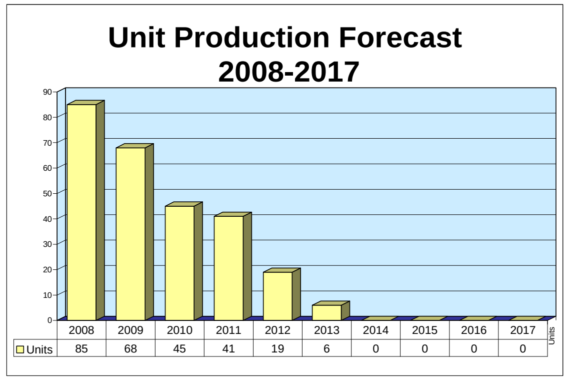
APX-111(V)/113(V) (CIT)

Outlook

- Most recent customers include Turkey, Greece, and Morocco
- More modern IFF transponders will be chosen for newer aircraft, limiting the APX-113's sales opportunities
- In recent years, South Korea and Singapore chose the APX-113 for their F-15s, further increasing sales as well as sales prospects



Orientation

Description. The APX-111(V)/113(V) airborne Combination Identification Friend or Foe Interrogator/Transponder supports both interrogation and response operations in a single unit. It supports all IFF modes in use today and is upgradeable to next-generation IFF signals.

Sponsor

BAE Systems - North America
Advanced Systems
One Hazeltine Way
Greenlawn, NY 11740-1606
USA
Tel: + 1 (516) 261-7000
Fax: + 1 (516) 262-8002
Web site: http://www.baesystems.com

Status. In production, ongoing support.

Application. The APX-111(V) Combined Interrogator Transponder (CIT) is used on early-model F/A-18s. The APX-113(V) AIFF is currently installed on the F-16. It has been approved for F-16Cs equipped with the electronically scanned array radars. The APX-113 also equips Japanese F-2s, the Taiwanese indigenous defense fighter, Greek F-4Gs, U.K. Sea King helicopters, Nimrods, and Sea Harriers. It has also been selected to equip F-15s in South Korea and Singapore.

Price Range. Based on recent contracts, the average price of a single APX-111/113 ranges between \$225,000 and \$400,000.

Contractors

Prime

BAE Systems Electronics & Integrated Solutions, Network Systems	http://www.eis.na.baesystems.com, 450 Pulaski Rd, Greenlawn, NY 11740-1606 United States, Tel: + 1 (631) 261-7000, Prime

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Contractors are invited to submit updated information to Editor, International Contractors, Forecast International, 22 Commerce Road, Newtown,

APX-111(V)/113(V) (CIT)

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Technical Data

	Metric	U.S.
Dimensions		
APX-111(V)		
Combined Interrogator Transponder (CIT) RT-1679(V)		
Size	208 x 146 x 320 mm	8.17 x 5.75 x 12.61 in
Weight	15 kg	33 lb
C-12222(V) Beam Forming Network		
Size	178 x 249 x 76 mm	7.00 x 9.80 x 3.00 in
Weight	5.4 kg	12 lb
AS-4267(V) Fuselage-Mounted Antenna Elements (4)		
Size	29 x 55 x 237 mm	1.13 x 2.16 x 9.32 in
Weight	0.2 kg	0.5 lb
Number of Elements	5	
APX-113(V)		
Combined Interrogator Transponder		
Size	204.5 x 146.4 x 353.8 mm	8.26 x 6 x 14.5 in
Weight	14.5 kg	32 lb
Beam-Forming Network		
Size	158.6 x 212.8 x 97.6 mm	6.5 x 8.38 x 4 in
Weight	4.5 kg	10 lb
Fuselage-Mounted Antenna Elements (4)		
Size	37.8 x 79.3 x 319.6 mm	1.55 x 3.25 x 13.10 in
Weight	0.23 kg	0.5 lb
Lower Interrogator Antenna (1 conformal)		
Size	14.6 x 414.8 x 341.6 mm	0.6 x 17 x 14 in

