International Civil Aviation Organization

DGP-WG/08-IP/3
03/11/08

INFORMATION PAPER

DANGEROUS GOODS PANEL (DGP)
MEETING OF THE WORKING GROUP OF THE WHOLE

The Hague, 3 to 7 November 2008

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 2011/2012 Edition

CHEMICAL OXYGEN GENERATORS

(Presented by R. Richard)

SUMMARY

The purpose of this paper is to provide further notification and outreach to shippers and operators to help explain, understand and follow the US regulations (49 CFR) in the transportation of Chemical Oxygen Generators (COG).

1. INTRODUCTION

1.1 Despite the fact that the 1996 ValuJet Flight 529 incident was caused by improperly packaged and labelled Oxygen Generators, shippers are still offering undeclared COG.

1.2 In order to help combat this issue, informational presentations are provided by CD for panel member's to review with the hope that these presentations will then be disseminated to shippers and operators within their individual States for information and training purposes.

1.3 A PowerPoint presentation has been developed for the overview of COG with the ICAO TI requirements and the relationship between those requirements and the US variations as many of the incidents have originated outside the US.

1.4 A second PowerPoint presentation has been created breaking down the United States requirements from 49 CFR for shipping COGs so that the information provided within the PowerPoint can be used by trainers, shippers and operators in panel member States for training.

1.5 A limited number of copies of the PowerPoint presentations are available during WG-08. The presentations will also be made available electronically on the ICAO Website. Panel members are invited to provide comments and/ or suggestions on how the international community may better address this growing problem.

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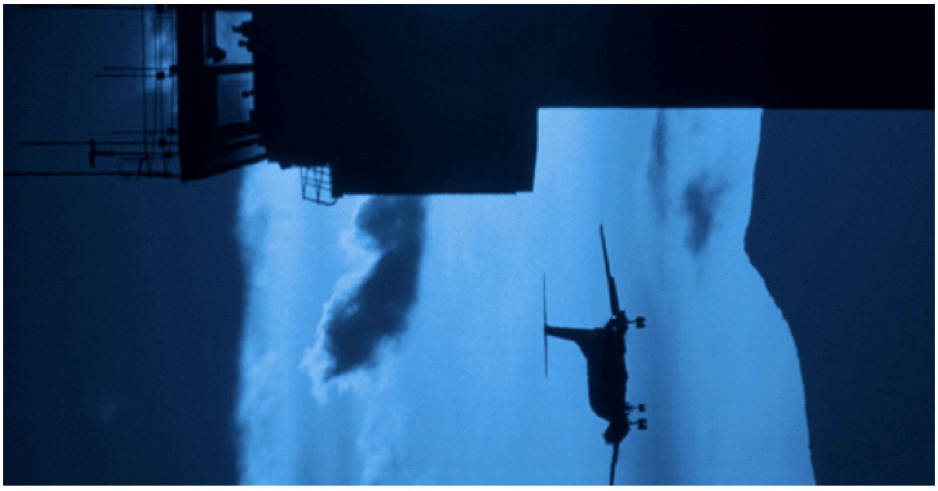
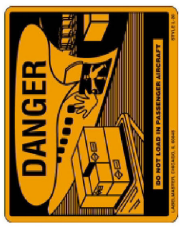
APPENDIX A

UNITED STATES REQUIREMENTS (49 CFR) FOR SHIPPING CHEMICAL OXYGEN GENERATORS



Effective 10/01/2008

The Air Transportation of Oxygen Generators

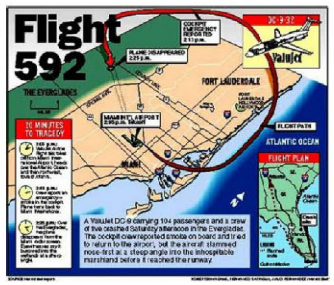


This guidance is not intended to be a substitute for any FAA or PHMSA regulation. It is provided with the understanding that the shipper is already adhering to all applicable laws and regulations. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Oxygen Generators

- **ValuJet Flight 592**
- **Statistics**
- **Current Regulations**
  - Unspent Oxygen Generators
  - Spent Oxygen Generators
- **Changes in the Regulations**

ValuJet Flight 592



- May 11, 1996
- DC-9 carrying 105 passengers and 5 crew members
- Impacted the Florida Everglades at 440 knots
- No survivors
- NTSB concluded: "The accident was caused by improperly packaged, marked, and labeled oxygen generators."

Statistics

- Shippers are still transporting undeclared oxygen generators.
- 1996 – 1999: 60 incidents
- 800 undeclared oxygen generators on one passenger aircraft
- 2000 – 2007: 130 incidents

Current Regulations
Unspent Oxygen Generators

Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Federal Aviation Administration

