United Arab Emirates

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

Air Accident Investigation Sector

Incident

- Final Report -

AAIS Case N^{o} AIFN/0014/2013

Carriage of Cargo on an Aircraft (Dangerous Goods Onboard Passenger Aircraft)

Operator: Flydubai
Type: Boeing 737-800
Registration: A6-FEB
Location: Dubai International Airport
State of Occurrence: United Arab Emirates
Date of Occurrence: 6 December 2013

Synopsis

A Boeing B737-800 passenger aircraft, registration A6-FEB, returned as a ferry flight to its base at Dubai International Airport following a maintenance visit to an Aircraft Maintenance Organization based in Amman, Jordan. Six Passenger Service Unit assemblies, each containing a chemical oxygen generator, were loaded into the cargo hold of the Aircraft and transported to Dubai. Chemical oxygen generators are prohibited for carriage onboard passenger aircraft.

The investigation determined that the causes of the incident were that the PSU assemblies that had been removed from the Aircraft were not labeled as containing dangerous goods, the AMO maintenance personnel did not consult, and follow, the instructions contained in *AMM ATA 35 – Oxygen,* and that the Engineering Order prepared by the STC holder did not adequately address dangerous goods issues associated with the chemical oxygen generators installed in the PSU assemblies.

Also established as causes were that the Operator and AMO personnel, involved in the configuration modification work on the Aircraft were unaware that the PSU assemblies contained dangerous material. In addition, the contract agreed between the Operator and the AMO contained a term related to the return of removed aircraft parts and materials to the Operator by air, which did not differentiate between normal and dangerous goods.

This Report contains eleven recommendations. Five recommendations are addressed to Flydubai, two to Jordan Aircraft Maintenance Company, three to TIMCO and one to the General Civil Aviation Authority.

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General Civil Aviation Authority
The United Arab Emirates

Accident Brief

GCAA AAI Report No.:	AIFN/0014/2013
Operator:	Flydubai
Aircraft Type and Registration:	Boeing 737-800, A6-FEB
MSN	40255
No. and Type of Engines:	Two Turbofan, CFMI CFM56-7B27E
Date and Time (UTC):	6 December 2013, 2331
Location:	Dubai International Airport
Type of Flight:	Ferry
Persons Onboard:	2
Injuries:	None

Investigation Objective

This Investigation is performed pursuant to the UAE Federal Act No 20 of 1991, promulgating the Civil Aviation Law, Chapter VII, Aircraft Accidents, Article 4. It is in compliance with the UAE Civil Aviation Regulations, Part VI, Chapter 3, in conformity with Annex 13 to the Convention on International Civil Aviation and in adherence to the Air Accidents and Incidents Investigation Manual.

The sole objective of this Investigation is to prevent aircraft accidents and incidents. It is NOT the purpose of this activity to apportion blame or liability.

Investigation Process

The occurrence details were submitted by the Operator to the GCAA mandatory occurrence reporting system. The potential significance of the occurrence was noticed by an AAIS investigator while carrying out a regular review of mandatory reports.

After an Initial evaluation, the occurrence was classified as an “Incident” and the investigation that is the subject of this report commenced.

Notes:

1 Whenever the following words are mentioned in this Report with the first letter Capitalized, it shall mean:

- (Aircraft) - the aircraft involved in this Incident.
- (Investigation) - the investigation into this Incident
- (Incident) - this investigated Incident
- (Report) - this Incident Report

2 Unless otherwise mentioned, all times in this Report are Coordinated Universal Time (UTC), (UAE Local Time minus 4).

3 Photos used in the text of this Report are taken from different sources and are adjusted from the original for the sole purpose of improving the clarity of the Report. Modifications to images used in this Report are limited to cropping, magnification, file compression, or enhancement of color, brightness, contrast or insertion of text boxes, arrows or lines.

Abbreviations and Definitions

AAIS	Air Accident Investigation Sector
AMO	Aircraft Maintenance Organization
AOC	Air Operator Certificate
BER	Beyond Economic Repair
CoA	Certificate of Airworthiness
CoR	Certificate of Registration
CSB	U.S. Chemical Safety Board
DI	Duty Investigator
EO	Engineering Order
GCAA	General Civil Aviation Authority of the United Arab Emirates
JCARC	Jordanian Civil Aviation Regulatory Commission
MSN	Manufacturer Serial Number
P/N	Part Number
PSU	Passenger Service Unit
ROSI	Report of Safety Incident
S/N	Serial Number
SMS	Safety Management System
STC	Supplementary Type Certificate
UAE	United Arab Emirates
UTC	Universal Time Coordinated

CONTENTS

1. Factual Information

1.1 History of the Flight

A Boeing 737-800 passenger Aircraft, registration A6-FEB, operated by Flydubai, was ferried to Dubai International Airport (DXB) on 6 December 2013, having undergone a C-Check carried out by JorAMco, an approved maintenance organization (AMO) based in Amman, Jordan.

In addition to undergoing a C-Check, a modification to change the passenger-seating configuration was carried out. The modification, which altered the seating configuration in the forward cabin from economy to business class, required the removal of three sets of triple seats of economy passenger seating, and associated equipment. The associated equipment included three passenger service unit (PSU) assemblies, each containing a chemical oxygen generator.

The three removed PSU assemblies, which had been tagged with a serviceable tag on removal from the Aircraft, were brought to the AMO stores. In the stores, details of the PSU assemblies were entered into the computerized parts tracking system. The assemblies were then individually wrapped in bubble wrap and placed in cardboard boxes.

The cardboard boxes were stored together with cardboard boxes containing PSU assemblies that had been removed from eight other, previously modified aircraft. The total number of PSU assemblies stored was twenty-seven, which had been removed from nine aircraft. The number of PSUs contained in each box varied between one and three. The Aircraft was the ninth of the Operator's aircraft to undergo the passenger seating configuration modification, in conjunction with a C-Check.

The PSU assemblies, each containing an oxygen generator, were stored in a general storage area of the Stores. The chemical oxygen generators had not been removed from the PSUs, nor had they been made safe by the installation of a safety pin and safety cap. In the case of each oxygen generator, the firing pin was engaged in the firing mechanism and the activation cable was connected to the pin. Neither the individual PSU assemblies, or oxygen generators, nor the boxes containing them, were labeled as dangerous goods.

On completion of the maintenance visit on 6 December, A6-FEB was ferried to Dubai. The only occupants of the Aircraft were the crew of two pilots. Prior to departure from Amman, six PSU assemblies, each containing a chemical oxygen generator and packaged and unlabeled as described above, were removed from the stores and loaded onboard the Aircraft, together with other parts being returned to the Operator. Chemical oxygen generators are prohibited from carriage onboard a passenger aircraft.

On arrival at Dubai, the boxes containing the PSU assemblies were unloaded and taken to the Operators stores "Pending Receiving Area". The boxes were opened and their contents inspected by a Quality Assurance engineer. The engineer observed that each PSU assembly contained an oxygen generator. He was aware that chemical oxygen generators are classified as dangerous goods, and that they

are banned from carriage on passenger aircraft. The engineer reported the incident internally to Flydubai, and to the UAE General Civil Aviation Authority (GCAA). The oxygen generators had not been made safe by the insertion of a safety pin in the firing mechanism, or by the installation of a safety cap.

The return flight of the Aircraft to Dubai was a ferry flight. The Aircraft was the first post-maintenance Flydubai aircraft to depart the AMO facility as a ferry flight, departing directly from the AMO Ramp. The return flights of the previous eight modified aircraft had all operated from the airport passenger terminal as scheduled commercial passenger flights.

