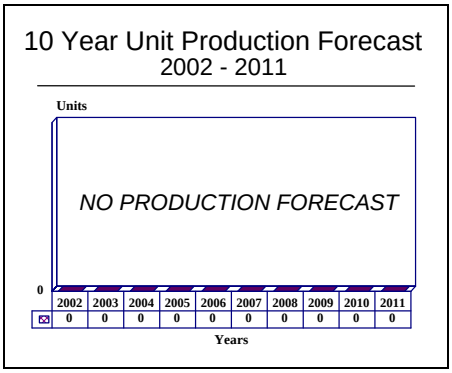
FGM-77 Dragon - Archived 3/2003

Outlook

- No longer in production
- Manufacture of this missile in the United States and overseas has ceased
- With the availability of next generation alternatives, little interest has been shown in procuring the Dragon
- No clients for the SuperDragon have been announced



Orientation

Description. Manportable anti-tank missile.

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

Contractors. Primex Technologies, Incorporated, Ordnance and Tactical Systems Division, CMS Defense Systems business unit, St. Petersburg, Florida, USA, is the prime contractor for the Dragon.

Major Subcontractor(s). Firestone Tire & Rubber Company, Hercules Incorporated, Texas Instruments, Teledyne Brown Electronics, and Timex Corporation were major subcontractors under the original McDonnell Douglas-led Dragon program. Subcontractors involved in the CMS SuperDragon project include Atlantic Research, Sequa, Omega Training, Perceptronics, and Loral.

Licensee. The Swiss Federal Aircraft Factory/Emmen (FFA Emmen) of the Armament & Technology Group of the Swiss Military Department, Berne, Switzerland, has a license for Dragon system production.

Status. CMS is marketing a new version called the SuperDragon that builds on the former McDonnell Douglas Dragon Generation II Plus. No orders for this advanced Dragon version have been placed.

Total Produced. Awaiting orders for SuperDragon. Approximately 178,139 Dragon full-up missiles (including RDT&E units) were produced by McDonnell Douglas and Switzerland. Full-up round production by McDonnell Douglas ceased prior to the sale of the responsible unit to CMS. Approximately 33,474 Dragon Generation II modification kits were manufactured by McDonnell Douglas for the US Army and another 1,460 by Switzerland. Production of the Dragon Generation II in Switzerland was believed to have been superseded by a new tandem-charge version, with some 2,755 units manufactured through the end of 1997.

Application. Manportable, anti-tank weapon for the destruction of armored vehicles.

Price Range. Approximately $4,500 per round, with the Dragon night sight costing $30,500 each. These prices are in 1978 dollars. The unit cost of the Dragon Generation II kit is approximately $1,937 in a quantity buy. An all-up Dragon missile in the Generation III version was expected to cost approximately $6,700 in FY88 dollars.

Technical Data

	Metric FGM-77A	**Metric** FGM-77B	**Metric** FGM-77C	**US** FGM-77A	**US** FGM-77B	**US** FGM-77C
Dimensions						
Missile Length:	112 cm	112 cm	112 cm	3.67 ft	3.67 ft	3.67 ft
Missile Diameter:	25 cm	25 cm	25 cm	9.84 in	9.84 in	9.84 in
Missile Weight:						
Ready to Fire:	10.9 kg	12.3 kg	14.8 kg	24.0 lb	27.06 lb	32.5 lb
w/Tracker (Day):	14.0 kg	15.4 kg	17.7 kg	30.8 lb	33.88 lb	39.0 lb
w/Tracker (Night):	20.7 kg	22.1 kg	24.6 kg	45.6 lb	48.62 lb	54.1 lb
Fin span:	34 cm	34 cm	34 cm	1.12 ft	1.12 ft	1.12 ft
Performance						
Speed (to 1,000 m):	11.2 mps	11.5 mps	11.5 mps	36.7 fps	37.72 fps	37.72 fps
Speed (to 1,500 m):	8.8 mps	11.5 mps	11.5 mps	28.86 fps	37.72 fps	37.72 fps
Altitude:	Line of sight	Line of sight	Line of sight	Line of sight	Line of sight	Line of sight
Range:	65-1,000 m	65-1,000 m	65-1,500 m	213-3,281 ft	213-3,281 ft	213-4,920 ft
Penetration (at 90^{o}):	50 cm	50 cm	50 cm	19.68 in	19.68 in	19.68 in