	Interrogator	Transponder
Characteristics		
Power	1,350 W – APX-111(V) 2,400 W – APX-113(V)	400-460 W
Duty Cycle	1% max	
Frequency	1,030 MHz	1,090 MHz
Receive	-83 dBm	-77 dBm
Interrogator Detection Range	185 km 100 nm	
Sector Coverage	± 70° (azimuth) APX-111(V) ± 60° (azimuth) APX-113(V) ± 60° (elevation)	
Accuracy	± 2° (azimuth) 152 m 500 ft (range) 500 ft (range)	
In-Beam Targets	32	
Modes	Monopulse receive AJ Protection Mode 1, 2, 3A, C, and 4	
Reply Evaluation/Degarbling	1, 2, 3/A, C, and 4	
Standards	International ATC DoD AIMS 65-1000B NATO STANAG 4193 RTCA/DO-181 (Mode S)	
Features	Monopulse receive Anti-jam	
Antennas	5	
Crypto	KIV-6 Cryptographic Computer	
MTBF	1,600 hr (system) 1,800 hr (CIT only)	

APX-111(V)/113(V) (CIT)

Characteristics	Interrogator	Transponder
MTTR	0.25 hr	
BITE	97% fault detection 99% fault isolation	
Prime Power Voltage	28 Vdc (115 Vac optional)	
Wattage	180 W APX-111(V) 200 W APX-113(V)	
Forced Air Cooling	CIT unit only (integral fan optional)	

Design Specifications. The APX-111(V) Friend-finder and APX-113(V) Advanced IFF systems merge functions that had been performed by separate but integrated Identification Friend or Foe (IFF) subsystems into a small, light, and easy-to-maintain single modular unit. The APX-111(V) was designed to meet the requirements of the F/A-18C/D, with the APX-113(V) tailored for the F-16A/B/C/D. It combines the interrogator, transponder, and crypto/code computers into a single unit, and can use either electronically or mechanically scanned interrogator antennas. It provides full IFF operation in compliance with STANAG 4193 and DoD AIMS 65-1000.

Both the interrogator and transponder operate in Modes 1, 2, 3A, C, and 4. Additionally, the transponder provides Mode S level 1 and 2, with software growth to level 3 possible. All CIT signal processing is digital – performing Interrogator Sidelobe Suppression (ISLS), Receiver Sidelobe Suppression (RSLS), Gain Time Control (GTC), diversity selection, de-fruiting, and degarbling, and using 13 customized application-specific integrated circuits (ASICs). The all-digital signal processing is a significant improvement over older analog systems. Digital processing enhances signal extraction in heavy jamming and self-interfering environments. The use of ASICs contributes to the system's reduced size and weight, and substantially increases reliability.

Both systems feature a fully compliant, dual-redundant MIL-STD-1553B data bus that operates in conjunction with a high-performance 32-bit microprocessor that is programmed in the Ada software language and is field-programmable via a 1553B data bus. This provides for rapid on-site load and verification of the computer program.

The APX-111/113 is very reliable, utilizing a built-in test (BIT) system that negates the need for organizational maintenance test equipment. The system is capable of automatically detecting 99 percent of its functional faults. It can isolate more than 94 percent of the detected faults to one failed module. A maintainability demonstration showed that the mean active repair time (MART) on the F-16 aircraft is only 5.2 minutes.

The APX-111(V)/113(V) was designed for growth. In addition to having a transponder with Mode S capability, the system was designed for growth to the next-generation IFF (NGIFF) waveform. Existing signals on the front panel connector can interface directly with an external NGIFF unit, which generates and processes the NGIFF waveform.

Mode S capability and a design that accommodates growth are extremely important features for fighters, maritime patrol aircraft (MPA), or airborne early warning (AEW) applications. Conventional IFF systems normally require new equipment to satisfy future needs. The design allows growth without expensive replacement, significantly reducing life-cycle costs.

The NATO/Joint Mark XXI/XXIA Mode 5 capability is being developed to combine with Mode S. This cryptologically based identification technique will replace the National Security Agency-decertified Mode 4 Cooperative Identification system.

The CIT is currently employed on six different platforms in eight countries. Platforms include fighters, maritime surveillance helicopters, and early warning aircraft.

Engineered to the Mk XII IFF standard, the CIT replaced the APX-76(V) interrogator and the APX-100(V) or APX-101(V) transponders with enhanced performance. Compared with the equipment it replaced, the CIT weighs 50 percent less, consumes 26 percent less power, and requires 63 percent less space. A single unit replaces six or seven older units, releasing significant space for other avionics components.

