The *Ejection* Site *Presents:*

Editors Note: Although the following article does not deal with ejection seats or egress systems specifically, John Paul Stapp's contribution to the field is a large part of how egress systems are designed to this day. The testing done on the Gee Whiz track and Sonic Wind sleds helped with the design and development of rocket sled testing that is still done to this day for egress systems, albeit the days of a man or animal being strapped to such a sled is in the past.

In the spring of 1946, just months after the end of World War II, a B-17 bomber nosed skyward on an urgent mission. Stripped down to a bare airframe, and naked of guns and bombsights, the B-17 had heavily modified engines that allowed it to do something unprecedented: fly into the stratosphere. It cruised for hours at altitudes of nearly 45,000 feet, its flight crew shivering in the sub-zero cold, while in the rear fuselage a lone man conducted a risky set of experiments. Captain John Paul Stapp, a medical doctor and member of the AAF Aero Med Lab, was studying the effects of high altitude flight. And he was using himself as the guinea pig.

The questions Stapp was attempting to answer were absolutely critical to the future of aviation. Could men actually survive for any length of time in extremely high altitudes? Could they fully function, physically and rationally? And how could they keep themselves from freezing, severely dehydrating, or becoming incapacitated by the bends — the deadly formation of bubbles in the bloodstream? These were riddles Stapp was duly bound to solve, and he did, one by one. The riddle of the bends, however, proved an extremely tough nut to crack. But after nearly 65 hours in the air, Capt. Stapp found an answer. If a pilot breathed pure oxygen for thirty minutes prior to takeoff symptoms could be avoided entirely. That was an enormous breakthrough. As far as man was concerned, the sky now truly was the limit.

The discovery pushed Capt. Stapp to the forefront of the Aero Med Lab, a facility he had joined only months before. Once he'd planned to become a pediatrician, but now he had decided to dedicate his life to research. The Lab's mandate, to study medical and safety issues in aviation, was a perfect match for his talents. During WWII it had produced a steady stream of innovations including advanced breathing systems, parachutes, even pressure suits for fighter pilots. And it had emerged as the premiere facility in the world for the study of human factors and the new science of biomechanics.

As a reward for his diligent work on the high altitude problem, Capt. John Stapp was assigned to supervise the Lab's most important research project: human deceleration. This was, simply put, the study of the human body's ability to withstand G forces. (A 'G' is the force of gravity acting on a body on Earth at sea level). According to most sources, 18 Gs was the most a human could receive and expect to survive. As a result, all military airplane cockpits were built to withstand an 18G impact. Yet during the war a great deal of contradictory evidence had emerged about this figure. There were some well documented cases where Navy pilots had crashed into the islands of aircraft carriers or even other aircraft at very high speed. Statistics and physics said they should have been killed. Yet they had walked away. More troubling were a whole host of low magnitude yet fatal crash landings — the Lab routinely reviewed accident reports — in which pilots' seats broke loose or their harnesses failed. Many within the Lab suspected that these pilots had probably survived the initial impact, only to be killed by the structural failure of the cockpit and its affiliated components.

In April 1947, Capt. Stapp traveled out to Los Angeles to view the "human decelerator" being built at Muroc (later Edwards Air Force Base). That remote base was about as far as you could get from Wright Field, but a key component was already in place there: a 2000' long rocket sled track. Built during WWII for tests of Nazi V-1 "buzz bombs", it would form the core of the decelerator. At one end Northrop engineers installed 45 foot-long sets of hydraulic brakes, capable of slowing a rocket sled from 150 miles per hour to half of that speed in one precious fifth of a second. When it did, G forces would be produced equivalent to those experienced in an airplane crash.

The sled that would ride down this track would be called the "Gee Whiz." Built out of welded tubes, it was designed to withstand 100 Gs of force with a 50% safety factor. The 'Whiz was 15' long, 6.5' wide, weighed about 1500 pounds, and sat on a series of magnesium slippers. Atop the chassis was a lightweight metal cab (later removed to facilitate photography) that enclosed a rugged, specially built seat and a bed for prone position tests (also later removed). To the rear was a telemetry antenna mast and a rack capable of holding four rocket bottles. The bottles, the same type used to boost heavy aircraft off short runways, would be capable of generating 5000 pounds of thrust apiece. By varying the number of bottles, and the brake pressure, a wide variety of G forces could be applied to the sled and its occupant.

