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Information Summary

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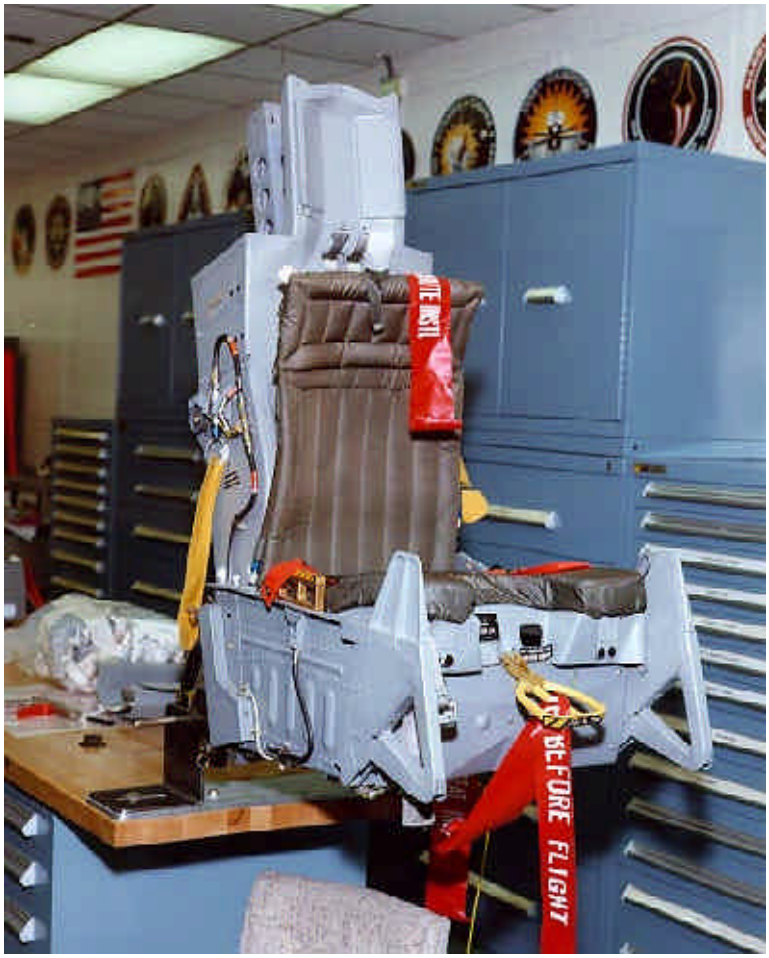
Aerospace Careers: Aircraft Escape Systems

One of the most important safety features on a NASA research aircraft is also one of the most complex systems. It is the aircraft escape system, more commonly called the ejection seat.

The job of an aircraft ejection seat is simple. When a crewmember must leave the aircraft in an emergency, it is the ejection seat that lifts him or her safely out of and away from the aircraft. The ejection seat system then deploys the parachute that will slowly return the crewmember to Earth.

Ejecting from an aircraft takes less than two seconds from the moment the crewmember pulls the ejection handle until a parachute begins to unfurl overhead. For the ejection seat to save a crewmember's life, nearly 500 parts in the seat's system must function properly and quickly in sequence.



F-16 ejection seat (ACES II)

At the Dryden Flight Research Center, where more than two dozen ejection seats are used in a fleet of NASA research and support aircraft, the essential job of aircraft escape system maintenance is part of the mission of the Life Support Branch.

Different Models, Common Sequences

The five types of ejection seats used in NASA aircraft flown at Dryden are made by three

Zero zero ejection seat test

different companies. All five types of seats function in a similar manner. When the ejection handle is pulled, an explosive cartridge is fired that triggers a chain of events, including activation of other explosive devices. These devices release the cockpit canopy, position the crewmember upright for a safe exit from the cockpit, move the seat up the rails and out of the aircraft, separate the seat from the crewmember, and deploy a small drogue parachute followed by the main parachute.

This sequence of events is engineered so precisely and occurs so fast that all new aircraft escape systems are now rated as “zero zero” — no altitude and no movement. “Zero zero” means a crewmember could eject from an aircraft which was sitting motionless on the taxiway and be boosted high enough to safely parachute back to the ground.

The F-15’s & F-16’s

The ejection seats used in Dryden’s F-15 and F-16 aircraft, including two F-16XL’s, are called ACES II, the acronym for Aircraft Common Ejection Seat, Model II. They were made by McDonnell Douglas. Although both types of aircraft use the same basic ACES II system, the cockpits of the F-15’s and F-16’s are different enough to require engineering variations between the two seats. This requires different maintenance and technical orders for each version and they are considered separate models.

ACES II seats are designed to deploy a five-foot ribbonstyle drogue parachute immediately after the ejection seat leaves the aircraft. The drogue helps stabilize the fall of the crewmember and seat until reaching an altitude of 15,000 ft, where the main parachute is released by an altitude sensor. If the ejection is below 15,000 ft there is no delay in the release of the main parachute.

The complete ACES II system weighs about 200 lb.

