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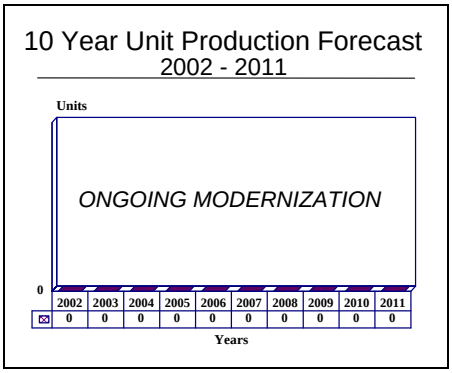
MIM-23A HAWK/MIM-23B Improved HAWK - Archived 2/2003

Outlook

- No longer in production
- Upgrade packages for HAWK missiles and fire units are offered
- Both Greece and Taiwan purchased upgrade kits for their HAWK air defense units
- Raytheon and Kongsberg are offering modified HAWK air defense systems equipped with AMRAAM missile. Denmark may be interested in this upgrade



Orientation

Description. Supersonic, medium-range, surface-to-air missiles.

Sponsor. The United States Department of Defense through the United States Army Aviation & Missile Command (AMCOM), Redstone Arsenal, Huntsville, Alabama.

Contractors. Developed and produced by Raytheon Company, Missile Systems Division, West Andover, Massachusetts (MA), USA. Raytheon and Litton are the prime contractors for the HAWK Phase III Product Improvement Program (PIP).

Major Subcontractors. Aerojet General and Raymond Engineering.

Licensees. European manufacturing is organized under a five-nation consortium called Societe Europeenne de Teleguidage (SETEL) with the Raytheon European Management and Systems Company (REMSCO) acting as the overall program manager for the European production of HAWK.

Mitsubishi Heavy Industries, Tokyo, Japan, also coproduces the Improved HAWK under license. Contractors associated with the Japanese production effort are Toshiba, Toyo and Mitsubishi Electric.

Status. Production of new HAWK missiles has been concluded. The upgrade and remanufacture of some HAWK air defense systems and missiles is proceeding on an as-needed basis.

Total Produced. Approximately 25,281 MIM-23A HAWK and MIM-23B I-HAWK missiles had been completed or were in production by 1996. This figure includes RDT&E units and missiles produced under license in Europe and Japan.

Application. HAWK (Homing All-the-Way Killer) and Improved HAWK are widely deployed as the free world's definitive medium-range surface-to-air missiles against hostile aircraft.

Price Range. The Improved HAWK missile is listed at $154,631 in the Fiscal 1990/91 budget documents (compared with $278,070 the previous year).

Technical Data

MIM-23B

	Metric	US
Dimensions		
Missile Length	503 cm	16.50 ft
Missile Diameter	36 cm	1.18 ft
Missile Wingspan	121 cm	3.97 ft
Missile Weight	638.7 kg	1,405.14 lb
Performance		
Speed	Mach 2.5	Mach 2.5
Altitude	30-16,000 m	98.42-52,493.33 ft
Range	40 km	21.59 nm

Propulsion. HAWK (MIM-23A) has one Aerojet General M22E8 two-stage, solid propellant motor. The MIM-23B Improved HAWK is powered by Aerojet General's M112 dual thrust solid propellant motor.

Control & Guidance. This missile uses semi-active homing guidance with a proportional navigation component. The semi-automatic command and control equipment, designated TSQ-73, is equipped with two acquisition radars: pulse and continuous wave. A separate range-only radar provides quick range and range-rate data for the continuous-wave illuminator which acquires, tracks, and illuminates the target.

The MIM-23B Improved HAWK missile incorporates a new guidance unit which allows engagement of multiple targets and improved resistance to electronic countermeasures. The fire control system of the basic and Improved HAWK is constantly being upgraded. The latest upgrade, Phase III, modifies the continuous wave radar to allow for single scan target detection. A fan-shaped beam is added to the illuminator radar for enhanced accuracy; it is also needed for the Low Altitude Simultaneous HAWK Engagement (LASHE) operating mode. This operating mode allows for multiple engagements by the HAWK battery in saturation attacks. The Tracking Adjunct System, described below, is also added.

