Memo: To George Petterson 5 January, 1998
From: Mike Melvill
Regarding: Long-EZ, N228VS

Hi George, sorry it has taken me so long to get this report to you, on my investigation of the John Denver accident, at the Jet Center, at Del Monte Aviation, on the morning of October 14, 1997. As you will remember, I flew my own Long-EZ, N26MS, up from my home in Tehachapi, CA, at your request, so that it might be used as an exemplar aircraft, to possibly assist in identifying the various pieces of wreckage. I have included my weight and balance calculations, together with some CAD drawings showing the fuel system as it was in the Denver Long-EZ, as well as the fuel system as called out in the Long-EZ plans. I have also included a set of photos that I took during my visit to Monterey. I hope this information will be useful to you, and please do not hesitate to contact me if there is anything more that I can help with.

I found that much of the wreckage of Long-EZ, N228VS, which had been repainted, and now had the registration number, N555JD, had been delivered to an empty hangar, and that most of it was contained in plastic garbage bags. I spent the next 6 hours carefully identifying these pieces and parts, and placing them on the floor of the hangar, in the rough form of a Long-EZ aircraft. There were very few intact large parts. Most of the pieces consisted of shattered fiberglass skins, and broken bits of foam which once identified, could be layed out on the hangar floor, and could then be easily seen to be, for example, a left wing, or whatever. These parts in fact consisted of several splintered pieces making up the lower wing skins, lower spar caps, shear webs, bits of the leading edges, trailing edges, upper skins, spar caps, etc. Almost all of the foam core was missing from the insides of the wings, winglets, and canard. A lot of this foam core material was recovered, and had been placed in several black plastic garbage bags. The ailerons were broken, but essentially intact, and could be fitted quite well into their positions in the trailing edges of the wings. I located and identified every piece of the control system, consisting in each wing for example, of a pushrod, bellcrank, another pushrod, a bellhorn, a torque tube and a universal joint. All were located, and placed in their respective positions. I checked every broken rodend, flattened pushrod and bent weldment in the control system, and in my opinion, all identified failures were due to massive overloads. I saw no evidence of any pre-existing cracks, or flaws.

The centersection spar box, was heavily damaged, the center area, forward of the engine, was essentially gone, due to the fact that the engine had traveled forward, through the centersection, on impact. Later, I met with one of the divers, who

recovered the engine from the bottom of the ocean, and he told me that there were large rocks, located only about 10 feet below the surface, and that there was evidence that the plane had impacted this rocky area. This does explain the tremendous amount of damage to all of the structure, probably caused when the engine crashed through the centersection spar, the back seat bulkhead, front seat bulkhead, the pilot, the instrument panel and nose area of the plane. The damage to the welded engine mount, and mechanical fuel pump, both located on the front of the engine, confirms this theory.

The damage to the propeller, is such that there may have been some power being developed by the engine, although I don't believe there could have been much power. There is some evidence of wood fibers, bent against the direction of rotation, on one of the prop blades, however, the other blade has essentially none of this evidence. The damage to the prop, in my opinion, is not typical of impact failure of a wood prop, while being driven at high power by the engine. The fact that the engine/prop burst through the centersection spar, during the crash impact may help explain the unusual damage pattern to the wood prop, but I am inclined to think that the damage to the prop, is likely the result of the engine/prop, windmilling, with little, or no power, at the time of impact.

There was very little of the forward fuselage that was recognizable, which again points to the engine coming forward through the whole fuselage, and smashing down against the rocks on the bottom. The canard was virtually destroyed, and only small and shattered pieces were identified. The center of the canard, where the engine would have impacted, was pulverized. The spar cap unidirectional glass fiber material, was literally in strings, small bundles of fibers, separated from each other. Only about 30% of the canard was identified, several small pieces of the leading edge, both canard tips, some short pieces of the trailing edge, most of the elevator torque tubes, but only three short pieces of the elevator skins,(these were made from carbon fiber, rather than the fiberglass called out in the plans) were found. There was a fairly large pile of small pieces of wreckage, that could have been identified, given enough time, but these pieces were so tiny, as to make correct identification difficult in the time available.

John Denver had planned to have his new Long-EZ repainted, and Eric Cobb offered to fly it from Santa Inez to the paint shop on the Santa Maria airport. Eric purchased 20 gallons of fuel at the Santa Inez airport, and reported that there was about 4 gallons in the plane before putting the 20 gallons in. He used about four gallons of fuel, flying to Santa Maria. After the plane was painted, Eric gave John Denver a checkout, and estimates that this used an additional 5 gallons, leaving a total of 15 gallons on board. When John took off to fly to Monterey, Eric says that there was indeed only 15 gallons on board, 5 gallons on

one side, and 10 gallons on the other, and that John took off using fuel from the fuel tank that had 10 gallons in it. Apparently John never obtained any additional fuel, and the flight to Monterey, which took 1:05 hours, would have used at least 10 gallons of fuel.

