Aviation Safety Council

Taipei, Taiwan

CI611 Accident Investigation
Factual Data Collection
Group Report

Organizational and Management Factors Group

June 03, 2003

ASC-AFR-03-06-001

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I. Team Organization

Chairman:

Thomas Wang / Investigator, ASC, ROC

Members:

1. Tracy Jen / Investigator, ASC, ROC
2. Sherry Liu / Engineer, ASC, ROC
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4. Ian McCallum / Special Assistant to the Vice President Safety & Security, CAL, ROC

II. History of Activities

Date	Description
10/15/02	● CI611 Organizational and Management Factors Group was formed.
10/28/02	● Off Aircraft groups Progress meeting.
12/17/02 ~ 12/18/02	● TRM 2 at ASC headquarters in Taipei.
01/06/03	● Interview CAA PMI of China Airlines.
01/24/03	● Interview China Airlines Assistant VP (MX) Aircraft Maintenance, Engineering & Maintenance Division ● Interview China Airlines Assistant VP (MY) Shop Maintenance, Engineering & Maintenance Division ● Interview China Airlines General Manager, Quality Assurance Department (MI), Engineering & Maintenance Division
02/12/03	● Interview China Airlines Manager of Audit Section, Quality Assurance Department (MI) ● Interview China Airlines Manager of Regulation Section, Quality Assurance Department (MI) ● Interview China Airlines Manager of System Engineering Department, Shop Maintenance ● Interview China Airlines Manager of Aircraft Structure Section, Engineering Department

03/04/03	● Interview China Airlines Manager of Base Maintenance Department, Aircraft Maintenance ● Interview China Airlines Manager of Production Planning Section, Base Maintenance Department ● Interview China Airlines Manager of Structure Maintenance Section, Base Maintenance Department ● Interview China Airlines Engineer of Production Planning Section, Base Maintenance Department ● Interview China Airlines Manager of Maintenance Planning Section, Base Maintenance Department
03/07/03	● Group meeting to discuss the contents in the Group Factual Report
03/11/03	● Interview China Airlines General Manager of Technical Training Department, Engineering & Maintenance Division ● Interview China Airlines Manager of Administration & General Training Section, Technical Training Department ● Interview China Airlines Manager of Line Maintenance Department, Engineering & Maintenance Division ● Interview China Airlines Manager of Wheel & Brake Shop, Shop Maintenance Department ● Interview China Airlines Engineer of NDI Shop, Wheel & Brake Shop, Shop Maintenance Department
03/20/03	● Interview China Airlines Boeing Field Service Manager
03/27/03	● Interview China Airlines Flight Safety Officer, Safety & Security Management Division

III. Factual Description

1.17 Organizational and Management Information

1.17.1 CAL Engineering & Maintenance Division (EMD)

The CAL Engineering & Maintenance Division is a maintenance organization for the repair of aircraft and aircraft components approved by the ROC. CAA and is located at Chiang Kai Shek (CKS) International Airport. It is also an authorized FAA and JAA repair station and is capable of performing all types of maintenance for B727, B737, B747, A300, and MD-11 aircraft. It has one two-bay hangar, one three-bay hangar for wide-body aircraft, and an engine overhaul shop. The CAL Engineering & Maintenance Division employs about 2,000 people.

1.17.1.1 Engineering & Maintenance Division Historic Evolution

The EMD was founded in 1960 and located at Sung Shan Airport, Taipei Taiwan.

In 1977, the Division started in-house maintenance for B747 aircraft and established capability of JT9D engines B-2 repair.

In February 1979, CAL Line Maintenance operation of the EMD moved to the CKS International Airport after the CKS started its operation in Tao-Yuan. In May 1979, the EMD started B747-200 level C repair.

In 1980, the EMD had 9 departments, including Aircraft Maintenance, Shop Maintenance, Customer Service, Chief Engineering, Quality Assurance, Administration, Accounting, and Security. It had total of 1,250 employees. The Division maintained 17 CAL airplanes, including one B747-100, two B747-200, one B747-SP, four B707, three B737-200, and four B727-100. In the same year, the EMD had contracted with United Airlines and adopted UA's Maintenance Program for B747-200 level D repair. In addition, the EMD planned to implement B747 fuselage, engine and component maintenance capability.

In 1982, the EMD relocated its facilities from Sung Shan airport to the CKS International Airport.

In 1983, the EMD completed planning and job card system for the 4th stage

inspection and maintenance for B747 aircraft. It had improved JT9D engine maintenance capability from B-2 maintenance level to B-3.

In 1985, the EMD established D check capability and capacity on 747 type aircraft. It had completed new capability and capacity for JT9D-7R4D engine cool section and hot section maintenance.

In 1986, the EMD established D check capability and capacity for B747 cargo planes and established overhaul capability and capacity for B747 and A-300 aircrafts.

In 1987, the EMD established the capability for advance composite material and introduced Quality Audit System to ensure inspection quality.

In 1990, the EMD completed the planning for construction of engine shop and second jumbo aircraft maintenance hangar as well as large test cell.

In June 1991, the EMD restructured from one Division to two Divisions: the Maintenance Division and the Technical & Supply Division.

In 1993, the EMD applied for JAA licensing and technical review system. The Quality Assurance Department became one of the independent departments with 85 staffs report directly to VP Maintenance. The Quality Assurance Department had 5 sections included Shop Inspection, Aircraft Inspection, Quality procedures/record/analysis Section, Equipment and Supply Inspection and Non-destructive Inspection Section.

In 1994, the CAL invested 50 million US dollars in the construction of new engine shop at the CKS International Airport; the maximal capacity is 200 shop-visit per year. It also introduced FODAS (Flight Operations Data Analysis System) from UK.

In 1995, Tzu-Chiang Project began, the EMD reorganized from two Divisions back to one Division with 13 different Departments, Centers, and Offices. In the Division, both Maintenance Division and Quality Assurance Department reported to VP Maintenance. The Quality Assurance Department was responsible for ISO9000 application. In the same year, the EMD received Repair Station license from JCAB (Japan Civil Aviation Bureau) and oxygen bottle inspection and testing certificates from FAA. It passed RAI (Italian Aviation Registration Bureau) technical evaluation.

In 1996, the EMD completed ISO-9002. It obtained JAR145 Repair Station license (JAA) and received certificates from the National Calibration Laboratory of the Republic of China.

In 1997, the CAL founded PW4000 HPT overhaul, a joint venture with Singapore Aviation Engineering and The United Technology Pratt & Whitney. It obtained 16 quality certificates for maintenance from CAA, JAA, FAA, and JCAB.

In 1998, the CAL invested 3.2 billion NT dollars in the construction of its new three-bay hangar at the CKS International Airport. It completed the reorganization of Maintenance Division. The Quality Manual was approved by the JAA. The internal technical personnel certified & authorized system was established

In 1999, the Tzu Chiang Project was ended. CAL incorporated qualification system that meets JAR-66 and FAR-66 requirements for maintenance quality. In addition, to simplify aircraft type and rejuvenate the fleet, A300-B4 fleet was no longer in service. The Maintenance Management training course was established. The Quality Assurance Department completed internal personnel's certification and authorization process.

In 2000, the CAL founded Aviation & Technology Inc. for aircraft modification, a joint venture with EVA Airways. The Quality Assurance Department relocated to under the Maintenance Division. Non-destructive Inspection Section moved back to Shop Maintenance Department. Shop Maintenance & Engine Maintenance Department started the Quality Check (QC) system with QC inspectors.

In 2001, CAL was awarded as TransAsia Airway A320/A321 aircraft C level heavy maintenance, Dragon Air airplane equipped JT9D engine maintenance, and ROC Air Force B737-800 aircraft and ATE-5000 tester designated maintenance contractor.

1.17.1.2 The Structure of CAL Engineering & Maintenance Division

The EMD is one of the five Divisions of China Airlines Limited. The other four Divisions are Marketing, Service, Administration, and Flight Operations.

The EMD is headed by a Vice President (VP) and is divided into several departments and sections as outlined in the Quality Manual. According to CAL

Quality Manual, the Vice President of Engineering and Maintenance Division has been delegated with full authorities and responsibilities for the CAL EMD.

The departments within the EMD are Aircraft Maintenance, Shop Maintenance, Business & Support, and Quality Assurance. A General Manager heads the Quality Assurance Department. Assistant Vice Presidents manage the other three departments.

The organization Chart of the EMD is shown in Figure 1.17-1.

