LAMK Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

Preparing repair capability of ovens and water heaters for Airbus A320 and A350 aircraft

Finnair Technical Services Ltd

LAHTI UNIVERSITY OF APPLIED SCIENCES LTD
Faculty of Technology
Degree in Mechanical and Production Engineering
Production Oriented Mechatronics
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SILANDER, RUDOLF:

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Finnair Technical Services Ltd

Bachelor's Thesis in Production Oriented Mechatronics, 30 pages, 6 pages of appendices

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ABSTRACT

The aim of this thesis was to prepare and arrange all needed resources for Finnair Technical Services repair capability of Essence® Inserts Collection ovens and water heaters manufactured by B/E Aerospace. Finnair Technical Services was the mandator for this thesis.

The new model ovens and water heaters are being incorporated into the Finnair fleet and it has been seen beneficial to repair them in-house. These new components have been previously repaired at the manufacturer´s facility, but will be soon done internally.

Research objectives included test bench facility management, training coordination, document collection and control, procurement coordination and other project coordination related duties. Considering the explored subjects, this thesis could be thought to be widely multidisciplinary and educational for future work assignments.

All phases from ordering to implementation were to be studied, planned and managed, to ensure smooth flow throughout. Principles behind project management, work safety and functionality of components were explored as well.

The thesis created an information base for starting the repair operations of the mentioned ovens and water heaters.

Key words: Airbus, oven, project management, repair shop, user documentation, water heater

Lahden ammattikorkeakoulu
Kone- ja tuotantotekniikan koulutusohjelma

SILANDER, RUDOLF:

Airbus A320 ja A350 uunien ja vesikeittimien korjausvalmiuksien nosto
Finnair Technical Services Oy

Tuotantopainotteisen mekatroniikan opinnäytetyö, 30 sivua, 6 liitesivua

Kevät 2017

TIIVISTELMÄ

Opinnäytetyön tarkoituksena oli valmistella kaikki tarvittavat resurssit Finnair Technical Servicesille B/E Aerospacen valmistamien Essence® Insertions Collection -uunien ja -vedenkeittimien korjaustoiminnan aloittamiseksi. Toimeksiantajana toimi Finnair Technical Services.

Uuden malliset uunit ja vedenkeittimet ovat tulossa käyttöön ja niiden korjausvalmius on katsottu kannattavaksi suorittaa itse. Nämä uudet laitteet on aiemmin huollettu valmistajan korjaamolla ja tarkoituksena on tuottaa tämä palvelu sisäisesti.

Selvityksen kohteina olivat erityisesti testipenkin tilajärjestelyt, koulutuksien koordinointi, dokumenttien kerääminen ja hallinta, hankintojen koordinointi ja kaikki projektin koordinointiin liittyvät tehtävät. Tämän johdosta työtä voitiin pitää erittäin monialaisena ja opettavaisena tulevia työtehtäviä varten.

Kaikki työnvaiheet tilauksesta käyttöönoton jälkeiseen aikaan tarkasteltiin, suunniteltiin tai hallinnoitiin. Työssä tutkittiin myös projektinhallinnan, työturvallisuuden ja laitteiden toiminnallisuuksia perusteita soveltuvin osin.

Työllä saavutettiin tietoperusta edellä mainittujen uunien- ja vedenkeittimienkorjaamotoiminnan nostamiseksi.

Asiasanat: Airbus, korjaamo, käyttäjän dokumentaatio, projektinhallinta, uuni, vedenkeitin

TABLE OF CONTENTS

ABBREVIATIONS

ARINC	Aeronautical Radio, Incorporated
ATA	ATA 100 numbering system for aircraft documentation
CMM	Component Maintenance Manual
FTS	Finnair Technical Services Ltd
HMI	Human Machine Interface
MOE	Maintenance Organization Exposition
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
OEM	Original Equipment Manufacturer
RSPL	Recommended Spare Parts List
SB	Service Bulletin
SQMM	Safety and Quality Management Manual
TOPI	Technical Operations Procedures and Instructions

1 INTRODUCTION

This thesis was made for Finnair Technical Services Ltd (FTS), located at Helsinki-Vantaa Airport. The subject for the thesis was mutually agreed upon together with the company, as it was deemed necessary and beneficial.

A new line of Essence® ovens and water heaters are slowly being incorporated to the entire Airbus fleet, which creates a need for a new repair capability.

FTS currently has line maintenance and components maintenance in three hangars located at Helsinki-Vantaa Airport. The in-house repair capability of the components discussed in this thesis are planned to be repaired in the largest of them, hangar 7. The preceding models of these components are repaired in the same room.

Formerly all Essence® line ovens and water heaters installed on Finnair aircraft have been repaired at the manufacturer´s repair facility, at Nieuwegein in the Netherlands. For the initiation period of in-house repairs, it was decided to partially use the manufacturer´s repair facilities to ensure no disturbances in flight operations and customer experience due to the necessity of the equipment during flight.

Long experience of in-house repairs brings valuable knowledge when preparing for this new line of components. Finnair has also been able to collect valuable data on the reliability and common problems in the components starting from the first Airbus A350 delivery in October 2015. It is a good starting point for establishing in-house repair capability. All data is retrieved from MRO production software called AMOS produced by Swiss AS, which has all aircraft-related maintenance data Finnair needs.

