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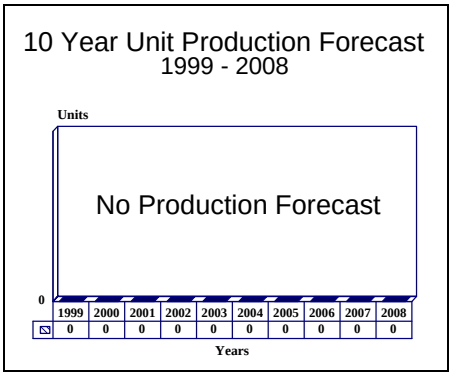
TRC-170(V) - Archived 7/2000

Outlook

- Production to fill US contracts completed in 1995
- Unit was available for FMS, but only one such customer identified to date (1980s)
- No further procurements, foreign or domestic, expected
- Barring any additional market activity, this report will be archived next year, 2000



Orientation

Description. Tactical digital troposcatter radio.

Sponsor

US Air Force
Electronic Systems Center
Combat Theater Communications Program Office
Hanscom AFB, Massachusetts (MA)
USA

Contractors

Raytheon Co
Electronics Systems Division
Hartwell Road
Bedford, Massachusetts (MA) 01730
USA
Tel: +1 617 274 7100
Website: http://www.raytheon.com
Emai: jmknotts@west.raytheon.com
(Prime: development/production)

Status. In service; production believed to be complete.

Total Produced. Approximately 732 were produced.

Application. Developed to provide high-capacity backbone and spur links for C^3 systems in accordance with the TRI-TAC (Tri-Service Tactical Communications; also titled the Joint Tactical Communications Program) system architecture.

Price Range. Based on a 1992 contract, the unit price of the TRC-170(V)3 is approximately US$350,000 (in dollars unadjusted for inflation).

Technical Data

	TRC-170(V)2	TRC-170(V)3
Characteristics		
Frequency (all variants):	4.4 GHz to 5.0 GHz	
Frequency Control (all):	Frequency synthesizer, rubidium reference, 100 kHz increments	
Nominal service range:	80.5 km (50 mi)	161 km (100 mi)

	TRC-170(V)2	**TRC-170(V)3**
Characteristics		
Occupied Bandwidth:	3.5 MHz or 7.0 MHz	3.5 MHz or 7.0 MHz
Traffic Capacity (all):	128 256 512 1024 1536 2048 4096 kbps 7, 15, 30, 45, 60, or 120 Ch. at 32 kbps 7, 15, 30, 60, 90, 120 or 240 Ch. at 16 kbps	
RF Output:	2 kW x 2 kW	1 kW x 2 kW
Waveguide Feed Loss:	0.5 dB	0.4 dB
Receiver Noise Figure:	4 dB	4 dB
Receiver Loss:	0.3 dB	0.3 dB
Antennas:	61 cm (2 ft) x 290 cm (9.5 ft)	61 cm (2 ft) x 183 cm (6 ft)
Antenna Gain:	40.5 dB	36 dB
Diversity:	Quad	Dual
Prime Power:	120/208 V 50/60/400 Hz	120/208 V 50/60/400 Hz
Operational Environment (all)		
Temperature:	-46°C to + 52°C (-50.8°F to 126°F)	
Relative Humidity:	Suitable for tropical use	
Altitude:	3,048 m (10,000 ft)	
Weight: (max less power unit)	4,218 kg (9,300 lb)	2,812 kg (6,200 lb)
Set-Up Time:	5 hr	1 hr

Design Features. The family of three TRC-170 (sets (V)1, (V)2 and (V)3) radio terminals for tactical military microwave communication employs adaptive digital modulation techniques for line-of-sight or tropospheric scatter (troposcatter) path lengths that have typical ranges of 50 to 250 miles.

Each system provides a complete troposcatter terminal including antenna, multiplex, and order wire facilities, and operates compatibly with all members of the family. They are all suitable for use in tactical environments and can be shipped by military or commercial transport. No special tools are required for installation or recovery, and set-up and take-down times range from one to seven hours. The sets can be operated on their transport vehicles, and high wind and lightning kits are available for extreme conditions. They can be adapted to provide service at alternative data rates or with different arrangements of digital group multiplex equipment. All sets are built to military specifications.

All sets use a Time Division Multiplex (TDM) implementation which is selectable for channel capacities of 64, 48, 32 or 16 (inclusive of order wires) each at a bit stream of 16 or 32 kbps. Each TRC-170 incorporates one multiplex module (i.e., one tactical or trunk group multiplexer (TGM), one group modem [GM], or two loop group multiplexers [LGM]) plus two low-speed cable driver modems (LSCDMs). Due to the limited number of LGMs, only 30 channels are terminated. These channels are not readily accessible for patch and test, because they are pre-wired to the shelter wall. The other 30 channels are throughput in multiplexed groups of 15 each. The maximum baseband data rate is 4.608 Mbps at frequencies in the 4.4 GHz to 5.0 GHz band.

