No fighter pilot wants to go through an emergency ejection. It’s a violent, inherently risky event. The canopy over the pilot is deliberately shattered by an explosive charge. Then the entire seat is blasted upward with tremendous force before the parachute is fired outward. The whole thing takes only three seconds.

But with the military’s next-generation $159 million fighter jet, pilots could find themselves literally putting their necks on the line. Nearly 1 in 3 pilots who will fly the F-35 Joint Strike Fighter run a heightened risk of fatal whiplash during an emergency ejection, according to Pentagon documents obtained by CQ. Mannequin tests this summer showed that the lightest F-35 pilots, in particular, face a lethal risk in an ejection when the F-35 is taking off or landing. The pilots are rotated backward into a position where they face all but certain death from the rocketing parachute’s force snapping their heads. Even more worrisome, the Pentagon lacks the data to assess the safety of pilots of average weight, defense officials say.

“I’ve got to just tell you: If my son or daughter is flying the airplane, or I’m flying the airplane, we owe it to our folks out there to make sure it’s right,” says Maj. Gen. Jeff Harrigian, the Air Force’s point man for the F-35.
The ejection seat is just the latest of many afflictions to beset the effort to acquire 2,457 F-35s for nearly $400 billion, plus about $1 trillion to operate them — the most expensive military initiative in history. Fourteen years into its development, the F-35 program is seven years behind schedule, the cost per plane has roughly doubled and the jets are still plagued by everything from engine fires to structural cracks to software glitches. The test fleet has been grounded several times over the past two years because of major flaws.

But the F-35 program was designed to be too big to fail. The jet is the only new manned fighter rolling off U.S. assembly lines today. It will be used by the Air Force, Navy and Marine Corps, with a different model for each. Several top U.S. allies will also buy the plane. And the military is accepting the risk to some pilots. After all, it has left itself no alternative to the F-35.

"If I had it to do all over again, obviously I would not approve of that kind of weapons system and the cost overruns that are associated with it," Senate Armed Services Chairman John McCain, an Arizona Republican, told reporters in May after his panel approved a fiscal 2016 defense authorization bill that authorizes spending enough money into its development, the F-35 program is set to buy 63 planes, six more than the Obama administration requested. "But now that it is at the stage that it is, we need to go ahead and continue to acquire it, in my view."

Back in 2009, the Pentagon had expected to have 684 fighters by now. But today, there are just over 150 jets, none of which is being used yet for combat operations.

And the costs continue to escalate. Because the F-35 program was consciously put into production well before the design and development work was complete, the military now has to reconfigure every single jet manufactured so far, along with hundreds more rolling off the assembly line in the coming years. It’s a risk the military took — and Congress went along with — and it’s coming home to roost.

Concern Over Welterweights

There are three different variants of the F-35, but the services’ planes have much in common with each other — including the same troubled ejection seat, made by Martin-Baker Aircraft Co. Ltd. of the United Kingdom.

The Defense Department has publicly acknowledged the risk to its lightest pilots: those under 135 pounds. But those who are closer to average weight are also potentially in danger.

According to previously undisclosed documents issued by the jet program in September, for F-35 pilots weighing 135 pounds or less, there is a 98 percent “probability of fatal injury” during ejections from the jet at 160 knots, a typical speed at takeoff or landing. At such low altitudes, there’s no time to release a smaller parachute that, at higher altitudes, is used to slow down the ejected pilot and ease the effect of the main parachute’s violent release.

With Martin-Baker’s F-35 seat, lightweight pilots are more likely to be rotated backward into a position where their neck and head are extended and their bodies are aligned in the wrong position just when the parachute is explosively released from the seat, according to knowledgeable officials.

The result is “potentially fatal whiplash,” Air Force Lt. Gen. Christopher Bogdan, the manager of the F-35 program, said in a summary of the problem written last month.

Those lightweight pilots are currently not allowed to fly the F-35 because they are at “high risk,” the documents say. Historical data indicate, according to the documents, that more than 7 percent of Air Force officers fall into this weight category, which is equivalent to that of a lightweight boxer.

Of far greater concern, however, is data that has not previously been made public about the possible effects of ejection from the F-35 at relatively slow speeds for pilots of more normal size — the welters and middleweights of U.S. military aviation, to use the boxing analogy.