When he decided to go flying that Sunday afternoon,(Oct. 12) at Monterey, he declined an offer from a local mechanic, Chris Hadland, to add fuel. He discussed the fuel valve's inaccessibility, and it's resistance to turning, with this mechanic, who even provided John with a pair of vice-grips to try to turn the fuel valve, but this did not help. John told him that he would use the auto pilot to hold the plane level, while he reached around to turn the valve in flight. Chris told John that it looked like he had less than half a tank of fuel on the right, and less than a quarter of a tank on the left, referring to the clear plastic sight gauges located in the rear cockpit. Chris lent John a small mechanics mirror, to assist him to view his fuel sight gauges, and this mirror was found in the aircraft wreckage.

This is exactly what was printed on the metal DATA plate, located in the wreckage:

Model-Rutan Long-EZ		Empty weight	949 lb.
Serial #	54	Gross weight	1425 lb.
June, 1987			
Engine	LYC 0-320-E3D	Power	150 HP
	Built By:		
		Adrian Davis Jr.	
		[redacted]	
		Houston	
		Texas 77069	

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ve

This is a history of the Long-EZ, taken from RAF's records:

Adrian Davis	N5LE	Original builder, Purchased plans from RAF March 31, 1980. Serial # 54.

Van Snow	N228VS	Purchased from Davis, sold it to Denver
John Denver	N555JD	

A friend of mine, Klaus Savier, flew this aircraft to Lakeland, Florida, and flew it in the Sun 60 race. Had some problems with the fuel valve, did not like the valve switching logic, or where it was located, left side, shoulder level.

Phone interview with Klaus, 2 December, 1997:

While Klaus' own Varieze airplane was down for repairs, Van Snow lent this Long-EZ to him. In return, he was too hop it up, and work on drag reduction. Klaus was pleased enough with his work, that he decided to fly it from his home in Santa Paula, CA to Lakeland, FL and to enter it in the Sun 60 race. This is a closed course speed race, flown at low altitude. Preparing for the race, he found himself with an almost full fuel tank on one side, and just enough on the other side to use that tank only in an emergency "get home situation". Due to some confusion with the placarding of the unusually placed fuel tank selector handle, and in spite of the fact that he had already accumulated more than 40 hours of flight time in this particular plane, he inadvertently selected the tank with only emergency fuel in it, and as a result, he had the engine quit on him during the race. It quit with several misfires, and did not quit cleanly. Since he was flying low he knew he would probably only have one shot at switching to the full fuel tank, so he released his shoulder harnesses, pulled the nose way up, then turned in the seat and selected the other tank. It took the engine several seconds to restart, but it did, and he continued with the race. Klaus told me that he had told Van Snow that this fuel selector location was bad news, and that he should fix it. His confusion with the fuel selector handle, was that he was not certain which end of the handle itself, was the pointer for the placards. I asked him how well he would have handled running it out of fuel, if he only had a couple of hours in the plane. He said he would not have flown the plane in the race!

Phone interview with Eric Cobb, the instructor who checked John Denver out in the Long-EZ, 2 December, 1997

Eric told me that he had put 20 gallons into the Long-EZ, before flying it from Santa Inez to Santa Maria. He said that there was only 4 gallons on board at the time, approximately 2 gallons on each side. He estimates that he burned 4 gallons getting to Santa Maria, where the plane was to be painted. After the paint job was completed, John Denver flew down from Monterey in his Lear Jet, and was very pleased with the new paint job on his Long-EZ. He took all the folk involved out to lunch, and then Eric flew with him in the Long-EZ, giving him a thorough check out, including the fuel selector, which he said was firm but not real tight.

