TAMPERE UNIVERSITY
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IMPROVEMENT OF CORROSION CONTROL PROGRAM OF AN AIRLINER

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ABSTRACT

Tampereen ammattikorkeakoulu
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PENTTINEN, TIINA:
Improvement of Corrosion Control Program of an Airliner

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The purpose of this thesis was to improve the methods of reporting and information management in the corrosion control program of an airliner. The methods used to collect data and apply the information for analysis did not provide a sufficient way to monitor corrosion findings at Nordic Regional Airlines. The objective was to create general instructions for entering the data into the company's maintenance management system as well as to create an analysing tool for the information.

This study was carried out as a project. Interviews were made in the airline to investigate the main issues with the current program as well as to define desired results. As the outcome, step-by-step instructions were made for processing the data in the material management system. A report template was created and added to the system by using Structured Query Language programming. By using the template is was possible to gather the desired data, analyse it and save the document or print it.

To make a corrosion control program effective, appropriate instructions as well as an analysing tool for the data have to be implemented. The research indicates that the personnel needs to be aware of the importance of entering all the available data into the system. It also states that corrosion can be a hidden threat and neglecting it can have major impacts on safety and the operator's economy. The results of this project will help the personnel working in a maintenance organisation to monitor and analyse the data and thus improve the effectiveness of their corrosion control program.

Key words: corrosion control, data management, reporting, maintenance organisation

TIIVISTELMÄ

Tampereen ammattikorkeakoulu
Konetekniikan koulutusohjelma
Lentokonetekniikka

PENTTINEN, TIINA:
Improvement of Corrosion Control Program of an Airliner

Opinnäytetyö 39 sivua, joista liitteitä 4 sivua
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Opinnäytetyön tarkoituksena oli kehittää lentokonelaivaston korroosiohuolto-ohjelman raportointi- ja tiedonkäsittelymenetelmiä Nordic Regional Airlinesille. Tavoitteena oli luoda ohjeet korroosiolöydösten kirjaamiseksi huollonhallintajärjestelmään sekä tuottaa analysointityökalu tietojen tarkasteluun. Tarkoituksena oli luoda yleispätevät ohjeet, joita voidaan käyttää lentokonetyypistä tai -laivastosta riippumatta. Opinnäytetyö toteutettiin projektina. Teoreettisten lähtökohtien määrittelyyn käytettiin internetlähteitä, kirjallisuutta sekä virallisia säädöksiä ja määräyksiä. Asiantuntijahaastattelujen avulla selvitettiin nykyisen ohjelman tärkeimmät kehityskohteet sekä määritettiin halutut tulokset.

Korroosiolöydösten kirjaamiseksi järjestelmään laadittiin yksityiskohtaiset ohjeet sekä yleisohjeistus tiedon selailuun ja tarkasteluun. Analysointityökaluksi korroosiolöydöksille luotiin Structured Query Language -ohjelmoinnilla raporttipohja. Raporttipohjaa käyttämällä voitiin koota kaikki korroosiolöydökset halutuilla parametreilla ja analysoida tuloksia sekä seurata korroosiolöydösten kehittymistä tietyissä huoltotehtävissä.

Jotta korroosio-ohjelmasta saadaan tehokas, operaattorilla täytyy olla selkeät ohjeet ohjelman toteuttamiseen sekä työkalu tietojen seuraamiseen ja analysointiin. Tulokset osoittavat, että henkilöstön täytyy olla tietoinen informaation saatavuuden ja sen analysoinnin tärkeydestä. Opinnäytetyö havainnollistaa korroosion uhat turvallisuudelle sekä sen taloudelliset vaikutukset operaattorille. Kehitetty raportointitapa on luonteeltaan yleispätevä, ja sitä voidaan hyödyntää myös muiden konetyyppien huolto-ohjelmissa. Ohjelman tehokkuuden kannalta on tärkeä noudattaa laadittuja raportointiohjeita kokonaisvaltaisesti. Työn tulokset auttavat huolto-organisaation henkilöstöä seuraamaan ja analysoimaan saatavissa olevaa tietoa ja siten parantamaan korroosio-ohjelmansa tehokkuutta.

Asiasanat: korroosio-ohjelma, tiedonhallinta, raportointi, huolto-organisaatio

CONTENTS

ABBREVIATIONS AND TERMS

AD	Accidental Damage
AD	Airworthiness Directive
AMP	Aircraft Maintenance Program
CAM	Continuing Airworthiness Manager
CAMO	Continuing Airworthiness Management Organisation
CMMS	Computerized Maintenance Management System
CPCP	Corrosion Prevention and Control Program
EASA	European Aviation Safety Agency
ED	Environmental Deterioration
FC	Flight Cycle
FD	Fatigue Damage
FH	Flight Hour
ISC	Industry Steering Committee
JIC	Job Instruction Card
MPD	Maintenance Planning Document
MRB	Maintenance Review Board
MRBR	Maintenance Review Board Report
MRO	Maintenance and Repair Organisation
MSG-3	Maintenance Steering Group
MSI	Maintenance Significant Item
SSI	Structural Significant Item
SQL	Structured Query Language
WIS	Workorder Information System

1 INTRODUCTION

Aircraft Maintenance Programs (AMP's) in an airline are highly regulated by an aviation authority. Corrosion Prevention and Control Program (CPCP) is included in commercial airliner's AMP and it is monitored by a Continuing Airworthiness Management Organisation (CAMO). Corrosion is a natural phenomenon for materials used in aircraft structures and it can be prevented using proper sealants, drainage paths and corrosion prevention compounds. Corrosion causes deterioration of the material, which can cause a loss of mechanical strength and therefore lead to a structural failure. It can also have significant economic effects for the operator. Preventing corrosion as well as treating the damage can be costly, and it is important to find the perfect balance between these two expenditures.

Reporting and analysing the corrosion findings are mandatory in an airline, and without reporting the findings it is not possible to monitor them. Maintenance organisation in an airline must have an appropriate maintenance management system for entering and browsing the data. An analysing tool allows the personnel to view the desired information and it helps the organisation to present the data in reviews and meetings. Communication and collaboration between the operator, aircraft manufacturers and authorities make an AMP successful and effective.

The objective of this study is to improve the reporting and information management methods in corrosion control program of an airliner. The project is done for Nordic Regional Airlines (later Norra). Based on interviews done in the airline, an improved corrosion control program is done by creating instructions for reporting corrosion findings, as well as a report template for analysing the data. The thesis presents theory about corrosion and regulations that need to be followed by a maintenance organisation and CAMO. The theoretical section in the thesis is limited to commercial aviation and the rules and regulations discussed are viewed from European Aviation Safety Agency (EASA) standpoint. The results of the study are not dependent on a particular aircraft and can generally be used by the airline. Finally, discussion about the topic and conclusions are made.

2 CORROSION IN COMMERCIAL AVIATION

2.1 Aircraft corrosion

As aircraft get older, they get more vulnerable to corrosion. Different metals and aluminum alloys are highly used in the structures of most modern-day aircraft, and corrosion is a natural phenomenon for them. Corrosion can be controlled but it can not be stopped. When ignored, neglected or forgotten it can threaten the integrity of aircraft structure, thereby causing major safety risks during operation. In 1988, Aloha Airlines' Boeing 737 suffered significant damage during flight in 24 000 feet as a result of metal fatigue (picture 1). The fatigue cracks around the rivets of the front section of the fuselage were caused by corrosion that resulted from operating in intense maritime climate in Hawaii, and it caused a major portion of the upper skin of the fuselage to be torn away (Aerotime 2017). Since this incident, the authorities and aviation experts started to focus more on the effects of corrosion and tried to create reliable models, algorithms and analysis for predicting corrosion on aging aircraft (Benavides 2016, 2–3).