1.2 Injuries to Persons

Table 1. Injuries to persons

Injuries	Flight Crew	Cabin Crew	Other Crew Onboard	Passengers	Total Onboard	Other
Fatal	0	0	0	0	0	0
Serious	0	0	0	0	0	0
Minor	0	0	0	0	0	0
None	2	0	0	0	2	0
TOTAL	**2**	**0**	**0**	**0**	**2**	**0**

1.3 Damage to Aircraft

The Aircraft was undamaged.

1.4 Other Damage

There was no other damage to property or the environment.

1.5 Personnel Information

All personnel involved were properly qualified, and all were experienced in carrying out their responsibilities.

1.6 Aircraft Information

1.6.1 General

Table 3. General Aircraft data

Make and Model:	Boeing 737-800
MSN:	40255
Registration:	A6-FEB
State of Registry:	United Arab Emirates
Certificate of Airworthiness (CoA)	
Issuing Authority:	The General Civil Aviation Authority, United Arab

	Emirates
Issuance date:	17 October 2012
Valid until:	Until revoked by the GCAA
Engines:	Two Turbofan, CFMI CFM56-7B27E

1.6.2 Removal of PSUs

In order to accomplish the passenger seating modification it was necessary to remove three PSU assemblies and other equipment. The instructions for this work were contained in documentation provided by the Supplementary Type Certificate (STC) holder and in the Aircraft Maintenance Manual (*AMM*).

1.6.2.1 Documentation and Instructions

The documentation provided by the Operator to the AMO for the accomplishment of the change of passenger seating configuration included Engineering Order[1] (EO) 12T478E056 Revision C entitled: "Removals – Interior Components, 737-800". EO Part V, B, Item 30 states "Remove triple PSU assemblies; LH Row 1, LH Row 2 and RH Row 1, per Boeing 737-800 *AMM 25-23*. "*Route* [Send] *removed PSU Assemblies to customer for disposition".* Step 30 also contains a note referring to capping of gasper air spuds and capping and stowing of electrical wiring.

Step 30 of the EO did not require an inspection signature, nor did it contain any reference to the presence of hazardous materials (oxygen generators) installed in the PSU assemblies. Step 30 referenced the Boeing 737-800 *AMM ATA 25-23 (Passenger Service Unit – Removal/Installation)* for instructions on removal of the PSU assemblies. The EO did not categorize the removal of the PSUs as a critical step, nor did it specifically reference *AMM ATA 35 (Oxygen)* which provided the critical instructions required to make the oxygen generators safe. However, *AMM 25-23* did provide a reference to *AMM ATA 35*.

Step 30 of the EO stated, "Route removed PSUs to customer for disposition." The EO did not provide any guidance or reference to the correct procedures for safe storage of the uninstalled PSU/oxygen generator assemblies.

The engineer who uninstalled the PSUs referred to EO step 30 which referred him to *AMM* 25-23. He removed the PSUs as per the instructions included in *AMM 25-23.* He did not refer to *AMM 35-22 (Oxygen)* as required by *AMM 25-23*. After removing the PSUs, he tagged them with "Serviceable" tags. A stores runner then brought the PSUs to the stores. The engineer signed EO step 30.

[1] An Engineering Order is an explicit list of sequential instructions, warnings, and references that enable technical tasks to be carried out on an aircraft safely, efficiently and in accordance with airworthiness requirements.

1.6.2.2 Special Tooling

EO 12T478E056, Revision C, Part III, Planning information Section E: 'Special Tooling", sub-section 1 states that no special tooling is required to accomplish the seating configuration modification. The Boeing 737-800 *AMM 35-22-11* entitled *"Oxygen Generator – Maintenance Practices" Section 1 General*, *sub-section G* stated that: *"It is necessary to use an approved pair of pin retraction pliers and a safety pin to deactivate an oxygen generator".*

The contract called for the special tools to be provided by the Operator. The special tools were not provided by the Operator, however, the AMO did have them available in their Stores.

1.6.2.3 Storage of Removed PSU Assemblies

The removed PSU assemblies were routed [sent] to stores where they were kept in the general stores area. The stores personnel wrapped each PSU assembly in a single layer of bubble wrap and then placed the assemblies in cardboard boxes. Each box contained one, two or three PSUs. The cardboard boxes were not labelled as hazardous material that must not be carried on passenger aircraft, and they were stored in the general stores.

It had been agreed between the AMO Service Engineering Department and the Operator that the removed PSUs would be accumulated in the stores, and shipped by road to Dubai at the end of the maintenance program.

1.7 Meteorological Information

Not relevant.

1.8 Aids to Navigation

Not relevant.

1.9 Communications

Not relevant.

1.10 Aerodrome Information

Not relevant.

1.12 Wreckage and Impact Information

Not relevant.

1.13 Medical and Pathological Information

Not relevant.

1.14 Fire

Not relevant.

1.15 Survival Aspects

Not relevant.

1.16 Tests and Research

No tests or research were performed during this Investigation.

1.17 Organisational and Management Information

1.17.1 The Operator

Flydubai is certified for the carriage of passengers by the UAE General Civil Aviation Authority (GCAA). The Operator is not approved by the regulator to transport dangerous goods.

The Operator had a Safety Management System that had been accepted by the UAE General Civil Aviation Authority (GCAA), and a Quality Management System, which was approved by the GCAA.

Heavy Maintenance of the Boeing 737-800 fleet is carried out under contract by Jordan Aircraft Maintenance Ltd., (JorAMco), an AMO based at Queen Alia International Airport, Amman, Jordan.

1.17.1.1 Operator Quality System

The Operator's *Engineering Procedures Manual*, Section 1, Paragraph 1.2 - Purpose, states that Base Maintenance Audits are intended: “To ensure that the contracted maintenance organizations base maintenance facilities meet both contractual and regulatory requirements, and that management processes and procedures are being adhered to.

Organizations wishing to become contracted service providers to the Operator must undergo two audits, an Initial Assessment and a Supplier Audit, prior to being accepted as an approved service provider. The audit documents are controlled and are held in the Electronic Flight Operations System (EFOS) as standalone documents.

1.17.1.2 Operator Safety Management System (SMS)

The Operator manages air safety through the use of an SMS accepted by the GCAA according to the UAE *Civil Aviation Regulations (CAR) Part X - Safety Management System.*

The SMS is managed by the Safety Manager who reports to the Chief Operating Officer. The Chief Operating Officer is the Accountable Manager.

Paragraph 2.6.6 of the Operator's *Safety Manual* stated that any contracted engineering services must comply with the requirements of the Operator's SMS, and must have appropriate levels of safety management in their company structure.

Section 3.4 of the *Safety Manual* stated that: *“It is important, therefore, that the safety standards required of contracted organizations are at a level acceptable to the Operator and are clearly defined and understood before the finalization of any contract. The Safety Manager is responsible for ensuring that contracted agencies have the necessary safety standards in*

place and are considered during the process of appointing contractors to provide services to the Operator."

According to the Operator's policies, when procuring services from outside agencies, due regard should be given to the contractor's previous safety record. Any safety related failures uncovered by this process of due diligence should be fully investigated under the direction of the Safety Manager, to remove any doubt as to the suitability of the agency to provide a service or product to the Operator. These factors were to be given equal weight with other considerations, such as quality and prompt completion.

