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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the Transport of Dangerous Goods (Twenty-first session, 1-10 July 2002, agenda item 9)	**Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals (Third session, 10-12 July 2002)**

PROPOSAL FOR THE DEVELOPMENT OF A NEW WARNING SIGN FOR HAZARDOUS RADIOACTIVE SOURCES

An IAEA-Coordinated proposal issued for comment

The IAEA Secretariat is issuing a proposal for the development of a new warning sign for hazardous radioactive sources. The proposal is being distributed to Member States and relevant organizations with the purpose of soliciting comments and ideas from interested parties. Comments on the proposal and any suggestions for sign designs are welcome and should be sent to the contact point in the IAEA Secretariat before the end of the comment period. Comments received after this period may be taken into consideration if possible and appropriate.

Background

Experience has shown that uninformed individuals who may come in contact with orphan radioactive sources often do not understand the radiation trefoil symbol as a hazard warning. This is because the symbol does not have inherent meaning. It requires education or training to understand its message. Indeed, it can be argued that the symbol was never intended to be a warning sign. An early ISO standard on the trefoil [1] states that it "shall be used or displayed only to signify the actual or potential presence of ionizing radiation…" and that it "may be accompanied by additional symbols or words, where necessary to indicate danger". However, in a new draft standard [2] a black trefoil within a yellow and black triangle is stated to mean "Warning: radioactive material" with its function "To warn of a hazard or danger from radioactive material".

Accident investigations demonstrate that several people die and many are injured each year as a result of contact with sources that are not under regulatory control. In several documented cases [3, 4, 5] these exposures have occurred despite the presence of the radiation trefoil sign on or near the source. One of the observations and recommendations from the IAEA report on the radiological accident in Goiania, Brazil [3] was that "Recognition by the general public of the potential danger of radiation sources is an important factor in lessening the likelihood of radiological accidents. Due consideration should be given to a system of markings for radiation hazards that would be recognizable to the wider public." This theme was repeated in the IAEA report on the radiological accident in Istanbul [4], which states: "The trefoil symbols on the source containers failed to convey the potential radiation hazard. Another symbol might provide a more effective warning to the public of the potential hazard." Similarly, the Samut Prakarn (Thailand) accident report [5] recognizes that "There is a need for an international review of the usefulness of the trefoil symbol and the possible need for a more intuitively understandable warning sign for Category 1 or 2 sources."

The December 2000 International Conference of National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Materials [6] addressed the issue in finding No. 7: "Consideration should be given by governments to the possibility of establishing, under the aegis of the IAEA, a universal system of labelling of radiation sources. It is obviously necessary for radiation sources to be labelled in such a way that the public is immediately aware of the associated hazards, but at present they are not so labelled. The trefoil symbol alone is often not a sufficient warning of the hazards associated with a particular radiation source." Accordingly, the IAEA's Revised Action Plan for the Safety and Security of Sources [7] has an activity which states that the IAEA should "As a highest priority, explore the possibility of developing and implementing a universal system of labelling such that any member of the public is immediately aware of the dangers associated with hazardous radiation sources." This proposal is the next step in this process.

The purpose of this proposal is to solicit comments on a programme to develop, test, and implement a new sign that will readily convey the message, to anyone who may encounter it, that the object to which it is affixed is hazardous (or contains something hazardous), and that the individual should avoid contact with it.

Benefits

The implementation of a new warning sign for radioactive sources should reduce fatalities and serious injuries due to exposure, since people encountering such sources will be less likely to contact the source or attempt to dismantle its shielding. However, it should be recognized from the outset that a new sign is unlikely to prevent *all* future accidents.

A new warning sign, when used in conjunction with the trefoil, has the additional benefit in that it will assist trained emergency first responders by helping to convey the potential magnitude of the radiation hazard and the proximal location of a hazardous source.

The Target Audience and the Message

Before any programme to develop and implement a new warning sign is undertaken, it is important to know the audience to which the warning is to be directed, and to understand the intent of the message that the sign must convey to that audience.

It is proposed that the audience for this new warning sign include potentially any citizen, anywhere in the world, who may encounter an orphan source; and that the simple message to be conveyed is that this source is dangerous and should be left alone. This proposal excludes radiation protection experts and emergency first responders from the target audience. They do not require such a sign to inform them of the hazard because they have already been trained on the use of the trefoil to identify such hazards. However, as noted above, a new sign could also be of benefit to these professionals by conveying additional useful information to them.

