IMPLICATIONS OF PROPOSED NEW GROUPING SCHEME AND SYSTEM OF REQUIREMENTS FOR THE TRANSPORT OF LSA-TYPE AND SCO-TYPE MATERIALS

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A new system of regulations for the transport of Low Specific Activity Materials and Surface Contaminated Objects (LSA/SCO) is being developed as a proposal to replace the current LSA/SCO classification system. This is a joint project between the above-named organisations in three countries, and is part-funded by the European Commission.

The numbers of transport movements of LSA/SCO-type materials are likely to increase in the future as nuclear facilities are decommissioned and radioactive wastes are transported to disposal facilities. However, the experience of transport users with the existing transport regulations (IAEA 1985/1990) has not proved totally satisfactory, and further problems can be expected in demonstrating the compliance of new types of LSA/SCO materials and transport packages.

The proposed system (Lange et al, 1995) groups packages containing solid LSA/SCO-type materials into three main categories, which are based not only on the radioactivity contents of the packaged materials but also on the properties and performance of the materials and packages, and on assessments of the potential radiological consequences of accidents. This system would maintain the safety levels of the existing transport regulations (IAEA 1985/1990). Consideration of the material properties and radiological consequences is in accordance with modern regulatory thinking, but had not been fully applied to LSA/SCO packages until now.

This paper considers the implications of classifying solid LSA/SCO-type materials according to the proposed new system using data on the materials and packages that are either presently transported in Germany, France and the United Kingdom, or will need to be transported in the future.

CURRENT DIFFICULTIES

The current system of LSA/SCO classification was introduced in the 1985 version of the IAEA Transport Regulations (IAEA 1985/1990) and has continued into the 1996 version (IAEA 1996). Limitations of the present system of LSA/SCO classification have been identified as follows (Lange et al 1995).

- It is difficult to distinguish between LSA-type material and SCO-type. Largely for this reason, and because of the difficulties of demonstrating compliance with SCO criteria (see 2 and 3 below), movements of 'LSA/SCO' materials are generally made as LSA. This brings into question the practical value of a separate SCO classification.

- It is difficult to distinguish surface contamination from activity within the object, and between "fixed" and "non-fixed" contamination.

- To demonstrate compliance with SCO requirements, measurements of both "accessible" and "inaccessible" contamination are needed. It is not clear how compliance with the "inaccessible" contamination limit can be measured if it cannot be reached.

- Many other terms are not well defined (e.g. "distributed throughout" and "combustible") and this makes it difficult to demonstrate unequivocal compliance with the regulations.

- The relevance of the leaching test for LSA-III is not obvious, and the test is very difficult to perform in practice.

- Even trace quantities of materials that are forbidden can bring compliance into question.

- The underlying radiological basis is rather weak. The regulations make gestures towards the mitigation of transport accidents (e.g. the limit on a single conveyance for combustible materials) but the accident consequences have not been systematically assessed, and some potentially significant exposure pathways have been missed (e.g. exposure due to activity deposited on the ground).

In summary, the present LSA/SCO system has a number of limitations, and also it does not meet modern standards of radiological justification.

PROPOSED NEW SYSTEM

The proposed system (Lange et al 1995) aims to cover a wide range of transport packages. At present LSA-I is retained as the lowest classification under its old name, but a new system of "G" classification replaces the whole of LSA-II/III and SCO-I/II. At a later stage, consideration will be given to incorporating LSA-I into the G-system, and also to the requirements for the transport of gases and liquids.

The basis for defining the new groups G1, G2 and G3 is the release behaviour of the package in accident conditions. This approach leads to criteria that are not based on the contents activity alone, but also take account of the combined effects of material properties, other protective measures and external packaging. The three new groups are for materials with 'high', 'intermediate' and 'low' radionuclide release fractions under specified accident conditions.

Figure 1 shows the proposed criteria in the form of a decision tree. The general requirements for all groups are that:

- The radioactive materials must be in solid form (liquids and gases will be considered at a later stage).
- The volume of radioactive material in the package must be greater than 50 litres.
- The material is allowed to contain up to 1% of the activity limits of components that are nominally excluded from that classification. For example, if a requirement within the G-system is that the material must contain "no powders", it means that up to 1% of the radioactivity limit may be present in powder form.