PICTURE 1. The damage on Aloha Airlines' Boeing 737 (Aerotime 2017)

There are numerous factors that affect corrosion. Aspects like environment, maintenance procedures, proper cleaning, and training of the personnel are just a few examples that effect the phenomenon. Also, variables like humidity, pollutants and protection have an impact on aircraft corrosion. (Benavides 2009, 2.) Protecting can be done by using sealants, ensuring appropriate drainage paths in the structure and applying corrosion prevention compounds. There is a large variety of corrosion prevention compounds. Some compounds act by spreading through the structure and cracks, eliminating any existing moisture and leaving behind a residue to act as a protection for corrosion. Other compounds dry out to a waxy film and provide a coating to corrosive environments. (Corrosion Doctors n.d.) However, the best assurance against corrosion-related problems is achieved by taking corrosion into account when selecting materials early in design phase. Effective maintenance procedures done by qualified personnel are equally important. By including an effective corrosion prevention program into the aircraft's maintenance program as well as maintaining a dynamic and ongoing monitoring process, the operator may extend the lifespan of its fleet by many years. (NACE n.d.)

2.2 Structural effects of corrosion

There are several types of corrosion and they can be divided into many categories. The most common types are uniform surface attack, pitting and intergranular corrosion. Uniform surface attack, also known as general attack, is the most general type of corrosion and it is caused by a chemical reaction that results from exposing the metal to oxygen in the air. It can happen after poor pre-paint preparation or by exposing the structure to high humidity or pollutants. Since it is the most common type of corrosion, it can be relatively easily predicted and treated. Proper painting, cleaning, drainage and application of corrosion preventive compounds are effective ways of preventing the structure from corrosion. (AOPA n.d.)

Pitting is a type of corrosion where numerous isolated pits are formed in the aircraft structure. This kind of corrosion is usually more difficult to detect, as the pits are usually small and may be hidden under the protective coatings (The Balance 2017). It is a dangerous formation, because these pits provide an ideal situation for cracks formation and growth in the structure. Most metals used in today's aerospace industry, like aluminums and high-strength steels, are vulnerable to pitting, especially if the protective coatings fail. For example, cadmium coating is often used when protecting high-strength steels. If the coating were not there, the structure would most likely go under a general attack. But, when using a coating, any fracture in the coating can lead to pitting. This can be even more dangerous for the structure than a uniform surface attack. (Mills, Prost-Domasky, Honeycutt & Brooks 2009, 39–40.)

Less common, but particularly harmful type of corrosion is intergranular corrosion (picture 2). It is usually found in high strength aluminium alloys that are used in structures like wing spars and other high-strength aircraft parts. Heat treatments are used to increase the ultimate tensile and strength of these alloys, but it makes them more susceptible to corrosion. Heat treatments create galvanic couples in the grain bodies and it causes the alloy to be shaped irregularly in the structure. This creates an ideal environment for intergranular corrosion, and it may exist without visible evidence in the surface. Intergranular corrosion may also develop into more severe state – exfoliation. In this state the delamination of the grain boundaries causes the surface of the metal to flake. It is usually too late to save the structure when the intergranular corrosion has reached its exfoliating state. (DVI Aviation n.d.)

PICTURE 2. Intergranular corrosion (DVI Aviation n.d)

Different types of corrosion have different ways of forming and spreading in the aircraft structure, but they all have the same effect on it; they make the structure weaker by affecting the load carrying capabilities of it. Corrosion causes less material in the structure to carry more loads by reducing the cross-sectional area of the structure. It also provides a site for cracks. This is particularly dangerous when multiple small cracks create a long crack. Also, continued repairing and removing of corroded material will eventually make the structure too thin and the structure will need to be replaced. (Benavides 2009, 3–4.)

2.3 Economic effects of corrosion

In addition to safety, corrosion also has negative impacts in financial costs. There are many sources of corrosion costs, so it is sometimes difficult to characterize them. For example, maintenance hours, parts and materials usage, training, and research are typical corrosion cost elements. The downtime of an aircraft caused by corrosion can also be costly for the operator. It is important to monitor and analyse costs, because operators can use the information to choose the appropriate level of resources and evaluate the effect of chosen solutions on overall cost. However, not all costs are directly useful for business decisions. Only costs that are attributable to a specific source of corrosion should be considered as a higher priority to acquire. Although training, research and development are essential elements in corrosion control, their costs are not directly varying according to changes in corrosion conditions. (Herzberg 2009, 18–20.)

According to Herzberg (2009) corrosion costs can be characterized into two categories; corrective costs and preventive costs. Corrective costs are incurred when an existing problem is being fixed. For example, maintenance hours and materials spent repairing a corrosion damage, or hours spent on planning for the maintenance procedures, are considered as corrective costs. Preventive costs are incurred when preparing for a future problem or when removing the cause of a potential problem. For example, hours and materials used inspecting, cleaning or applying corrosion preventive coatings are classified as preventive costs. From a business point of view, it is important to distinguish the ratio between corrective and preventive costs. It is usually more expensive to fix an existing problem than it is to prevent it, but it is also possible to overestimate the potential threat and therefore overspend preventing it. Finding the perfect balance between corrective and preventive costs helps operators to minimize the overall costs of corrosion prevention. (Herzberg 2009, 21–23.)

3 FORMATION OF CORROSION PREVENTIVE AND CONTROL PROGRAM

3.1 Background

Because of issues of corrosion discussed in previous chapter, an operator must run a Corrosion Prevention and Control Program. CPCP is developed based on several documents, regulations and authorities' requirements. It is a program created in collaboration of different organisations, working groups and authorities after years of monitoring and analysing the effects of corrosion. The documents and programs needed for formation of CPCP are discussed in the following chapters.

3.2 Maintenance Steering Group

Maintenance Steering Group (MSG-3) was first developed by Boeing Company in the 1960's. The first version, MSG-1, was used for developing scheduled maintenance for Boeing 747. Improvements were made to the program in later version of MSG-2 and in 1980 the original version of MSG-3 was published. MSG-3 is a methodology used for acknowledging scheduled maintenance tasks and intervals, as well as recognising the reliability of aircraft components and systems, and avoiding unnecessary maintenance. It is a widely used approach for developing preliminary maintenance requirements for commercial aircraft, which will be acceptable to the authorities, the operators and the manufacturers. The principle of MSG-3 is to provide a holistic approach for more effective, task-oriented maintenance program, as well as to reduce human errors in maintenance procedures by decreasing unnecessary maintenance tasks. The present version of MSG-3 also focuses more on sustaining a reliable, more efficient maintenance by requiring a component or a system to be inspected periodically to maintain the reliability and functionality of a component, rather than having specified maximum allowable age limits for components and therefore having the operator replace the component regardless to the condition of it. (Skybrary 2017a.)

In practise, MSG-3 consists of two sections; "Systems & Powerplant" and "Aircraft Structures". In Systems & Powerplant Section the first task is to identify Maintenance Significant Items (MSI's). A table is made for each MSI, and their function, possible failure modes, consequences of failures, and cause of failures are listed. Then, MSG-3 logic is used to determine the effects of failure in safety, aircraft availability and financial cost. Based on this analysis, an appropriate maintenance task is determined. The most simple task is selected from the following tasks: servicing, visual check, functional check, restoration or discard. Finally, the selected task is added in the aircraft's maintenance program. Respectively, in Aircraft Structures Section the first task is identifying the Structural Significant Items (SSI's). Then, the structure's susceptibility to failure is defined analysing potential Accidental Damages (AD), Environmental Deterioration (ED) and Fatigue Damages (FD). This is where corrosion damages are taken into consideration. Finally, the probability of identifying a fault is analysed and the appropriate maintenance procedures and intervals for the structure are determined (figure 1). (Halinen 2017.)