The Essence® line has been chosen to be used on many current and future A320 and A350- series aircraft that Finnair operates. At the moment the line is only installed on A350-series, but later on it will be either retrofitted or factory-installed on A320-series.

2 BACKGROUND INFORMATION

Here is gathered information of the components to be repaired, the facilities and the test bench. Present and future workshop functions are presented as well.

2.1 Ovens

Two types of ovens are used in aircraft convection and steam. Here is presented the specific models that will be installed in most Finnair operated aircraft. They will serve for a long period of time. Functionality is also explored and visualized.

2.1.1 Convection

The convection type oven is DF3500-series oven and is manufactured by B/E Aerospace. The oven can be seen in Image 1.

IMAGE 1. DF3500 Series Oven (B/E Aerospace 2017b, 1)

Forced convection is used in this specific case. It occurs when air is heated and circulated via an integrated fan (Bahram 2015, 1).

To operate, both ovens use standard aircraft power 115V at 360-800Hz. Unlike the steam oven, the convection type requires only a power source to operate. (B/E Aerospace 2016a, 4)

All the presented products have an interface to connect it the aircraft nervous system. The operation and status can be monitored through a mobile application made by the manufacturer to ease use in the aircraft. (Schlieske, 2017) A human machine interface (HMI) with a display is used to control all functions of the ovens and view errors (B/E Aerospace 2016a, 8).

2.1.2 Steam

The steam oven is externally identical to the convection oven and is a DS3500 -series oven. The image is left out due to similarity.

Internally the steam oven is slightly more complicated than the convection oven. In addition to a power source, it requires a water source as well, which makes it technically more complex than its counterpart. (B/E Aerospace 2016b, 4) The water connection between the aircrafts galley and the oven is produced by the ARINC 810 standard, which specifies standard interfaces to be used in galley inserts (B/E Aerospace 2016, 10). An image of the HMI is displayed on the next page.

Steam ovens are superior to the convection oven in two aspects, in cooking quality and heat transfer. The moisture content and flavor of the food are both preserved well, therefore creating a quality meal for customers. Due to the steam, the heat transfer properties are improved and lower cooking temperatures can be achieved. (Oslin 1994)

IMAGE 2. HMI Display and Buttons (B/E Aerospace 2016b, 12)

2.2 Water Heater

The water heater belongs to the same line of products as the ovens and therefore is visually similar. It is a 4660-series water heater.

IMAGE 3. 4660 Series Water Heater (B/E Aerospace 2017a, 1)

As with the steam oven, the water heater requires a power and water source. Simplicity of function makes it technically more robust for example by means of a missing front control panel. (B/E Aerospace 2014, 1) The heater is available in high and low tap models, both found in Finnair fleet. Two tap models are required to enable installation into varying galley shapes.

Operationally the water heater is much simpler than the ovens. It is operated through a single button, whereas the oven has an HMI. The water heater has a couple of indicators to indicate either readiness or an error. (B/E Aerospace 2017a, 4)

An example of an installation configuration inside a Finnair aircraft is presented below.

IMAGE 4. Photo of an Airbus A321 AFT Galley Configuration

2.3 Component Count

Total count of components installed on aircraft and stored as spares was checked from AMOS-software at time of publishing the thesis. Aircrafts on order and arriving with set components or being retrofitted were considered when analyzing the future numbers. Steam ovens are not installed on A320-series at all due to shorter hauls.

A350-series is configured as follows:

- 8 convection ovens
- 6 steam ovens
- 11 water heaters.

A320-series is configured as follows:

- 6 convection ovens
- 5 water heaters.

Having a harmonized component inventory throughout the majority of the fleet brings several benefits. Once a spare inventory has been established for the components, it will be applicable to a much broader component count than having a diverse combination of components. It allows an edge in inventory turnover rate.

Another advantage that is gained through the harmonized line of products is reduced training requirements and complexity for flight crews and technical personnel. Rather than having to attend trainings for each varying line of products or manufacturer, all related personnel can attend a much narrower range of trainings sessions. This will result in less training required per person and increase familiarity to products in use.

As understanding and experience is gained, it could be thought to have a positive effect on various areas, such as:

- fault isolation
- user related defects
- unnecessary removal from aircraft.

2.4 Test Equipment

The test bench used is model CS 710-530 manufactured by AWL-Techniek B.V. according to B/E Aerospace specifications. It is a double test bench capable of testing two units at once. A picture of the test bench is presented in Image 5.

IMAGE 5. CS 710-530 Test Bench (B/E Aerospace 2016c, 7)

The test bench is equipped to provide electricity, water and air pressure to the operator. Key meters needed for testing can be found on a control panel, including:

- voltage
- current
- temperature
- flow
- water pressure.

The digital pressure meter for water is there to ensure sufficient input pressure from the mains to both the steam oven and the water heater. (B/E Aerospace 2016c, 16)

The control panel includes the main power connector, plug socket, temp sensor and ESD connector. While testing, the main connector supplies aircraft grade power to the component and the temp sensor will be used to track the oven temperature development and function. The component itself can run several tests, but also external computer software connected via USB-cable can assist with fault isolation and testing. The computer software is also used to upload and update the components (B/E Aerospace 2016b, 11009).

Below are some labeled views of the control panel in Image 6 and switch board in Image 7.