Given the diversity of the target audience, it is suggested that any new sign should not necessarily attempt to convey the nature of the hazard; but rather indicate only that a hazard exists and that it is important to avoid contact with it. This is because the effectiveness of any sign is directly related to its simplicity and clarity. The nature of radiation and its effects on the body are difficult to depict and explain in a simple sign, particularly one that may have to be quite small and that must be understood regardless of language, culture, literacy or the environment in which it may be found. In short, a sign could convey one of a number of simple messages such as: "Don't touch," "This will hurt you", "Don't open," or "Run away." Flexibility regarding the message needs to be maintained at the early stages of design, since one message may be easier to convey graphically than another. Testing and evaluation will provide the real indicator of effectiveness.

It is proposed that any new sign not be considered a replacement for the radiation trefoil but as a supplement to it. This is suggested for several reasons:

a. The trefoil provides information to knowledgeable individuals about the material and assists first responders.

b. The trefoil is extensively used, internationally, and is codified in existing regulations throughout the world.

c. The ISO standard [1] on the basic ionizing radiation symbol allows the trefoil to "be accompanied by additional symbols or words, where necessary to indicate danger".

d. Use of the trefoil is much broader than the identification of sources.

However, the incorporation of the trefoil in the new sign should not be precluded. If a trefoil is incorporated, then careful consideration will have to be given to the relationship and placement of the new and existing signs.

Application

It is proposed that the new sign only be used for those sources that can cause significant harm in a short period of time. Specifically, sources should be identified with the new sign if their radioactivity exceeds 10^{-2} times the A_1 value as defined in the IAEA Regulations for the Safe Transport of Radioactive Material [8]. These criteria include all sources in Category 1 and many of those in Category 2 in the IAEA's Categorization of Radiation Sources [9], even though it was developed for different purposes.

An A_1 value is essentially that activity which will deliver an external exposure of 50 mSv to a person standing for 30 minutes at a distance of 1 m from an unshielded radioactive source. Accidents involving found sources typically result in exposure times much longer than 30 minutes and frequently at distances closer than 1 m. Hence 10^{-2} times the A_1 limit is chosen as a reasonable balance between the additional technical and administrative burden and the reduction in risks posed by these sources.

Further, it is proposed to exclude sources and products based on radioisotopes with a half-life less than 30 days from the list of items requiring the new sign. A half-life limit is appropriate, since experience has shown that sources are unlikely to be orphaned and found by a member of the public shortly after release from the producer.

For maximum effectiveness, it is proposed that any new sign be used only in close proximity to an actual source and its shielding. Because the message to be conveyed is that the individual has encountered a hazard that should be avoided, this message should be placed only on the source itself or its immediate shielding, and not, for example, on the door to a room that contains sealed sources, or on a vehicle carrying such sources.

Similarly for devices that house sources, the sign should be applied directly to the radiation shield, preferably at the point of potential access to the source. Careful consideration needs to be given to the placement of the sign for those devices used in patient treatment. The intent would be to ensure that a sign is seen by anyone attempting to open or destroy the device, but not by patients undergoing treatment.

When practicable, the sign should be engraved, or otherwise permanently marked on the sealed source itself. The sign should be scaled as required, but remain as large as possible. If it provides better clarity and visibility, only the icon could be engraved rather than the whole sign and its border. The engraving should have maximum contrast, but must not compromise the source integrity. When it is not practicable to engrave the sign or icon on the source itself due to size limitations, it should be engraved on the source holder if applicable.

Guidance will be developed as to when and where the new sign should be used; when and where it should *not* be used, how it should be used in conjunction with the trefoil, and where it should be affixed to sources and shielding containers of different shapes and sizes.

A warning sign that relies upon the visual senses to convey its message in an unambiguous and timely manner will become useless over time if it is not maintained for cleanliness consistent with conspicuity and legibility. Accordingly, the guidance regarding use of the sign will also need to include the provision for the long-term maintenance of the warning sign.

The Design and Evaluation of Possible Signs

Independent of a sign's ultimate design and appearance, it must be developed in accordance with human factors principles. A design development process incorporating these is outlined below and discussed in more detail in Annex I. Similarly, the test and evaluation protocol must be developed with the assistance of survey research experts. Therefore, again only an overview is given here with more detail in Annex I.