The contractor was to be made aware of the Operator's SMS, and of their responsibilities within it. Contractors would be audited as part of the Safety Department audit schedule, to ensure safety standards were being maintained.

The Safety Review Board (SRB) was established to perform the following functions: "*…Monitor the effectiveness of safety oversight of sub-contracted operations carried out on behalf of the Company."*

1.17.1.3 Operator Approval of AMO

The first Operator's audit *(Initial Assessment)* of the AMO took place on 21 January 2013, and the first aircraft to undergo maintenance at the AMO arrived shortly afterwards. The AMO passed the *Initial Assessment*.

The Operator's Quality Assurance Department carried out a *Supplier Audit* of the AMO. The purpose of the audit was to evaluate the AMO's Base Maintenance capability, prior to including the AMO in the Operator's approved Base Maintenance Contractor list. The AMO also satisfied the *Supplier Audit*.

Neither the *Initial Assessment* nor the *Supplier Audit* included the AMO stores in their scope.

A contract for the provision of certain maintenance support services to the Operator by the AMO was signed by both parties on 7 March 2013. Attachment 1 to the contract detailed the services to be provided by the AMO and included *"Base Maintenance Check"* as per the work package provided by the Operator, and in accordance with its *Maintenance Program*, using job cards provided by the Operator.

The contract also covered the implementation of Service Bulletins (SBs), Airworthiness Directives (ADs), and Modifications. In these cases the contract states: *"Upon the request of Flydubai, JorAMco will perform modifications and implementation of Service Bulletins (SBs) and Airworthiness Directives (ADs) as per the work package provided by the Operator."*

Section 2 of the contract covered the *"Supply of Material"*. This Section stated that; *"Unless otherwise agreed, Flydubai deliver the following materials at its own expense including cost of material, insurance, and freight (CIF) to JorAMco before the Aircraft delivery date."* In the sub-section, dealing with "*Modifications Materials*" it was stated that Flydubai: "[Provides] *modification kits and tools required to perform all SBs, ADs, SWRs and modifications requested under the respective Annex."*

1.17.1.4 The Operator's requirement for return of aircraft parts to base

The sub-section "*Redelivery of Parts"* in Section 2 of the contract stated that: *"All Components supplied by Flydubai but installed into the aircraft or those Components removed from the Aircraft and not reinstalled will be returned to Flydubai on the return ferry flight, i.e. on board of the Aircraft, commercial flight or can be scrapped if deemed BER (Beyond Economic Repair) in Amman subject to prior approval and charges."*

1.17.1.5 Disposition of Removed Oxygen Generators

Up to 6 December 2013, a total of nine of the Operator's aircraft, including the Incident Aircarft, had undergone the passenger seating configuration change modification in conjunction with C-Checks at the AMO. As each aircraft was modified, three PSU assemblies, which were no longer required to be installed on the aircraft due to the reduction in seating capacity, were removed from the aircraft, and moved to the stores.

1.17.1.6 The Operator's dangerous goods training

The Operator provided dangerous goods training for flight crew, cabin crew and ground operations personnel. It was not the policy of the Operator to provide Dangerous Goods training to maintenance personnel.

1.17.1.7 Post-Maintenance dispatch of aircraft by the Operator

The eight aircraft that had undergone C-Checks, and the seating configuration modification, prior to the Incident Aircraft, had all departed from Amman as commercial flights. Therefore, their dispatch was in line with the normal flight dispatch procedures of the Operator.

No documentation related to the process for the dispatch of a post-maintenance aircraft directly from the AMO ramp was found, nor did the Operator have a documented process for the handling of aircraft parts to be returned to base.

1.17.1.8 The Operator's Base Maintenance Liaison Engineer

The Operator's Base Maintenance Liaison Engineer stated that he was provided with an office in the AMO hangar and that the nature of his work required him to spend most of his time in the office. He did not visit the Aircraft often, and had not observed the removed PSUs onboard the Aircraft, or in the stores.

The engineer stated that there was a job description for the Base Maintenance Liaison Engineer function. The job description did not specifically mention dangerous goods.

The post-maintenance loading of material onboard the Aircraft for return to base was outside the scope of the job description. The engineer stated that the arrangement for returning parts to base commenced when he passed a message to the departments responsible for materials management in the AMO and the Operator, and that these departments then specified the loading requirements.

Eight of the nine aircraft that had been modified departed the AMO airport from the passenger terminal, operating as normal commercial flights. The Base Maintenance Liaison Engineer had not observed the loading of those aircraft. Among

the aircraft that departed from the passenger terminal was a flight on 28 November 2013. The Incident Aircraft departed from the AMO Ramp as a ferry flight on 6 December 2013. The Base Maintenance Liaison Engineer did not observe the loading of this Aircraft either, and his job description did not require him to do so. He was aware that the flight crew received the flight documentation from the AMO. He did not see the loadsheet at any time.

The Base Maintenance Liaison Engineer stated that he had not received any training in dangerous goods since he joined the Operator.

1.17.2 AMO organizational information

The AMO was certified under Part 145 of the Jordanian Civil Aviation Regulations (JCARs) to maintain a variety of aircraft models & engines.

1.17.2.1 AMO Quality system

JorAMco has in place a Quality Management System, which has been approved by the JCARC.

1.17.2.2 AMO Safety Management System

The AMO did not have a Safety Management System that had been accepted by the Jordan Civil Aviation Regulatory Commission (JCARC).

1.17.2.3 AMO Dangerous goods training

The AMO did not provide dangerous goods training to its personnel until early 2014 as the JCARC had not approved a dangerous goods trainer for Jordan. This situation was rectified and the AMO agreed the services of the approved trainer in November 2013.

1.17.3 UAE GCAA airworthiness oversight of the AMO

The GCAA first approved the AMO to provide aircraft maintenance services to UAE registered aircraft in 2004. The AMO has been regularly audited since then by the GCAA.

Although the GCAA has required UAE based AMOs to operate an SMS since January 2010, it has not mandated that UAE operators ensure that the AMO possess an SMS when entering into contracts with foreign AMOs.

1.18 Additional Information

The transportation of chemical oxygen generators has resulted in aircraft accidents and incidents over an extended period. Following the fatal Valujet accident that occurred near Miami in 1996, the carriage of chemical oxygen generators on passenger aircraft was forbidden. In spite of this prohibition, there have been incidents where oxygen generators were inadvertently carried onboard passenger aircraft.

1.18.1 Oxygen generator function

Each PSU installed on the Boeing 737-800 aircraft contains a chemical oxygen generator to provide oxygen for the passengers, in the event of cabin depressurization (Figure 1). The oxygen is provided either through masks that drop from the PSUs, automatically, or by activation of a switch in the cockpit.

When a passenger pulls the mask down, this action causes a pin to be released from the firing mechanism of the oxygen generator, resulting in ignition of an explosive charge, which activates chemicals contained in the generator causing oxygen to be produced. The resultant exothermic reaction produces heat as a byproduct, and the outside temperature of the oxygen generator canister can reach 450 degrees Fahrenheit (232 degrees Centigrade). In addition to activation by release of the generator firing pin, the reaction may commence due to exposure of the generator to high temperatures. Once the oxygen producing chemical reaction commences it cannot be stopped.

The oxygen generators installed in the PSU assemblies were designed to produce oxygen for at least 12 minutes. The gaseous oxygen passes through a filter medium and then flows out of the output manifold. The output manifold ports are connected to the passenger oxygen masks by flexible tubing. A pressure relief valve prevents over-pressurization of the generator.