That occupant, by the way, was intended to be a 185-pound dummy named Oscar Eightball. The staff at the Aero Med Lab had designated in fact that all the tests would be run with dummies; no human runs were contemplated. If 18 G's of force was lethal, after all, then even lower G runs weren't worth the risk. But the Aero Med Lab had reckoned without Stapp, who proved from day one that he was a bit of a maverick. When he first introduced himself to George Nichols, Northrop's project manager, Stapp noticed Oscar Eightball right away. "He walked over and patted that," remembers Nichols, "and then he said, 'We're not going to use these. You can throw this away. I'm going to be the test subject.'"

Nichols was flabbergasted and immediately called his boss, Jack Northrop. Believing the Aero Med Lab must be behind the change in plans, Northrop promptly endorsed human testing. But he also admonished Nichols to "keep track of the fact that our equipment has to withstand the force that you're developing." Oscar Eightball could survive any miscue. With a person riding the sled, the consequences of a failure would be catastrophic.

Before human tests could begin therefore, all the bugs would have to be worked out. In this regard Stapp was nothing if not methodical. He was after all a scientist. So, Oscar would make the first rides on the Gee Whiz. It proved a wise strategy: on the first run, April 30, 1947, the hydraulic brakes and backup restraint system failed, and the 'Whiz slid off the track and into the desert. It wasn't badly damaged, but the brakes were another story. A series of steel teeth intended to trip cams had instead broken clean off on impact. When the teeth were beefed up, George Nichols recalls, the cams broke off instead. It was the type of thing that happened all summer long.

At one point, to learn more about what they might be up against, Oscar Eightball was sent down the track at 150 mph wearing only a light safety belt. At the end of the run the brakes locked up, instantly producing 30 Gs. The belt neatly parted and Oscar, in meek obedience to Newton's Second Law of Motion, sallied forth. He went right through an inch thick wooden windscreen as if it were paper, left his rubber face behind, and finally came to a halt 710 feet downrange. Clearly, some damnable forces of physics were at work.

In December 1947, after eight months and 35 test runs, John Stapp felt his team had obtained enough experience to attempt a manned run. (Perhaps he had also gained some inspiration from Chuck Yeager who, two months earlier, broke the sound barrier in the skies above the sled track. "The real barrier wasn't in the sky," Yeager would later say, "But in our knowledge and experience.") Ever the cautious scientist, on the first ride Stapp used only one rocket, and he faced backwards to minimize the acceleration effects and G-load. It was no sweat. The 'Whiz barely reached 90 miles an hour, and the deceleration was only about 10 Gs. The next day, Stapp added two more rockets and the sled reached 200 mph. Afterwards, it was clear that the Captain had hardly been affected by the ride. In fact if he appeared giddy, it was from anticipation, not fear. The secrets of human deceleration seemed well within his reach.

Within a few weeks' time, Stapp began to vary the number of rockets used on the sled, and tested various braking configurations. The idea was not only increase the G forces involved, but vary the "rate of onset" — the time it took for forces to build to a maximum — and their duration. By August 1948, Stapp had completed sixteen runs, surviving not just 18 G's but a bone-jarring, jaw-dropping 35. And he felt he was still far from any kind of limit.

But while his first run had involved "no unpleasant sensations", the later runs were torturous. Even at low Gs the straps of Stapp's harness dug painfully into his shoulders. At higher ranges of acceleration and deceleration, they cracked his ribs. Over the course of the tests at Edwards, he suffered a number of concussions, lost a few dental fillings and dinged his collarbone. On a couple of other occasions, he broke his wrist. Being a physician and a bit of a stoic, he set one fracture on his way back to his office.

Out of all the things Stapp was subjected to, the most disturbing (concussions aside) was blurry vision, which he began experiencing while facing backwards at speeds above 18 Gs. The cause was intuitively obvious. Blood was rapidly leaving his eyeballs and pooling towards the back of his head in response to gravity, resulting in a "white out." During later tests, when he faced forwards and the blood was pushed up against his retinas, Stapp would experience "red outs" caused by broken capillaries and hemorrhaging. Clearly, when it came to G forces the most vulnerable part of human anatomy were the eyes.