Launcher Mode. HAWK is fired from towed ground launch vehicles. Each launcher carries three missiles. The HAWK air defense battery consists of the following: the MIM-23 missile (three to a launcher), six to nine launchers to a battery, an MPQ-48 continuous wave (CW) acquisition radar, an MPQ-50 pulse acquisition radar, two MPQ-46 illuminator radars (one with each of the two firing platoons in the battery), a range only radar, and a battery control center. Included in the battery is a loader transporter. In the US Army, four batteries are assigned to each HAWK battalion. A tactical battery consists of two assault fire units, and each assault fire unit (AFU) requires about 105 soldiers to man. The Army plans to retain 19 batteries (63 AFUs) indefinitely in the field. It is estimated that there are 450 HAWK launchers stationed in Central Europe.

There are two battery deployment modes for HAWK/ Improved HAWK. The standard battery includes two firing platoons, each with a tracking radar and three triple launchers. The triad battery is made up of three firing platoons, each with three triple launchers.

Warhead. A 30 kg (66 lb) high-explosive, blast fragmentation warhead with impact plus proximity fusing, with impact override. Raymond Engineering, Middletown, Connecticut (CT), manufactures the HAWK M100 safe/arming device.

MIM-23 HAWK

Source: US Army

Variants/Upgrades

The HAWK missile has been manufactured in two primary versions: the MIM-23A and the MIM-23B I-HAWK. The HAWK missile system has undergone a number of modifications and upgrades over its service life, the most recent of which is the HAWK Phase III effort. Northrop has also added an infrared focal plane array and an advanced silicon charge coupled device (CCD) to the Tracking Adjunct System for significantly improved target acquisition and identification at greater ranges, regardless of weather or atmospheric conditions. The enhanced units, called the Improved Target Adjunct System (ITAS), provide the HAWK with passive target detection, acquisition, tracking, and classification. Furthermore, Atlas Elektronik has provided the German and Dutch militaries with the HAWK Electro-Optical Sensor (HEOS) to provide passive all-weather, day/ night acquisition and tracking prior to radar activation and missile firing. The HEOS will also improve system effectiveness in an electronic countermeasures environment.

For additional information on these missile versions and upgrades, please see the pertinent entries in the **Program Review** section.

Program Review

Background. The initial HAWK system was deployed in 1960, and research and development on an improved variant commenced in 1963. Basic HAWK production and deployment were terminated in 1968. The Improved HAWK began initial production in June 1969 and attained operational deployment in November 1972.

MIM-23B I-HAWK. The US Army decided in January 1982 to retain a minimum I-HAWK force indefinitely. The MIM-23B Improved HAWK upgraded the basic system in several areas. Essentially, the improved version reduced system reaction time and increased lethality through better radar and electronic countermeasures. These advances have also been integrated into the Improved HAWK missile which is more reliable and requires less maintenance and logistics support.

Through August 1979, 18 US Army and three US Marine Corps Improved HAWK battalions were

deployed. This deployment status remains today, and while no additional deployments are planned for the US Army, the US Marine Corps was procuring the system through 1989.

The MIM-104 Patriot weapon system was originally scheduled to begin replacing Improved HAWK units in the early eighties, leading to phase-out of the entire system by the later part of the decade, although support elements would continue while the missile remained in service. This action has been delayed due to budgetary constraints and the modernization of the entire HAWK force. The modernization includes a two-year extension of shelf life with the addition of a new rocket motor. These technical improvements will keep the Improved HAWK production line open for the Marine Corps as well as a projected steady export market. New production for the Marines and product improvement kits for the US Army/USMC were funded through Fiscal 1989.

System Components. The TSQ-73 HAWK/Improved HAWK air defense missile control and coordination system, also called Missile Minder, consists of the following components:

- *MPQ-50 Pulse Acquisition Radar* - The primary source of high- to medium-altitude aircraft detection for the battery. Working in L (D)-band (30 to 15 cm), the radar is an all-weather system; a moving target indicator is provided for enhanced detection capability in high clutter. Several ECCM features are included in this radar.
- *MPQ-48 Improved Continuous Wave Acquisition Radar* - This radar provides for the detection of aircraft flying at the lowest altitudes in the presence of heavy ground clutter. Enhanced capability data processing is incorporated in the system. Frequency modulated ranging and built-in test equipment are included, as is an automatic data processor.
- *TSW-8 Battery Control Central* - This component provides for the man-to-system interface with a tactical control officer in charge of three operators.
- *Information Co-ordination Central* - This is the data processing and communications center for the battery. The TPX-46 IFF and communications equipment are fitted here.
- *MSW-11 Platoon Command Post* - This is the command post for the entire battery. Additional IFF, communications and display equipment is provided.
- *MPQ-46 High Power Illuminator* - This X (I/J)-band (3.75 to 2.25 cm) radar automatically acquires and tracks targets in azimuth, elevation, and range. The target track is continued throughout the flight of the missile, and after interception, the data are used for a kill evaluation. This component contains ECCM and built-in test equipment.
- *MPQ-51 Range Only Radar* - This K (K)-band (1.5 to 1 cm) radar provides quick-response range measurements when the other radars (1, 2, and 6 above) are electronically jammed. This radar transmits only when commanded.
- *M192 Launcher* - The launcher has three missiles at the ready. When activated, the launcher slues and elevates automatically to the designated positions while the missile's electronics and gyroscopes are activated.

HAWK Phased (I, II & III) Modifications. In early 1982, Northrop Corporation, Hawthorne, CA, began delivering 129 Tracking Adjunct Systems to the US Army and US Marine Corps under a $55 million contract. This system enables the Improved HAWK batteries to distinguish between several targets approaching at the same time. It can also discriminate between low-flying objects and ground clutter.

The Phase I product improvement program included a new klystron transmitter, enhanced built-in test equipment, and modifications to the antenna of the continuous-wave acquisition radar. The Army Tactical Data Link performance was enhanced with additional memory and other computer/data processing modifications. Finally, the pulse acquisition radar was modified with a new moving target indicator program and other hardware changes. The Phase I program has been completed.

The Phase II product improvement plan was approved for production in 1983 and is now being incorporated into US Army and NATO systems. This second series of PIPs (Phase II) focused on four improvements to upgrade system effectiveness and performance:

1. Providing an optical tracking capability
2. Making RAM and emissions control (EMCON) improvements to the I-HAWK tracking radar (i.e., Improved High Power Illuminator (IHPI). Modifications to the high-power illuminator improve its reliability and reduce maintenance/ logistics requirements
3. Enhancing the missile's capability to counter enemy jamming techniques (Missile Electronic Counter-Countermeasures Upgrade - MEU), and reduction of stray electromagnetic emissions
4. Upgrading the tactical software

The PIP name for the optical tracking capability is Tracking Adjunct System (TAS). TAS is an alternative tracking mode that can be used in an Electronic Countermeasures (ECM) environment or when normal tracking cannot be accomplished. Tracking Adjunct System involves a camera with a television monitor. Before the addition of TAS, the HAWK radar continuous beams alerted an enemy aircraft crew that they were being tracked.

Using the camera, soldiers can track the aircraft without the pilot's knowledge, cutting down the pilot's reaction time. The TV monitor allows the HAWK crew to identify the target visually. TAS was tested in Europe in Fiscal 1978 and was redesigned and re-tested, and the kits were placed under contract to Northrop in Fiscal 1980. Deliveries began in November 1981. Northrop Electro-Mechanical Division was contracted to build 129 TAS units for the Army and Marine Corps. Northrop had produced 275 TAS through 1985, the sixth year of production, for all HAWK users. The MEU modification development was completed in early FY82, and the Army began fielding the improvement in September 1983.

The Tracking Adjunct System underwent an engineering change proposal (ECP) that was tested and approved in July 1982. Due to the unavailability of hardware, production testing for the high power illuminator, reliability, availability, and maintainability (RAM) program was slipped to Fiscal 1983. Acceptance testing of Phase II HAWK PIPs was completed in March 1983. Installation of Phase II modifications began in August 1983 and was completed in the spring of 1986.

In April 1980, the US Army Missile Command (MICOM) completed a study to determine what additional improvements beyond Phase I and Phase II would be required for MIM-23B I-HAWK to effectively phase in its role of augmenting the air defense capabilities of the Patriot weapon system in the late eighties. The study recommended the development/fielding of six additional improvements called Phase III:

1. Giving the I-HAWK missile the ability to counter the Multiple Blinking Jammer (MBJ);
2. Increasing the computer capability of the command post that controls the missile engagements of each firing section;
3. Providing the I-HAWK battery with improved fire power capabilities against low-altitude targets;
4. Providing 100 percent solid-state components to the tracking radars to further improve RAM aspects;
5. Fielding a new training simulator; and
6. Incorporating either active or passive continuous wave (CW) decoys as an anti-radiation missile (ARM) diversion against the projected threat.

