NOT AN OFFICE CHAIR

ACHIEVING INCOMPATIBLE GOALS, COMFORT, AND SAFETY IN AN EJECTION SEAT

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Not An Office Chair

I've been tasked with providing a brief history of the seat cushion systems designed by Oregon Aero for use in ejection seats. With apologies, for me, this is brief.

Asked to deliver an example of a seat cushion kit designed by Oregon Aero for an ACES II ejection seat, I was also asked if it would meet the following list of requirements, requirements that I found surprising, vague, and confusing.

NEW REQUIREMENTS (?)

A3T Ejection Seat Padding (A/3)

Aircrew utilizing aircraft with ejection seats require multiple seat padding options to place on top of current seat system/padding to support individual comfort levels for lengthy flight durations. Solutions should meet the following criteria: be of a shape or form that does not interfere with man/seat/aircraft disconnects or operation of ejection seats, portable and easily removable as aircrew individually use and hand carry their preferred padding to aircraft as needed, not be affected by electrostatic discharge events, not have electronics or magnets that could impede aircraft avionics systems, should be no thicker than 2" in bulk, resistant to flame, burn, melt/drip. Although not required, sheep skin cover and/or inflatable, adjustable paddings are encouraged.

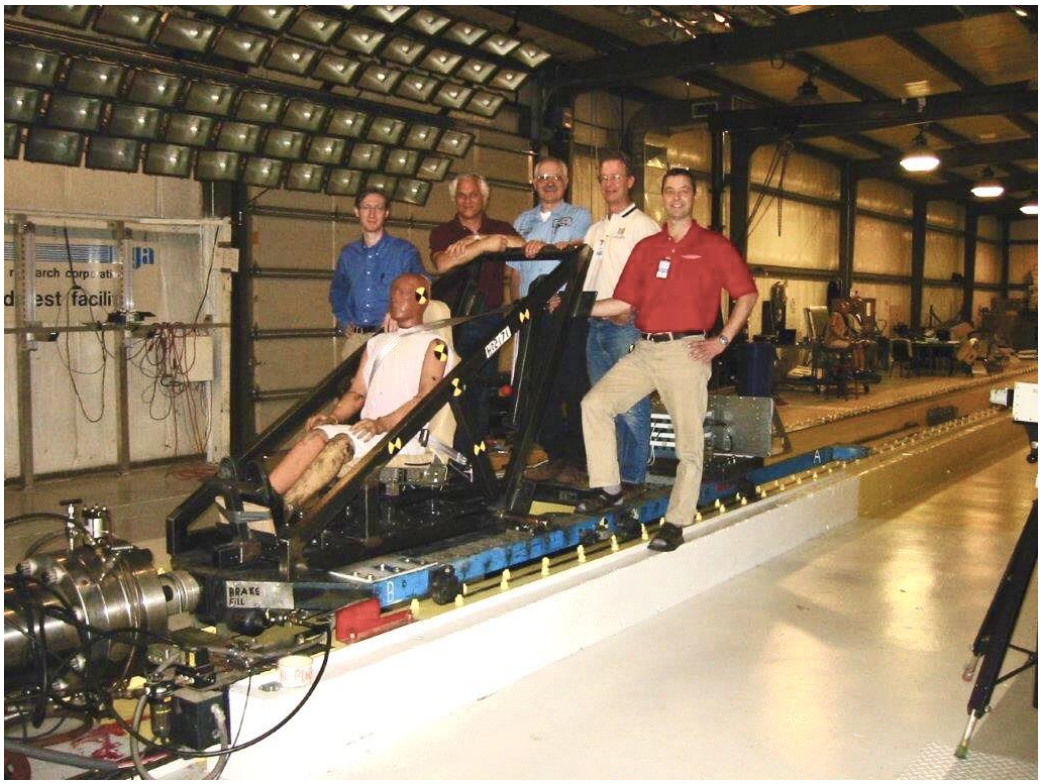
Air Crew Operations
A3T Aircraft Lumbar Support(A/3)
Aircrew utilizing aircraft with ejection seats require multiple lumbar padding options to support individual comfort levels for lengthy flight durations. Solutions should meet the following criteria: NOT have electronics or magnets that could impede aircraft avionics systems, ;, portable and easily removable as aircrew will individually use and hand carry their preferred padding to aircraft as needed, ability to be temporarily placed (hook/pile tape) to the back of the seat or to the pilot to prevent movement of the pad during flight, should be no thicker than 2" in bulk, be of a shape or form that does not interfere with man/seat/aircraft disconnects or operation of ejection seats, be resistant to flame, burn, melt/drip. Although not a requirement, sheepskin cover and/or inflatable, adjustable paddings are encouraged.

NOT YOUR AVERAGE SEAT

Confusing because I've been designing FAA Part 23 crashworthy seats since 1991 and ejection seat cushion kits (just a crash in reverse) since 1996, both of which have a stringent set of rules and expectations the designer must comply with. In 1996, I was contracted by McDonnell Douglas, who both designed and built the ACES II ejection seat, to develop a pilot acceptable cushion kit for the model of ACES II to be used in the new F-22. The engineers who'd built a new, zero velocity, zero altitude rocket seat with a 2% fatality rate and 50% injury rate, far superior to the previous explosive seat with its 50% fatality and 80% injury rate, were rightfully proud of the accomplishment, admitted they knew little to nothing about how to simultaneously achieve comfort and safety, and contacted an automotive seat component supply company to design the cushion. The vendor demanded payment in advance, then provided a file of ASTM standard data that McDonnell Douglas had upstairs in their library.

INTUITION

Seats seem simple, even intuitive. Soft should produce comfort , a spring improve the ride, and a "lumbar" cushion is needed to fix low back pain. "NOT force the upper shoulder straps to dig into the upper chest which can cause spinal pre-loading (bad for ejection)" is a commonly held myth.



Crash testing at MGA laboratories, the first, and still only, patented, certified crashworthy aircraft seat with no moving, or crushable components able to protect from secondary and even tertiary hits.

In a perfect world, non-intuitively, shoulder straps that create a painfully tight bond between the pilot and his seat pan prior to ejecting would represent the safest possible condition. The pilot and the seat would begin the acceleration phase at exactly the same instant, zero velocity slowly progressing to maximum acceleration without any opportunity for the seat to slap the pilot. Strangely, the perfect seat, the one with the least opportunity to injure the pilot would be a SOLID.

Shoulder straps cannot "pre-load" the spine as the acceleration is always going to UNLOAD the straps, assuming the upper body motion is downward. Straps, pre-loaded or otherwise, can cause injury when the out-of-position pelvis causes the upper body to rotate forward during the upward acceleration and the head is cantilevered out over the knees. In this scenario, the only scenario possible when the seat lacks proper pelvic support, the upper body is caught in a head forward arch (slouch) between the shoulder harness and the seat bottom, and is a perfect set up for a back injury: usually compression failure of L2 and or L3, and sometimes as high as L4.

THE CHALLENGE

Although I'd been invited to the meeting at McDonnell Douglas to solve the issue and not briefed on the previous events, because of the recent swindle, I was subjected to hours of adversarial grilling. I guessed I was following something like this because I'm usually engaged after the time and money is all gone, the dynamic tests have failed, and heads are about to roll.

"Tell you what, I can tell you guys have been burned so I'll design the cushion system, no charge, and if it passes all the tests, and the pilots like it, you buy it." I did, and they did. The prototype F-22 in the US Air Force Museum in Dayton, as well as the entire fleet, is equipped with our cushions.