Group G1

Group G1 is for radioactive materials that are not expected to retain their radionuclide content in fire accident conditions, although substantial retention is assumed in impact accidents. The low radioactivity limits that result from these assumptions are compensated by few regulatory requirements concerning the materials themselves, and no special requirements for packaging beyond the normal IP-2 and IP-3 'strong industrial package' standards. Group G1 may therefore include materials such as powders that are easily dispersible by mechanical impact, or materials that are defined as 'combustible'. It may also include surface contaminated objects, but there is no assumption or requirement that any of the activity is 'fixed' or 'inaccessible'.

Group G2

Group G2 is for materials that are not easily dispersible, so powders are excluded. This group can also include materials that are combustible or can be decomposed by heat, but their melting point must exceed 300°C. Experimental findings show that activity releases during a fire are much reduced if the material essentially remains in bulk form within a breached packaging than if material flows out of the packaging and burns within the open flames of the fire. All exclusions are subject to the 1% allowance, which is justified by the radiological assessment. As with group G1, group G2 involves no special requirements for packaging beyond normal 'strong industrial' standards.

Group G3

Group G3 is intended for materials and packaging that will ensure low radionuclide release fractions under the specified accident conditions; and this allows a higher radioactivity content. The penalty is that both the materials and their packaging are specified more closely, and this results in more complex requirements for Group G3.

There are a total of four sub-groups in G3, so that compliance can be demonstrated using different combinations of radioactive material properties and packaging. To meet the requirements for a particular G3 sub-group, the package must meet **all** of that sub-group's criteria as shown in Figure 1, which together ensure that the overall level of accident performance will be approximately the same in all cases.

In keeping with modern practice, the justification for the proposed criteria for the G-series of packages is based on assessments of the radiological consequences of transport accidents. Details are given in the previous paper (Lange et al 1995).

EVALUATION OF PROPOSED SYSTEM

If the proposed system is to be a worthwhile improvement on the present LSA/SCO regulations, it must be shown to be practicable:

- It must cover all practical LSA/SCO-type packages requiring transport, both at present and in the foreseeable future.

- It must be as simple as possible for users to identify the correct package category and to demonstrate compliance.

To measure the performance of the proposed system with respect to these requirements, it has been tested using package databases from France, Germany and the United Kingdom.

France

An IPSN database on the movements of radioactive material in France during 1996 has been used for the purposes of this study. This database is not limited to either waste or LSA/SCO materials, but covers all categories of radioactive materials and packages (from excepted to Type B packages) from different groups of producers including the nuclear power industry, civil and military scientific research, and industrial and medical sectors. Collection of information is still in progress for other consignors identified in the main national RAM transport database.

The LSA/SCO packages were extracted and re-classified as LSA-I or into the proposed G-system, making reasonable assumptions about the materials and packaging involved.

All the LSA-I packages remained in that classification, but almost all other packages were re-classified as G1. Together these two categories make up 95% of all the packages considered. Only 1% fell into groups G2, G3 or Type B. The remaining 4% of the packages could not be re-classified owing to a lack of information about radionuclide contents, but these are too few to affect the overall pattern. In France, almost 25% of the present LSA/SCO movements analysed are performed using Type A or Type B packages because they are available, even though the Transport Regulations do not require it. Therefore it might not be necessary to use groups G2 and G3 at all, because Type A/B transport capacity is available for the relatively small numbers of movements involved. The following table shows the results, in terms of numbers of packages.

Original classification	Total packages	LSA-I	G1	G2 or G3 or Type B	Not re-classified (see note)
LSA-I	64234	64234	-	-	-
LSA-II	39192	-	37116	616 (UF_6)	1460
LSA-III	4422	-	4283	-	139
SCO-I	335	-	71	-	264
SCO-II	2899	-	60	-	2839
Total	111082	64234	41530	616	4702
%	100 %	58 %	37 %	1 %	4 %

Note: not re-classified due to lack of information about radionuclide contents.

Germany

The database used for the evaluation of LSA/SCO transport criteria has been compiled for radioactive waste management and disposal purposes and comprises about 220 waste categories. The data available comprise type and origin of waste, type and net-volume of packages, type of conditioning/immobilisation, radionuclide specific activity, unspecified α-activity and β/γ-activity as well as average and upper values of total α-activity and total β/γ-activity. The number of individual radionuclides specified is typically 10 to 30 per package out of about 150 different radionuclides considered in total, and the fraction of packages in the upper activity range is not well known, but even pessimistic assumptions were found to have little effect on the classification results. As in the French assessment, reasonable assumptions were made about the materials and packaging involved, in order first to classify the waste as LSA-II, LSA-III or above LSA-III and then to re-classify them into the proposed G-system. In this study, LSA-I was not considered and there was insufficient information for SCO classification. The results are presented below, in terms of numbers of packages.