The system uses a MIL-STD-1750 processor and a 1553 data bus. The transmitter is fully self-contained, and the modular design makes maintenance easier. A statistical reply evaluator increases confidence in the returns processed.

Operational Characteristics. The APX-111(V)/113(V) can interrogate other aircraft as well as respond to identification queries. Transponders provide a set of established identification codes upon request of IFF/SIF interrogators. These codes provide specific information about the aircraft in question.

The sophisticated Mk XII system for identifying military aircraft is currently used by combat forces to distinguish friendly aircraft from foes. By using cryptologically based ID codes, identity can be established with better confidence. The system meets all international air traffic control requirements, as well as AIMS and STANAG standards. Growth to Mode 5 SIF was planned and will be implemented. [AIMS = **A**ir Traffic Control Radar Beacon System (ATCRBS), **I**dentification Friend or Foe (IFF), **M**ark XII/XIIA, **S**ystems; STANAG = Standardization Agreement].

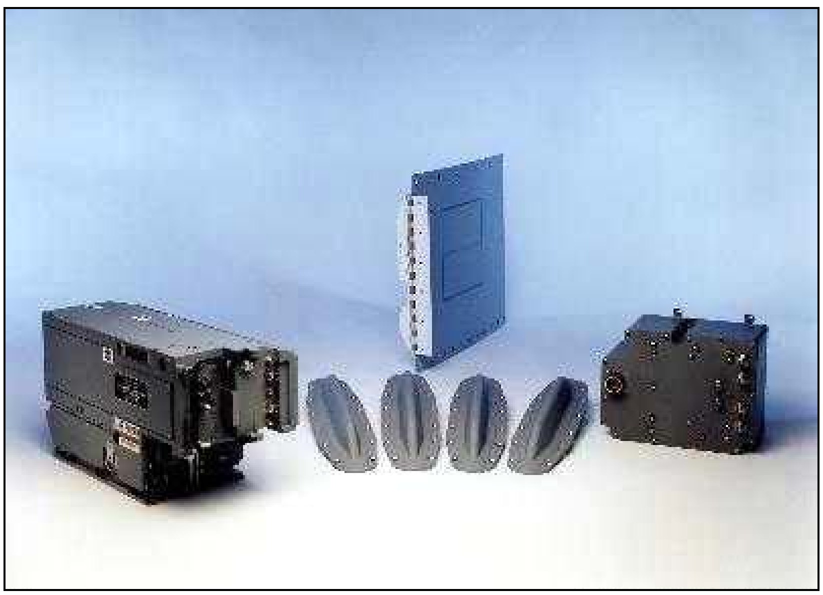
The Mode S air traffic control (ATC) system provides air traffic controllers with precise location and identification of aircraft within their flight paths. Existing Mk XII IFF systems, such as the APX-100(V) and APX-101(V), are not fully compatible with Mode S. Because military aircraft must be able to operate in established ATC systems, the APX-111(V)/113(V) was specifically designed to accommodate Mode S operation. It was also designed for better protection of overall operation in a hostile, combat environment. Electronic counter-countermeasures and crypto-coding are not needed on commercial IFF equipment.

Variants/Upgrades

APX-111. The APX-111(V) was adapted for the F/A-18C/D and the APX-113(V) for the F-16C/D. The units required some physical adaptation for the different airframes.

APX-113. As part of a mid-life avionics upgrade for the NATO F-16 conducted in 1993, an Advanced IFF (AIFF) system was developed based on a modification of the APX-111(V). It was designed to support beyond-visual-range weapons delivery and enhance situational awareness. The advanced system enables operation in four modes: military identification, military secure identification, air traffic identification, and altitude reporting.

