Avionics Operational Test Standards
FS/AMD A-24
Revision E

August 10, 2011

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

Abbreviations and Selected Definitions are in Section 9.

1. Installations, Maintenance and Other Items	
Visual Inspection	
Inspect for obvious damage, inoperative displays, missing or incorrect parts, proper labeling, and documentation	
Antennas, Mounting, and Installation	
Forward/Reverse ratio of 3.0:1 or better, broadband aircraft type antennas, rigidity, doubling plates, proper bonding, proper RF cables, security, proper wire size	
Magnetic Direction Indicator (Compass)	
Installed, placarded, calibrated with engines operating stating that radios were on or off, calibration readings of not more than 30^0 increments (normal category airplanes) or 45^0 increments (all others), (system required on standard category A/C per 14 CFR 91.205; if installed, installed and placarded per 14 CFR Parts 23, 25, 27, or 29)	
Accessory Power Source	
Connector	MS3112E12-3S installed, proper location, permanently mounted, polarity, voltage at correct pins
Circuit Breaker	Correct amperage value, operation
Remote Cargo Hook Connector: Helicopter	
Connector	MS3101A24-11S installed, polarity, switched voltage, within 12" of cargo hook, securing lanyard or fixed to aircraft structure
Wiring	Per FS/AMD A-16 for intended application
Circuit Breaker	50 ampere, operation

Cargo Bell and Light System: Smokejumper	
Cargo Bell	Location, activation, sound level
Light System	Location, activation, indicators
2. Communications Systems	
Emergency Locator Transmitter (ELT)	
Type	TSO-C91a or TSO-C126C
Mounting	Per TSO and manufacturer's instructions
Antenna	External to the fuselage, proper mounting, correct location, portable antenna available for automatic portable types
G Switch	Subject TSO-C91a ELTs to a quick jerking motion (if easily removable), test N/A for TSO-C126 ELTs
Battery Date	Date not expired, matching dates on ELT and in aircraft records
Operation	Manually operates, PRF acceptable, (only check TSO-C126 units when directly connected to a test set)
Remote	Location visible and accessible to PIC, functionality, indicator
Logbook	Annual 14 CFR 91.207(d) test completed, battery expiration date on ELT matches date in maintenance record
VHF-AM Transceiver	
Type	TSO'd, selectable frequencies in 25 kHz increments, 760 channel minimum, operation from 118.000 to 136.975 MHz, 720 channel acceptable only if contractually permitted
Operation	To and from service monitor
Receiver	Squelch opens at acceptable level, clarity
Transmitter	Modulation from 15% to 85%, 5 watts nominal output minimum, frequency within 20 PPM (±2.46 kHz @ 122.925 MHz) (per NTIA Manual Chapter 5)
Display	All segments visible in direct sunlight

P25 Digital Aeronautical VHF-FM Transceiver	
Type	Listed on Fire Approved Radios list and meets FS/AMD A-19
Power Output	10 watts nominal output, multiband transceivers 6 to 10 watts nominal output
VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
Antenna	Cobham (Comant) CI 177-1 or equivalent, installation and mounting
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
Main Receiver	Squelch opens @ 1 to 2 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
Main Transmitter	Narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM (±421 Hz @ 168.3500 MHz) (per NTIA Manual Chapter 5)
Guard Receiver	Squelch opens @ 1 to 2 uV with direct connection at 168.6250 MHz, audio output of at least 100 mV with narrowband input (1.5 to 2.5 kHz modulation), less than 10% distortion
Guard Transmitter	Quickly selectable, operates on 168.6250 MHz, TX CTCSS tone of 110.9 Hz, narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM (±422 Hz @ 168.6250 MHz) (per NTIA Manual Chapter 5)
Mounting	Meets AC 43.13-2B, controls equally convenient to PIC and SIC/observer
Software	Current operating software per NIICD Hotsheet
Analog Aeronautical VHF-FM Transceiver: Forest Health Protection Only (non fire)	
Type	Technisonic TFM-138 (serial number 1540 & up), TFM-138B/C/D, or TFM-500, Northern Airborne Technology NTX138-070
Power Output	10 watts nominal output

VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
Antenna	Cobham (Comant) CI 177-1 or equivalent, installation and mounting
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
Main Receiver	Squelch opens @ 1 to 2 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
Main Transmitter	Narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM (±421 Hz @ 168.3500 MHz) (per NTIA Manual Chapter 5)
Guard Receiver	Squelch opens @ 1 to 2 uV with direct connection at 168.6250 MHz, audio output of at least 100 mV with narrowband input (1.5 to 2.5 kHz modulation), less than 10% distortion
Guard Transmitter	Quickly selectable, operates on 168.6250 MHz, TX CTCSS tone of 110.9 Hz, narrowband deviation from 1.5 to 2.5 kHz, narrowband frequency within 2.5 PPM (±422 Hz @ 168.6250 MHz) (per NTIA Manual Chapter 5)
Mounting	Meets AC 43.13-2B, controls equally convenient to PIC and SIC/observer
AUX-FM Provisions	
Operation	RX & TX functions through aircraft audio system(s), sidetone present, TX deviation output matches portable's stand alone output, installed per FS/AMD A-17
Controls	TX ***and*** RX selectors on all required audio controls
VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
Antenna	Cobham (Comant) CI 177-1 or equivalent, installation and mounting
Mounting Facilities	Meeting AC 43.13-2B (Field Support Services 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
VHF-FM Programming Port	
Operation	Location, ability to program each radio
Adapters	Available for installed radio type, serial or USB connector
VHF-FM Aeronautical Antenna: Light Fixed Wing	
RF Cable	Location, cable length, male BNC connector
Antenna	Cobham (Comant) CI 177-1 or equivalent, installation and mounting
VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
P25 Digital VHF-FM Mobile Radio	
Type	Listed on Fire Approved Radios list
Operational Check	Proper RX and TX operation
Power Output	30 watts minimum nominal output
VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
Antenna	Antenna Specialists ASPR-7490; Maxrad MWB-5803; or equivalent, installation and mounting
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 (±421 Hz @ 168.3500 MHz) (per NTIA Manual Chapter 5)
Field Programmability	Contractor demonstration without the use of a computer to program the radio
Software	Current operating software per NIICD Hotsheet

P25 Digital VHF-FM Portable Radio	
Type	Listed on Fire Approved Radios list
Operational Check	Proper RX and TX operation
Power Output	1 watt but no more than 10 watts nominal output
VSWR	Forward/reverse ratio of 3.0:1 or better at 138, 156, and 173.975 MHz
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 (±421 Hz @ 168.3500 MHz) (per NTIA Manual Chapter 5)
Field Programmability	Contractor demonstration without the use of a computer to program the radio
Software	Current operating software per NIICD Hotsheet
Automated Flight Following	
Operation	Accurate & current position data displayed on Webtracker, required data in Webtracker database, uses satellites
Installation	Per manufacture's manual and AC 43.13-2B, operates using aircraft power, dedicated circuit breaker
Antenna	Antenna external to unit, antenna with clear path to satellites
Public Address System: External	
Operation	Acceptable operation, ability to understand voice 100 feet below aircraft while aircraft is in flight, uses headset/helmet mic

Controls	PA TX selector on all required audio controls
Public Address System: Internal	
Operation	Acceptable operation, ability to hear clearly throughout cabin/PAX area, Smokejumper A/C amplifier with 25 watts output with less than 10% distortion for conveying intelligible messages to all occupants from all positions with jump door open, uses headset/helmet mic, (system required on A/C with +19 PAX seats per 14 CFR 135.150 & Smokejumper A/C)
Controls	PA TX selector on all required audio controls
Siren	
Operation	Provides Yelp and Wail tones, uses External PA speakers
Controls	Manual activation for PIC & SIC/observer
3. Navigation Systems	
Panel Mounted GPS	
Type	TSO'd, panel mounted
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
Portable/Handheld GPS	
Type	Aviation portable, not a drive along the road type
Installation	Convenient to both PIC and SIC/observer, installation meets AC 43.13-2B, uses aircraft power for operation, approved installation
Antenna	Antenna remoted from unit with clear path to satellite signals
Operation	Correct present position or lock on, database does not exceed contract limit, WGS-84 datum, degrees/decimal degrees display
Moving Map	Display area 1.5" high x 3.0" wide minimum, aircraft position relative