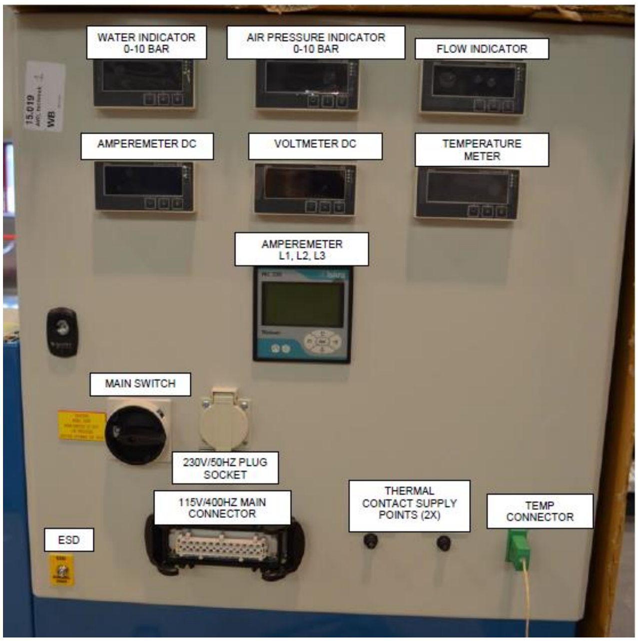

IMAGE 6. Front view of control panel (B/E Aerospace 2016c, 16)

Location of the switch board has been modified from the previous design, from beneath the control panel to the front of the working surface. This was done for customer convenience. (Schlieske 2017)

IMAGE 7. Switch board (B/E Aerospace 2016c, 17)

On the 23rd of February 2017, a one-day excursion was made to B/E Aerospace Netherlands Nieuwegein repair workshop to see the test bench in action. This workshop handles ovens and water heaters of many European customers, including FTS at the time of publishing. Meeting B/E Aerospace personnel in person was truly helpful as a great deal of interaction was required during the thesis process. Overall, the excursion gave many practical insights and a short video was filmed to be shown to FTS mechanics.

2.5 Workshop

Up to date, Finnair has had capability for all its ovens and water heaters installed on its Airbus fleet. The long experience has refined operations to well suit the entire fleet. The retrofits to A320-series and factory installations to A350-series, will not affect the total amount of units circulating drastically at first. The old A340-series, and later A330-series, will all be replaced by a total of 19 aircraft from the A350-series.

The personnel working in the workshop have a long solid experience with aircraft components and are easily trainable for new ones. The persons chosen for training have been working with the preceding models of the components.

2.5.1 Present

The layout of the current workshop has been planned well, but minor changes will be made to accommodate the new test bench. As other sensitive electrical components are currently being repaired in the same room, they are to be moved to an isolated room close by. This will help to keep different type components separate, especially from the water needed to test the ovens and water heaters.

IMAGE 8. Photo of the current test bench at the workshop

The functionalities are fairly similar to the existing ones, but updated to current standards and requirements. Image 8 above presents the current test bench with additional equipment on-top.

2.5.2 Future

Once the test bench is set up and all personnel is trained, Finnair will have an efficient and updated workshop ready to serve both in-house and external repair needs. To ensure future competitiveness and quality, FTS will monitor the mean time between failures (MTBF), mean time to repair (MTTP) and repair costs. Components will still be sent for external repair to the manufacturer from time to time to benchmark FTS operative success and quality in repairs.

The facility that will enclose the workshop consists of several working benches, a chemical treatment room and the final test bench. With this configuration, it is possible to have multiple units in repair simultaneously and still maintain cleanliness and order during operations.

3 PROJECT MANAGEMENT

In this section, project management, project life cycle and further details of projects will be explored. Especially risk management and approaches to cope with unforeseen events are looked into. In a risky and competitive environment, such as the aviation industry, it is valuable to recognize and analyze these conditions in order to effectively deal with them.

3.1 Project Definition

A project can often be defined by the characteristics presented here (Paasivaara, et al 2008, 7-8):

- unique and definite task
- pre-defined scope of work
- set objective.

In general, projects are non-routine tasks that are aimed at a specified problem, improvement requirement or implementation of something new. One of its strengths is the fact that it can be aimed accurately at each task needing attention, enabling focus on one rather than a group of tasks. This requires giving each individual project a proper context and thorough examination to succeed. (Paasivaara, et al 2008, 8):

3.2 Life Cycle of a Project

Each project, whether short or long, has a life cycle. They can be divided into multiple phases, of which a five-phase life cycle is presented here below (Paasivaara, et al 2008, 103):

- recognizing the necessity
- planning and initiation
- experimentation and implementation
- closing and assessment of effectiveness
- handing over and integrating the project outcome to its function.

3.3 Risk Management

With all projects and operations there are risks that may compromise or delay the desired end-results. It is always good practice to map all risks that can be identified beforehand and minimize their effects. Sometimes unexpected risks can arise and they have to be dealt with ad hoc. (Karlsson & Marttala 2001, 130-131) In this project for example a sudden change of the chosen facility or major delivery problems could both result in delays of the workshop initiation.

Here are explored the detected risks and guidelines how to manage them.

3.4 Identifying, Analyzing, Prioritizing and Controlling

Various ways of categorizing risk sources have been identified, of which some common ones are listed below (Artto, et al 2006, 205):

- external
- internal
- communication
- decision making
- human factors
- unforeseen events
- project adjacent factors
- complications in coordination.