It should be noted that design development will likely result in more than one design that meets many, if not all, of the design criteria. The test and evaluation process will then serve to limit the number of acceptable alternatives.

Design Components

Any sign, regardless of its design, will usually have three or four components:

a. The "element" is the innermost part of the sign. If the sign contains a graphic image, then the element is referred to as an "icon."

b. The "symbol" refers to the shape or perimeter of the sign – typical symbols include circles, triangles, rectangles and diamonds. The symbol may be thought of as the frame around the image.

c. The "background" is the surface against which the element appears, within the confines of the symbol.

d. Text messages are often used with or without graphics; however it is proposed that they not be used in the new warning sign. This is primarily because they require literacy and because language and alphabets are not universal.

Human Factors Guidelines Applicable to Design Development

The human factors discipline offers a number of principles to guide the sign design development process in general, and the design of icons in particular. Sign design should be based on these principles, and the guidelines that follow from them, if inappropriate behaviours when an individual sees a sign are to be avoided. Such behaviours may include: error in interpretation, confusion, and lack of response or compliance. Details on key guidelines to be used in the development of the new sign are given in Annex I.

Arising from consideration of the guidelines, it is proposed that the triangle be used as the starting point for the symbol shape for the warning sign because of its widespread acceptance for this purpose and because it is the shape required by ISO-3864 [10]. Similarly, it is proposed that the sign feature a yellow background with red and/or black used for the icon and border. This combines the strongest elements of existing warning signs and is also consistent with ISO standards.

Pragmatic Factors in Sign Design

In addition to the human factors guidelines discussed above, there are several pragmatic issues that must be considered in sign design for this application. These include:

a. *Environmental exposure.* Signs must be able to withstand exposure to a wide range of environmental conditions without significant change in their colour, shape or appearance. Such environmental conditions include, but are not necessarily limited to: temperature (-40° to +70° C),

rain and salt water. Further, for signs to be placed directly on sources, radiation resistant materials must be used.

b. *Colour.* It should be recognized that engraving on sources, or source holders, is not as effective as a full colour warning sign because the colours that are central to conveying a warning sign's meaning are not present. However, attempts to incorporate colour on the source itself may be difficult because of discolouration from radiation effects. In addition they may cause problems with sources in wet storage if materials are leached into the water that might increase corrosion.

c. *Orientation.* Because a source or container may be observed in almost any orientation, it is desirable that either the proper orientation should be intuitively obvious, or that the orientation of the sign not matter to its proper understanding. Similarly, consideration should be given to the fact that many sources are cylindrical in nature, which may result in only part of an icon being initially seen.

d. *Cost Effectiveness.* Signs should be as inexpensive as possible to produce and affix. Nonetheless, it is recognized that effective signs produce cost-effective "insurance" against the risk of injury and death, and against potential lawsuits over "failure to warn" issues.

Design Development

Designs, sketches or ideas for appropriate signs that meet the criteria discussed in this proposal will be solicited from a number of potentially interested parties; however any and all ideas will be accepted for consideration during the two-month comment period. Graphics artists will perform any rendering necessary to make the signs of a professional quality prior to testing and evaluation.

The design development process and the test and evaluation process will likely be iterative. As the process identifies effective components or colours, signs may be appropriately modified and retested.

Test and Evaluation

To know whether signs, as designed, will function and communicate their message within the diverse languages and cultures of the world, candidate signs must be tested and evaluated with representative samples of the user populations of interest. Sign characteristics that may be inappropriate for use in certain countries due to religious, cultural or historical associations with certain shapes, colours, or symbols clearly need to be identified and eliminated. Surrogates cannot be used for such population samples because research has shown that even subtle differences in sign design can have a profound effect on response accuracy and consistency.

A complete testing and evaluation protocol will be developed with the assistance of survey research and human factors experts with the objective of finding the most effective sign. More details about possible processes are given in Annex I, but a two-phase procedure is envisioned. The first phase would involve the review of proposed signs by a panel who will evaluate them against the criteria in order to select a small number of candidate signs for phase two. The second phase would involve a scientific analysis of the level of comprehension of each sign by representative user populations world-wide.