Unspent Oxygen Generators

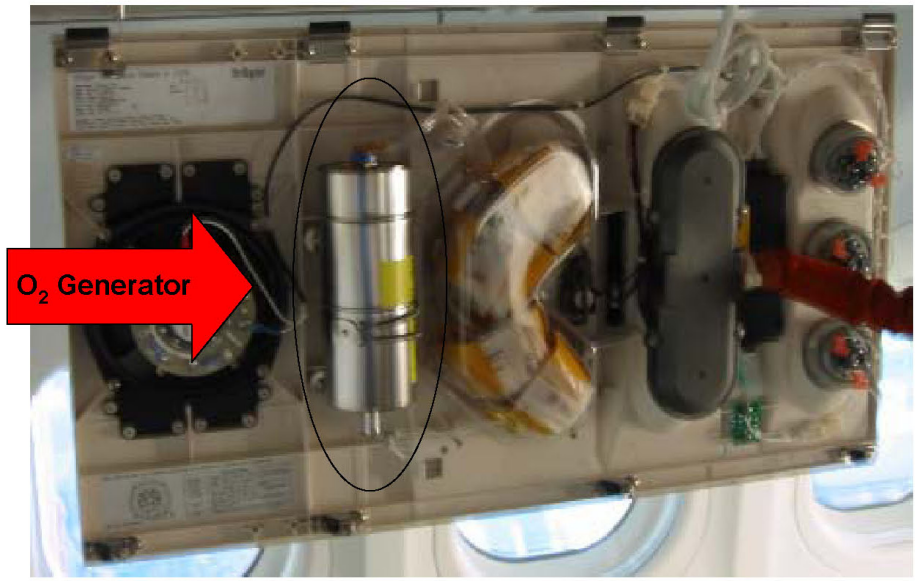
- **Classified as UN3356, Oxygen generator, chemical, 5.1, II**
- **Includes oxygen generators in passenger service units and protective breathing equipment**
- **Packaging exceptions: None**
- **Non-bulk packaging: 49 CFR 173.168**
- **Quantity limitations:**
  - Passenger aircraft: Forbidden
  - Cargo aircraft only: 25 kg gross

An Unspent Oxygen Generator within a Passenger Service Unit

Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

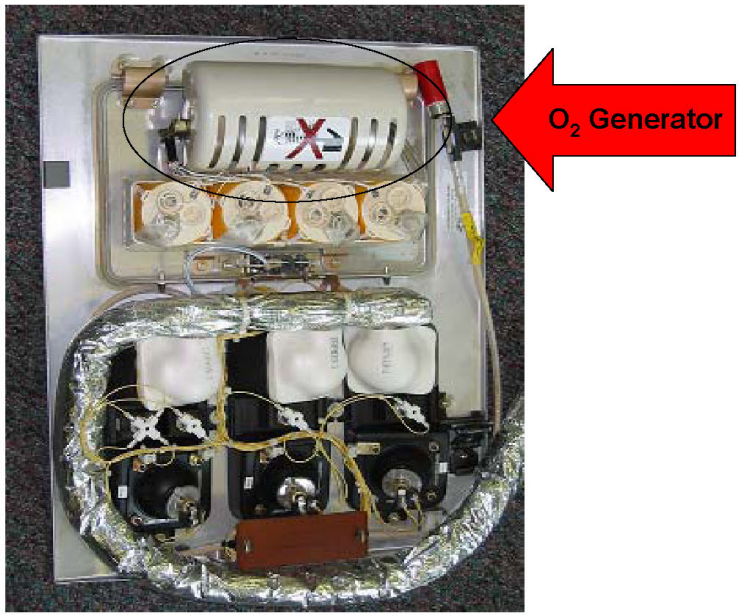
Federal Aviation Administration

An Unspent Oxygen Generator within a Passenger Service Unit



Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

An Unspent Oxygen Generator within a Passenger Service Unit



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Federal Aviation Administration

An Unspent Oxygen Generator within Protective Breathing Equipment

Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

An Unspent Oxygen Generator within Protective Breathing Equipment

Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Federal Aviation Administration

49 CFR 173.168(a)

- **Approval**
  - A chemical oxygen generator that is shipped with a means of initiation attached must be classed and approved by the Associate Administrator.

49 CFR 173.168(b)

- **Impact resistance**
  - A chemical oxygen generator, without any packaging, must be capable of withstanding a 1.8 meter drop onto a rigid, non-resilient, flat and horizontal surface, in the position most likely to cause actuation or loss of contents.

49 CFR 173.168(c)

- **Protection against inadvertent actuation**
  - A chemical oxygen generator must incorporate one of the following means of preventing inadvertent actuation:

49 CFR 173.168(c)(1)(i)

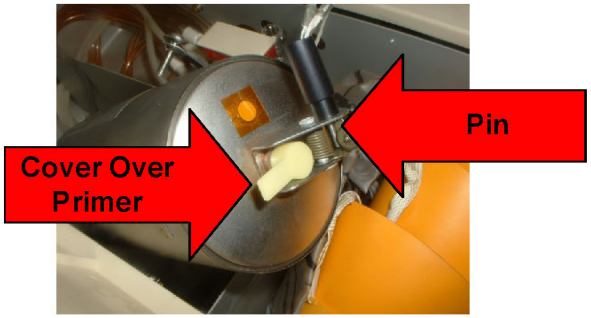
- **A mechanically actuated chemical oxygen generator that is not installed in protective breathing equipment must incorporate:**
  - Two pins, installed so that each is independently capable of preventing the actuator from striking the primer; or

49 CFR 173.168(c)(1)(i)

- **A mechanically actuated chemical oxygen generator that is not installed in protective breathing equipment must incorporate:**
  - One pin and one retaining ring, each installed so that each is independently capable of preventing the actuator from striking the primer; or

49 CFR 173.168(c)(1)(i)

- **A mechanically actuated chemical oxygen generator that is not installed in protective breathing equipment must incorporate:**
  - A cover securely installed over the primer and a pin installed so as to prevent the actuator from striking the primer and cover.



49 CFR 173.168(c)(1)(ii)

- **An electrically actuated chemical oxygen generator that is not installed in protective breathing equipment:**
  - The electrical leads must be mechanically shorted; and
  - The mechanical short must be shielded in metal foil.