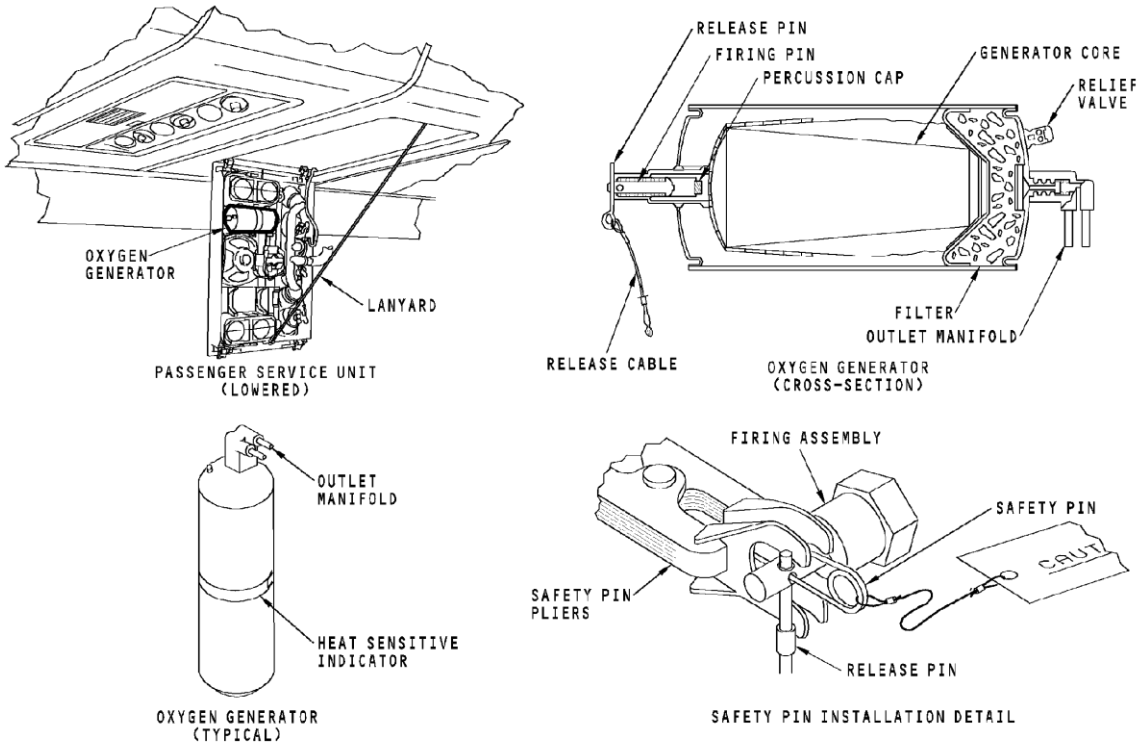

Figure 1. General arrangement of oxygen generator

1.18.2 Examples of Accidents and Incidents Involving Oxygen Generators

August 10, 1986 - American Trans Air Flight 131: A DC-10 aircraft was unloaded following a charter flight. Company maintenance personnel had placed damaged passenger seatbacks in the forward cargo hold which incorporated seatback-mounted chemical oxygen generators (although most generators are installed overhead, usually in passenger service units, some are installed in passenger seatbacks). A company mechanic examining the seatbacks encountered a loose oxygen generator, which he handled improperly by its oxygen hose. The generator activated, generating high temperatures and a high, localized oxygen concentration, resulting in ignition of seat covers and eventually resulting in a fire that burned through the cabin floor.

September 24, 1993 - Federal Express: A fire was discovered in a cargo container that was unloaded from a Federal Express Model 727 series airplane. Smoke was seen emitting from a corner of the cargo container, and was attributed to a chemical oxygen generator in a passenger service unit that was being shipped. The packaging for the unit did not identify that it included hazardous material.

October 20, 1994 - Fire was observed in a box as a truck unloaded. The contents of the truck were destined for an Emery flight. The box contained 37 chemical oxygen generators individually wrapped in bubble plastic. The fire started when one generator inadvertently activated, providing an ignition source. No safety caps were installed.

May 11, 1996 – Valujet Flight 592. At 1413:42, eastern daylight time (EDT), a Douglas DC-9-32 crashed into the Everglades about 10 minutes after takeoff from Miami International Airport, Miami, Florida. The airplane, N904VJ, was being operated by ValuJet Airlines, Inc., as flight 592. Both pilots, the three cabin crew members, and all one hundred and five passengers were killed. Visual meteorological conditions existed in the Miami area at the time of the takeoff. Flight 592, operating under the provisions of 14 CFR Part 121, was on an instrument flight rules flight plan destined for the William B. Hartsfield International Airport, Atlanta, Georgia.

The National Transportation Safety Board determined that the probable causes of the accident, which resulted from a fire in the airplane's class D cargo compartment, that was initiated by the actuation of one or more chemical oxygen generators being improperly carried as cargo, were (1) the failure of SabreTech to properly prepare, package, and identify unexpended chemical oxygen generators before presenting them to ValuJet for carriage; (2) the failure of ValuJet to properly oversee its contract maintenance program to ensure compliance with maintenance, maintenance training, and hazardous materials requirements and practices; and (3) the failure of the Federal Aviation Administration (FAA) to require smoke detection and fire suppression systems in class D cargo compartments.

June 27, 2007 - Raleigh, N.C., The U.S. Chemical Safety Board (CSB) issued a Safety Advisory concerning the dangers of transporting and handling unexpended aircraft chemical oxygen generators. The action followed a CSB finding that the devices most likely contributed to the rapid spread of a fire at the EQ Industrial Services (EQ) hazardous waste facility in Apex, NC on the night of October 5, 2006. The fire resulted in the evacuation of thousands of residents of

Apex, located about 16 miles southwest of Raleigh, and destroyed the EQ facility's hazardous waste building.

The devices that contributed to the EQ fire were past their projected service life but remained fully charged and hazardous. They originated at an aircraft maintenance facility in Mobile, Alabama, that did not expend the contents prior to transport. In addition, shipping documents did not identify them as unspent chemical oxygen generators as required by Department of Transportation regulations.

Years 2001 to 2007 - Between 2001 and 2007, the FAA investigated over 80 incidents of undeclared or improperly prepared chemical oxygen generators. Combined, the subjects of these investigations paid over $3,000,000 in civil penalties to the US Federal Government. While continuing its aggressive enforcement in this area, the FAA is also increasing its outreach efforts on oxygen generators.

1.18.3 Other Occurrences Involving Oxygen Generators

During the course of this investigation, while reconciling the number of PSU assemblies remaining in the AMO stores following the Incident, it was determined that another post maintenance return to base flight had inadvertently transported three PSU assemblies containing chemical oxygen generators.

This flight was operated by a Boeing 737-800 aircraft, A6-FDR, as a commercial flight from the AMO base to the Operator' base on 28 November 2013 with 6 crewmembers and 165 passengers onboard.

On the arrival of this flight at Dubai, the unlabeled box of PSUs containing chemical oxygen generators was not identified as containing dangerous goods. Therefore, the incident was not reported at the time. It was subsequently reported to the GCAA on 18 January 2014.

1.19 Useful or Effective Investigation Techniques

None.

2. Analysis

2.1 General

The flight crew who operated the Incident flight from the AMO base to the Operator's base were unaware that anything untoward had occurred.