Due to the uniqueness of each project, each one has to be assessed separately and with creativity when predicting risks. Project management experience can bring certain benefits to recognizing risks. However, diverse views are required to get a comprehensive idea. It may also benefit the overall team spirit, help to motivate and enhance the focus of the project participants. (Artto, et al 2006, 204-205)

In this project, the risks were first assessed superficially based on prior knowledge of the author and later assessed together will all participants.

This brought contrast between views and helped realize why it is important to have as many people involved as possible.

A risk assessment matrix was prepared to display identified risks together with their probability, impact and preventive actions. It can be found in Attachment 4. (Karlsson & Marttala 2001, 130-131) The matrix provides risk assessment from all phases up to the date of workshop initiation.

3.5 Handling Chaos

Even if a team consisting of the world´s leading experts, project managers and employees were put together, things can still go horribly wrong. To completely avoid this, there is no other option than to either not participate in such projects or to only choose risk-free projects. The problem is that this attitude hardly ever spawns successful projects or project managers. (Berkun 2006, 272)

It requires a certain type of knowledge to understand that after things have gone wrong, they cannot be undone. So, it can be thought to be crucial for the project's success to have a team that can overcome the problems and find solution effectively. (Berkun 2006, 272) Personally having noticed this as well, it gives greater motivation to help others comprehend and cope in tough situations. Here below is a quote to help bring self-awareness in problem solving:

> *You can blame people who knock things over in the dark or you can start lighting candles. You are only at fault if you know about a problem and choose to do nothing.*
>
> *-Paul Hawken (Berkun 2006, 272)*

Here are a few general steps to apply when facing difficult situations (Berkun 2006, 273-275):

- Calm down.
- Asses the problem in respect to the project.
- Keep yourself calm.
- Assemble the right people.
- Explore the options.
- Come up with a simplistic plan.
- Execute the plan.
- Organize a debriefing of the situation afterwards.

Although theories and visuals of project management might give a general understanding on how to cope with difficult situations, the only way to master them is to learn through practical simulations together, with trial and error. It has to be kept in mind that it is a long process and cannot be learned overnight. It is also important to do a post-analysis of what were the root causes and what improvements to make for the next time. (Berkun 2006, 281)

Before plunging into the real world and problems, it is beneficial to recognize when you in fact are in a tough situation. Presented below are a few common characteristics of how to recognize one (Berkun 2006, 277):

- There is a gap between reality and the current plan that needs urgent attention.
- It is unclear where the gap is, what caused it and whose job it is to solve or whether it is even there.
- It is unclear what resources should be used to fill the gap. Also, there might be a fear that taking initiative or doing nothing will make things worse.

Through personal experience, it can be noted that the times something has failed or gone wrong are the ones that can be recalled with ease.

At the time of occurrence, the situations have been recognized and researched thoroughly for future occurrences. This has led to a much deeper learning experience and overall situational awareness.

Minimizing the damages the problems might cause has to be given some thought. Once an unforeseen urgent problem arises, there might not be time to research and ponder it in depth, but it requires immediate actions to be taken. Good examples are astronauts and pilots when confronted with a serious problem. They have to start diagnosing and isolating the problem systematically through a procedure manual. Procedure manuals may not be available for the projects manager and therefore it is advised to have guidelines on how to proceed efficiently. (Berkun 2006, 284-286) A guideline is presented below in Image 9 with steps to help with minimizing damages in urgent problematic situations.

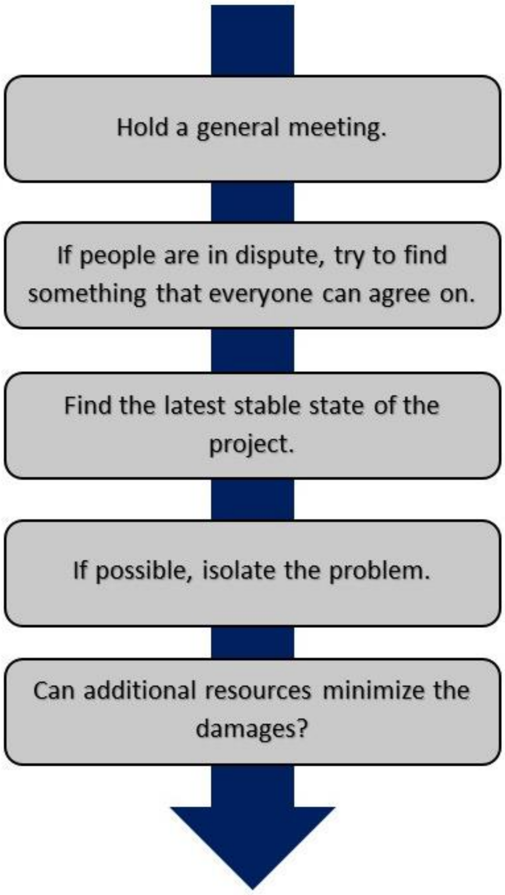

IMAGE 9. Minimizing Damages (Berkun 2006, 285-286)

4 PLANNING AND PREPARATIONS

This section will discuss measures and phases that must be considered before the implementation stage of the project. Overall project success and on-time initiation of the workshop depend highly on this stage.