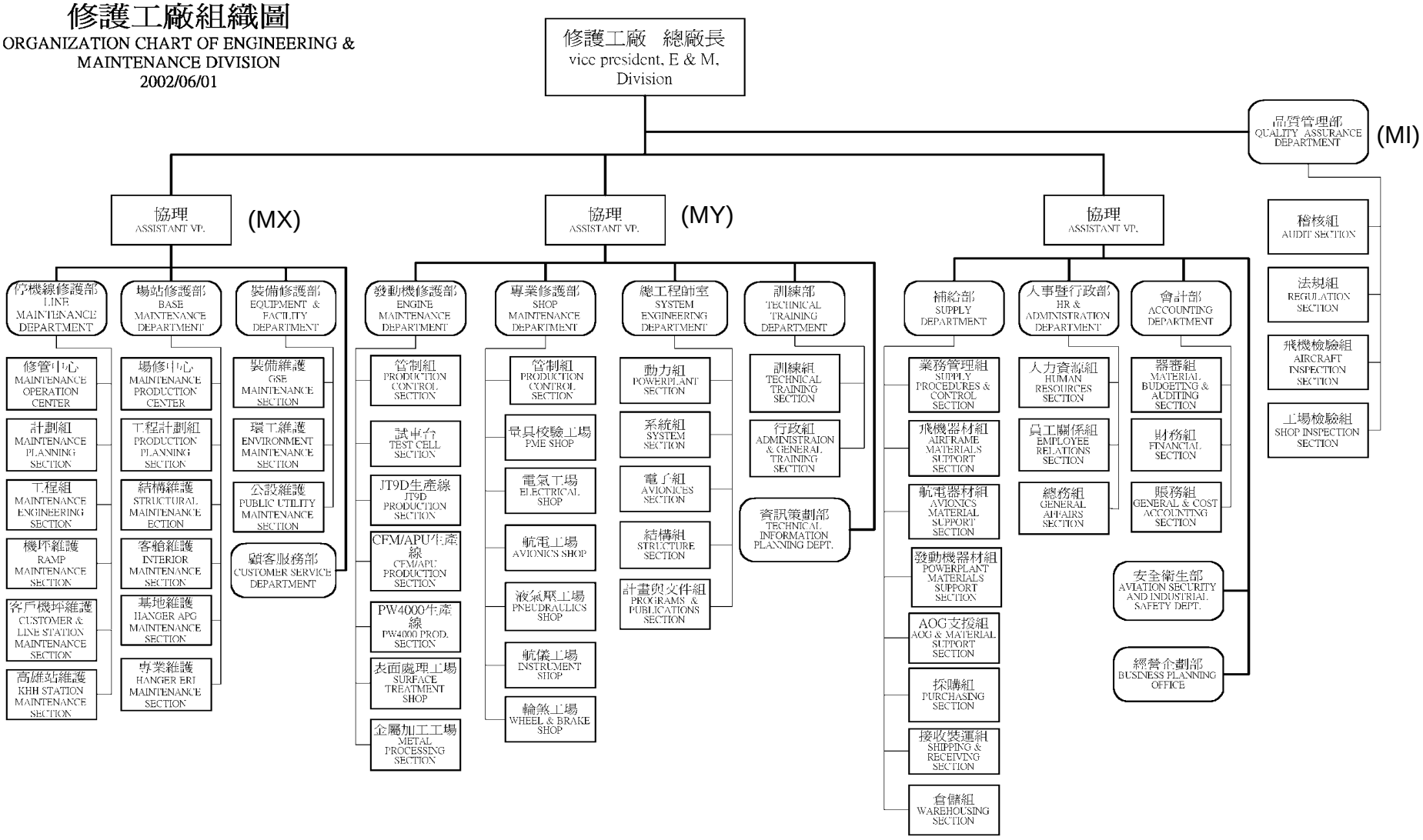


Figure 1.17-1 The organization Chart of the EMD

1.17.1.3 Aircraft Maintenance Department (MX)

The Aircraft Maintenance Department has four departments: Line Maintenance, Base Maintenance, Equipment & Facility, and Customer Service. The Assistant VP for Aircraft Maintenance is delegated as a management representative of the Division and reports to the VP EMD.

The CAL Quality Manual, lists responsibilities of the Assistant VP for Aircraft Maintenance as:

- Assist the VP in supervising the daily activities of Base Maintenance (MB), Line Maintenance (ML), Customer Service and Equipment & Facility Maintenance (MV) Departments;
- Ensure that maintenance procedures are established and published within the organizations, to achieve good maintenance practices and compliance with Airworthiness Authorities requirements; and ensures that work is accomplished to the highest standards of airworthiness and workmanship;
- Ensure the promotion of awareness of customer requirements throughout EMD;
- Ensure that all maintenance is correctly certified and that records of maintenance carried out are retained safely and securely for the statutory period;
- Exercise control over the duties & responsibilities of the Maintenance Operation Center/ML and Maintenance Production Center/MB;
- Coordinate with the other Assistant VPs (Shop Maintenance/Business & Support) and General Managers for the implementation and improvement of company policies, procedures, and/or correction of deficiencies;
- Ensure sufficient competent personnel to plan, perform and supervise the maintenance job;
- Supervise all sub-departments to ensure compliance with the JAA, FAA, local CAA Airworthiness Requirements for JAA, "N", “B" registered aircraft and/or equipment;
- Participate in and attend industry meetings with attendance of counterpart personnel of the other airlines; and

- Maintain liaison with the other airlines and manufacturers for interchange of information.

1.17.1.3.1 Line Maintenance Department (ML)

The General Manager of Line Maintenance Department is in charge of all line maintenance events for CAL's and contracted customer's aircraft at CAL's home base and on domestic and international line maintenance stations. He reports to the Assistant VP (Aircraft Maintenance) and, according to CAL Quality Manual, is responsible for:

- Ensuring all CAL or customer aircraft maintenance and rectifications in Line Maintenance are properly done and meet the company flight schedule;
- Ensuring the Line Maintenance is carried out in accordance with Airworthiness Authorities Regulations and company's requirements and standards;
- Ensuring the competence of all personnel engaged in Line Maintenance by establishing a program of training and continuation training;
- Satisfactory completion and certification of all work required by contracted operators/customers in accordance with the work specification;
- Monitoring the daily routine maintenance and rectification of CAL aircraft in all line stations;
- Supervising the rectification of deferred items to be completed within the MEL category;
- Investigation of irregularities identified during maintenance under leadership of Quality Assurance Department; and
- Responsible for the feedback of Quality Data to Quality Assurance Department. (Duplicate inspection)

Line Maintenance Department has 6 sub-sections: Maintenance Planning Section, Maintenance Engineering Section, Ramp Maintenance Section, Customer & Line Station Maintenance Section, KHH Station Maintenance Section, and Maintenance Operation Center.

The General Manager of the Line Maintenance Department stated that the

department is in charge of A-Checks and all maintenance up to A-Check level, including pre-flight, transit, daily, weekly maintenance job. The Maintenance Planning Section is responsible for the preparation of work packages, as a result of Engineering Orders (EO) issued by the Systems Engineering Department, the preparation of job cards and the scheduling of all maintenance for the Line Maintenance Department. Work packages are sent to the Maintenance Operation Center for maintenance slot scheduling.

The Maintenance Operation Center controls the maintenance schedule for all company airplanes. A manager is on duty 24 hours to monitor and control all maintenance activities. When the duty manager receives the work package, he/she will arrange the required maintenance into the airplane's schedule according to the priority of the work required.

The Maintenance Engineering Section provides the technical supports to all line maintenance, base maintenance, and outstation technicians. It also provides suggestions or modifications to the maintenance procedures. When a problem needs to be clarified with the manufacturer, the engineers in the Maintenance Engineering Section will communicate with the manufacturer's representative to solve the problem.

The Ramp Maintenance Section is the section that actually performs the maintenance work on the production line. The Customer & Line Station Maintenance Section is responsible for all customer maintenance events.

1.17.1.3.2 Base Maintenance Department (MB)

The General Manager of the Base Maintenance Department controls all organizational, technical, and personnel aspects of heavy maintenance, structural repair, electric, radio, instrument (ERI) maintenance, cabin maintenance and aircraft components. He reports to the Assistant VP (Aircraft Maintenance) and, according to CAL Quality Manual, is responsible for:

- Professional, on schedule and economic maintenance and preventive maintenance, repair, and alterations according to approved and authorized Maintenance Documents of:
- Aircraft systems, airframe, airframe parts and components;
- Interior parts and components;
- Cleaning and paint of CAL and customer aircraft and aircraft

components;

- Assuring of principles, standards and quality rules and regulations defined in CAL E & M Div. Quality Manual;
- Definition, publishing and revision of Quality Procedures of Base Maintenance Department;
- Fixing of discrepancies found by Quality Audits during audits;
- Certification of the continuous airworthiness inspection and airworthiness of aircraft/issue of certificates of release to service;
- Investigation of irregularities identified during maintenance under leadership of Quality Assurance Department;
- Feedback of Quality Data to Quality Assurance Department;
- Handling and investigation of incidents, accidents, and special events on request; and
- Assist the VP of Engineering and Maintenance Division in performing his Reliability Control Board task with the expertise in their specific field.

