

**Avionics Operational Test Standards**  
**FS/OAS A-24**  
**Revision F**

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September 10, 2018

The following standards apply to all contractually required/offered avionics equipment under US Forest Service contracts and Department of the Interior interagency fire contracts.

Abbreviations and Selected Definitions are in Section 7.

<b>1. Communications Systems</b>	
<i><b>Interference</b></i>	
No squelch breaks or interference with other transceivers with 1 MHz separation. No transmit interlock functions for communications transceivers on fire aircraft.	
<i><b>VHF-AM Transceiver</b></i>	
Type	TSO approved, selectable frequencies in 25 kHz increments, 760 channel minimum, operation from 118.000 to 136.975 MHz, 720 channel acceptable for DOI if contractually permitted
Display	Visible in direct sunlight
Operation	To and from service monitor
Transmitter	System modulation from 50% to 95% and clear, 5 watts minimum output power, frequency within 20 PPM (+2.46 kHz @ 122.925 MHz) (47 CFR 87.133)
Receiver (All Aircraft)	Squelch opens when receiving a signal from 50 Nautical Miles or greater when no other radios on the aircraft are transmitting. (See FS/OAS A-30 Radio Interference Test Procedures)
Receiver (Fire aircraft approved for passengers or aircraft requiring two pilots)	Squelch opens when receiving a signal from 24 Nautical Miles or greater while other radios on the aircraft are transmitting with a spacing of 2 MHz or greater. (See FS/OAS A-30 Radio Interference Test Procedures)

<b>Aeronautical VHF-FM Transceiver (P25 required for Fire)</b>	
Type	Listed on <a href="#">Approved Radios</a> list, P25 meets <a href="#">FS/AMD A-19</a>
Power Output	10 watts nominal output, multiband transceivers 6 to 10 watts nominal output
Antenna	<a href="#">Cobham</a> (Comant) CI 177-1 or equivalent
CTCSS Tones	All current TIA-603 standard tone encode & decode tone capability, TX tone level of 300 to 600 Hz in narrowband, frequency within 1.5 Hz of selected tone, proper operation
NAC and TGID (P25)	Operator selectable
All Transmitters	Narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM ( $\pm 421$ Hz @ 168.3500 MHz) (per <a href="#">NTIA Manual Chapter 5</a> )
Guard Transmitter	Quickly selectable, operates on 168.6250 MHz, TX CTCSS tone of 110.9 Hz
All Receivers	Squelch opens when receiving a signal from 50 Nautical Miles or greater when no other radios on the aircraft are transmitting. (See FS/OAS A-30 Radio Interference Test Procedures), audio output of at least 100 mV with narrowband input, less than 10% distortion
All Receivers (Fire aircraft approved for passengers or aircraft requiring two pilots)	Squelch opens when receiving a signal from 24 Nautical Miles or greater while other radios on the aircraft are transmitting with a spacing of 2 MHz or greater. (See FS/OAS A-30 Radio Interference Test Procedures)
Guard Receiver (Fire Aircraft)	Independent receiver, operates on 168.6250 MHz, cannot scan Guard, capability to enable/disable CTCSS tone of 110.9
Mounting	Meets AC 43.13-2B, controls equally convenient to PIC and SIC/observer
<b>AUX-FM Provisions</b>	
Operation	RX & TX functions through aircraft audio system(s), sidetone present, TX deviation output matches portable's stand-alone output, installed per <a href="#">FS/AMD A-17</a>
Controls	TX <b>and</b> RX selectors on all required audio controls
Antenna	<a href="#">Cobham</a> (Comant) CI 177-1 or equivalent