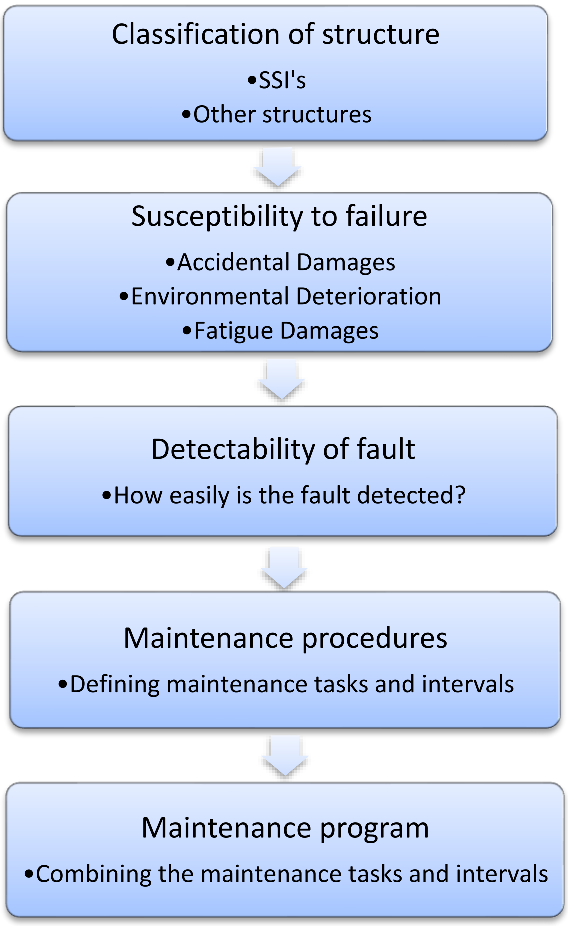


FIGURE 1. Formation of Aircraft Structures Section in MSG-3 (Halinen 2017, modified)

3.3 Maintenance Review Board Report

Maintenance Review Board Report (MRBR) contains the minimum maintenance requirements for an individual aircraft type. MRBR is processed using MSG-3 as a tool and it is produced in cooperation with the aircraft manufacturer, operators and authorities. The Industry Steering Committee (ISC) designates specific Working Groups and based on the analysis and review development made by the Groups, a proposal for MRBR is made to the Maintenance Review Board (MRB). The final report is issued by the MRB and it is accepted by an aviation authority, such as EASA. (Skybrary 2017a.)

The report contains requirements for maintenance and inspection tasks for the airframe, engines, systems and components of the aircraft. The maintenance and inspection intervals are provided in flight hours, flight cycles or calendar time. However, it needs to be considered that a MRBR issued for an aircraft for commercial operations is not applicable for an aircraft used in cargo or corporate operations. For cargo operations, corporate or other low utilization purposes it is necessary to discuss additional procedures. MRBR is intended to contain all the recent and most efficient requirements and it is being updated regularly. (Embraer 2017a.)

3.4 Maintenance Planning Document

Aircraft manufacturers provide a Maintenance Planning Document (MPD) for the operators to provide information about the maintenance requirements. It contains all the requirements included in MRBR together with all additional maintenance tasks recommended by the manufacturer (Aeracle 2017). While MRBR is the document that includes all the regulations that are required for the aircraft to remain airworthy, the MPD includes recommendations and additional information for planning and preparation of the maintenance tasks. It specifies the maintenance actions such as tools, equipment and man hours used, as well as required skills and the time intervals for maintenance. It is updated regularly to reflect the in-service experience of the operators, modifications resulting from Airworthiness Directives (AD’s), as well as developments in technical status of the aircraft. (ATR 2017a.)

MPD is divided into several sections and programs. Corrosion-related tasks are usually found in Zonal Program and in Structure Program. Zonal Program gathers all the general visual inspection tasks necessary to check each aircraft section, defined as zones, both inside and outside the aircraft. General visual inspection does not require any special tools. However, it might require removal of access panels, lifting of insulation blankets or moving of flight controls to gain access to hidden parts. The zonal program's inspections must check for damages, cracks, leaks and corrosion in the structure, as well as proper attachment of all components and installations. More specific corrosion tasks are defined in Structure Program of the MPD. It defines all the scheduled inspections related to the aircraft structure and its tasks result from MSG-3 analysis performed for fatigue damages, environmental deterioration and accidental damages. The inspection levels vary from general visual inspection, identical to one in Zonal Program, to special detailed inspection, which requires special techniques to inspect hidden parts of the structure. Tasks belonging to the Corrosion Prevention and Control Program in MPD are referred as "CPCP" in the task table (picture 3). (ATR 2017a.)

TASK REFERENCE (Source Document)	ZONE	DESCRIPTION	THRESHOLD INTERVAL SAMPLE	JOB PROCEDURE	M	M.H	EFFECTIVITY
522106-DVI-10000-1 (CPCP) (MRBR : 522106-1)	837 845	PASSENGER COMPT EMERGENCY EXIT DETAILED VISUAL INSPECTION FOR CORROSION DETECTION ON INTERNAL STRUCTURE OF PASSENGER COMPARTMENT TYPE III EMERGENCY EXIT Acc :837AZ,845AZ.	T: 8 YE I: 8 YE	JIC: 522100-DVI-10015	1 0 a	0,20 0,00 0,10	POST 0877
522107-DVI-10000-1 (AWL : 522107-1) (MRBR : 522107-1)	837 845	PASSENGER COMPT EMERGENCY EXIT DETAILED VISUAL INSPECTION FOR CRACK DETECTION ON STOP AND SPIGOT FITTINGS OF PASSENGER COMPARTMENT TYPE III EMERGENCY EXIT Acc :837,845.	T: 36000 FL I: 18000 FL S: 20% Tc:70000 FL	JIC: 522100-DVI-10020	1 0 a	0,20 0,00 0,04	POST 0877
522107-DVI-10010-1 (MRBR : 522107-2)	837 845	PASSENGER COMPT EMERGENCY EXIT DETAILED VISUAL INSPECTION FOR CORROSION DETECTION ON STOP AND SPIGOT FITTINGS OF PASSENGER COMPARTMENT TYPE III EMERGENCY EXIT Acc :837,845.	T: 8 YE I: 8 YE	JIC: 522100-DVI-10020	1 0 a	0,20 0,00 0,04	POST 0877
522108-DVI-10000-1 (AWL : 522108-1) (MRBR : 522108-1)	837 845	PASSENGER COMPT EMERGENCY EXIT DETAILED VISUAL INSPECTION FOR CRACK DETECTION ON SPIGOT AND STOP BACK UP ***CONTINUED***	T: 36000 FL I: 18000 FL S: 20% Tc:70000 FL	JIC: 522100-DVI-10030	1 0	0,20 0,00	POST 0877

STRUCTURE PROGRAM : EMERGENCY EXITS   ISSUE : Oct 23/17   SECTION : 11-52/2   PAGE : 3

PICTURE 3. Example of a task table (ATR 2017a)

3.5 Aircraft Maintenance Program

Aircraft Maintenance Program (AMP) identifies the operators scheduled maintenance tasks required for the aircraft to ensure its continuing airworthiness. Creating an AMP is in the responsibility of the operator and it is based on MRBR and MPD. It meets the requirements of authorities and it is being updated continuously. The requirements in MRBR and MPD become the basis for each operator for developing their own AMP, and based on the experience gained by the operator, additional adjustments may be made to maintain efficient maintenance procedures. (Skybrary 2017c.)

The AMP contains a list of aircraft specific maintenance tasks with time intervals given in units of Flight Hours (FH), Flight Cycles (FC) or Calendar Time. For a typical commercial aircraft, the AMP consists of hundreds of tasks and it is usually divided into some major sections. For example, it includes requirements and information about structural inspections, corrosion control, engine maintenance and pre-flight maintenance tasks. It also specifies the criteria by which a specific task needs to be accomplished as well as guidelines for thresholds on tasks. A typical content of a maintenance task table consists of AMP task and zone numbers, time intervals, references and task descriptions. (Airlinebasics 2017.)

In order to maintain an effective AMP, an operator must run and maintain several programs included in it, such as the CPCP. It must also run a Reliability Program in which the operator monitors maintenance data like the item removal rate and failure data to define the reliability of its AMP. By monitoring and analysing the data the operator will improve the AMP based on its own experience. (Airlinebasics 2017.)