Implementation

Full development, testing and implementation of a new sign will require significant support and input from a wide variety of individuals, organizations, governments, agencies and other bodies. It is intended that this be done in an open and consensus-building manner, recognizing that several steps will be required before an effective sign can be implemented on a widespread basis. Because many of these steps can be undertaken in parallel, and because of the uncertain nature of certain aspects, the timelines proposed below are tentative. The steps include:

a. Obtain internal IAEA approval for distribution of this proposal. *(April 2002)*

b. Translate the proposal into the official languages of the IAEA.

c. Distribute the proposal as widely as possible to all interested parties. *(Early May 2002)* A listing of those to whom it will be initially distributed is given in Annex II.

d. Begin the development of an appropriate test and evaluation protocol. *(Spring 2002)*

e. Submit a proposed New Work Item to ISO that includes this proposal. *(May 2002)*

f. Allow a two-month period for comments and ideas for sign designs to be submitted. *(July 2002)*

g. Gather, evaluate and incorporate comments as appropriate. If there are any major problem issues that are identified, convene a Technical Meeting to address and hopefully resolve them. If it becomes clear that the disadvantages of a new sign outweigh the advantages, then the programme will be stopped.

h. Gather and professionally render an appropriate range of possible signs.

i. Follow the test and evaluation protocol and eventually decide on the most effective sign. *(End 2002)*

j. Obtain the approval of IAEA's Committee on Safety Standards for the selected sign. *(Next meeting after design selected)*

k. Continue with the detailed ISO approval and registration process.

l. Encourage voluntary implementation of the new sign and work with source and shielding manufacturers to ensure correct usage.

m. Develop and implement a public information programme about the new sign.

n. Begin the process of revising applicable IAEA documents such as the Basic Safety Standards [11], and the Code of Conduct on the Safety and Security of Radioactive Sources [12].

o. Work with the cognizant regulatory bodies in each Member State to encourage incorporation of the sign into national regulations as soon as ISO approval is obtained.

Conclusions

This proposal has discussed the outlines of a possible programme for the development of a new warning sign for hazardous radioactive sources.

It is concluded that:

(1) There are significant potential safety benefits, in terms of lives saved and exposures avoided, to be gained from the development and implementation of a new sign to warn of hazardous radioactive sources.

(2) The development and implementation of a new sign should take place in an open manner, involving as many interested parties as possible.

(3) A process and criteria for the design, development, test and evaluation of such a sign is feasible, and such a process has been proposed.

(4) Although there are likely to be a number of issues not yet identified and questions to be addressed, and although some compromises may need to be made, it is believed that the task is achievable in a reasonably short period of time.

References

1. INTERNATIONAL STANDARDS ORGANIZATION, Basic ionizing radiation symbol, International Standard, ISO-361, ISO, (1975).

2. INTERNATIONAL STANDARDS ORGANIZATION, Graphical symbols – Safety signs in workplaces and public areas, Draft International Standard, ISO/DIS 7010, ISO, (2001).

3. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Goiânia, IAEA, Vienna (1988).

4. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Istanbul, IAEA, Vienna (2000).

5. INTERNATIONAL ATOMIC ENERGY AGENCY, The Radiological Accident in Samut Prakarn, IAEA, Vienna (2002).

6. INTERNATIONAL ATOMIC ENERGY AGENCY, National Regulatory Authorities with Competence in the Safety of Radiation Sources and the Security of Radioactive Material, (Proc. Int. Conf. Buenos Aires, 2000), IAEA, Vienna (2001).

7. INTERNATIONAL ATOMIC ENERGY AGENCY, Revised Action Plan for the Safety and Security of Radiation Sources, Attachment to Measures To Strengthen International Co-Operation In Nuclear, Radiation, Transport And Waste Safety, GOV/2001/29-GC(45)/12, IAEA, Vienna (2001).

8. INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. TS-R-1 (ST-1, Revised), IAEA, Vienna (2000).

9. INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radiation Sources, IAEA-TECDOC-1191, Vienna (2000).

10. INTERNATIONAL STANDARDS ORGANIZATION, Safety colours and safety signs, International Standard, ISO-3864, ISO, (1984).

11. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANISATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, IAEA, Vienna (1996).

12. INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2000).

CONTACT POINT

Comments on the proposal, and/or suggested ideas for the new sign design should be submitted *before 31 July 2002* for full consideration. Comments or designs received after this period may be taken into consideration if possible and appropriate.