Experience had led me to understand pilot preference is only one-third of the equation, successful technical test results a third, and maybe the most critical challenge to acceptance, the maintainers had to buy off on the gizmo. I went to the local Air National Guard Egress Shop, told the manager I was going to make a safer cushion the pilots would like, but "While we're designing this thing, is there anything from the perspective of the maintenance shop we should fix while we're at it?"

After a long silence, the shop manager looked at me and said, "I've been here for twenty-eight years, and no one has ever asked me that question." He wrote out a list of dozens of maintenance issues that we easily designed out of the cushion kit. Maintenance man-hours were dramatically reduced, no monthly damage maintenance, no annual replacement when it was no longer possible to put one more patch over the patches. No more pilot induced damage on boarding that grounded the plane therefore improved readiness. Reduced inventory requirements (two-thirds less) for three different back assemblies each with a different retention snap placement were accommodated with an adaptable universal attachment system.

A complete redesign of the base cushion retention snap mounting and straps, oxygen hose, and ELT antenna routing drastically simplified installation, and reduced maintenance.
Previously, cushion change out required two maintenance stands, two technicians, and one and a half man hours. The new cushion required just five minutes to change out by a single technician from the boarding ladder.

ABSOLUTE REQUIREMENTS

After many trips to McDonnell Douglas and hours of conversation with the engineers, the following short list of hard dynamic requirements was derived:

The cushion thickness at the base of the spine could be no more than ONE inch thick and must be constructed from well-tested, shock mitigating rate, temperature, and pressure sensitive viscoelastic aqueous CF-47 urethane supplied today by 3M. Non-Newtonian, where there's no reaction to action. (More on that later.)

CF-47 is a member of a family of viscoelastic foams that all behave in the exact same manner, but exhibit their unique characteristics at different temperatures. Seat kits from Oregon Aero may include as many as six different viscoelastic foam products chosen for their unique characteristics depending on various local forces affecting the cushion.

Years of extensive tests revealed that ALL commercially available portable cushions are enormous rate amplifiers (Newtonian with vigorous reaction to action), potential FOD, and are specifically NOT allowed in aircraft equipped with an ejection seat.

Fighter pilots have all seen the safety film detailing the consequences of smuggling on an inflatable whoopie cushion that will kill the pilot dead if he ejects sitting on it. So educated, the pilots were miserably uncomfortable, often played the odds, and took one along anyway.

THICKNESS

The issue concerning thickness is driven by the pilot's distance from the seat created by the portable cushion. Any additional thickness, or unapproved cushion will give the seat an opportunity to accelerate before it hits the pilot. Bad enough, the common Newtonian (all action has an equal and opposite reaction) cushion materials compress, load up like a spring, then bounce the pilot away from the seat. The seat continues to accelerate, catches up, hits the pilot harder, then does this four more times like a jackhammer before he clears the rails and dies when his spine is crushed.

How is this possible, you ask?

We're used to watching events like an ejection in slow motion, and therefore we think we understand the process. Unfortunately, slow motion has tricked us into imagining we know what's happening. We don't, so intuition fills the gap. The entire process happens faster than we can mentally or visually process it. From zero velocity through multiple impacts and a crushed spine is only 75 milliseconds, less time than it takes to blink.

WHY CF-47?

Non-Newtonian CF-47 exists in a world of its own. Rate sensitive, there's no reaction to action (not a spring) where semi liquids can transform into solids in a millisecond and back again in proportion to the change in acceleration. During a dynamic event (accelerating) CF-47's unique gravity polarized molecular structure absorbs the force of vertical acceleration by deflecting it horizontally into every

molecule, even those that are unloaded in the static condition. The result is a uniform load (no point loads) across the entire, well, pilot's backside. Additionally, some of the energy that might injure the pilot is converted to an energetic burst of heat, an internal temperature rise of five degrees F in fifty milliseconds, or a total of 100 degrees over the entire one second of acceleration. For the first few milliseconds of acceleration, the molecular construction unique to the CF foam family is effectively a SOLID mold the exact opposite shape of the individual pilot.

The seat and its occupant begin the acceleration at the same instant to prevent seat slap. As the velocity increases, the CF-47 begins to slowly deform to absorb energy and simultaneously convert to heat some of the kinetic energy that the pilot would have seen.

In other words, the cushion delivers multiple beneficial actions simultaneously to reduce the load on the pilot's spine by applying the acceleration smoothly over time. Admittedly, a very short period of time.

The inclination of a seat, over a long time, to produce the painful sensation of heat in the buttocks is caused by the springlike character of common cushion material to exceed capillary closure pressure of .62psi and deprive the skin tissue of blood, the early symptom of a bedsore. Skin death. Every foam tested exceeds capillary closure pressure at less than two percent displacement of its thickness, except the CF family of foam.

There's a secondary benefit to this ability. There's also no significant pressure between the muscle and bones. A common result of long-term sitting is a little known, but frequent cousin to ischemia, Deep Vein Thrombosis. DVT is a catastrophe in slow motion. Long-term pressure that collapses a vein creates a blood clot that, usually three days later, breaks loose and travels to either the heart, lungs, or brain. To the victim, it makes no difference where the clot goes, the outcome is the same in all three cases. Death.

If you think I'm overstating the severity for dramatic affect… well you're right, because it's devastating and not that uncommon. I lost a good friend to one of these monsters, and if you're fortunate enough to live to my age, you will, too.

Pressure, temperature, and rate sensitive, CF-47 in the static condition (unaccelerated), assembled into a shape that approximates the human form, a bowl with a pelvic wedge, will establish perfect spinal alignment, place the head directly over the spine, establish all the correct postural spinal lordosis, conform to the exact shape of the pilot and distribute his mass evenly over the largest area possible, like a liquid. Non-Newtonian, it has no rebound character and will not injure the skin tissue or throw a DVT.

IS THERE A DOWNSIDE TO CF-47?

Yes, it's frangible. Small frictional accelerations will reduce it to dust. The conversation with McDonnell Douglas almost went in the ditch over this point until they allowed us to mix materials in the design so long as the thickness of the CF-47 under the spine did not exceed ONE inch, and impact testing revealed no negative results from the composite of materials used to prevent material breakdown.

CF-47, or any of the CF family of products are not silver bullets. You can make a very uncomfortable and fragile cushion from this material. I know because I've done it. It required years of experimenting with composite blends to achieve longevity, comfort, and safety.

SHAPE

Normally flat or crowned because the upholsterer doesn't know how to sew a cover with an inverted compound curve, seats always allow the pelvis to rotate aft around the ischial tuberosity (sits bones) from the standing pelvic position because the seated body's center of gravity is behind its center of pressure at the sits bones. This reverses all the lumbar lordosis, the head moves forward, cantilevered out in space, held in position only by the compression of the guts and the shoulder restraints. Grandma's slouch, guaranteed to injure in even mild accelerations.

RESILIENT OR INFLATABLE CUSHIONS

Why NOT? Even less intuitive than the delayed acceleration of the pilot from a too-thick cushion, the springlike action of a resilient foam or air cushion changes the math. Energy equals ½ mass times velocity squared but add a spring or two to the structure and the math suddenly blows up. The shock the pilot will have to absorb now is this; Energy equals ½ mass times the spring constant of the resilient cushion, times the velocity squared. Take the same seat, add a resilient cushion, and the lumbar load will increase on average 5X. Not good and not particularly intuitive, hence my windy diatribe.

