ACADEMY

AIRBUS CORPORATE ANSWER TO DISSEMINATE ENVIRONMENTAL MANAGEMENT SYSTEM

Process for Advanced Management of End-of-Life of Aircraft

ECO-EFFICIENCY AND SUSTAINABILITY - G9 - ISSUE 1

PAMELA

AIRBUS EADS GIFAS CRCI CHAMBRE RÉGIONALE DE COMMERCE ET D'INDUSTRIE MIDI-PYRÉNÉES THE SOCIETY OF BRITISH SBAC AEROSPACE COMPANIES ATECMA Life

I. Introduction

In the commercial aerospace business, AIRBUS is still a "young" company: since its early beginnings in 1970, 5500 airbus aircraft have been delivered to customers. and less than 500 aircraft (< 10% of the total) have been retired from service.

Nevertheless, in the frame of its ISO 14001 certification and according to its long term vision, Airbus is voluntary setting up refernces and solutions for its aircraft End-of-Life phase.

In fact considering the expected growth in the number of retired aircraft (more than 200 retired aircraft per year in the world), the management of their End-of-Life must be addressed in a responsible manner. Airbus has joined forces with key partners to draw up and disseminate a process capable of decommissioning and dismantling aircraft in safe and environmentally responsible conditions. This to avoid uncontrolled practices, achieving an appropriate material recycling rate and controlling the second-hand spares market to ensure aviation safety.

This project, led by Airbus, is named PAMELA - LIFE which stand for Process for Advanced Management of End-of-Life of Aircraft (PAMELA).

Therefore the objectives of PAMELA - LIFE are:

- To demonstrate, by full-scale experimentation on aircraft, that 85% of the weight of an aircraft can be recycled, reused or recovered
- To set up a new appropriate standard for safe and environmentally responsible management of the End-of-Life of Aircraft (ELA). This process will cover all aspects, from storage (D1) (at pre-decommissioning phase) to disassembling (D2), smart and selective dismantling (D3) and recycling or elimination of materials or parts through controlled dedicated processes
- To install, through an efficient, competent and complementary partnership, international network capable of further disseminating the so-called 3D process (D1, D2, D3)

Key expected deliverables of the project are:

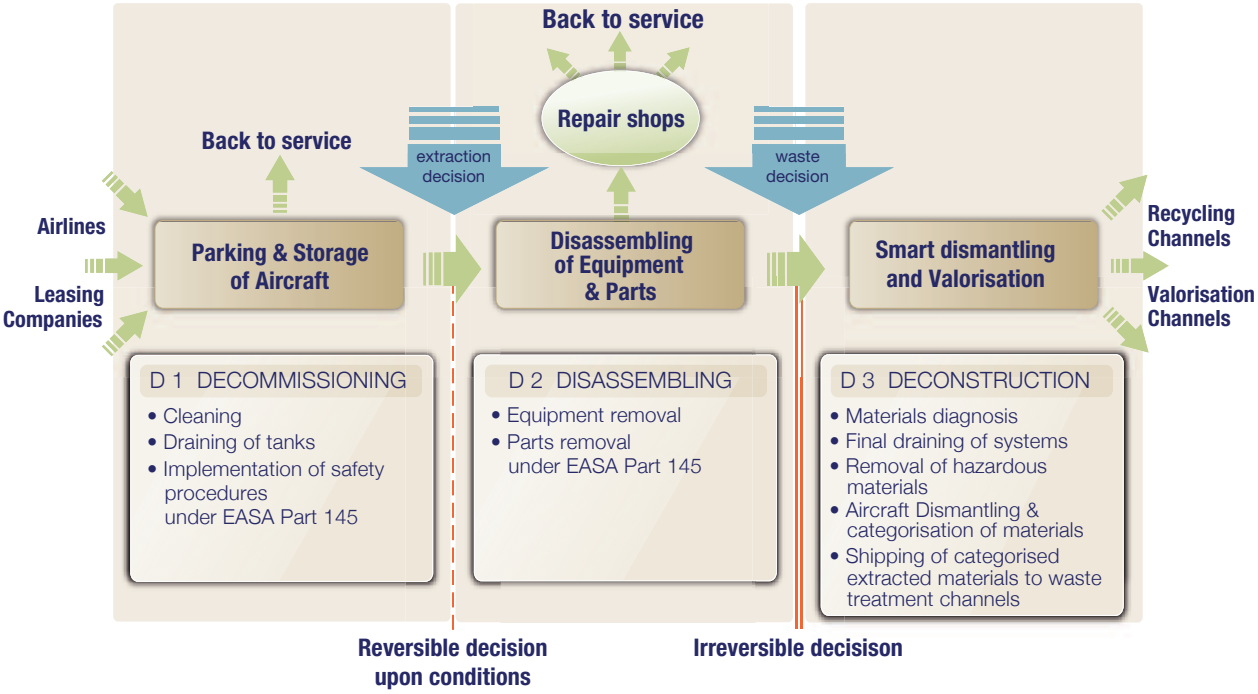
Best practices related to End-of-Life of commercial aircraft.