49 CFR 173.168(c)(1)(iii)

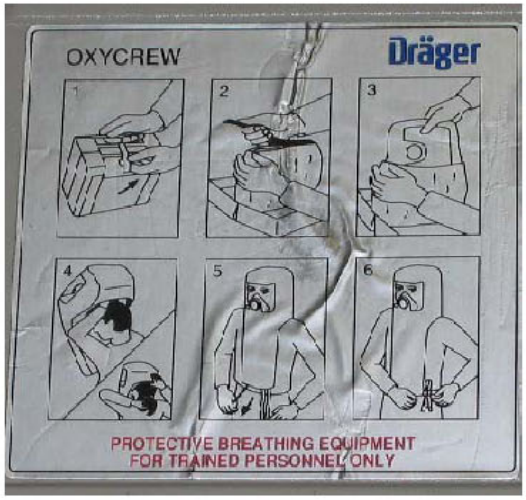
- **A chemical oxygen generator with a primer but no actuating mechanism that is not installed in protective breathing equipment must have:**
  - A protective cover over the primer to prevent actuation from external impact.

49 CFR 173.168(c)(2)

- **A chemical oxygen generator installed in protective breathing equipment must:**
  - Contain a pin, installed so as to prevent the actuator from striking the primer; and
  - Be placed in a protective bag, pouch, case or cover such that the protective breathing equipment is fully enclosed in such a manner that the protective bag, pouch, case or cover prevents unintentional actuation of the oxygen generator.

49 CFR 173.168(c)(2)

Protective Breathing Equipment (PBE)



Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Federal Aviation Administration

49 CFR 173.168(d)(1)

- **Packaging**
  - A chemical oxygen generator and a chemical oxygen generator installed in equipment must be placed in a rigid outer packaging that conforms to the requirements of either:
    - Part 178, subparts L and M, at the Packing Group I or II performance level; or
    - The performance criteria in Air Transport Association (ATA) Specification No. 300 for a Category I Shipping Container.

49 CFR 173.168(d)(1)

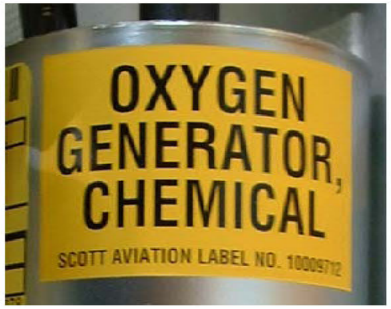
- **Packaging Examples**

Part 178, Subparts L and M, at the Packing Group I or II Performance Level

ATA Spec. No. 300 for a Category I Shipping Container

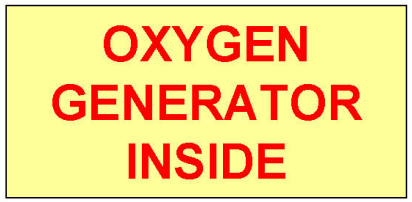
49 CFR 173.168(e)

- **Equipment marking**
  - The outside surface of a chemical oxygen generator must be marked to indicate the presence of an oxygen generator.
    - Example: "oxygen generator, chemical"



49 CFR 173.168(e)

- **Equipment marking (continued)**
  - The outside surface of equipment containing a chemical oxygen generator that is not readily apparent must be clearly marked to indicate the presence of the oxygen generator.
    - Example: "Oxygen Generator Inside"



49 CFR 173.168(f)

- **Items forbidden in air transportation**
  - A chemical oxygen generator is forbidden for transportation on board a passenger-carrying aircraft.
  - A chemical oxygen generator is forbidden for transportation by both passenger-carrying and cargo-only aircraft after:
    - The manufacturer's expiration date; or
    - The contents of the generator have been expended.

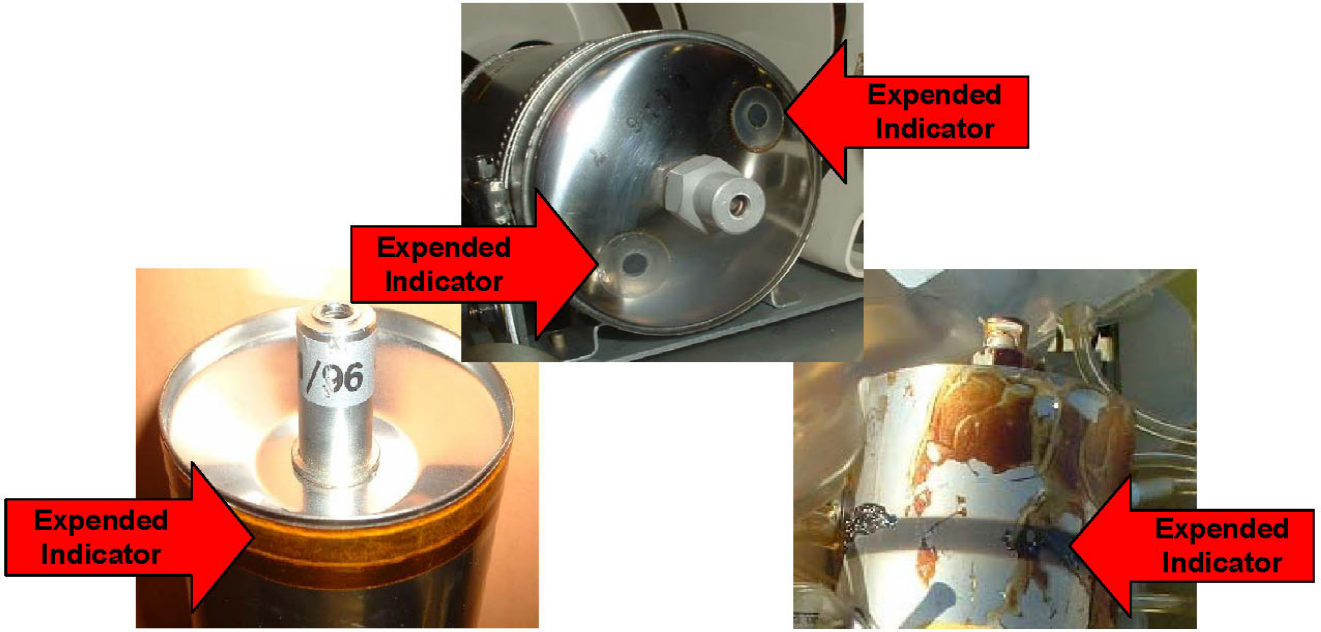
49 CFR 173.168(f)