The Base Maintenance Department handles all B, C, D Checks, heavy maintenance, and all the maintenance that is beyond the capabilities of the Line Maintenance Department. The Base Maintenance Department is divided into 6 sections: Production Planning Section, Maintenance Production Center, Structural Maintenance Section, Interior Maintenance Section, Hanger APG Maintenance Section, and Hanger ERI Maintenance Section. The General Manager of the Base Maintenance Department stated that in these 6 sections, Production Planning Section is in charge of heavy maintenance schedule planning. The Maintenance Production Center is in charge of monitoring and controlling the maintenance flow and status. The rest of the sections are the actual maintenance production sections.

1.17.1.4 Shop Maintenance Department (MY)

The Shop Maintenance Department is managed by an Assistant VP and has four departments: System Engineering, Technical Training, Shop Maintenance, and Engine Maintenance Departments. The Assistant VP for Shop Maintenance reports to the Division VP and, according to CAL Quality Manual, holds the following responsibilities:

- Assist the VP to direct the daily activities of the Shop Maintenance (MD), Engine Maintenance (MH) and System Engineering (ME) Departments;
- Supervise the performance of the duties and responsibilities of the Customer Service Department, and Technical Training Office;
- Coordinate with the other assistant VPs (Aircraft Maintenance / Business & Support) for implementation of company policies, procedure and/or correction of deficiencies;
- Supervise all sub-departments to ensure the compliance with the JAA, FAA, and local CAA Airworthiness Requirements for JAA, "N", “B" registered aircraft and/or equipment;
- Maintain liaison with counterpart of the other airlines personnel for interchange of information;
- Participate in and attend industry meetings with attendance of counterpart personnel of the other airlines;
- Supervise the Engineer Reliability committee activities; and
- Supervise the activities of components repair and maintenance in Shop Maintenance Department.

The Assistant VP for Shop Maintenance stated that the System Engineering Department was in charge of converting all the Maintenance Planning Data (MPD) to the company Aircraft Maintenance Program (AMP) for implementation, issuing Engineering Orders (EO), fleet planning, technical support, and project research. The Technical Training Department provides regulations, human factors, language, and aircraft type training to Divisional personnel. The Engine Maintenance Department is in charge of “off-wing” engine maintenance. The Shop Maintenance Department is in charge of aircraft component overhaul and parts maintenance.

The Assistant VP for Shop Maintenance stated that the Quality Assurance Department audits the Engine Maintenance and the Shop Maintenance Departments on both scheduled and unscheduled basis. During the maintenance process, some items needed to be double-checked by the quality inspectors when the maintenance is in progress. The Quality Assurance Department also spot-checks the process, procedures, and job cards during maintenance. Within the Shop Maintenance Department, managers of different shops will crosscheck each shop for self-audit. Within every six-month period,

all 13 departments in the EMD will crosscheck each other in accordance with the self-audit checklist.

1.17.1.4.1 System Engineering Department (ME)

The System Engineering Department is managed by the Chief Engineer, who reports to the Assistant VP (Shop Maintenance) of the EMD and, according to CAL Quality Manual, holds the following responsibilities:

- Establish and maintain the Aircraft Maintenance Program (AMP);
- Evaluate and implement Airworthiness Directives and other regulatory requirements for aircraft and equipment;
- Evaluate and implement Service Bulletins and other equivalent O.E.M;
- Originated documentation that is related to aircraft systems for which the System Engineering Department is responsible;
- Perform Reliability Control in accordance with the current Reliability Control Program and compliance with the rules laid down in Reliability Control Program;
- Perform and develop Engine Condition Monitoring Program;
- Perform and develop Weight & Balance Program;
- Support maintenance in difficult troubleshooting and fix of repeated Items;
- Contact O.E.M. for solution of technical problems;
- Establish Technical Specification for aircraft;
- Perform or support Vendor Selection and develop selection criteria;
- Perform Configuration Control on software used in aircraft systems;
- Support Maintenance Shops as required;
- Establish liaison between the EMD and Operations Division;
- Supply and maintain all technical documentation required by the EMD; and
- Responsible for technical data control program.

The System Engineering Department was divided into five sections: Technical

Information Section, Structure Section, Powerplant Section, System Section, and Avionics Section. The Chief Engineer of the System Engineering Department stated that in addition of converting the MPD into the company AMP, System Engineering Department received and reviewed AD and SB, converted them into company EOs and issued to the respective maintenance departments for implementation. Some special program, such as RAP, CPCP, and aging aircraft issues, are all evaluated by the System Engineering Department.

1.17.1.4.2 Shop Maintenance Department (MD)

The Shop Maintenance Department is engaged in the maintenance, repair and overhaul of aircraft components as well as inspection, repair, and calibration of test equipment and precision measurement equipment. There are seven sections in the Shop Maintenance Department: Production Control Section, PME Shop, Avionics Shop, Pneudraulics Shop, Instrument Shop, and Wheel & Brake Shop. The NDI (Non-destructive Inspection) Shop was originally under the Quality Assurance Department but is now under the Wheel & Brake Shop. The General Manager, Shop Maintenance Department reports to the Assistant VP (Shop Maintenance) of EMD and, according to CAL Quality Manual, holds the following responsibilities:

- Establish policies and procedures for control of quality and cost of maintenance performed by other sections and shops to realize a high level of schedule reliability;
- Exercise management control over the duties and responsibilities of the Electrical, Pneudraulic, Instrument, Wheels & Brakes and Avionics shop, as well as the Precision Measurement Equipment Laboratory and Production Control Section;
- Coordinate and supervise the maintenance, overhaul, repair & modification of company and customer components and/or equipment;
- Establish levels of personnel requirements and assignment necessary for the efficient conduct of the Department;
- Assist the Technical Training Office in training of the maintenance personnel.
- Ensure that the organization’s procedures and standards are adhered

to when carrying out maintenance;

- Provide maintenance support for repair work on aircraft as required.
- Monitor that equipment & work areas under his jurisdiction are kept in clean and orderly conditions;
- Assist the Customer Service Department in negotiating maintenance contracts with other airlines and/or vendors;
- Ensure through the workforce under his control, that the quality of workmanship in the final product is to a standard acceptable to the EMD and the Regulatory Authorities;
- Supervise the maintenance and the recording of the technical records pertinent to company and customer components and/or equipment;
- Certification of the continuous airworthiness inspection and airworthiness of aircraft / issue of Certificates of release to service;
- Investigation of irregularities identified during maintenance under the leadership of Quality Assurance Department; and
- Responsible for feedback of the Quality Data to Quality Assurance Department. (RII)

1.17.1.4.2.1 The NDI Shop

The NDI Shop is under the Wheel & Brakes Shop and in charge of the non-destructive testing of aircraft and aircraft components. The NDI engineer stated that there are currently 5 NDI methods in use in the shop: Magnetic Testing (MT); Liquid Penetration Inspection (PT); Eddy Current Inspection (ET); Ultrasonic Testing (UT); and Radiographic Testing (RT).

The NDI engineer stated that when the Engineering Department issued job cards, if there is a requirement for NDI, the method of NDI would be specified on the job card. If the Engineering Department cannot determine the proper NDI method for an inspection, the engineers would consult the NDI Shop.

Currently, the most widely used NDI method (except Visual Inspection) in the NDI Shop is high frequency Eddy Current Inspection.

1.17.1.4.3 Technical Training Office (TTO)

The Technical Training Office is a training center under the EMD of CAL that

takes into account of the qualification requirements. It is responsible for the definition and documentation of the training objectives and specification of training programs. The purpose of the training program is to ensure that each person (including inspection personnel) is fully informed about procedures, techniques, and new equipment in use, and is competent to perform his/her duties. The training program is established and conducted in accordance with Regulatory Authorities (CAA/FAA), local orders, directives, CAL Quality Manual (training regulations/policies) and manufactures' recommendations.

Technical Training Office is responsible for:

- Taking account of the qualification requirements, for the definition and documentation of the training objectives and specification of training programs, and their internal and external coordination;
- Selecting and commissioning suitable training institutions and the monitoring thereof;
- Involving in the acceptance of tests, and issue and recall of internal permits and authorization;
- Keeping the technical training records of all engineering and maintenance staff;
- Carrying out training projects for domestic and overseas manufactures;
- Conducting training on Computer Based Training and Multimedia;
- Proving guidance training for CAA and FAA certificate applicants;
- Giving summer training for students of technical institutes;
- Compiling and editing various technical training manuals;
- Evaluating the need for new training equipment, purchasing and maintaining new training equipment; and
- Selecting, cultivating and evaluating new technical instructors.

The technical training provided by Technical Training Office includes all categories of training related to professional skills and responsibilities of employees of the EMD Basic training (Initial new-hire training). It has two sections: Technical Training Section and Administration & General Training Section. The General Manager of Technical Training Office takes care of the administration, development, control, and organizational efficiency of the Technical Training Office. He reports to the Assistant VP (Shop Maintenance).

The General Manager of the Technical Training Office stated that Technical Training Section is in charge of aircraft technical training, such as initial training for new maintenance personnel, basic and aircraft type training for technicians. In addition, the Technical Training Section provides the special training such as CATII, CATIII, RVSM, and RNP training.