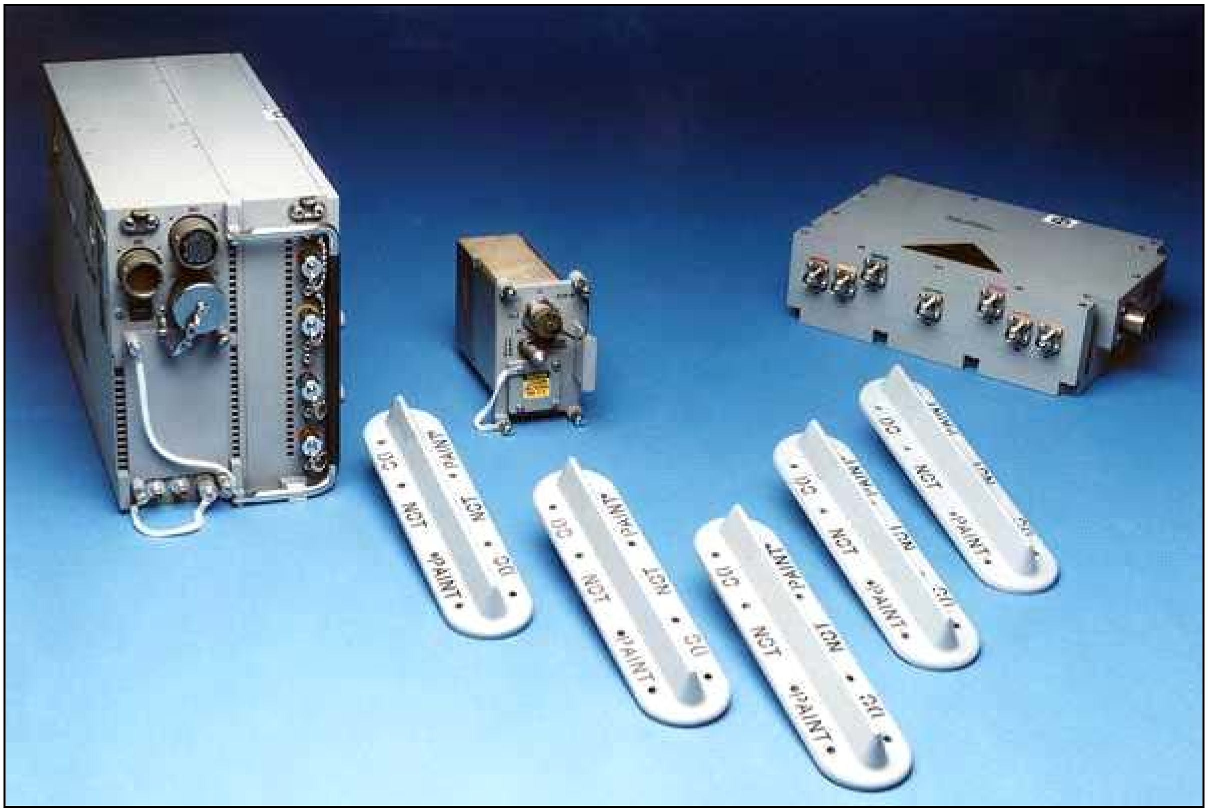
The AIFF includes a conformal interrogator antenna in the aircraft's chin, an upper interrogator fuselage-mounted antenna array set forward of the cockpit, and a beam-forming network module situated below the right side of the cockpit.



APX-113(V)

Source: BAE Systems

APX-111(V)/113(V) (CIT)



APX-111(V)

Source: BAE Systems

Program Review

In 1993, (then) Hazeltine initiated development of the APX-111(V)/113(V) as a company-sponsored effort to create a new product that would meet expected changes in the Mk XII standard. Hazeltine had lost the competition to develop the airborne IFF segment of the Mk XV program. However, once that program was cancelled, Hazeltine saw an opportunity to break into the market once again. The APX-111(V)/113(V) was designed with growth in mind to take advantage of any changes to the Mk XII IFF format (Mode 5) as well as ATC Mode S waveforms.

A production agreement for the NATO mid-life upgrade (MLU) program was signed in 1993. It involved 301 European F-16A/B aircraft. Forty-eight Belgian, 61 Danish, 136 Dutch, and 56 Norwegian aircraft were scheduled to be upgraded, and Hazeltine increased production rates accordingly. The total number of upgrades had been scaled back from a planned 403.

International Market. The selection of the APX-111(V)/113(V) for foreign versions of the F-16 and F/A-18 generated many sales. Greece selected the system for its F-16 fleet, and it was also selected for the avionics of the F-18s being procured by Finland and the F/A-18s being acquired by Switzerland. The APX-113(V)'s first helicopter application was a retrofit for the Royal Navy's Sea King ASW/AEW/SAR fleet as part of a general upgrade of sonars and other avionics.

The APX-113(V) broke into the Asian F-16 market with Taiwan's selection of the system for its procurement of 150 F-16A/Bs. Japan received its first units for the prototypes of the troubled F-2 fighters based on the F-16C (Block 40).