FGM-77 Dragon

Source: US Army

Variants/Upgrades

The Dragon anti-tank missile system is available in several versions, including the original FGM-77A Dragon; the FGM-77A Improved Dragon, equipped with a new 122 mm warhead; the FGM-77B Dragon Generation II, also equipped with a new 122 mm warhead; the FGM-77B Dragon Generation II Plus, which incorporates some of the capabilities of the Dragon Generation III; the FGM-77C Dragon Generation III, outfitted with the Generation II Dragon warhead and a spring-loaded probe and a new crush fuze; the tandem-charge Dragon being developed by Switzerland (tentatively designated FGM-77D); and now the CMS SuperDragon.

For additional information on these systems, please see the pertinent entries in the **Program Review** section.

Program Review

Background. The M47 Dragon system employs a command-to-line-of-sight guidance system and consists of three main items: a tracker, a recoilless launcher, and the FGM-77A missile. The tracker includes a telescope for the gunner to sight the target, a sensor device, and an electronic package. The tracker is reusable and is attached to the launcher. The missile is never seen by the gunner, and after firing the launcher is discarded.

The initial R&D contract was awarded to McDonnell Douglas in September 1966. Production engineering was initiated, with engineering development in 1967 to 1969. Limited production began in 1972, while the Army completed field engineering and operational testing. Shortly thereafter, the Army selected second-source contractors (Raytheon and Kollsman) for the two major system components: the missile and tracker, respectively. This dual-phase procurement, continuing through 1975, produced 18,000 rounds.

In FY75 and FY76, a split-award competition for 16,000 rounds resulted in a 60-percent share for McDonnell Douglas and a 40-percent share for Raytheon/Kollsman. After FY76, competition was on a winner-take-all basis.

Raytheon manufactured Dragon components at the Bristol, Tennessee, facility, while final assembly of rounds, including warheads and packaging for delivery to the Army, was performed in government-owned facilities at Redstone Arsenal. The complete Dragon system weighs approximately 17 kilograms (37.4 lb), is completely manportable, and was initially claimed to be powerful enough to destroy almost any known enemy armor or field fortification.

Follow-On Sought. The US Army stated its desire to begin fielding a Dragon replacement during the mid-1980s and explored several avenues toward this end. Contracts were awarded in September 1980 to Honeywell and McDonnell Douglas to develop the Infantry Manportable Anti-armor Assault Weapon System (IMAAWS); both contracts were canceled less than two months later, and the entire program was canceled in April 1981. Prototype systems were considered too heavy and too large, and the Army reevaluated the entire IMAAWS concept. The program subsequently followed a roller-coaster course: it was cut, refunded, cut, terminated, and finally refunded again. Early in 1982, the project was redesignated Rattler, but was terminated again in early 1983. Weight problems plagued the system.

Another approach is the Tank Breaker project, handled by the Defense Advanced Research Projects Agency (DARPA). This fire-and-forget anti-tank missile, which uses infrared imagery guidance, is being worked on by Rockwell International. The Army had hoped to begin full-scale engineering development during late 1982, but the ongoing turmoil in the entire manportable anti-tank program has continued to push this date back. The future of Tank Breaker remains clouded.

McDonnell Douglas produced enhanced warhead and tracking system components for the US Marine Corps in a product improvement program which the US Army has now embraced; the modified missile is called Dragon Generation II and should be type classified FGM-77B. In addition, McDonnell Douglas proposed a greatly enhanced Dragon Generation III for the M47 replacement effort, now designated the Advanced Anti-tank Weapon System-Medium (AAWS-M).

Interim Selection: Dragon. In 1988, the Senate Armed Services Committee (SASC) stated that the available evidence did not support the continued consideration of the RBS56 BILL and MILAN II as potential interim replacements for the Dragon. The SASC recommended that any interim investment should be directed towards the improvement of the M47 missile system. However, a new development came to light in mid-June 1989. A classified assessment by the office of Operational Testing & Evaluation (OT&E) contradicted a US Army decision by saying that the RBS56 BILL (see the report "RBS53/RBS56 BILL") is the best option for the US Army for an interim manportable anti-armor weapon.