Items Forbidden in Air Transportation

	Passenger Aircraft	Cargo-only Aircraft
O_2 Generator	FORBIDDEN	HAZMAT TABLE
Expired O_2 Generator	FORBIDDEN	FORBIDDEN
Expended O_2 Generator	FORBIDDEN	FORBIDDEN

Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Current Regulations
Spent Oxygen Generators

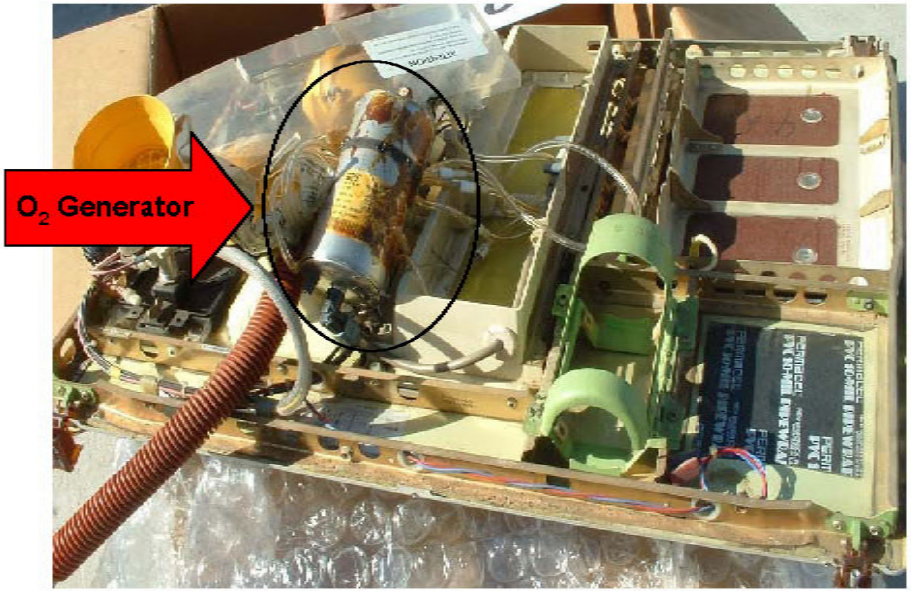


Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

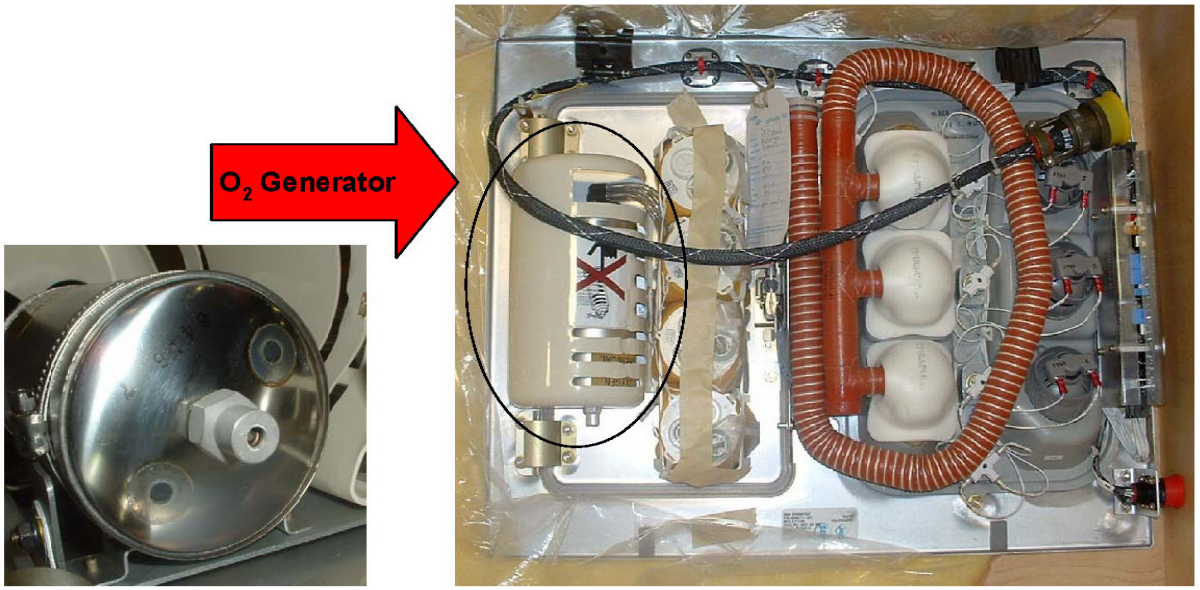
Spent Oxygen Generators

- **Classified as NA3356, Oxygen generator, chemical, spent, 9, III**
- **Special provision: 61**
- **Quantity limitations:**
  - Passenger aircraft: Forbidden
  - Cargo aircraft only: Forbidden

A Spent Oxygen Generator within a Passenger Service Unit



A Spent Oxygen Generator within a Passenger Service Unit



Effective 10/01/2008: This guidance is not intended to be a substitute for any FAA or PHMSA regulation. In the event this guidance is in conflict with applicable law or regulation, that law or regulation takes precedence over this guidance. For further information, please refer to 49 CFR 173.168.

