When All

LOCKHEED MARTIN **F-35 LIGHTNING II**

Mark Ayton outlines this life

British company Martin-Baker has developed the US16E ejection seat specifically for the Lockheed Martin F-35 Lightning II Joint Strike Fighter to the requirements laid down through the JSF Contract Specification (JCS). The company has been on the F-35 programme since its inception and to ensure a low-risk approach was followed, design of the US16E evolved from the proven Mk16 ejection seat range.

Many demanding requirements for the ejection seat were introduced in the system development and demonstration (SDD) phase of the F-35 programme. These requirements shaped the design of the US16E seat in a manner unlike other programmes in which MBA has participated. This led to the adoption of a fully integrated and full production standard design from inception.

Requirements

Because the F-35 is destined to replace so many different aircraft types, affordability is crucial to ensure that the F-35 is deployed in sufficient quantities for all of the air arms due to operate the Lightning II. This requires a common ejection seat configuration for all three variants; the F-35A CTOL, F-35B STOVL and F-35C CV.

The F-35 requirement for crewmember accommodation has been expanded to include the widest nude population mass range (103 to 245lb/47 to 111kg) and the multivariate accommodation range (cases 1 through 8), as defined by the F-35 sub-set of the Civilian American and European Surface Anthropometry Resource (CAESAR) database. This requirement formally includes the female gender for the very first time.

Terrain clearance is defined as the height above ground that the ejectee first attains the safe descent rate of 24 feet per second (7.3 metres per second) while suspended under the parachute. The descent rate must be achieved across the wide accommodation range.

These requirements are based on the 'best-of-legacy' approach in which all ejection seat terrain clearance charts have been amalgamated and distilled from the US Seat inventory (Stencel SIIIS), MBA Navy Aircrew Common Ejection Seat (NACES) and Advanced Concept Ejection Seat (Douglas ACES II) into a common set of terrain clearance tables.

F-35 is the first programme to introduce neck injury criteria (NIC) because it combines three criteria: accommodation range, gender and the need for the pilot to wear a helmet-mounted display (HMD). The US16E seat is the only ejection seat that meets the NIC across the speed and accommodation ranges, including small females.

Ejection seat mass plays a critical part of the cockpit mass allocation, which was essential for the F-35B STOVL variant following the STOVL Weight Attack Team weight optimization effort launched by Lockheed Martin in February 2004. Design-to-mass is a fundamental principal of MBA seat design.

The STOVL aircraft propulsion configuration results in unique failure mode conditions, which the pilot is not able to react to quickly enough to eject manually. This resulted in the US16E seat interfacing with Lockheed Martin's auto-eject system which caters for low-altitude, low-speed and adverse pitch attitude escape conditions.

Integrated Design

The F-35 ejection seat is customer specified and not government specified, which is the ideal circumstance for Lockheed Martin to entertain a fully integrated solution for

Main Image: ***This shot shows the launch trajectory taken by the US16E seat.*** *All images Martin-Baker*
Below left: ***The Martin-Baker US16E ejection seat is designed specifically for the F-35 Lightning II.***

Else Fails

-saving US16E ejection seat

the F-35 cockpit, balancing the design requirements for accommodation, mass, life support, HMD requirements against the life-cycle cost targets.

A US16E ejection seat comprises six major assemblies: the guide rail, catapult, seat bucket, parachute and harness, and the seat survival kit. The guide rail assembly is mechanically attached onto the cockpit rear bulkhead and is able to rotate manually from 16.5° to 22°.

An air-vehicle interface disconnect unit (AIDU) which interfaces the electrical, ballistic, pneumatic services between the seat and the aircraft, is attached to the bottom of the guide rail.

The catapult is installed onto the rails and is the initial means by which the pilot is ejected from the cockpit. The catapult contains the neck protection device (NPD), which is an inflated system that supports the HMD during ejection thereby enabling the NIC requirements to be met.

A seat bucket, which mounts all the pilot controls, is connected to the catapult and a seat raising actuator raises and lowers the seat bucket over a range of 7.4 inches (188mm). For reasons of safety and operation, the HMD system is integrated onto the US16E seat. The catapult carries both the helmet transmitter unit (HTU) and seat position sensor (SPS), which are integral to determining HMD relative position in the cockpit.

Integrated within the seat bucket is a quick disconnect connector that carries all of the HMD signals to and from the aircraft. The US16E also carries a seat-mounted life support system. Integration onto the seat offers advantages from reach, maintenance, mass and cost perspectives.

The seat bucket houses the services connection package (SCP) which regulates breathing and anti-g supplies.

The catapult houses a 300L backup oxygen system (BOS) which can be removed or re-charged on the seat. Both the SCP and BOS are supplied by Honeywell Aerospace based in Yeovil, Somerset, UK.

A seat survival kit (SSK) contains all the survival aids, including a life raft and automatic inflation unit (ALIU). The SSK is installed into the seat bucket, on which the pilot sits. A fifth generation integrated harness is able to accommodate the wide range of pilot sizes and provides restraint during aircraft acceleration and ejection conditions.

The US16E seat meets the F-35 performance requirements by having a low acceleration catapult, the neck protection device which enables the neck injury criteria to be met, a drogue which is deployed early and downwind, and a larger main parachute, which is deployed early in the sequence and downwind.

Sustainment

Legacy aircraft programmes have commonly used three levels of maintenance: maintenance tasks that take place daily on squadron to enable self sufficiency when deployed away on operation (without industry support known as organisational level (O-level); centralised maintenance tasks on base for several squadrons referred to as intermediate level (I-level); and deeper maintenance undertaken back at a depot or back with the manufacturer, known as depot level (D-level).

In order to minimise the in-service sustainment costs, Lockheed Martin has eliminated the need for I-level maintenance across the programme by transferring these tasks to either O- or D-level. The US16E seat modular design enables component removal and replacement at O-level, thereby supporting the sustainment philosophy.