F-15 Cockpit

The F-18's

The test conductor is the center of all communications during a research flight at Dryden. This is quite often an engineering

The chutes of a Martin-Baker system.

mission planner. The EMP sits at a workstation where the research aircraft can be seen on a television monitor as it is followed by one of Dryden's long-range video cameras. Next to the EMP is a display on which all parameters associated with aircraft performance can be seen — speed, altitude, location as determined by radar tracking, flight control systems status, engine performance and fuel status.

At this workstation the EMP can also communicate with and hear the research pilot as he accomplishes each event on the set of flight cards strapped to the knee of his flight suit. The EMP monitors each step in the flight cards for safety procedures. Information from the project engineers that must be relayed to the pilot is passed through the EMP.

Dryden's F-18 aircraft use ejection seats made in England by Martin-Baker. Two models of the Martin-Baker system are found in the F-18's: one is used in the single-seat F-18's and in the rear seat of the two-place F-18's, the other is used in the front seat of the two-place aircraft.

The first parachute to deploy from a Martin-Baker system is a 22-in. drogue. It is used to pull out a 5-ft drogue that stabilizes the crewmember and seat until the main parachute is deployed at 13,000 ft by an altitude sensor. If the ejection is below 13,000 ft there is no delay in the release of the main parachute.

Fully equipped Martin-Baker seats weigh about 400 lb.

The SR-71's

Lockheed manufactured the ejection seats used in the two NASA SR-71 aircraft flown at Dryden. The system is a modified version of the Lockheed C-2 ejection seat used in F-104's called the Lockheed ADP F-1.

The parachute used on the SR-71 seat is a back style chute. The sequence of events when the

SR-71 cockpit and pressure suit.

ejection process is initiated is similar to the ACES II and the Martin-Baker systems. The aircraft, which can cruise at altitudes up to 90,000 ft at speeds of more than 2000 mph, has a crew of two. Each person wears a full pressure suit and helmet, much like a space suit. The pressure suits and helmets are required to provide the SR-71 flightcrew protection from the possible loss of cockpit pressure. The cockpit is normally pressurized

to a cabin (cockpit) altitude of 35,000 ft. Should this pressure be lost the suit will protect the crewmember from the loss of pressure.

When an ejection from an SR-71 takes place, regardless of altitude, a drogue parachute is instantly deployed to stabilize the fall of the crewmember and seat. The main parachute is timed for release at 15,000 ft, the same altitude at which the seat is automatically separated from the crewmember. In ejections above 15,000 ft, crewmembers remain strapped to the seats until a moment before the main parachute is released.

The completely equipped SR-71 ejection seat system weighs about 400 lb.

Maintenance

Maintenance on all models of ejection seats is controlled by technical orders, some as much as three inches thick, with instructions and specifications covering every part of the mechanical and pyrotechnic systems in each seat. Precise checklists must also be followed to remove, disassemble, reassemble, and reinstall any part of the system.

Technicians repair ejection seat

At Dryden, the job of overhauling an ejection seat requires two people; one who performs the work while the other follows technical order instructions and monitors each step in the overhaul process. Positions can be exchanged from task to task, or from system to system, because only experienced and knowledgeable Life Support Branch technicians are authorized to work on aircraft escape systems.

Periodic inspection and overhaul for all ejection seats follow the same process, regardless of the model. Once the seats are removed from the aircraft, explosive devices are disarmed and every explosive, pressure, and mechanical system is disassembled and carefully checked. Parts that show signs of wear are replaced, while others may be replaced because the manufacturer's time limitations have expired.

Components that function under explosive and gas pressure, tension or tension release, atmospheric pressure, or have a timed-release mechanism are thoroughly tested before reassembly takes place. Devices that fire drogue parachutes must be tested. Allowable tolerances for pull levers and handles are measured and dozens of "O" rings that hold gas pressure are changed.

The ACES II seats use a gyroscopic stabilizer to help keep the seat from tumbling during ejection. The stabilizer is also disassembled with the rest of the seat systems so that bearings and gear teeth can be checked and cables inspected.

An ejection seat overhaul and reassembly requires approximately eight hours to complete. An overhaul can take much more time if there is a higher-than-normal number of parts to be replaced.

ACES II ejection seats are removed from the aircraft and undergo the complete inspection and overhaul cycle every three years, while the Martin-Baker units receive a complete inspection and overhaul every 448 calendar days, the equivalent of 14 months. SR-71 seats

are removed from the aircraft every six months for inspection and replacement of items according to the seat manufacturer's time-limit requirements.

NASA's B-52 launch aircraft is equipped with four ejection seats. They are maintained and inspected on a regular schedule by the Air Force Life Support and Test Parachute unit at Edwards AFB.

Air Force life support personnel at Edwards also inspect and repack all parachutes at Dryden, including those integrated into ejection seats.

Experience

Considerable training and experience are required before a person is qualified to work on aircraft escape systems. The principle sources of this training and experience are the military services and the ejection seat manufacturers.

A person already working in the life support field can be trained and qualified for aircraft escape system maintenance, but it requires attending either formal military schools or schooling provided by the seat manufacturers. The individual would then work at an apprentice level with experienced personnel until he or she reached a level of competence to be certified.

As modifications and improvements are made to existing ejection seat systems, training courses are conducted by the military services or by the manufacturers to keep personnel fully qualified.

Introduction of a completely new ejection seat by a manufacturer would also require an extensive training effort.