Indeed, a large percentage of F-35 pilots could find themselves at risk, some in the Pentagon worry. Female pilots, who tend to weigh less than their male counterparts, would be disproportionately affected, experts say.

First, in relatively low-and-slow flight, the probability of fatal injury to pilots weighing up to 165 pounds is 23 percent — a degree of peril that the documents officially term a “serious risk.” Fully 27 percent of male and female officers weigh that much, the program documents indicate.

The at-risk population is pilots weighing between 103 and 165 pounds for all F-35 variants, wrote Gregg D. Costabile, the F-35 program’s director of engineering.

An Aug. 27 document, “F-35 System Safety Risk Assessment,” put it this way: “The Serious risk for pilots between 136 and 165 pounds will require acceptance of the Serious risk or further weight restrictions.” That document was signed by Mike Nennmann, a safety executive with Lockheed Martin Corp., the main contractor on the F-35, and Jack Landreth, a safety official with Naval Air Systems Command.
Bogdan, the program manager, signed a document on Sept. 14 indicating he is willing to accept the “serious risk” for pilots between 136 and 165 pounds. In the document, he recommends that the U.S. military and its allies do the same.

So roughly 7 percent of pilots could be at “high risk” and 27 percent at “serious risk” during ejections near takeoff or landing, or about a third of personnel, if historical data on Air Force officer weights provide any clue.

However, some senior Air Force officials are concerned there’s even more to the story. The brass are worried that pilots weighing as much as 199 pounds — if they are wearing the latest F-35 pilot’s helmet, which is heavier than its predecessor — may have a risk of severe neck injury that has yet to be quantified because of a lack of test data, according to a defense official.

That’s because no tests have been done to gauge the pressures of ejection on pilots of average weight, the officials say.

The program office assumes that tests on a 136-pound mannequin can be used to determine the effects on pilots weighing up to 165 pounds. If so, then tests on mannequins heavier than 136 pounds would be needed to gauge the effect on pilots who weigh up to 200 pounds. But those tests have apparently not been done.

What’s more, the only mannequins whose necks were broken in tests were those

**Broken Wings**

The F-35 has a history of flaws and design problems, adding to the enormous cost overruns in the Pentagon’s fighter jet program.

1. **PROJECTED EJECTION DEATH RATES AS HIGH AS 98 PERCENT**
   Because of ejection-seat flaws and heavy helmets, the necks of 103-pound and 136-pound test mannequins were snapped in safety tests.

2. **HELMET DISPLAY**
   Suffers from a low rate of threat detection, poor accuracy, a high rate of false alarms and stability issues. The newest version is heavier and exacerbates the ejection issues.

3. **FUEL TANKS**
   Tanks found to be unacceptably vulnerable to damage from threats and lightning. Safety measures were removed to keep the plane’s weight at an acceptable level.

4. **HEAVY BUFFETING**
   A problem since 2009, the F-35 suffers from intense buffeting at times, leading to significant cracks developing on bulkheads and the fuselage and impairing the plane’s offensive and defensive capabilities.

5. **BURNING RUBBER**
   Tires found to wear out much faster than expected, requiring frequent replacement.

6. **ON-BOARD COMPUTER, SOFTWARE**
   Computer too bulky to be deployed. Software development plagued with delays and, as of last year, 151 mission-critical deficiencies.

7. **INERT GAS SYSTEM**
   Despite a redesign, component found to insufficiently remove excess oxygen from the fuel tanks in order to prevent fire and explosion from on-board power infrastructure, enemy fire or electrical storms.

8. **ENGINE PROBLEMS**
   As recently as this year, the GAO and DoD Inspector General noted that the “engine reliability ... is extremely poor.” After a catastrophic engine failure last year, precautionary limits have been placed on speed and maneuvers, limiting testing abilities.

9. **MOVING ON ITS OWN**
   “Wing drop” — uncommanded and uncontrollable movement — occurs when maneuvering at high speeds. Proposed fixes will reduce maneuverability and stealth.

Source: GAO analysis of DoD data
Budget Takes Flight, Planes Don’t

As costs for an F-35 have nearly doubled, the fleet has been downsized and delayed.

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Source: GAO analysis of DoD data

Note: Dollar figures are not adjusted for inflation

equipped with the latest, heavy helmets, according to officials and documents. That begs the question of what role the heavier helmets played in the testing failures.