3.6 Corrosion Prevention and Control Program

The goal of CPCP is to maintain an acceptable level of corrosion by defining the tasks, inspections and repair procedures needed to achieve this goal. An average susceptibility to corrosion is considered in the baseline CPCP, but it is the ultimate responsibility of the operator to adapt its own CPCP to the environment it is operating in. The program is expected to maintain the aircrafts resistance to environmental deterioration, as well as to keep control of the corrosion to level 1 or lower on all aircraft structures where corrosion is expected to be found. Structures that are considered particularly prone to corrosion are, for example, areas behind or below galleys and lavatories, where spilled food and waste may pile up if the area is not cleaned properly. Doors, landing gear and bilge area are also structures proved to be highly susceptible to corrosion. (Embraer 2017b.)

The effectiveness of corrosion control program depends on the level of corrosion found on scheduled inspection. The operator is obligated to report the manufacturer and aviation authorities for any corrosion findings that are level 2 or higher. If corrosion is found continuously in the same part of the structure, changes to the operator's CPCP needs to be made, as well as the actions taken to inform the authorities. The changes to the CPCP may include reduction of the inspection interval, considering a higher inspection level, applying multiple layers of corrosion prevention compound, or modifications to drainage paths. (ATR 2017a.) CPCP is constantly renewed, as the research and development work in corrosion control is a continuing process and as the operators learn and gain experience.

Corrosion damages are categorized to different levels, and they are usually defined in the MRBR. However, different manufacturers may have different definitions for the levels. Depending on the MRBR, the corrosion level definition is usually following:

- Level 1: Corrosion that occurs between successive inspections that does not require structural reinforcement or replacement and can be blended out within allowable limits,
  or
  Corrosion damage that exceeds allowable limits and could require reinforcement or replacement of structure, but can be considered to be caused by an event not typical for operator and is not critical airworthiness concern,
  or
  Operator has detected only light corrosion occurring between each successive inspection, but the latest inspection and blend-out treatment now exceed the allowable limits and the structure could require reinforcement or replacement.
- Level 2: Corrosion occurring between successive inspections and requires a blend-out which exceeds the allowable limits and requires reinforcement or replacement of structure, but is not an urgent airworthiness concern.
- Level 3: Corrosion found during first or later inspection which is considered to be an urgent airworthiness concern requiring immediate actions. (ATR 2017b.)

4 AIRCRAFT CONTINUING AIRWORTHINESS AND MAINTENANCE

4.1 Part M

EASA monitors the European Commission set regulations for all operation in commercial aviation in Europe. EASA Part M is a regulation that includes requirements for continuing airworthiness of aircraft and aircraft parts together with specifications of qualified personnel and organisations involved in such airworthiness management. Complying those requirements is mandatory for all EASA approved commercial air transport organisations. (Sofemaonline 2016.) Part M is divided into several subparts in which detailed information and technical requirements for continuing airworthiness, maintenance standards, accountability and aircraft release to service is found (European Commission Regulation No 1321/2014 2017).

CAMO is an EASA approved organisation responsible for the continuing airworthiness of an aircraft. Different authorities have different definition for term "continuing airworthiness", but the general meaning of it can be explained in terms of controlling and ensuring that, in any time in its life, an aircraft meets its technical requirements that has been set and is in condition for safe operation. The requirements and regulations for CAMO are set in Part M Subpart G. The requirements for running a CPCP are included in these regulations. It is in the responsibility of CAMO to manage and monitor the CPCP. The requirements are met by ensuring that all maintenance is carried out according to the CPCP and the corrosion damages found during maintenance are reported and repaired appropriately. CAMO also manages the approval of those repairs and modifications and ensures that Airworthiness Directives (AD's) and the operational directives set by authorities are applied. It also ensures a proper filing of the maintenance logs and airworthiness records and makes sure that the status of the aircraft corresponds to the logs. (Skybrary 2017b.)

4.2 Part 145

EASA Part 145 is another part of continuing airworthiness regulations and it contains the requirements for Maintenance and Repair Organisations (MRO's). Maintenance organisations to be certified include all the organisations behind maintaining aircraft components, structures and engines. Part 145 sets the standards and procedures for qualifying as a repair station and for providing appropriate maintenance in order to provide an acceptable level of safety. (Airlinebasics 2016.) For example, it contains requirements for facilities, personnel and maintenance data reporting as well as production planning and occurrence reporting (European Commission Regulation No 1321/2014 2017).

Maintenance organisation with EASA Part 145 approval is an EASA certified maintenance station worldwide. The approval is very specific, as it presents precisely which components or parts the maintenance organisation is allowed to service as well as the scope of the validity. For example, some organisations are qualified to perform base maintenance on all the aircraft in the same product family, while others are approved to service only hydraulic actuators of a given part number. (Airlinebasics 2016.)

Part 145 organisations are performing line maintenance and base maintenance. Line maintenance includes frequently performed checks and defect repairs, but which do not require extensive repair work and/or disassembling of aircraft structures. Tasks including in CPCP are included in base maintenance. Base maintenance is considered as heavier, less frequently performed maintenance for the aircraft, and one maintenance package in base maintenance includes more tasks than in line maintenance. (Airlinebasics 2016.) There are hundreds of different CPCP tasks in base maintenance, performed in such structures where corrosion is most likely to be found.

Because Part 145 organisations are usually independent from Part M organisations, a liaison with Part M organisation should be carried out accordingly (European Commission Regulation No 1321/2014 2017). The maintenance process of an aircraft is a continuing process and it requires cooperation between different organisations and companies. The organisations in aircraft maintenance process and the output of such organisations is shown in figure 2.

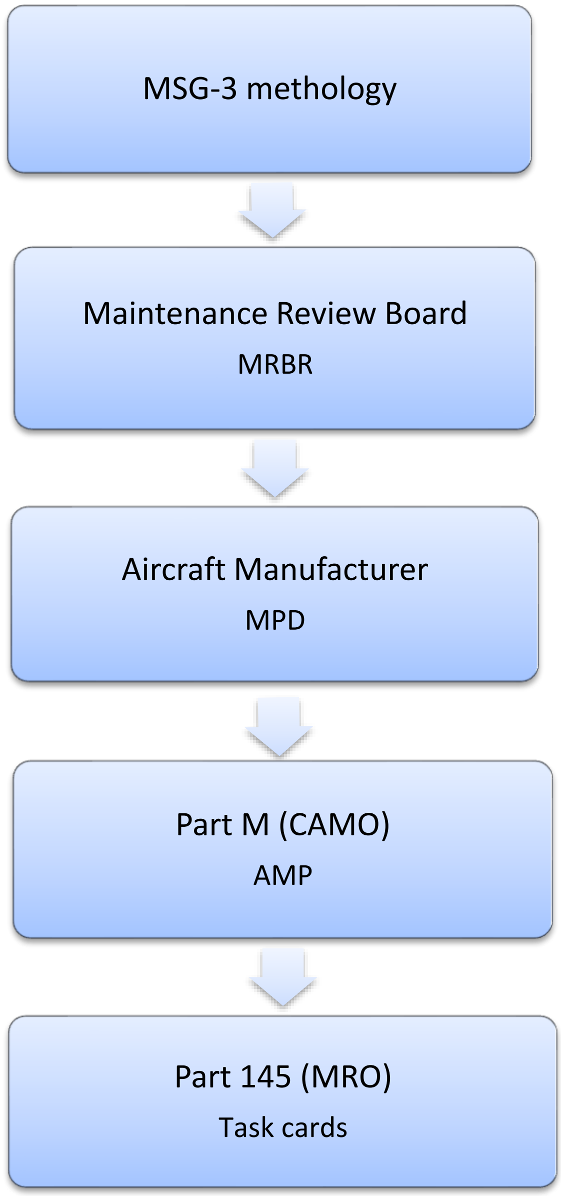


FIGURE 2. Process of aircraft maintenance

5 CASE STUDY

5.1 Research background

The research for this project was done by interviewing people at Norra, as well as self-studying the topic from the internet and official maintenance documents. The interviewed people were the company’s Continuing Airworthiness Manager (CAM) and Fleet Managers. It was understood that these people have the most accurate view and knowledge of the program, as well as the issues about it. The interviews took place between 6.3.2018 – 15.3.2018. The theory about the topic was studied using internet, books and the company’s maintenance documents, such as MRBR’s, MPD’s and AMP’s. Also, an access to a test version of company’s maintenance management system was given to thesis writer for research purposes. The test version of the system contains all the same data and programs as the live version.

