-----SYSTEMS GROUP CHAIRMAN'S FACTUAL REPORT -------
Exemplar Aircraft Examinations

A. ACCIDENT:

Location:	McKinneyville, California
Date:	July 29, 2016
Time:	About 0105 Pacific Daylight Time
Aircraft:	Piper PA-31T
Registration:	N661TC

B. SYSTEM'S GROUP:

Chairman:	Michael Bauer National Transportation Safety Board Washington, D.C.
Investigator in Charge:	Brice Banning National Transportation Safety Board Anchorage, AK.
Fire Investigator:	Nancy McAtee National Transportation Safety Board Washington, D.C.
Member:	Dan Butler Federal Aviation Administration Oakland, CA.
Member:	Charlie Little Piper Aircraft
Member:	Dan Brattain Cal-Ore Life Flight
Member:	Bob Bareggi Cal-Ore Life Flight

C. SUMMARY

On July 29, 2016, about 0105 Pacific daylight time, a twin-engine, turbine-powered, Piper PA-31T Cheyenne II airplane, N661TC, reported smoke in the cockpit and subsequently sustained an in-flight breakup and collision with tree-covered terrain near Arcata/Eureka Airport, McKinneyville, California. The accident airplane was being operated by Cal-Ore Life Flight as an instrument flight rules (IFR) air transport medical flight under the provisions of Title 14, CFR Part 135. The airline transport pilot, two medical personnel, and one patient were fatally injured; the airplane sustained substantial damage. Dark night, instrument meteorological conditions prevailed. The flight departed Crescent City, California, at 0045, destined for Oakland International Airport, Oakland, California.

D. DETAILS OF THE INVESTIGATION:

During the wreckage examination of the accident aircraft, the investigation team examined two exemplar aircraft from the operator's fleet. The exemplar examination was conducted so the investigative team could familiarize themselves with certain areas of the aircraft based on information from the accident aircraft's wreckage. The following report documents information from those examinations. The FAA inspected additional aircraft after the wreckage examination, information on those examinations is included in Appendix A.

D.1 Electrical System Description

The Piper Cheyenne is equipped with a 28 VDC electrical system powered by a battery and two starter generators. External power provisions are available for ground operational requirements.

The typical power distribution system is of split-bus design with individual circuit protection and separate pilot accessible bus-tie circuit breakers, including diode protection, providing operational flexibility during single engine or single alternator operation.

The accident aircraft was manufactured in 1981. The main tie bus circuit breakers are located on a panel on the floor between the pilot and copilots seats. Prior to 1981, the main tie bus system design contained four circuit breakers. Three circuit breakers were rated at 200 amps (A) and one circuit breaker was rated at 100 amps.

The accident aircraft serial number was 31T-8120022. This aircraft also contained a main tie bus panel located between the pilot and copilot's seats. The panel contained at the time of delivery twelve circuit breakers in two rows of six with current ratings

ranging from 50 A to 200 A.. The accident aircraft also contained a supplemental type certificate (STC) modification, Lifeport STC (SA00528SE), for cabin medical equipment, which accommodated additional power requirements for medical equipment installed in the aircraft. The STC modification introduced two additional circuit breakers to the main bus tie panel with ratings of 30A and 50A.

In the structural bay, below the floor, where the main bus tie panel was located, additional wiring and components for the left and right starter solenoids were mounted.

D.2 Hydraulic System Description

The aircraft contains a hydraulic system, which operates the retractable landing gear. Hydraulic lines for the main landing gear travel from the hydraulic reservoir along the fuselage below the floor, through the main spar and then to the left and right main landing gear actuators and door actuators. Four hydraulic lines labelled "Gear Down", "Gear Up", "Door Open", and "Door Closed" travel through the structural bay that contains the main bus tie circuit breaker panel. The hydraulic lines are located below the circuit breakers. The hydraulic fluid used by the aircraft system is MIL-H-5606.

D.3 Exemplar Aircraft #1 Examination:

The first exemplar aircraft from the operator's fleet that was examined by the group was of similar build, based on serial numbers, to the accident aircraft. The aircraft also included the Lifeport STC, which included similar modifications to the power distribution system. The examination consisted of inspections of the area underneath the main circuit breaker panel located on the floor between the pilot's and copilot's seats just forward of the main spar, Figure 1 and Figure 2. The area was accessed through the electrical lead access panel in the fuselage of the aircraft. The examination utilized a small high definition video camera and a borescope to supplement the visual inspection.