Kuwait was the first among Foreign Military Sales (FMS) F/A-18 operators to field the APX-111(V). The Kuwait Air Force operates in a much less congested air traffic environment than its Western European counterparts, and Mode S was omitted. Kuwait's units were designed so users could add Mode S in the future with a software change.

A major new U.S. upgrade contract was signed in 1995, with a McDonnell Douglas award for the Navy's planned retrofitting of up to 500 F/A-18C/Ds with the APX-111(V) IFF system. Work on this contract began in 1997 and was completed in 2003. The APX-117/118 later replaced these systems.

On August 10, 1999, the USAF awarded Lockheed Martin a contract for engineering and manufacturing development (EMD) of an air-to-air interrogator for its F-16s. The upgrade would be retrofitted to roughly 251 Block 50/52 F-16C/Ds as part of the Common Configuration Implementation Program. This capability already existed in Air National Guard F-16A/Bs used for continental U.S. air defense. It would replace APX-101(V)s. Lockheed Martin selected the APX-113(V). Integration and testing began in June 2001. The first USAF fielding of operational units took place in mid-2002.

In late 1999, Boeing awarded BAE Systems-North America a contract for the qualification and production of new IFF transponders for production F/A-18s. The new systems would replace APX-100(V) transponders on F/A-18A/B/C/Ds and F/A-18E/Fs not equipped with the APX-111(V) CIT. The original contract was for 16 EMD units and a follow-on production of up to 380 systems. The open-architecture transponder would be MIDS-, Mode S-, and Mode 5-compatible.

Installations Accelerated. Under an October 2000 contract, the effort to equip active and Air National Guard F-16s with an air-to-air interrogator (AAI) system was accelerated. This was part of the F-16 Common Configuration Implementation Program (CCIP). The effort would provide commonality between Block 40 and Block 50 F-16s. Work included the production of 241 AAI upgrade kits. Ten additional new Block 50/52 F-16s were to be provided with the upgraded interrogators. But the FY00 budget did not contain any AAI funding, so the Pentagon asked Congress to reprogram $9.9 million from other CCIP programs to AAI so that the work could begin.

A version of the APX-111(V)/113(V) CIT was selected for the joint U.S. Navy/U.S. Army Common IFF Digital Transponder (CXP) program to replace APX-64(V), APX-72(V), APX-100(V), and APX-101(V) systems. Initial qualification testing would extend through FY04.

In 2000, the APX-113 was sold to a number of U.S. allies. Egypt purchased 311 systems as part of a $300 million defense modernization package. Portugal purchased 20 APX-113s for its F-16s. The next year, Finland purchased 37 APX-111s for its F/A-18s.

In October 2002, the Republic of Korea awarded the Boeing Company a contract for 40 F-15K aircraft. Boeing then awarded BAE Systems a $9.9 million contract for up to 40 APX-113(V) advanced IFF CIT systems for those aircraft. An additional 40 aircraft could be procured, depending on fiscal and other issues. The deliveries of the first batch of 40 are to be completed by 2008.

In January 2003, the Air Force awarded BAE Systems a $4.6 million contract to provide Advanced IFF (AIFF) systems for F-16 Block 25, 30, and 32 aircraft. Five annual options could bring the value of the contract up to $100 million. The APX-113s will replace the APX-101s currently in service.

Recent awards for the APX-113 include Turkey, Greece, and Morocco.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
BAE Systems	10	Sep 2004 – Not-to-exceed ceiling price order against a Basic Ordering Agreement for newly manufactured F/A-18 CIT components for an upgrade program for Finland. Completed Sep 2006. (N00383-03-G-038B)

Timetable

Month	Year	Major Development
	1988	APX-111(V)/113(V) development begins
	1990	Selected by Kuwait for F/A-18s
	1991	Wins NATO F-16 MLU
	1993	Selected by Turkey for F-16s
	1994	Selected for U.K. Sea King avionics upgrades
	1995	Selected for U.S. Navy F/A-18C/D retrofit

APX-111(V)/113(V) (CIT)