5.2 Nordic Regional Airlines

Nordic Regional Airlines (Norra) is a Finnish airline with its hub located in Helsinki-Vantaa Airport. It was founded in 1993 as Finnish Commuter Airlines and afterwards it has also served as Flybe Finland. Currently the company has approximately 600 employees in Finland. There are currently 24 aircraft in their fleet, 12 of which are ATR-72 turboprops (picture 4) in Norra livery, suitable for short distances, as well as 12 Embraer E190 jets in Finnair livery, suited for European transportation. Norra’s core mission is to provide flight operations for other airlines, and it is currently operating a large part of Finnair’s domestic and European flights. (Norra n.d.) The functions of maintenance organisation is currently divided between Norra and Finnair. Part M organisation is mainly managed by Norra (i.e. CAMO), but Norra has also subcontracted some CAMO functions from Finnair. Finnair is a contracted Part 145 organisation for Norra, therefore the maintenance of Norra’s fleet is done by Finnair’s Part 145 organisation. However, some maintenance (e.g. base maintenance) is contracted from other Part 145 organisations. (Continuing Airworthiness Manager 2018; ATR Fleet Manager 2018; Embraer Fleet Manager 2018.)

PICTURE 4. ATR-72 in Norra livery (Norra n.d.)

5.3 Finnair

Finnair is the largest airline in Finland and it is based in Helsinki-Vantaa Airport. It was founded in 1923 as Aero O/Y. Currently it has approximately 6 000 employees and its revenue in 2017 was 2,6 billion euros (Finnair 2018a). Finnair is operating passengers and cargo mainly in Europe, but they also have several destinations in Asia and in the United States. Including Norra's fleet, there are currently 74 aircraft in Finnair's fleet. Most of the fleet consists of Airbus' A320 family narrow-body aircraft, while the rest are wide-body A330's and A350's. Finnair was the first airline in Europe to purchase A350-900 XWB aircraft and it is currently the largest aircraft in its fleet. (Finnair 2018b.)

5.4 Maintenance Management System

In order to manage all the data and information of maintenance organisation, a (Computerized) Maintenance Management System (CMMS) is needed. Norra and Finnair are using AMOS, a Swiss AviationSoftware owned aircraft maintenance and engineering system. It is a complex software package that manages the engineering, maintenance and logistic functions of an airline. AMOS consists of multiple modules, such as Material Management, Maintenance & Engineering, Maintenance Planning, Production, and Reporting. All the data and details related to each aircraft and their maintenance programs is managed and analysed using AMOS. An overview of a typical CMMS is seen in figure 3. (AMOS n.d.)

One of the most important tools in AMOS is Workorder Information System (WIS). It contains all workorders, including CPCP findings, existing in the system. Workorders play a central role in AMOS and they can be searched by using filters. The user can search workorders over a specific time slot (e.g. weeks, months, years), or by a specific aircraft registration number, part number, ATA number, description text or headline. Results can also be filtered for example by open/closed workorders, scheduled/unscheduled workorders, type of workorder (raised by pilots, cabin crew or maintenance staff), or using some of various customized search filters. A workorder can be a scheduled task done in a routine maintenance, or it can be a fixing procedure for a detected defect, such as corrosion damage. (AMOS n.d.)

When a specific workorder with a defect (e.g. a dent) is opened, the defect is then entered into Structural Damage module. Structural Damage module is used to present data and show an overview of all damages, dents and cracks on an aircraft. Structural Damage usually contains drawings of each aircraft from both sides of the fuselage, as well as wings, horizontal stabilizers and engine nacelles. In AMOS, these drawings are referred as “Dent & Buckle Charts”. Every damage on a chart has a reference to the specific workorder it was detected in. Each chart is also printed and kept inside the cockpit, so the pilots are aware of all the damages visible on the aircraft they are flying. (AMOS n.d.)

FIGURE 3. Structure of Maintenance Management System (AMOS n.d.)

5.5 Current implementation of CPCP

In practice, the implementation of CPCP starts in maintenance planning, where all tasks, including CPCP tasks in AMP, are scheduled. In AMOS, planning uses Maintenance Forecast, where a forecast of tasks together with their thresholds and intervals are found. The individual tasks collected together create Workpackages that are categorized as Line maintenance or Base maintenance. Line maintenance Workpackages are respectively categorized to daily, weekly, monthly etc. maintenance packages, while CPCP tasks are usually included in Base maintenance Workpackages. The planners create individual Workpackages for each aircraft, and each Workpackage includes tasks scheduled for the same time interval. (Continuing Airworthiness Manager et al. 2018.)

The finished Workpackages include Workorders. They can be classified as Scheduled workorders, issued by the planning department, or Maintenance workorders, issued by the technical staff, pilots or cabin staff. In other words, Workorders are usually issued regarding scheduled checks and maintenance tasks, or defects and failures detected on aircraft. (AMOS n.d.)

A Task card is printed from AMOS and given to a mechanic. A Task card includes descriptions of tasks together with instructions for procedures and reference to manufacturer's Job Instruction Card (JIC). JIC includes manufacturer-recommended instructions for every phase of the performed task, as well as a separate document for reporting a corrosion finding to the manufacturer (appendix 1). A mechanic performs the maintenance tasks in accordance to instructions and if no corrosion is found, the Task card is signed and archived. (Continuing Airworthiness Manager et al. 2018.)

If corrosion is found, it is the responsibility of the mechanic to report it. The base line instruction for reporting corrosion is to create a Finding Workorder in AMOS (picture 5) with a reference to the specific task number. The mechanic also needs to add a reference of a finding to the Task card and fill out the corrosion finding reporting form included in JIC. If the corrosion level is 2 or higher, the documents are taken to the Fleet Managers, who will report the finding to the manufacturer. The mechanic will then repair the corrosion damage according to repair instructions. (Continuing Airworthiness Manager et al. 2018.)

	Finnair Technical Operations Finland	W/O 3003451 Original 1	Barcode WO3003451	Registration OH-ATE AT72FC

Type	Origin	ATA	Position	Zone	Area
M MAINT	N/A	57-00 WINGS	N/A	N/A	N/A

Workpackage

Workpackage No. / Sequence No.	Planning-Date Start - Planned-Date End	Maintenance Provider
ATE/H-17 2Y, 1C,	13.Jan.17, 15:00 - 03.Mar.17, 15:00 Flight-No.	

Description Step 1

SHEET/WINGS: CORROSION ON HOUSING SURFACE OF PANEL 521DT AND 522CT

REFERENCES TO SKYWAYS TECHNICS (DK.145.0105) DOCUMENTS:
WORKPACKAGE: ST-FIN-NRA-02
CUWO: 6165, ITEM: 3
DEFECT: 137463

Action Step 1-1

HOUSING SURFACE CORROSION REMOVED IAW. SRM 571412-300-801-A01 REV 97 AFTER CORROSION REMOVAL HOUSING SURFACE AT PANEL 622CT IS FOUND OUT OF ALLOWABLE LIMIT ATR TO BE CONTACTED FOR REPAIR INSTRUCTION. SEE MEA SUREMENTS IN AIRCRAFTNOTES. EDDY CURRENT INSPECTION PERFORMED IAW. NDTM 51-60-00 REV 38 AT PANEL 5 22CT AND 521DT NO FINDINGS. 521DT AND 522CT REPAIRED IAW. SRM 571412-300-801-A01 REV.97.

Work Performed Workorder Closed

Date	Total Aircraft Hours	Total Aircraft Cycles	Place / Station	Closing Sign / Stamp (approval DK.145.0105
03.Mar.2017 12:00	18464	24750	SGD	(SKYWAYS)

Commercial Information

Customer:
Project Number: ATE

PICTURE 5. A screenshot of a Workorder (AMOS n.d.)