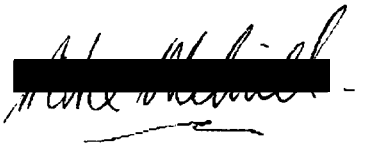
He said that he could feel the detents, as he turned the selector. Eric told me that he had had to put an extra cushion behind John, so that he could easily reach the rudder pedals. This made it a little more awkward for him to reach the fuel selector, which was located at the level of John's left shoulder, but aft(more so with the extra cushion) and outboard of his shoulder. He said that John did indeed switch the fuel selector a couple of times, while on the ground. When John got ready to leave for Monterey, Eric told him that he had exactly 10 gallons, or one hour of fuel on the right side, and 5 gallons, or 30 minutes of fuel on the left side, and that he should think of the 5 gallon side as strictly reserve fuel. John was running on the right fuel tank, with 10 gallons in it, when he departed from Santa Maria for Monterey. Eric was concerned enough to give John his home phone number, and asked him to call when he landed in Monterey. John did call and reported that he was really pleased with his new Long-EZ, and had had a good flight. When Eric heard that the Long-EZ had crashed the next afternoon, he told me that he was sure that John had probably run it out of fuel. He told me that this Long-EZ had a hopped up engine, and that it would normally use around 10 gallons per hour. Eric said that this engine would quit with a popping or misfiring when it was shut down. He also told me that there was one graduation mark on each fuel sight gauge, and that these marks were located to show when the fuel tanks contained 10 gallons of fuel.

Klaus Savier's hon	
Eric Cobb's home	
Van Snow's home	

Flight tests flown

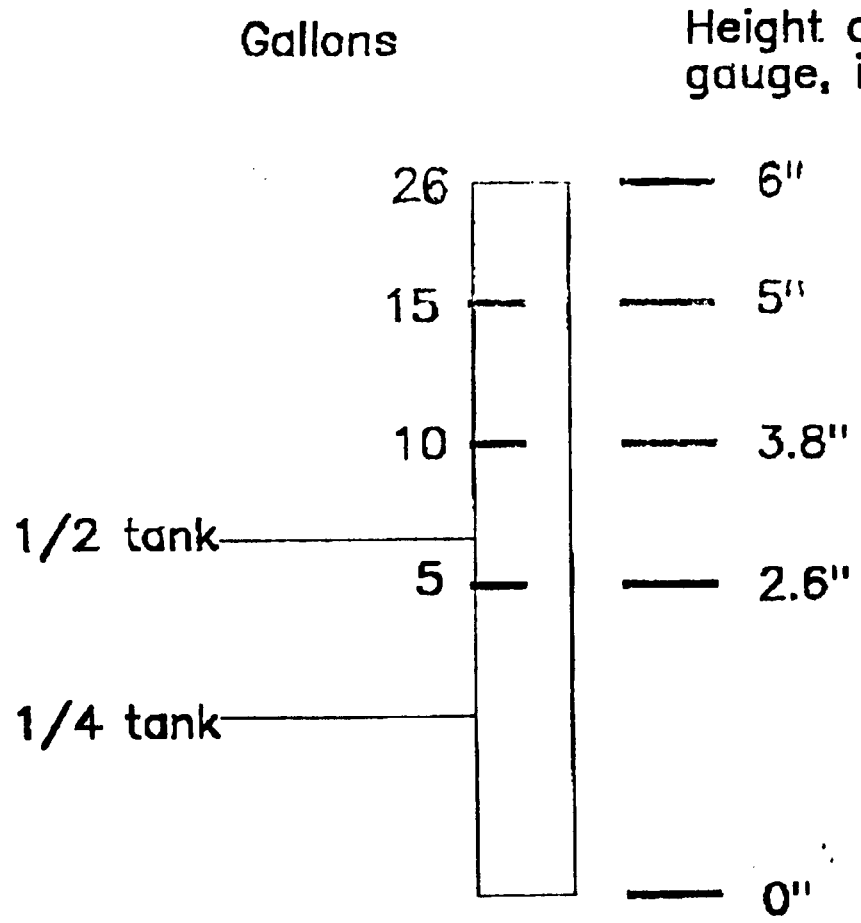
I conducted two separate flight tests in my own Long-EZ. These tests were designed to measure how much fuel it would require to start the engine, warm it up, taxi out to the active runway, check the magnetos, then take off and fly a normal traffic pattern, and shoot three touch and go landings, and then fly approximately 4 miles away at 500 feet of altitude. I used a calibrated ALCOR fuel flow meter to measure the fuel used during these tests. I found that it took between 2.6 and 3.7 gallons of fuel to get this done, depending on the size of the traffic pattern flown, and I believe that it would require a little more fuel at sea level. Mojave is located close to 3000 ft above sea level. Assuming that Eric was right and that there was 4 gallons in John's Long-EZ before he put 20 gallons in it at Santa Inez, that means there was 24 gallons total on board. He used 4 gallons getting it over to the paint shop on the Santa Maria airport, leaving 20 gallons on board. Then while checking John Denver out in the airplane, he used 5 more gallons, leaving only 15 gallons, total. No more fuel was put in to the plane, and John departed Santa Maria for Monterey with only 15 gallons on board. This

flight reportedly took 1:05 hours, which would have used at least 10 gallons, leaving less than 5 gallons on board. John rejected an offer to add fuel to his plane, from Chris Hadland, the mechanic who helped John pull his Long-EZ out of the hangar, so we must assume that he took off that afternoon, with no more than 5 gallons on board. He flew three touch and go's, then departed the traffic pattern toward the beach. In my opinion, he would have used close to 4 gallons to get this done, leaving only 1 gallon on board, and of course, there is no way to know if he had switched tanks at all, which says that this last gallon may not have all been in one fuel tank, it may have been distributed in both fuel tanks.