The Administration & General Training Section provides non-technical training. It plans, executes, and evaluates training programs on technical English, aviation regulations and work procedures. The regulation training includes CAA regulations, JARs, FARs, ICAO SARPs, and company IPM, QP, QM, QR, and Technical Training Manual (TTM). In addition, the Administration & General Training is in charge of editing and revising the TTM, maintaining the training records, and evaluating the training program.

1.17.1.5 Quality Assurance Department (MI)

Quality Assurance Department is responsible for quality regulations and audits for the EMD. It ensures that all works performed on the aircraft, engines, and associated components are in compliance with applicable requirements of relevant Airworthiness Authorities prescribed procedures, technical specification, current engineering and aviation standards, and sound industry practices. The General Manager for Quality Assurance Department reports to the Vice President and, according to CAL Quality Manual, has the following responsibilities:

- Establish an independent quality assurance system in consultation with supervisory authorities and Vice President and coordinating and proposing measures to assure and promote quality;
- Establish, implement and monitor approved company policies and procedures for the daily operations of the Quality Assurance Department;
- Maintain liaison with and reporting of unairworthy conditions to the JAA, FAA and Local Airworthiness Authorities;
- Authorize manufacturers and dealers in the context of the procurement of material;
- Authorize and monitor of subcontractors;
- Implement quality audit program and procedures;

- Make departmental coordination to ensure compliance with the JAA, FAA and local CAA Requirements for maintenance activities on aircraft, power plant and components;
- Ensure mandatory modification programs and AD/alert service bulletins are incorporated or complied with within the statutory time limits;
- Approve the technical personnel qualification procedures and issue of approval certificates to properly qualified maintenance staff to carry out work in accordance with the terms of approval certificates;
- Be responsible for monitoring the amendment of quality manual;
- Approve the duplicated inspections or Required Inspection Item (RII) procedures;
- Evaluate the inspection feedback reports;
- Assist in investigation of aircraft accidents, incidents and special events;
- Supervise the Regulation, Audit, Aircraft Inspection and Shop Inspection Sections;
- Approve the EO, RCPM, RVSM and CAT II/III procedures issued by the System Engineering Department;
- Responsible for the inspection system; and
- Report to CAA when detecting any suspected unapproved parts.

According to the CAL Reliability Control Program Manual, the purpose of quality assurance is to ensure the continuous airworthiness of all airplanes, including engines and components, and comply with both CAA and FAA requirements. The Reliability Control Program is a closed loop process, managed and governed by the Reliability Control Board (RCB) to ensure a safe, reliable and economical fleet operation.

There are four sections in the Department: Audit Section, Regulation Section, Shop Inspection Section, and Aircraft Inspection Section. The General Manager of Quality Assurance Department stated that the department has a total 95 staff; including 6 from the Audit Section, 9 from the Regulation Section, 16 from the Shop Inspection Section, and 61 from the Aircraft Inspection Section.

The Regulation Section is to develop a quality assurance system acceptable to

all regulatory authorities concerned. It is responsible of coordinating with related regulatory authorities and submitting report to relevant authorities, manufacturers and customers of any service difficulties encountered by CAL fleets.

The Audit Section is responsible of developing the quality audit system. It monitors the quality audit system and evaluates the inspection feedback reports of Quality Inspection Function.

The Aircraft Inspection Section carries out Quality Control Sampling Checks on all overnight, scheduled maintenance, defect rectification, and overhaul maintenance. It performs on-site inspection of Required Inspection Item (RII) for aircraft maintenance activities. In addition, it provides release to service of aircraft undergone regular checks, such as A, B, C, and D checks.

The Shop Inspection Section conducts Quality Control Sampling Checks on testing, repair, modification or overhaul for shop maintenance and engine maintenance activities.

1.17.1.5.1 Reliability Control Program (RCP)

The CAL RCP is managed and governed by the Reliability Control Board (RCB). The board members include the VP of the EMD, General Manager of the Quality Assurance Department, Managers of Line, Base, Shop, Engine, Supply Department, Technical Training Office, and Chief Engineer of System Engineer Department. The Board uses reliability reports to keep track of the reliability target and alert and oversee the corrective actions. The Board also approves the Maintenance Program and its revisions.

The General Manager of the Quality Assurance Department has the responsibility to assure all new released regulations pertinent to the program will be brought to the attention of RCB for consideration and submit the RCP to authorities for approval.

The reliability reports come from different sources including Monthly Reports (includes technical delay, cancellation, and incidents, engine IFSD etc.); Quarterly Reports (includes pilots & maintenance reports, components unscheduled removals data etc.). Those reports generate the Fleet Performance Report, Incident Report, ATA Report, Unscheduled Component Removals Report, ETOPS Reliability Event Log, and Condition Monitoring Report.

The Quality Assurance Department is responsible to distribute those reports to the RCB members and the CAA. The RCB will analyze the above reliability data, observe the trend, and determine the area that requires improvement and corrective actions. The System Engineering Department conducts the detail analysis and makes decisions regarding the cause of reliability degradation, deficiencies, procedure shortcomings, and human error. Other departments can also propose possible improvements. The corrective actions will be initiated by the System Engineering Department, which will revise, modify, adjust, and improve maintenance program, procedures, and training.

There are three different meetings associated with reliability control activities.

The Daily Morning Meeting: chaired by Line Maintenance Manager, discusses the technical irregularities and abnormalities, working program for the day, and deferred items follow-up. The attendees at the meeting include relevant department managers (Line, System Engineering, Supply and QA).

The Weekly Review Meeting: chaired by Manager of Line Maintenance discusses delays and cancellations, incidents, ADs, Alert SBs, Significant Deferred Items, and repeated items that happened during the week. The attendees include the Manager or Deputy Manager of relevant departments (Line and Base Maintenance, Engine & Shop Maintenance, System Engineering, Supply and QA).

The Monthly Reliability Control Board Meeting: chaired by the VP of EMD, focuses on reviewing the reliability reports and data analysis, incident reports and corrective actions, ETOPS reliability event log, reliability target and alert values, maintenance interval revisions, maintenance errors prevention, and the adjustment of the reliability Control Program. The attendees include all RCB and authorized personnel.

1.17.1.6 CAL Maintenance and Inspection Procedures in 1980

The investigation team was unable to locate any documents regarding maintenance and inspection procedures in 1980. Several CAL senior mangers stated that the work and inspection procedures, regarding the removal of the scratch area, were quite different 22 years ago. Basically, the technicians would follow the manual to do the repair at that time. When there was no SRM instruction available, the repair would be based on manufacturer’s instructions or engineer’s experience. The EO or job cards might not be available for the

workplace. The QC system did exist at the time. However, it's very difficult to trace the QC procedures since CAL did not keep a history record file.

1.17.1.7 CAL Flight Safety Department

The Flight Safety Department is one of the four Departments of China Airlines Safety, Quality Assurance & Compliance Division. The other four Departments are Ground Security, Industrial Safety, and Aviation Medical.

According to CAL Flight Safety Manual, the Flight Safety Department is responsible of:

- Setting policies, procedures, and standards in relation to aviation safety;
- Investigating and reporting on safety, incidents/situations that adversely affect, or are likely to affect, China Airlines operations, revenue, assets or reputation;
- Conducting analysis to identify causes of error, violations and/or systemic weaknesses that create hazards and risks or other conditions that lead to operational degradation;
- Auditing compliance against relevant company and regulatory standards, and reporting non-compliance to the Senior Management and the Corporate Safety Committee; and
- Providing advice on the implementation of safety risk mitigation programs.

The Flight Safety Officer of Flight Safety Department stated that the Flight Safety Department does not conduct audits or inspections of maintenance activities. The Quality Assurance Department of the EMD has auditors and inspectors to conduct the quality audit and inspection duties. The relation between the Flight Safety Department and the EMD is mainly through Safety Report handling.

When a safety related event occurs, the flight crewmembers and flight attendants of the flight are responsible for reporting the event to the Safety, Quality Assurance & Compliance Division by using the China Airlines Crew Report form. Upon receipt of the report, the Safety, Quality Assurance & Compliance Division defines and classifies the report and forwards the report to relevant Divisions for investigation.

For investigations conducted by the Flight Safety Department, the reports, including recommendations are reviewed by the VP Safety, Quality Assurance & Compliance. For investigations conducted by other Divisions, such as maintenance related issues investigated by the EMD, the reports shall be submitted by the investigating Division to the Flight Safety Department and will be reviewed by the designated Flight Safety Department officer for completeness. When the report handling process is completed, the report will be submitted to the VP Safety, Quality Assurance & Compliance. The actions taken by other Divisions, as a result of recommendations, will be recorded in the Flight Safety Department database and retained on file for a period of 10 years.

The Flight Safety Department publishes selected events as case studies for Company crewmembers on the CAL Intranet system. Occurrences of interest will also be provided to the CAA for information.