My COO, Tony Erickson, who's been to the test lab many times, shared, "It reminds me of the painful conversation at Wright-Patterson Lab with the guy that had been there forever about having to write a procedure for 'stabbing an inflatable cushion with a pen prior to ejecting.' I said, so if things are going so poorly that you need to eject, step one is grab a sharp object and stab at your crotch?" The guy answered, "Yup. Ejecting on an inflatable cushion will kill you."

INTERFERENCE

"Should be of a shape or form that does not interfere with man/seat/aircraft disconnects or operation of ejection seats."

Easier said than done. Although the various models of ACES II seats superficially look the same, there are many small differences that had to be, and were addressed for the individual aircraft including live fire rocket sled tests to be sure nothing interfered with the activation of or completion of the ejection sequence.

FIRE

"Should be resistant to flame, burn, melt/drip." The requirement has an element of redundancy in it. With no flame, burn, melt/drip are irrelevant. The APECS ejection seat kits were subjected to the most vigorous aircraft flame resistant test, the vertical burn certification. APECS cushions do not burn.

We manufacture civilian aircraft seats and cushions and take burn certification very seriously. When we pressed the military engineers on this point they answered, "It's a zero/zero, no airspeed or

altitude required for escape ejection seat, the pilot should have initiated the escape sequence long before fire in the cockpit could progress this far."

ELECTROSTATIC DISCHARGE, ELECTRONIC/MAGNETIC INTERFERENCE

As tested, APECS seat kits do not exhibit electrostatic discharge, and include NO electronic devices or magnets.

UNEXPECTED OTHER STUFF

Loose objects can be just as dangerous and are generally not allowed as, during an ejection, they can behave in an unexpected manner that can injure or even be fatal to the crew. An example, a Velcro fastened pencil holder I designed for use in the F-15 was not approved for use in the F-16. Why?

The rubber/Velcro mounting attached to the pencil allowed it to be stored under the glare shield where it was accessible while wearing gloves. If dropped, the attached mounting prevented it from rolling under the seat where it would have to be retrieved by disarming and removing the seat from the aircraft with a crane, a $10,000 undertaking (in 1996 dollars) to retrieve a ten-cent pencil.

The F-16, unlike the F-15, has no forward windscreen. When the canopy on an F-16 departs prior to ejection, the wind blast rolls under the glare shield and scours out anything under it. The debris is caught in a horizontal tornado spinning just over the pilot's lap. The early night vision goggles helmet mount was also susceptible to this phenomenon. Heavy, angular, or sharp pointed stuff orbiting in front of the pilot has obvious negative repercussions for the health of the aircrew who is about to exit the cockpit on the business end of a rocket.

LOCAL KNOWLEDGE OVER TIME

Designing products to protect humans from shock while also providing the difficult to quantify attribute, comfort, since 1989, in 2023 Oregon Aero still owns all the application patents ever issued for viscoelastic aqueous urethane except one, the thin, shock mitigating layer of CF40 used in every cell phone. This piece of self-molding, pressure sensitive material forms itself around the components, and its rate-sensitive nature protects them from being snapped off the circuit board when you drop the phone.

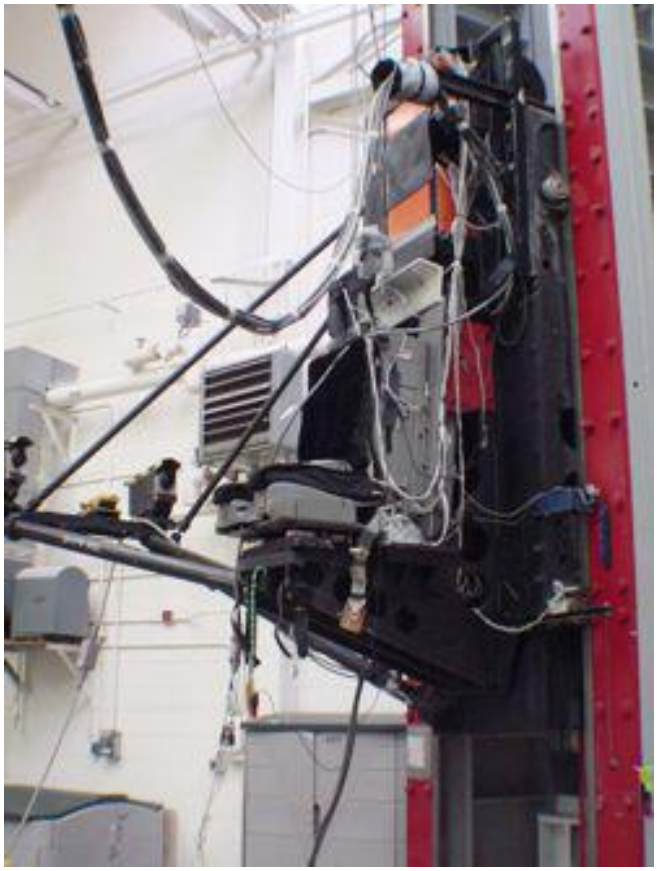
Currently, Oregon Aero manufactures in-house (MADE IN THE USA) over eleven thousand discrete part numbers. Nothing comes from 'Pop's Leather' in Turkey or China, and although the entire high-tech textile industry has gone overseas, we source just one textile from Japan, the only choice.

We also designed the only machine tools that can cut the CF material with the precision necessary for these cushions. Commercial foam saws designed for polyfoam have a thickness tolerance of plus or minus one-eighth inch with viscoelastics because of the material's unusual, non-Newtonian characteristics. The Oregon Aero designed saws have a thickness tolerance of plus or minus three-thousandths of an inch, accuracy that eliminates tolerance stack up for cushions with precise dimensions.

Other proprietary equipment, and processes, allow us to fabricate cushions with three-dimensional contours from two-dimensional material that cannot be molded.

TESTING

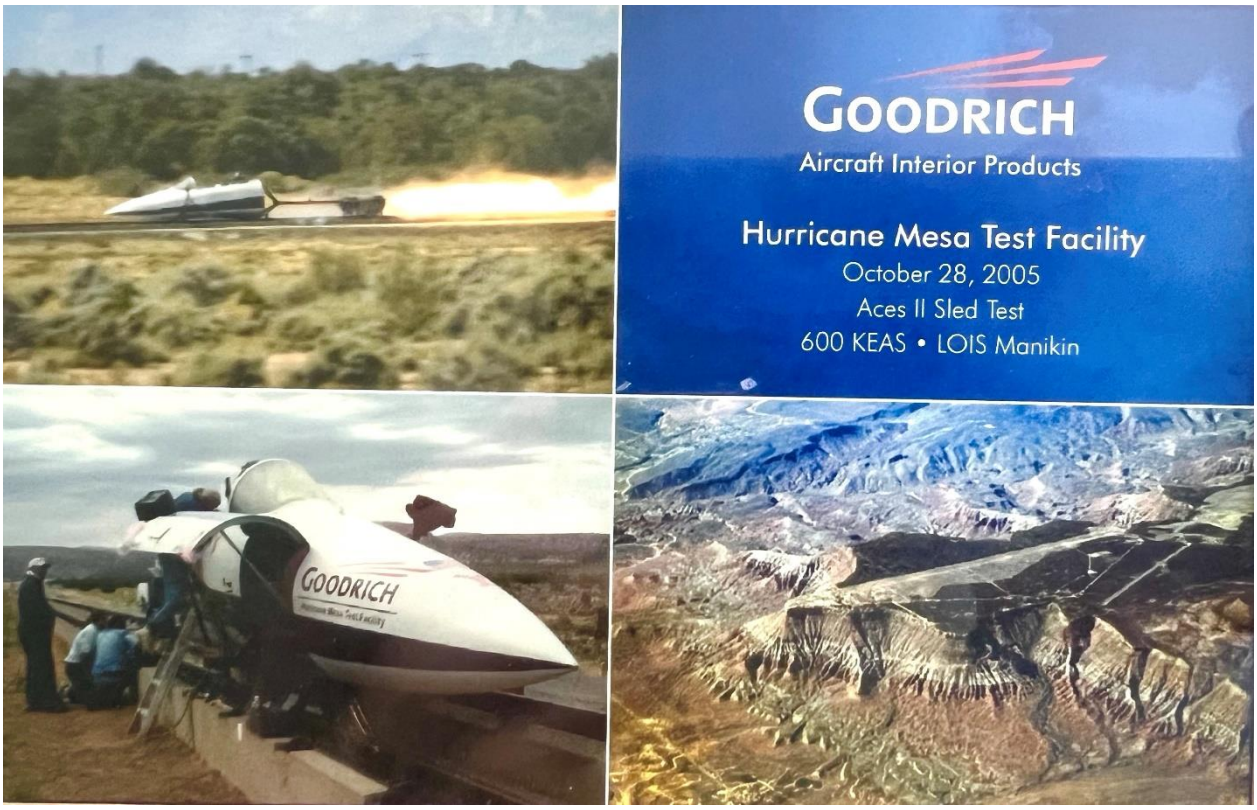
The list of AWR approvals and their long compendium of requirements would eventually include centrifuge tests and 1.05 Mach rocket sled live fire tests as the pilot population expanded to include both larger and smaller physiques.