4.1 Overall Project

Before the workshop can be initiated and the first authorized release certificate given to a part, multiple internal preparations relating to aviation regulations are required. A comprehensive evaluation of tooling, spares, personnel and facilities is to be made and compared to the requirements set forth by the CMM and manufacturer. A considerable factor is the scope of work to be performed, which is required to be defined. For example, a defined work scope of overhaul or bench test require entirely different resources. These components are removed only when faulty and they require repair.

A widely use planning and scheduling technique is called Gantt -chart. Dividing the project into tasks and sub-tasks makes it easier to monitor the progress of the project and keep track of planned versus realistic workload. (Paasivaara, et al 2008, 108) One shall be prepared to track the remainder of the project. Below, in Image 10, is an example of a Gantt -chart. Additional information can be added to columns, such as:

- start and end-date
- responsible person
- resource needs.

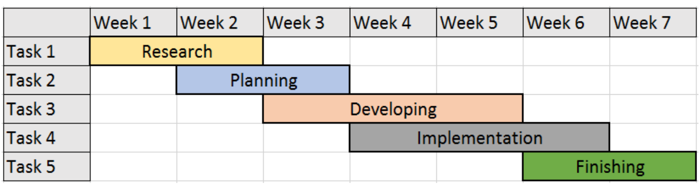

IMAGE 10. Example Gantt Chart (Paasivaara, et al 2008, 107)

In Attachment 3, a supporting checklist can be found.

4.2 Procurement

To successfully operate a workshop, it is required to have a sufficient spare part inventory, as well as proper tooling to be able to complete repair and maintenance tasks on any components in a timely manner. Here is explored the different procurement needs and guidelines on how they will be fulfilled.

4.2.1 Spare Components and Parts for Components

Ensuring minimal operational disruptions and maximal customer satisfaction is one of the core goals of FTS. It is required to have a sufficient component inventory together with optimal turn-around-times for repairs. Calculating the annual demand of spare components is a key contributor and therefore it is vital to do so. The formula used to accomplish this is similar to the one presented below in Formula 1:

$$D_a = \frac{FH * FS * QPA}{MTBUR}$$

FORMULA 1 Calculating Annual Demand of Spares (SAP 2017)

In which "D_a" represents annual demand, "FH" flight hours per aircraft per yer, "FS" number of aircraft in the specified period, "QPA" quantity per aircraft and "MTBUR" mean time between unscheduled removals. The term "MTBUR" can be calculated from the formula below in Formula 2:

$$MTBUR = \frac{FH * QPA}{R_{us}}$$

FORMULA 2 Calculating MTBUR (Carroll 2005)

Where "R_{us}" represents the number of unscheduled removals during that period and others as mentioned previously. These calculations will be performed during the project.

Together with the components, the manufacturer has provided recommended spare parts lists (RSPL) that identify a set of parts recommended to be available during workshop activities. An RSPL for only line maintenance activities was provided as well, but the workshop level RSPL is more detailed and better suited for the planned operations.

Due to the volume of parts listed on the RSPL, it must be thoroughly analyzed before a decision is made on which parts are economically and operationally wise to procure. During analysis, it is expected that some parts might already be available in stock because of on-going workshop operations with preceding ovens and water heaters. The manufacturer of the currently repaired components is the same and therefore it is reasonable to expect some similarities in parts, especially standard issue parts.

In today's world, inventory turnover must be monitored carefully. It is essential for a company´s success not to have capital fixed to an inventory which has low turnover. (Sakki 2001, 156) FTS is currently using supply chain management software, synchronized with AMOS, to manage and optimize its inventory. Especially in the aircraft maintenance industry, lead times of parts vary greatly, in worst cases to over 120 days, but at the same time the parts might be essential to operating the aircraft. These two programs play a key role in assisting in finding harmony between parts availability and inventory turnover management.

To assist with the analysis, information on used parts was gathered from all shop reports available in the production software AMOS. The listed parts indicate commonly failed parts and reasons leading to scrapped parts. Although most shop reports were from warranty orders, they still had the information available.

After a decision has been made on parts to be procured, an order will be placed with the manufacturer and followed up to ensure on-time delivery. Based on current knowledge, the workshop might be initiated by the end-of 2017 and therefore it is recommended to have procurement lists ready not later than the end-of May 2017. Should the schedule change, an order is recommended to be made a minimum of 120 days in advance.

4.2.2 Spare Parts for Test Bench

A spare parts list is available for the test bench, but it was decided that parts will be purchased on an ad hoc basis due to commercial availability. Also, the ability to utilize existing test benches via adapters creates a back-up for any defects that may arise with the new test bench.

4.2.3 Tooling

The CMM provides a comprehensive list of tooling required to complete workshop activities. In addition to hardware, some software is required as well and therefore a computer needs to be integrated on top of the test bench. (B/E Aerospace 2016b, 1003) An evaluation of needed tools versus existing ones will be made during the months following the completion of this thesis. Preceding components have not been digitally advanced and therefore software has not been required before.

4.3 Safety

Safety comes first in any work situation and therefore great emphasis is put on it. Every day the goal is to return home safely and go to work without feeling afraid of something happening. Here is explored how we can achieve this goal and other safety measures that must be taken into account.

