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Plane & Simple

Ever wondered what happens when an aircraft reaches the end of its working life? Well, it's a complicated process to recover all of the reusable components and materials, as **Aine Spoors** explains

As you fly home from holidays, or from a business trip, have you ever wondered what happens to the aircraft when it reaches the end of its useful life?

According to the Aircraft Fleet Recycling Association (AFRA) an estimated 12,000 aircraft are due to be retired in the next two decades. As environmental regulation becomes more robust, landfill regulations bite, and the materials used in aircraft manufacture change, the aerospace industry is constantly evolving, seeking new environmentally-sound methods for aircraft disposal.

Previously, aircraft were retired on average at 30-plus years old. Over the past 10 years this has changed due to the improvement in technology, making newer aircraft more efficient – the average age of aircraft being retired is now 20 years and the time scale is reducing; some of the newest aircraft GJD Services Ltd have disposed of were only eight years old.

A newer generation aircraft can be worth more as spare parts than as a whole, and many parts such as the engines, avionics and landing gears are being re-certified or overhauled and resold into the market place for reuse on other aircraft, or being returned to the airline to be put in to stock for use on the remaining fleet.

Aircraft require regular maintenance and important parts need to be replaced before they fail. Aircraft contain life-limited parts (LLP), which need to be replaced in accordance with certain cycles, revolutions or timescales. When these parts reach the limit of their useful life, they are sent for overhaul and re-work, or sent for disposal by mutilation to prevent re-entry in to the second-hand parts market. This is vital to ensure that any removed parts that are not fully serviceable cannot re-enter the supply chain; failure to follow this procedure will compromise the safety of an aircraft.

As a result of European legislation, most notably the EU Waste Framework Directive 2008/98/EC, aircraft had to comply with the end of life vehicle (ELV) legislation. GJD

became the first aircraft recycling company in the UK to gain an approved permit for the dismantling and disposal of aircraft under the Directive; it was a challenging process as the classification of when an aircraft becomes "waste" had to be clearly defined; working practices employed in the vehicle disposal industry did not fit with the aircraft disposal industry.

The Depollution Process

IN ADDITION to the myriad of recoverable spare parts, an end of life aircraft will have many pollutants classified as hazardous waste, and the legislation requires that aircraft are depolluted to remove these hazardous materials and fluids.

"Parting out" is the activity of removing salvageable parts for reuse and is carried out by trained mechanics, using the approved tooling in accordance with the approved maintenance data. It is classified as a maintenance activity to ensure these parts are properly handled and remain airworthy. Cutting lumps off the aircraft to get access, or cutting hydraulic lines to make the removal of a part easier, are absolutely forbidden. The simple rule with parts removal is that from the time the aircraft can no longer be put back together to fly, then that aircraft becomes waste, and any parts subsequently removed cannot be re-certified without a "repair shop" visit.

The depolluting process is also laid down in the aircraft maintenance manual and the aircraft disposal activity is governed by a set of procedures approved under our bespoke Environment Agency permit. The disposal activity must be carried out on an area with impermeable surface and sealed drainage system. When carried out correctly, after depollution, a Boeing 747 will have no more than 10 litres of residual oils trapped in hydraulic and fuel lines, which is an insignificant amount considering there are over two miles of pipes, tubes and wiring in each B747.

After the aircraft lands, its data plate (a unique plate put on each aircraft when the aircraft is built) and the registration number on the outside of the aircraft are cross-referenced with the documentation on board the aircraft. This process is part of the "back to birth" records inspection for each component requiring re-certification or mutilation.

The first action after landing is to check for any unserviceability that may affect any of the components to be recovered; function checks are carried out of all the systems… including flushing the toilets. Engine runs are carried out at full power to check the take-off performance data against a set of tables in the aircraft maintenance manual. Once all of the aircraft systems are checked, the aircraft is made safe by fitting safety pins and disabling certain systems.

The aircraft is configured for parts removal, which will include the lowering of the flaps, deploying the speed brakes, dropping the undercarriage doors and fitting all required locks to prevent inadvertent movement of flight controls or undercarriage doors, which would easily cause serious injury.