Mike Melvill

6 December, 1997



This is an accurate depiction of the Fuel sight gauge in my Long-EZ, N26MS, and is probably fairly representative of the average long EZ, although there is still the individual workmanship factor to consider, which could change the calibration up OR down.

WEIGHT AND BALANCE
LONG-EZ N228VS

	WEIGHT	ARM	MOMENT
Empty Aircraft	949.0	111.8	106,082
Oil	13.1	140.0	1,834
Fuel (15 gal @ 6 lb/gal	90.0	104.5	9,405
Pilot (John Denver)	168.0	59.0	9,912
If ballast	50.0	6.0	300
TOTAL	1270.0	CG = 100.4	127,533
If no ballast	-50		-300
TOTAL	1220.0	CG = 104.3	127,233

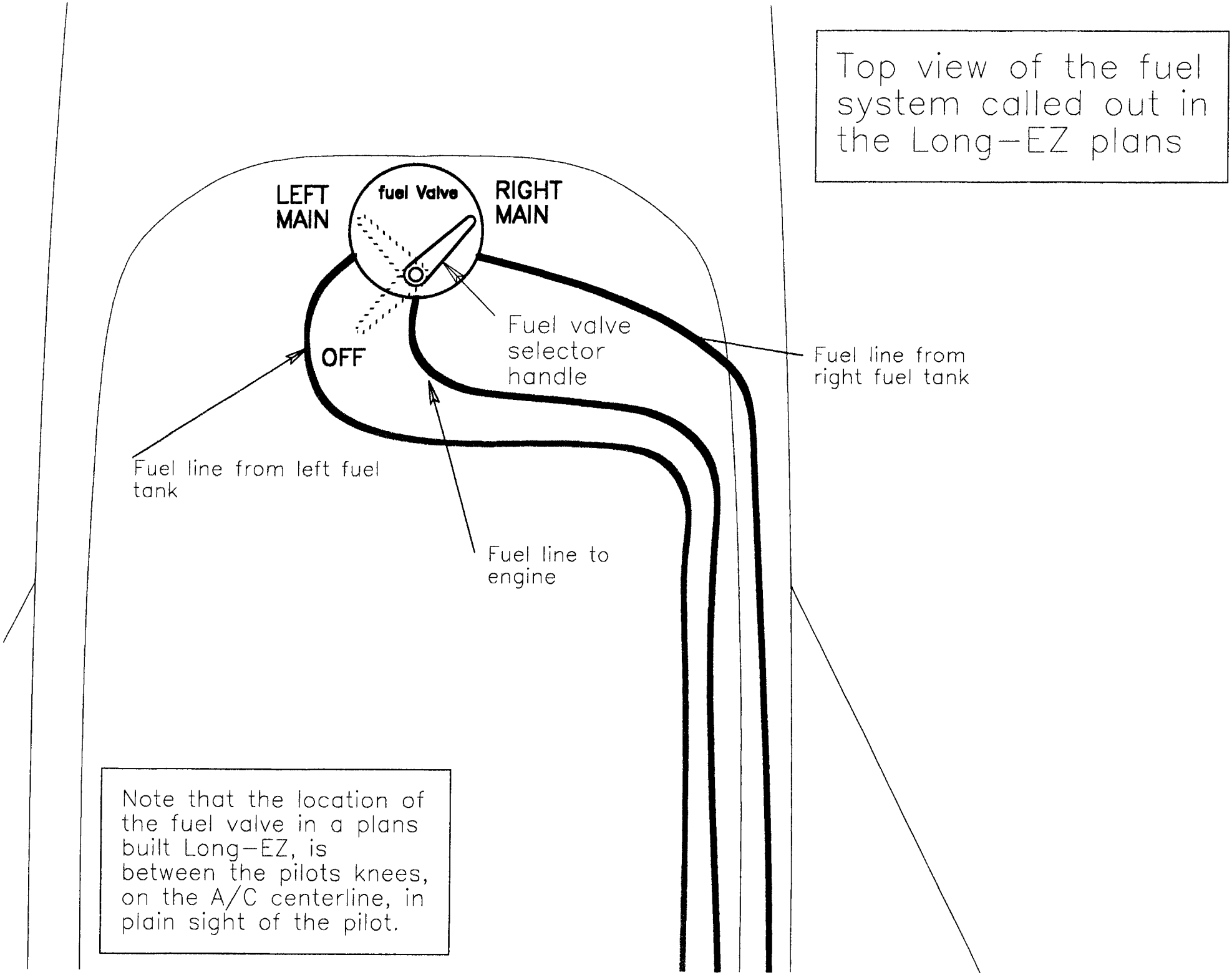
Gross Weight Limit = 1425 lb

CG Envelope Limit = 98 Fwd - 103 Aft

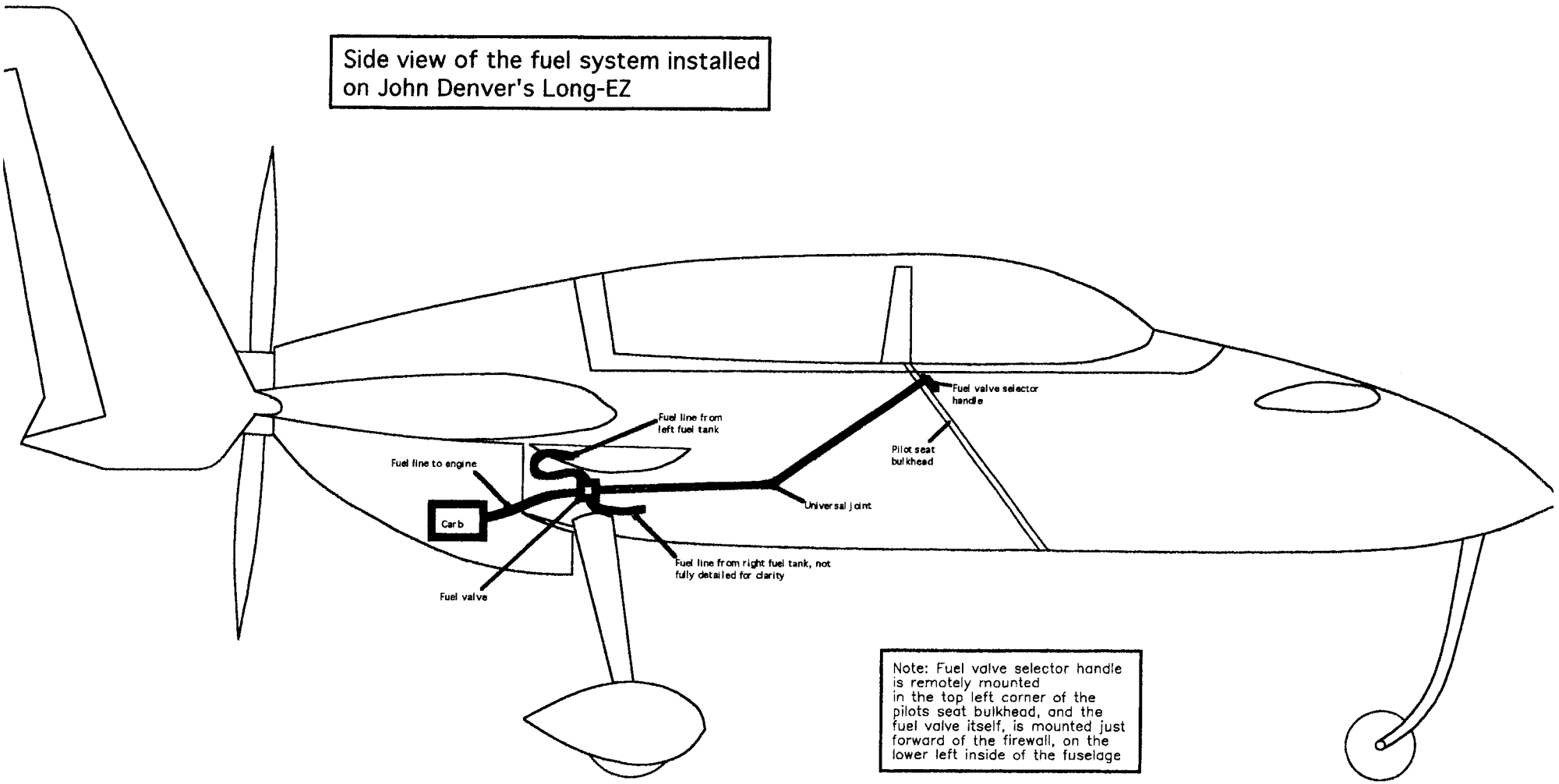
IF THERE WAS NO BALLAST INSTALLED IN THE AIRCRAFT - HE WAS WELL WITHIN THE GROSS WEIGHT LIMIT, & ALSO WAS WITHIN THE CENTER OF GRAVITY ENVELOPE — CG LIMITS 98-103, HE WAS 100.4.