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Annex I – Sign design criteria and evaluation process

From human factors considerations, the radiation trefoil symbol can be regarded as both "insufficient" and "inappropriate" as a warning message to uninformed individuals who may come in contact with orphan radioactive sources. It is insufficient because the symbol is "arbitrary" in that it does not have inherent meaning (it requires specialized knowledge or training to understand it). This is because it is not easy to depict the concept of radiation graphically, and thus *any* such symbol will be an abstraction from reality. Furthermore many people do not understand ionizing radiation and its health effects. The trefoil is inappropriate because it has been designed and used in accordance with human factors principles for *information* signs rather than for *warning* signs. From this, it can be seen that it is important that the design and evaluation process for any new sign must take human factors research into account.

Human factors guidelines applicable to design development

The human factors discipline offers a number of principles to guide the sign design development process in general, and the design of icons in particular. Sign design should be based on these principles, and the guidelines that follow from them, if inappropriate behaviours when an individual sees a sign are to be avoided. Such behaviours may include: error in interpretation, confusion, and lack of response or compliance. Key guidelines are briefly summarized below.

a. *The "figure-ground" relationship.* Emphasize a clear distinction between the graphic image (icon) and its background.

b. *Figure boundaries.* Solid shapes are better than thin, open, or dotted lines for conveying the boundaries of an image. The only exception to this principle is when action or movement must be conveyed.

c. *Closure.* Closed figures should be used rather than images formed with discontinuous lines, outlines, or disjointed elements.

d. *Simplicity.* Icons should be constructed of the simplest possible image consistent with the need to provide important detail. Only those details that will add to the meaning of the icon should be included, and any details that distract from the icon's support of recognition and comprehension should be eliminated.

e. *Unity.* All parts of the icon should be enclosed within a single boundary.

f. *Conspicuity.* If a sign is to be quickly and accurately read, it must first be seen. To be seen, it must visually stand out clearly from the background or ambient environment in which it is located. The degree to which it stands out from the background is called conspicuity.

g. *Expectancy/consistency.* Over time, people become accustomed to certain characteristics of their environment. Signs and icons must be compatible with this "expectancy." Violations of the user's expectancy typically result in incorrect action or no action at all.

h. *Universality.* It is understood that the sign must have the same meaning to any individual who may encounter it regardless of the country in which it is found, the cultural traditions of the individual, and the individual's educational and literacy abilities. This is perhaps the most challenging task to be faced during the sign design development task, and it will require the assistance of IAEA Member States to ensure that this objective is achieved to the greatest extent possible.

i. *Symbol shape.* In many industrialized countries, specific symbol shapes have been historically associated with certain messages, albeit not with complete consistency. For example, circles are commonly used for regulatory messages and for prohibitions; squares or rectangles for general information or instructions; and triangles (equilateral with apex at top) for warnings or cautions. It

should be noted that the triangle is also the shape required for warning signs by ISO-3864 [10]. Thus, although further investigation into the use of symbols by Member States is necessary, it is proposed that the triangle be considered the "starting point" for symbol shape for a warning sign because of its widespread acceptance for this purpose.

j. *Colour.* Colour plays a critical role in communicating the purpose of a sign, as well as contributing to the ease or difficulty of reading it. When addressing colour, it is vital to consider the colour of the element itself, the background against which the element is viewed, and the outline of the symbol. In road safety, for example, specific colours are typically associated with particular functions. Regulatory signs commonly use black markings on a white background although red may be added for safety-critical regulations, whereas red markings on a white background with a black surround are used in Europe. Information signs and those that provide guidance are typically white on a blue background, although European nations also use this colour scheme for "compulsory" messages. Of specific interest to this project, warning signs may be yellow in colour, with black markings and a black border or white with black markings and a red border. Other colours, including green, orange, and brown are used for different purposes that need not be further discussed here. It should be noted that the colours in use for road safety result from years of empirical study into their legibility under a variety of natural and artificial lighting conditions as well as human comprehension and perceptual response. Although preliminary, it is suggested that a radiation warning sign featuring a yellow background, with red and/or black used for the icon and border would combine the strongest elements of existing warning signs used for road safety in a formula that would set it apart from other warning signs yet make it readily identifiable. This is consistent with ISO 3864 [10].

