THE FUTURE OF SUSTAINABLE, END-OF-LIFE AIRCRAFT MANAGEMENT

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Sustainability is fundamental to how Bombardier conducts its business. As an organization, we adhere to a Product Innovation Lifecycle to ensure the innovations we incorporate into our products at every stage meet and exceed customer expectations as well as produce the most sustainable and high-performing solutions, while mitigating the risks of new technology integration.

The Bombardier C Series commercial aircraft family has been developed following this innovative approach. The first aircraft, the CS100, is scheduled to enter into service in the second quarter of 2016 with SWISS. Later in 2016, a CS100 Environmental Product Declaration (EPD) document, an industry first, will be published.

As a responsible manufacturer of both commercial airliners and business jet aircraft, Bombardier has established a dedicated Ecodesign Program to integrate environmental concerns during all lifecycle stages of each new aircraft program, from the design phase to end-of-life (EoL), as illustrated below.

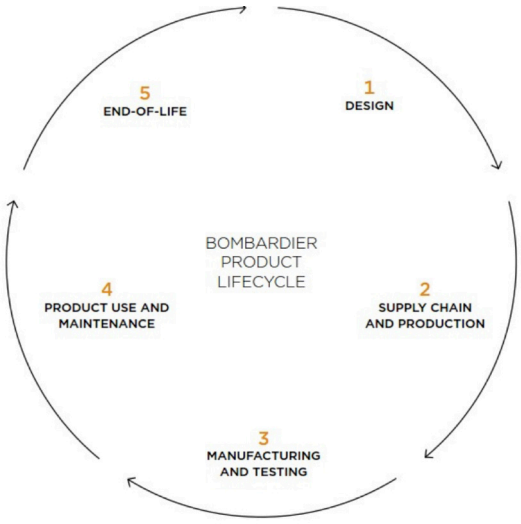

Figure 1. Product Lifecycle

Bombardier has established an End-of-Life program to support its corporate objective that all new products be 100 per cent recoverable by 2025. This program is focused on developing more efficient dismantling operations, maximizing the value of materials, and increasing the recoverability of 20 to 25 per cent of the materials that are discarded today, while reducing their overall environmental impact.

The rapid growth of air traffic over the last few decades has resulted in a high number of aircraft entering in service. However, whether for technical or economic reasons, many of these aircraft will retire from service over the next 20 years; in its 2015 Commercial Aircraft Market Forecast, Bombardier believes that 5,000 aircraft in the 60- to 150-seat categories will retire by 2034.

The storage of aircraft parked on airport grounds worldwide either waiting for a potential return to service or a tear-down operation has been considered the only option for a long time. Today however, this solution is no longer socially or environmentally acceptable for it can potentially create environmental issues, such as the release of pollutants from aircraft materials during dismantling as well as the unattractive view it forces on neighbourhoods surrounding the airport.

Figure 2. Routes to improve End-of-Life management

The aerospace industry, along with aircraft dismantlers, have looked at implementing a safe and sustainable solution for the management of the EoL of aircraft. In fact, the Aircraft Fleet Recycling Association (AFRA), in which Bombardier is actively engaged, assembled a team representing aerospace manufacturers, recyclers and dismantlers to provide their recommendations concerning best practices for the management of EoL.

Today, it is generally recognized that 80 to 85 per cent of an aircraft can be recycled. One objective for the different parties involved in EoL management is to address new challenges that can include developing more efficient dismantling operations,

maximizing the value of materials, and increasing the recoverability of materials being discarded today.

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For example, aluminium is literally used everywhere in current-general aircraft: in the fuselage, in the trims, in wing panes and many other locations. One of the most widely used alloys in aviation is the alloy known as 7075 which consists of aluminium, zinc, magnesium and copper. However, during the current recycling operation, alloy 7075 is usually mixed with other metals, thereby lowering both the final value and the end application of this valuable recycled aluminium (**Figure 4**).

The introduction of advanced materials to lighten structures - such as the increasing use of carbon fibres composites - is also a growing challenge for EoL management. Finding innovative solutions to recycle and reuse these carbon fibre materials must be part of the way forward.

Bombardier has led a research and development project, in collaboration with other industry partners and Canadian universities, to find new ways to increase the recyclability and recoverability of metals and maximize the value of the high quality aluminium alloys while also reducing the environmental footprint of the recycling operation.

Funded through the Consortium for Research and Innovation in Aerospace in Québec (CRIAQ), Canada, this project started in October 2011 and was completed in December 2015, with these outcomes:

Figure 3. Bombardier CRJ100 tear down

- Recommendation of new ways to optimize aircraft dismantling while reducing environmental and safety risks;
- Improvement of recyclability rates and material valorization (e.g. improve segregation based on the type of alloys and increase the value of recyclable materials);
- Assessment of potential environmental impacts related to EoL operations; and
- Integration of lessons learned in aircraft design to improve the design for EoL.

The consortium also has worked with Industrial Design students at the Université de Montréal to re-design leftover aircraft material into potentially commercially viable items such as bicycles, clothes, etc. Known as up-cycling, it aims to identify / demonstrate solutions to discarding non-recyclable material into landfill.

Figure 4. Re-designed leftover aircraft material