1.17.1.8 CAL Boeing Field Service Representative

Boeing has three Field Service Representatives (FSRs) at China Airlines to provide technical supports of the Boeing's products. The Boeing FSR office is located at CAL CKS hanger.

According to Boeing Commercial Field Service Procedure Manual, the FSRs responsibilities are:

- Assigned to operators as technical advisers and serve as the single point-of-contact for Boeing support issues in the field;
- Apply their understanding of the operators' business environments to reduce cost of ownership, increase safety, and improve operational efficiency;
- Work closely with operator teams to solve a broad range of airline management concerns; and
- Understand all Boeing CAS offerings and use their knowledge and technical expertise to advise operators in the selection and use of Boeing products and services.

In addition to the requirement for data collection and reactive reporting, the FSR is expected to be more involved in predictive and proactive problem solving.

Boeing Commercial Field Service Procedure Manual also stated the limitations of the FSRs. The FSRs may advise and recommend, with the understanding that final decisions are entirely the responsibility of the operator. The FSRs must be particularly careful to avoid being placed in a role of approving technical work or modifications to operator airplanes. The FSRs work with the operator only in an advisory capacity.

The Boeing Field Service Manager for CAL stated that after an airplane is delivered to an operator, Boeing FSRs provide the technical support to maintain the airplane. Usually the Structure Repair Manual, Wire Diagram Manual, and other maintenance manuals provide the operators with information to do the standard repairs. The operator will conduct the repair if the manual covers the procedures of the repair. If the problem goes beyond the limitation in the manual, then Boeing FSRs may be requested to be involved.

The Boeing Field Service Manager for CAL stated that only when the manual covers the problem, the FSRs can make a suggestion to the operators regarding how to solve the problem. If the problem is beyond the manual, then the FSRs cannot design nor approve the repair regardless of their background. The FSRs will send a technical message to Boeing, describe the problem and get the repair permit from the home office. When a person becomes a FSR, no matter what his/her previous background was, he/she has no authority to do anything on site. The FSRs act as the liaison personnel between the operators and Boeing Head Office.

1.17.1.8.1 Communication Procedures

Facsimiles, telephone, or e-mail may all be used for communication between Boeing and external customers. However, formal communication between Boeing and external customers must use BOECOM for information exchange. According to Boeing Commercial Field Service Procedure Manual, BOECOM is a three-part computing system that supports formal communication between the Boeing Home office, the customer, and Field Service remote offices.

When Boeing FSRs receive a request from CAL engineers, such as if the engineer could not find the repair in the standard repair manual, the FSRs would suggest the engineer do certain research. If the repair relates to structure repairs, the CAL engineers have to complete sketches and other information, Boeing FSRs will not do so for the operator. The engineers will

provide Boeing FSRs with the information and the FSRs will send the information to Boeing Home office. After receiving the reply, the FSRs will review the reply for appropriateness and completeness and distribute the information to related operator personnel.

1.17.1.8.2 RAP guidelines and consultation

As a response to a query regarding the FSRs' involvement with the RAP program, the Field Service Manager stated that the RAP document is an industry effort. By following the FAA's instructions, Boeing provides recommendations to operators on how to conduct the repair assessment.

The Field Service Manager stated that the RAP program is a huge program and has been developed over a long period. Since RAP is not fully implemented yet, CAL structure engineers consulted Boeing FSRs regarding the content of the RAP, as some of the program content is vague to non-English nationalities. The RAP program is a guideline, which provides operators guidance to develop their own programs. Operators have to raise official request for Boeing's consultation but the manufacturer has no authority to approve an operator's program. Boeing Field Office did not approve the CAL RAP program.

1.17.2 Civil Aeronautics Administration R.O.C.

1.17.2.1 CAA Historic Evolution

In 1919, an aviation authority was established to handle aviation affairs in ROC. In 1929 the office of civil aviation went to the jurisdiction of the Ministry of Communications (MOC). On January 20, 1947 the Civil Aeronautics Administration was set up in Nan King, China, placed under MOC. At that time the CAA consisted of five departments namely Operations, Airways, Aerodrome, Safety and Secretariat, plus the offices of Accounting and Personnel.

Having moved to Taiwan with the government in 1949, CAA amended its organic rules to meet operational demand in 1972. Following the government open sky policy in 1987, to cope with the flourishing aviation industry, another amendment of the organic rules were drafted for promulgation in June 1998.

1.17.2.2 CAA Organization

The Director General who was aided by two Deputy Directors General and a Secretary General heads the CAA. Internal units comprise the seven Divisions of Planning, Legal & International Affairs, Air Transport, Flight Standards, Air Traffic Services, Aerodrome, Air Navigation Facilities and the Logistics, along with the five Offices of Information, Secretariat, Accounting, Personnel and Government Ethics.

At present CAA and affiliated organizations together have more then 2,400 employees.

1.17.2.3 CAA Oversight

Based on the stipulations of the Civil Aviation Law, CAA undertakes to oversee the functions of airlines and conduct flight safety inspections. Such inspections cover flight operation and airworthiness, to ensure that flight crews are qualified, trained and judiciously dispatched, air carriers operate in full compliance of the law and receive periodical maintenance and repair to stay airworthy. Airlines will be notified of any deficiency uncovered at flight safety checks and subject to follow-up checks until improvement is made.

1.17.2.4 The Inspection System of CAA

During 1995 to 1997, The CAA renovated its Aviation Safety Inspection System in accordance with the recommendations of ICAO Annex 6. The purpose of the renovation was to establish the required regulations, manpower and training for the air safety inspectors.

Among the divisions in CAA, Flight Standards Division conducts the safety inspections to ensure the safety of aviation operations, including operations inspection, airworthiness inspection, and aircraft maintenance inspection. In addition, the division is in charge of all the test, interview, certification, register, and training of the civil aviation personnel. It also plans and manages the flight safety policy, flight standards, and related regulations and international convention

Operations inspection is to ensure the civil air transport related staffs, affairs and operations are up to CAA standard. Each inspection needs to complete a series of examination and evaluation for particular purpose or region. The new

candidates will be certificated after passing the examination of "Civil Air Transport Operations Inspection Table".

Airworthiness inspection is to inspect and certify the civil air transportation products. After passing the inspection, producers receive the airworthiness certificate for commercial functions.

Aircraft maintenance inspection is to maintain the aircraft is airworthy in normal operation. The current standard include Aircraft Worthiness Inspection and Certification Regulation, Aircraft Service Center Establishment Regulation, Plan and Maintenance Process, Maintenance Approval Process, and Aircraft Inspection Manual. There are scheduled and unscheduled inspections to oversight every airline’s condition, to suggest or to issue reprimands.

1.17.2.5 The Inspection System of CAA in 1980

The investigation team was unable to locate any document related to the inspection system of the CAA in 1980. The CAA stated that the aviation regulations at the time were not as completed as they are now and that the CAA aviation safety inspection system was not well established as the present system. There was no specific inspection system or inspection plan at the CAA in 1980. Furthermore, the inspectors had no handbook for inspection guidelines and no inspector training to carry out flight safety inspections.

In 1996, the FAA conducted an International Aviation Safety Assessment (IASA) of the CAA and the CAA was categorized as a Category II authority. As a result, CAA copied the inspection system from FAA, recruited new inspectors, set up inspector training programs, and established inspector handbooks. The CAA were given Category I authority status from the FAA in 1997.

Before the FAA IASA, the CAA had 10 flight operations inspectors and 11 maintenance inspectors. The CAA now has 28 flight operation inspectors (including cabin safety inspector and dangerous goods inspector) and 24 maintenance inspectors.

1.17.2.6 CAA International Connections

As a response to the query of how CAA keep up-to-date with international aviation regulations, the CAA stated that the Regulation and Policy Group, which is under the CAA Flight Safety Consultation Committee, provides regulation revision and procedures for the CAA and operators. In general, the

CAA can search the latest status of FAR, JAR and ICAO SARPs through the ICAO eshop and HIS AV-DATA on-line searching system. Furthermore, the CAA Flight Standard Division is responsible for monitoring the ICAO Annexes 1, 6, and 8. The Division reviews ICAO Annexes related to regulations and revises the regulations, if necessary, once per year.

According to the CAA, ROC is not an ICAO contracting state. Therefore, the ICAO does not assess ROC's aviation safety. In this case, the FAA conducts the IASA on behalf of ICAO. Officially, the CAA and the FAA have no obligation toward each other. The CAA stated that when the FAA planned to issue an AD or revise its regulations, the FAA does not inform the CAA. The CAA regulates that operators must complete the ADs issued by the state of the manufacturer in accordance with the ICAO SARPs.

1.17.2.7 CAA Aging Aircraft Program

The CAA PMI for CAL stated that the CAA would search the FAA or Boeing's web site to gather aging aircraft information. As for the Repair Assessment Program, the CAA originally obtained the information from China Airlines.