The Operator uses a Safety Management System (SMS) to manage air safety, as required by the GCAA. The Operator had sub-contracted the heavy maintenance of its fleet to an AMO, which did not have in place an equivalent effective method to manage air safety. Therefore, the AMO did not have a formal risk assessment process to identify, evaluate, and mitigate potential risks related to air safety, resulting from the work carried out during C-Checks, and during the incorporation of aircraft modifications.

Had such a system been in use it is likely that weaknesses in dangerous goods handling would have been identified and appropriate steps could have been taken to manage dangerous goods correctly, and unexpended chemical oxygen generators in particular, being inadvertently transported on passenger aircraft.

2.2 Contract between the Operator and the AMO

In Section 2 of Attachment 1 to the contract between the Operator and the AMO, the sub-section "*Redelivery of Parts"* stated that: "All components supplied by Flydubai, but installed into the aircraft, or those components removed from the aircraft and not reinstalled, will be returned to Flydubai on the return ferry flight, i.e. on board of the Aircraft, commercial flight or can be scrapped if deemed BER [Beyond Economic Repair] in Amman subject to prior approval and charges."

There are many components installed on aircraft that are classified as dangerous goods, and any of these may be removed from the aircraft during maintenance, and may not be re-installed. The requirement contained in the contract to return all components to the Operator's base, onboard ferry flights or commercial flights, may not always comply with the GCAA prohibition on Flydubai transporting dangerous goods.

Contracts related to the airworthiness of the Operator's aircraft, that could have implications for air safety, were not required to be reviewed for appropriate safety content by the Operator's Safety Manager. The content of the contracts was not formally risk assessed. Maintenance contracts between UAE registered Operators and AMOs are not reviewed and subjected to oversight by the GCAA for safety or airworthiness content before signature.

UAE CAR Part X, Section 11- Subcontracting and Purchasing, requires that:

> *"(a) The Organization shall have a documented process, acceptable to the GCAA, to ensure that when subcontracting or purchasing any part of its SMS activity, the subcontracted or the purchased service or product conforms to applicable requirements.*

(b) The subcontracted organization and its products, services and/or credentials shall be evaluated periodically by the Organization. Upon request, the Organization shall ensure that the GCAA is given access to the subcontracted organization, to determine continued compliance with the applicable requirements."

The Operator did not ensure that the JCARC requirement was complied with by the AMO by having an accepted SMS in place.

2.3 Operator Initial Assessment and Supplier Audit of the AMO

Prior to the awarding of the base maintenance contract, an *Initial Assessment* of the AMO was carried out on 21 January 2013 and the AMO satisfied the requirements of the Operator.

In January 2013, the Operator's Quality Assurance Department carried out a *Supplier Audit* of the AMO. The purpose of the audit was to evaluate the AMO's Base Maintenance capability prior to including the AMO in the Operator's *Approved Base Maintenance Contractor* list. The AMO also satisfied the *Supplier Audit*.

In relation to air safety, the content of the audits was limited to the reporting of air safety related incidents to the Operator, and verification that safety and quality policy had been established.

The Operator's *Safety Manual*, *Section 2.6*, contained requirements related to the scope of the SMS systems of contracted service providers whose services could have an effect on air safety. These requirements were not included in the initial inspection or supplier audit used by the Operator.

The AMO stores were not audited as part of the supplier audit. Therefore, issues related to the storage, quarantine, and labeling of dangerous goods, and dangerous goods training of stores personnel, were unknown to the Operator prior to the approval of the AMO as a base maintenance provider. This situation posed a particular threat to air safety as, due to the requirement of the contract to ship all removed parts back to the Operator's base, it created a situation where it was likely that, at some time, dangerous goods would be inadvertently loaded onboard an aircraft.

Eight non-conformances were recorded during the *Supplier Audit*, none of which are relevant to this investigation.

2.4 Air Safety Requirements of the Operator's Service Providers

Paragraph 2.6.6 of the Operator's *Safety Manual* stated that contracted engineering services must comply with the requirements of the Operator's SMS, and contracted engineering service providers should have appropriate levels of safety management in their company structure.

Section 34 of the Operator's *Safety Manual* stated that: "*… contracted agencies* (shall) *have the necessary safety standards in place and these are considered during the process of appointing contractors to provide services to Flydubai."* The Safety Manager did not have visibility of the draft service provider contracts, nor did the draft contracts contain air

safety requirements to be met by the service provider, such as operation of a risk assessment system.

At the time that the contract was awarded to the AMO, the AMO did not have a manager with responsibility for the management of an SMS.

At the time of the incident, the AMO did not operate an SMS, appropriate to its size and complexity, as described in the ICAO *Document 9859 - Safety Management Manual* and as required by *JCAR, Part 19 - Establishment of Safety Management System*. The AMO Quality Department operated a reporting system and carried out investigations of reported events. It was not clearly defined as to whether the reporting system was for quality deficiencies, health and safety issues, or air safety reports or a combination of these.

No dedicated air safety or SMS training had been provided to the management or maintenance personnel of the AMO.

Had the AMO operated an SMS, it was likely that the air safety reporting and/or formal risk assessment components, would have led to the discovery of the systemic shortfalls related to dangerous goods control. Also, had the contract and audits required the AMO to have an SMS in place, the lack of an SMS should have become apparent.

2.5 Operator Review of the Seating Configuration Modification Paperwork

The Operator's technical review of all instructions applicable to the maintenance and modification of the Operator's fleet was carried out by the Technical Planning Department.

The review process consisted of four steps: The first two steps involved review of the documentation by the Technical Service Engineer, and then by the Manager Fleet Support. The documentation was then discussed with the Engineering Manager, Head of Engineering and Senior Vice President Maintenance and Engineering. The final step was to release the technical documentation, attached to the minutes of the meeting. This review process was applied to the technical instructions for the seating configuration change modification.

The technical review process did not discover the lack of detail in Step 30 of the EO, in that Step 30 failed to assign sufficient priority to the importance of dealing correctly with the oxygen generators. Step 30 was not classified as a Critical Step requiring a dual signature. The EO did not mention the special tools requirement to make the oxygen generators safe.

2.6 AMO Review of the Seating Configuration Modification Paperwork

The reviewed modification documentation was provided by the Operator's Technical Planning Department to the AMO's Service Engineering Department. The Service Engineering Department checked the work pack for applicability and content. It was assumed by the AMO's Service Engineering Department that since the Operator had already checked the work pack for technical content the AMO was not required to do so. According to section 6 of the contract, the responsibility for the provision of technical documentation and tools rests with the Operator.

The fact that the AMO Service Engineering Department did not carry out a technical assessment of the modification instructions was a lost opportunity to uncover the weaknesses in the EO originally prepared by the holder of the Supplementary Type Certificate (STC).

2.7 Removal of PSU Assemblies from the Aircraft

Step 30 of the STC holder's EO did not require an inspection signature, nor did it contain any reference to the presence of hazardous materials (oxygen generators) contained in the PSU assemblies. Step 30 referenced the Boeing 737-800 *AMM 25-23- Passenger Service Unit–Removal/Installation*, for instructions on removal of the PSU assemblies. The EO did not categorize the removal of the PSUs as a critical step, nor did it specifically reference *AMM 35-Oxygen, which* provides the instructions to make the oxygen generators safe. *AMM 25-23* provides a reference to *AMM 35.*

Step 30 of the EO also stated: *"Route* [Send] *removed PSUs to customer for disposition."* The EO did not provide any guidance or reference to the correct storage procedures or transportation requirements for the removed PSUs.