Special Provision 61

- **A chemical oxygen generator is spent if its means of ignition and all or a part of its chemical contents have been expended.**

Hazmat Table

Items Forbidden in Air Transportation

	Passenger Aircraft	Cargo-only Aircraft
Expended O_2 Generator	FORBIDDEN	FORBIDDEN

Changes in the Regulations

- **HM-224B**

  Hazardous Materials Regulations: Transportation of Compressed Oxygen, Other Oxidizing Gases and Chemical Oxygen Generators on Aircraft

  – Outer packaging compliance date:

    • October 1, 2009

49 CFR 173.168(d)(2)

- **Packaging**
  - A chemical oxygen generator and a chemical oxygen generator installed in equipment must be placed in a rigid outer packaging that, with its contents, is capable of meeting the following additional requirements when transported by cargo-only aircraft:

49 CFR 173.168(d)(2)

- **Packaging (continued)**
  - The Flame Penetration Resistance Test:
    - Specified in Appendix E to part 178;
  - The Thermal Resistance Test:
    - Specified in Appendix D to part 178; and

49 CFR 173.168(d)(2)

- **Packaging (continued)**
  - None of the following conditions may occur when one generator in the package is actuated:
    - Actuation of other generators in the package;
    - Ignition of the packaging materials; and
    - A temperature above 100 °C (212 °F) on the outside surface temperature of the package; and

49 CFR 173.168(d)(2)

- **Packaging (continued)**
  - A visual inspection of the package before each shipment must verify that:
    - All features of the packaging are in good condition, including all latches, hinges, seams, and other features; and
    - The packaging is free from perforations, cracks, dents, or other abrasions that may negatively affect the flame penetration resistance and thermal resistance characteristics of the packaging.

Questions?

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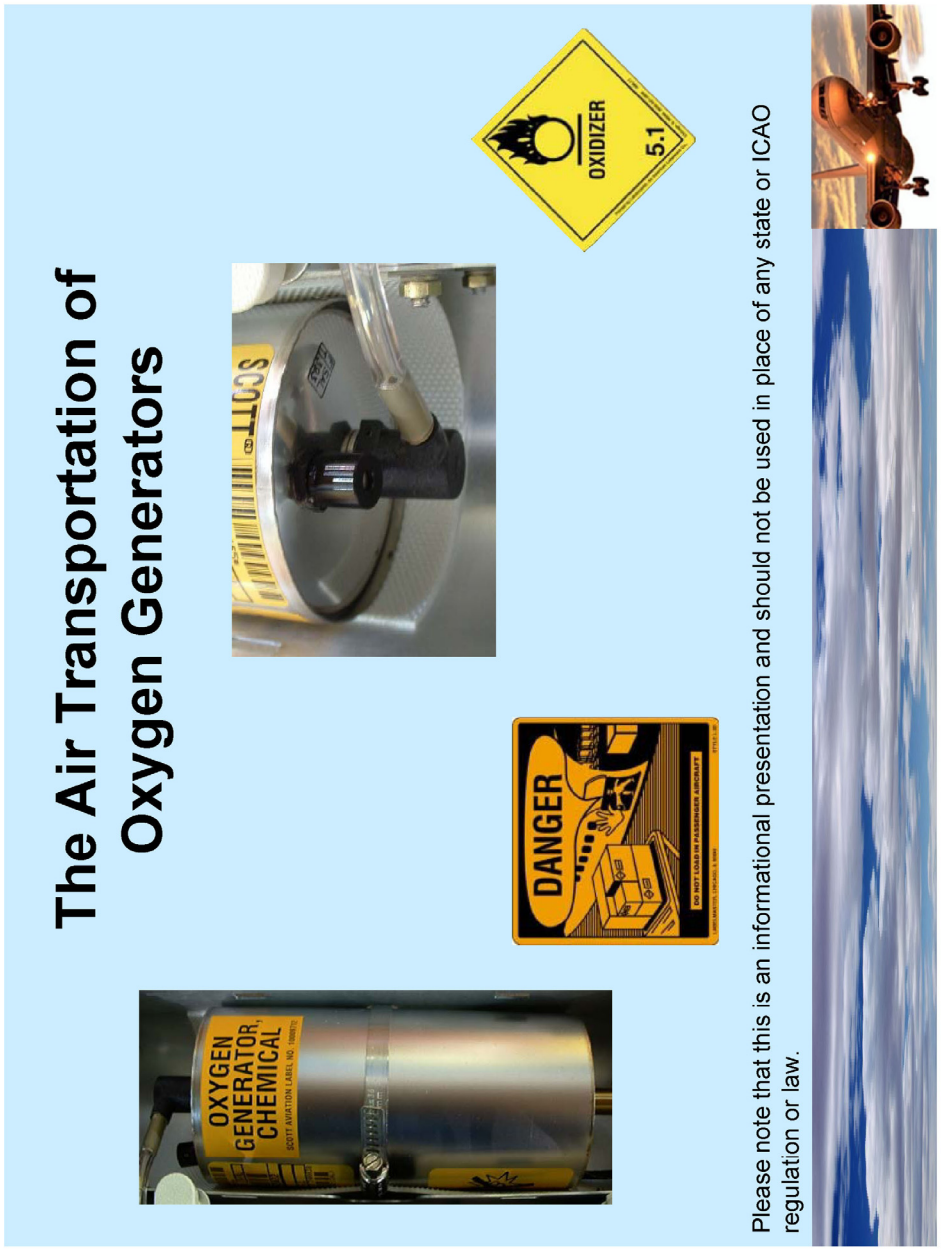
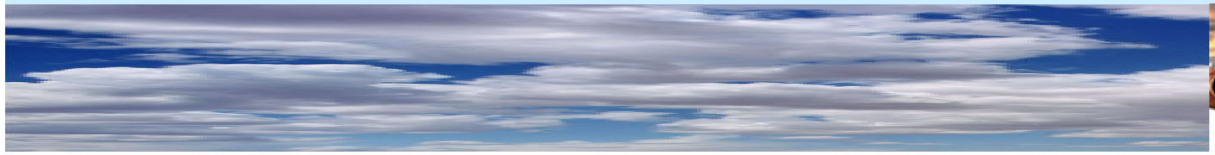
APPENDIX B