After the accident, the CAA issued an Airworthiness Directive (AD 2002-09-02, Repair Assessment for Pressurized Fuselages) for aircraft type including B737, B747, MD DC-9/MD-80, and A300-B4-200 for repair assessment program. In addition, the CAA issued an Advisory Circular (AC120-020, Damage Tolerance Assessment of Repairs to Pressurized Fuselages) to request operators adopt the FAA-approved repair assessment guidelines for the fuselage pressure boundary to part of their maintenance program.

1.17.2.8 The CAA Oversight of China Airlines Maintenance

Basically, the CAA performs regular safety oversight of the operators and their maintenance organization contractors to ensure that aircraft are airworthy for flight in accordance with CAA airworthiness requirements. The CAA has an annual plan for routine maintenance inspection and the guideline of the surveillance is outlined in its Airworthiness Inspector's Handbook. The handbook directs the actions and provides guidance for all inspectors.

According to CAA PMI of China Airlines, the inspector inspects the operator's maintenance operations for its adequacy of the procedures and facilities provided by the operators to the maintenance personnel. The inspections also

examine the standard of maintenance management, the workmanship of the maintenance technicians, and the level of compliance with regulatory and maintenance manual requirements.

The CAA assigned three maintenance inspectors to CAL. The inspection is conducted both regularly and irregularly. The inspection plan is arranged annually in according to the job function of inspector's handbook, including operator's maintenance facility inspection, cabin en-route inspection, major repairs and alterations inspection, and maintenance log book inspection. The objective of the inspection is to ensure that maintenance personnel are comply with the regulation, company policy and maintenance manual. Furthermore, inspectors also approve or accept documents prepared by the operator, such as aircraft maintenance program, special operation program, training program and standard operation procedure (SOP).

The PMI of CAL stated that CAL has a sound maintenance mechanism. In addition, the company is willing to invest maintenance software and hardware to maintain high quality maintenance and safe operation.

1.18.5 Aging Aircraft

1.18.5.1 Background

Following a structural-failure accident to an aircraft operating a passenger flight in the United States of America in 1988, there was significant public and aviation industry concern about the airworthiness of aging transport-category aircraft. The U.S. Congress passed the Aviation Safety Research Act of 1988. The Act increased the scope of the U.S. Federal Aviation Administration (FAA) to include research improving maintenance technology and detecting the onset of cracking, delamination, and corrosion of aircraft structures.

The FAA organized number of conferences on aging aircraft, the first being held in June 1988. As a result, in August 1988, the Airworthiness Assurance Task Force (AATF) was established as a sub-group of the FAA's Research, Engineering and Development Advisory Committee representing the interests of aircraft operators, aircraft manufacturers, regulatory authorities and other aviation groups. The AATF initially set forth five, with a sixth being added later, elements for keeping the aging aircraft fleet safe.

The elements were:

- Structural Modification Program,
- Corrosion Prevention and Control Program,
- Structural Maintenance Program Guidelines,
- Review and Update Supplemental Structural Inspection Documents,
- Damage tolerance of Repairs (RAP),
- Program to preclude widespread fatigue damage from the fleet.

In January 1991, the FAA established the Aviation Rulemaking Advisory Committee (ARAC) to provide advice and recommendations concerning the full range of the FAA's safety-related rulemaking activity. In November 1992, the AATF was placed under the auspices of the ARAC and renamed to the Airworthiness Assurance Working Group (AAWG). One of the tasks assigned to the AAWG was to develop recommendations concerning whether new or revised requirements and compliance methods for structural repair assessments of existing repairs should be initiated and mandated for the identified group of aging aircraft. The Boeing 747-200 model was one of the groups identified as aging aircraft.

1.18.5.2 The Concern Posed By Older Repairs

Repairs are a concern on older airplanes because of the possibility that they may develop, cause, or obscure metal fatigue, corrosion, or other damage during service. This damage might occur within the repair itself or in the adjacent structure, and might ultimately lead to structural failure. The objective of the repair assessment is to assure the continued structural integrity of the repaired and adjacent structure.

In general, according to FAA NPRM of Repair Assessment for Pressurized Fuselages, repairs present a more challenging problem than the original structure because each repair is unique and tailored in design to correct particular damage to the original structure. Whereas the performance of the original structure may be predicted from tests and from experience on other airplanes in service, the behavior of a repair and its effect on the fatigue characteristics of the original structure are generally not known to the same extent as for the basic un-repaired structure.

The NPRM also stated that the available service record and surveys of out-of-service and in-service airplanes have indicated that existing repairs

generally perform well. However, repairs may be of concern as time-in-service increases. When airplanes age, both the number and age of the existing repairs increase. Along with this increase is the possibility of unforeseen repair interaction, autogenous failure, or other damage occurring in the repaired area. The continued operational safety of these airplanes depends primarily on a satisfactory maintenance program (inspections conducted at the right time, in the right place, using the most appropriate technique). In addition, some repairs described in the airplane manufacturers' Structural Repair Manuals (SRM) were not designed to current standards. Repairs accomplished in accordance with the information contained in the early versions of the SRM's may require additional inspections if evaluated using the current methodology.

1.18.5.3 Repair Assessment Program (RAP)

Initially the aircraft manufacturers began to prepare model specific repair assessment guides. These guides were presented to operators to provide feedback for acceptability and improvement. During this period the AAWG conducted two surveys covering some 1051 repairs on 65 aircraft that had been retired from operational usage. The findings of both surveys were issued in a report in December 1996. Both surveys found that about 40% of the repairs were adequate and the remaining 60% required additional supplemental inspections. The AAWG recommended that repair assessment operational rules require a damage tolerance assessment of fuselage pressure boundary repairs (fuselage skins, door skins and bulkhead webs) for all aging aircraft models.

In December 1997, the FAA issued a Notice of Proposed Rulemaking (NPRM 97-16) on the repair assessment subject. The final rule was published on April 25, 2000 and was effective on May 25, 2000. The applicable new rules including 14 CFR 91.410, 121.370, 125.248, and 129.32. The final rule states that no operator could operate nominated aircraft (including Boeing 747-200 models) beyond a certain number of flight cycles or May 25, 2001, whichever occurs later, unless its operations specifications have been revised to reference repair assessment guidelines and those guidelines are incorporated in its maintenance program.

For the models of the Boeing 747, the flight cycle implementation time is 15,000 cycles.

FAA AC 120-73 entitled "Damage Tolerance Assessment of Repairs to

Pressurized Fuselages" was issued on December 14, 2000.

1.18.5.4 Repair Assessment Process

The Structures Task Groups was to develop a common industry approach for all aging airplane models. Industry agreement was reached on a general approach consisting of three stages assessment.

The stage 1 processes are to gather repair data based on visual inspection, and allows operators identify the areas of the airplane where structural repairs may require supplemental inspection to maintenance damage tolerance. The stage 2 process is to determine repair category by using the data collected in stage 1. The stage 3 processes are to determine the structural maintenance requirements.

The operators will define the inspection threshold from the time of repair installation if the supplemental inspection and/or replacement requirements were required.

1.18.5.5 Repair Assessment Threshold and Grace Period

The introduction of mandatory continuing airworthiness requirements, such as the Repair Assessment Program, involves the determination of compliance threshold and grace periods. This kind of the inspection program are developed by aircraft manufacturers and approved by the relevant State of Design. The State of Registry then determines what aspects of the program should be mandatory for aircraft of that type on their register.

According to the FAA Airworthiness Directives Manual, two types of analysis are typically necessary when determining compliance times for a mandatory continuing airworthiness requirement: threshold and grace periods.

A compliance threshold stipulates the time in service of the aircraft by which action should be taken to detect or prevent the unsafe condition. It may be specified in terms of flight cycles, calendar time or flight hours, depending on which are more critical for the specific problem being addressed.

Grace periods provide an allowance for aircraft, components, or engines that have already exceeded the compliance threshold at the time the continuing airworthiness requirement is introduced. The intent of allowing a grace period is to avoid aircraft being grounded unnecessarily. In determining the

appropriate grace period, the degree of urgency of the unsafe condition must be balanced against the amount of time necessary to accomplish the required actions, the availability of necessary replacement parts, operators' regular maintenance schedules, and other factors affecting the ability of operators to comply. In some cases it may be necessary to ground aircraft, but in most cases the grace period can be selected to avoid grounding and interference with normal maintenance schedules, while still obtaining expeditious compliance.

1.18.5.5.1 FAA Notice of Proposed Rulemaking

According to FAA Notice of Proposed Rulemaking (NPRM), RIN 2120-AF81, Repair Assessment for Pressurized Fuselages, the implementation time for the assessment of existing repairs is based on the findings of the repair surveys and fatigue damage considerations. The repair survey findings indicated that all of repairs reviewed appeared to be in generally good structural condition. This tended to validate the manufacturer's assumptions in designing both the repair and the basic structure. Since the manufacturer had based the design stress levels on a chosen Design Service Goal (DSG), it was concluded that the repair assessment needed to be implemented sometime before a specific model reached its DSG. Based on this logic, the manufacturers and operators established an upper boundary for an assessment to be completed, and then reduced it to establish an "implementation time," defined as 75% of DSG in terms of flight cycles. Therefore, under this approach, incorporation of the RAG into an airplane's maintenance or inspection program ideally should be accomplished before an airplane accumulates 75% of its DSG.