4.4 Preventive Actions

Finnair has a Safety and Quality Management Manual that lays down a Just Culture and the general line for safety. Safety must be implemented at an organizational level, not just as each individual´s own responsibility. The Just Culture enables finding root causes and preventing future occurrences without shifting blame. It is also possible to freely report safety issues and openmindedly discuss them for the benefit of everyone. (Finnair Plc 2017b)

Proper safety gear has always been easily accessible to all personnel working in conditions requiring protection. By observing current operations, it can be noted that safety measures are followed well. With the oven and water heater a few risks are present, but by following instructions and having awareness of the job at hand can go a long way in preventing them. Here below are presented the easily noticeable risks:

- chemical contact
- falling object on body part
- minor scratches from sharp edges
- presence of hot parts during and after test cycles
- presence of electricity and water.

Warnings included in the CMM and common awareness help to prevent these unpleasant incidents. To ensure that the project itself has safety nets to implement safety on its part, a check list including safety related aspects was prepared. It may be found in Attachment 1. It was prepared to assist the tracking of safety items. (Robinson & Choudhuri 2011, 6)

4.5 Documentation

Here are listed documents that have to be gathered before starting operations:

- CMM´s for each component part number
- user manual for components
- user manual for test bench
- calibration manual for test bench
- spares list for components and test bench
- certificate of conformity for test bench
- training certificates from manufacturer
- CE-certificate.

4.6 Listing Repair Capability

All components, that are to be repaired under the company´s EASA Part 145 license, must be listed in the capability list. The MOE of the company specifies what information is required for a component to be listed on the capability list. Current listing holds more than 800 individual part numbers. (Finnair Plc 2017a)

Here below is listed information needed for each part number according to MOE (Finnair Plc 2017a, 21):

- manufacture part number or model number including the dash-number
- description
- manufacturer
- ATA chapter
- scope of capability
- overhaul, repair, inspection and/or testing
- responsible work shop
- category in accordance with EASA Part-145 approval (C1-C20)
- date of incorporation to the list or date of last amendment of the scope of the work.

Additionally, the following information is required to maintain the repair capability and future compliance with all applicable requirements (Finnair Plc 2017a, 21):

- current manufacturer maintenance data or other CAA FI acceptable specification
- trained and authorized personnel
- appropriate facilities
- required equipment and tools (an opportunity to lease tool or equipment when needed shall be demonstrated to the authority by letter of intent or by other means).

According to procedures a FTS standard capability list amendment form 1051 will be filled in and signed by the production manager. After all requirements and the form have been fulfilled it is possible to start operations. (Finnair Plc 2017a, 21): The forms will be completed during the project.

5 IMPLEMENTATION

This thesis will be completed before the actual hardware needed to set up the workshop has arrived and therefore great effort is put into describing and analyzing each phase in depth to ensure a smooth start of operations.

5.1 Training

For both components, B/E Aerospace will arrange separate training at different locations. The product and maintenance training for the oven will be held in Nieuwegein, Netherlands, and for the water heater in Lenexa, USA. Training will be held in two separate locations, as it will provide the best training results. (Schlieske, 2017) It was seen beneficial for Finnair to have me attend both training sessions later this year together with the attending mechanics. It enables me to understand the component in depth and give minor engineering support to production when necessary.

Attendance to training will be arranged in groups to ensure uninterrupted flow in production. It is also seen optimal to attend the trainings after all annual leaves have been held in the summer. This will also give a possibility for mechanics to try out the test bench before attending training and come up with any questions related to use.

According to EU directive 2006/42/EY, if a machine is seen to require training for safe use, the manufacturer shall arrange some form of familiarization or instruction to ensure this. A fully comprehensive training is not expected, but a training enabling safe use of the machine. (The European Parliament and Council 2006/42/EC 2006) In this case, the training discussed is mainly for product and maintenance. However, it will include usage of the test bench and therefore could be thought to cover safe use of the test bench. A certificate will be issued by the manufacturer for each participant completing the training.

5.2 Facilities

The existing workshop handling preceding components has made the facility capable of housing the new test bench with minimal modifications, allowing cost-efficient adaptation for the successive components. The main requirements are (B/E Aerospace 2016c, 13):

- 115V 400Hz aircraft power
- 230V 50Hz standard power
- internet connection
- water supply
- air pressure supply
- drainage.

All these can be found in existing test benches in the same room. The only task is to run the existing connections to where the test bench will be installed. This will be done by the standard facility management company outsourced by FTS.

Should changes to the chosen location of the workshop arise later in the project, they will be dealt with within the guidelines discussed in the project management section of this thesis. This is due to the fact that the changes will be unforeseen and will also affect other operations present at the current location. It can be considered to be a major risk to the schedule if the facility is later on decided to be established in another location. Further risk assessment, with possible preventive actions, can be found in Attachment 4.

5.3 Test Bench

The test bench is scheduled to arrive after 28 July 2017 per current information received from the manufacturer. Slight delays will not have considerable effects as the training will be held from October 2017 onwards. After the arrival of the test bench, it will be set-up as per instructions and a comprehensive deployment inspection will be made.

Set-up instructions are required in the user manual of the test bench (The European Parlament and Council 2006/42/EC, 2006). The employer is required by law to do a deployment check and scheduled checks to ensure safety of the equipment at all times (Occupational Safety and Health Act 738/2002, 43§). FTS has a form 3035 for completing the deployment inspection as described in the MOE Part 2.4 (Finnair Plc 2017a, 13).