During the formal PIP review process in December 1980, the CW decoy improvement was not supported by the Army Training and Doctrine Command (TRADOC) and was deleted from the Phase III PIP list. Development of the Multiple Blinking Jammer (MBJ) modification began in FY81. The initial development contract for Phase III PIP was awarded in April 1982. Phase III engineering development hardware was installed in two I-HAWK Assault Fire Units and tested in 1983. A Phase III PIP initiated in FY83, called Collective Protection Equipment (CPE), will provide nuclear, biological, chemical (NBC) protection of I-HAWK fire unit command posts. An additional Phase III PIP called Low Altitude Simultaneous HAWK Engagement (LASHE), will upgrade the I-HAWK firepower and permit simultaneous engagement of low altitude targets in a saturation raid.

During FY85, the Army began a first year incremental buy for Phase III modification master kits and initial spares. The FY85 funding completed procurement of the Multiple Blinking Jammer modification kit and bought 525 replacement HAWK rocket motors.

The Phase III product improvement program is in production. The planned modifications are intended to extend the system's effectiveness throughout the nineties. Phase III deletes the Range Only Radar and Information Coordination Center and replaces them with a Battery Command Post.

The HAWK Phase III is deployed in three configurations: an Assault Fire Platoon consisting of a CW Acquisition Radar, Platoon Command Post, one High Power Illuminator, and four to six launchers; an Assault Fire Platoon Plus consisting of the same components as above but with a Pulse Acquisition Radar; and a battery consisting of a CW Acquisition Radar, Pulse Acquisition Radar, Battery Command Post, two High Power Illuminators, and six launchers.

The Marine Corps has concluded its procurement of the I-HAWK. NATO has produced I-HAWK Phase I PIP and has expressed interest in Phase II and III PIPs. The I-HAWK missile was being considered for a role in the US Army's proposed anti-tactical missile program. However, the US Army decided to withdraw the HAWK from duty with active service units and instead depends on the MIM-104 GEM Patriot missiles to provide for short-range ballistic defense.

HAWK Phase IV. Another improvement for HAWK will be the addition of an Agile Continuous Wave

Acquisition Radar (CWAR) that will increase the autonomous detection capability of the system. This improvement will enable the HAWK to provide all-altitude detection in an electronic countermeasures environment and to survive anti-radiation missile attacks. The radar will provide multiple simultaneous beams and after various modifications will provide the missile with mid-course targeting data. These modifications are expected to provide HAWK with a limited anti-tactical ballistic missile capability. This modification might be part of the overall Block IV modification package.

A modified HAWK missile successfully intercepted a simulated Soviet ballistic missile in April 1989. A Patriot radar detected the incoming ballistic missile and electronically communicated data to the HAWK fire unit enabling the MIM-23's illuminator to track the target and fire its missile. The target in the test was destroyed at an altitude above 7,625 meters (25,000 feet). Another successful test was conducted in 1991.

These tests are part of a three-year joint program between the US, Germany, and Netherlands to demonstrate the interoperability of the Patriot and HAWK. The tests are aimed at evaluating the Block IV software and a minor hardware modification to the tracking radar. The warhead and fuzing circuits have been slightly modified to improve performance against ATBMs.

USMC HAWK Upgrade. The US Marine Corps completed a program to provide its HAWK air defense systems with an enhanced ATBM capability and mobility improvements in 1998. This project, found under PE#0603863C HAWK, was jointly funded with BMDO and yielded a low-risk, near-term capability for expeditionary forces against short-range ballistic missiles.

Under this program and the Air Defense Missile System (ADMS) project (PE#0206623M), the US Marine Corps contracted General Electric and Raytheon to develop new radar, missile and launcher improvements for the HAWK. General Electric Ocean & Radar Systems Division, Syracuse, New York (now part of Lockheed Martin Corp), commenced work under a $43 million 27-month contract to modify existing TPS-59 ground-based air defense radars. The intent was to improve the system's ability to track targets 1 meter in size at up to 400 nautical miles at a 500,000 foot altitude. Technical, developmental, and operational testing was conducted in FY96, with the first units equipped in FY97.