CHEMICAL OXYGEN GENERATORS AND THE TECHNICAL INSTRUCTIONS



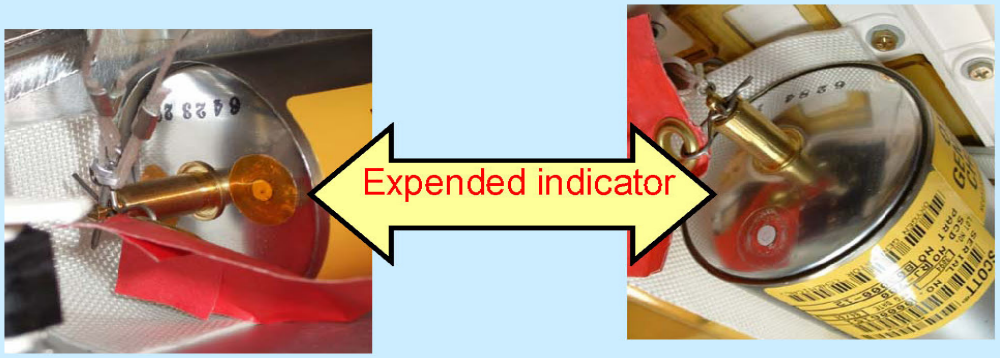
Oxygen Generators

- **Current Regulations**
- ICAO
- US State Provisions
- **More Information**



Unspent Oxygen Generators

- "Classified as UN3356, Oxygen generator, chemical, 5.1, II
- Includes oxygen generators in passenger service units and protective breathing Equipment"[1]
- Special Provisions: A1, A11, A116, A144 and A201



Packing Instructions 523

- Applies to **Cargo Aircraft** only

- There is a 25Kg G maximum quantity limit

Packing Instructions 523

A

- “A chemical oxygen generator, without any packaging, must be capable of withstanding a 1.8 meter drop onto a rigid, non – resilient, flat and horizontal surface, in the position most likely to cause actuation without loss of contents and without actuation”. [2]

Packing Instructions 523

B

- "When a generator is equipped with an actuating device, it must have at least two positive means of preventing unintentional actuation. For PBE, which are in a vacuum – sealed bag as part of their containment system, the vacuum - sealed bag may be considered the second positive means of preventing unintentional actuation." 3

Packing Instructions 523

c

- “The generators must be transported in a package which will meet the following requirements when one generator in the package is actuated:

  1- other generators in the package will not be actuated
  2- packaging material will not ignite and
  3- the outside surface temperature of the complete package will not exceed 100 C”[4]

Packing Instructions 523

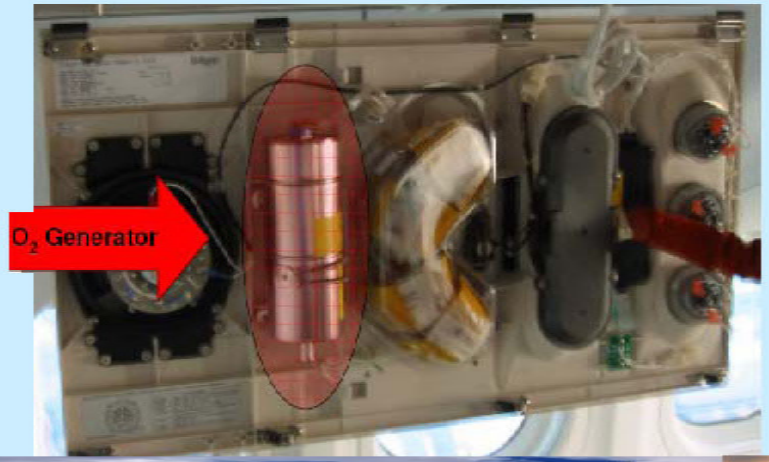
D

- "The generators must be tightly packed in steel drums (1A2), aluminum drums (1B2), plywood drums (1d), fibre drums (1G), plastic drums (1H2), steel jerricans (3A2), plastic jerricans (3H2), metal boxes (4A, 4B), wooden boxes (4C1, 4C2), plywood boxes (4D), reconstituted wood boxes (4F), fibreboard boxes (4G) or solid plastic boxes (4H2)".[5]

Packing Instructions 524

- Applies to Passenger Aircraft only and is not permitted to be used to, from or through the US

- There is a 25Kg G maximum quantity limit



Packing **Instructions** 524

- "Oxygen generators, chemical, must be packed as required by Packing Instructions 523. In addition, each package offered fro transport must be capable of withstanding the following fire exposure test:"[6]

Packing Instructions 524

"Test Procedure:

The package, as prepared for transport, is subjected to a fire exposure test in accordance with this procedure. A .9 –m square wood crib is prepared from air dried wood 30 to 50 mm square and .9 m long. The wood sticks are placed in seven layers with the spacing distance between each stick equal to the thickness of the sticks employed, and with each layer of sticks perpendicular to the layer below. A 1.0 m square open metal mesh grid made of 6.mm steel rods on 50- mm centres is supported 150 mm above the crib on legs of suitable height made from steel angle – iron. The package to be tested is placed in the centre of the mesh grid. The wood crib is ignited by four ignitors, one placed in each corner at the bottom of the crib. Each ignitor consists of cotton cloth rolled into a 150 mm long by 25mm diameter roll placed in a plastic bag and soaked in hexane. Optional test instrumentation would include sheathed thermocouples (TC) placed inside the package and protected outside the package by sheathing. These TC's are used to record the temperature inside the package during the test." [7]

