United Nations ST/SG/AC.10/C.3/2012/60

Secretariat

Distr.: General
23 October 2012

Original: English

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

Forty-second session
Geneva, 3 – 11 December 2012
Item 2 (b) of the provisional agenda
Recommendations made by the Sub-Committee on its thirty-ninth, fortieth and forty-first sessions and pending issues: listing, classification and packing

Neutron radiation detectors

Transmitted by the Dangerous Goods Advisory Council[1]

Introduction

1. Based on comments provided on DGAC's documents submitted at the last session (ST/SG/AC.10/C.3/2012/5 and informal document INF.32) investigating means of providing for the transport of neutron radiation detectors, DGAC is submitting a revised proposal.

2. As noted previously, neutron detection is a key component in the identification of illicit nuclear materials (e.g., plutonium) passing through ports of entry and borders of a country. Radiation detection systems can be employed to scan freight containers or perform searches using portable radiation detectors. The shortage of Helium-3 gas has prompted the search for alternative neutron detection medium and boron trifluoride (BF_3) has been proven to be an effective alternative. Through over 70 years of use, radiation detection systems employing BF_3 have been shown to be safe and effective. In transport, the small quantity of toxic gas present at atmospheric pressure often causes delays that appear unwarranted based on the overall safety of these systems. These delays can be detrimental to nuclear security and safety. Efficient transport is in the interest of transport security worldwide. For this reason DGAC seeks to clarify the appropriate requirements for neutron radiation detectors and radiation detection systems consistent with their degree of risk.

[1] In accordance with the programme of work of the Sub-Committee for 2011-2012 approved by the Committee at its fifth session (refer to ST/SG/AC.10/C.3/76, para. 116 and ST/SG/AC.10/38, para. 16).

Please recycle

Discussion

3. The safety features inherent in these neutron radiation detectors and radiation detection systems raise the fundamental question of, "How safe does a device need to be in order to no longer be subject to the Model Regulations?" To more comprehensively evaluate the risks in transport, DGAC intends to provide a risk analysis on the transport (including air transport) of neutron radiation detectors and radiation detection systems (Note: a radiation portal monitor or "RPM" is an example of a radiation detection system) and to provide this analysis for consideration in an informal document in time for the Subcommittee meeting.

4. A neutron radiation detector is a hermetically sealed electron tube transducer that converts neutron radiation into a measureable electric signal. Each detector:

- Contains less than 12.8 grams of BF_3 at a pressure often below atmospheric pressure but at most not more than 105 kPa absolute at 20^oC;
- Is manufactured under a registered quality assurance program;
- Is subject to leak testing to a1 x 10^{-10} cc/sec leak tightness standard before filling with BF_3;
- Has a burst pressure ranging from 1800 kPa for smaller units to 10,000 kPa for large units. Considering a 16.2 kPa gauge pressure at 55^oC, this represents a minimum factor of safety (based on 1800 kPa) of roughly 111:1; and
- Testing has shown that these neutron radiation detectors survive a drop test unpackaged from a height of 4m as well as crush tests without leakage (see INF. 64 to the 41st session illustrating testing conducted by the United States of America government's Brookhaven National Laboratory).

5. In spite of 70 years of transport and use, there is no evidence of failure. Safety considerations include:

- The robust nature of the detectors as evidenced by the Brookhaven testing conducted (drop testing and crush testing).;
- In radiation detection systems (e.g., radiation portal monitors), the detectors are embedded in an absorbent material proven to absorb gas from any detector leak and the proposal also calls for individual detectors to be similarly packaged with absorbent material. The effectiveness of this packaging has been demonstrated through testing (see Brookhaven study report);
- The gas contained inside the detector is at atmospheric pressure at room temperature so that release of any leaking gas would be through diffusion (i.e., the random movement of gas molecules) and not rapid gas transfer as one would expect from a pressurized cylinder. Ambient air currents would likely keep the concentration of BF3 in the vicinity of any small leakage point low;
- Boron trifluoride, has a 1 hour LC50 of 2541 ppm. While, given the above safety features, formation of a toxic atmosphere is difficult to envision, the 12.8 g per detector at this concentration would occupy a space of 1.7 m^3. In a totally dry atmosphere, boron trifluoride is a colorless gas with a pungent odour. However, in the presence of even the smallest amount of moisture, BF_3 forms a cloud of dense, white smoke which has a sharply acidic odour. Even small leaks (as little as 1 ppm) are easily detected because of these properties.
- In a fire situation the maximum pressure in the radiation detector filled to 105kPa absolute at 20^oC would be 200 kPa gauge (assuming a fire temperature of 500^oC) so

that the detector tube would be expected to retain the gas contents in a fire. In addition, such a small quantity of gas would not be a factor in a fire condition.