Mounting Facilities	Meeting AC 43.13-2B ( <a href="#">Field Support Services</a> AUX-EPH-RB or equivalent), within 18" of AUX-FM connectors, controls convenient to SIC/observer
Connectors	MS3112E12-10S, female BNC, both bulkhead mounted, both adjacent to each other
<b><i>VHF-FM Programming Port</i></b>	
Operation	Location, ability to program each radio
Adapters	Available for installed radio type, serial or USB connector
<b><i>VHF-FM Aeronautical Antenna: Light Fixed Wing</i></b>	
RF Cable	Location, cable length, male BNC connector
Antenna	<a href="#">Cobham</a> (Comant) CI 177-1 or equivalent
<b><i>P25 Digital VHF-FM Mobile Radio</i></b>	
Type	Listed on <a href="#">Approved Radios</a> list
Operational Check	Proper RX and TX operation
Power Output	30 watts minimum nominal output
Antenna	Antenna Specialists ASPR-7490; Maxrad MWB-5803; or equivalent
CTCSS Tones	All current TIA-603 standard tone encode & decode tone capability, TX tone level of 300 to 600 Hz in narrowband, frequency within 1.5 Hz of selected tone, proper operation
NAC and TGID	Operator selectable via radio controls
Receiver	Squelch opens @ 0.25 to 0.5 uV with direct connection at 138, 156, and 173.975 MHz, audio output of at least 100 mV with narrowband input (1.5 to 2.5 kHz modulation), less than 10% distortion
Transmitter	Narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM ( $\pm 421$ Hz @ 168.3500 MHz) (per <a href="#">NTIA Manual</a> Chapter 5)
Field Programmability	Contractor demonstration without the use of a computer to program the radio

<b>P25 Digital VHF-FM Portable Radio</b>	
Type	Listed on <a href="#">Approved Radios</a> list
Operational Check	Proper RX and TX operation
Power Output	1 watt but no more than 10 watts nominal output
Battery	Alkaline: At least one clamshell; Rechargeable: Two fully charged battery packs at beginning of each shift
CTCSS Tones	All current TIA-603 standard tone encode & decode tone capability, TX tone level of 300 to 600 Hz in narrowband, frequency within 1.5 Hz of selected tone, proper operation
NAC and TGID	Operator selectable via radio controls
Receiver	Squelch opens @ 0.25 to 0.5 uV with direct connection at 138, 156, and 173.975 MHz, audio output of at least 100 mV with narrowband input (1.5 to 2.5 kHz modulation), less than 10% distortion
Transmitter	Narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM ( $\pm 421$ Hz @ 168.3500 MHz) (per <a href="#">NTIA Manual</a> Chapter 5)
Field Programmability	Contractor demonstration without the use of a computer to program the radio
<b>Public Address Systems</b>	
Controls	Operated through each required aircraft audio control systems, uses headset/helmet mic
Siren	Provides Yelp and Wail tones activated by PIC and SIC/observer
External	External speakers, easily heard 100 feet below aircraft in flight
Internal	Internal speakers, easily heard throughout the passenger compartment while in flight, Smokejumper A/C less than 10% distortion for conveying intelligible messages to all occupants from all positions with jump door open, (system required on A/C with +19 PAX seats per 14 CFR 135.150 & Smokejumper A/C)

<b>2. Audio Systems</b>	
<b><i>Audio Control System: General Requirements Applicable to Each Required System</i></b>	
Location	Convenient to required operator(s), not a safety hazard
Labeling	Legible, permanent, understandable (i.e. COM 1, COM 2, FM 1, AUX, etc or COM 1, COM 2, COM 3, COM 4, etc with radios marked accordingly)
Hum, Noise, and Crosstalk	40 dB below specified audio output
Specified Audio Output	100 mW with an input of 250 mV, both at 600 ohms
Distortion	Less than 10%
TX Selection	Automatically selects proper radio and companion receiver; each required transceiver and PA has separate TX position
RX Selection	Selects proper radio receiver (on/off switch)
PTT Switch	Proper operation, non-pilot switches not on flight controls
ICS and Radio RX Volume	Proper operation, audio level
Sidetone	Present for each transceiver, acceptable audio level
<b><i>Audio Control System: Helicopter: <u>See applicable drawings</u></i></b>	
Required Controls	Individual RX selection of each radio, separate master RX and ICS audio level controls
RX Selection	Each required receiver has individual RX selector independent of the transmitter selector
PTT Switch	Separate radio TX and ICS TX switches at all required positions
Rappel/EU	Proper ICS and TX capability at specified positions, additional Audio Control System per contracts and drawings
<b><i>Audio Control System: Air Tactical Type 1 &amp; 2</i></b>	
Required Controls	Dual systems with individual RX selection of each radio
ATGS Instructor	TX/RX operation uses SIC/observer audio control or has a separate system (Nav audio not required for Instructor system)

