimes analyzed as point sources that remain within the insert whereas the analyses in Attachment 2 to that chapter use a different configuration for the liquid contents. Staff also noted that the application refers to different sources (e.g., Ir-192 vs. Cs-137 in Section 5.4.1.1) and a different package (e.g., Sections 1.2.1.2 and 1.2.1.4 refer to a SAFKEG LS package). This information is necessary for the staff to evaluate compliance with 10 CFR 71.33, 71.35, 71.47, and 71.51.	The attached shielding report [ref Serco xxxx] which discusses the Monte Carlo analysis, has been revised to remove the liquid contents. Chapter 5 has been edited to include a fuller description of the shielding methods and calculations.
1.3	Provide clear and legible drawings in Chapter 1 of the application. The application indicates that the drawings included in Chapter 1 (Section 1.3.2) are the basis for the analytical models. The images of	The calculation drawings have now been taken out of the text of chapter one and added as attachments. Scanned copies of the A3 drawings are provided with Revision 1 of the SARP.

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	these drawings in the current submittal are difficult to read. These images are important in enabling the staff to understand the models and ensure their consistency with the licensing drawings. This information is necessary for the staff to evaluate compliance with 10 CFR 71.35.	
2.1	Provide representative Abaqus CAE files (input and output) so that staff may perform a review of the computational methodology used, per ISG-21. Staff requests load cases NCT-9, NCT-1 0, HAC-3, and HAC-5 to make a safety determination. This information is necessary to evaluate compliance with 10 CFR 71.71 and 10 CFR 71.73.	The Abaqus files have been provided along with this response document.
5.1	Provide all appropriate analyses to support the shielding evaluation of the proposed package and its contents. The analyses should address the following aspects: a. all tolerances resulting in minimum shielding dimensions, b. material properties which result in maximum dose rates, c. both normal conditions of transportation (NCT) and hypothetical accident conditions (HAC) and demonstrate compliance with the limits for the respective conditions, d. package and source configurations and conditions assumed for NCT and HAC conditions with justification for those conditions, and e. bounding values for all proposed contents and insert combinations. The analysis provided is apparently for an "as-fabricated' package that equates to an "as designed' package. Since the design drawings to which the packages will be fabricated include tolerances which permit the use of less shielding material, the analyses should reflect the effect of using these tolerances. In addition, the application appears to propose contents limits that are based on back-calculation from the regulatory dose rate limits, and although there appears to be some discussion of source configuration, it is unclear that the configurations adequately address NCT and HAC conditions. Further, some analyses may not address all aspects of the	The following comments refer to the sub-paras of the RSI [a, b, etc]. a. & b. The package limits are based on the approach of using a “back-calculation” for determining the contents from the most restrictive of heat output, mass, radiation/shielding and fissile limits. For the radiation/shielding limits, the nominal values for shielding thickness and material densities were used. An evaluation has shown that if these properties deviate from nominal by the maximum amount to minimize the shielding and maximize the external dose rates for the package, then these done rates would be <30% higher than for the nominal values. Conservative values were used for various factors in the calculations which are considered to be very conservative overall and therefore the listed contents are expected to produce the external dose rates for the package less than the regulatory limit [which was used for the back-calculations]. However, the SARP has been edited to include the option of exclusive use shipping [paras 1.1 and 5.2]. Exclusive use shipping allows the surface dose rate to be 5x that for non-exclusive use. The check in Section 7.1.3.7 of the SARP that the external dose rates for the package are less than the regulatory limit, ensures that the requirements of 10 CFR 71 are met - either for exclusive use or non-exclusive use, and the shipment will