IF THE 50 LB BALLAST, SHOWN IN ORIGINAL WEIGHT & BALANCE INFORMATION, WAS INSTALLED, HE WAS STILL WITHIN THE GROSS WEIGHT LIMIT, BUT WAS 1.3 INCHES AFT OF THE AFT CG LIMIT.

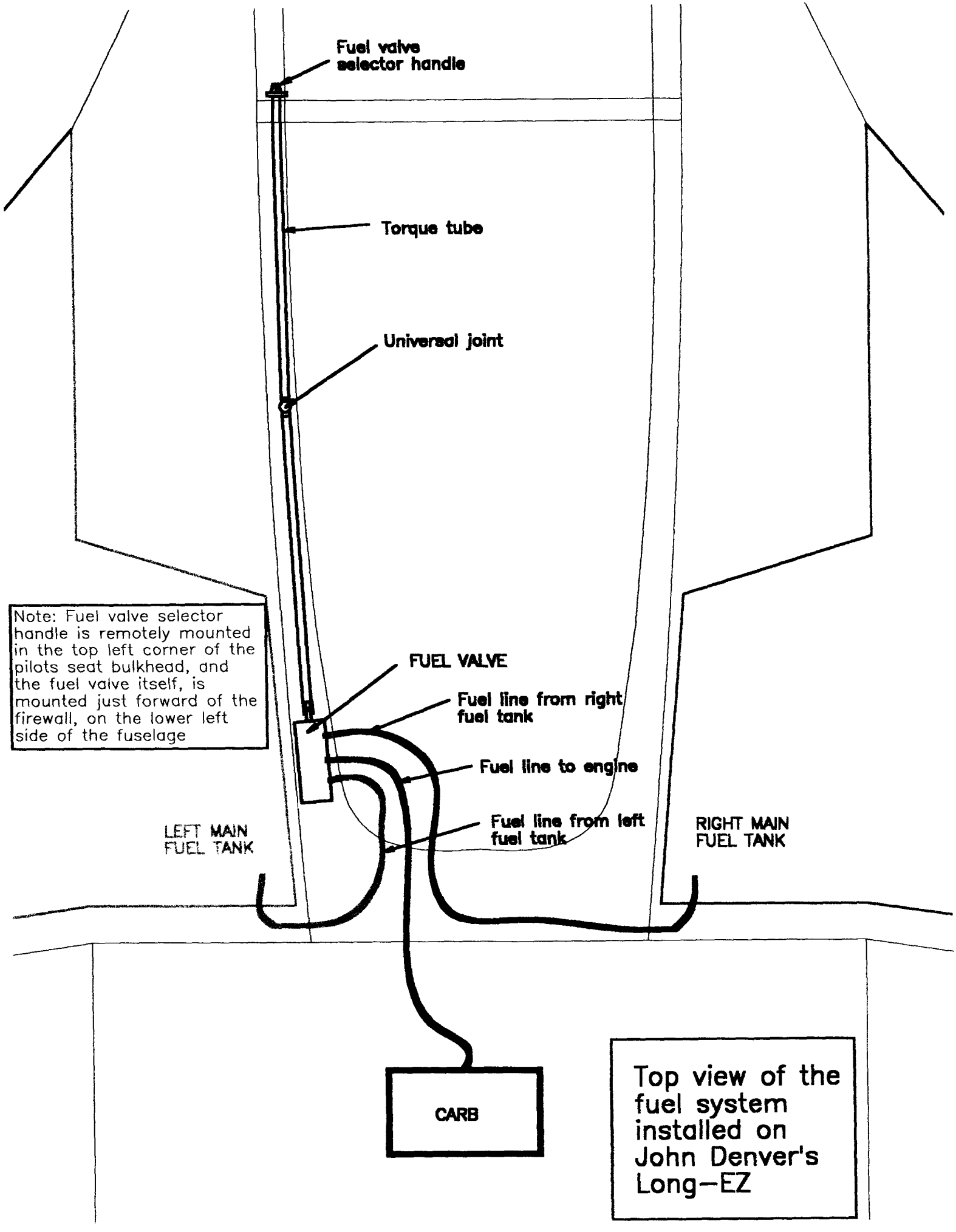
[redacted]