(when required)	to waypoints, displays geographical features
GPS Data Connector	
DB-9F connector, correct pins active, proper location	
Additional GPS Antenna	
Freeflight Systems 16248-20 antenna, female type N connector & location	
Altitude Encoder and Pitot Static Systems	
Meets 14 CFR 91 Part 91 IFR requirements, 14 CFR 91.411 & 14 CFR Part 43 Appendixes E and F logbook entry not expired (24 calendar month maximum)	
Transponder with Altitude Reporting Capability	
Type	TSO-C74b (Mode A), TSO-C74c (Mode A with altitude reporting capability), 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)
VOR	
Panel mounted, flag pull, to/from operation, audio, all display segments visible in direct sunlight, maximum bearing error of $\pm 4^0$ ($2/5^{ths}$ deflection per side (usually 2 out of 5 dots)) or meeting the manufacturer's specifications (whichever is more stringent), maximum variation between dual system of $\pm 4^0$ ($2/5^{ths}$ deflection per side (usually 2 out of 5 dots)) or meeting the manufacturer's specifications (whichever is more stringent), IFR aircraft require aircraft log/record entry for IFR 30 day check per 14 CFR 91.171	
Localizer	
Maximum error of $\pm 0.5^0$ ($1/5^{th}$ deflection per side (usually 1 out of 5 dots)) or meeting the manufacturer's specifications (whichever is more stringent), flag pull, interfaced to #1 VOR system	
Glideslope	
Maximum error of $\pm 0.05^0$ ($1/10^{th}$ deflection per side (usually ½ out of 5 dots)) or meeting the manufacturer's specifications (whichever is more stringent), flag pull, interfaced to #1 VOR system	
Marker Beacon	
All indicators operate properly, acceptable sensitivity, acceptable audio level (service monitor required)	
DME	
Proper heading to station, proper distance to station, all display segments visible in direct	

sunlight, independent from GPS system	
ADF	
Points to station, 360^0 operation, acceptable audio, all display segments visible in direct sunlight	
4. Weather Systems	
Thunderstorm Detection Equipment	
Acceptable operation, Weather Radar is an approved alternative, (system required on aircraft with +10 PAX seats except helicopters in day VFR per 14 CFR 135.173), (not required in Hawaii & Alaska)	
Weather Radar	
Acceptable operation, (system required on aircraft with +10 PAX seats per 14 CFR 135.175), (not required in Hawaii & Alaska)	
5. Collision Avoidance Systems	
Ground Proximity Warning System (GPWS)	
GPWS requirements expired on 3/29/2005. See Terrain Awareness and Warning System (TAWS)	
Radar Altimeter	
Indicator near glare shield or low altitude light installed, range of 0' to 2,000' minimum	
Terrain Awareness and Warning System (TAWS)	
Acceptable audio, Flight Manual documentation, disabled on Smokejumper and paracargo operations, (system required on turbine powered airplanes with +6 PAX seats per 14 CFR 91.223 and 135.154)	
Traffic Advisory System (TAS)	
Type	TSO'd active system, on and operating per 14 CFR 91.221 (system required on turbine airplanes with +10 PAX seats per 14 CFR 135.180)
Installation	Manufacturers display or MFD, convenient to PIC and SIC, acceptable audio level, Airtanker MFD display area 2.75" high x 3.0" wide minimum, Flight Manual documentation
Range	Operator selectable from 2 NM (or less) to at least 10 NM