5.6 Challenges in current CPCP

The main issue in current CPCP is the lack of searching and analysing tool for corrosion findings. In current state, data of the findings is mainly documented on paper and archived. The data is getting lost in archived documents and in Workorders in AMOS. This way of managing data does not provide a sufficient way to monitor and analyse the information. It is wished that the findings could be entered into the maintenance management system as a separate data and that it could be analysed as an individual information. (Continuing Airworthiness Manager et al. 2018.) An analysing tool for information helps maintenance organisation to present data of the findings in meetings and reviews, and it also provides a practical way to monitor the information.

Current instructions do not require marking corrosion findings to Structural Damage module. However, some employees use this method, but it is not a widely recognized procedure. While it is possible to generate reports about damages in a specific aircraft by using the reporting tool in Structural Damages module, the report does not present all the data relevant to corrosion findings. Also, without filtering the search results first, it is not possible to exclude other damages and consequently get a report that includes only corrosion findings. AMOS also has KPI Analyzer tool that is used to analyse and present data, but it is not possible to input data about structural damages in the module. (Continuing Airworthiness Manager et al. 2018.)

Lastly, even though mechanics fill out the manufacturer’s corrosion findings form included in JIC, it is noticed that there is uncertainty in defining the corrosion levels and often the level definition is left undefined (Continuing Airworthiness Manager et al. 2018). Neglecting this information can be considered as a contributing factor to problems with reporting corrosion findings, and the appropriate instructions, training and attitude of the staff to corrosion findings comes highly essential.

6 CORROSION CONTROL PROGRAM FOR AN AIRLINER

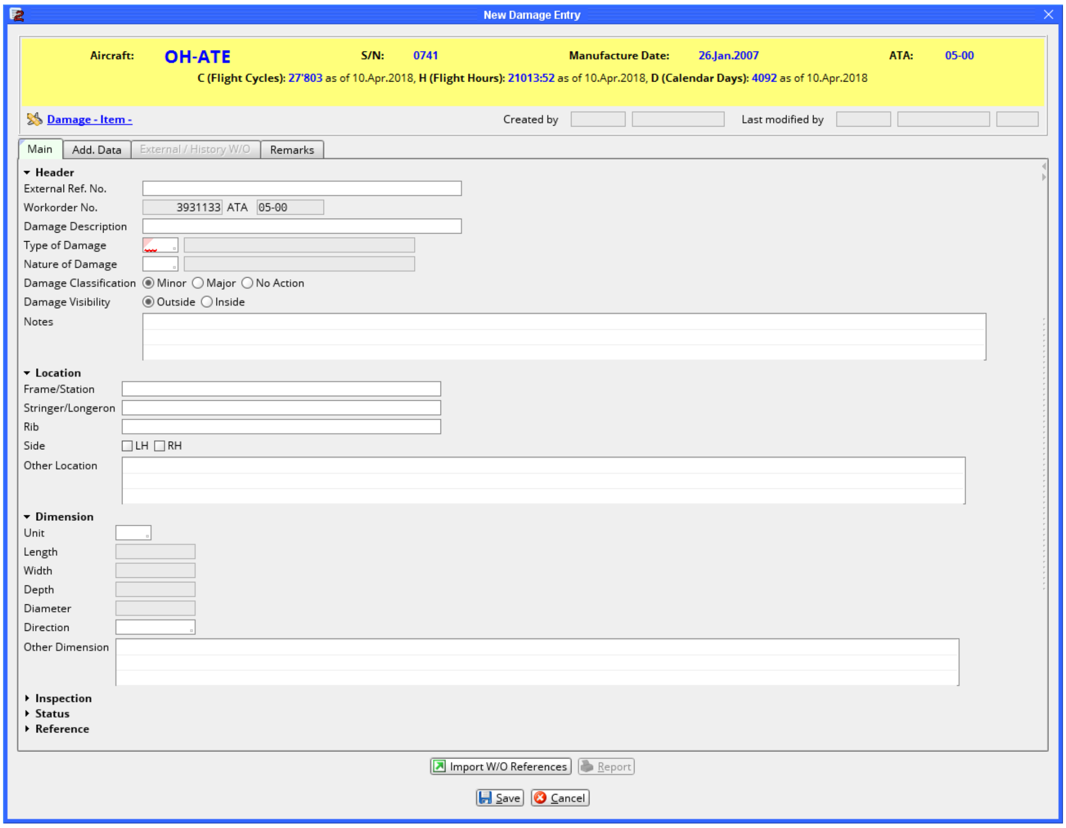
6.1 Purpose of the outcome

In this chapter the instructions for managing the data in the maintenance management system are discussed. The instructions are made for AMOS software and they can be used regardless of the aircraft type. The instructions are made considering the key issues with reporting and data management at Norra. As the outcome, creating clear instructions for entering the data into the system were considered fundamental. Following the instructions also allows the information to be analysed. A report template as an analysing tool is introduced in the end of this chapter.

6.2 Entering the data to the system

After Finding Workorder for repairing a corrosion damage is issued, the Workorder is found in WIS. When Workorder is opened to a new window, additional data can be entered. Under “Related Data” headline, a “Structural” link opens a new window and a New damage can be created into Structural Damage module (picture 6). All available information about the corrosion damage is added to the system from this window. Data fields and descriptions in the main tab are described in appendix 2.

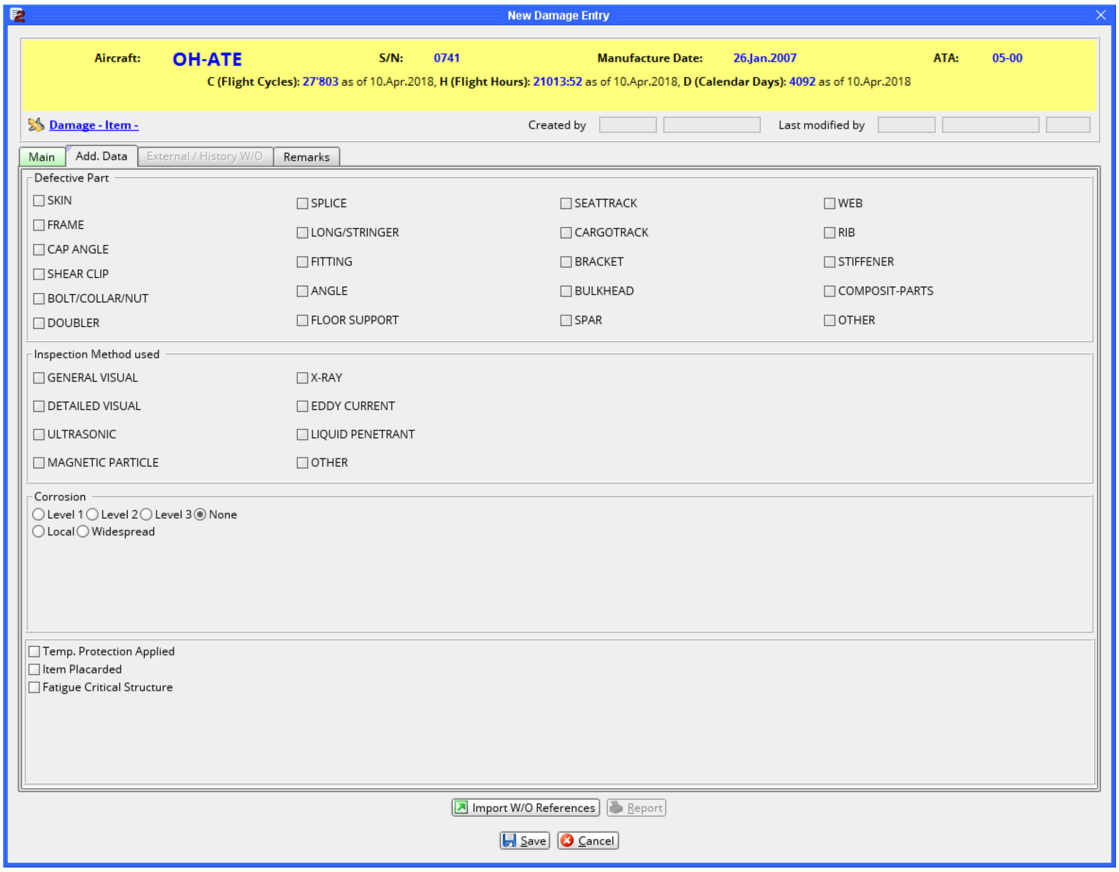
It is crucial to fill out all the fields in Header section. Damage description should be as descriptive and accurate as possible, yet it should be kept short. For type of damage, as well as nature of damage, “COR1” for corrosion is selected from the drop-down menu. Type of damage is mandatory information and without selecting it, it is not possible to save the New damage. Damage classification is selected according to the level of corrosion, as well as the actions taken to repair the damage. The visibility of the damage is also important to specify, as corrosion can be found both outside and inside of the aircraft. If there are any relevant notifications, (e.g. corroded part has been replaced, delays in part deliveries etc.), they should be marked to Notes.