Figure 1 – Main bus tie circuit breaker panel

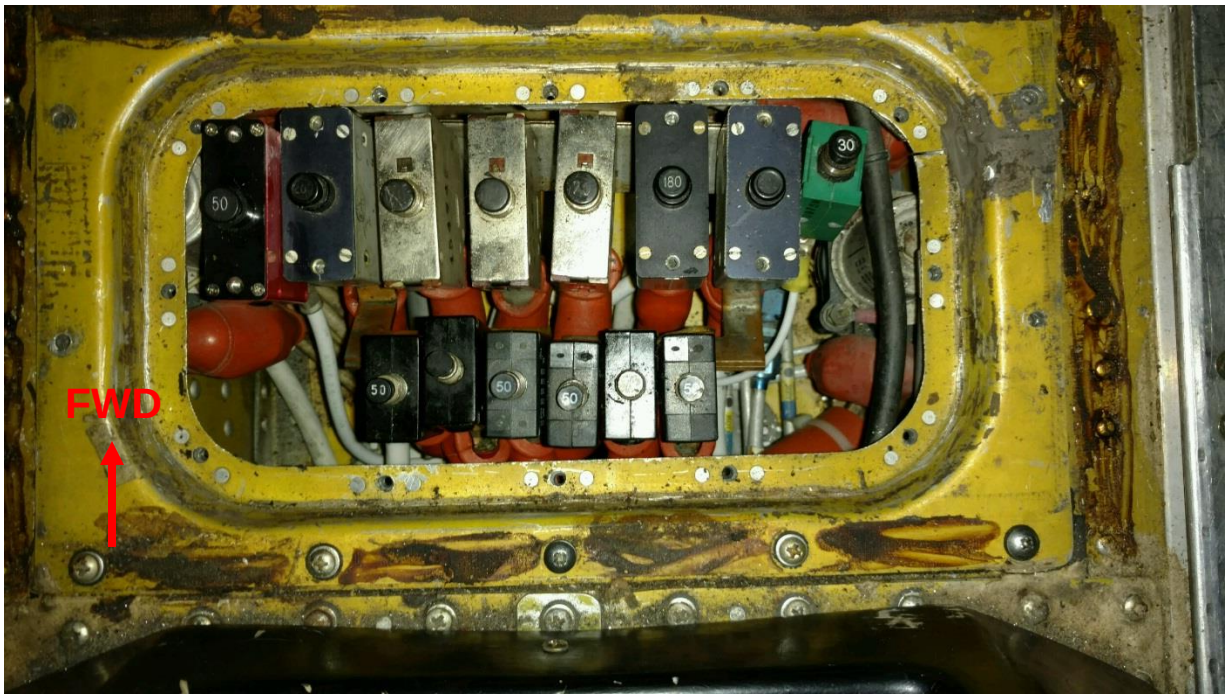


Figure 2 - Main bus tie circuit breaker panel with cover panels removed

Four wires, identified as R MAIN 1, R MAIN 2, RAD 1, RAD 2, were found passing directly above the hydraulic lines, (see Figure 3). The wires were bundled in a rubber gasket material, secured by two cable ties in the area where the wiring would be in contact with the hydraulic lines. One wire identified as EMS PWR was routed between a power supply wire labeled "P2E" and within less than ½ inch of the hydraulic line "DOOR CLOSED", (see Figure 4).

Two wires from the STC installation, identified as EMS PWR and EMS INV passed below the four hydraulic lines and above the fuselage structure and then continued through a lightening hole in a longeron on the right side of the aircraft.