5.3.1 Logistics

The test bench will be shipped in a specially designed crate. The FTS logistics department has decades of experience shipping aircraft goods to and from Europe. The shipment of the test bench will not pose a great challenge. Once it arrives at Finnair facilities it will be opened and moved to the workshop. The elevator inside the hangar will be able to lift the test bench to the workshop located on an upper floor. Measurements were made to ensure that the test bench can be maneuvered to its final location (AWL-TECHNIEK B.V. 2015) The only risks posed are improper handling during transportation or poor packaging. Having shipped many units before, the manufacturer has ensured their shipping crate is capable of safe transport of the test bench (Schlieske 2017).

5.3.2 Calibration

For procedures and data required for calibration, the B/E Aerospace User Manual Calibration Procedure must be used. As per manufacturer's manual and internal manuals calibration is required at an annual interval. The test bench will arrive readily calibrated and must be calibrated next in late 2018. Per previous knowledge and calibration procedures, the calibration itself should take no more than one working day to complete and can be done on site. (B/E Aerospace 2013)

6 CONCLUSION

The thesis was successfully finished on time and the desired state to continue further along the project was achieved. Knowledge and resources gathered during the making will help in the next phases and until initiation of the workshop. In these last sections, a summary and a review of the thesis process and project will be looked into.

6.1 Summary

Starting this thesis and the project was exciting event and it was truly a great learning experience. Without much prior experience of projects or their management, it was clear almost everything would be new. It was motivating to research the world of project management; especially studying how to manage conflicts and unforeseen events was thought-provoking.

Although working in high pressure conditions and a hectic environment is familiar, the ability to handle these tough situations has been a weakness and quite unknown so far. Now that a solid knowledge base has been set, the learning experience will continue as new situations are faced. It is beneficial to keep a learning mindset in the future and keep on top of current knowledge as well.

Preparing the repair capability will continue as specified in the thesis together will all related groups. FTS procedures from MOE and TOPI together with other applicable laws, will be followed to ensure compliance with aviation regulations and safety in every aspect.

At the time of publishing the thesis it is estimated that the workshop will be fully functional during the year 2017. Great effort will be put into meeting this goal.

6.2 Review

Continuous learning and improvement in any task requires awareness of the whole process and the end result. Enhancing performance for the next round of tasks requires evaluation and reflection of the performed tasks. Meeting the evaluation criteria set for the thesis was also a goal to be achieved.

Theoretical background data and documentation was successfully harvested. The big picture was well perceived and a solid base was created to continue with the project management. Also, valuable connections, both internally and externally, were made to assist with each phase of the project. It was challenging at first, due to a new working environment, but thanks to an open and supportive atmosphere it was manageable. Active cooperation and interaction has to be maintained with all parties to address both positive and negative subjects that may arise. A more precise grip on scheduling and managing meetings is required for the remainder of the project.

A rigorous familiarization with the thesis guidelines assisted in writing it efficiently. Having all appropriate resources at hand and knowing how to utilize them, was the key to being efficient. Albeit a firm schedule was not prepared, excluding the deadline, a preliminary plan and adaptive scheduling worked well during the process. As mentioned earlier, a specific plan will be prepared to track the rest of the project.

New and challenging things can often require leaving one´s comfort zone, but doing so is rewarding and educational. This requires a modern, multi-disciplinary and versatile work place, which FTS has proven to be. It is a pleasure to learn and implement the knowledge in such an environment.

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APPENDICES

Attachment 1: Safety Checklist

Attachment 2: Set-Up Checklist

Attachment 3: Project Master Checklist

Attachment 4: Finnair 3035 Form Koneturvallisuustarkastuspöytäkirja

Attachment 5: Risk Assessment Matrix

Attachment 6: Finnair 1051 Form Capability List Amendment

Attachment 1

Safety Checklist

- ☐ Safety instruction sheet available in Finnish (Turvaohjeet)
- ☐ CE- label found on test bench
- ☐ Machinery Directive -Certificate of Conformity for test bench (2006/42/EC)
- ☐ EMV-Directive -Certificate of Conformity for test bench (2006/30/EC)
- ☐ Low Voltage Directive -Certificate of Conformity for test bench (2006/95/EC)
- ☐ Test bench and product user training by manufacturer
- ☐ Finnair internal risk assessment completed
- ☐ Preliminary inspection and test before use, documented
- ☐ Connect ESD between test bench and ground, verify continuity
- ☐ All safety related documentation archived digitally and physically

Attachment 2

Set-Up Checklist

- ☐ Unpack the test bench from shipping crate
- ☐ Inspect completed for possible damages
- ☐ Navigate the test bench to designated installation location
- ☐ Clear and clean installation area
- ☐ Place test bench on spot and adjust to height
- ☐ Connect 3x 115V 400Hz to power supply
- ☐ Connect 1x 230V 50Hz to switch board
- ☐ Water connection to water supply
- ☐ Air connection to air pressure supply
- ☐ Place the PC on the test bench as planned, make all needed connections and setups required for use
- ☐ Connect ESD between test bench and ground, verify continuity
- ☐ Drainage connection to sewage line
- ☐ Place PVC/Teflon protector plates on test bench table and fasten
- ☐ Complete preliminary inspection and test, with documentation