«The first known systematic approach to dismantling commercial aircraft».

Martyn GRAHAM
Airworthiness & Environment SBAC-UK

II. Technology

The overall so called "3D process" is displayed below. This model is used as the reference.



For the PAMELA - LIFE project, several advanced and innovative technologies were selected and evaluated.

1. D1 - Decommissioning's key points

1.a. Aircraft Cleaning and decontamination

The aircraft was decontaminated and cleaned according to the Airbus AMM and the Sogerma PART 145 approved procedures. In addition, some specific decontamination processes were tested and successfully performed with two different technologies supplied by the following companies: Sterinis and T.M.C.

Achieved results by far passed the given standards, demonstrating the achievability of such activities, and paved the way for future developments.

1.b. Draining of tanks

After the aircraft landed at Tarbes, its tanks were drained by Sogerma according to PART 145 procedures approved:

- Used water tanks
- Water from galleys
- Fuel tanks

2. D2 - Implementation Phase

2.a. During the D2 Disassembling phase

All resalable parts and equipment have been removed under PART 145 approved processes, and in compliance with Customs regulations.

The parts and equipment removed were:
- Engines
- APU
- Avionics
- Landing gears

Removing the vertical tail plane

2.b. D3 phase preparation

Once removal made the remaining aircraft structure was laid down on prepositionned support jigs at ~1m from the ground. This is the starting status for the D3 Smart and Selective Dismantling phase.

Positioning the cranes prior to the lifting operation (Jacks removal)

Lifting down the aircraft

2.c. Spectrometric analysis

In order to complement the material mapping achieved by Airbus Engineering and to set up an in workshop conditions material diagnosis process, portable devices were selected and tested.

EADS IW conducted a market and technical study. Half a dozen devices were short-listed, for metallic and composite substrates.

Evaluation tests were conducted according to a set of criteria: first at the EADS-IW central laboratory in Suresnes (Paris-France) and later on, when the results proved successful, on site at Tarbes (France) in industrial conditions, directly onto aircraft substrates and parts.

Spectrometer

This demonstrated the very high accuracy of some of the tested devices. However, surface preparation before testing was shown to be compulsory.

The results of such tests, combined with others carried out by the recovery channels, can be used to complement the initial mapping of the aircraft and can even serve as a fall-back solution when no material mapping is available.

3. D3 - Smart and Selective Dismantling + Valorisation

3.a. Monitoring system

- Objective
  - To collect data from the different dismantling scenario implemented onto A300 B4-MSN194 structure
  - The data collected are related to the kind of activity, the tools and means used, time and the amount of material removed from the aircraft

- Operator of the monitoring system

  The Developer and Operator of the monitoring system is SITA France.

- Performance

  The monitoring system was supplied with data such as time, cutting tools and devices, materials by type and by weight resulting from smart and selective dismantling, consumables. Data were taken from each operation by engineers. Thus the production costs of every secondary raw material from the aircraft were estimated with great accuracy. Every smart and selective dismantling practice performed for the PAMELA - LIFE project on one or more sections was extrapolated to the overall size of the aircraft.

