

Safety Release Fasteners Enable New Cabin/Cargo Decompression Concept

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ABSTRACT

In the frame of incremental product improvement, AIRBUS has developed and implemented a new innovative rapid decompression / pressure relieve concept for the cargo compartment area. The core change lays with detaching the complete cargo lining panels from the substructure in case of a rapid decompression in the cargo area instead of using dedicated blow in panels. In that way, pressure equilibrium can be achieved by air flow through the opened areas around the cargo lining panels rather than through specific blow out / blow in venting areas. The key for this is a self-detaching fastener AIRBUS has developed in an outstanding cooperation with ARCONIC Fastening Systems & Rings (former Alcoa Fastening Systems & Rings) in Kelkheim, Germany. These fasteners are installed to keep the cargo lining panels in place and tight against smoke in case of fire which is one of the main purposes for their use. In case of a rapid decompression event in the cargo area, the multi-piece self-detaching fastener fails within a defined timeframe and releases the ceiling and sidewall panels. The main challenge was to develop a fastener that on the one hand fulfils the tightness requirements, characterised by a certain compression level of a drytape seal, as well as mechanical conditions such as hard landings, wheel imbalance, windmilling etc. but on the other hand detaches (releases) at a narrow pressure difference load window in a given timeframe. Also, since the fastener is frequently removed and re-installed in service, a high number of re-use cycles needed to be achieved.

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INTRODUCTION

In a commercial aircraft there are in general two pressurised zones: the cabin (p_1) and the cargo (p_2) hold, see [Figure 1](#).

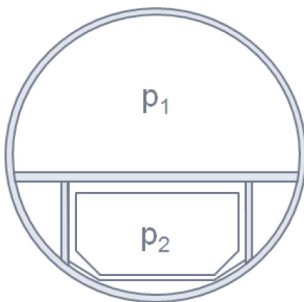


Figure 1. Principle of cabin and cargo hold

In the event of rapid decompression in one zone, air pressure equilibrium must be realised quickly in order to prevent severe structural damage since the airframe is typically not designed to sustain pressure difference loads across these zones and may collapse. The state of the art response to this problem in the commercial aircraft world are so called blow in / blow out panels in the cargo hold ceiling and walls to ensure the equalisation of air pressure between passenger and cargo area in case of abovementioned event. However, there are a number of drawbacks with this design such as manufacturing complexity, weight and cost of the panels and cargo & cabin substructure.

With the new design, 75% of the blow in panels could be eliminated enabling a weight saving of 15kg per A320 aircraft as well as a reduction of assembly lead-time. In addition, the new design also reduces the possibility of inadvertent releases of today's blow in / blow out panels during maintenance and cargo loading operations. The new system is supposed to offer improved operability characteristics and a clear visual improvement of the cargo compartment as well.

This paper shall provide insight into the fastener development for which two new qualification, respectively validation & verification tests were developed and conducted: one for verifying the release behaviour of one single fastener in a vacuum chamber to assess the fastener performance itself and another one being a full-scale trial of a panel with a size of approximately 5 m² (54 square feet) for a demonstration of the application. For the full scale test, a reservoir with a very large volume (30.000 m³, respectively 10.594.400 cubic feet) acting as low pressure accumulator was required to simulate the airflow of a rapid decompression event on flight altitude on an aircraft. As such big accumulators cannot be realised in a typical laboratory, these tests have been performed inside a large cavern that is located in an abandoned German salt mine 500 metres (1.640 feet) beneath the surface. Certain regions of this mine can be sealed and evacuated to generate the required volume to simulate before mentioned airflow pressures and quantities.

Based on the successful qualification of the new fastener and cargo lining concept, AIRBUS now offers an advanced cargo compartment to its customers that is already available for A320 Family CEO and NEO. Beside the fact that this solution will be baseline for any new aircraft generation, further deployment as customer option is ongoing for other programmes such as A330.

A320 DECOMPRESSION PRINCIPLE & OBJECTIVE

In an AIRBUS Single Aisle aircraft the decompression principle was originally realized by means of several blow in / blow out panels, which are held in position with special latches (see Figure 2) that allow the panels to release in both directions to ensure the equalisation of air pressure between passenger and cargo area in case of unexpected rapid decompression in one zone.



Figure 2. Latch (PRE MOD)

The blow in / blow out panels are surrounded by titanium frames on which aluminum grids are installed (see Figure 3) with the purpose to avoid an unplanned release of those panels caused by a physical impact during cargo on- and offloading for instance.



Figure 3. PRE-MOD cargo compartment with blow in / blow out panels

This concept is technically robust, however, it is a relatively heavy solution and requires a significant assembly time. In frame of one of AIRBUS' continuous improvement projects a new principle has been developed enabling eliminating the vast majority of those panels. The key for achieving this objective is a small fastening system developed by ARCONIC Fastening Systems & Rings in close cooperation with AIRBUS and specifically designed to detach once a certain axial load is reached. As shown in Figure 4, this fastening system consists out of four elements: a head section (in brown colour), a washer (in yellow),

a stud nut (in blue colour) and a clamp (in green) which is holding the head section and the stud nut in position as long as the axial load is below the defined release load.

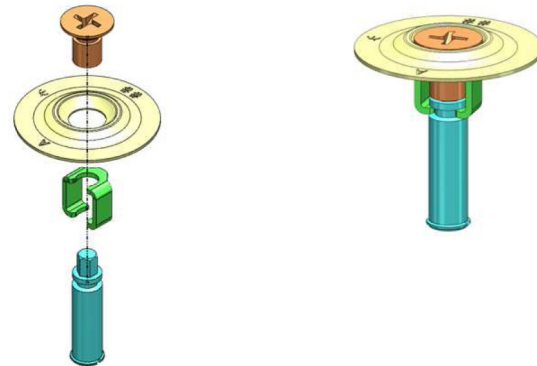


Figure 4. Safety release fastening system

This newly developed fastener is intended for use in installation of certain ceiling and lining panels and therefore enables the entire panel to detach at critical pressure difference between passenger and cargo area. During this development it was essential to obtain a design similar to the existing baseline fastener so that the same installation tools and the same receptacles (into which the stud nut is installed) can be used. This enabled to minimize the modifications to the existent and certified major component as much as possible whilst ensuring that MROs (Maintenance, Repair and Operations) and aircraft operators will not be affected.

VALIDATION & VERIFICATION TESTS

Under validation and verification test phase, the self-detaching fastener had to pass various mechanical tests which have been conducted at ARCONIC Fastening Systems & Rings in Kelkheim, at AIRBUS in Bremen, Technische Universität Dresden, IMA Dresden and in a few more locations. Among typical tests addressing mechanical performance, fatigue life and the installation performance of the system, two new test methods were developed and conducted and will be described hereafter more in detail: one for verifying the release behaviour of one single fastener in a vacuum chamber to specify and assess the fastener performance itself and another one being a full-scale trial of a panel with a size of approximately 5 m² (54 square feet) for a demonstration of the fastener performance in the final application. For the full scale test, a reservoir with a very large volume (30.000 m³, respectively 10.594.400 cubic feet) acting as low pressure accumulator was required to simulate the airflow of a rapid decompression event on flight altitude on an aircraft.

Single Dynamic Release Test

The single dynamic release test (SDRT) was carried out to obtain the dynamic release performance of a pressure difference triggered fastening system since the part performance under quasi-static tensile test conditions turned out to not be representative with the fastener behavior in case of rapid decompression. The main principle is that there is a test chamber with a defined volume in which the pressure shall drop rapidly (< 5ms) to a defined lower pressure level to simulate a rapid decompression scenario. Due to the pressure