Beaten, bruised and battered though he was by the tests, Stapp initially refused to allow anyone else to ride the 'Whiz. He had his reasons. He feared that if some people, especially test pilots, were allowed on the sled their hot-doggedness might produce a disaster. Volunteers might make some runs — eventually at least seven did – but whenever a new profile was developed, Stapp was his own one and only choice as test subject. There was one obvious benefit at least: Dr. Stapp could write extremely accurate physiological, not to mention psychological, reports concerning the effects of the experiments on his subject, Capt. Stapp.

When after many months the results of all Stapp's work was presented to the Aero Med Lab brass, they were horrified. Surprisingly, the words "court martial" were never mentioned, perhaps because Stapp had shown such courage. His initiative however was another matter entirely. To reign him in, Stapp was promoted to the rank of major, reminded of the 18 G limit of human survivability, and told to discontinue tests above that level. And he was told in no uncertain terms that human tests had to end. Chimpanzees, his superiors advised, would be acceptable substitutes.

Now-Major Stapp retreated back to Edwards with scarcely an argument. He wasn't worried; he sensed that, after the Lab reviewed his data, they would cave. They did. And soon, Stapp's data was having an impact. The rocket sled had clearly proven the inadequacy of certain types of aircraft restraint systems, and these shortcomings were addressed immediately. Stapp had also clearly shown that passengers in rear-facing seats could survive much higher G-loads than forward facing passengers. The military rapidly seized on this concept, and ordered seats on all new transport aircraft reversed.

The most significant development, of course, lay in the debunking of the 18 G limit. When it was finally acknowledged by the Air Force, it had serious implications. If a pilot or passenger could survive a 30 G plus deceleration, then his seat, harness and cockpit ought to be augmented so they could survive it as well. The next series of rocket sled tests, which would feature a new heavyweight harness — permitting the first forward-facing human runs — represented an attempt to produce truly definitive data about that subject. Beginning in June 1949, the Northrop team put the Gee Whiz through various profiles, sometimes with Stapp, sometimes with volunteers, and sometimes with chimpanzees.

Stapp decelerating in the G-Whiz sled.
This five frame 'movie' shows pretty well
the stress he experienced.
Courtesy EAFB History Office

Lt Col Stapp with his car circa 1953
Courtesy EAFB History Office

Northrop Aircraft team for the G-Whiz tests
l-r Ed Swiney- Project Manager, George Nichols- Chief Mechanic, Jake Superata- Asst, Jerry Hollabaugh- Instrumentation Chief, and Ralph DeMarco- Asst.
Courtesy EAFB History Office

Final touches on the 'absolutely fearless' Oscar 8-Ball manikin before a sled run
Courtesy David Hill Collection

Front view of Stapp as he feels the force of deceleration
This frame from a movie camera shows Stapp wearing a helmet designed by Dr. Charles F. Lombard that includes an accelerometer to measure the G forces.
Courtesy David Hill Collection (First published in conjunction with this article)

Early picture of the hydraulic brake for the G-Whiz
Courtesy David Hill Collection (First published in conjunction with this article)

Oscar 8-Ball tears through a wooden windbrake wall on the G-Whiz sled.
This was done to show the forces involved in a rapid deceleration.
Courtesy David Hill Collection

Another frame from a film showing the force of deceleration
Courtesy David Hill Collection (First published in conjunction with this article)