The PSU assemblies were uninstalled from their positions in the aircraft and they were tagged as serviceable. The *AMM ATA 35* instructions were not referred to by the maintenance personnel carrying out the task, due to over-familiarity with the task. The PSU assemblies were not labelled as dangerous goods, nor were the oxygen generators made safe as required by the instructions of *AMM ATA 35*. After removal, a Stores Runner brought the PSUs to the Stores.

This process was applied identically for all nine aircraft that had been modified up to the end of December 2013. The PSUs were kept in the stores with the intention of having them shipped by road to the Operator's base on completion of the modification program.

Over the period of the modification program, up to and including the modification of the Incident Aircraft, A6-FEB, a total of twenty-seven PSU assemblies, each containing an oxygen generator, had been removed from nine aircraft and they were placed in the AMO stores. It was known that six PSU assemblies had been inadvertently shipped to the Operator's base on the Incident flight. A count of the PSU assemblies in the AMO stores following the Incident determined that there were 18 PSU assemblies in stock. Three PSU assemblies were unaccounted for.

A review of the cargo manifests for the return flights to the Operator's base of the eight aircraft modified prior to the Incident indicated that one preceding aircraft, A6-FDR, had completed a C-Check and a similar seating modification, and had inadvertently transported three PSU assemblies containing chemical oxygen generators to Dubai on 28 November.

The preceding incident was not noticed at the time, and therefore the Operator did not report the incident to the GCAA. When this Incident became known, the Operator immediately reported it through the GCAA ROSI system, as required by regulation.

Although the AMO's Operation Manager- Avionics advised a person in the stores that the PSUs contained oxygen generators, none of the storemen or stores runners had given proper weight to the advice due to their lack of skills in identifying and handling dangerous goods, because no training in this subject had been made available to them.

2.8 Storage of PSU Assemblies in AMO Technical Stores

The removed PSUs were brought to the stores, checked by stores personnel, and logged into the stores computer system. The stores personnel were not familiar with the

oxygen generators, which were part of the PSU assemblies, and they were not labelled as dangerous goods.

Each PSU assembly was individually wrapped in a single layer of bubble wrap, and they were then placed in cardboard boxes, each box containing between one and four PSUs, complete with oxygen generators. The boxes were not labelled in any way. In particular, the boxes did not carry “dangerous goods” labels or “prohibited from carriage on passenger aircraft” labels.

The PSU assemblies were stored in the general stores. The agreement between the Operator and the AMO that the removed PSUs would be accumulated in Stores, and then shipped by road at the end of the modification program, was not properly made known to the stores personnel.

The AMO stores did not have a dedicated quarantine area where dangerous goods could be segregated and secured. The cardboard boxes containing the PSUs were stored together with miscellaneous parts that were to be shipped back to the Operator’s base.

The lack of appropriate labelling and physical control of the boxes containing the PSUs created a situation where some or all of the boxes could be inadvertently included with other aircraft parts in a shipment being returned to the Operator's base.

2.9 Control of Chemical Oxygen Generators Removed from Aircraft

It had been agreed between the AMO's Service Engineering Department and the Operator that the PSU assemblies containing chemical oxygen generators would be accumulated at the AMO facility as the modification program progressed, and on completion of the program, the PSU assemblies would be shipped, using the services of a shipping agent, by road to the Operator's base. In addition, it was the practice of the AMO not to ship any dangerous goods on the Operator's aircraft, and to have such items returned to the Operator by engaging a shipper to make the necessary arrangements.

The agreement between the AMO Service Engineering Department and the Operator was outside the terms of the contract. The agreement was not documented, and no physical controls were implemented in the stores to ensure that PSU assemblies containing oxygen generators were not shipped on the Operators' aircraft. For such an arrangement to be effective, the boxes containing the PSU assemblies would have had to be clearly labeled as dangerous goods. The boxes containing the PSUs had not been labeled, nor were they stored in a segregated dangerous goods area of the stores.

A lack of control occurred, caused by the failure to correctly label the boxes containing the PSUs, and to segregate them in the stores, and also due to the undocumented understanding to accumulate the PSUs in the stores and then ship them by road at the end of the modification program.

This situation almost allowed PSU assemblies to be transported onboard a commercial return to base flight, on a date prior to the A6-FEB Incident ferry flight. This commercial flight took place on 9 October 2013 and was operated by a Boeing 737-800, A6-FDO. On that day, an email was sent from the AMO stores requesting delivery to the stores, before 1200 LT, of all parts that had been removed from the Operators aircraft. The parts were to be shipped onboard the commercial flight to the Operator's base. That email was sent at 1019 LT and only the intervention of the Avionic Engineer, who was aware that the PSU

assemblies contained chemical oxygen generators, prevented their shipment onboard that aircraft.

Because of the history and nature of chemical oxygen generators, this near incident should have alerted several people to the lack of control over the PSU assemblies. If appropriate action had been taken at this time, the subsequent two incidents, involving A6-FDR and A6-FEB, could have been prevented.

2.10 Loading of PSU Assemblies onboard A6-FDR on 28 November

The three PSU assemblies that had been removed from A6-FDR arrived at the stores a short time before the aircraft was due to depart the AMO facility for the Operator's base on 28 November 2013. The PSUs were not labeled as dangerous goods. The PSUs were individually wrapped in bubble wrap and placed in boxes. The oxygen generators installed in the PSUs had not been made safe. The boxes containing the PSUs were loaded onboard A6-FDR due to the lack of any dangerous goods labels having been attached to them, and because the storeman felt under time pressure, due to the short time available before the departure of the aircraft.

2.11 Loading of PSU Assemblies onboard A6-FEB on 6 December

When the three PSU assemblies that had been removed from the Aircraft arrived at the AMO stores during the afternoon of the day of departure of the aircraft, the storeman who was detailed to pack the parts to be returned to the Operator's base had already started to pack parts into the “Blue Box”. This box would be loaded onboard the Aircraft. The storeman was working a 07:30 to 16:30 shift. The PSUs arrived in the Stores after 16:30. Due to the limited time available, and the fact that the PSUs were not tagged as dangerous goods, the storeman wrapped the individual PSUs in a single layer of bubble wrap and placed them in cardboard boxes, which were packed into the “Blue Box”.

Also packed into the “Blue Box” were a further three PSUs that had been removed from a previously modified aircraft. Neither the PSUs, nor the cardboard boxes, were labeled as dangerous goods. None of the oxygen generators had been made safe by the use of a safety pin and safety cap.

The shipping invoice detailing the parts to be returned to the Operator, did not require certification verifying that the items listed had been correctly packed and labeled, and were in conformance with regulatory requirements. Such a statement, requiring a signature, would have necessitated a final check of the items being loaded onboard the Aircraft, and possibly would have presented a final opportunity to identify the oxygen generators installed in the PSUs as unlabeled dangerous goods. The Operator did not have a documented process in place for dispatch of post-maintenance aircraft directly from the AMO ramp. The Operator did not have a documented process for handling of parts to be shipped in the “Blue Box”.

2.12 Post-Maintenance Dispatch of Aircraft Parts by the Operator

As each aircraft was scheduled to undergo a C-Check the Operator assigned a Base Maintenance Liaison Engineer (referred to in the contract as a “Representative”) to oversee the maintenance check, and any modifications to be embodied on that aircraft. The Operator’s Engineer who was assigned to both the A6-FEB and A6-FDR C-Checks had not received any dangerous goods training while employed by the Operator, nor did his responsibility extend to

oversight of the loading of parts to be returned onboard the aircraft, prior to departure from Amman. The engineer had received dangerous goods training in his previous employment.

