Executive Summary

On September 8, 2013, a China Airlines B747-400F cargo airplane, flight number CI5621, registration number B-18716, flew from Taoyuan International Airport to Abu Dhabi International Airport to execute a cargo transportation mission. The flight departed with 3 flight crew members including 1 pilot and 2 copilots.

During took off, the pilot seated at the left hand side as the pilot flying, 1 of these 2 copilot seated at the right hand side as the pilot monitoring, the other copilot seated at the observation seat as the pilot monitoring. The airplane took off from 05R runway at about 0325 Taipei time and adopted instrumental departing procedure to fly. At the time the airplane took off, cabin pressure was 14.62 pounds per square inch (psi) and cabin pressure altitude was about 100 feet (ft). At 0346:54, the airplane reached altitude 30,000 ft and changed to level flight. At this time, cabin pressure was 11.28 psi and cabin pressure altitude was about 7,000 ft. At 0351:56, the airplane encountered excessive cabin pressure altitude warning. At this time, cabin pressure was 10.09 psi and cabin pressure altitude was about 10,000 ft.

Flight crew expressed that it was normal inside the cockpit when the airplane reached cruise altitude 30,000 ft. A few minutes later, upper Engine Indicating and Crew Alerting System (EICAS) Display Unit appeared abnormal cabin pressure warning. Flight crew checked Environmental Control System page from lower EICAS Display Unit. Outflow valve was at close position. While at the same time, flight crew also checked outflow valve indication on overhead panel, it was at close position too. Then, checked cabin pressure altitude at 10,400 ft and it was

on the rise continuously. The rate of increase was about 400 ft/min to 500 ft/min. Therefore, the pilot declared emergency situation, donned oxygen mask, executed emergency descent procedure, broadcasted to cabin and announced to Air Traffic Control.

The excessive cabin pressure warning was disappeared when the airplane descended to cross about altitude 19,400 ft. When the airplane descended to about altitude 10,000 ft, flight crew checked cabin pressure altitude and it was decreased to about 5,000 ft. The pilot cancelled emergency declaration. The pilot judged that the airplane was already unable to fly to the destination. After crew discussion and communicated with System Operation Control Center, the pilot decided to fly back to Taoyuan International Airport. The airplane landed on 05R runway of Taoyuan International Airport at 0551. The airplane had no damage and flight crew members were all safe.

After the occurrence, the investigation team went to China Airlines hangar using the airplane to perform a cabin pressure test. It was found that #3 air condition duct which supply conditioned air to forward cargo compartment fell off from the connection of check valve and duct assembly.

The Aviation Safety Council (ASC) is an independent agency responsible for civil aviation, public aircraft and ultra-light vehicle occurrences investigation. According to the Republic of China Aviation Occurrence Investigation Act and referencing to the related content of Annex 13 to the Convention of International Civil Aviation Organization (ICAO), the ASC launched an occurrence investigation by law. The organization or agency been invited to join the investigation team also included: Civil Aeronautics Administration of Ministry of Transportation

and Communications, China Airlines, National Transportation Safety Board of United States of America and airplane manufacturer, the Boeing company.

In accordance with procedure, the draft investigation report was revised by the ASC Board members on May 27, 2014, in the 23rd Board meeting. The draft report then distributed to related organizations and agencies for comments. The draft investigation report was revised again and approved by the ASC Board members on August 26, 2014, in the 25th Board meeting.

The Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: findings related to probable causes, findings related to the risk, and other findings.

Based on the factual information gathered during the investigation and the results of analysis, 10 findings and 2 flight safety recommendations were obtained, finished actions were 7 as stated below.

3.1 Findings related to probable causes

1. As the maintenance personnel tried to repair the duct assembly, the materials above and below flange were protruded to form a flat geometry of the flange such that the clamp could not be secured on the flat flange of duct assembly after installation. (1.6.4.1, 1.16.3, 2.2.1, 2.2.4)
2. The recommended tightening procedure of clamp in Aircraft Maintenance Manual lacked instruction on how to tap the coupling. Therefore, the tightness of coupling might not reach required constant torque value. That caused the clamp could not be secured on the flange of duct assembly. Under the condition of airplane operation and the

usage of pack, the tightness of clamp was insufficient to sustain the interactions of airplane vibration and the clockwise bending moment resulted from the conditioned air acted on the air condition duct. The air condition duct fell off from the connection of check valve and duct assembly, conditioned air leaked from the opening of airframe continuously and caused excessive cabin pressure altitude warning. (1.16.5, 1.18.5, 2.2.2, 2.2.3, 2.2.4, Appendix 8)