PICTURE 6. New Damage main tab (AMOS n.d.)

Details of the location of the damage is entered to Location section. The location is entered either according to the aircraft frame or station (e.g. between frame 10 & 14), stringer or longeron (e.g. below lap joint F), or rib of the wing (e.g. rib 5). Location according to the side of the aircraft is chosen from LH (left hand) or RH (right hand) boxes. Description of any other location than those above is entered to Other location. Dimensions of the damage, as well as inspection details (i.e. damage limits and repetitive inspection dates) are filled to subsequent sections. In the next section, choosing the status of the damage is mandatory. Status is chosen from given options, such as Allowable, Finally repaired, Deleted or Superseded. If the corroded part needs to be replaced, it is important to make sure to change the status of the damage to “Deleted”, so the damage no longer appears in the list nor in the chart. In order to make the status more descriptive (e.g. Damaged part replaced), it is necessary to change the data table in the system options. Finally, references and links can be added to the damage. It is necessary to make sure that all references, including JIC with corrosion level definitions and corrosion finding reporting form, as well as a picture of the finding, have been added.

Following information is added to the second tab of the window (picture 7). In the first section, to choose the defective part where corrosion has been found, the part is selected from multiple check box options (e.g. frame, bracket, cargo track, fitting, other etc.). In the next section, the inspection method used is selected from the available options (for corrosion findings; general visual or detailed visual). It is necessary to define the level of corrosion, as well as the extent of the damage in the next section. The corrosion level is chosen from 1, 2, and 3 and the extend is either local or widespread. If at any point additional remarks have to be added, it is done in Remarks tab. It is important to add date and personal signature of the user after a remark. After defining all the available data, the New damage is saved, and it can be browsed in Structural Damage module. All the information described above can be considered as relevant information and defining all the data makes monitoring it possible. In addition, it needs to be considered that certain data tables (e.g. Nature of Damage) need to be extended in the system by the admin.

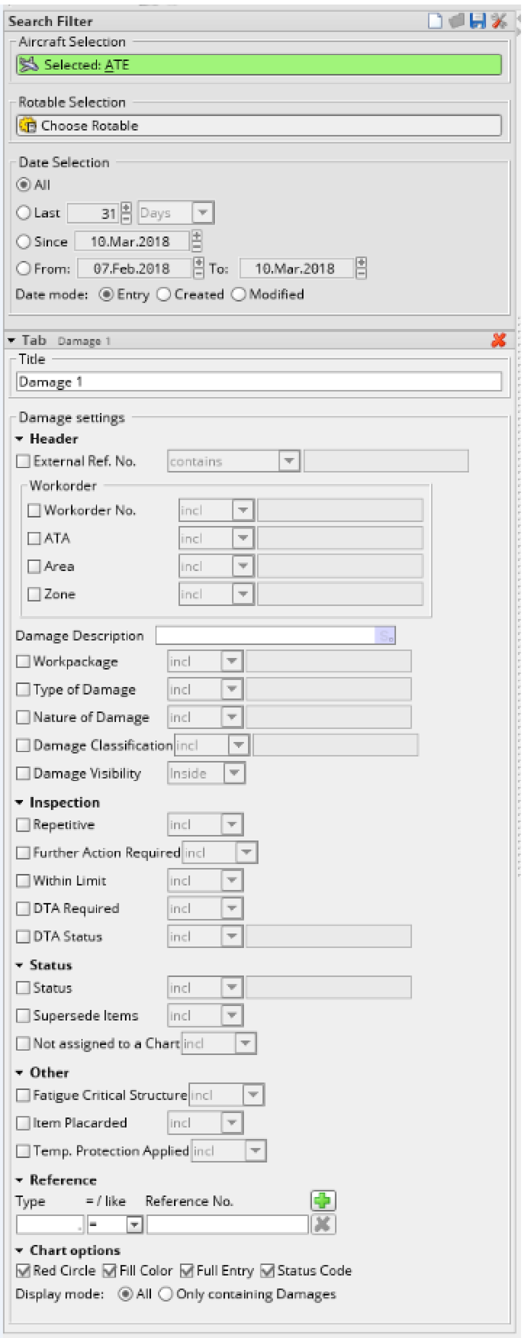


PICTURE 7. New Damage additional data tab (AMOS n.d.)

Saving the Damage does not create a mark in the Dent & Buckle chart on default. Damages that are not positioned in the chart are marked in yellow in the table. If it is wished to add a mark of the damage on the chart, for a corrosion damage in outside structure of the aircraft, locating the damage on the chart is done by clicking the chart on the wanted spot when the damage is selected in the table. If the spot needs to be moved or edited, it can be moved freely on the chart with mouse. If the mark needs to be deleted, a right-hand click lets the user to edit the damage, and in “Move options” tab, a “Reset damage position to x=0, y=0” button is found. For corrosion damages found on the inside structures of the aircraft, it is not necessary to mark them on the chart. Creating and maintaining the pictures of inside structures is considered too impractical, due to the amount of structures and removable parts. Damages located on inside structures are not shown on the Dent & Buckle chart but can be viewed by activating “Not assigned to a Chart” under Status section in search panel.

6.3 Browsing the data

Browsing the corrosion data in the system is done by filtering search results. Searching tools are found on the left-hand panel of the Structural Damage window. Depending on the purpose, corrosion findings can be searched for an individual aircraft, or for entire fleet. Most relevant searching method is selecting “COR1” in Type of Damage and Nature of Damage boxes. Other searching filters are seen in picture 8. After the search for wanted results has been done, the results are listed in a table.



PICTURE 8. Structural Damage search filters (AMOS n.d.)

6.4 Analysing the data

The data is analysed using Report Designer module in AMOS. Report Designer is used to create various customized reports using Structured Query Language (SQL) programming. A report template (appendix 3) has been created by a third party and it has been added to the system. The template is found in report browser and depending on the purpose, it can be previewed, saved or printed. Aircraft fleet and the time interval are chosen from the drop-down menus. The template is seen in picture 9. The data used in the picture is an example data and does not represent real situation of corrosion findings in a particular aircraft.

Fleet: AT72FC

01.Jan.2012 - 31.Dec.2016

Task Number	WO Date	Aircraft	TAH	TAC	Description	Level	Workorder	Item
571406-GVI-10000-1	24.Jun.2015	ATG	14874	20282	WING: CUT OUT IN WING AT 521DT, 522CT, 622CT	1	3002179	29
571406-GVI-10000-1	16.Jul.2014	ATJ	11479	15301	FRETTING ON HOUSING SURFACE OF PANEL 521DT, 622CT, 522CT	2	3000652	37
531106-DVI-10000-1	20.Jan.2015	ATE	14881	20549	CORROSION ON INTERNAL SKIN UNDER DME/2 ANTENNA	2	756772	42

PICTURE 9. Corrosion level report example data (AMOS n.d.)

The report shows all the corrosion findings in selected fleet in the selected time slot. The results are sorted based on the AMP's task number. Subsequent columns show the date of the finding, aircraft registration number, operating times, damage description and the level of corrosion, as well as the workorder number and item number. These parameters were chosen because they represent the most relevant values in monitoring corrosion and they allow a realistic comparison of the results. One of the most practical information in controlling corrosion in the future can be considered the AMP's task number. Using this information, the operator can compare the number of corrosion findings with respect to a particular maintenance task and take the necessary steps to develop the program if needed.