Month	Year	Major Development
Aug	1999	Selected for USAF AIFF for F-16C/D Block 50/52
Late	1999	APX-113(V) selected by Portugal for F-16A/Bs acquired under the Peace Atlantis program
Jan	2000	MLU production (NATO) complete
Jun	2001	Start of USAF flight testing of AAI
Jul	2002	First AAI-equipped units operational in USAF
Oct	2002	Korea procures 40 F-15K aircraft with APX-113(V) CITs
	2003	Finland and Portugal rollouts
Jan	2003	U.S. Air Force chooses APX-113 for upgrade of F-16 Block 25s, 30s, and 32s
Oct	2006	Turkey orders 35 APX-113s
Jul	2007	Greece orders 40 APX-113s
Dec	2007	Morocco orders 4 APX-113s

Worldwide Distribution/Inventories

Finland, **Kuwait**, **Switzerland**, and the **United States** use the APX-111 on their F/A-18s.

Belgium, **Denmark**, **Greece**, the **Netherlands**, **Portugal**, **Taiwan**, **Turkey**, and the **United States** use the APX-113 on their F-16s. **Morocco** has asked for the system to be included with its recent order of F-16s.

Egypt selected the APX-113(V) for the upgrade of 311 aircraft.

Japan chose the APX-113(V) for its F-2.

The **Republic of Korea** and **Singapore** have selected the APX-113(V) for their F-15s.

The **United Arab Emirates** has installed the APX-113 on its F-16E/Fs.

The **United Kingdom** has installed the APX-113(V) on its Sea King helicopters.

Forecast Rationale

The APX-113 has become the standard IFF transponder for F-16s sold throughout the world. In addition, it has recently been chosen to equip F-15s sold in Singapore and South Korea. The F-16 continues to sell well around the world, recently being chosen by Morocco and Greece to equip their air forces. In both instances, Lockheed Martin faced opponents offering more modern aircraft. However, the F-16 was able to win these competitions.

In both victories, the APX-113 has been chosen to equip the F-16s. Morocco is currently only requesting four APX-113s, however, Forecast International believes that the Moroccan government will eventually purchase enough systems to equip all its F-16s. The APX-113 has a number of advantages over older systems, including Mode S compatibility, making it desirable as an upgrade to older platforms. Many U.S. allies continue to purchase IFF systems that are compatible with U.S. and NATO signals so that joint operations and peacekeeping missions are easier to conduct.

The APX-113 has essentially cornered the IFF transponder market for new-build F-15s and F-16s. Over the next 10 years, expect 264 APX-113s to be produced. All production will be for F-16s and F-15s. As production of F-15s and F-16s decline, production of the APX-113 will decline as well. More modern IFF transponders will be chosen for newer aircraft, limiting the APX-113's sales opportunities. Therefore, production is expected to decline throughout the forecast period until it ceases in 2013.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program		**High Confidence**				**Good Confidence**			**Speculative**			
	Thru 2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Total**
BAE Systems Electronics & Integrated Solutions												
APX-113 <> Greece <> Air Force <> F-16 C/D												
	0	0	14	14	2	0	0	0	0	0	0	30
APX-113 <> Israel <> Air Force <> F-16 C/D												
	294	13	12	0	0	0	0	0	0	0	0	25
APX-113 <> Japan <> Air Force <> F-2												
	98	5	5	5	5	3	0	0	0	0	0	23
APX-113 <> Korea, South <> Air Force <> F-15 K												
	40	12	0	10	10	0	0	0	0	0	0	32
APX-113 <> Morocco <> Air Force <> F-16 C/D												
	0	0	0	0	8	10	6	0	0	0	0	24
APX-113 <> Norway <> Air Force <> F-16 C/D												
	88	14	0	0	0	0	0	0	0	0	0	14
APX-113 <> Saudi Arabia <> Air Force <> F-16 C/D												
	28	12	12	12	12	6	0	0	0	0	0	54
APX-113 <> Singapore <> Air Force <> F-15 S												
	0	2	10	4	4	0	0	0	0	0	0	20
APX-113 <> Turkey <> Air Force <> F-16 C/D												
	5	15	15	0	0	0	0	0	0	0	0	30
APX-113 <> United Arab Emirates <> Air Force <> F-16 C/D												
	92	12	0	0	0	0	0	0	0	0	0	12
Subtotal	645	85	68	45	41	19	6	0	0	0	0	264
Total	645	85	68	45	41	19	6	0	0	0	0	264