The Operator did not have a procedure, nor did it delegate responsibility to its representative at the AMO, to ensure that it could exercise sufficient control over the return of aircraft parts to Dubai.

2.13 JCARC Oversight of the AMO

The AMO did not have an SMS that had been accepted by the regulatory authority. *The Jordanian Civil Aviation Regulations, Part 19, dated August 2008,* required Operators and Service Providers, including AMOs, to establish, maintain, and adhere to, a Safety Management System that was documented in a Safety Management Manual, and was acceptable to the Jordan Civil Aviation Regulatory Commission. Paragraph 19.11 stated that:

> *"Each operator and/or service provider as defined in 19.1(b) shall have in place a safety management system (SMS) that is acceptable to Civil Aviation Regulatory Commission (CARC), that, as a minimum:*
>
> *(1) Identifies safety hazards;*
>
> *(2) Ensures that remedial action necessary to maintain an acceptable level of safety is implemented. The acceptable level of safety shall be subject to CARC approvals.*
>
> *(3) Provides for continuous monitoring and regular assessment of the safety level achieved; and*
>
> *(4) Aims to make continuous improvement to the overall level of safety."*

Had these minimum SMS components been in place, it was likely that the systemic deficiencies in the control of dangerous goods would have been identified and rectified during normal SMS hazard identification and risk assessment activities.

3. Conclusions

3.1 General

From the evidence available, the following findings, causes, and contributing factors were made with respect to this Incident. These shall not be read as apportioning blame or liability to any particular organization or individual.

To serve the objective of this Investigation, the following sections are included in the conclusions heading:

- **Findings-** are statements of all significant conditions, events or circumstances in this Serious Incident. The findings are significant steps in this Serious Incident sequence but they are not always causal or indicate deficiencies.
- **Causes-** are actions, omissions, events, conditions, or a combination thereof, which led to this Serious Incident.
- **Contributing factors-** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

3.2.1 The aircraft was certified, equipped, airworthy, and maintained in accordance with existing regulations and approved procedures.

3.2.2 The Operator had agreed a contract with the AMO for the provision of aircraft heavy maintenance services.

3.2.3 The Operator's Safety Manager had no visibility of contracts potentially affecting air safety, entered into between the Operator and contracted service providers.

3.2.4 The Operator did not formally risk assess the process of subcontracting aircraft heavy maintenance and modifications to the AMO before signing the contract.

3.2.5 The aircraft underwent a C-Check and a passenger seating configuration change modification at the AMO base.

3.2.6 The seating configuration modification required the removal of three PSU assemblies from the aircraft. Each assembly contained a chemical oxygen generator.

3.2.7 The Operator’s Technical Planning Department performed a technical evaluation of the seating modification documentation and instructions, which accepted the instructions contained in the STC holder’s EO, and other instructions, as being appropriate to safely implement the passenger seating configuration change modification.

3.2.8 The EO (Step 30) directly referenced only *AMM ATA 25* for the removal of the appropriate PSU assemblies from the Aircraft.

3.2.9 The EO (Step 30) did not contain an appropriate breakdown, warning note or requirement for an inspection signature, to the task of removal of the PSU assemblies and ensuring that the oxygen generators they contained were made safe.

3.2.10 The special tools (approved pliers, safety pin and safety cap), required by the instructions contained in *AMM ATA 35* to make the oxygen generators safe, were not directly referenced in the EO. They were available in the AMO Stores, but were not used.

3.2.11 *AMM ATA 25*, in turn, referenced *AMM ATA 35- Oxygen*. The procedures and warning notices necessary to ensure the safe handling of oxygen generators are contained in *AMM ATA 35*.

3.2.12 The Maintenance personnel involved in uninstalling the PSUs from the aircraft referred only to *AMM ATA 25*, as directly referenced in the EO. They did not refer to *AMM ATA 35* as directed by *AMM ATA 25*, nor did they carry out the instructions contained in *AMM ATA 35*, which were essential in making the oxygen generators safe, once the PSU assemblies had been removed from their installed positions.

3.2.13 The errors and omissions related to the treatment of the PSU assemblies containing the oxygen generators were not noticed by the Operator's Base Maintenance Liaison Engineer at the AMO, since his job description did not specify any inspection or safety oversight functions, nor had he received any dangerous goods training from his employer.

3.2.14 In total, the change of seating configuration modification had been incorporated on nine aircraft between February and December 2013. The modification program resulted in the removal of twenty-seven PSU assemblies each containing an oxygen generator. None of the oxygen generators had been made safe in line with the instructions in B737-800 *AMM ATA 35*, nor were they, or the boxes they were stored in, labeled as dangerous goods.

3.2.15 The PSU assemblies, containing the oxygen generators, were not treated correctly as dangerous goods from the time of their removal from the aircraft, through their placement in the Stores, and their carriage onboard the Aircraft on the return flight to the Operators base.

3.2.16 The AMO did not review the detailed technical content of the work packs for the C-Checks and seating configuration modification. This review was assumed to have been carried out by the Operator.

3.2.17 Chemical oxygen generators are classified as dangerous goods, and are forbidden from transportation on passenger aircraft, due to their previous involvement in aircraft accidents and incidents.

3.2.18 The Operator was not approved by the UAE GCAA to transport dangerous goods.

3.2.19 The flight crew were not aware that dangerous goods had been loaded onboard the Aircraft.

3.2.20 The Operator's policy, contained in Sections 2.6 and 3.4 of the *Safety Manual*, required the subcontracted AMO to have an SMS in place prior to carrying out maintenance of the Operator's aircraft. The Operator did not positively determine,

during the *Initial Assessment*, or the subsequent *Supplier Audit*, that the AMO had in place an appropriate SMS as required by the Operator's Safety policy.

3.2.21 The Operator's *Safety Manual*, which contained the detailed SMS requirements applicable to the Operator's contracted service providers, was not made available to the AMO.

3.2.22 The requirements related to the scope of the SMS' of contracted maintenance service providers contained in the Operator's *Safety Manual* were not included in the *Initial Assessment*, or *Supplier Audit* checklists, used by the Operator to approve the AMO.

3.2.23 The contract drafted by the Operator, and agreed by the AMO, did not require the AMO to have an SMS.

3.2.24 The contract between the Operator and the AMO contained a clause stating that any components removed from the aircraft should be returned to the Operators base onboard the Operators ferry flights or commercial flights, without taking into account the likelihood that some aircraft parts removed from the aircraft would be classified as dangerous goods.

3.2.25 The *Jordanian Civil Aviation Regulations, Part 19*, required operators and/or service providers (including AMOs) to establish, maintain, and adhere to, a Safety Management System.

3.2.26 The AMO did not have an SMS.

3.2.27 The Jordanian Civil Aviation Regulatory Commission did not ensure that the AMO had implemented the requirements of *JCAR Part 19, "Establishment of Safety Management System"*.

3.2.28 The AMO Customer Support Department personnel had not received dangerous goods training.

3.2.29 The AMO engineer who removed the PSU assemblies was aware that the oxygen generators are classified as dangerous goods.

3.2.30 The engineer who removed the PSU assemblies referred to *AMM ATA 25,* as directed by the EO. He did not refer to *AMM ATA 35-22* as directed by *AMM ATA 25,* due to his familiarity with the task.