G-Whiz with full cabin beginning to accelerate *Courtesy David Hill Collection*
Typical test setup on G-Whiz. Note the telemetry antenna on the circular platform on the windbrake, and the camera below it. *Courtesy EAFB History Office*
CAPT Stapp and the G-Whiz crew *Courtesy EAFB History Office*
Test subject gives the O.k. sign before an early G-whiz test *Courtesy EAFB History Office*
The G-Whiz slamming into the hydraulic brakes with a live subject *Courtesy EAFB History Office*
Stapp on the G-Whiz sled *Courtesy EAFB History Office*
Stapp smiles as they strap him into G-Whiz *Courtesy EAFB History Office*
Stapp (center) and the G-Whiz crew *Courtesy EAFB History Office*
Stapp strapped to Sonic Wind *Courtesy EAFB History Office*
Stapp on G-Whiz. Note the photo markings on his cheek, leg and arm. *Courtesy EAFB History Office*
Stapp strapping into Sonic Wind. Note the lack of windscreen for this test *Courtesy EAFB History Office*
Stapp on G-Whiz. Note the straps on the helmet, probably to strap it to the seat. *Courtesy EAFB History Office*
Stapp being prepped for his high speed run on Sonic Wind *Courtesy EAFB History Office*
Good view of the G-Whiz hydraulic brake system *Courtesy EAFB History Office*
Setting up the cameras on Sonic Wind (with windscreen installed) *Courtesy EAFB History Office*
Sonic Wind slamming into the water brake as COL Stapp feels 46.2 Gs of eyeballs-out force *Courtesy George Nichols Collection*
Strapping the helmet to the seat on Sonic Wind *Courtesy EAFB History Office*
Stapp working on an ejection seat at North American Aviation
Sonic Wind's rocket packs *Courtesy EAFB History Office*
The G-Whiz track today *Photo by Nick T. Sparks, the author*
Part of the G-Whiz track system today *Photo by Nick T. Sparks, the author*
More of the remnants of the G-Whiz track *Photo by Nick T. Sparks, the author*

Two years later, in June 1951, Stapp made his last run on the Whiz, absorbing more than 35 Gs of deceleration in the forward position. By then he'd also survived a 46 G run with a rate of onset of 500 Gs per second, and a 38 G run with an onset of nearly 1300. That was about as much punishment as the sled could produce with four rockets blazing and with the brakes at their maximum setting. In total, 74 manned runs had been made on the sled. More than 80 additional runs had taken place with the chimps. The tests established a standard strength requirement for aircraft seats (32 G) that was rapidly adopted. And Stapp developed and tested a new regulation pilot's harness, passenger restraints, and invented a "side saddle" harness for paratroopers.

Yet while the Gee Whiz had allowed Stapp to answer most if not all of the crash deceleration questions, new ones had emerged. In 1951, no one had yet ejected from an aircraft at supersonic speed and lived to tell about it. Very little was in fact known about the effects of wind blast and deceleration acting on a pilot ejecting at those speeds. Yet it was obvious that many pilots, whether they wanted to or not, were going to be attempting those kind of escapes in the near future. Could they survive? And what could be done to help them survive?

Answering questions such as those were beyond the limits of the Gee Whiz, and while Stapp did some tests in a special open-cockpit F-89, it was clear that another rocket sled would have to be developed in the search for answers. So beginning in 1953, Stapp relocated to the Aeromedical Field Laboratory at Holloman Air Force Base in New Mexico. Here there was a 3,550 foot sled track, originally built to test the Snark missile. It terminated in a segment that could be dammed and filled with water. By equipping a sled with water scoops, and varying the water depth precisely, various braking speeds and durations could be produced.

Northrop was put to work constructing a new sled, the Sonic Wind No. 1. Slightly longer and wider than the Gee Whiz, Sonic Wind could carry up to twelve rockets that could produce well over 50,000 pounds of thrust. Additionally, it had a sophisticated two-stage design. After the rocket bottles burned out, the "propulsion sled" would be jettisoned, allowing the "subject sled" to continue onwards without the extra weight. Engineers calculated that the Wind could travel at upwards of 750 supersonic miles per hour, and withstand an astonishing 150 Gs.

In November 1953 the Sonic Wind was tested with Sierra Sam, a second-generation crash test dummy. A few months later in January 1954 the first live subject run was made with a chimpanzee. Everything seemed to work well. On March 19, Lt. Colonel Stapp (he had been promoted again) made his first trip down the track. "I assure you," he said to a reporter as he boarded the sled, "I'm not looking forward to this." Burning six rockets, the Sonic Wind reached a speed of 421 miles per hour in five seconds, and was still traveling at 313 miles an hour when it hit the water brake. In the span of 200 feet, the Wind slowed from that speed to 153 mph, producing up to 22 Gs of force. For a brief instant Stapp's body weighed more than 3,700 pounds. More impressively, for 0.6 seconds, Stapp endured 15 Gs of punishment. That was a duration nearly twice as long as any ever produced at Edwards. "I feel fine," the Lt. Colonel said after the run. "This sled is going to be a wonderful test instrument. I'm ready to do it again this afternoon."