The radar upgrade also adds a datalink, via the Air Defense Communications Platform (ADCP), for communications between the system and the Joint Tactical Information Distribution System (JTIDS). The Air Defense Communications Platform converts TPS-59 data messages and Tactical Data Information Link - J (TADIL-J) formatted messages into the intra-battery datalink formats required by the HAWK air defense system. This allows the TPS-59 to transmit automatically targeting data to HAWK missiles. Initial production of the ADCP began in 1997.

The HAWK weapon system modifications included upgrades to the battery command post and improvements to the HAWK missile that resulted in a configuration called the Improved Lethality Missile (ILM). The modified HAWK battery command post processes cued data to control the high power illuminator radar. The ILM package incorporates fuze and warhead (much larger fragments and a higher energy explosive) improvements to 300 missiles that have been transferred from the US Army to the Marine Corps. Another 700 ILM modification kits were procured and installed by the end of FY96. Production of the battery command post modification kits began in FY95. The installation of all battery command post modifications was completed by the end of FY96.

The Raytheon-headed HAWK Mobility Survivability Enhancement (HMSE) project improves the battery's ability to deploy and fire quickly while reducing the amount of transports needed to carry equipment. The HMSE includes an update of the launcher, which now can be loaded with HAWK missiles while on the move. The HMSE improvements began to enter service in late 1994; the 43rd kit was delivered in mid-1995. These upgrades also allow the launcher to accept a variety of missiles, such as the AMRAAM, Standard, Sea Sparrow and PAC 3.

An AMRAAM-HAWK hybrid has already been developed by the US Army and Air Force and dubbed HAMR. This system is being offered to current and potential HAWK customers. Raytheon, Hughes, and Kongsberg are teamed to offer the AMRAAM-HAWK combination to potential international customers. The system combines the HAWK air defense system with the Hughes MPQ-64 radar, Kongsberg's Norwegian advanced surface-to-air missile system fire direction center, and the Raytheon surfaced-launched AMRAAM.

Sparrow-HAWK. In early 1985, the US Marine Corps began testing a new system called Sparrow-HAWK. This is the standard three-round HAWK launcher modified to accept two rows of RIM-7 Sparrow missiles, with five missiles per row. Either type of missile can then be fired from the modified launcher. Tests are continuing on this evolutionary system.

Funding

The US has provided no new funding for the HAWK program. Modification money ended with the FY99 budget.

US FUNDING

	FY98		FY99		FY2000		FY2001	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
USMC								
HAWK	-	-	-	-	-	-	-	-
EADS Mods	-	1.5	-	1.0	-	-	-	-

Recent Contracts

In December 1999, Aerojet & Atlantic Research Corporation, Sacramento, California, was awarded a $9.8 million contract for the purchase of 236 HAWK rocket motors for the countries of South Korea and Taiwan. Work will be completed by November 2001. Contract Number DAAH01-00-D-0002. In February 1999, Aerojet & Atlantic Research Corporation, Sacramento, California, received a $7 million modification to an existing contract for 110 HAWK rocket motors. Contract Number DAAH01-97-C-0017

In December 1998, Raytheon signed a $6.6 million contract with Egypt to provide technical assistance service for its HAWK air defense systems. This contract is part of an annual arrangement with Egypt for supporting this missile system. In March 1998, Raytheon Electronic Systems, Bedford, Massachusetts, received a $12.9 million definition of a letter contract as part of a $13.1 million modification to a contract for hardware and services in support of remanufacturing eight HAWK assault fire units. Contract Number DAAH01-97-C-0106

Timetable

Month	Year	Major Development
	1953	Development begun
	1957	Initial HAWK production begun
	1959	Initial operating capability tested
	1960	NATO agreement reached
	1963	Improved HAWK research begun
	1968	HAWK production/deployment terminated
	1969	Low-rate production (Improved HAWK) begun
	1972	Improved HAWK operational capability
	1973	New NATO deployment agreement made
	1977	Survivability testing program completed
	1979	Patriot/HAWK analysis initiated
Oct	1981	Phase I PIP completed
Jan	1982	Army decided to retain I-HAWK indefinitely
	FY85	Phase II modifications scheduled to be completed
	FY85	Phase III Mod kits procurement initiated
	1988-89	Production and modification to existing missiles and systems continued
	1990	Procurement terminated by the US Army and Marine Corps
Dec	1998	Greece ordered HAWK Phase III upgrade
	2000s[(a)]	Export orders and modification programs continue to support HAWK

[(a)] Estimated

Worldwide Distribution

Denmark could be interested in replacing its HAWK missiles with AIM-120 AMRAAMs. A decision on procuring a replacement could be made in 2004.