Although the RBS56 BILL may have the best one-shot kill probability, other inherent costs had to be considered. The chosen system was to act as an interim weapon until the new Advanced Anti-tank Weapon System-Medium (AAWS-M) became available. The US Army's decision, however, was to be based not only on which system performed the best, but also on cost, impact on training and logistics, and scheduling. The BILL would have required the United States to invest funding in an all-new weapon system and the associated support and training programs. The outgoing director of the OT&E office said that lethality is important, but not the only issue.

The situation has changed with the supposed withdrawal of the Euromissile MILAN 2T from the competition. Euromissile withdrew the MILAN due to objection that the US Army was not planning to fire live missiles during its upcoming side-by-side tests. The US Army agreed in July 1990 to perform side-by-side tests of the Dragon, MILAN, and RBS56 BILL missile systems, now reduced to the Dragon and BILL. The

result of these tests, completed in 1991, was that the Dragon Generation II was selected as the AAWS-M interim system. The Dragon was found to be superior to the BILL except in dealing with reactive armor (the Dragon cannot penetrate reactive armor.)

Missile Models. Since the Dragon was introduced into the US Army anti-tank inventory, various upgrades and enhancements have been incorporated into the production line.

Improved Dragons. In the early 1980s, Switzerland decided to keep the Dragon, which the Swiss designate B/B-77, in service into the 21st century. McDonnell Douglas was asked to develop a new 122 millimeter (4.8 in) warhead to test against a similar-diameter warhead developed by the licensee, the Federal Aircraft Factory. McDonnell Douglas assigned this work to Physics International, a firm well-known in the area of developing advanced, shaped-charge warheads. Switzerland eventually selected this warhead for retrofitting to its inventory of Dragon missiles.

In August 1986, the United States Marine Corps awarded McDonnell Douglas a $4.7 million contract to qualify the Physics International warhead for retrofit to its Dragon inventory. This was followed by another contract, eventually to total $40 million, in December of that same year, for the full-scale development of a further improved Dragon. The first Improved Dragon (the Dragon with the improved warhead) is now designated Dragon II or Generation II Dragon, while the follow-on greatly improved version of the Dragon detailed below was called Dragon III or Generation III Dragon; this latter variant was expected to be type classified FGM-77C.

Generation II Dragon. The only difference between the Generation II Dragon and the original FGM-77 missile is the enhanced 122 mm warhead. This full diameter warhead is 850 grams (1.87 lb) heavier than the original 101.6 mm one, which increases the missile's total weight to 6.98 kilograms (15.356 lb). The other dimensions remain the same as the original missile. The warhead contains 1.63 kilograms (3.586 lb) of Octol explosive; cone stand-off is approximately 26 centimeters (10.24 in). Our standardized formula for shaped-charge warheads yields a penetration figure of 76.86 centimeters (30.26 in) for the Generation II warhead. However, research indicates that this warhead employs some unique cone geometry, specifically a trumpet-shaped cold-forged copper liner and other advanced technology that renders our formula in error. Actual penetration is said to be around 89 centimeters (35 in). This is an 85 percent increase in penetration performance over the standard warhead. The only other change in the missile is the replacement of the aluminum stabilizing surfaces with ones of steel in order to counterbalance the slightly heavier warhead. The warhead and stabilizers are supplied as a kit, which the US Marine Corps and the Swiss are procuring for retrofit to their inventories of existing missiles, The Generation II Dragon is also available as new production if demand warrants.

Generation II Plus. This is a provisional designation of another Dragon variant. The Dragon Generation II Plus would allow users of the original Dragon system to incorporate the capabilities of the Generation III. This would require some modifications to the system's night tracker and other training equipment. The new missile would be able to fly 1,500 meters in 8.8 seconds.