7 CONCLUSIONS AND DISCUSSION

Because corrosion can not be stopped, it needs to be monitored in order to control it. The objective of this study was to improve the corrosion control program of an airliner by developing the reporting methods in the case of a corrosion finding. The goal was to increase the efficiency of the program and create guidelines for the reporting methods. As the outcome, instructions for entering the data into the material management system as well as for browsing and analysing the data were created. A report template was also designed and added to the company's maintenance management system.

The final outcome of the project can be considered to be successful. Communication and interviews of the personnel at Norra were successful and all the information needed for the project was obtained. As the outcome, clear instructions and guidelines for managing the data were created and data analysis in a new way was made possible. The developed program can be used regardless of the aircraft type, as intended. The instructions are to be brought into general use in the company, as the instructions for processing the data can be used on a daily basis by anyone in the maintenance organisation. The report template is used as an analysing tool mostly by Part M organisation. The report can be used either generally to observe the development of corrosion findings or it can be taken into closer view in monthly meetings and reviews in the airline. One of the most significant advantages is that it allows the data to be examined so that corrosion findings found in the same AMP task number can be seen clearly. If it is noticed that corrosion is found repeatedly during the same task, it indicates that the operator might want to report it to the manufacturer and the corrosion control program of the aircraft might need to be modified.

There are some limitations in the solution. For example, impracticability and complexity makes it difficult for the 2D drawings of the inside structures of the aircraft from being added to the Dent & Buckle chart. However, even though this makes it difficult to visualize a corrosion finding inside the aircraft, the finding can still be entered into the system and listed in a table. Also, due to the qualities of the maintenance management system, the SQL created for the report template needs to be rewritten in the case of a system update in it. Nonetheless, this is not considered to be a challenging task and it is confirmed that certain personnel in the airline have the knowledge to modify the SQL.

The developed program is made to serve current needs in corrosion control in the airline. In the future, further developments in the report template can be made. If there are some significant changes in maintenance programs or authorities' requirements, the template should be updated to meet the new needs. The produced program and the concept of the report template can also be applied on other maintenance programs of an airliner. In addition to analysing the findings data in meetings inside the airline, the methods can be brought into use in Part 145 organisations where base maintenance is done. Representatives from the operator and Part 145 organisation personnel should bring the corrosion findings data into their meetings and reviews and analyse the results together in order to make the program more effective. This way the maintenance personnel are also aware of the overall situation of CPCP and they can affect the status of the program by their own actions. Also, this way the importance of recording the findings as well as defining the corrosion levels is highlighted.

In summary, collaboration of divisions in maintenance organisation makes reporting and analysing corrosion findings productive. In order for the program to work, all the instructions and regulations should be followed. Furthermore, reporting and information management process starts from the moment of a finding is discovered and they should not be neglected. This project provides fresh perspective on the matter and the effectiveness of the developed program is established when the program is brought into use.

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APPENDICES

Appendix 1. ATR In-service Findings Reporting Form (ATR 2017c)

ATR72 - AIRCRAFT MAINTENANCE MANUAL - Job Instruction Cards

53-61-00 DVI 10005-002
PAGE 10 MAR17

IN-SERVICE FINDINGS REPORTING FORM

OPERATOR .... Inspection date........ Repair Station........
Contact Name........ Ref........ Tel ....
e-mail........ Fax........
Area of a/c operation........

ATR42 O ATR42-400/500 O
ATR72 O ATR72-212A O

MSN........

A/C FC........
A/C FH........

REASON OF INSPECTION MPD/MRBR REF........
OTHER........ INTERVAL........

O Corrosion — Level 1 O Level 2 O Level 3 O

TYPE OF CORROSION : ....

Crack O
Disbonding O
Composite damage O

Inspection method used : General Visual O Ultrasonic O X-Ray O
Detailed Visual O Magnetic particle O Eddy current O
Other O (describe)........

DAMAGED PART : P/N........
DESCRIPTION........

ZONE ....
STRINGER/STIFFENER n° .... to .... LH O RH O
FRAME n° .... to .... LH O RH O
RIB n° .... to .... LH O RH O

Stiffener/Stringer O Frame O Web O Rib O Doubler O Floor Beam O
Bracket O Spar O Chord O Skin O Bulkhead O Fitting O Door O

Time since last maintenance task for concerned part : ....months ....FH ....FC
Reference doc (SRM, SRKM, IPC,...) for part identification: ....

DESCRIPTION OF DAMAGE (see also SRM 51-00-01)

ATTACHED SKETCH: YES O NO O

Length .... Surface ....
Width ....
Depth........ mm O inches O

CAUSE AND DETAILED DESCRIPTION OF DAMAGE
....

CORRECTIVE ACTION
....

Report to be sent to **structuredata@atr.fr** or by fax **+33 (0)5 62 21 62 90** ASAP with photos and sketch if possible

SJ5 530000 DVI 00100 001 C AC

ATR FORM: FOR-3-CG-0221-000-A3 page 1/1

EFFECTIVITY : FC

INSPECTION DATA FORM

53-61-00
DVI 10005-002
2-400 PAGE 10
MAR 01/17

Printed in France

Appendix 2. Data fields and descriptions (AMOS n.d.)

Field	Description
Header Section	
External Ref. No.	External reference number.
Workorder No./ATA	Workorder number of the task and ATA number. Linked automatically.
Damage Description	Free description of the damage.
Type of Damage	Damage type selected from the drop-down menu. Multiple options, such as crack, burn mark or dent. For corrosion select *COR1*.
Nature of Damage	Nature of damage selected from the drop-down menu. Multiple options, such as incident, bird strike or manufacturing defect. For corrosion add *COR1* to data dictionary.
Damage Classification	Classification of the damage; select *Minor*, *Major* or *No Action*.
Damage Visibility	Visibility of the damage; select *Outside* or *Inside*.
Notes	Enter any relevant remarks.
Location section	
Frame/Station	Location of the damage according to the aircraft frame/station.
Stringer/Longeron	Location of the damage according to the stringer/longeron.
Rib	Location of the damage according to the rib.
Side	Location of the damage according to the side of the aircraft.
Other Location	Free description of any other location than those above.
Dimension section	
Unit	Unit of measurement of the damage. Only length units are accepted.
Length	Length of the damage.
Width	Width of the damage.
Depth	Depth of the damage.
Diameter	Diameter of the damage.
Direction	Direction of the damage.
Other Dimension	Free description of any other dimension than those above.

2 (2)

Inspection section	
Within limit	Select if the damage is within limits.
Further action required	Select if the damage needs further action.
Action note	Only active is the *Further action required* check box is selected. Enter any remarks regarding the action.
Repetitive inspection	Select if repetitive inspection is necessary for the damage. If yes, enter the value and define the dimension H (Flight Hours), D (Calendar Days), C (Flight Cycles) or Others.
Last performed	Date of the last performed inspection.
Next due	Date the inspection is next due.
Status section	
Status	Status selected from the drop-down menu. Multiple options, such as *Finally Repaired*, *Deleted*, *Superseded*, etc.
Repair limit (for status Temporary Repaired*)*	Selecting *Temporary Repaired* status activates *Repair limit* check box. Enter the value and define the dimension *H* (Flight Hours), *D* (Calendar Days), *C* (Flight Cycles) or *Others*.
Supersede items	Select the check box to activate the *Supersede Reason* field and a small window appears to the right. In this window you can select the items which are superseded by the entry you are currently creating/editing.
Entry date/Sign	The date of creating the damage. The actual date is selected by default. Personal code of the person who entered/approved this action.
Final date/Sign	The date the damage was repaired, finally repaired, cancelled, replaced and so on. Personal code of the person who entered/approved this action.

Appendix 3. Report template (AMOS n.d.)

FINNAIR	**Corrosion Level Report**	**03.May.2018 14:42**	**Page 1 / 1 PAR**

Fleet: XXX

DD.MM.YY - DD.MM.YY

Task Number	WO Date	Aircraft	TAH	TAC	Description	Level	Workorder	Item

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