Current applicable transport restrictions

6. United States of America and Canadian permits provide for transport of neutron radiation detectors and radiation detection systems. Under ADR/RID, it is understood detectors and radiation detection systems fall under the equipment exemption in section 1.1.3.1(b) so that these regulations are understood not to apply.

7. To provide an interim solution, DGAC proposed an amendment to the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air until such time as the Sub-Committee could consider the appropriate requirements for detectors and detection systems. An amendment to be incorporated in the 2013-2014 ICAO Technical Instructions will permit air transport on cargo aircraft as UN 1008 BF_3 under a new Special Provision.

Proposal

8. Considering the low degree of risk (expected to be borne out by a pending risk analysis), it is DGAC's opinion that neutron radiation detectors and radiation detection systems warrant consideration for being exempt from the Regulations entirely. At the same time, we recognize that some may wish to restrict their transport on aircraft to cargo aircraft only. Assignment to Class 9 would be consistent with the low level of danger posed by detectors and detection systems while providing a basis for forbidding their transport on passenger aircraft. For this reason DGAC proposes that a special provision be added against UN 3363 to permit these neutron radiation detectors and radiation detection systems to be transported under that entry. The content of the special provision is consistent with that already included in the 2013-2014 edition of the ICAO Technical Instructions.

9. On this basis, DGAC proposes the following:

Proposal 1: Introduce in the glossary two new terms:

"Neutron radiation detector is a hermetically sealed electron tube transducer that converts neutron radiation into a measureable electric signal. The gas in the device is the neutron detection medium.

Radiation detection system is an apparatus that contains radiation detectors as components.".

Proposal 2: Add a new special provision XXX against UN3363 to read as follows:

"XXX Neutron radiation detectors containing non-pressurized boron trifluoride gas in excess of 1 gram may be transported under this entry provided that the following conditions are met.

(a) Each radiation detector shall meet the following conditions.

(i) The pressure in each detector must not exceed 105 kPa absolute at 20°C;

(ii) The amount of gas must not exceed 12.8 g per detector;

(iii) Each detector must be manufactured under a registered quality assurance program;

(iv) Each neutron radiation detector must be of welded metal construction with brazed metal to ceramic feed through assemblies. They must have a minimum burst pressure of 1800 kPa; and

(v) Each detector must be tested to a 1 x 10^{-10} cc/sec leak tightness standard before filling.

(b) Radiation detectors transported as individual components shall be transported as follows:

(i) Detectors shall be packed in a sealed intermediate plastic liner with sufficient absorbent material to absorb the entire gas contents;

(ii) They shall be packed in strong outer packaging. The completed package shall be capable of withstanding a 1.8 meter drop test without leakage of gas contents from detectors;

(iii) The total amount of gas from all detectors per outer packaging shall not exceed 51.2 g.

(c) Completed neutron radiation detection systems containing detectors meeting the conditions of paragraph (a) shall be transported as follows:

(i) The detectors shall be housed in a strong sealed outer casing;

(ii) The housing shall contain sufficient absorbent material to absorb the entire gas contents;

(iii) The completed systems shall be packed in strong outer packagings capable of withstanding a 1.8 meter drop test without leakage unless a system's outer casing affords equivalent protection.

Except for air transport, radiation detection systems meeting the requirements of paragraph (c) are not subject to these Regulations.

Neutron radiation detectors containing not more than 1 gram of boron trifluoride, including those with solder glass joints, are not subject to these Regulations provided they meet the requirements in paragraph (a) and are packed in accordance with paragraph (b). Radiation detection systems containing such detectors are not subject to these Regulations provided they are packed in accordance with paragraph (c).".