After the guidelines are incorporated into the maintenance or inspection program, operators should begin the assessment process for existing fuselage repairs within the flight cycle limit specified in the FAA-approved model-specific Repair Assessment Guideline (RAG). There are three "deadlines" for beginning the repair assessment process, depending on the cycle age of the airplane on the effective date of the rule.

<u>Airplane cycle age equal to or less than implementation time on the rule effective date</u>

The operator is required to incorporate the guidelines into its maintenance or inspection program by the flight cycle implementation time, or one year after the effective date of the rule, whichever occurs later. The assessment process

begins (e.g., accomplishment of Stage 1) on or before the flight cycle limit specified in the RAG after incorporation of the guidelines. (The flight cycle limits are expressed in flight cycle numbers, but are generally equivalent to a D-check.)

Airplane cycle age greater than the implementation time but less than the DSG on the rule effective date

The operator is required to incorporate the guidelines into its maintenance or inspection program within one year of the rule effective date. The assessment process then begins (e.g., accomplishment of Stage 1) on or before the flight cycle limit specified in the RAG (this flight cycle limit is generally equivalent to a D check), not to exceed another specified flight cycle limit (computed by adding the DSG to the flight cycle limit equivalent of a C-check) after incorporation of the guidelines.

Airplane cycle age greater than the DSG on the rule effective date

The operator is required to incorporate the guidelines in its maintenance or inspection program within one year after the effective date of the rule. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the flight cycle limit specified in the RAG (generally equivalent to a C-check) after incorporation of the guidelines. In each of these three cases, the assessment process will have to be completed, the inspections conducted, and any necessary corrective action taken, all in accordance with the schedule specified in the FAA-approved RAG document.

1.18.5.5.2 FAA AC120-73 Damage Tolerance Assessment of Repairs To Pressurized Fuselages

FAA AC120-73 stated, after the guidelines are incorporated into the maintenance or inspection program, operators must begin the assessment process for existing fuselage repairs within the flight cycle limit specified in the FAA-approved model-specific repair assessment guidelines. There are three deadlines for beginning the repair assessment process, depending on the cycle age of the airplane on the effective date of the rule:

Airplane cycle age equal to or less than implementation time on May 25, 2000

The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by the flight cycle implementation time, or May 25, 2001, whichever occurs later. The assessment process would begin

(e.g., accomplishment of Stage 1) on or before the cycle limit specified in the repair assessment guidelines (generally equivalent to a D-check), not to exceed the cycle limit computed by adding the DSG to the cycle limit equivalent to a C-check (specified in the repair assessment guidelines) after the incorporation of the guidelines.

Airplane cycle age greater than the implementation time but less than the DSG on May 25, 2000

The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by May 25, 2001. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the cycle limit specified in the repair assessment guidelines (generally equivalent to a D-check), not to exceed the cycle limit computed by adding the DSG to the cycle limit equivalent of a C-check interval (specified in the repair assessment guidelines), after incorporation of the guidelines.

Airplane cycle age greater than the DSG on May 25, 2000

The operator must incorporate the repair assessment guidelines into its maintenance or inspection program by May 25, 2001. The assessment process would begin (e.g., accomplishment of Stage 1) on or before the next cycle limit specified in the repair assessment guidelines (equivalent to a C-check) after incorporation of the guidelines.

1.18.5.5.3 FAA Approved Boeing 747 Repair Assessment Guideline

According to Boeing Repair Assessment Guidelines – Model 747, document number D6-36181, repairs were to be examined by the following points:

Aircraft with flight cycles less than 15,000 cycles on the rule effective date of May 25, 2000

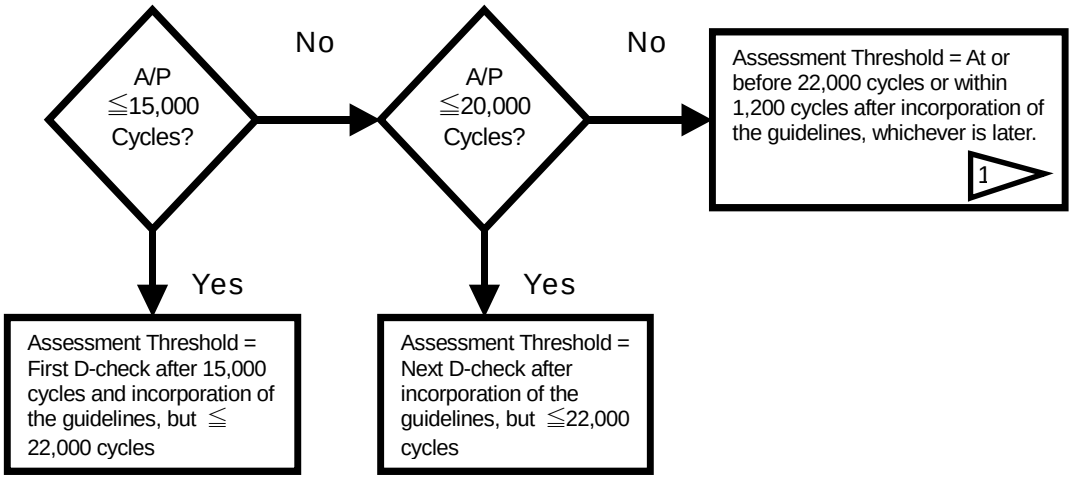
The guidelines must be incorporated into the maintenance program at 15,000 cycles or within one year of the effective date of the rule, whichever is later. Begin the assessment process on these airplanes (e.g. at least complete repair examination) at or before the next major check (D-check equivalent) after the incorporation of the guidelines not to exceed 22,000 cycles.

Aircraft with flight cycles greater than 15,000 but less than 20,000 cycles on the rule effective date of May 25, 2000

The guidelines must be incorporated into the maintenance program within one year of the effective date of the rule. Begin the assessment process on these airplanes (e.g. at least complete repair examination) at or before the next major check (D-check equivalent) after the incorporation of the guidelines not to exceed 22,000 cycles.

Aircraft with flight cycles greater than 20,000 cycles on the rule effective date of May 25, 2000

The guidelines must be incorporated into the maintenance program within one year of the effective date of the rule. Begin the assessment process (e.g. at least complete repair examination) at or before 22,000 cycles or within 1,200 cycles, whichever is later, after the incorporation of the guidelines.



Legend:
A/P Airplane cycles on May 25, 2000

1 22,000 cycles is in agreement with access to majority of areas in SB 747-53-2349

Figure 1.18-23 FAA Approved Boeing 747 Repair Assessment Guideline

1.18.5.5.4 Background of the determination of the Assessment Threshold 22,000 Cycles

According to the FAA-approved Repair Assessment Guideline, the reason of using flight cycles 22,000 as the Assessment Threshold was because 22,000 cycles is in agreement with access to majority of areas in SB 747-53-2349. According to the SB, the 22,000 flight-cycles was determined by the 747 Structures Working Group.

As a response to investigation team's query regarding why and how the RAG D6-36181 decided to adopt the implementation period of SB 747-53-2349, Boeing stated as following:

Boeing has reviewed available material documenting the Structures Task Group meetings regarding implementation period. Boeing has found no record of the implementation period as the subject of specific discussions with industry/regulatory groups. However, the document as a whole was generated by, and reviewed by, the Structures Task Group as indicated in the preface material in the document.

There are two reasons why the 22,000 cycles assessment threshold for the airplanes beyond the 15,000 cycles threshold was chosen.

(1) Technical Justification

The fatigue testing that resulted in SB 747-53-2349 also tested the fuselage skin lap splices and circumferential splices and resulted in an external lap splice inspection requirement at 22,000 cycles per SB 747-53-2367. The details of these splices are duplicated in the SRM skin repairs that are the subject of the RAG. The data generated to establish the 22,000 cycles threshold for the skin lap splices is also applicable to the skin repairs.

(2) Operational Considerations

As previously stated, the 22,000 cycles threshold corresponds to a mandated major maintenance requirement in SB 747-53-2349. This bulletin requires internal access to most of the fuselage. One goal of the RAP was to require that the assessment be accomplished no later than the next major maintenance visit beyond DSG. The existing mandated inspection per SB 747-53-2349 satisfied this goal.

As a response to investigation team's query regarding why and how the 747 Structures Working Group determined the implementation period to be Flight Cycle 22,000, Boeing stated as following:

The Structures Task Group primarily focused on the assessment threshold of 15,000 cycles. This was based on extensive durability analysis of SRM repairs. The maximum assessment threshold of 22,000 cycles was chosen to agree with the existing mandated internal access requirement per SB 747-53-2349. This threshold can also be justified technically by comparison to SB 747-53-2367. The inspection requirements for the internal structure per SB

747-53-2349 and the skin lap splices per SB 747-53-2367 were based upon extensive fatigue testing and the requirements for these bulletins were reviewed by the Structures Task Group independent of the RAP. The skin splices, which replicate the details of a typical SRM skin repair, were closely monitored during the fatigue testing for crack initiation and progression of cracking. The data from this testing was used to establish the threshold.