	Total packages	G1	G2	G3
Total	92532	76570	8292	7670
%	100 %	82.8 %	8.9 %	8.3 %

United Kingdom

The analysis used information from the UK Radioactive Waste Inventory (United Kingdom, 1996) which includes both current stocks of wastes and forecast future arisings. A total of 1073 waste streams were considered, and classified into LSA-II, LSA-III and Type B. It was assumed that all packages containing more than 15g of fissile material would automatically be transported as Type B, and reasonable assumptions were made where material properties of the wastes were not available. An algorithm was devised to implement the group G3 sub-classification shown in Figure 1, and the results were as follows.

	Total packages	G1	G2	G3a	G3b/G3c	G3d	Type B
Total	209361	148284	5514	68	39	0	55456
%	100%	70.8%	2.6%	0.03%	0.02%	0%	26.5%

A separate study from the UK considered mostly the needs of small-scale transport users. These movements are mainly of low level radioactive waste (LLW). Although the volumes of waste and the quantities of radioactivity from individual users are usually very small, the quantities increase when waste is collected for bulk transport to a disposal site. Even so, hardly any radionuclides arising in LLW from small users could exceed the G1 limit in any practical transport movement (a possible exception being a large movement of LLW containing americium-241, which could reach G2). A second example is the transport of pipelines and vessels that have been used for oil extraction, and have become internally contaminated with a mineral scale containing natural radium-226. Components that require de-scaling are currently transported in freight containers as SCO-I, although some can be transported as Excepted packages. These packages would fall well within the G1 category. Ores containing natural radioactivity generally require no higher transport classification than LSA-I, which has not yet been considered as part of the proposed G-system.

The same study also considered the movement of a large contaminated plant item that had taken place as SCO-II. Because the available data were in terms of surface contamination (Bq cm^{-2}) reasonable assumptions had to be made about the surface area in order to estimate the total activity. The item was a nuclear reactor gas circulator pump, designed to be transported in an ISO-style freight container as an SCO-II item after decontamination, leaving sulphur-35 as the main radionuclide. Even with extremely pessimistic assumptions about the contamination levels, the total activity would still be about four orders of magnitude below the proposed G1 limit. Extending this example further, if the item had been activated as well as contaminated, there would have been problems under the present system in deciding whether it was LSA or SCO; under the proposed system this problem disappears.

DISCUSSION

Although various LSA/SCO waste streams could not yet be included in the three studies for various reasons, there is no evidence of 'unclassifiable' materials. In other words, the proposed G-system can be expected to adequately cover all practical cases of solid materials.

All three of the above analyses show that the large majority (>80%) of items presently classified as LSA-II and LSA-III would fall into group G1. Only a few examples of SCO items have yet been considered, but these show very comfortable margins of compliance with group G1 criteria. Therefore group G1 would cover most practical requirements. This would be a great benefit to transport users, because demonstration of compliance for group G1 is very straightforward.

However, the G3 proposals could potentially be simplified from the four sub-groups, considering the small numbers of items involved, and further consideration should be given to this.

To avoid the need for complex demonstrations of compliance, especially in groups G2 and G3, the radiological justification of the proposed new regulations needs further work to make it more robust. The assumed release fractions would benefit from another review on a world-wide scale, to ensure that they are conservative for all practical types of packaged LSA/SCO-type radioactive material. Similarly the definitions of key criteria such as *sufficiently homogeneous*, *mechanically stable* and *thermally stable* need to be further quantified.

Above all, it is important to ensure that there are practical routes to demonstrate compliance for every type of radioactive material and transport package involved. Therefore any future programme requires continuing participation from transport users. Further work will address the incorporation of LSA-I material, liquids and gases.

CONCLUSIONS

The work carried out to date demonstrates that the proposed new system for regulating the transport of radioactive material which is of low specific activity and/or consists of objects with surface contamination has significant benefits for both regulators and transporters of such material. However further work is necessary before the system can be finalised and its benefits compared with the existing fully identified.

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Figure 1: Decision Tree for Proposed System