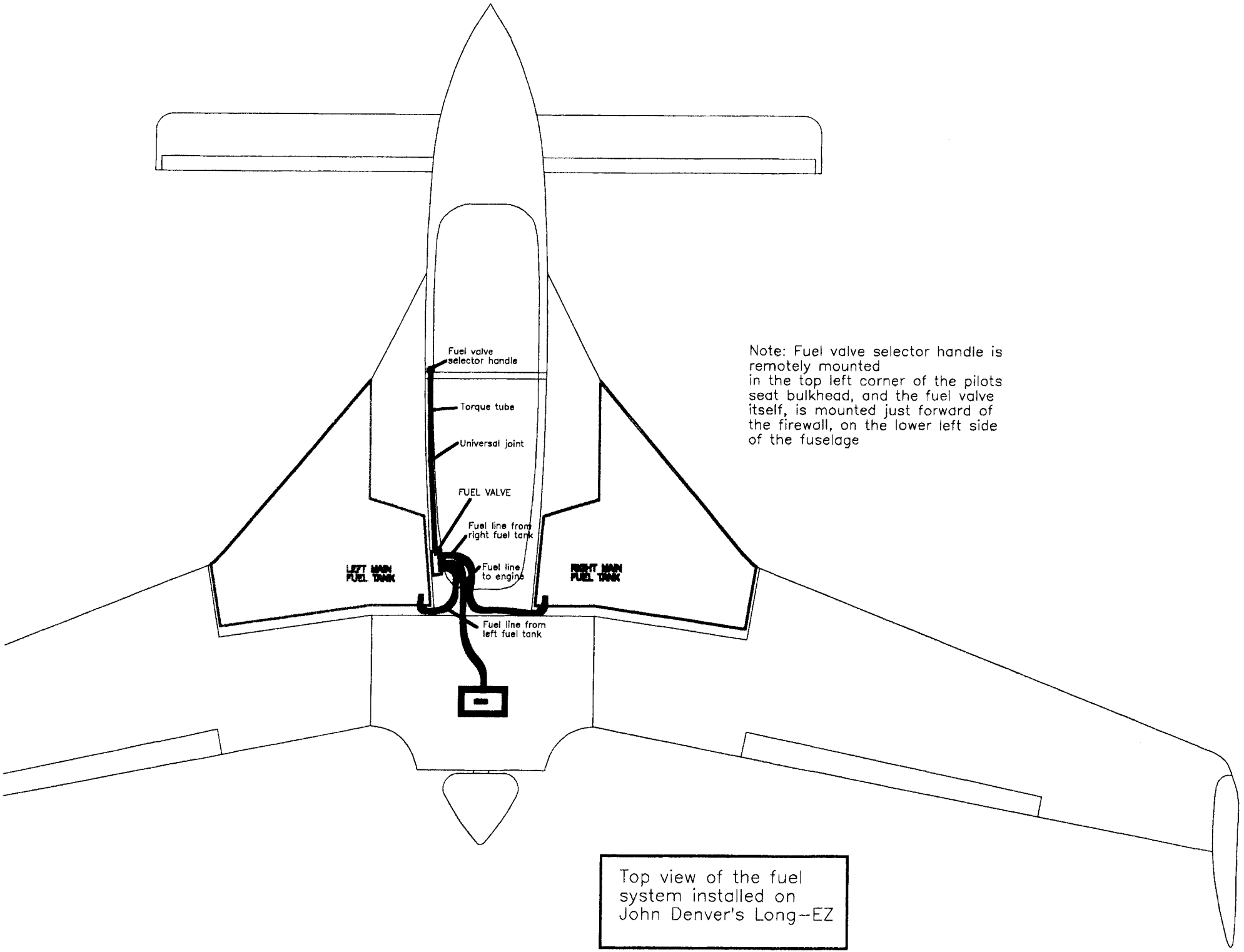

Top view of the fuel system called out in the Long–EZ plans
LEFT MAIN
fuel Valve
RIGHT MAIN
OFF
Fuel valve selector handle
Fuel line from right fuel tank
Fuel line from left fuel tank
Fuel line to engine
Note that the location of the fuel valve in a plans built Long–EZ, is between the pilots knees, on the A/C centerline, in plain sight of the pilot.