Testing the Oregon Aero APECS cushion kit on the Ejection Seat Drop Tower at Wright-Patterson AFB

LUMBAR

The requirement writer has some concern about “lumbar” placement without qualifying what exactly that means. When the shape of a cushion back is referred to as “lumbar support” it reveals a certain lack of understanding about human physiology. Low back pain has nothing to do with this concept. If it were so, the last car you bought with an inflatable or adjustable lumbar cushion should have fixed your discomfort. It didn’t, did it?

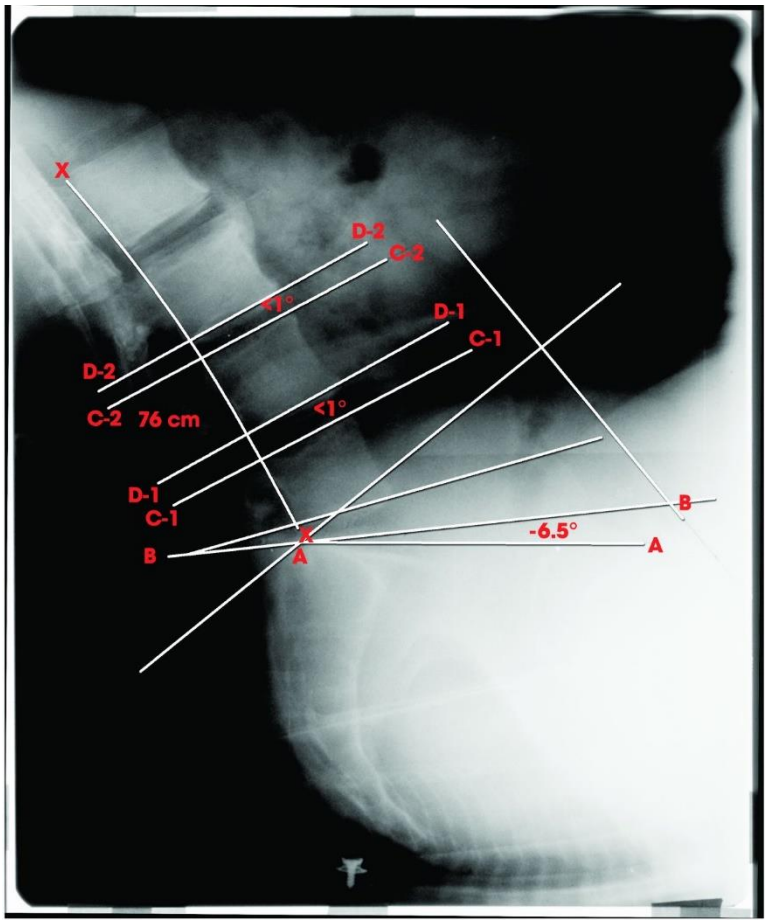


Oregon Aero® APECS® Ejection Seat Cushions have been successfully tested at NASA's Dryden Flight Test Center, Rosamond, CA; Wright-Patterson Air Force Base, Dayton, OH; Patuxent River Naval Air Station, Lexington Park, MD; Brooks Air Force Base, San Antonio, TX; and McDonnell Douglas, St. Louis, MO.

Low back distress is a function of the alignment of the pelvis, and pelvic alignment is a function of the shape of the bottom cushion, not the seat back. Normally, the upholsterer determines the shape of the seat bottom, flat or worse, crowned, because it's the easiest shape to sew covers for. On a flat or crowned cushion gravity pulls down on the pelvis which easily rotates nineteen degrees around the ischial tuberosity (your sits bones). This destroys all three curves of the spine, lumbar, thoracic, and cervical, so you end up in the classic forward slouch. In an argument with gravity relentlessly pulling down, a 'lumbar' cushion pushing horizontally is destined to lose, and just force the occupant forward. The placement of the pelvic wedge is critical.

This slouch is way more significant than just causing a pain in the low back; it increases the likelihood of back injury from any acceleration by 100%, hard landing as well as ejection. An injury unique to the reclined seat in the F-16 with its single piece canopy is also a surprise: a concussion from the pilot's head impacting the head rest during ejection. The unavoidable slouch from the force of acceleration and a misaligned pelvis moves the pilot's head and torso forward eleven inches away from the headrest during the first few milliseconds in spite of thoughtfully forcing himself to 'sit upright and make himself skinny," distance that's used to increase the velocity of the impact when the lack of a windshield milliseconds later, drives his head into the headrest. Energy equals half mass times velocity squared; energy that has to be absorbed by the pilot's head. Proper pelvic position, as well as making the pilot comfortable, reduces the helmet/headrest distance from eleven to two inches, and significantly reduces the velocity of the head and the severity of the impact. Remember, the energy increases with the increase in velocity, SQUARED.

You can’t beat gravity, especially when it’s amplified by a rocket.



This is an X-Ray of the pelvis of a pilot sitting in the original cushion of an ACES II ejection seat.

Line A-A is the medial line of the pelvis. Line B-B, the pelvic angle, -6.5 degrees off the medial line is tipped aft.

Vertebral lines C-1, D-1 and C-2, D-2, less than one degree is compressing the anterior (front) side of the normally wedge-shaped discs.

The arc X-X, the lumbar curve, has a very large radius of 76cm.

The surgeon I asked to blindly evaluate the X-Ray said, “Well, this is probably extremely uncomfortable and a setup for an injury.”