Improved HAWK is the major medium-range, surface-to-air missile deployed within NATO and other countries. The most recent contract activity involving the HAWK was an order placed by **Greece** in October 1998. As part of a major air defense missile system purchase, Greece will receive six Patriot air defense missile batteries, worth about $1.1 billion, and HAWK Phase III upgrades worth $145 to $150 million. The prime contractor for this work is HKV, a joint venture of Raytheon and Kongsberg.

Jordan is also interested in upgrading its HAWK inventory. The Jordanian military has 14 I-HAWK battalions in fixed positions. These systems have been upgraded to Phase II. Jordan wants to upgrade its I-HAWKs to Phase III and possibly acquire a further 10 systems. **Oman** has also mentioned an interest in acquiring surplus US HAWK air defense systems.

Singapore was reported in 1983 to be planning to buy an undisclosed number of HAWK missile systems. Later reports confirmed that Singapore was operating the I-HAWK Phase II system in its 163 ADA battalion. Now Singapore is considering upgrading its HAWKs to the Phase III configuration.

In 2000, **Taiwan** announced its was modernizing its HAWK air defense systems. Taipei wants to convert its TPS-43F air surveillance radar to the TPS-45V configuration. With all other items included, the deal would be worth $96 million. Under the Missile Reliability Restoration program, Taiwan will upgrade 162 MIM-23 missiles to the Intercept Aerial guided missile configuration. This contract could be worth an estimated $106 million.

User Country(s). HAWK is in the inventories of at least 25 countries including **Bahrain** (reported), **Belgium** (systems for sale), **Denmark**, **Egypt** (Phase III), **Federal Republic of Germany**, **France**, **Greece**, **Iran**, **Israel**, **Italy**, **Japan**, **Jordan** (MIM-23B), **Kuwait** (inventory inoperable since Kuwait-Iraq Gulf War), **Nationalist China**, **Netherlands**, **Norway**, **Republic of Korea** (under an early 1987 program, these systems would receive the Phase II upgrade), **Saudi Arabia** (Phase III), **Singapore**, **Spain** (Phase III), **Sweden**, **Thailand**, **United Arab Emirates**, **United Kingdom**, and the **United States** (which has retired its HAWKs).

Forecast Rationale

Although the HAWK missile has been out of production for many years, the system remains in front-line service around the world. By some estimates, the HAWK could stay on active duty for upwards of another 20 years. If true, Raytheon could see a steady flow of modification, upgrade and support contracts over the next five to 10 years or even longer.

Raytheon claims it can maintain the HAWK's effectiveness through 2020 and beyond. This could be an attractive option for countries that neither want nor need to procure next-generation systems. Over the next decade, Raytheon could see annual HAWK-related revenues in the area of $25 million to $35 million.

No new HAWK missile units are expected to be manufactured. Future HAWK orders are expected to be met through the delivery of surplus US systems and missiles.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

			High Confidence Level				Good Confidence Level			Speculative			
Missile	**(Engine)**	**thru 01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**Total 02-11**
RAYTHEON COMPANY													
MIM-23B	M112	12565	0	0	0	0	0	0	0	0	0	0	0
Subtotal - RAYTHEON COMPANY		12565	0	0	0	0	0	0	0	0	0	0	0
MITSUBISHI ELECTRIC CORP (Licensee)													
MIM-23B	M112	3275	0	0	0	0	0	0	0	0	0	0	0
Subtotal - MITSUBISHI ELECTRIC CORP		3275	0	0	0	0	0	0	0	0	0	0	0
SETEL/REMSCO (Licensee)													
MIM-23B	M112	9441	0	0	0	0	0	0	0	0	0	0	0
Subtotal - SETEL/REMSCO		9441	0	0	0	0	0	0	0	0	0	0	0
Total Production		25281	0	0	0	0	0	0	0	0	0	0	0