- Results

  Data have been collected and were used to:
  - set up dismantling procedure used
  - populate a dedicated database and analysed taking into account manual/mechanical ratio activities
  - adapt/chose the dismantling process techniques according to the economic conditions of the market thanks to an interactive software (based on the LME - London Market Exchange)

3.b. Technical performance of the smart and selective dismantling process: activities performed

- Objective

  The target of the project was to demonstrate that advanced dismantling process of old aircraft, allowing greater recovery of parts and materials, can be implemented together with full compliance with Health and Safety regulations combined with full environmental compliance.

  The objective of the PAMELA - LIFE project was to identify the best recovery options. The dominant material - aluminium - was prepared and sent to different recovery channels according to different set of criteria. So while some aircraft sections were cut and different aluminium families were separated, other sections were sent for shredding without any preliminary processing or removal of passenger compartment elements.

- Entry data

  IPPC status required.

- Description of operations

The PAMELA - LIFE Smart and Selective Dismantling stages were as follows:

- Identification of different recovery channels and associated requirements
- Separation of the right wing from the fuselage, cutting and sorting into different materials (into types of aluminium alloy according to the requirements of the recovery channels, titanium, austenic nickel-based superalloys, stainless steel, etc.)
- Cutting and sorting of the materials from the vertical tail plane (into types of aluminium alloy according to the requirements of the recovery channels, titanium, austenic nickel-based superalloys, stainless steel, etc.)
- Extraction and sorting of all elements from passenger compartments, cargo compartments, bulk compartments (seats, window panels, baggage compartments, insulators, cables, etc.)
- Separation from the fuselage of frontward's section (pilot's cabin and electrical compartment), extraction of elements, sorting into types of materials
- Removal of elements from the hydraulic compartment
- Extraction of all remaining elements in the passenger compartment (except in a given section),
- Removal of empty section and preparation for shredding
- Removal of the fully equiped section and preparation for shredding
- Cutting of empty aircraft structure and preparation for smelting
- Cutting of left wing and preparation for shredding
- Cutting and material separation of center section (wing)
- Grouping of materials as per type and their preparation for shipment for recovery or elimination during dismantling phases
- Waste storages according to identify process and applicable EHS regulations

- Tools and devices used

Different cutting tools were used to separate the recoverable materials: plasma torch, angle grinder with different types of abrasive grinding discs, high pressure water jet (2000 bars and abrasive), chainsaw, hydraulic scissors-type tools. Manual tools such as spanners, utility knives, crowbars, screwdrivers, etc., were used to separate the materials from non-recoverable parts. Their uses were assessed according to time consumption, safety requirements and the status of the outgoing materials for recovery quality.

- Material sorting and recovery

The materials composing the aircraft (A300 B4 MSN194) were sorted and sent to the recovery channels: aluminium alloys, non-ferrous metals, stainless steel, WEEE, wiring, tires, plastics.

The aircraft weight for the smart and selective dismantling phase was estimated at 74,5 tons (the total weight of the PAMELA - LIFE aircraft was estimated at 88 tons, of which 13,5 tons of removed spare parts were recovered). Weight measures scatter together with materials used as test samples for the recovery channels account for less then 2%.

Major non-aluminium components were removed to leave the highest potential of aluminium components. The elements removed (containing: stainless steel, titanium, copper, titanium linked to aluminium elements, WEEE, tyres, some plastics) were sent for recovery to the appropriate channels. The non-recoverable parts and materials (mixed plastics linked to metallic elements) were sent for appropriate processing in certified elimination centres.

On 2/3 of the aircraft body the aluminium components were pre-sorted per alloy type (7075, 2024, 2618, etc.) or per main aluminium family (2XXX, 7XXX, etc.). The remaining structure was sent for shredding, with further sorting of the metallic part. The post-shredding residues were sent to the certified ultimate treatment centre.

After re-fusion or smelting, the recycled metal was cast into ingots and returned to the appropriate markets (aeronautic, mechanical or automobile) according to their chemical composition.

High-pressure water jet cutting

Plasma torch cutting

Fully equipped section shredding

Empty aircraft structure shredding

Left wing shredding

- Results

The aircraft used at a test bed for the project was an airbus aircraft of former generation weighted approximatively 90 tons (A300 B4 MSN194).

Up to 75% of the total weight of the aircraft were made of aluminium materials.