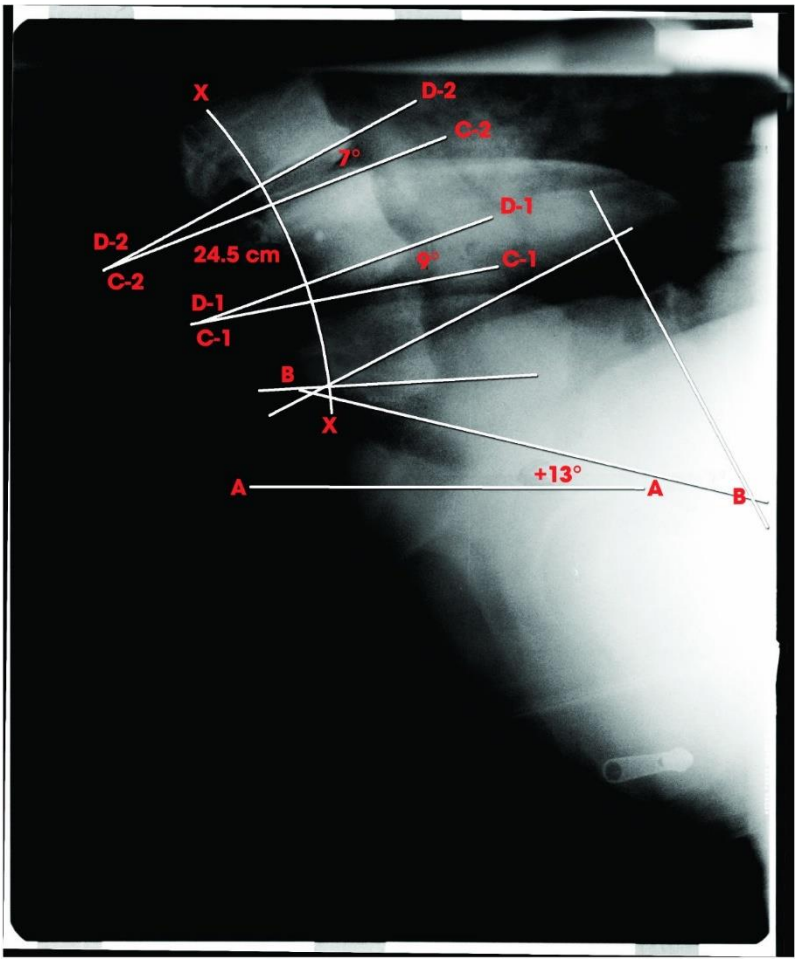
The pilot: “I can’t fly with my head back. To get it up, I have to pull from my gut and bring my head and shoulders up. Ugh.”

An X-ray picture of the same test subject, same structure, but with the new cushion. Line B-B, the pelvic angle line, +13 degrees has tipped forward a total of 19.5 degrees.

The relative vertebral angle, D-1, C-1 increased 8+ degrees. The vertebral angle of D-2, C-2 increased 6+ degrees.
The arc X-X, the lumbar curve radius, has been reduced by 51.5 cm to a radius of 24.5 cm.

The surgeon's evaluation: "Gads! These are perfect numbers, the same as standing posture! Only half as likely to be injured by an acceleration, and incredibly comfortable! I know you did that with a cushion! I just don't know how!"

The pilot: "I don't have to assume the position. The cushion makes me sit up, and I don't need to perform a continuous crunch to get my head up to fly, I just drop my chin."



When the pelvis is repositioned into the standing position by, of all things, the shape of the seat bottom sometimes aided by a very small cushion at the true lumbar -- under the belt… (that big curve you think is the lumbar is actually the thoracic curve) the spine's natural lordosis (curves) are restored, and the head moves aft directly over the spine to produce a small two-inch gap between the helmet and the head rest. This also removes all the discomfort and strain of sitting in the reclined F-16 seat. A common response is, "Wow! This is nice!"

BIODYNAMICS

A little-known fact straight from McDonnell Douglas: "The 30 degree recline of the seat in the F-16 has nothing to do with G tolerance, that doesn't begin until 45 degrees. The airplane was originally designed with a smaller seat from Upco Propulsion. After the F-16 design was frozen the Air Force decided to standardize ejection seats and when the ACES II was installed, the canopy wouldn't close. The seat was reclined until it would."

Get biodynamics right, and good things happen. The downside? Upholsterers who've never created inverse compound curves in fabric hate me. Impossible to hire people with these skills, we hire skilled talent then run them through a two-year in-house course in specialty sewing.

The seat back of the APECs cushion system can accommodate via Velcro a small lumbar cushion, but because of the aggressive pelvic support built into the seat bottom, it's not necessary. This capability of the bottom cushion to accomplish the desired outcome on its own was required because the space for the lumbar cushion is often filled with a rolled up flat pack of nylon rope known as a PLD. A Pilot Lowering Device is for getting out of the tree he just parachuted into.

OXYGEN SATURATION

All this is bad enough, but wait, there's more. Recent discoveries in how the body removes the trash of cellular combustion from the brain explains an anomaly we've observed for years: Grandma was right when she told you to "sit up, don't slouch," like it was a moral imperative.

For years we've measured a significant reduction in blood oxygen saturation when seated with the pelvis tipped aft (like every seat you've ever sat in including the one you're in right now.) When the pelvis is out of position, despite adequate oxygen from the mask, there is a restriction of cerebral spinal fluid (CSF) flow, the brain's oxygen delivery mechanism and trash removal system. In spite of adequate oxygen at the mask, the body can not deliver it efficiently when the CSF flow is restricted. Blood oxygen levels as low as 85% have been recorded when the pelvis is tipped aft. Healthy oxygen saturation is 95-100%, and surprisingly, under normal circumstances anything below 90% requires supplemental oxygen. This reduced oxygen content over time explains the measured decrease in pilot cognitive performance as measured on long flights, and possibly how an airplane ends up in the approach lights on a nice evening after a long day in the air. More simply put, the longer we sit in an uncomfortable seat, the stupider we become.

In a fighter, the phenomenon is amplified by the increased G forces while maneuvering, so much so the pilot wears a G suit to maintain pressure in the lower extremities to keep as much blood in the brain as possible.

An increase in total blood oxygen saturation is measurably beneficial to the pilot.

Without a doubt, the ejection seat cushions on the ACES Seat in the F-22 are the finest I have flown with. I (concentrated) on flying the jet, not saving my back." — Lt. Col. Paul "Max" Moga, the first Air Force F-22 Raptor Demo Pilot

Additionally, a painful seat is more than an irritating distraction. The body's response to chronic pain is to escape from the condition by retreating into sleep. Coupled with the fatigue of a long flight, reduced cognitive performance and pain, an enthusiasm for sleep can be disastrous.

Implications of This Seat Are Tremendous

Years ago, after sitting in a demonstration seat at a conference, an Air Force colonel abruptly said, "Hey! That's just like my seat!"

"What do you fly, sir?" I asked.

"The F-22… do you know, the seat is the same one we used in the F-15, but we can pull two and a half more Gs in the F-22?"

Greater oxygen saturation is good.

"[At first], I couldn't figure out how or why the F-22 seat would be so different from my previous aircraft or why my comfort level was so much higher. [With the Oregon Aero Ejection Seat Cushion], after pulling G's in the Raptor and after flying it for years with many long sorties behind us [up to nine hours in the seat at a time in my case]—the experience is that we don't get as sore and we're less fatigued. I don't find myself wiggling around in the seat, trying to get comfortable like I used to [in other jets]. Most amazing for me is I can get out of the plane without feeling like I've been sitting in it for 15 hours. The implications of this little seat—of all the things you can think of in an F-22—are tremendous!"— Lt. Col. Michael Shower in 2006, now retired, F-22 test pilot and Raptor squadron commander

EXISTING AWR'S AND AIR WORTHINESS DOCUMENTS

AWR's are not passed out like party favors, but are the result of vigorous testing. "Lost" supporting data or not, the existence of the AWR is evidence of successful testing and evaluation.