All variants use space-diversity antennas. For all variants, the mechanical design is such that erection is simplified, the antennas can be conveniently stowed for transport, and the degree of beam-pointing stability is high even in extreme wind and soil loading conditions. Special tools or prior site preparation are not needed. The system includes special facilities that allow accurate beam alignment and maintenance.

The TRC-170(V)2 and (V)3 terminals supply secure digital long-haul radio trunking between major nodes of TRI-TAC communications networks, and interface with other TRI-TAC systems such as assemblages of DGM equipment or various switching facilities. The TRC-170(V) replaces older, analog sets, such as the TRC-132, TRC-121, TRC-112 and TRC-80.

Operational Characteristics. The radio utilizes the troposcatter principle of bouncing radio signals off the lowest layer of the earth's atmosphere (the troposphere) and over the horizon. Digital technology allows the transmission of millions of data bits per second over a range of hundreds of miles. The TRC-170's Distortion Adaptive Receiver (DAR) modem automatically adapts to the troposphere's continual changes and minimizes

losses that come from multipath distortion. Before transmission, the bits of information are separated by a short time delay and are received as a continuous stream of distorted but non-overlapping symbols. The DAR modem uses the distorted signal waveform and a matched filter demodulator to recreate the original signal. The result is a data rate eight times higher (over 2,000,000 bits per second) than any previous system, coupled with an error rate of less than one in 100,000.

Variants/Upgrades

TRC-170(V)1. The (V)1 is the most powerful TRC-170 variant and is capable of transmissions over nominal 200-mile paths. This variant is particularly suited for use in strategic systems and in cases where difficult propagation paths are encountered. The (V)1 is completely compatible with the (V)2, and when operating in dual diversity, with the (V)3. All electronic subassemblies are interchangeable with the (V)2 and (V)3 with the exception of the high-power amplifier.

The (V)1's transmitter has two klystron power amplifiers (10 kW maximum RF output) which use vapor phase cooling. The quad diversity (dual frequency/ space) receivers have low-noise FET amplifiers that have a noise figure of less than 3 dB. The (V)1 has two 15-foot dual space diversity parabola antennas that are waveguide-fed and tripod-mounted. All the (V)1's electronics are housed in a S280 shelter, with a total weight of about 15,000 pounds (less power generator). The (V)1 can be brought to an operational readiness condition in seven hours using four people. The antenna setup accounts for six of these hours. The antennas are elevated about 15 feet off the ground.

TRC-170(V)2. The (V)2 is meant for tactical applications that call for a nominal range of 150 miles. The (V)2 is fully interoperable with the (V)1, and when used in dual diversity, with the (V)3. All the (V)2's electronic subassemblies are interchangeable with the other two models (except the high-power amplifier).

The transmitter has two efficient air-cooled klystron power amplifiers which are rated at 2 kW maximum output. The quad diversity receivers have low noise FET amplifiers that have a noise figure less than 3 dB. The 9.5-foot dual-space diversity parabola antennas are waveguide-fed and tripod-mounted. All the electronics are housed in an S-280 shelter, with a total weight of about 9,300 pounds. The (V)2 can be set up in five hours (three hours for antenna) by four people. The complete system is transported by means of two trucks: a M923 five-ton truck carrying the S-280 shelter and towing a M1061 five-ton trailer with two 30 kW generator units; and an M35A2 2.5-ton truck carrying the antennas on a low-profile pallet and towing a M105 1.5-ton trailer housing a GRC-193A radio.

TRC-170(V)3. The most mobile variant is the (V)3, with a nominal range of 100 miles. It is fully interoperable with the (V)1 and (V)2 when in dual diversity. All its electronic subassemblies are interchangeable with the other two models (except for the high-power amplifier).

The efficient air-cooled klystron power amplifier is rated at 2 kW maximum RF output, with a noise figure of less than 3 dB. The (V)3 has a quick-reaction antenna that can be set up in less than one hour by only two people. The (V)3's dual six-foot parabolic reflectors are mounted onto a transport trailer and are quickly erectable. This antenna configuration can also be used with the (V)1 or (V)2 variants. The system's electronics are housed in an S250 shelter, with total weight of approximately 6,200 pounds. The system is transported by means of an M1097 (Heavy HMMWV) carrying the shelter and an M116A2 trailer with the quick-reaction antenna.

Anti-Jam Subsystem. In March 1986, the US Air Force issued notice that it was seeking to develop anti-jam subsystems (AJS) for the TRC-170(V)2s and (V)3s that it was fielding. The effort was scheduled to commence in the third quarter of FY87, with development to last 30 months. This effort was to develop an FSED (full-scale engineering development) multiple-diversity digital radio anti-jam subsystem to replace an existing tropo-modem while requiring a minimum of modifications to the TRC-170. Also part of the developmental effort was an auxiliary antenna.

Activities fell behind schedule and this notice was followed up with a May 1988 revision, which stated that the Air Force intended to issue a competitive request for proposals for AJS development and low-rate initial production that would result in a dual award to two

individual offerers for a firm fixed-price brassboard effort, with a downselection to a single contractor for two options: an NTE FSD completion option, and an NTE low-rate initial production option. The outcome of this process has not been identified.