The newer version of the heads-up display helmet has better, and bigger, night-vision sensors. The latest model of the helmet weighs more than 5 pounds, a good half-pound more than its predecessor. That doesn’t sound like a lot — until one is wearing the helmet, pilots say. Each additional ounce on the head adds to the pressure felt during ejection, which is at least a dozen times that of gravity, they say.

The role of the heavier helmet in the ejection seat risk is a matter of dispute. When the program tested a 136-pound mannequin wearing the lighter helmet in 2010, the mannequin’s head and neck were essentially undamaged. But when the heavier helmet was put on a 103-pound mannequin in July, and then again on a 136-pound mannequin in August, the mannequins’ necks were broken both times, according to officials and documents.

The program office maintains there is no connection between the helmet and the August test setback. But the fact that only the mannequins with the heavier helmet failed in the test has caused concern among senior decision-makers in the Air Force and elsewhere in the Pentagon, officials say.

They want to see tests with middleweight mannequins wearing the heavier helmet before they stop worrying about the risk to most U.S. military pilots.

But it’s not clear when those tests might take place, adding to the uncertainty of how much additional design work — and retrofitting — will be needed to make the F-35 safe enough to fly in combat.

Until these questions are settled by additional tests, senior Air Force and Pentagon officials say they won’t rest easy about any F-35 pilots.

Hard Questions Ahead

Martin-Baker, the ejection seat manufacturer, wasn’t the Air Force’s first choice to build the ejection seat, Defense Department and industry officials say. The service wanted to stay with the same “ACES” model that had worked on most other warplanes. But after a cost-benefit review, the Pentagon decided to go with Martin-Baker.

Martin-Baker did not return emails requesting comment. A Lockheed Martin spokesman said the F-35 program office is answering queries about the ejection seat.

The F-35 office did not reply to a series of detailed questions but provided a statement. In it, officials did not acknowledge even potential problems for pilots weighing more than 136 pounds.

“The safety of our pilots is paramount, and the F-35 Joint Program Office, Lockheed Martin and Martin-Baker continue to work this issue with the U.S. Services and International Partners to reach a solution as quickly as possible,” said Joe DellaVedova, the F-35 program spokesman.

“There are no flying restrictions with higher-weight pilots. The escape system restrictions only affect pilots weighing less than 136 pounds because lightweight individuals are assessed to have lower neck strength to absorb force.”

Efforts are underway to improve the odds of survival for the lightest pilots, including reducing the weight of the new helmet, according to DellaVedova.

“The potential for an increased risk of neck injury will be reduced with three fixes: installing a switch on the seat for lightweight pilots that will slightly delay parachute deployment and lessen parachute opening forces; designing a lighter helmet; and mounting a head-support panel, which is a fabric panel sewn between the parachute risers which will protect the pilot’s head from moving backwards during the parachute opening,” he said.

The congressional defense committees have already been keeping a keen eye on ejection seat issues on other jets.

Lawmakers inserted a provision in the fiscal 2015 defense authorization law ordering the Pentagon’s inspector general to investigate concerns that the military’s older fighter jets had ejection systems that were unsafe given the newer, heavier helmets in use by today’s pilots. The provision was prompted by a fatal incident where an F-16 pilot was killed after ejecting off the cost of Italy in 2014. The Air Force subsequently announced it would improve its standard helmet, which is different from the F-35 model.

The F-35’s helmet and ejection seats are newer models, but the same physics apply. Any new fighter jet is supposed to meet a standard that the risk of major injury from an aircraft ejection be under 5 percent.

“More testing will be helpful to us to make sure we fully understand how the seat is operating,” the Air Force’s Harrigian says. “I want to make sure it’s right.”

Harrigian would not offer a timetable for how long it will take to get there.

Congress may press him to move faster.

A House Armed Services subcommittee will hold a hearing Oct. 21 on the F-35 at which the ejection seat and helmet issues are likely to come up, aides say.

“It’s extremely serious anytime a weapons system could pose a danger to its own pilot,” says Rep. Jackie Speier, a California Democrat on the committee and one of the lawmakers most concerned about the ejection seats.

“I will be looking into this issue very carefully to make sure that F-35 cockpits are made safe and that the Pentagon is taking appropriate measures in light of the risk. We need to put safety first above the desire to field an untested aircraft.”