International Civil Aviation Organization

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WORKING PAPER

DANGEROUS GOODS PANEL (DGP)

TWENTY-THIRD MEETING

Montréal, 11 to 21 October 2011

Agenda Item 2: Development of recommendations for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2013-2014 Edition

REQUIREMENTS FOR NEUTRON RADIATION DETECTORS

(Presented by the Dangerous Goods Advisory Council)

SUMMARY

This proposal would define the conditions under which neutron radiation detectors containing a non-pressurized Division 2.3 gas may be transported by air.

Action by the DGP: The DGP is invited to agree to the proposals as presented in the appendix to this working paper in order to facilitate the transport of neutron radiation detectors by cargo aircraft.

1. INTRODUCTION

1.1 Neutron detection is key component in nuclear arms interdiction. For example, Radiation Portal Monitors (RPMs) for cargo screening (e.g. screening of freight containers being off loaded from a cargo vessel in port areas) use a combination of gamma radiation and neutron radiation detectors for the identification of highly enriched uranium and plutonium in warheads. In the words of one security expert, they are deemed “an essential aspect of interdiction of radiological threats for homeland security purposes since plutonium, a material used for nuclear weapons is a significant source of fission neutrons.” Additional applications for neutron radiation detectors include nuclear reactor monitoring, neutron-based cancer treatments, neutron spallation, non-destructive testing and health physics applications.

1.2 Neutron radiation detectors described in this proposal are hermetically sealed electron tube devices that contain a non-pressurized gas that functions as the detection medium. Neutrons are not directly ionizing and therefore cannot be detected directly; they must react with another medium to produce ionizing particles that can be detected. Boron trifluoride is used because the boron in the gas provides target nuclei for the neutron conversion reaction. When a boron atom in the gas captures a neutron emitted by an outside neutron source, the neutron radiation detector produces an electrical signal. Boron trifluoride filled neutron radiation detectors have been in use in industrial, medical and scientific

applications for over seventy years. They have been shipped around the world without incident. With more than 100,000 boron trifluoride sensors in service worldwide in the nuclear power and radiation protection industries, there has never been an incident of a boron trifluoride leak in transport.

1.3 To prevent nuclear terrorism, it is essential that neutron radiation detection systems and detector system components can be rapidly deployed worldwide. With boron trifluoride (UN 1008) classified as a Division 2.3 (8), air transport is currently only permitted under approvals by the State of Origin and State of the Operator in accordance with Special Provision A2. Such approvals have been issued by the United States and Canada. Clarifying the applicable requirements for their transport aboard cargo aircraft in the Technical Instructions would greatly facilitate deployment and in doing so would improve worldwide responsiveness to the security threat posed by certain radioactive materials.

1.4 A number of safety features are incorporated in the neutron radiation detectors, the component of radiation detection systems containing boron trifluoride, to provide for safe transport and use:

a) the gas is non-pressurized with the pressure at the time of filling kept at 105kPa at 20^{o}C or below (note that, while neutron radiation detectors are constructed differently and are subject to far more stringent construction requirements, Division 2.3 gas samples may be transported on cargo aircraft (Special Provision A1 for passenger) under UN 3169 at a pressure of 105 kPa or less);

b) the neutron radiation detector is extremely rugged;

c) the detection systems and neutron radiation detectors transported as components are packaged with an absorbent material that is capable of absorbing all of the gas contained in package. A study by a United States national laboratory shows the absorbent material to be highly effective in absorbing the gas should it leak from the electron tube under use or transport conditions; and

d) the neutron radiation detectors are hermetically sealed. Each unit is helium mass spectrometer leak tested to 1×10^{-10} standard cc/sec leak tightness before filling. Note that the operation of the neutron radiation detectors is dependent on their absolute vacuum tightness.

1.5 An interpretation by the United States Department of Transportation authorizes neutron radiation detectors containing not more than 1 gram of gas to be treated as not subject to the regulations as dangerous goods. Approvals for transporting neutron radiation detectors and radiation detection systems by cargo aircraft have been issued by both the United States Department of Transportation and Transport Canada. Documents supporting these statements can be made available to the panel.

1.6 For purposes of the proposal:

a) **Neutron radiation detector** is a hermetically sealed electron tube device. It is a transducer that turns neutron radiation into a measureable electric signal. It must be powered by an electrical circuit to function; and

b) **Radiation detection system** is an apparatus that contains neutron radiation detectors as components.

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APPENDIX

AMENDMENTS TO THE TECHNICAL INSTRUCTIONS

PROPOSAL 1:

For the entry boron trifluoride (UN 1008) insert in Column 7 of Table 3-1 "The Dangerous Goods List" of Part 3, Chapter 2: "AXX":

									Passenger aircraft		Cargo aircraft	
Name	*UN No.*	*Class or division*	*Subsidiary risk*	*Labels*	*State variations*	*Special provisions*	*UN packing group*	*Excepted quantity*	*Packing instruction*	*Max. net quantity per package*	*Packing instruction*	*Max. net quantity per package*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Boron trifluoride	1008	2.3	8		AU 1 CA 7 NL 1 US 3 IR 3	AXX			FORBI	DDEN	FORBI	DDEN

PROPOSAL 2:

Add the following special provision:

Chapter 3

SPECIAL PROVISIONS

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Table 3-2. Special provisions

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AXX	Neutron radiation detectors containing small quantities of non-pressurized boron trifluoride gas in excess of 1 gram and radiation detection systems containing such neutron radiation detectors as components may be transported on cargo aircraft in accordance with these Technical Instructions irrespective of the indication of "forbidden" across columns 12 and 13 of Table 3-1, provided: a) the pressure in each neutron radiation detector must not exceed 105 kPa at 20°C; b) the volume of each neutron radiation detector must not exceed 4 L so that the amount of gas may not exceed 12.8 grams per detector. The total volume of neutron radiation detectors per outer packaging or per radiation detection system must not exceed 16 L; c) 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; d) each neutron radiation detector must be packed in a sealed intermediate plastic liner with sufficient absorbent material to absorb the entire gas contents. Neutron radiation detectors must be packed in strong outer packagings that are capable of withstanding a 1.2 meter drop test without leakage.

TIs *UN*

Radiation detector systems containing neutron radiation detectors must also include absorbent material sufficient to absorb the entire gas contents of the neutron radiation detectors. Absorbent material must be surrounded by a liner or liners, as appropriate. They must be packed in strong outer packagings unless neutron radiation detectors are afforded equivalent protection by the radiation detection system; and

e) transport in accordance with this special provision must be noted on the dangerous goods transport document.

Neutron radiation detectors containing not more than 1 gram of boron trifluoride, including those with solder glass joints, and radiation detection systems containing such detectors where the neutron radiation detectors meet and are packed in accordance with the above conditions, are not subject to these Instructions irrespective of the indication of “forbidden” in columns 10 to 13.

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— END —