k. *Colour contrast.* Since signs containing graphical elements will often contain 2 or 3 colours (one each for the icon, background, and border), it is imperative that the colours chosen provide sufficient contrast when seen together if the elements are to be readily distinguishable. Thus, colours too close to one another on the colour spectrum are inappropriate for use on signs because it can be difficult to visually distinguish the figure (icon) from the ground. Conversely, colours that provide too much contrast (especially when the largest area of colour [typically the background] is very bright) can suffer reduced legibility due to glare. This can be exacerbated at night, or in a darkened room if the sign is seen through use of a lighting source such as a flashlight, automobile headlight, or flame.

l. *Redundant coding.* Because shape and colour are the two predominant methods of conveying information on signs, they are often used together to provide "redundant coding." In other words, if a triangle conveys a message of warning, and a yellow background conveys a message of caution, the use of the two together reinforces the communication conveyed by each separately. Thus, if the triangular shape is somehow distorted (as might occur from an accidental or deliberate impact to the sign), the redundancy caused by its yellow colour can still convey the general message of caution. Conversely, if the colour is distorted (perhaps by exposure to chemicals or radiation), the triangular shape can still communicate the warning message of the sign. Further, redundant coding provides an added perceptual cue to the sign's meaning, thus contributing to a simpler, more rapid, more accurate interpretation of its message.

m. *Visual angle.* Line thickness for any significant detail within a sign should subtend, at a minimum, 2 degrees of visual angle. Significant details that form any part of an icon should subtend, at a minimum, 3 degrees of visual angle.

n. *Realism/representativeness.* Icons can be broadly classified by the extent to which they resemble a "real-world" object, concept, or action. "Image-related" icons are highly realistic, pictorial depictions of their real-world counterpart. They can be quickly and accurately understood and thus should be used whenever possible. "Concept-related" icons are based on an example or a property of their real-world counterpart. Although less effective than image-related icons, concept-related graphics can be used successfully when the user can be expected to be able to understand the

context in which the icon is presented. Finally, "arbitrary" icons do not resemble or represent the real-world object, concept or action that they depict, but become meaningful to the user only through education, training and experience. As such, arbitrary icons can be difficult to recognize, learn, and remember, particularly for users who do not encounter them on a routine basis. If at all possible, their use should be reserved for those applications in which the user both understands the context and possesses the specialized knowledge required to understand them. Unfortunately, because of the difficulty of depicting radiation in graphic form, neither image-related nor concept-related icons are possible. Accordingly, the trefoil is an arbitrary icon and although it is readily recognized and understood by radiation safety experts (as a result of their training and experience), this is not likely to be the case for the general public.

o. *Lack of ambiguity.* For all icons, but particularly for those that are arbitrary, their imagery should be as unambiguous as possible. Icons are considered arbitrary, not because they present an image that is unrecognisable, but because that image is not clearly related to the real world object, concept or action that it represents. Arbitrary icons, therefore, should, to the extent possible, present a clear, recognizable visual image, even though that image may not clearly relate to its real world counterpart.

p. *Consistency.* Once developed, tested, and adopted for use, all aspects of the sign, including the design of the icon itself, should remain invariant to the greatest extent possible. In other words, the design of a sign (particularly one intended for warning purposes) should not be treated as a means for artistic expression, where the sign designer feels free to create a novel icon, unless empirical testing has demonstrated that the new design represents a substantial improvement in performance compared to the sign in use.

q. *One icon for one message.* Multiple icons should not be used for the conveyance of a particular message, and a single icon should not be used for the presentation of more than one message.

r. *Text.* If it is determined that a text message is a necessary part of a sign, clear human factors guidelines exist, and should be followed, for the creation of character style, font, stroke width, and aspect ratio (among other design elements), as well as for the number of words, letters and lines of text that should be considered for use. When a sign incorporates text without graphics, the text message becomes the element. When a sign uses an icon as its principle element, a text message may be used as a supplement, in which case it should be placed outside the symbol, against its own background. Text messages (whether used without, or as a supplement to icons) are difficult to justify for the present need because they require literacy, they use language and alphabets that are not universal, they cannot be easily read at a distance or when the sign is small, and they can be readily defaced, thus changing or removing their intended meaning. Accordingly, text messages should be used only when absolutely necessary if determined through testing and evaluation that the user population cannot correctly or consistently understand the sign without it.