Operation	360 target acquisition, minimal airframe shadowing, on MEL (when applicable) with inoperable status NTE 15 days
Traffic Collision and Alert Device (TCAD)	
See Traffic Advisory System (TAS)	
Traffic Collision and Alert System (TCAS)	
See Traffic Advisory System (TAS)	
6. Recorder Systems	
Cockpit Voice Recorder	
Proper area mic location, headset mic(s) operation, radio RX operation; locator beacon battery date current, (system 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)	
Flight Data Recorder	
Locator beacon battery date current, (system required on multiengine turbine powered A/C with +10 PAX seats if manufactured/registered after 10/11/1991 per 14 CFR 91.609 & 135.152 and with +20 PAX seats if operated after 10/11/1991 per 14 CFR 135.152)	
7. Audio Systems	
Audio Control System: General Requirements Applicable to All	
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)
Specifications	
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%
Audio Control System: Helicopter: See applicable drawings	
Required Controls	Individual TX selection, individual RX selection switches, separate RX

	and ICS audio level controls
Operation	
TX Selection	Automatically selects proper radio and companion receiver; each required transceiver, PA, and ICS (N/A w/hot mic) system has individual TX selection
RX Selection	Selects proper radio receiver (on/off switch), each required receiver has individual RX selector independent of the transmitter selector
PTT Switch	Proper operation, separate radio TX and ICS TX switches at all required positions
ICS and Radio RX Volume	Proper operation, audio level
Sidetone	Present for each transceiver, acceptable audio level
Crosstalk	Proper operation at all required positions
Rappel/Shorthaul	Hot Mic at Spotters position, Spotter cord proper length, proper ICS and TX capability at specified positions, additional Audio Control System (FS light helicopters may use SICs, DOI required to use SICs)
Audio Control System: Light Fixed Wing	
Required Controls	Individual TX selection, individual RX selection switches (Air Tactical)
Operation	
TX Selection	Automatically selects proper radio and companion receiver; each required transceiver, PA, and ICS (N/A w/hot mic) system has individual TX selection; ATGS Instructor TX operation uses SIC/observer audio control or has a separate system (Air Tactical)
RX Selection	Selects proper radio receiver (on/off switch)
PTT Switch	Proper operation, non-pilot switch not on flight control
ICS and Radio RX Volume	Proper operation, audio level
Sidetone	Present for each transceiver, acceptable audio level
Crosstalk	Proper operation at all required positions
Audio Control System: Airtanker	
Required Controls	PIC and SIC systems interchangeable, individual TX selection, individual RX selection switches, pilot inspector monitors SIC or has a

	separate system (no TX or NAV required)
Operation	
TX Selection	Automatically selects proper radio and companion receiver; each required transceiver, PA, and ICS (N/A w/hot mic) system has individual TX selection
RX Selection	Selects proper radio receiver (on/off switch)
PTT Switch	Proper operation
ICS and Radio RX Volume	Proper operation, audio level
Sidetone	Present for each transceiver, acceptable audio level
Crosstalk	Proper operation at all required positions
Audio Control System: Smokejumper	
Required Controls	Individual TX selection, individual RX selection controls, separate RX master and ICS audio level controls
Operation	
TX Selection	Automatically selects proper radio and companion receiver; each required transceiver, PA, and ICS (N/A w/hot mic) system has individual TX selection; spotter with TX indicator
RX Selection	Selects proper radio receiver (on/off switch for PIC & SIC, adjustable volume controls for spotter/mission coordinator)
PTT Switch	Proper operation
ICS and Radio RX Volume	Proper operation, audio level sufficient for intelligible reception to helmeted spotter with jump door open while in flight
Sidetone	Present for each transceiver, acceptable audio level
Crosstalk	Proper operation at all required positions
8. Intercommunications System (ICS)	
Available at Required Positions	Per contractually required locations
Operation	Proper audio & mic operation at each required position, Smokejumper isolation with Call button and PIC LED

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
Specifications	
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%

9. Abbreviations & Selected Definitions

AC	Advisory Circular
A/C	Aircraft
ADF	Automatic Direction Finder
AFF	Automated Flight Following
AM	Amplitude Modulation
AMD	Aviation Management Directorate
ATGS	Air Tactical Group Supervisor
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)
LED	Light Emitting Diode
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, Manual of Regulations and Procedures for Federal Radio Frequency Management
NTE	Not To Exceed
P25	Project 25 Digital, 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 and Alert Device, see TAS
TCAS	Traffic Collision and Alert System, see TAS
TGID	Talkgroup, a sub code of a NAC

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