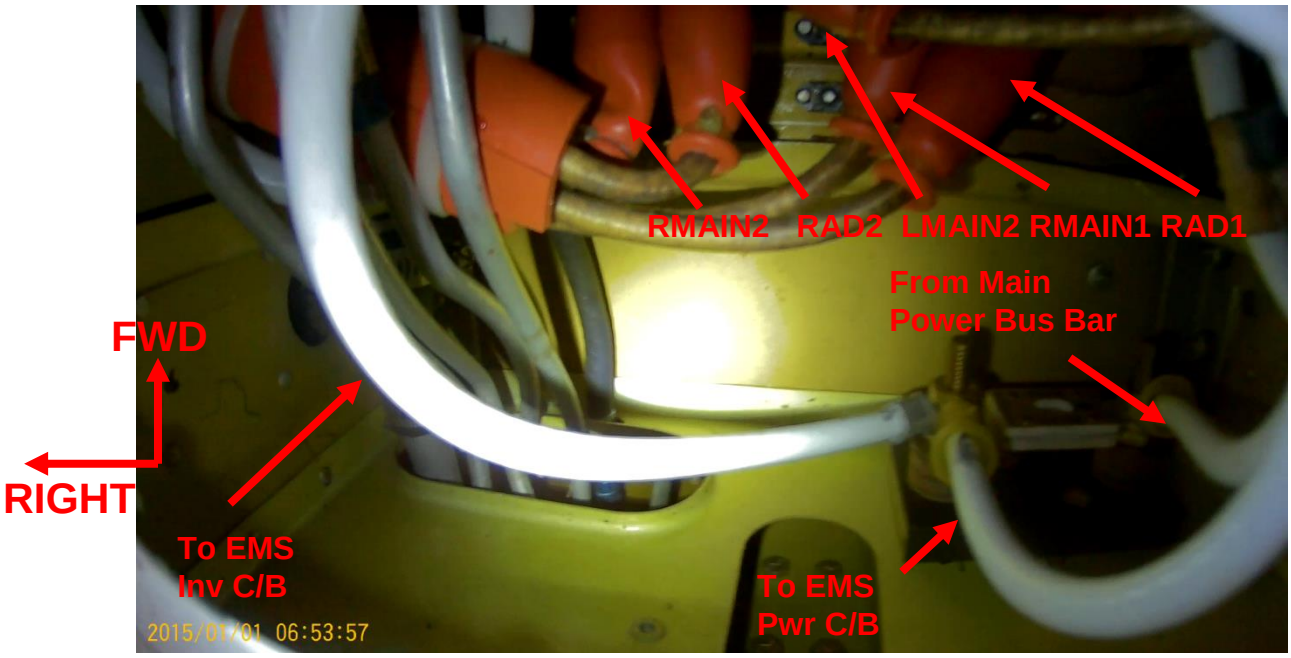


Figure 3 – Aircraft 1: electrical inspection bay (view looking up)

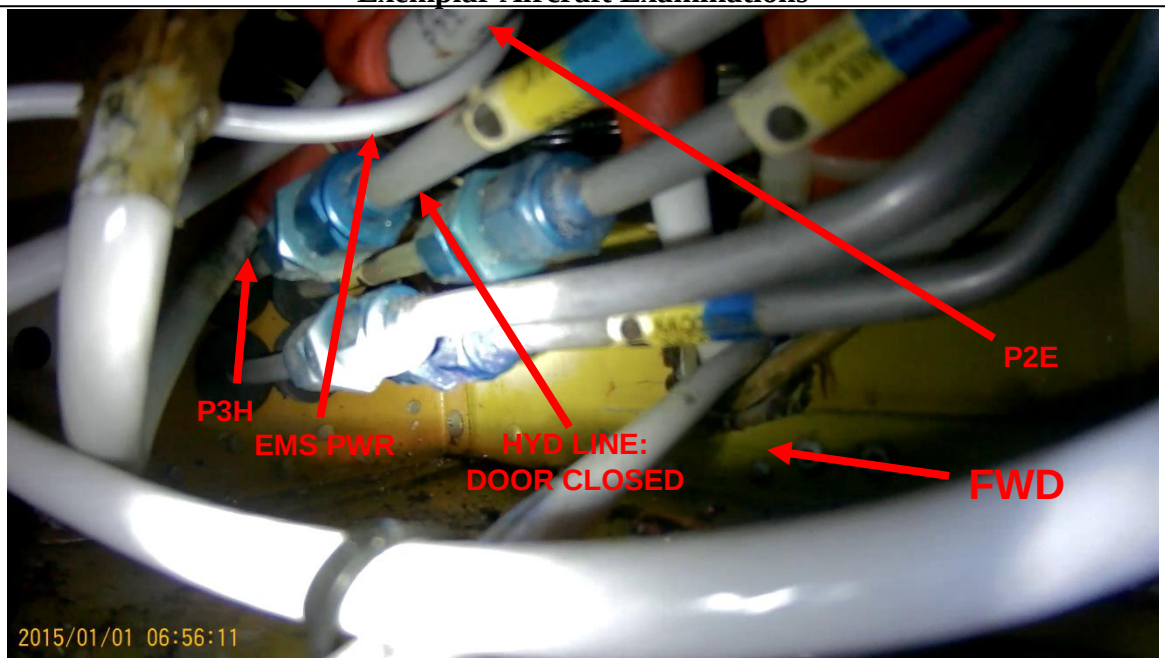


Figure 4 - Aircraft 1: hydraulic lines and electrical wires below panel (view looking forward)

The two wires identified as L MAIN 1 and L MAIN 2 passed through a lightening hole in a longeron on the left side of the aircraft.

One wire identified as "P3H", which was routed between the right starter solenoid and the battery circuit breaker could be seen in direct contact with the hydraulic line "DOOR CLOSED", (See Figure 5)

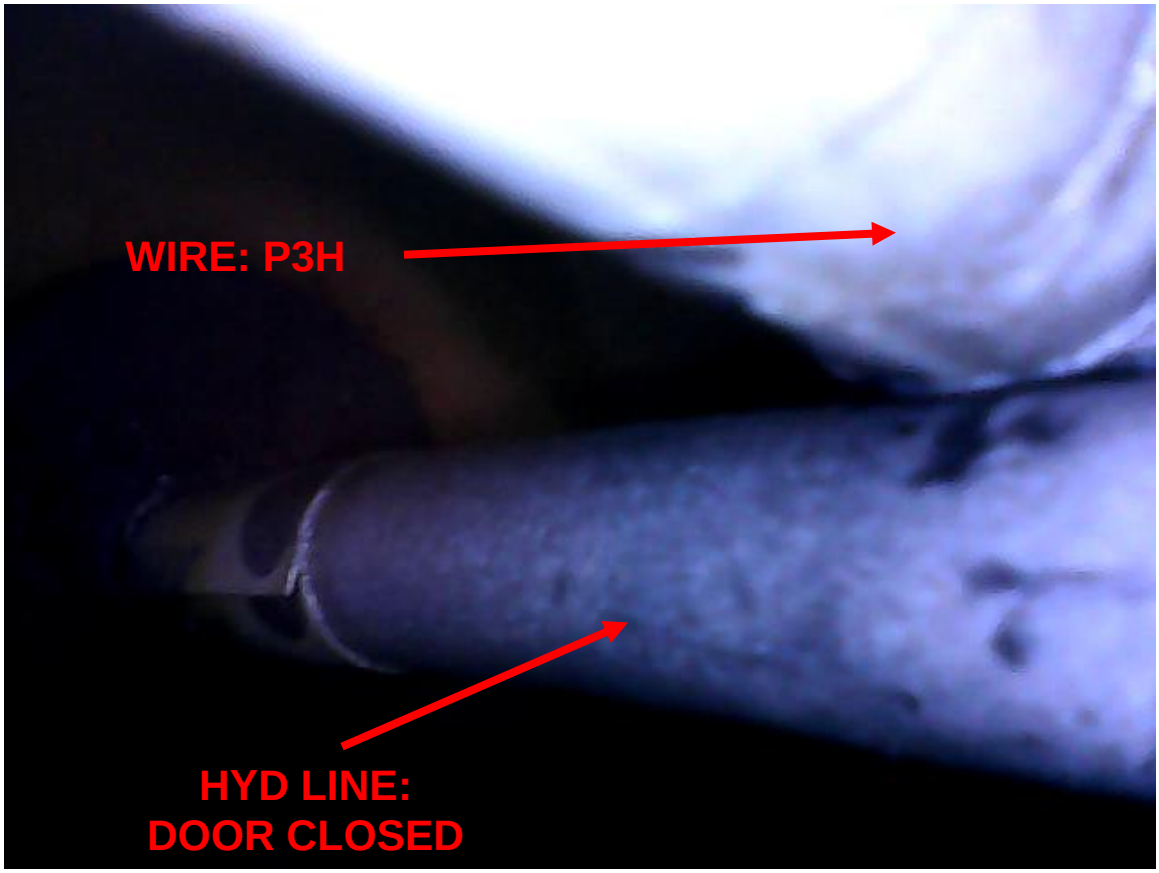


Figure 5 - Aircraft 1: Wire P3H and "Door Closed" hydraulic line (borescope view)

D.4 Exemplar Aircraft #2 Examination:

A second exemplar aircraft from the operator's fleet was examined by the group. The second aircraft contained the older electrical distribution system which consisted of 4 bus tie breakers. The aircraft did not contain the Lifeport STC. The examination consisted of inspections of the area underneath the main bus tie circuit breaker panel located on the floor between the pilot's and copilot's seats just forward of the main spar, (See Figure 6). The area was accessed through the electrical lead access panel in the fuselage of the aircraft and from above the floor, (See Figure 7).

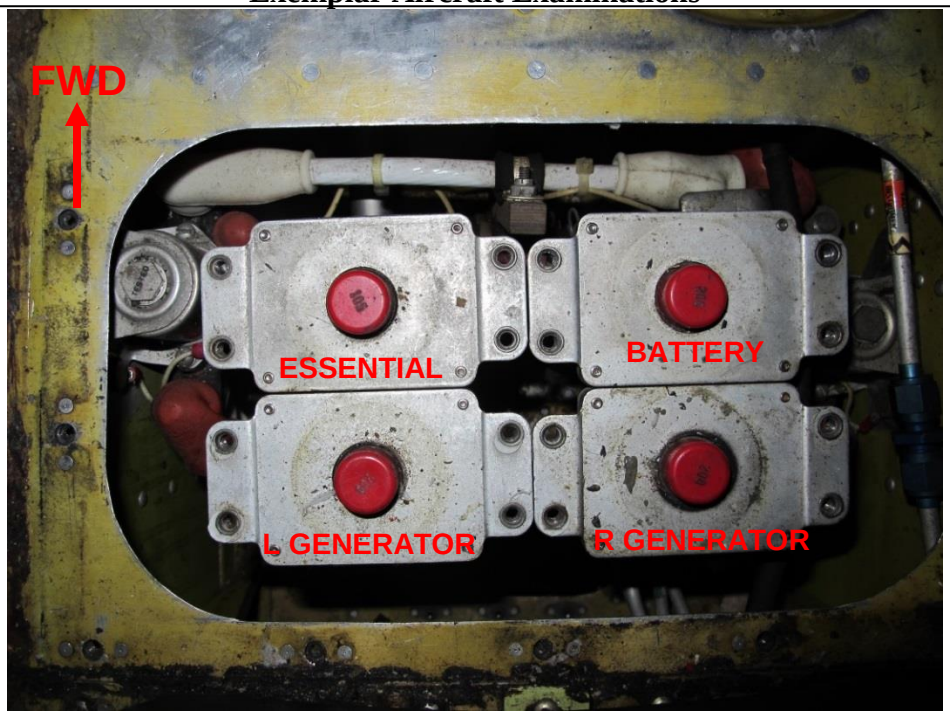


Figure 6 - Main bus tie circuit breaker panel with cover panels removed, labels added for clarity (view looking down)

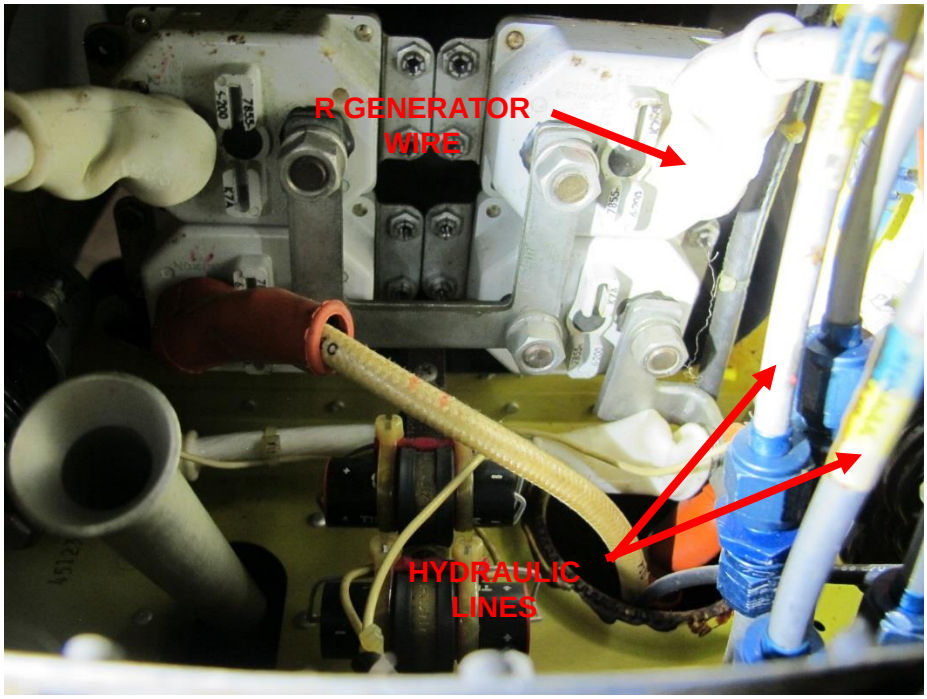


Figure 7 – Bottom of circuit breaker panel and forward bulkhead (view looking up and forward)

The right generator circuit breaker wire could be seen in direct contact with the hydraulic line "DOOR OPEN", (See Figure 8).

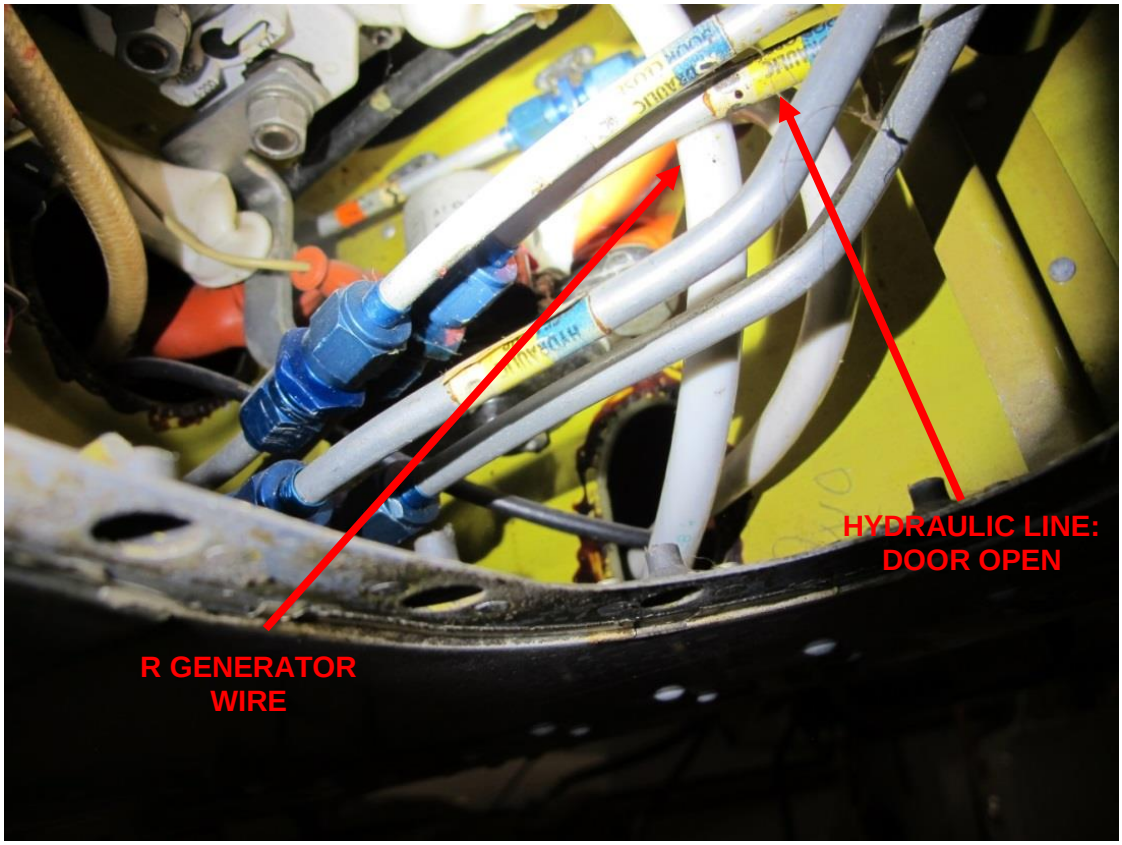


Figure 8 - Hydraulic lines and electrical wires (view looking up and right)

D.5 Regulatory Material

The following section contains excerpts from regulatory material related to electrical installation requirements and guidance material regarding wiring. Based on the aircraft's type certificate data sheet (TCDS), the PA-31T certification basis was Civil Aviation Regulation (CAR) part 3[1].

[1] Complete certification basis can be found at www.faa.gov, type certificate data sheet A8EA.

D.5.1 CAR § 3.681 – Electrical Systems and Equipment

"*Installation.* (a) Electrical systems in airplanes shall be free from hazards in themselves, in their method of operation, and in their effects on other parts of the airplane. Electrical equipment shall be of a type and design adequate for the use intended. Electrical systems shall be installed in such a manner that they are suitably protected from fuel, oil, water, other detrimental substances, and mechanical damage."

D.5.2 FAA Advisory Circular AC 43.13-1B CHG 1

AC 43.13-1B was specified on the STC wiring installation drawing.

From Section 11-96:

"**w. Where practical,** route electrical wires and cables above fluid lines and provide a 6 inch separation from any flammable liquid, fuel, or oxygen line, fuel tank wall, or other low voltage wiring that enters a fuel tank and requires electrical isolation to prevent an ignition hazard. Where 6 inch spacing cannot practically be provided, a minimum of 2 inches must be maintained between wiring and such lines, related equipment, fuel tank walls and low voltage wiring that enters a fuel tank. Such wiring should be closely clamped and rigidly supported and tied at intervals such that contact between such lines, related equipment, fuel tank walls or other wires, would not occur, assuming a broken wire and a missing wire tie or clamp."

D.5.3 MIL-W-5088L – Electrical Systems and Equipment

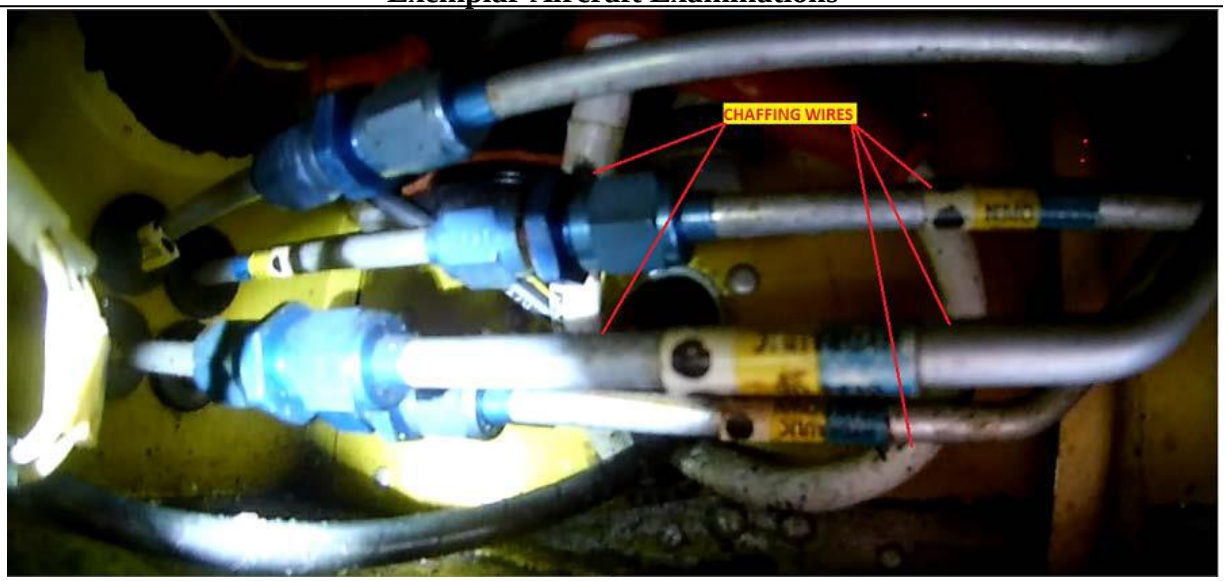
MIL-W-5088L was specified on the STC wiring installation drawing.

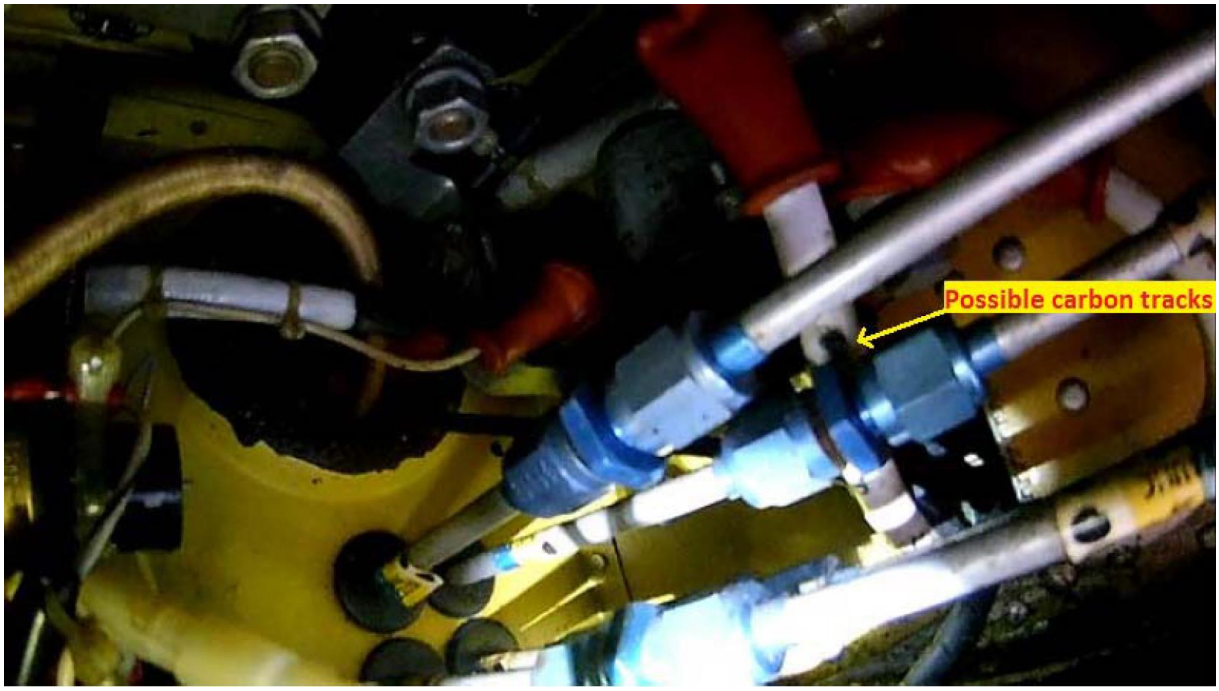
"*3.11.11* Gas and fluid carrying lines and tubes. Wiring shall be supported independent of and with the maximum practicable separation from all fluid-carrying lines, tubes and equipment. Wiring shall be routed above, rather than below liquid carrying lines, tubes and equipment to prevent contamination or saturation of the wiring in the event of leakage. Where this routing is not practicable, the wiring shall pass below the lines at an angle rather than parallel to the lines. Terminating devices shall not be placed under any lines. Wiring shall not be attached to fluid carrying lines, tubes and equipment unless they require electrical connections or their separation is less than two inches. In areas where separation is less than two Inches, the wiring shall be installed to maintain positive separation of at least .500 inch. Examples: (a) separate the wiring from the line with a suitable separation device, (b) attach the wiring to primary support(s) at the closest proximity of the wiring to the line. Where lines and wiring are installed such that they are separated by rigid nonmetallic conduit, metal conduit, ribs, webs, frames, channels, extrusions, stringers, or other suitable barriers, the above minimum separation requirements do not apply.."

E. Appendix A – FAA Exemplar Aircraft Examinations

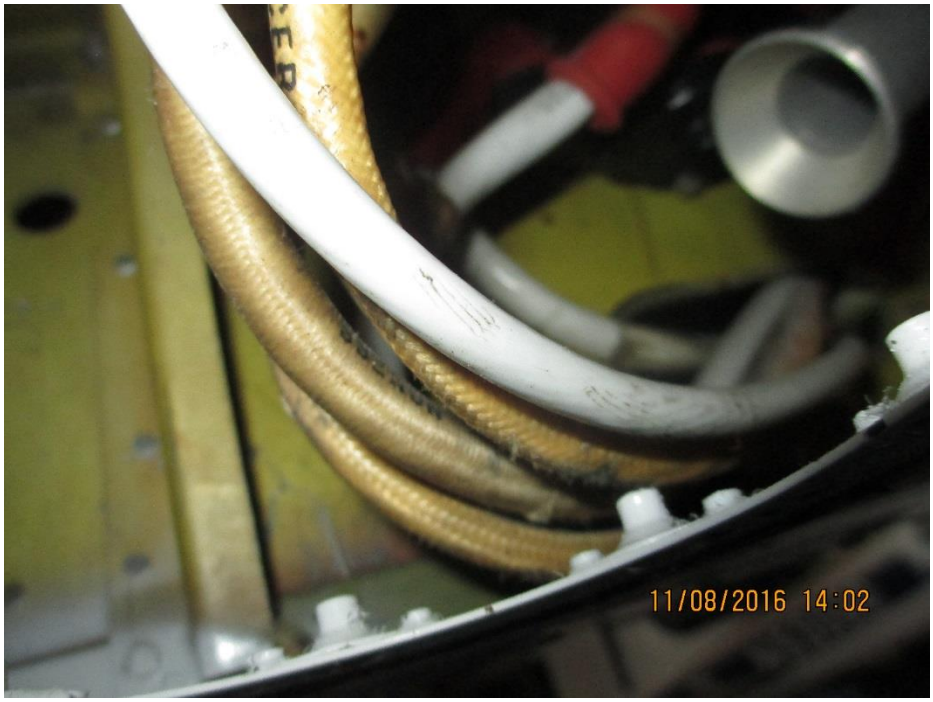
The following section contains the photo documentation from the FAA inspection of additional PA-31 series aircraft.

E.1 Aircraft 1 – PA-31T – Cheyenne II


CHAFFING WIRES


Possible carbon tracks

E.2 Aircraft 2 – PA-31T



E.3 Aircraft 3 – PA-31T2