3.2 Findings related to risk

1. Maintenance personnel did not comply with the「Components Repair and Overhaul Procedure」to carry out parts receiving inspection, they also did not confirm whether or not China Airlines had repair capability of duct assembly which might increase the risk that the repair of aircraft component might not conform to required quality. (1.18.1.6, 1.18.1.7, 1.18.1.8, 1.18.3, 2.3.1)
2. China Airlines Capability List Manual does not include the repair capability of duct assembly. Maintenance personnel did not comply with the 「System Engineer Technical Support Procedure」 to coordinate System Engineering Department to consult with manufacturer. Therefore, no timely technical assistance could be obtained. (1.18.1.7, 1.18.3, 2.3.2)
3. Maintenance personnel did not comply with the「S.O.P. of A/C Parts/Components Replacement」 procedure to hang a tag on the parts removed from airplane which might increase the risk of misuse after parts removal. (1.18.4, 2.3.3)
4. The deletion of the recommended tightening procedure of clamp from the Aircraft Maintenance Manual may increase the risk of air condition duct fall-off. (1.18.5, 2.2.4)

3.3 Other findings

1. There was no abnormal entry on Daily Check, Preflight Check and Transit Check during the period from one month before the incident to the date of incident. The affected Airworthiness Directives, Maintenance Difficult Reports and the corrections of Deferred Defects all complied with specified time constraints and controls. (1.6.4.1, 2.1)
2. The material of duct assembly complied with the specifications specified in manufacturer’s drawing. (1.16.3, 1.16.4, appendix 7)
3. The airplane had a similar air condition duct fall-off incident which occurred in August 13, 2013 to the incident occurred in September 8, 2013. There was no abnormal cabin pressure condition occurred at that time. It was probable that the collapsed inner air duct blocked the passage of air supply and prevented compressed air from leakage. Therefore, no abnormal cabin pressure condition occurred. (1.6.4.1, 1.11.2, 2.4.1)
4. Flight crew's interview indicated that before the appearance of cabin pressure audio alarm, there was no abnormal message on the upper Engine Indicating and Crew Alerting System Display Unit. The statement of flight crew neither conformed to Boeing’s design nor the test result after the occurrence. But, there was no other objective evidence to support flight crew's statement that before flight crew noticed cabin pressure abnormality, no related abnormal message on the upper Engine Indicating and Crew Alerting System Display Unit. (1.6.6, 1.11.2, 1.16.2, 1.18.1.1, 2.4.2)

4.1.1 Safety recommendation to Boeing

1. Re-evaluate the air condition duct design of the #3 pack to prevent fall-off of air condition duct from the coupling of check valve and duct assembly.
2. A recommended tightening procedure for the clamp should be set up

in the 747-400 Aircraft Maintenance Manual. The procedure should include the instruction on how to tap the coupling, specify the material, size and weight of the mallet and quantify the range of hitting force in the clamp tightening works.

4.2.1 Safety actions accomplished of China Airlines

1. Issued 5 work orders for aircraft B-18716, replaced cabin pressure controller and carried out repeated inspection on the area where the #3 air condition duct fell off.
2. Issued 2 engineering orders and carried out one time inspection of all 744 cargo aircrafts.
3. Finished announcement of the example case to maintenance personnel, totally 77 man times; Finished work relay and work report related safety announcements, totally 76 man times; Performed on job training of air condition duct related removal and installation as specified in the Aircraft Maintenance Manual Chapter 21, classroom study first then practical training. Practical training included the tightening of clamp fixed nut, hitting techniques and precautions of wood mallet application.
4. Incorporated the inspections of the #3 air condition duct area and check valves of forward/rear cargo compartments into C check inspection items.
5. Finished announcement and education to maintenance personnel of the ERI Maintenance Section; Requested to fill out maintenance record and make sure its correctness when performing maintenance work; Reinforced the double check mechanism of supervisory personnel before and after the installation of air condition duct.
6. Finished announcement and education to maintenance personnel of the Structure Maintenance Section; Requested to comply with the

「System Engineer Technical Support Procedure」 to carry out maintenance support.

7. Finished announcement and education to section managers of the Base Maintenance Department; Requested to supervise maintenance personnel to comply with the「Components Repair and Overhaul Procedure」, the「System Engineer Technical Support Procedure」and the procedure of 「S.O.P. of A/C Parts/Components Replacement」to carry out maintenance work; Requested section managers of the Base Maintenance Department to have situational awareness and risk sense and to comply with related operational quality procedures.