<b>Audio Control System: Airtanker</b>	
Required Controls	PIC and SIC systems interchangeable, individual RX selection of each radio, pilot inspector monitors SIC or has a separate system (no TX or NAV required for inspector)
<b>Audio Control System: Smokejumper</b>	
Required Controls	Individual RX selection of each radio, separate master RX and ICS audio level controls
ICS and Radio RX Volume	Audio level sufficient for intelligible reception to helmeted spotter with jump door open while in flight
<b>Intercommunications System (ICS)</b>	
Required Positions	Per contractually required locations
Operation	Proper audio & mic operation at each required position, Smokejumper isolation with Call button and PIC annunciator
Hot Mic/VOX	Presence per contract requirements, proper operation
PTT and Volume Controls	Presence per contract requirements, proper operation, Airtanker ICS PTT not required if normal conversation can be maintained while in flight
<b>3. Navigation Systems</b>	
<b>Global Positioning Systems (GPS): All</b>	
Installation	Convenient to both PIC and SIC/Observer
Operation	Correct present position or lock on, database age does not exceed contract limit, WGS-84 datum, degrees/decimal degrees display
Moving Map (when required)	Display area 1.5" high x 3.0" wide minimum, aircraft position relative to waypoints, displays geographical features
Data Connector (when required)	DB-9F connector, correct pins active, proper location
<b>Aeronautical GPS</b>	
Type	TSO approved, panel mounted, IFR installation requires Flight Manual documentation

<b>Portable GPS</b>	
Type	Aviation portable, not a drive along the road type
Installation	Meets AC 43.13-2B, operates using aircraft power
Antenna	Antenna remoted from unit with clear path to satellite signals
<b>Additional GPS Antenna</b>	
Type	TSO approved, compatible with the portable GPS of the requesting unit
<b>VOR</b>	
Type	TSO approved, panel mounted
Operation	Display visible in direct sunlight, audio, flag pull, to/from operation
Bearing Error	±3° maximum (usually 1½ out of 5 dots) or meeting the manufacturer's specifications (whichever is more stringent), maximum variation between dual system of ±4° (usually 2 out of 5 dots), IFR aircraft require aircraft log/record entry for IFR 30 day check per 14 CFR 91.171
<b>Localizer and Glideslope</b>	
Type	TSO approved, flag pull, proper deviation direction, interfaced to the correct navigation system
Deviation Error	.07% maximum (approximately 1 needle width) or meeting the manufacturer's specifications (whichever is more stringent)
<b>Marker Beacon</b>	
Type	TSO approved, three light
Operation	All indicators operate properly, acceptable sensitivity, acceptable audio level (service monitor required)
<b>DME</b>	
Type	TSO approved, independent from GPS unless IFR GPS is allowed to replace DME by contract
Operation	Display visible in direct sunlight, proper distance to station
<b>ADF</b>	
Operation	Display visible in direct sunlight, points to station, 360° operation, acceptable audio

<b>4. Surveillance Systems</b>	
<b><i>Emergency Locator Transmitter (ELT)</i></b>	
Type	TSO-C91a or newer (DOI requires TSO-C126 or newer for most contracts)
Mounting	Per TSO and manufacturer's instructions (deflection less than 0.1" with 100 lbs. of force applied)
Antenna	Mounted externally to the aircraft unless installed in a location approved by the aircraft manufacturer, portable antenna available for automatic portable types
Battery Date	Not expired, date marked on ELT which matches aircraft records
Operation	Direct connection to ELT required if operating outside of the first five minutes of the hour, use test function if available, manually operates, PRF acceptable, buzzer activates for 406 MHz models
Remote	Location visible and accessible to PIC, functionality, indicator
Logbook	Annual 14 CFR 91.207(d) test completed
Registration (for TSO-C126)	Currently registered with national authority (NOAA in USA)
TSO-C126 Transmissions	Hex code matches registration document, correct country code, correct aircraft registration number (if transmitted)
<b><i>Automated Flight Following (AFF)</i></b>	
Operation	Current position data displayed on aff.gov, required data is accurate
Installation	Per manufacture's manual and AC 43.13-2B, operates using aircraft power, dedicated circuit breaker
Antenna	External to unit, clear path to satellites
<b><i>Additional Telemetry Unit (ATU)</i></b>	
Operation	Reports required data through AFF, correct data confirmed by USFS AFF program
Installation	Per manufacture's manual and AC 43.13-2B, operates using aircraft Power,