All of the following AWRs include a note of mention about sheepskin and fungal issues. Real sheepskin, unlike artificial wool, is organic, food for microorganisms. This issue was dealt with many years ago by the application of a mild fungicide to the skins. Contrary to popularly held assumptions, sheepskin adds little to overall structural comfort. Its major contribution is to control local heating and maintain a constant body temperature, something synthetic wool cannot do.

DEPARTMENT OF THE AIR FORCE
77th AERONAUTICAL SYSTEMS GROUP (AFMC)
BROOKS CITY BASE TEXAS

SEP 1 8 2007

MEMORANDUM FOR ACC/DRA 16

FROM: 77 AESG/CC
7980 Lindbergh Landing
Brooks City-Base 782355119

SUBJECT: Oregon Aero Seat Cushion Airworthiness Certification for F-16

I certify the Oregon Aero seat cushion, P/N 30350, as airworthy for use on F-16 ejection seats. This airworthiness certification is contingent on acceptance of risks identified in the attached risk assessment.

2. During fungus testing, the seat cushion was found to be a nutrient for fungal growth. Oregon Aero has corrected this problem; however, the outer covers of the seat cushions should be inspected periodically for fungal growth. If any fungal is found, the outer covers should be laundered or discarded.
3. The using organization, ACC, shall assume Operational Safety, Suitability, and Effectiveness responsibility as directed by AFI 63-1201, section 2.9.4. Configuration management resides with the vendor. Therefore, ACC must address future issues with the vendor, ACC must also address procurement, sustainment logistics and maintenance directly with the vendor.
4. My POC for this airworthiness certification is 2Lt Alexander Annen, DSN 240-8277. COMM 210-536-8277

Commander

Attachment:
Oregon Seat Cushion Risk Assessment

Risk Assessment for Oregon Aero F-16 Seat Cushion

Possible Risks:

Seats are a nutrient for fungal growth. There is a potential for a pilot to have an allergic reaction to the fungus.

Mishap Severity Categories

Description	Category	Environmental, Safe and Health Result Criteria
Catastrophic		Could result in death, permanent total disability
Critical	11	Could result in permanent partial disability, injuries or occupational illness that may result in hospitalization

Marginal	111	Could result in injury or occupational illness resulting in one or more lost work days
Negligible		Could result in injury or illness not resulting in a lost work day

Mishap Probability Levels

Description	Level	Specific Individual item	Fleet or Inventory
Frequent		Likely to occur within the life of an item. Probability of occurrence greater than 10^{-1}	Continuously Experienced
Probable	B	Will occur several times in the life of an item. Probability of occurrence less than I but greater than 10	Will occur frequently
Occasional	c	Likely to occur sometime in the life of an item. Probability of occurrence less than but greater than 10^{4} Unlikely but possible to occur in the life of an item. Probability of occurrence less than 10^{0} but greater than 10	Will occur several times
Remote	D		Unlikely, but can reasonably be expected to occur
Improbable	E	SO unlikely, it can be assumed Occurrence may not be experienced. Probability of occurrence less than 10	Unlikely to occur, but possible

Assumptions for Risk

l, Oregon Aero delivers cushions without proper fungal treatment, Probability .01

2, Seat cushion must be in an environment conducive för fungal growth. Probability .25

3. Seat cushion must be left in improper storage for 6 months or more to produce sufficient growth to affect the pilot. Probability .10

4. Pilots and maintenance personnel must not notice fungal growth. Probability .50

5. Pilot must have an allergic reaction to the fungus. Probability .05

Analysis For Risk

Non treated cushion .01

Improper storage .25

Prolonged storage , I O

Growth goes unnoticed .50

Pilot has allergic reaction .05

Probability of mishap

10-6

Mishap Category IV-E

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 3 1 1 HUMAN SYSTEMS WING (AFMC)
BROOKS CITY BASE TEXAS

MEMORANDUM FOR ACC,/DRA52DEC 2004

2 3 Dec 2004

FROM: 311 HSWIYA
7980 Lindbergh Landing
Brooks City-Base TX 78235

SUBJECT: Final Safe-to-Fly Recommendation for Oregon Aero B-52 Seat Cushion

l . Our office is providing a Safe-To-Fly recommendation for the use of the modified Oregon Aero Seat Cushion (P/N 3008821-049) installed on B-52 ejection seats. This Fly recommendation is contingent on your acceptance of the risk identified in paragraph 4 and attached risk assessment. The recommendation is extended to the following:

Oregon Aero B-52 Ejection Seat Cushion, P/N 3008821-049

2. The above approval is based on successful completion of the following tests:
a. Flammability Testing
b. Environmental Testing
c. Vertical Impact (Drop Tower) Testing
d. Operational Ground Testing

3. The configuration of the Oregon Aero B-52 Seat Cushion P/N 3008821-049 has been improved from the previously approved cushion (PIN 3752012) in the following ways:

a. Due to minor wear and foam. deformation in the leg area of the previous seat cushion, stiffer foam was desirable. To reduce wear while maintaining aircrew comfort, stiffer CF-47 foam (used extensively for construction of the previously approved cushion), will replace the softer CF-42 and CF-45 foam layers originally used in the upper leg areas. As B result. the new version, P/N 3008821-049, will be more resistant to wear and deformation. The CF-47 foam has already undergone testing and was approved; therefore. the previous environmental, fungus, and flammability testing remains valid. Limited ejection drop tower testing was re-accomplished by AFRL to verify performance under ejection acceleration and resulted in similar or better performance than the previously approved cushion.

b. The exterior color of the cushion changed from black to gray. No new materials were used in the outer covet of the improved cushion. The previous cushion safe-to-fly approval based on the environmental, fungus. and flammability testing remains legitimate and meets All requirements.

c. The overall width of the cushion increased by 1/2 Inch to help provide more area of support and to improve the fit onto the seat]survival kit container. Limited ground testing was accomplished at Barksdale AFB, which verified improved fit and showed no evidence of interference or any other form-fit-function problems.

4. During fungus testing, the seat cushion was found to be a nutrient for fungal growth, Oregon Aero has corrected this problem; however, the outer covers of the seat cushions should be periodically inspected

for fungal. If any fungal growth is found, the outer covers should then be laundered or discarded. In accordance with MIL-ST.D-882, a risk hazard index of IVD (negligible/vemotc) is assigned to Oregon Aero Cushion (ref. attached RHA).

5. This safe-to-fly recommendation only extends to the Oregon Aero B-52 Seat Cushion, (P/N 3008821-049). Any configuration changes in the seat cushion by the vendor or the user will negate this recommendation. Configuration management of the Oregon Aero Seat Cushion and its maintenance manual reside with the vendor. Future improvement, deficiencies, or corrective actions required or considered by the using activity will have to be addressed with the vendor.