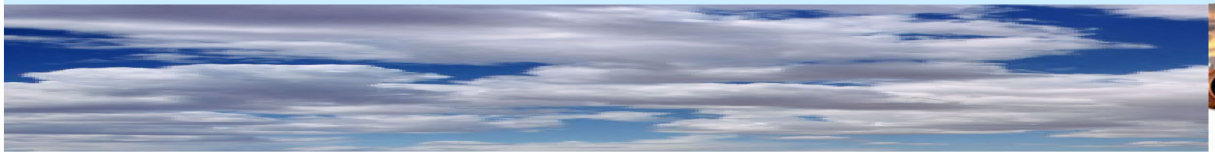
Packing Instructions 524

- "A propane torch is used to ignite each ignitor in succession. The test is run for 10 minutes after the wood crib is fully involved. A crib is considered to be fully involved when it is burning across the entire square top.

- No generator is activated from exposure to fire within 8 minutes after the time the crib is fully involved." [8]

US State Variations

The US requires operators to use the following additional requirements when flying into, within or above US territory.



US State Variation: US3

US 3 – 1

- "If A1 appears in column 7, the substance may not be transported to, from or within the United States aboard a passenger Aircraft without the prior approval for the appropriate authority of the U.S. This includes personal breathing equipment (PBE's) that contain a chemical oxygen generator component assigned to UN 3356."[9]

US State Variation: US3

US 3 – 3

- "If A109 appears in column 7, the substance may only be transported to, from or within the United States aboard a cargo aircraft with the prior approval of the appropriate authority of the U.S. This includes oxygen generators, chemical, UN3356."[10]

US State Regulations required by variations that are not included in the ICAO Technical Instructions

US Regulations

Approval

– "A chemical oxygen generator that is shipped with a means of initiation attached must be classed and approved by the Associate Administrator."[11]

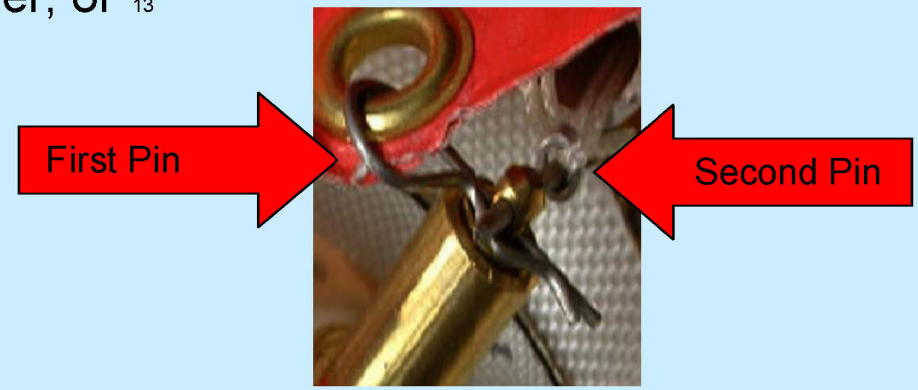
Protection against inadvertent actuation

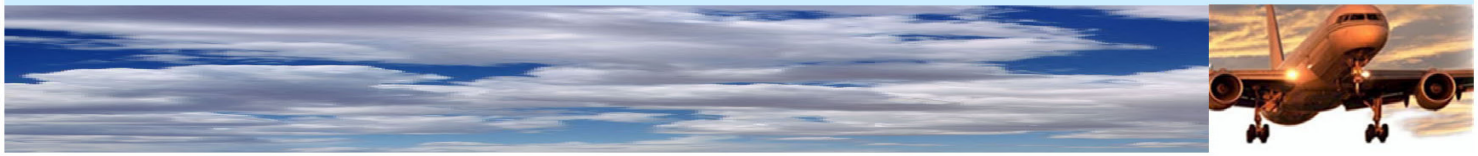
– "A chemical oxygen generator must incorporate one of the following means of preventing inadvertent actuation:"[12]

Protection against inadvertent actuation

1. **"A mechanically actuated chemical oxygen generator that is not installed in protective breathing equipment must incorporate:**

– Two pins, installed so that each is independently capable of preventing the actuator from striking the primer; or"[13]





Protection against inadvertent actuation

2. "A mechanically actuated chemical oxygen generator that is not installed in protective breathing equipment must incorporate:

– One pin and one retaining ring, each installed so that each is independently capable of preventing the actuator from striking the primer; or

– A cover securely installed over the primer and a pin installed so as to prevent the actuator from striking the primer and cover.

3. An electrically actuated chemical oxygen generator that is not installed in protective breathing equipment:

– The electrical leads must be mechanically shorted; and

– The mechanical short must be shielded in metal foil.

4. A chemical oxygen generator with a primer but no actuating mechanism that is not installed in protective breathing equipment must have:

– A protective cover over the primer to prevent actuation from external impact." [15]

An Unspent Oxygen Generator within Protective Breathing Equipment

Protective breathing equipment

"A chemical oxygen generator installed in protective breathing equipment must:

– Contain a pin, installed so as to prevent the actuator from striking the primer; and

– Be placed in a protective bag, pouch, case or cover such that the protective breathing equipment is fully enclosed in such a manner that the protective bag, pouch, case or cover prevents unintentional actuation of the oxygen generator."[17]

Protective Breathing Equipment (PBE)

Packaging

– "A chemical oxygen generator and a chemical oxygen generator installed in equipment must be placed in a rigid outer packaging that conforms to the requirements of either:

• Part 178, subparts L and M, at the Packing Group I or II performance level; or

• The performance criteria in Air Transport Association (ATA) Specification No. 300 for a Category I Shipping Container."[18]

Packaging Cont.