Bucket Operations	Bucket provides ground to ATU without action beyond connecting the bucket to aircraft or longline
<b>Transponder</b>	
Type	TSO-C74b, TSO-C74c (Mode A/C) or TSO-C112 (Mode-S)
Installation	Meets 14 CFR 91.215(a), 91.215(b), and 91.413
Records	Required 14 CFR 91.413 & 14 CFR Part 43 Appendix F logbook entry not expired (24 calendar month maximum)
<b>Altimeter and Automatic Pressure Altitude Reporting systems</b>	
Installation	Maintained to 14 CFR Part 91 IFR requirements
Records	14 CFR 91.411 & 14 CFR Part 43 Appendixes E and F logbook entry not expired (24 calendar month maximum)
<b>Traffic Advisory System (TAS)</b>	
Type	TSO approved active system. Maximum range at least 10 NM, TCAS required on turbine airplanes with +10 PAX seats per 14 CFR 135.180
Display	Within view of PIC and SIC, traffic displayed graphically, range selection of 2 miles or less unless the 2 mile display area has a diameter of 2.75 inches or larger (ASM requires 1 NM display range)
Operation	On and operating per 14 CFR 91.221, coverage in all directions above and below aircraft,
<b>Automatic Dependent Surveillance - Broadcast Out (ADS-B OUT)</b>	
Type	Approved to TSO-C154c (UAT) or TSO-C166b (1090ES) (TSO-C166b required outside of the United States)
<b>5. General Systems</b>	
<b>Autopilot</b>	
Operation	Capable of operating the aircraft controls to maintain flight and maneuver it about the three axes
<b>Auxiliary Power Source (3 Pin)</b>	
Connector	MS3112E12-3S installed, proper location, permanently mounted, polarity, voltage at correct pins
Circuit Breaker	Correct amperage value, operation

<b>Bucket/Torch Connector (9 Pin)</b>	
Connector	MS3101A24-11S installed, within 12" of cargo hook, securing lanyard or fixed to aircraft structure
Wiring	Pin D = ground, Pin E = switched 28V, Pin G = bucket connected (Pin G only required for ATU)
Circuit Breaker	50 ampere, operation
<b>Cargo Bell and Light System: Smokejumper</b>	
Cargo Bell	Location, activation, sound level
Light System	Location, activation, indicators
<b>Cockpit Voice Recorder</b>	
Type	TSO approved, (required on multiengine turbine powered A/C with +6 PAX seats requiring two pilots by TC or operating rule per 14 CFR 91.609 and 135.151)
Operation	Proper area mic location, headset mic(s) operation, radio RX operation, locator beacon battery date current
<b>Magnetic Direction Indicator (Compass)</b>	
Installation	Placarded and legible, calibrated with engines operating stating that radios were on or off, calibration readings of not more than 30 <sup>0</sup> increments (normal category airplanes, airtankers and smokejumpers) or 45 <sup>0</sup> increments (all others), Errors within 10 <sup>0</sup> , compass swing required after installation of new avionics systems
<b>Multi-Function Display (MFD)</b>	
Operation	In view of PIC, GPS navigation displayed on color moving map, Displays TAS and weather datalink when installed
<b>Radar Altimeter</b>	
Operation	0-2000 feet AGL, altitude low (DH) light in PIC's primary field of view, DH is adjustable
<b>Terrain Awareness and Warning System (TAWS)</b>	
Type	Approved to TSO-C151 (required on turbine powered airplanes with +6 PAX seats per 14 CFR 91.223 and 135.154), Flight Manual documentation
Operation	Acceptable audio, disabled on Smokejumper and paracargo operations

