
SAFETY SERIES

No. 7

Regulations for the Safe Transport
of Radioactive Materials

Notes on Certain Aspects of the Regulations

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA 1961

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**REGULATIONS FOR THE SAFE TRANSPORT
OF RADIOACTIVE MATERIALS**

**NOTES ON CERTAIN ASPECTS
OF THE REGULATIONS**

INTERNATIONAL ATOMIC ENERGY AGENCY
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MATERIALS
NOTES ON CERTAIN ASPECTS OF THE REGULATIONS
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FOREWORD

The International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Materials were published in May this year.

During the meetings of the two panels which (as stated in the Introduction to the Regulations) were convened by the Agency to prepare the regulations, the view emerged strongly that there would be great advantage to all concerned if a document could be published by the Agency to supplement the regulations themselves with material of both a scientific and a general character relating to them.

The present notes have been produced in response to that demand.

They attempt to provide some broad general guidance to users as to the purpose of the regulations and their working out in practice. They contain also the scientific background to the classification of radioisotopes for transport purposes given in the regulations. Furthermore, an approach has been made to the difficult question of design of containers in relation to the factors that have to be taken into account by competent authorities in approving Type B containers, with a view both to helping those concerned on both sides of this transport problem, and to stimulating further thought on the subject, in order to build up a corpus of practical experience in this field.

So far as broad guidance to users is concerned, two papers are incorporated in this supplement; firstly, a layman's guide to the regulations prepared by Mr. A. H. K. Slater (United Kingdom) who served on both panels and secondly, a synoptic table of the regulations prepared by Monsieur G. E. André (Belgium) who was chairman of the first of the Agency's transport panels. An example has also been given of an assessment of the amount of exposure to transport personnel, through the courtesy of British European Airways and the United Kingdom Atomic Energy Authority. The paper on the classification of radioisotopes has been prepared by Mr. A. Fairbairn (United Kingdom) who served on the panels mentioned above and Mr. N. J. Dunning, a former member of the UKAEA. Mr. Fairbairn has also contributed a paper on the derivation of maximum permissible levels of radioactive surface contamination of transport containers and vehicles. The paper on the testing of transport containers was written by Mr. A. Grange (United Kingdom).

The Agency is grateful to all those named for their work, and for their help in producing the present document. The notes are now issued in the hope that further thought on these and on other related problems may be stimulated; but they should not be regarded as representing the official policy of the Agency on the subject with which they deal.

A handwritten signature in black ink, reading "Sterling Cole". The signature is written in a cursive style with a large, prominent "S" and a long, sweeping underline.

August 1961

Director General

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CORRIGENDA

Page 43, line 3 For " case A " read " case B ".
 line 9 For " half-life " read " effective half-life ".

Page 44, Table VI Under column "Metal" read:
 "Natural Thorium"
 "Thorium"
 "Natural Uranium"
 "Uranium"

Tables V
and VI Points should not be type-set.

Page 88, line 10 For " 100°C " read " 82°C "
 from bottom

Page 102, last line " Container, wood, moderated Type B,
 from for massive metal " should come in
 bottom between figure and legend on page 100.
 last line " Container, heat-insulated Type B, for
 fluids " should come below figure on
 page 101.

A LAYMAN'S GUIDE TO THE INTERNATIONAL ATOMIC ENERGY AGENCY'S REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS*

A. H. K. SLATER

UNITED KINGDOM

1. *Why is the International Atomic Energy Agency concerned itself with a matter like transport of radioactive substances?*

The IAEA is the United Nations body concerned with the peaceful uses of atomic energy, and is authorized by its Statute to establish standards of safety for protection of health and minimization of danger to life and property; its Transport Regulations have been made in pursuance of those functions.

2. *What relation do these Regulations bear to national regulations?*

They apply at the moment—and only could so apply in advance of any convention on the subject—to States who have taken them over into their own national legislation. But they are written in such a form that a State not having such legislation can take them over complete, if it so wishes, for its own purposes. They will, of course, greatly facilitate international movement of radioactive substances to the extent that States which are Members of the Agency either adopt them firmly themselves or agree to apply their provisions to international movements.

3. *What do these Regulations cover?*

The carriage of all radioactive substances. Now it must be made clear that a substance is not regarded as radioactive at all for the purposes of these Regulations unless it has an activity of more than $0.002 \mu\text{c/g}$: and a consignor may be required by a carrier to certify that any given substance does not fall within the scope of the Regulations.

* (*Caution:* This guide is not a substitute for the Regulations themselves and for the details of the specific requirements in each case, reference must always be made to the Regulations. General references to the Regulations have been given at appropriate points throughout the guide: these are intended as “signposts” only, and readers are warned that they are not necessarily exhaustive).