3.2.31 The engineer who removed the PSU assemblies tagged them with green serviceable tags and they were brought to the stores by a Stores Runner. The oxygen generators were not made safe, and the PSU assemblies were not labeled as dangerous goods. The Engineer verbally advised the Stores Runner that the PSU assemblies contained oxygen generators.

3.2.32 Dangerous goods training was not provided to the Operator's maintenance personnel, nor is such training required by the UAE Civil Aviation Regulations.

3.2.33 Dangerous goods training was not provided to the AMO stores or customer support personnel.

3.2.34 The *Supplier Audit* of the AMO, conducted by the Operator prior to signing the maintenance contract, did not include the AMO stores in its scope.

3.2.35 The Operator did not have a process in place for dispatch of post-maintenance aircraft directly from the AMO ramp as ferry flights.

3.2.36 The Operator did not have a documented process for the control and handling of parts to be shipped back to its base.

3.2.37 The GCAA has required UAE based AMOs to operate an accepted Safety Management System since January 2010. The GCAA did not require UAE based operators to restrict subcontracting of aircraft maintenance activities solely to AMOs that have an accepted SMS in place.

3.2.38 The GCAA did not review or risk assess aircraft maintenance contracts agreed between UAE based Operators and AMOs prior to signature.

3.3 Causes

The Air Accident Investigation Sector determines that the causes of the carriage of prohibited dangerous goods (chemical oxygen generators) onboard passenger aircraft were:

3.3.1 The chemical oxygen generators contained in the PSU assemblies that had been removed from the Aircraft were not labeled as dangerous goods.

3.3.2 The AMO maintenance personnel did not label the oxygen generators as dangerous goods because they did not consult, and follow, the instructions contained in *AMM ATA 35 - Oxygen*.

3.3.3 The Engineering Order prepared by the STC holder did not contain a direct reference to *ATA 35 - Oxygen* in regard to handling the removed PSU assemblies as having dangerous goods installed. Neither the Operator nor the AMO identified shortcomings in the STC holders EO.

3.3.4 The Operator and AMO personnel, involved in the configuration modification work on the Aircraft were unaware that the PSU assemblies contained dangerous material.

3.3.5 The contract agreed between the Operator and the AMO contained a term related to the return of removed aircraft parts and materials to the Operator by air, which did not differentiate between normal and dangerous goods.

3.4 Contributing Factors to the Incident

3.4.1 The lack of dangerous goods markings on the oxygen generator casings.

3.4.2 The quality system of the AMO was unable to detect a lack of control of dangerous goods improperly kept in the stores for a lengthy period.

3.4.3 The lack of an SMS did not enable the AMO to promote a safety culture among the line maintenance and stores personnel that could enable them to deduce that the PSU assemblies contained dangerous goods, which required special handling.

3.4.3 The noncompliance of the Operator with its *Safety Manual* policy that required sub-contracted AMOs to operate a Safety Management System.

3.4.4 The GCAA did not exercise sufficient oversight of the foreign contracted aircraft maintenance arrangements of the Operator in that they did not discover that the operators own requirement that contracted AMOs must have an SMS was not met.

4. Safety Recommendations

4.1 General

The "Safety Recommendations" listed in this Report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation[2], and are based on the "Conclusions" listed in heading 3 of this Report. The GCAA expects that all safety issues identified by the Investigation are addressed by the receiving States and organizations.

The Air Accident Investigation Sector would like to acknowledge the full cooperation and support of the, Operator, AMO, JCARC and GCAA in this investigation.

4.2 Safety Actions Taken

The following safety actions were implemented by the Operator, the AMO and the JCARC shortly after the Incident occurred:

4.2.1 Safety Actions taken by the Operator:

4.2.1.1 The Operator took steps to ensure that the instructions to accomplish complex and/or critical maintenance tasks are sufficiently detailed and appropriately referenced, and that an appropriate level of checking and verification is established to minimize risk.

4.2.1.2 The Operator established a new policy to involve the Safety Department in the process of contract approval. This policy is applicable for maintenance and other contracts that could affect air safety.

4.2.2 Safety Actions taken by the AMO:

4.2.2.1 All concerned maintenance and stores personnel have attended an IATA dangerous goods training course.

4.2.2.2 A *Technical Continuation Bulletin* highlighting dangerous goods matters was distributed to all personnel.

4.2.2.3. The Training Department included a dangerous goods overview in continuation training.

4.2.2.4 *Dangerous Goods Advisory Bulletin DGAB-07-02* "*Chemical Oxygen Generators (COGs) and Chemical Oxygen Generators Installed in Equipment"* has been distributed to all concerned.

4.2.2.5 A new policy was established to ensure that no shipment will be processed without a "Shipping Declaration Form", and the AMO will not ship any materials without the approval of the customer.

4.2.2.6 The Service Engineering Department procedures for evaluating *Engineering Orders* have been strengthened and greater emphasis has been placed on identification of Critical Tasks and tasks involving the handling, storage and shipping of dangerous goods.

4.2.3 Safety Actions taken by the JCARC:

4.2.3.1 The AMO is required to submit a Safety Management System Manual to the JCARC within two months of the end of May 2015.

4.3 Final Report Safety Recommendations

In addition to the safety actions already implemented and described in section 4.2, the Air Accident Investigation Sector recommends that:

4.3.1 Flydubai should:

SR 25/2015

include in contracts agreed with maintenance service providers, and also in appropriate audits, a requirement that the service provider operates a Safety Management System that is accepted by the AMO regulatory authority.

SR 26/2015

provide its *Safety Manual* and a reporting form in its online incident reporting system that is accessible to all appropriate third party contractors to enable incidents involving the Operator's aircraft to be reported to the Operator.

SR 27/2015

improve the *Initial Assessment* and *Supplier Audit* checklists to include check items relevant to the Operator's SMS for maintenance contractors requirements.

SR 28/2015

provide initial and recurrent dangerous goods training, appropriate to the responsibilities of the position, to maintenance and stores personnel.

SR 29/2015

broaden the scope of the job description of the Base Maintenance Liaison Engineer to include a wider range of air safety issues such as observing, on an ad hoc basis, work in progress on the aircraft, and conducting random spot checks on safety critical tasks.

4.3.2 Jordan Aircraft Maintenance Company (JorAMCo) should:

SR 30/2015

enhance initial and recurrent training for all maintenance employees to ensure that they adhere to approved maintenance instructions.

SR 31/2015

enhance the maintenance procedure to ensure that work involving oxygen generators, or PSU assemblies containing oxygen generators, should be classified as a critical task, requiring a dual signature on the appropriate work instructions.

4.3.3 TIMCO, as the Supplemental Type Certificate holder should:

SR 32/2015

permanently mark each individual oxygen generator canister with the appropriate dangerous goods marking. The marking should be designed to be highly visible, especially when the canister is in its installed position in the PSU.

SR 33/2015

review *EO 12T478E056* and ensure that steps that involve dangerous goods are appropriately classified and clearly identified.

SR 34/2015

Include a caution in Step 30 of *EO 12T478E056* to require a certifying engineer to verify, with his signature that correct procedures have been adhered to.

4.3.4 The General Civil Aviation Authority should:

SR 35/2015

consider requiring initial and recurrent dangerous goods training, appropriate to the responsibilities of the position, for certifying maintenance engineers, service engineers and stores personnel engaged in the maintenance of UAE registered aircraft. This requirement should be applicable to UAE Operators and AMOs, and foreign AMOs engaged in maintenance of UAE registered aircraft.

Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates