

Airworthiness and inoperative equipment

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Background

- DREX at Oakland, normal taxi and run-up
- Extensive delay for takeoff due to training MO, mission request to stop on runway, and landing traffic
- Trim not checked immediately prior to takeoff
- Normal acceleration, rotation at 55 unsuccessful due to excessive control pressures
- Takeoff aborted, left runway, trim observed full nose down
- Disabled electrical trim with AP circuit breaker, reset trim, took off again
 - Required pilot analysis indicated no possibility of recurrence with CB pulled
 - CAWG ruled this a 14 CFR 91.213(d) violation with no risk to crew or equipment

Flying with inop equipment

- For Part 91 piston aircraft, not allowed UNLESS:
 - Equipment not required by
 - 14 CFR 91.205 (A TOMATO FLAMES, etc.),
 - Aircraft certification,
 - Airworthiness directives, or
 - Aircraft operating handbook or placards
 - Equipment is disabled or removed and placarded
 - Pilot in command determines flight can be accomplished safely

Equipment required by regulation, day VFR

- Anticollision lighting (aircraft newer than 1993)
- Tachometer
- Oil temperature gauge (air cooled engines)
- ~~Manifold pressure gauge (not for naturally aspirated engines – but see KOEL for 182T)~~
- Airspeed indicator
- ~~Temperature gauge (not for air cooled engines)~~
- Oil pressure gauge (if oil is pressurized)
- Fuel gauges for each tank
- ~~Landing gear position indicator (not for fixed gear)~~
- Altimeter
- Magnetic Compass
- Emergency location transmitter (with a few rare exceptions)
- Seat belts and shoulder harnesses
- Floatation gear (for hire out of gliding distance from land)
- Transponder (certain areas or IFR)

Equipment required by regulation, night VFR

All day VFR equipment, plus

- ~~Fuses~~ (182Ts don't have any that can be changed in flight)
- Landing light (for-hire operations)
- Anticollision lights (aircraft newer than 1971)
- Position lights (red, green, white)
- Source of power adequate for operation

Equipment required by regulation, IFR

All day and night VFR equipment, plus

- Generator or alternator of adequate capacity
- Rate of turn indicator (gyroscopic turn coordinator)
- Adjustable sensitive altimeter
- Ball (slip/skid indicator)
- Clock with second display (digital or analog)
- Attitude indicator
- Radio and navigation suitable for route of flight
- Directional gyro
- ~~DME or GPS~~ (above FL240; above service limit for 182T)

Other required equipment for G1000 182T

- None required by airworthiness directives
- None required by type certification not described in POH
- Kinds of Operation Equipment List has some additions
 - G1000 pilots reference guide
 - Two avionics fans
 - Main battery and ammeter
 - Flap motor and indicator
 - Elevator and rudder trim and indicators
 - Electric fuel pump
 - Alternate static and air induction (IFR only)
 - Stall warning
 - System annunciations
 - Various interior and instrument lights (night only)
 - Standby attitude indicator, airspeed indicator and altimeter (IFR only)
 - Vacuum system and indicator (IFR only)
 - Manifold pressure and fuel flow indicators
 - Cylinder head temperature gauge
 - Oil dipstick

So, something doesn't work. What now?

14 CFR 91.213(d)

For small piston aircraft operated under Part 91:

- Check regulations
- Check type (TCDS) and airworthiness directives on FAA website
- Check Kinds of Operation Equipment List in POH
- Deactivate or remove
- Placard
- Review for safe operation

If you do ALL of these things and the inop equipment is not required, it is legal to take off

Traps and pitfalls

- Removal from aircraft
 - FAA allows removal of some simple types of systems by pilots
 - Must be logged, and specifically listed as "preventive maintenance" in Part 43 Appendix A
 - Must use established procedures in maintenance manual
 - Aircraft must be reweighed if not replaced
 - **CAP does not allow this.** Per CAPR 66-1, only a licensed and insured aircraft mechanic may remove systems.
 - Autopilots, transponders, and DME units are explicitly excluded from "preventative maintenance" and are not removeable by pilots.

Traps and pitfalls, part 2

- Disabling equipment
 - Very badly understood in community; conflicting data from FAA and others
 - AC 91-67 says systems can be disabled by turning a switch off, but makes a confusing double-negative prohibition on actions that are not "preventive maintenance"
 - If taken literally, it's not legal to turn the lights off.
 - 14 CFR 91.213(d) says it must be logged and performed consistent with Part 43 if it is maintenance, but a pilot can do maintenance if it is classified as "preventive." CAP restricts this; see previous slide.
 - **CAWG does seem to classify pulling a circuit breaker as maintenance.**
 - But, there is disagreement; it depends which CAP flight instructor you ask.
 - Unpublished "best practices" require it to be impossible to reenble the system unintentionally in flight. The source appears to be risk of restarting electrical fires when a breaker has been opened to service a previous fire.
 - **CAWG insists a breaker be held open with a zip tie or collar**
 - There is elevated risk of CB damage, so it's probably not advisable to attempt this.
 - Recommendation: have a mechanic perform this on CAP aircraft

Placarding

- Widely ignored in the private pilot community, but the regulation is clear.
- Any equipment permanently installed in the aircraft must work or be disabled and placarded.
 - This includes CAP radios and DF.
- FAA requires 1/8" or larger lettering, but it can be written on a piece of masking tape (ref: AC 91-57)
 - All CAP APs carry blue painter's tape and Sharpies

Evaluation

- Sometimes disabling systems has a side effect
 - Example: AP and electric trim are controlled by Avionics Bus 2. Turning off Bus 2 disables the aft avionics cooling fan, required by KOEL, and taking off is not permitted with Bus 2 turned off.
- A legally disabled system may result in hazardous flight under some conditions.
 - Example: Both GPSs inop, but weather degrades to low instrument conditions. Only LPV approaches available within fuel range.

Pilot's responsibility is to determine that flight safety is not compromised by the inoperative system.

If there is any doubt, scrub the mission.

Application to AP DREX

- AP DLSR sorties are almost exclusively hand-flown due to very frequent maneuvers beyond autopilot capabilities.
- Manual trim was working, with correct feel; electric trim judged unnecessary.
- Subsequent takeoff had an unrelated unexplained flapping noise, that the crew believed was a fuel cap. Precautionary landing to inspect revealed the oxygen tank strap was hanging out the door and both fuel caps were secure.
- MO was trained in round dial and overwhelmed by G1000, raising workload.
- Weather was becoming marginal over the photo target location (Sunol)
- PIC called for scrub after multiple issues and extra workload.
- Consequences: No aircraft damage, no injuries, no controllability issues beyond the trim setting. Overweight landing requiring inspection. Electric trim inspection found no anomalies. AP-T needs another sortie.

Lessons learned

- Inop equipment requires more than an assurance of safe operation for legal takeoff
- Systems understanding is critical
- CAP requirements may be more stringent than FAA
- Flight school conventions are not always legal
 - Law of Primacy means a lot of pilots may be mistrained
- Airworthiness rules and conventions are clear as mud, and published in several different places

References

- AC 91-67, Minimum Equipment Requirements for General Aviation Operations Under FAR Part 91
- 14 CFR 91.205, Powered Civil Aircraft with Standard Category US Airworthiness Certificates: Instrument and Equipment Requirements
- 14 CFR 91.213, Inoperative Instruments and Equipment
- 14 CFR 43 Appendix A, Major Alterations, Major Repairs and Preventive Maintenance
- CAPR 66-1, Civil Air Patrol Aircraft Maintenance Management
- Airworthiness Directives,
https://www.faa.gov/regulations_policies/airworthiness_directives/
- Type Certification Data Sheets (TCDSs),
https://rgl.faa.gov/Regulatory_and_Guidance_Library/rgMakeModel.nsf/Frameset?OpenPage