4. Are all modes of transport covered?

Yes, all except the post. But the warning should just be sounded here that some of the rules given below are slightly modified in relation to carriage by sea or by inland waterways—particularly with regard to numbers of packages carried and stowages in mixed loads especially with undeveloped X-ray or photographic films or foodstuffs.

5. What is the general aim of the Regulations?

It is to permit the carriage of radioactive substances (as described in Answer 3 above) quite freely. Radioactive substances are accepted to be dangerous goods; but there are now well-established procedures for the carriage of such goods generally, and the Regulations aim at fitting radioactive substances into these procedures safely and smoothly.

One particular point is that those concerned with or affected by the transport of a particular package (whether as transport workers or as members of the general public) will not receive a radiation dose in excess of that prescribed by the International Commission on Radiological Protection (ICRP) as acceptable annually for members of the general public (including children). (This is usually called the non-occupational dose).

6. How is this achieved basically?

By laying down rigorous standards of packaging and containment which are designed to keep radiation within permissible limits, even in the event of an accident.

7. Does this mean then that all these substances can be carried safely?

Yes, provided you observe the rules for each class.

8. Does that mean I need to differentiate between the substances themselves in some way?

Yes: they are classified according to their radiotoxicity in three classes as set out in the Regulations themselves and there are also special provisions for fissile materials.

[Annex I, Table IV: Sections 6 and 15]

9. *What does this differentiation mean in practice?*

It means that for each class only a certain activity level can normally be carried, subject to the type of packing used.

10. *Could we go a little more fully into "type of packing and container": what are these?*

Yes, we do not lay down hard and fast rules about materials to be used, or go into detail of the type of construction, but we distinguish two broad classes:

- (i) Type A packing which will prevent loss or dispersal of the radioactive content and retain shielding efficiently under conditions normally incident to transport (such as minor drops and spills) and under minor accidents; and
- (ii) Type B packing which has the same effect under conditions normally incident to transport, and must also take account of the maximum credible accident relevant to the mode of transport.

In general, of course, all radioactive materials must be so packed that the possibility of their escape in any form or manner is brought to the absolute minimum. Containers must therefore be leak-proof, and securely closed by a positive fastening device. Furthermore, this container must be enclosed in a shield adequate to prevent an external dose rate in excess of those laid down.

Where the radioactive materials are *liquid*, there are additional requirements in the interests of safety, chiefly that receptacles should have sufficient ullage to ensure that there is no gas pressure built up sufficient to disrupt the receptacle, and that these receptacles should be surrounded by enough absorbent material to absorb the entire contents.

[Section 5: Annex I, Packaging Note]

11. *So these materials can be sent by any mode of transport, i. e. road, rail, sea or air, once I have satisfied the Regulations?*

Yes, if they are packed according to the standards mentioned.

12. *So would I be right in summing up the position as follows:*

- (a) *Radioactive substances themselves are divided into three classes, according to radiotoxicity.*
- (b) *There are, for each such class, two types of packing possible, Type A or Type B, according to the requirements of each case, so that*

- (c) *This gives six possible variations; substances of Groups I, II and III in Type A packing or Type B packing respectively—and the limiting factor is the activity content in each case?*
- (i) *Group I substances in Type A packing.*
 - (ii) *Group II substances in Type A packing.*
 - (iii) *Group III substances in Type A packing.*
 - (iv) *Group I substances in Type B packing.*
 - (v) *Group II substances in Type B packing.*
 - (vi) *Group III substances in Type B packing—and the limiting factor is the activity content in each case?*

Yes, and there are two further safeguards in the interests of safety.

13. *What are these?*

They are:

- (i) That not more than 50 such packages may be placed in any one car or vehicle or aircraft or ships' hold at any one time; and
- (ii) That the number of packages with a certain type of label (see Question 15 below) to be placed in any one car or vehicle or aircraft at any one time shall be so limited that the total number of radiation units does not exceed 40. (You will see that a radiation unit is explained in the definitions to the Regulations).

[Section 10. 2. 1,—10. 2. 2. and 1. 1. 5.]

14. *Are there any other rules I have got to know?*

Yes, outside the framework described in Question 10 above we still have some other important factors.

15. *Can you tell me about all this?*

Yes, let us begin with the limitation of external radiation—I mentioned (in Answer 10 above) that packages in general had to be enclosed in a shield to prevent the external dose-rate from exceeding certain limits. Packages are divided into two categories according to these limits, and we call them White and Yellow. In general terms, White packages are such that the dose-rate of the radiation originating from the contents at any point of the external surface of the package at any time during transport will not exceed 10 mr/24 h for gamma and/or X radiation, and certain equivalents for other types of radiation: while the levels for the Yellow category are 200 mr/h for gamma and/or X radiation and

equivalents for the other types at the surface, and 10 mr/h for gamma and/or X radiation (and equivalents otherwise) at 1 m from any external surface of the package.

[Section 7]

16. *What does this mean for me in practice? Does it tie up in any way with what you have said about the substances in Question 12?*

There is no direct connection between these two things. In Question 12 we are talking about packaging and containment. Here we are talking about shielding in order to limit the external radiation dose-rate. That means that once you have decided on contents you have got to consider the sort of shielding necessary to achieve these dose rates. In practice nearly all alpha-emitting substances will come in the White category, and all gammas in the Yellow, and you will have to arrange accordingly. With the beta-emitters there is room for manoeuvre, and you will have to consider the energy emission of each particular substance before deciding what thickness of shielding you want and whether you can bring this down to the White category or whether it should remain at the Yellow. The category itself will be shown of course by affixing labels of the appropriate colour to the outside of the package, but we will come on to labelling later.

[Section 7]

17. *How do I measure these rates?*

You must use instruments approved by the competent authorities for the form of transport you are undertaking, but in general terms a simple beta-gamma dosimeter should tell you all you will need to know about surface and distance radiation levels here.

[Section 1.3]

18. *Can we sum up again at this stage?*

Yes. First of all, you have your radioactive substance. You decide first that it falls within the Regulations at all (Question 3), and then in accordance with activity level and radiotoxicity group you determine the type of packing and containment you want (Question 12). Then you must also consider the external radiation dose-rates, and this is essentially a problem of shielding of the package. What you have to achieve there is set out in Question 16.

19. *Are these all the other factors?*

No, I want to consider massive non-friable solids, fissile materials and special arrangements.

20. *What about the massive non-friable class?*

Where the radioactive material is made up in the form of a non-friable massive solid, non-reactive with air or water, and non-soluble in water, a total activity irrespective of radiotoxicity groups (Question 8) can be carried of up to 20 c in Type A packing and 2000 c in Type B.

[Section 6. 2. 1. 1.]

21. *And fissile materials?*

As you know, this is one of the special difficulties in this field and we are trying in the Regulations to make a move, with all possible safety precautions, towards a slightly freer concept of transporting this particular material.

First of all, for certain small quantities set out in the Regulations you do not need any additional precautions just because these materials are fissile. This is intended to help, for example, the traffic in very small samples and similar quantities.

After that, we have three main classes. The first is where the material is contained in such a way that every package is safe from neutron interaction in any arrangement: this means that a critical assembly will not be formed when any number of such packages are stacked together in any manner.

The second class comprises shipments in packages which do not meet the very stringent requirements of Class I, but where the number of packages transported together is strictly limited on the basis that a critical assembly will not be formed in any credible circumstance even if five times the allowable number were to collect together. Of course if the actual number of packages on this basis should exceed 50, then that number must be reduced to 50 in accordance with what was said in Question 13 above.

Class III covers all shipments not included in the foregoing. Packages used for shipments in this Class must be so constructed that the shipment will be nuclearly safe at all times during shipment, and competent authorities must certify the basis on which the nuclear safety of the shipment is insured. All this means that special arrangements are necessary under this Class.

[Section 6.2.2. and 15]

22. What exactly are these?

Perhaps I should explain the idea behind this. The Regulations have the concept of special arrangements in relation to fissile materials, large sources and explosives. In such cases there must be consultation with the competent authorities concerned on all the details of the particular consignment and its movement; and it is difficult in advance to say what special conditions or other measures these competent authorities may require.

23. Do fissile materials have any other special requirements?

Yes, you will want to look at these in detail but the following factors are important:

- (a) They must be so packaged that conditions of criticality cannot be reached.
- (b) They must always be in Type B packing.
- (c) You must also have a Certificate of Nuclear Safety for this type of shipment (See Question 21 above).

[Section 15]

24. Does this cover all the main types of source?

No, we had better also consider large radioactive sources. Anything above the levels I have given in Question 12 should be considered a large radioactive source and, in practice, they will often require a special arrangement. Basically they will also require a Type B package and the external dose-rate has a White and Yellow class just as the other sources. You will find the details of this set out in the Regulations.

[Section 16]

25. Do all these rules cover things like waste, sludges, ores, concentrates and so on?

No, these are rather special cases which have rules of their own, in general much less rigorous than those for the sort of things we have been discussing otherwise. You should refer to the Regulations themselves for the details.

[Section 14]

26. We have talked about labelling, what are the requirements here?

The form of the label and its colour, White or Yellow, according to the external dose-rate is set out in the Regulations themselves, and you will see that both of them call for certain information about the contents.