Generation III Dragon. The Generation III Dragon is so much more effective that it is essentially a new missile, much like the AIM-9M, which is essentially a new missile when compared with an AIM-9B. The Generation III Dragon, while having the same greatly improved warhead of the Generation II Dragon, further increases this warhead's anti-armor performance with the addition of a spring-loaded probe to increase the warhead's cone stand-off to 32 centimeters (12.6 in). Also, a new crush fuze is added to detonate the warhead at much higher angles of incidence. The manufacturer claims a 98 percent increase in armor penetration over the original FGM-77A missile; this equates to a 95 centimeter (37.4 in) performance. Reports are circulating that production missiles may well be fitted with the specialized probe used on the TOW-2A to deal with reactive armor. This probe uses a small precursor charge at its tip in order to disrupt the dynamics of the reactive armor detonation. To meet the increased range performance demanded by the US Marine Corps, a new sustainer motor with battery has been added; the weight of this component is 2.45 kilograms (5.39 lb) and length is increased by about 10 centimeters (3.94 in). The total weight of the encased missile is 15.6 kilograms (34.32 lb). While the new propulsion system appears to have sufficient energy to achieve a 1,750 meter (1,913.8 yd) range, current plans call for only 1,500 meters (1,640.4 yd) of copper wire to be mounted in the missile. A future option may employ a fiber-optic cable to achieve the full range. A main feature of the Generation III Dragon is a new day/night tracker to eliminate many of the problems of the old system. Using a digital processor greatly eases the guidance of the missile, and the gunner's capture range is reduced with the addition of an electronic track-assist feature. The target weight of the tracker is 7.27 kilograms (15.99 lb).

Integration testing of the Generation III was completed in 1988. However, due the US Army's selection of the fire-and-forget AAWS-M option (the system that the

Marine Corps supported), a 10-month slip in the development schedule of the Dragon Generation III, and a decreasing support base in Congress for the system, the US Marine Corps decided in mid 1989 to terminate the program (see Egyptian Dragon Deal entry).

SuperDragon. Building on the Dragon II Plus, the SuperDragon offers further enhancements over its predecessors. The SuperDragon includes aerodynamic refinements to reduce drag and weight, and reoriented rocket thrusters to help increase its velocity and range to 2,000 meters. The latter improvements were assisted by the addition of a sustainer motor under the McDonnell Douglas Dragon II Plus project. Flight time to maximum effective range is less than 11 seconds. The missile's warhead, also part of the previous Dragon II Plus project, provides an extended probe with a tip charge and delayed fusing to defeat explosive reactive armor (ERA).

The SuperDragon round has a carrying weight of 15.5 kilograms (14.8 kg when ready to fire), with the reusable day/night trackers adding 3.1 kilograms and 9.8 kilograms, respectively. These have been upgraded with digital electronics for increased reliability, as well as automatic temperature sensors for improved guidance control. Reliability is 98 percent.

Near-term prospective customers for SuperDragon could include the Republic of Korea and a Middle Eastern country. CMS has said that it expects to receive a Request for Proposals from an undisclosed Southeast Asian country (possibly Korea) for 1,500 to 2,000 units toward a total requirement of more than 15,000 in the near future. Also, an unidentified Middle-eastern country, possibly Egypt or Saudi Arabia, has supposedly shortlisted the SuperDragon to meet its requirement for more than 15,000 manportable anti-tank weapons. Other countries mentioning an interest in SuperDragon include Israel, Jordan, Morocco, and the Netherlands.

Funding

Procurement of the Dragon by the United States has been completed. The possibility exists of an additional order for some 1,800 Dragon II retrofit kits, but no contract has yet been placed. The US Army and Marine Corps had planned to procure upwards of 27,000 Dragon Generation II missile systems (17,000 US Army; 10,000 US Marine Corps). Original Dragon missile systems are being retained for training purposes, while the Dragon IIs already in inventory can be prioritized for combat missions. Dragon II 10-year statement of cost is $320 million.

The United States military is also considering the purchase of the SuperDragon from CMS Incorporated. These units could be provided to US Army Reserve and National Guard units.

Originally, Dragon missile procurement funding for the United States Armed Forces was terminated in 1980. The last-announced Dragon production contracts, made to Raytheon, included $18.58 million for 8,817 missiles in April 1980, $22.3 million for 6,200 missiles for Switzerland in December 1979, and $44.3 million for 4,292 missiles plus 172 night trackers for Saudi Arabia in September 1979. In addition, during 1979, the Pentagon notified Congress of a sale of 5,100 Dragons, valued at an estimated $21.1 million, to Israel. In 1987, funding for Dragon again appeared in the yearly budget submission documents, although initially only for product improvement kits. Approximately $3.2 million was requested in FY97 for unspecified Dragon modifications.