The next human run, however, didn't occur for nearly five months owing to the complexity of the task. Stapp hoped to explore the effects of abrupt wind blast. To do this, a pair of doors was added to the sled's windscreen. Tripped by a cam placed far down the track, they opened at high speed, hitting Stapp with a torrent of air estimated to be moving at 736 feet per second at 5.4 psi. Then he was decelerated 12 Gs. The effects were described as negligible, and Stapp characterized it as the "easiest" sled run he'd ever done. This despite the fact that grains of airborne sand had impacted his face, creating bloody blisters and bruising.

November and the beginning of December were spent preparing for what turned out to be John Stapp's 29th and as it turned out final sled ride. This time he would attempt to push the envelope all the way to the post office. The sled would travel into the transonic speed zone, mach .9. The heavy door mechanism would be removed, and Stapp would face the wind protected only by a helmet and visor. And when the sled stopped, and it would in a mere 1.4 seconds, Stapp would be subjected to more Gs than anyone had ever willingly endured. It made George Nichols extremely apprehensive just thinking about it. Stapp wasn't just out to prove that people could survive a high speed ejection, he was seemingly trying to find the actual limit of human survivability to G force. "To me there was no real justification for being killed from the deceleration," says Nichols. "I didn't want to see it. He was just too good a friend to see get hurt."

Air Force pilot Joe Kittinger, who had been participating in another ground- breaking set of Stapp experiments — flying zero G profiles to study the effects of weightlessness — remembers being asked to fly a photo chase plane for the run. "Stapp said, 'Captain we have a project coming up here in a couple weeks. It's a sled run and we're going to get up to 614 miles per hour'," remembers Kittinger. "But he didn't say it was a human sled run. And he did not tell me it was him." It wasn't until a day before the test that an astonished Kittinger finally learned the truth. "I was flabbergasted he was going to be going that fast," Kittinger says, "It was a point of departure — a new biological limit he was going to be establishing on that run." If he lived, it would be as significant a human achievement as breaking the four minute mile.

At X-minus ten on December 10, 1954, George Nichols helped fit a rubber bite block, equipped with an accelerometer, into John Stapp's mouth. Then with a final pat for good luck, he headed down to the far end of the track. As X-minus two approached, the last two Northrop crew members left the sled and hustled into a nearby blockhouse. Sitting alone atop the Sonic Wind, Stapp looked like a pathetic figure. A siren wailed eerily, adding to the tension, and two red flares lofted skywards. Overhead, pilot Joe Kittinger, approaching in a T-33, pushed his throttle wide open in anticipation of the launch. With five seconds to go Stapp yanked a lanyard activating the sled's movie cameras, and hunkered down for the inevitable shock. The Sonic Wind's nine rockets detonated with a terrific roar, spewing 35-foot long trails of fire and hurtling Stapp down the track. "He was going like a bullet," Kittinger remembers. "He went by me like I was standing still, and I was going 350 mph." Just seconds into the run the sled had reached its peak velocity of 632 miles per hour — actually faster than a bullet — subjecting Stapp to 20 Gs of force and battering him with wind pressures near two tons. "I thought," continues Kittinger, "that sled is going so damn fast the first bounce is going to be Albuquerque. I mean, there was no way on God's earth that sled could stop at the end of the track. No way." But then, just as the sound of the rockets' initial firing reached the ears of far off observers, the Wind hit the water brake. The rear of the sled, its rockets expended, tore away. The front section continued downrange for several hundred feet, hardly slowing at all until it hit the second water brake.

Then, a torrent of spray a hundred feet across exploded out the back of the Sonic Wind. It stopped like it had hit a concrete wall. To Kittinger, flying above and behind, it appeared absolutely devastating. "He stopped in a fraction of a second," Kittinger says, the shock of the moment echoing in his voice. "It was absolutely inconceivable that anybody could go that fast and then just stop, and survive."

Down below, George Nichols and the ground crew raced to the scene, followed by an ambulance. An agitated Nichols vaulted onto the sled, and much to his relief, saw that Stapp was alive. He even managed what looked like a smile, despite being in great pain. Once again, he'd beat the odds. He'd live to see another day.