Side view of the fuel system installed on John Denver's Long-EZ



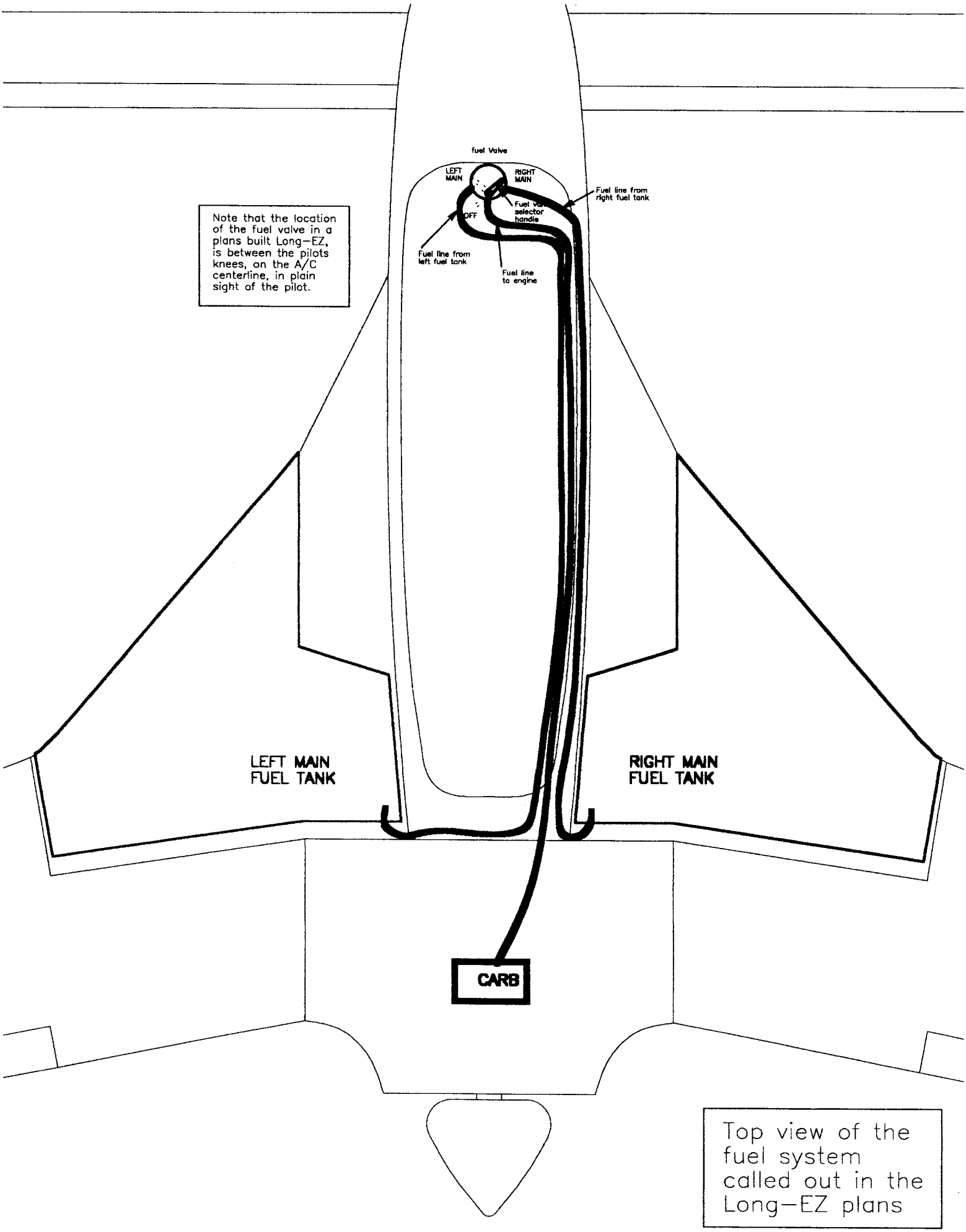
Note: Fuel valve selector handle is remotely mounted in the top left corner of the pilots seat bulkhead, and the fuel valve itself, is mounted just forward of the firewall, on the lower left inside of the fuselage


Fuel valve selector handle
Torque tube
Universal joint
Note: Fuel valve selector handle is remotely mounted in the top left corner of the pilots seat bulkhead, and the fuel valve itself, is mounted just forward of the firewall, on the lower left side of the fuselage
FUEL VALVE
Fuel line from right fuel tank
Fuel line to engine
Fuel line from left fuel tank
LEFT MAIN FUEL TANK
RIGHT MAIN FUEL TANK
CARB
Top view of the fuel system installed on John Denver's Long–EZ



Note: Fuel valve selector handle is remotely mounted in the top left corner of the pilots seat bulkhead, and the fuel valve itself, is mounted just forward of the firewall, on the lower left side of the fuselage

Top view of the fuel system installed on John Denver's Long-EZ



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