<b>USB Ports</b>	
Type	TSO approved, dual ports at each position
Installation	Proper location, circuit breaker size, access
Operation	Proper voltage, proper current (by contract but not less than 2A per port)
<b>6. Installation and Maintenance</b>	
<b>General</b>	
	Strict adherence to the guidelines in FAA AC 43.13-1B and AC 43.13-2B
<b>Visual Inspection</b>	
	Inspect for obvious damage, inoperative displays, missing or incorrect parts, proper labeling, and documentation
<b>Antennas</b>	
Type	Broadband aircraft antennas covering the proper frequency band for the interfaced system
Installation	Rigidity, doubling plates, proper bonding, proper RF cables, security, proper wire size, condition, not painted (except OEM), no corrosion, no unauthorized repairs
VSWR	3.0:1 or better
<b>Wiring</b>	
	Correct type, no chafing/rubbing, properly secured, properly terminated, condition
<b>7. Abbreviations &amp; Selected Definitions</b>	
AC	Advisory Circular
A/C	Aircraft
ADF	Automatic Direction Finder
ADS-B	Automatic Dependent Surveillance - Broadcast
AFF	Automated Flight Following

AM	Amplitude Modulation
AMD	Aviation Management Directorate (Changed to OAS)
ATGS	Air Tactical Group Supervisor
ATU	Additional Telemetry Unit
AUX-FM	Auxiliary Frequency Modulated portable radio
BNC	Bayonet Neill Concelman, a quick disconnect RF connector
CFR	Code of Federal Regulations
CTCSS	Continuous Tone Controlled Squelch System
CVR	Cockpit Voice Recorder
dB	Decibel
DME	Distance Measuring Equipment
DOI	Department of the Interior
ELT	Emergency Locator Transmitter
FDR	Flight Data Recorder
FM	Frequency Modulation
FS	Forest Service
GPS	Global Positioning System
GPWS	Ground Proximity Warning System, see TAWS
GS	Glideslope, see ILS
Hz	Hertz (1 hertz)
ICS	Intercommunication System

IFR	Instrument Flight Rules
ILS	Instrument Landing System, see GS and LOC
kHz	Kilohertz (1,000 hertz)
LOC	Localizer, see ILS
MB	Marker Beacon
MEL	Minimum Equipment List
MFD	Multifunction Display
Mic or mic	Microphone
MHz	Megahertz (1,000,000 hertz)
Multiband Transceiver	A transceiver capable of operating in more than one frequency band (i.e. 136 to 174 MHz and 403 to 512 MHz) as opposed to a standard VHF-FM transceiver which can only operate in the 136 to 174 MHz frequency band.
mW	Milliwatts (0.001 watts)
mV	Millivolts (0.001 volts)
NAC	Network Access Code, see P25
NAV	Navigation Systems
NM	Nautical Mile
NTIA Manual	National Telecommunications & Information Administration, <a href="#">Manual of Regulations and Procedures for Federal Radio Frequency Management</a>
NTE	Not To Exceed
OAS	Office of Aviation Services
P25	<a href="#">Project 25 Digital</a> , open architecture digital communications system
PA	Public Address

PAX	Passenger or passengers
PIC	Pilot in Command
PPM	Parts Per Million
PRF	Pulse Repetition Frequency
PTT	Push to Talk
RF	Radio Frequency
Rx or RX	Receive or reception
SIC	Second in Command, copilot
TAS	Traffic Advisory System
TAWS	Terrain Awareness and Warning System
TC	Type Certificate
TCAD	Traffic Collision Alert Device, passive system, does not meet TAS contract requirements
TCAS	Traffic Collision Avoidance System, subset of TAS
TGID	Talkgroup, a sub code of a NAC
TIS (Now TIS-A)	Traffic Information Service, obsolete passive traffic system, operational within 55 NM of specially enabled radar sites which are being decommissioned, does not meet TAS contract requirements
TIS-B	Traffic Information Service – Broadcast, passive traffic provided to ADS-B IN systems from ground stations, does not meet TAS contract requirements
Transmit Interlock	A function that reduces receiver sensitivity when other radios on the aircraft are transmitting
TSO	Technical Standard Order
Tx or TX	Transmit or transmission

USB	Universal Serial Bus
uV	Microvolt (0.000001 volts)
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VOX	Voice Activated
VSWR	Voltage Standing Wave Ratio