But could he see? George Nichols wasn't sure, and what he vividly remembers from that day, fifty years later, were John Stapp's eyes. He had suffered a complete red out. "When I got up to the sled I saw his eyes... Just horrible," recalls Nichols, his voice cracking with emotion. "His eyes …were completely filled with blood." When the Sonic Wind had hit the water brake, it had produced 46.2 Gs of force. And for an astonishing 1.1 seconds, Stapp'd endured 25 Gs. It was the equivalent of a Mach 1.6 ejection at 40,000 feet, a jolt in excess of that experienced by a driver who crashes into a red brick wall at over 120 miles per hour. Only it had lasted perhaps nine times longer. And it had burst nearly every capillary in Stapp's eyeballs.

As George Nichols and some flight surgeons helped Stapp into a waiting stretcher, Stapp worried aloud that he'd pushed his luck too far. "This time," he remarked, "I get the white cane and the seeing eye dog." But when surgeons at the hospital examined him, they discovered that Stapp's retinas had not detached. And within minutes, he could make out some "blue specks" and a short time later he could discern one of the surgeons' fingers. By the next day, his vision had returned more or less to normal.

But John Stapp's life would never be the same. Dubbed "The Fastest Man on Earth" and "The Bravest Man in the Air Force" by the media, his celebrity rose to dazzling heights. Stapp graced the pages of Collier's and Life magazines, was the subject of a Hollywood 'B' movie, and was featured in an episode of "This is Your Life!". If the attention was a bit much for the soft spoken Lt. Colonel, it nevertheless provided him with an opportunity he had longed for — to promote the cause of automobile safety.

For even in the earliest days of the Gee Whiz tests, Stapp had realized that his research was just as applicable to cars as it was to airplanes. And perhaps, in the general scheme of things, automobile safety was even more important. At every opportunity, in every interview and at every appearance therefore, Stapp urged Detroit to examine his crash data, and to design their cars with safety in mind. He lobbied hard for the installation of seat belts — at that time not even an option on American cars — and improvements such as soft dashboards, collapsing steering wheels, and shock absorbing bumpers. "I'm leading a crusade for the prevention of needless deaths," he told Time magazine (he made the cover in 1955). It was a cause that would continue the rest of his life.

Meantime, Stapp announced plans to make a Mach 1.0 and, beyond that, a 1000 mph run on the 'Wind. But it was not meant to be. At Mach .9, the safety factor had become too tenuous for the brass to contemplate another go and, as fate would have it, their fears turned out to be justified. In June 1956, while performing an 80 G test, the Sonic Wind left the track and was severely damaged. So if Stapp had traveled as fast as a bullet, he'd also managed to dodge one. Human tests were suspended, and although he would participate in subsequent tests on an air-powered sled known as the "Daisy Track", his days as a rocket man were over.

It didn't really matter. Stapp had already proven what he'd set out to prove: that a pilot, if adequately protected, could survive a high speed, high altitude ejection. And he had determined to a great extent a limit, if not the limit, of human physiology. The rest could be left to the chimpanzees, dummies and, in more modern times, computer simulators. "It was a proper decision to make," says Joe Kittinger about the end of rocket sled tests. "(Stapp) had already defined the limit. Now the engineers could go back and design the escape system so that they could keep the man within that envelope." And they would. Equipped with Stapp's data, engineers would produce a new generation of aircraft which could fly higher, faster, and were safer than any ever built.

They would also build much safer automobiles. Using his powers of persuasion, Stapp convinced the Air Force to built an automobile test facility, and conducted the first-ever crash tests with dummies. He also brought together auto manufacturers, researchers, and politicians for The Stapp Automobile Safety Conference, a groundbreaking symposium which continues to this day. And, when in 1966 President Lyndon Johnson signed a law requiring seat belts in all new cars, Stapp was by his side. So when you put your seatbelt on, just remember that you do so in part because of the "Fastest Man on Earth".

Stapp's work in aeronautics and automobiles continued right up until his death in 1999 at age 89. During his career, he'd received numerous awards and honors, including the Presidential Medal of Technology and the Legion of Merit. But for Stapp, the biggest reward was likely the knowledge that the work he had done helped save so many lives, not just in aviation, but on highways in the United States and around the world. And in that sense, his legacy not only continues, but grows with each passing day.

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The Ejection Site Home
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