1.18.5.6 China Airlines RAP

China Airlines operated Boeing 747 aircraft, including B18255 that are covered by the requirements of the RAP. The airline complied with the requirements of the FAA rule (which was adopted by the ROC. Civil Aviation Administration) and produced a Repair Assessment Manual, which was approved by the CAA on May 28, 2001.

The CAL's Structure Section of the System Engineering Department was responsible for evaluating the RAP for implementation. The manager of the Structure Section stated that the Structure Section received a telex from Boeing regarding a RAP training workshop in 2000. He was aware that there were several airplanes in the company over 20 years old at the time. Therefore, he sent two engineers to Boeing for RAP training and started to plan for RAP implementation.

According to the CAL documents, after receiving the Boeing Repair Assessment Guideline D6-36181, the System Engineering Department issued EO 740-53-00-0003 (Fuselage Pressurized Skin Inspection for Specific Repair Conditions) on May 21, 2001. On May 24, 2001, the System Engineering Department issued procedure QP08ME119 (Aircraft Repair Assessment Process Implementation). The CAA accepted the CAL's proposal for Repair Assessment Manual on May 28, 2001.

1.18.5.6.1 RAP of B18255

Records indicate that the occurrence airplane, B-18255, had accumulated 19,447 flight-cycles on May 25, 2000 and 20,402 flight-cycles on May 25, 2001. According to Boeing RAG D6-36181, B-18255 should begin the assessment process (at least complete repair examination) at or before the next major check (D-check equivalent) after the incorporation of the guidelines and prior to 22,000 cycles. On October 2, 2001, several departments of the Engineering and Maintenance Division, including Quality Assurance, Maintenance Planning,

Production Planning, Structural Maintenance, APG, System Engineering, and NDI shop, held a meeting regarding B-18255 RAP implementation assessment. According to the manager of Structure Section and the meeting minutes, the repair assessment of B-18255 was scheduled at the 7C-Check (November 2002). The reason for scheduling repair assessment at the 7C-Check was that there was insufficient information regarding the records of B-18255 repair doublers. Therefore, the meeting decided to document the repairs on B-18255 during the 6C-Check so that a better idea of how much time may be required to complete the repair assessment at the 7C-Check.

According to the record, CAL structural engineers completed the doubler mapping of B-18255 during the 6C-Check in November 2001.

1.18.5.6.2 RAP Organizational Responsibility

The China Airlines Repair Assessment Manual, designates that the following departments are responsible for RAP Maintenance Program; System Engineering Department, Line Maintenance Department, Base Maintenance Department, Shop Maintenance Department, Quality Assurance Department, and Technical Training Office.

Line Maintenance (ML), Base Maintenance (MB), NDI of Shop Maintenance (MD) Quality Management Office (MI) and System Engineering Department are responsible for aircraft repair assessment, re-repair and re-inspection per Repair Assessment Engineering Order (EO).

Maintenance Operation Center (MOC) of Line Maintenance (ML) and Production Planning Section (PPS) of Base maintenance (MB) are responsible for notification, communication, and control of the repair assessment, re-repair and re-inspection.

System Engineering Department (ME) is responsible for:

- Propose and issue Aircraft Repair Assessment Process Implementation and Repair Assessment Engineering Order (EO);
- Evaluate items of aircraft repair assessment and if damage on repair area is found, propose corrective method for damaged area;
- Propose supplemental inspection method, threshold and intervals of re-inspection for implementation of repair assessment item on affected aircraft and revise AMP to augment these new items in AMP;

and

- Every repair item of repair assessment should be sketched by Engineers including any fault and corrected action.

The System Engineering Department should file the Implementation Feed Back Sheet of the Engineering Order, Airplane Repair Assessment Items List, Figure of Repair Location, Repair Sketch and new items of after the revised AMP so as to control the condition of whole fleet.

Quality Assurance Department is responsible for spot inspection and audit of repair assessment, re-repair and re-inspection for aircraft.

1.18.5.6.3 CAL RAP Procedures

The CAL Quality Procedure, QP08ME119, Aircraft Repair Assessment Process Implementation outlines the procedure of CAL RAP as:

Maintenance Operation Center (MOC) of Line Maintenance Department schedules the timing of Aircraft Repair Assessment and incorporates it for the affected aircraft per Repair Assessment Engineering Order (EO) and Aircraft Repair Assessment Process Implementation.

Base Maintenance Department and NDI of the Shop Maintenance Department should perform inspections for all repairs per Repair Assessment Engineering Order (EO), Quality Assurance Department performs spot inspection and audit and System Engineering Department evaluates all repair assessment items.

If a defect is found during the repair assessment process, the Base Maintenance Department is responsible for carrying out repair to an approved schedule.

The responsible system engineer of System Engineering Department should analyze and decide the category of each item of repair assessment and propose and issue the supplement inspections for each Category B or C item including thresholds, intervals and the due date of terminal repair for incorporation. The engineer is also required to revise the AMP to include the above Category B items for repeat inspection.

Line Maintenance Department & Base Maintenance Department should compile worksheets per the new items in the AMP.

The Maintenance Operation Center (MOC) and the Maintenance Production

Center plan the timing and incorporation of the new items in AMP to the affected aircraft.

Line Maintenance Department and Base Maintenance Department should perform re-inspection and re-repair of the new items in the AMP.

Quality Assurance Department performs spot inspection and audit of the new items fin the AMP, which are revised in accordance with the results of repair assessment.

IV. Attachments

No	Item
10-1	CAL Quality Manual
10-2	Interview Note of China Airlines Assistant VP (MX) Aircraft Maintenance, Engineering & Maintenance Division
10-3	Interview Note of China Airlines Manager of Line Maintenance Department, Engineering & Maintenance Division
10-4	Interview Note of China Airlines Manager of Base Maintenance Department, Aircraft Maintenance
10-5	Interview Note of China Airlines Assistant VP (MY) Shop Maintenance, Engineering & Maintenance Division
10-6	Interview Note of Interview China Airlines Chief Engineer of System Engineering Department, Shop Maintenance
10-7	Interview Note of China Airlines Manager of Wheel & Brake Shop, Shop Maintenance Department
10-8	Interview Note of China Airlines General Manager of Technical Training Department, Engineering & Maintenance Division
10-9	Interview Note of China Airlines Manager of Administration & General Training Section, Technical Training Department
10-10	CAL Reliability Control Program Manual
10-11	Interview Note of China Airlines General Manager, Quality Assurance Department (MI), Engineering & Maintenance Division
10-12	Interview Note of Interview China Airlines Manager of Regulation Section, Quality Assurance Department (MI)
10-13	Interview Note of China Airlines Manager of Audit Section, Quality Assurance Department (MI)
10-14	CAL Flight Safety Manual
10-15	Interview Note of China Airlines Flight Safety Officer of Flight Safety Department, Safety & Security Management Division
10-16	Boeing Commercial Field Service Procedure Manual
10-17	Interview Note of the Boeing Field Service Manager of China Airlines
10-18	CAA response to investigation team’s query
10-19	CAA AD 2002-09-02 Repair Assessment for Pressurized Fuselages
10-20	CAA AC 120-020 Damage Tolerance Assessment of Repairs to Pressurized Fuselages

10-21	Interview Note of CAA PMI of China Airlines
10-22	FAA Notice of Proposed Rulemaking (NPRM), RIN 2120-AF81, Repair Assessment for Pressurized Fuselages
10-23	14 CFR 91.410
10-24	14 CFR 121.370
10-25	14 CFR 125.248
10-26	14 CFR 129.32
10-27	FAA AC 120-73 Damage Tolerance Assessment of Repairs to Pressurized Fuselages
10-28	FAA Airworthiness Directives Manual
10-29	Boeing Repair Assessment Guidelines – Model 747, document number D6-36181
10-30	Boeing SB 747-53-2349
10-31	Boeing SB 747-53-2367
10-32	China Airlines Repair Assessment Manual
10-33	CAL EO 740-53-00-0003 Fuselage Pressurized Skin Inspection for Specific Repair Conditions
10-34	CAL Procedure QP08ME119 Aircraft Repair Assessment Process Implementation
10-35	Meeting Minute, 10/4/2001, RAP Implementation Planning Meeting
10-36	CAL B18255 6C Check Maintenance Records
10-37	Interview Note of China Airlines Manager of Structure Maintenance Section, Base Maintenance Department
10-38	Interview Note of China Airlines Manager of Aircraft Structure Section, Engineering Department
10-39	Interview Note of China Airlines Manager of Production Planning Section, Base Maintenance Department

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