The results achieved by investigated techniques and scenarios show that more than 80% in weight can be either re-used (part-equipment) or sold for material recovery.

The complexity of aircraft material compositions and assemblies was highlighted when separating different materials according to recovery channel criteria.

However, further to the selective dismantling scenario, the technical feasibility of re-using aluminium from dismantled aircraft structure (as secondary raw material) for new aerospace production was successfully demonstrated. Structural parts made of aluminium alloys (including fasteners) were directly treated in a specific re-fusion furnace. The quality of the cast aluminium met the very demanding quality criteria required by the aerospace material specifications.

This is to be considered “a first-time event” in Europe and even worldwide. It can only be achieved by using appropriate sorting techniques designed according to the smart and selective dismantling principles defined by the PAMELA - LIFE project.

III. Conclusion

The PAMELA - LIFE demonstration project is a “première” in the aerospace business: for the first time ever, an aircraft manufacturer is operationally considering, from a responsible standpoint, the End-of-Life of a commercial aircraft.

To implement this project, Airbus has set up a consortium of partners with complementary expertise to fully address the End-of-Life issue.

The project is part of the approach related to the life-cycle management of Airbus products, now certified to the ISO14001-2004 standard and aimed at defining optimum practices.

Thanks to an efficient and multi-expertises partnership, in addition to the usual practices implemented so far, the project has identified an industrial implementation approach to aircraft End-of-Life management, providing the following benefits:

- Energy saving for aluminium casting (down by 90% compared to initial)
- Re-use of materials (e.g. aluminium) for aerospace purpose as secondary raw materials (aluminium,..)
- Saving of material resources by using secondary raw material
- Significant reduction of land filled wastes (down by 66%)
- Environmental Care
- Ensuring the safety and security of people
- Certifying the required reliability and safety relating to aerospace parts and equipment

This served to implement the demonstration project, which was performed in full compliance with identified applicable ESH and EASA regulations and procedures.

The experiment conducted on an A300B4 (former Airbus generation aircraft), in full compliance with regulations, defined a dedicated process model based on three main phases:

- Phase D1: Decommissioning of aircraft for parking and storage purposes (under PART 145)
- Phase D2: Disassembling of parts and equipment for re-use (under PART 145)
- Phase D3: Smart and Selective Dismantling of aircraft with related valorisation and recovery treatment

The methodologies and models set up are generic and can be used for any type of commercial aircraft.

Thanks to this experimentation, rates (in weight) of about 80% for valorisation and at least 70 % for secondary raw material generation were successfully achieved. This is an European and worldwide “première”.

Technically, industrial tests conducted with raw material suppliers demonstrated the ability to re-use the aluminium extracted from dismantled aircraft, for aerospace purposes. This is also an European and worldwide “première”.

Since the seventies, we have witnessed a continuous technological evolution in commercial aircraft, new technologies, materials and aircraft designs. Benchmarking with respect to other transportation industries involved in the End-of-Life management of their products shows that “aircraft design complexity” is highly crucial.

In addition, studies of current processes used for the treatment of aeronautical materials highlighted the pending need to organise and frame new technologies and treatment channels.

To further stress this point, the total weight of aircraft entering the End-of-Life phase (30.000 tons on average per year worldwide) is negligible compared to the weight of other transportation means such as personal vehicles or industrial trucks. The aerospace business is a very small "niche" in the overall business of treating materials from End-of-Life products, and cannot therefore generate its own dedicated reverse supply chain and related treatment channels.

These results lead us to consider setting up an hybrid aerospace/other industries reverse supply chain, partly based on existing industrial solutions and businesses and providing appropriate valorisation and recovery rates for aerospace products.

All the points listed above clearly show that an approach such as the one defined for ELV (End of Life Vehicle Directive 2000/53/EC) is not directly applicable as it is to commercial aircraft.

However, the results achieved by the demonstration project are themselves very promising, and we can already consider a step change improvement to current practices which are, moreover, no longer acceptable today.

It therefore appears necessary to rely on voluntary and responsible commitments likely to be decided by manufacturers in partnership with stakeholders, together with analyses of the suitable guidance and framework necessary at European and international levels, in order to implement best practices such as the ones highlighted by the project.