"A visual inspection of the package before each shipment must verify that:
• All features of the packaging are in good condition, including all latches, hinges, seams, and other features; and
• The packaging is free from perforations, cracks, dents, or other abrasions that may negatively affect the flame penetration.
resistance and thermal resistance characteristics of the packaging."[19]

Packaging Examples

"Part 178, Subparts L and M, at the Packing Group I or II Performance Level"[20]

"ATA Spec. No. 300 for a Category I Shipping Container"[21]

Equipment marking

– "The outside surface of equipment containing a chemical oxygen generator that is not readily apparent must be clearly marked to indicate the presence of the oxygen generator.
• Example: "Oxygen Generator Inside""[22]

OXYGEN
GENERATOR
INSIDE

– "The outside surface of a chemical oxygen generator must be marked to indicate the presence of an oxygen generator.
• Example: "oxygen generator, chemical""[23]

Items forbidden in air transportation

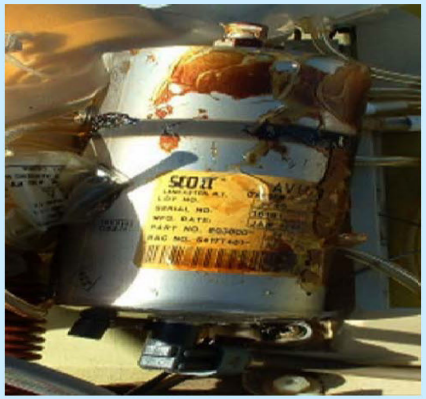
– "A chemical oxygen generator is forbidden for transportation on board a passenger-carrying aircraft."[24]

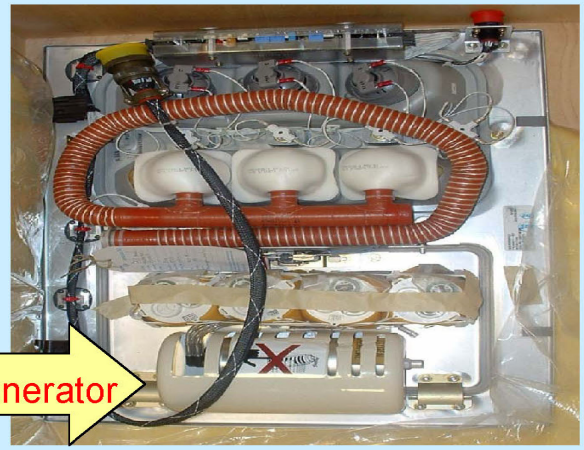
	Passenger Aircraft	Cargo-only Aircraft
O_2 Generator	FORBIDDEN	HAZMAT TABLE
Expired O_2 Generator	FORBIDDEN	FORBIDDEN
Expended O_2 Generator	FORBIDDEN	FORBIDDEN

– "A chemical oxygen generator is forbidden for transportation by both passenger-carrying and cargo-only aircraft after:
- The manufacturer's expiration date; or
- The contents of the generator have been expended."[25]

Spent Oxygen Generators

- **"Classified as Oxygen generator, chemical, spent, 9, III**
- **Quantity limitations:**
  - Passenger aircraft: Forbidden
  - Cargo aircraft only: Forbidden" [26]





How do you know if a generator is Spent

"A chemical oxygen generator is spent if its means of ignition and all or a part of its chemical contents have been expended."[27]

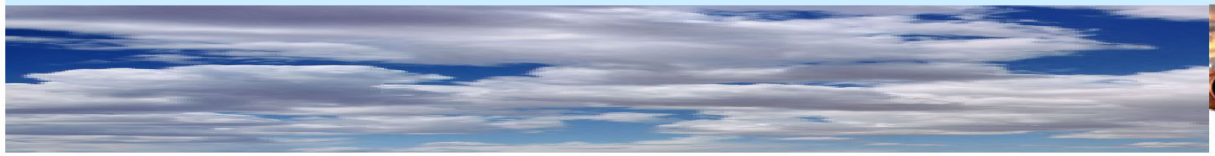
HAZMAT TABLE

	Passenger Aircraft	Cargo-only Aircraft
Expended O_2 Generator	FORBIDDEN	FORBIDDEN

Why does the US have additional requirements for O2 generators

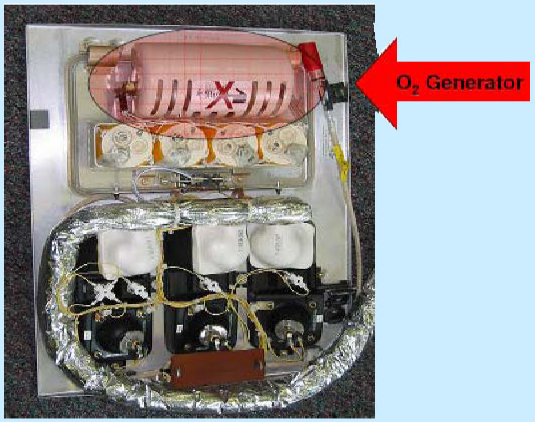
ValuJet Flight 592

"May 11, 1996
• DC-9 carrying 105 passengers and 5 crew members
• Impacted the Florida Everglades at 440 knots
• No survivors
• NTSB concluded: "The accident was caused by improperly packaged, marked, and labeled oxygen generators.""[28]



Statistics

- "Shippers are still transporting undeclared oxygen generators.
- 1996 – 1999: 60 incidents occurred within the United States
- 800 undeclared oxygen generators on one passenger aircraft
- 2000 – 2007: 130 incidents"[29]

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QUESTIONS

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