Testing and Evaluation

Phase I

Phase I of the testing and evaluation process involves the selection of a few candidate signs that should go on for field testing. The protocol to be developed would support review of any proposed sign or icon with regard to the human factors principles discussed above. Each potential sign would be reviewed by a panel of experts, including human factors subject matter experts against each criterion and rated in one of three categories:

a. Criterion fully met.

b. Criterion not fully met, but icon still effective.

c. Criterion not fully met and icon not effective.

A scoring protocol would be established to determine the extent of compliance for each icon against the human factors criteria. In addition to a compliance score, the output of this exercise would provide, if appropriate, design recommendations to improve the sign in any areas of deficiency.

Phase II

In the second phase, the test and evaluation protocol would support an analysis of the level of comprehension of each icon by representative user populations. As well as being regionally and culturally diverse, test populations will need to cover a range of ages, occupations and educational levels.

Key questions would be developed to test icon effectiveness at communication. Such questions might include, for example:

a. What information does this icon convey to you?

b. What action should you take if you see this icon?

c. How confident are you about your interpretation?

d. What is the nature of the problem/hazard?

e. What might happen to you if do not take the suggested action?

f. Is there any additional action that you should take?

Note that these questions are only examples of those that might be asked. The actual questions to be asked during the test and evaluation protocol will be developed after the candidate icons have been selected. It should also be noted that, because the evaluation of comprehension will be performed with respondents representative of the Member States, the questions must be asked in appropriate languages and perhaps, in some circumstances, verbally. Comprehension ratings will be obtained on a multi-point scale, which might include evaluations such as:

a. Response matches the intended meaning of the icon exactly

b. Response captures some aspects of the intended meaning of the icon, but is missing one or more key points

c. Response does not match the intended meaning of the icon, but it is somewhat relevant

d. Response is not at all relevant to the intended meaning of the icon

e. Respondent indicated that he/she did not understand the icon

f. No response.

A scoring system would be established that would enable a direct comparison of icon comprehension.

Annex II –Initial distribution list

The proposal is being distributed as widely as possible with the purpose of soliciting comments and ideas from interested parties. This Annex provides the initial distribution list, but this is not comprehensive. Therefore, the proposal may be further distributed without permission to any others who may wish to comment; however, it should be distributed in its entirety. Designs, sketches or ideas for signs that meet the criteria discussed in this proposal are welcomed. Comments on the proposal and any sign designs should be sent to the contact point before the end of the comment period for full consideration. Comments received after this period may be taken into consideration if possible and appropriate.

IAEA Member States

All IAEA Member States will receive this proposal.

International Bodies

European Commission (EC)
Food and Agriculture Organization of the United Nations (FAO)
International Air Transport Association (IATA)
International Civil Aviation Organization (ICAO)
International Commission on Radiological Protection (ICRP)
International Federation of Airline Pilots Associations (IFALP)
International labour Organisation (ILO)
International Maritime Organization (IMO)
International Standardization Organization (ISO) and its constituent bodies
North Atlantic Treaty Organization (NATO)
Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD/NEA)
Pan American Health Organization (PAHO)
Radiation Safety Standards Committee (RASSC)
Transport Safety Standards Committee (TRANSSC)
United Nations Economic Commission for Europe (UNECE)
Waste Safety Standards Committee (WASSC)
World Health Organization (WHO)
World Nuclear Transport Institute (WNTI)

National Authorities

In addition to sending the proposal to Member State missions, it is intended to send it directly to applicable regulatory bodies.

Atomic Energy Regulatory Board (India)

Australian Radiation Protection Society Inc.

Associations and Societies

Association of International Industrial Irradiation (AIII)
Bureau of Dangerous Goods Ltd
Dangerous Goods Council Inc
Federal Inspectorate of Dangerous Goods
Hazardous Material Advisory Council
Indian Society for Non Destructive Testing
International Radiation Protection Association (IRPA) and its constituent bodies

Radioisotope Producers and Distributors

Amersham International plc
AEA Technologies
Board of Radiation and Isotope Technology (BRIT)
Isotope Products Laboratories (IPL)
IZOTOPE – Moscow
Mayak (Industrial Association Mayak)
MDS Nordion
Nuclear Energy Corporation of South Africa Ltd. (NECSA)
Nucletron BV
RITVERC GmbH
Scaanray Metallurgical Services
Sievert India Pvt Ltd NDT Engineers
TENEX (Techsnabexport)
Varian Medical Systems International AG

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