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	package. For example, the contents associated with the steel insert do not appear to be addressed in the Monte Carlo analyses. Finally, the evaluation needs to demonstrate that a package which has undergone the respective tests for both NCT and HAC conditions (see 10 CFR 71.71 and 71.73) meets the respective dose rate limits. The information in the current shielding evaluation does not distinguish between NCT and HAC analyses, and it appears that the provided analysis only demonstrates package compliance with NCT dose rate limits. There is neither discussion of analyses for a package having undergone NCT or HAC conditions nor any justification provided as to why the current analysis is adequate to cover NCT and/or HAC conditions. There is also no discussion of HAC dose rate limits and compliance with them. This information is necessary for the staff to evaluate compliance with 10 CFR 71.35, 71.47, and 71.51	be made accordingly. c. Table 5-2 has been added to give maximum radiation levels for the proposed contents under HAC together with an explanatory paragraph. d. All the Microshield shielding calculations have been carried out with point sources positioned at the centre of the base of the cavity of the appropriate insert to give the worst case surface dose. This is explained in the SARP in Section 5.5.4.1. e. Bounding values for the activities of all listed radionuclides for all proposed contents and insert combinations are given in Section 1 in Tables 1-4-1 to 1-4-8. A discussion on the HAC dose rate limits has been added to Section 5 with Table 5-2.
5.2	Provide an evaluation with analyses that demonstrate compliance with the regulatory dose rate limits. The current shielding evaluation appears to rely upon the McBend and Microshield analytical methods to determine the dose rates and allowable contents. However, it is not always clear which method is used to demonstrate compliance with specific regulatory limits. In addition, the dose rates calculated for a variety of the contents using the McBend code appear to exceed the regulatory dose rate limits. Thus, it is not clear if compliance with those regulations has been demonstrated. The evaluation should be based upon analytical methods that are appropriate for the package and source configurations and the radiation emitted by those contents. This information is necessary for the staff to evaluate compliance with 10 CFR 71.47 and 71.51.	MCBEND was used to validate Microshield model and to determine the worst case shielding location. The quantity of Cs-137 on the contents list is far smaller than that on the report. Chapter 5 has been edited to clarify the shielding methods and calculation.
5.3	Provide a summary table showing the maximum radiation levels for the proposed contents under NCT and HAC conditions. Table 5-1 in the current evaluation appears to merely repeat the NCT dose rate limits for non-exclusive use packages. Since the evaluation appears to determine the allowable contents by back-calculation from the regulatory dose limits, dose rates calculated for one or more of the proposed contents would be sufficient to demonstrate compliance	Chapter 5 has been edited to clarify the shielding model, assumptions and outputs in order to provide the information required in this question. Table 5-2 has been added to give maximum radiation levels for the proposed contents under HAC together with an explanatory paragraph.

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	with the regulations. Supporting information, such as modelling assumptions used to generate the dose rates, should also be provided. This information is necessary for the staff to evaluate compliance with 10 CFR 71.47 and 71.51.	
5.4	Provide an evaluation that uses appropriate flux-to-dose rate conversion factors to demonstrate compliance with the regulatory dose rate limits. In the application, cite the conversion factors used in the evaluation. The application uses conversion factors that are based on effective dose equivalent (e.g., ICRP 51 and 74 factors) and are not appropriate for demonstrating compliance with 10 CFR Part 71 dose rate limits which are based on dose equivalent. The staff's guidance is to use the conversion factors from the 1977 revision of ANSI/ANS 6.1.1, "Neutron and gamma-ray flux-to-dose rate factors," and to provide the factors used in the analyses in the application. Other conversion factors that calculate the dose rates in terms of dose equivalent may be used; however, the application would need to include them along with a justification for their appropriateness. This information is necessary for the staff to evaluate compliance with 10 CFR 71.47 and 71.51.	The approach and terminology in the SARP follows IAEA TR-R-1 -1995 and ICRP 51. This was done as it was understood that the NRC are in the process of harmonizing with the IAEA regulations and it was expected that this would be effected before the review of the Safkeg-LS and Safkeg-HS certificates would be issued. This approach was followed for the Safkeg-LS SARP. The dose rates in the SARP are all Effective Dose rates [referred to as Effective Dose Equivalent by ICRP UP TO 1990 and currently in 10 CFR 71] – this is consistent with the IAEA regulations which uses Effective Dose rates. We propose that the approach in the SARP remains as is [this being then be consistent with IAEA and anticipated 10 CFR], but notes have been added to the SARP to explain that this difference will not cause the dose rates to exceed the allowable limits. An evaluation of the difference of using the flux-to-dose rate conversion factors in ANSI/ANS 6.1.1 1977 and ICRP 51 and 74 has shown that the calculated dose rates will only differ by <20% Evidence that this is acceptable in showing compliance with the requirements of 10 CFT 71 is given in the response to RSI 5.1.
6.1	Clarify the limits on fissile material to be shipped in the Safkeg-HS. Tables 1-3-1 through 1-3-3 for content types CT-1, CT-2, and CT-3 do not discuss fissile material as allowable contents; however, corresponding Tables 1-4-1 through 1-4-31ist activity limits for plutonium-239 and plutonium-241. Also, Tables 1-4-7 and 1-4-8 report activity limits corresponding to masses greater than the fissile material limits in the fissile exemptions in 10 CFR 71.15, and the general licenses in 10 CFR 71.22 and 10 CFR 71.23. This information is needed to ensure the	The fissile material was inadvertently listed in section 1 tables 1-4-1 to 1-4-3. These have been removed.

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	package design meets the fissile material requirements in 10 CFR 71.15, 10 CFR 71.22, and 10 CFR 71.23.	