Total US RDT&E, $121.0 million; total US Procurement, $424.7 million.

Recent Contracts

In August 1997, CMS Defense Systems Incorporated, Tampa, Florida, received $6.4 million as part of a not-to-exceed $12.8 million firm-fixed-price letter contract for a SuperDragon performance demonstration. Work on this contract was expected to be completed by December 1998. Contract Number DAAH01-97-C-0253

Timetable

Month	Year	Major Development
	1964	Design conceived
	1964	Research initiated
	1965	Prototype flight testing
	1966	Contractor selected (McDonnell Douglas)
	1966-69	Operational evaluation
	1968	Initial low-rate production
	1972	Initial procurement (US Army)
	1972	Second-source contract (Raytheon)
	1974	Operational deployment
Mar	1981	Dragon production terminated in US
	1983	Dragon production terminated in Switzerland
Late	1983	Dragon line reopened for production of components
Early	1988-89	Titusville production facility producing enhanced components for Generation II
	1989	Development funding for Generation III version stopped
	1993	Production of further improved Dragon in Switzerland
Dec	1993	CMS purchased Dragon program from McDonnell Douglas
	1998	Primex acquired Dragon from CMS
	2000-2002	No program activity

Worldwide Distribution

There have been no recent sales of the Dragon. Through Military Assistance Program (MAP) and Foreign Military Sales actions, the United States sold 110,449 Dragon missiles abroad through 1987.

User Countries. Identified overseas users include **Australia**, **Cambodia** (resistance groups - Khmer People's National Liberation Front), **Iran**, **Israel**, **Jordan**, **Morocco**, the **Netherlands** (Dragon I/Dragon II), **Saudi Arabia**, **Spain**, **Sweden**, **Switzerland**, **Thailand**, and **Yemen Arab Republic** (North). Although export sales are not always overtly acknowledged, it has been reported that **Egypt**, the Republic of (South) **Korea**, the **Republic of China** (on Taiwan), **Iraq** (possibly captured from Iran), and **Yugoslavia** also have Dragons in their inventories.

Forecast Rationale

No potential customers have expressed interest in procuring the Dragon anti-armor missile system over the last year. With the availability of next-generation alternatives, few nations seem interested in acquiring the Dragon.

The original Dragon's wide distribution was seen as possessing considerable market potential for the sale of upgrade kits. One could argue that the shear size of this operator base should be able to produce at least one contract for a CMS upgrade package. Alas, it appears such sales are just not meant to be.

No forecast has been provided for the SuperDragon since no orders are expected to be placed.

Note: No new production of the Dragon missile is expected to take place on behalf of the US government. All future production will likely be dominated by the manufacture of modification kits for the existing missile inventory.

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**
CMS INCORPORATED													
SUPER%DRAGON	UNSPECIFIED	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal - CMS INCORPORATED		0	0	0	0	0	0	0	0	0	0	0	0
MCDONNELL DOUGLAS CORP													
FGM-77A	UNSPECIFIED	173000	0	0	0	0	0	0	0	0	0	0	0
FGM-77B	UNSPECIFIED	33474	0	0	0	0	0	0	0	0	0	0	0
FGM-77C	UNSPECIFIED	39	0	0	0	0	0	0	0	0	0	0	0
Subtotal - MCDONNELL DOUGLAS CORP		206513	0	0	0	0	0	0	0	0	0	0	0
FFA EMMEN (Licensee)													
FGM-77A	UNSPECIFIED	5100	0	0	0	0	0	0	0	0	0	0	0
FGM-77B	UNSPECIFIED	1460	0	0	0	0	0	0	0	0	0	0	0
FGM-77D	UNSPECIFIED	2755	0	0	0	0	0	0	0	0	0	0	0
Subtotal - FFA EMMEN (Licensee)		9315	0	0	0	0	0	0	0	0	0	0	0
Total Production		215828	0	0	0	0	0	0	0	0	0	0	0