Program Review

Background. The TRC-170 is one of the major components of the TRI-TAC program, which was designed to develop digital communications equipment for tactical operations. The broad goals of TRI-TAC were to achieve interoperability between Army and other DoD telecommunications systems, provide new equipment to reflect the most recent technology, eliminate duplications in development among the services, and enhance interoperability with NATO systems. TRI-TAC equipment was designed to provide an evolutionary transition from analog communications to modern, flexible digital communications. The TRC-170 forms a crucial part of the terrestrial radio links and is part of the US Air Force contribution to this multiservice effort. Procurement of all hardware for TRI-TAC was completed in 1995.

Development of the TRC-170, popularly known as the "Track 170," began in 1976. Field testing of prototypes finished in November 1980. The first production contract was awarded in April 1982; initial deliveries (to the US Army) occurred in 1984. In September 1986 a Letter of Offer was issued for the sale of eight TRC-170 systems (with spares, tools, test equipment, mobilizing equipment, training, and support) to the United Arab Emirates at a cost of US$40 million. The UAE wanted these radio systems in order to set up a national defense communications system. The TRC-170 was used to supply a dedicated inter-regional communications link and integrated directly into the regional communications architecture that has already been selected by the UAE Defense Headquarters. The UAE remains the only known FMS customer.

The last versions to be procured by the US DoD were the (V)2 and (V)3 models. Three substantial contracts were issued in 1990: one to Raytheon in January (US$58.1 million) that covered 45 (V)2s, 24 (V)3s, 100 suites of spares and 59 loop test sets; one to Unisys in January (US$40.2 million) for 29 (V)2s, 18 (V)3s, 68 suites of spares and 59 loop test sets; and another to Unisys in March (US$54 million) for follow-on production.

The Army awarded Raytheon a contract in May 1991 for 140 TRC-170(V)3 radios, which was followed in August 1991 with a US$4.2 million spares option, and in March 1992 with a US$27.4 million contract for 77 (V)3s. These awards covered procurement for the Army National Guard, the Marine Corps and Air Force, and were scheduled to carry production through 1995. Raytheon's share of contracts totaled 622 TRC-170(V)s. Second-source Unisys (later to be acquired by Loral, then Lockheed Martin) completed its TRC-170(V) production in 1992 with approximately 110 systems built.

In 1996, the Area Common User System (ACUS) modernization plan, a comprehensive plan for ongoing and projected changes to TRI-TAC as well as the Mobile Subscriber Equipment (MSE), took effect. Any retrofit/upgrade activity to the TRC-170(V) would be controlled by this effort.

Funding

No funding identified in current budget documents.

Recent Contracts

None identified since the following:

Contractor	Award ($ millions)	Date/Description
Raytheon	27.4	Mar 1992 – FVI to a FFP contract for FY92 and FY93 US Air Force, FY92 US Marine Corps, and FY92 US Army requirements for the TRC-170(V). Contract entailed the production of 77 units. Completed Dec 1995. (F19628-91-C-0073)

Timetable

Month	Year	Major Development
	1976	Raytheon begins full-scale development
Nov	1980	Field testing of prototypes completed
Dec	1980	AFOTEC recommended a favorable production decision after correction of deficiencies
Jan	1982	Air Force evaluation report
Apr	1982	Production contract for 110 terminals awarded
FY	1984	Anti-jam approach selected
Nov	1984	First TRC-170 delivered to US Army
	1984	Path prediction testing over water performed over the English Channel in conjunction with the Digital European Backbone upgrade to the Defense Communication System
	FY85	Path prediction efforts completed; technical definition of an ECCM capability continued; Peculiar Support Equipment (PSE) design continued
Jul	1985	Initial Operational Capability for the Air Force Communications Command acquisitions
	FY86	Design of PSE completed; technical definition of ECCM design completed and source selection held for an FY87 contract; fielding TRC-170 supported
Sep	1986	Congress notified of intent to sell eight TRC-170s for US$40 million to the United Arab Emirates
	FY87	Beginning of ECCM subsystem full-scale engineering development
May	1987	Unisys selected as second-source for production
Oct	1987	Aydin protest of choice of Unisys as second source denied by General Accounting Office
Dec	1989	Unisys delivers first TRC-170 production units
	1992	Unisys production ceases
	1995	All hardware for TRI-TAC delivered
Dec	1995	Production complete under most recent contract

Worldwide Distribution

The only known customers of the TRC-170(V) are the **US** (724 systems) and the **United Arab Emirates** (eight systems).

Forecast Rationale

Production for the TRC-170(V) was completed in 1995, satisfying the most recent publicly announced contract. Though the system remains in US military service, lack of contract activity for spares or replacements suggests a move away from the TRC-170(V). With the communications system overhaul brought about by the Force XXI digital battlefield, the TRC-170 may well find itself the latest victim.

The primary market for communications equipment considered outdated by the US military is nations with limited defense budgets. The TRC-170 may go against this rule in that the system remains well above the price range of many developing nations. This cost reduces the potential market for the system to relatively wealthy nations, as confirmed in the eight systems the UAE purchased in the 1980s.