6. Questions regarding this recommendation should be directed to Daniel. Aldridge, 311 HSW/YAPAA, DSN 240-8620 or e-mail

ALBERT F. BURNETT, Colonel, USAF
Materiel Group Director
Human Systems Program Office

Attachment: Risk Assessment

cc: ACC/LGMS
OC-ALC/LHR
93BSDOT

20SS/OSL
23BSDOL

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS HUMAN SYSTEMS GROUP (AFMC)
BROOKS CITY-BASE TEXAS

MEMORANDUM FOR ACC/DRA 103 0 MAR
FROM: HSG/CC
7980 Lindbergh Landing
Brooks City-Base TX 78235

SUBJECT: Final Safe-to-Fly Recommendation for Oregon Aero A-IO Seat Cushion Set

l. Our office is providing a safe-to-fly recommendation for the use of the Oregon Aero seat cushions installed on A-IO ACES Il seats. This safe-to-fly recommendation is contingent on your acceptance of the risks identified in paragraph 3 and the attached risk assessment. The recommendation is extended to the following:

Oregon Aero A-IO Seat Cushion Set, Vendor Part Number 35A10012 and 37A10012

2. The approval is based on the successful completion of the following tests:
   a. Flammability Testing
   b. Environmental Testing
   c. Vertical Impact (Drop Tower) Testing
   d. Operational Ground Testing
   e. Operational Flight Testing
   f. AFRL Cushion/Anthropometric Evaluation
3. The Oregon Aero A-IO seat cushion has the following risks associated with it:

a. During fungus testing, the seat cushion was found to be a nutrient for fungal growth. Oregon Aero has corrected this problem; however, the outer covers of the seat cushions should be periodically inspected for fungal growth. If any fungal growth is found, the outer covers should then be laundered or discarded. In accordance with MIL-STD-882, a risk hazard index of IVD (negligible/remote) is assigned to the Oregon Aero Cushion (ref. attached RHA).

b. The use of this cushion leads to an approximate one inch increase in head/eye position which means an effective loss of one inch of head clearance to the Maximum Sitting Height. This one inch increase in head position will affect the following three areas:

(1) Head clearance (helmet to canopy contact) will be reduced by approximately one inch. This may result in the helmet contacting/rubbing the canopy and could possibly scratch the canopy and/or damage the helmet. The impact on head clearance with the current A-IO flying population will be negligible. The use of night vision goggles or other helmet-mounted devices, in the stowed configuration above the helmet will further aggravate this problem.

(2) The eye position relative to the HUD or sighting devices may change. Those pilots currently flying with the seat adjusted full down will be about one inch higher than before. This may create problems with instantaneous field of view.

(3) The potential for injury with tall crewmembers (helmet height above canopy breaker height) may increase during a through-canopy ejection. The through-canopy ejection is the backup mode and is highly unlikely to occur. The use of night vision goggles or other helmet-mounted devices (in stowed

configuration above the helmet) will negatively affect this issue. In accordance with MIL-STD-882, a risk hazard index of ID (catastrophic/remote) is assigned to the Oregon Aero Cushion. However, this same risk (ID) exists for the standard ACES Il cushion as well (ref. attached RHA).

c. A few pilots noted a minor interference with the seat safety arming lever during ground/flight testing, but were able to correct the problem by moving the cushion slightly to arm/disarm the seat.

4. This safe-to-fly recommendation only extends to the Oregon Aero A-IO Seat Cushion Set (vendor part number 35A10012 and 37A10012). Any configuration changes in the seat cushion by the vendor or the user will negate this recommendation. Configuration management of the Oregon Aero Seat Cushion and its maintenance manual reside with the vendor. Future improvement, deficiencies, or corrective actions required or considered by the using activity will have to be addressed with the vendor.

5. Pilots with sitting heights greater than 38 inches should be aware of the potential risks indicated above and should insure that no head clearance issues or design eye issues would adversely impact safe aircraft operations. Pilots affected may choose to use other qualified (thinner) A-10 ACES Il seat cushions.

6. Questions regarding this recommendation should be directed to Daniel Aldridge, 311 HSWNAPAA, DSN 240-8620 or e-mail daniel.aldridge@brooks.af.mil.

ALBERT F. BURNETT, Colonel, USAF
Materiel Group Director Human Systems Group

Attachment:
Risk Assessment

HISTORY

After thousands of hours of successful utility across the fleet, the following memorandum was released. When I asked why, I was told approval had been withdrawn when it was discovered that the test data had been “lost.” The system is vast, and I’m sure it’s easy to lose data. Thirty-five years ago, I was asked by the local National Guard Squadron if I’d develop replacement cushions for their C130s. I complied, and when other squadrons asked their supply people for the same, they got this for an answer. “Do the cushions meet the technical requirements? If not, then NO!”

When asked for the specifications, no one could find them, so I traveled at my own expense to Battle Creek, Michigan, home of the stock number system and repository for the technical specifications where I was graciously provided with a microfiche machine and “all the time you need to find what you’re looking for.”

Data stored on microfiche is not searchable like a computer, but is stored on film. It took three days to find. I was looking for a file with what I imagined would be a lengthy list of technical specifications, so I failed to notice this very brief section, ‘Seat Cushions, C-130, locally procured.’

That answered the question, “Do your cushions meet the technical spec?” Yes.

Of course, over time this list of specifications has expanded greatly.

Decades of safe operations by pilots pleased to find they no longer hurt on a daily basis and were seldom injured by ejecting were abruptly terminated by the following message from someone at Warner Robins. As far as I know, and that’s not that far, no one at Warner Robins has anything to do with the design and development of ejection seats, so it’s no surprise that intuition seems to have driven the ‘requirements.’

DEPARTMENT OF THE AIR FORCE
642 COMBAT SUSTAINMENT GROUP (AFMC)
WARNER ROBINS GEORGIA

30 June 2010

MEMORANDUM FOR: see Distribution List

FROM: 642 CBSG/GBED
460 Richard Ray Blvd
Suite 200
Robins AFB, GA 31098

SUBJECT: Oregon Aero Seat Cushion on ACES 11 Seats

1. The purpose of this memorandum is to inform the ACES Il community that the Oregon Aero Seat cushions are no longer authorized on ACES Il seats. Evaluation of testing data did not provide sufficient information to ensure safe ejection of the ACES Il aircraft resulting in possible injury to the flight crew. This memorandum rescinds all previous memorandums as listed below.

2. The Oregon Aero seat cushions are to be removed from service in accordance with TCTO 13A5-56-573 and TCTO 1B-2A-1000

Aircraft	Memo Subject	Dated
	Safe-to-Fly Recommendation	17 April 02
F-15	Safe-to-Fly Recommendation for Oregon Aero F-15 Seat Cushion	21 Jan 2003
10	Final Safe-to-fly recommendation for Ore on Aero A-IO Seat Cushion Set	30 Mar 2005
F-16	Oregon Aero Seat Cushion Airworthiness Certification for F-16	sept 18 2007

3. Point of contact is Larry Kramer, DSN 472-7418, commercial (478) 222-7418 or Tyler Sartin DSN 472-7409, commercial (478) 22 -7409 ; e-mail 642CBSG.GBED.EAR@R0bins.af.mil

Distribution List:
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I was personally surprised by this memorandum to remove approved Oregon Aero seat kits from ejection seats. The intention of the writer is a little convoluted and confused. The list of aircraft is uncertain, three Safe to Fly recommendations, one for an unknown aircraft, one for the 10 (?), one for the F15 and one Airworthiness Certification for the F-16. If the writer has data to question the quality and safety of cushions designed for the ACES II seat, he failed to include it. If his goal was to enhance the safety of the ACES II, he missed the F-22, B-1 and the B-2. By the process of elimination, the unknown aircraft must be the B-52, which is not equipped with ACES II seats.

In conclusion, over the course of twenty-seven years Oregon Aero has collaborated with the qualified, clever scientists, aero medical researchers, and engineers at Wright Patterson AFB, Brooks AFB, and others to resolve significant, dangerous, and mysterious anomalies with ejection seat products as demonstrated by the data that follows.

As you can see, our aviators don't ask for much, but they do prefer painless, safer seats. Politicians constantly proclaim, "Nothing but the best for our warfighters!" I wonder.