Attachment 3

Project Master Checklist

- Preliminary Plan
- Procurement
  - Spares
  - Tooling
  - Facility
- Setup and Initiation
- Checklists
  - Safety
  - Set Up
- Data Validation
  - CMM´s available
  - Failure Data available and analyzed
  - Spares list and vendors
  - Test bench manuals available
  - Future installation info and plan
- FTS Capability Requirements met
- Audits - Aviation Authority and Internal
- Data Validation and Final Check

FINNAIR

KONETURVALLISUUSPÖYTÄKIRJA
Technical Operations

Osasto	Osastokoodi	Finnair nro	Koneen nimi	Valm.vuosi	Tarkastus suoritettu
					/ 20
Tekijät					Käyttöönottohyväksyjä

Käyttö, rakenteet ja varusteet ym.		Kun-nossa	Korjat-tava	Ei koske	Huomautuksia	Korjattu
1	CE-merkki					
2	Konekilven tiedot					
3	Pyörimissuunnan merkinnät					
4	Merkkivalot, painikkeet, merkinnät					
5	Käyttöohjeet					
6	Vaatimustenmukaisuusvakuutus					
7	Liikkuvat voimansiirtoelimet					
8	Etäisyydet vaarakohtiin					
9	Terävät kulmat, kynnykset					
10	Työtasot, portaat, kaiteet					
11	Kuumat pinnat					
12	Vaara-alueiden suojukset					
13	Toimintaan kytketyt suojukset					
14	Valokennot ja valoverhot					
15	Tuntomatot ja -reunat					
16	Erottaminen energiansyötöstä					
17	Käynnistys					
18	Pysäytys					
19	Hätäpysäytys					
20	Toimintatapojen valinta					
21	Häiriöilmoitukset/toiminta häiriötilanteessa					
22	Ohjelmoinnin ja käsiajon turvallisuus					
23	Ohjausjärjestelmän luotettavuus					
24	Melu					
25	Pöly, kaasu					
26	Käyttö- ja ympäristöolosuhteet					
27	Vakavuus					
28	Valaistus					
29	Huoltotyöt					
30	Rikkoutumisvaara					
31	Palo- ja vuotovaara					
32	Räjähdysvaara					
33	Sähköiskuvaara					

Finnair 3035 C - XAL (24.4.2013)

Attachment 4 Finnair Form 3035 Koneturvallisuuspöytäkirja (Finnair Plc 2017a)

Attachment 5 Risk Assesment Matrix

Risk Description	Probability [1-3]	Impact Factor [1-3]	Importance P*IF= [1-9]	Impact Description	Preventive Actions
Facility change	2	3	6	Start-up of workshop delayed, creating infrastructure takes long	Keep on top of current knowledge, have a general guideline how to proceed, try to advance decision making
Long leaves of key persons	2	3	6	Start up of workshop delayed, valuable information lost	Assign back-ups if possible, ensure information distribution beforehand
Damages during shipment of any phase	2	3	6	Start up of workshop delayed	Safety marging in start-up, using manufacturer as repair shop, recognize and report damages right-away
Test bench delivery	2	1	4	Start up of workshop delayed	Trainings are scheduled several months ahead of scheduled delivery date, interaction with manufacturer
Spares delivery	2	2	4	Start up of workshop delayed	Define spares to purchased and initiate procurement well in advance, ensure correct delivery
Tooling delivery	2	2	4	Start up of workshop delayed	Define required tooling and initiate procurement well in advance, ensure functioning of tooling
Human factors, training	2	2	4	Unability to attend trainings, unforeseen prolonged leaves	Back-up dates or personel for trainings, interaction with workshop and manufacturer
Facility preparations	2	2	4	Infastructure not ready to support test bench	Initiate work order as per needs well in advance, follow-up on progress
Poorly defined end-results	1	3	3	Desired end-results not met	Consult end-users and adjacent parties to define end-results, understand the big picture of needs
Internal communication	1	3	3	Excessesive delays on progress, risk detection	Always think from different perspectives "who might need this information", ensure progress reports are delivered,
Project adjacent factors	1	3	3	Start up of workshop delayed	Interaction and activeness towards possible changes
Key person drop-put of project	1	3	3	Start up of workshop delayed	Information distribution, understand each persons role, assign back-up after notification
Meeting thesis deadline	2	1	2	Later graduation than planned	Managing time resources by scheduling weekly hours for thesis work, back-up deadline
Complications in coordination	1	1	1	Start up of workshop delayed	Support from collegues and other professionals with first time project coordination, familiarization with the big

CAPABILITY LIST AMENDMENT
Technical Operations

Part number			
Description			
Manufacturer/vendor			
COMPANY CAPABILITY ☐ Overhaul	☐ Repair	☐ Inspection	☐ Testing/Calibration
A/C type ☐ -SELECT- ☐	☐ ☐	☐ ☐	☐
ATA code	Technical Publications Control System	☐ Updated	☐ Updating not needed
Adequate facility			
List of required tools/equipment			
List of approved test equipment			
List of approved technical data			
List on trained/qualified personnel			
Miscellaneous information			
Category Code according to capability list			
Title shop / person amending list			
Date		Signature	

Title company / person approving amendment FINNAIR /	EASA Part 145 Category
Date	Signature

Finnair 1051 J - XAL (26.3.2013)

Attachment 6 Finnair Form 1051 Capability Amendment (Finnair Plc 2017a)