Next the aircraft is depolluted, the fuel and hydraulic systems are drained and the engineers remove all the required components. Once the parting out element is complete, the aircraft is certified to have had all required items removed; at this time the airworthiness certificate is revoked and the aircraft is de-registered. This is the point where the aircraft is no longer in maintenance and has now become "waste".

The interior of the aircraft is stripped and we endeavour to recycle or seek a reuse avenue for all the interiors – some parts, such as galley trollies and aircraft seats, will be reused on other aircraft and other elements have ended up on film sets or been reinvented as boardroom interiors and furniture, for example. The possibilities are endless… all that is needed is a good imagination!

The Teardown Phase

WITH THE interior stripped the remaining hull, which now consists of mainly mixed metals, enters the teardown phase. A heavy-tracked machine shears the hull into pieces for loading onto bulk tippers for transport to a metal processing facility, where it undergoes fragging and is processed further into a number of waste streams. At this point normally about eight percent by weight is classed as unrecyclable,

consisting of mainly fibrelam and sound-proofing material, with small amounts of plastics, rubber and other odd material which is normally sent for use as RDF.

The main material in the construction of aircraft 15 years or more old are aluminium alloys, stainless steel, titanium, glass or reinforced polymer composites and magnesium alloys. There are several tonnes of copper and aluminium wiring, which is heavily shielded and not cost-effective to remove, in addition to a number of different plastics and fibreglass panels with honeycomb cores, made from aluminium.

Newer aircraft are predominately made from carbon composite materials, which are less prone to fatigue, don't corrode, are stronger and easier to make into airfoil or complex shapes. These new composites will present new challenges to the industry as we seek new methods of disposal.

Textiles from the seat covers, carpets and the insulation also need a disposal route, and have ended up being reused in other objects, from bags to sound-proofing. Other materials, such as aircraft nickel-cadmium batteries, are currently reused. Older aircraft have contained depleted uranium and asbestos components and many still contain beryllium alloys and cadmium coatings.

Presently the industry average for aircraft recycling is achieving a rate of 80-85 percent. We at GJD Services Ltd currently aim to achieve a recycle rate of at least 95 percent. We have achieved a 99 percent recycle rate for an airline – there is an additional cost element, but larger airlines are willing to pay to reduce their carbon footprint as part of their corporate environmental responsibility.

As part of the process one cabin interior was reused by the marketing team to trial new products in the cabin. The remaining hull and aircraft were parted out, depolluted, the fuselage and wings were torn down and sent for recycling. The process involved completely stripping out the aircraft interior and finding a reuse or recycling stream for every material including the wiring.

We sent some of the more problematic elements of the interior to a specialist company that had found a method of recycling the most challenging materials into a useful end product, putting it through a saltus machine and additional processes that allowed different plastics to be mixed, creating an end product material that can be used in the manufacture of such things as plastic pallets.

The Challenging Aspects

CURRENTLY, A typically problematic part of the recycling process is the inside window reveal (the decorative panel surrounding the cabin window) which has such a high grade fire retardant finish, like all cabin interior items, it is very difficult to recycle. A typical window panel is made up of 14 different components, made from 10 different materials, which traditionally need to be segregated before they can be recycled. It is a very labour-intensive process, not commercially viable and to use these interior items as refuse derived fuel is problematic, due to the fire retardant coatings.

Newer generation aircraft, such as the Airbus A380 and Boeing's new 787 Dreamliner, are constructed using carbon fibre composites, which pose a new challenge for the industry and we will have to approach these materials from a different perspective, more akin to the disposal of asbestos due to the fine fibres that can be released during the shredding process.

GJD is working with a team from Toyota and a number of PhD students to develop scalable industrial methods to take the aircraft and reduce the composite material into manageable sizes in a safe, cost-effective and environmentally controlled way, enabling the recycled material to be used in future manufacturing.

The aerospace industry has begun thinking about aircraft from design to disposal, with a cradle-to-grave approach, and we are making great strides, engaging in the circular economy, embracing new ideas and innovative approaches throughout the entire lifecycle of an aircraft. ■

Aine Spoors is the environment compliance and ISO manager at GJD Services Ltd. Having worked in the aircraft recycling industry for the past eight years, she is an advocate for raising standards within the industry. Aine comes from a teaching background and actively supports research projects relating to her field.