"From all the aircrew who have flown with your seat cushions, they will never sit on another green brick seat cushion again...One guy from the active unit said he did not like the new [Oregon Aero®] cushion, but after flying a 15-hour sortie in the old style cushion he swore he would never complain again. For us older reservists, we cannot imagine how we flew this long on such a terrible cushion. Thanks." — C.R.

DEPARTMENT OF THE AIR FORCE
AIR FORCE LIFE CYCLE MANAGEMENT CENTER
WRIGHT-PATTERSON AIR FORCE BASE OHIO

31 May 2013

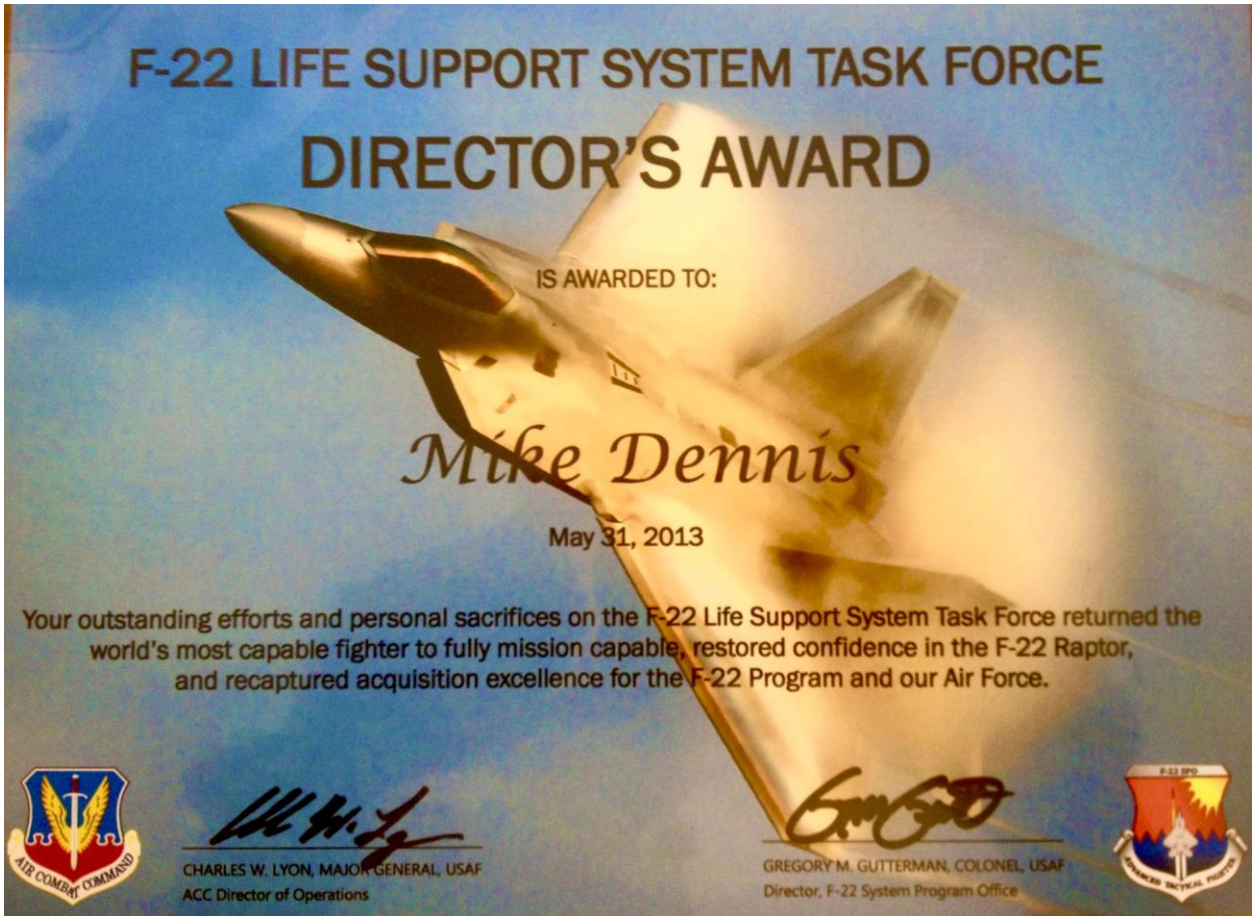
Colonel Gregory M. Gutterman
AFLCMC/WWU
2725 C Street, Bldg 553
Wright-Patterson AFB, OH 45433-7424

I would like to express my personal gratitude to your team for their support of the F-22 Life Support System (LSS) Task Force. The collaborative efforts, attention to detail, and professionalism of your team helped to restore confidence in the Raptor and ultimately returned the F-22 fleet to normal operations.

We are proud to have served with your team resolving the Air Force's toughest Life Support System issue in recent memory. On behalf of the thousands of men and women in Raptor Nation, thank you!

Sincerely,

GREGORY M. GUTTERMAN, Col, USAF
Director, F-22 System Program Office



This award was presented to Oregon Aero for our input in solving the mystery of why a fighter with a functional ejection seat crashed with the pilot still on board. It would be immodest of me to imply total responsibility for this outcome. Oregon Aero set aside all other work for the duration of the of the effort to get to the bottom of the crisis. Because it required the efforts of all sixty employees to expedite the investigation, design, manufacture and test the tools used to collect the data, Major General Lyon presented a personalized award like this to every employee of the company in every department: administration, logistics, planning, engineering, research, finance, shipping, and production. They developed, tested, and delivered a novel test kit used to isolate the problem for every aircraft in the fleet.

Mike Dennis
Founder, President, CEO,
Oregon Aero Inc.

As an aside, other than decades of designing solutions for human factor problems in everything from fighters to earth movers, my background qualifications include the following:

I decided that flight was my future when my mother flew a paper airplane for me, age 4.
First flight lesson, age 12
Introduced a pilot ground school into my high school when I was 16.
A&P mechanic, 19.
Pilot's license at 19. Single engine private pilot, glider, instrument, 8,000+ hrs
Owned 9 airplanes, built 3 of them.
Turbine, 4,500+ hr
Glider, 500+ hr
Single engine types, 35, a handful of helicopters, balloons, and skydiving lessons.
Flights to 49 states, 1 nonstop from Long Beach, CA to Warner Robbins, GA
Puerto Rico, Canada, Mexico, Greenland, Iceland, Scotland, England, France, Holland, Germany, and Switzerland.
Single engine transatlantic crossings, 16.
Simulator training in the Beechcraft King Air 300, Cessna Citation, and because I think the statute of limitations has run out, 2 hours of B-2 bomber simulator time. The first non-contractor civilian to do so, I went in through a side door. It was a thank you for equipping the fleet after 9-11 with new, no-cost seat kits for painless, injury-free, 32-72 hour trips to Afghanistan and back. The seat design had been approved, but because the aircraft was so far over budget, they had no money.

Here's the short version of the back story on this. To demonstrate to Saddam H. that we didn't need a base in Turkey to come visit, we sent B-1B's to Diego Garcia, air refueled, nonstop, 36 hours. Billed as a success, it wasn't really. Most all the pilots had their careers terminated when they arrived with infected bed sores.

I guessed we'd use B-2's to visit Afghanistan so I called Whiteman AFB, told them I'd built the cushion kits without an order, but needed someplace to store them. "Maybe you can help me. I can think of a place you could put them where they'd be out of the way."

Everyone knew the results of the trip to Diego Garcia.

When they returned from Afghanistan, injury free, I was asked to come to Whiteman for a ‘meeting.’ The entire base including very happy wives and kids turned out for the pizza and pop party with the simulator time tossed in as a thank you.

You gotta love this country! Where else on earth could this happen?