

**CASE STUDY:
IMPACT ASSESSMENT
ON
PRECISION STRIKE
WEAPON DATA LINK SYSTEMS
TO ACCOMMODATE
IMT 2000**

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IMPACT ASSESSMENTS

The AGM-130/ GBU-15 Weapon Data Link System operates in the 1710-1755 MHz and 1755-1850 MHz spectrum bands and would be significantly impacted by the introduction of IMT-2000 systems to either one of these bands. This assessment addresses the operational and associated cost impacts to the Weapon Data Link system in order to accommodate the introduction of IMT-2000 systems. This assessment considers the technical and cost analysis of band sharing, band segmentation, and vacating the frequency band to accommodate IMT 2000 systems.

System Description:

Tactical Weapons and Data Link System Components



Data Link Pod



Test Sets



Weapon Data Links



AGM-130

a. Air Force precision guided munitions (AGM-130 and GBU-15) were designed for employment against fixed, high-value targets in all weather conditions, day or night. These weapons, in the 2000-pound class of weapons, are launched from F-15E aircraft from either low or high altitude at ranges from 5 to in excess of 30 nautical miles. Equipped with TV or Infrared sensors and aided by GPS, these weapons provide operators the ability to attack targets in all weather conditions, day or night. These

weapons can be controlled from either the launch aircraft or a standoff aircraft at a range of more than 100 nautical miles. Operators require access to video and command link frequencies at any time during the mission, including ground operations, post take-off pre-launch operations, and post-launch weapon flight operations. Access to frequencies is critical during all training and testing operations-these operations require use of the frequencies for two hours per mission.

b. The RT-1210/AXQ-14 and RT-1624/ZSW-1 weapon control data link systems provide operators with the ability to control the AGM-130 and GBU-15 precision guided weapons. Video from the weapon seeker is transmitted to an F-15E Weapon Systems Officer (WSO) who identifies the target and manually controls the bomb to the designated impact point. The AGM-130 provides a longer range, compared to the GBU-15, because its flight is assisted with a rocket motor. Both the AXQ-14 and ZSW-1 data links utilize multiple frequencies, within the 1710-1855 MHz band, for both video and command links. The AXQ-14 and ZSW-1 Weapon Control Pods (WCP), carried on the centerline station on the F-15E, receive and display the weapon video and provide weapon guidance through the frequency shift keying command link. The AXQ-14 WCP uses a horn antenna to provide forward coverage and a phase scanned array for coverage to both sides of the aircraft. The ZSW-1 WCP automatically shifts among the pod antennas to provide 360-degree coverage. The AGM-130 weapon uses an OA-8921D switchable data link antenna mounted on the rear of the weapon. This antenna has two beams that provide directional coverage back to the aircraft. The antenna automatically switches from the high to the low beam depending on the weapon's pitch angle. The coverage provided by the GBU-15 weapon antenna is less capable than, but similar to, the coverage provided by the AGM-130 weapon's antenna.

Impact Assessments:

Option 1:

Full band sharing of IMT-2000 Systems and the Tactical Weapon Data Link Systems.

Full sharing of the 1710 - 1755 MHz frequency band and/or the 1755 - 1850 MHz frequency bands with IMT-2000 systems would not preclude operations of the Weapon Data Link system provided the Air Force would be able to use specific frequencies with IMT-2000 systems on a non-interference basis. The IMT-2000 systems would be affected wherever and whenever training or testing occurs. During training in the CONUS, aircraft using this system could possibly remain in the protected areas as established in Appendix F of the OBRA 93 report. During training and testing the system is transmitting (at high power) for at least a few minutes per simulated launch. Each flight could consist of approximately four launches, and each location flies approximately eight training missions per month. For training, a relatively inexpensive modification to

this data link must be made to prevent IMT 2000 systems interfering with the weapon data link in target areas where IMT-2000 systems are established. Any modifications to the weapon data link to accommodate IMT 2000 would have to be funded.

Option 2 and Option 3:

Option 2 recommends band segmentation with 1755 - 1805 MHz retained for Federal Government use, to include continued use by the (Precision Weapon Data Link system,) and 1805 – 1850 MHz transferred to commercial use for IMT-2000 systems. Option 3 recommends band segmentation with 1755 - 1780 MHz transitioned to commercial use in 2006 and 1780 - 1790 MHz transitioned to commercial use in 2010. The 1790 – 1850 MHz spectrum band would be retained for Federal Government use, to include continued use by the Precision Strike Weapon Data Link system.

These segmentation plans are perhaps viable for the short term only, if band sharing is utilized (Option 1). The loss of bandwidth proposed in these two options would ultimately hinder weapon system training and testing. Furthermore, this system's video links are located in the 1705 - 1755 MHz band. A separate effort is under way to auction this frequency band to industry and the AGM-130 and GBU-15 systems will be affected if sharing is not allowed in that band. Due to the design of this system, any movement within any portion of our needed spectrum would be as complex and costly as vacating the entire band. The Precision Strike office is currently evaluating a segmentation plan developed by Raytheon to determine its suitability.

Option 4:

Loss of DOD accesses to the full 1755 – 1850 MHz bands.

a. If the Precision Weapon Data Link system could not be used on its current frequency in 2003, there would be immediate loss of combat capability to the war-fighter. The AGM-130 and GBU-15 could not be used to their full potential. These systems provide precision attack capability from fighter aircraft, and they represent the vast bulk of the total man-in-the-loop precision capability from all aircraft. Without the Data Link system, there is no man-in-the-loop capability, thus eliminating precision accuracy, last-minute target identification, the ability to gather intelligence data, and the ability to minimize collateral damage.

b. If the Precision Weapon Data Link system could not be used on its current frequencies in 2003, there would also be immediate loss of combat capability to the war-fighter. Assuming availability of funding by 2003, all of the weapon control pods, support equipment and 20% of the weapon data terminal inventory could be modified to operate with a new set of frequencies by 2007. This update would include a significant redesign and retrofit of key components in the Weapon Control Pods (ZSW-1 and AXQ-14), the Weapon Data Links (WDLs, SDLs, and WCDTs), and the associated support equipment to include factory and field test units. The remaining weapon 80% of the weapon data links could be modified by the end of 2011. The majority of this study

examines the cost associated with modifying these components to accommodate new frequencies. Since there has not been a new frequency assigned, we assumed, for this estimate that the 8 GHz band would become available for us to migrate to. Since our contractor was tasked to develop notional schedules, and since the migration effort can be accomplished with moderate risk by 2007, assuming funds are received by FY03, delaying the migration effort from 2007 to 2010 will only increase cost (assuming the start date remains the same). In other words, if sufficient funds are made available by FY03, the migration out of these frequency bands will be complete before the end of 2007.

Migration of the AXQ-14 and ZSW-1 weapon control subsystems to the 7258 – 8400 MHz band was estimated to cause a free space loss increase of up to 14 dB. An increased loss of 14 dB would impact the antenna design in both weapon control pods as well as all of the weapon data link designs. A corresponding cost estimate was developed for recommended redesign of the antenna, which utilizes phase scanned arrays for the pod and horn antennas for the weapon data links.

A number of other RF components are affected by the migration of these systems to the new frequency band, including:

Mixers	Transceiver Assembly
Power Amplifiers	Synthesizer Assembly
Filters	Pod Radomes
Attenuators	Pre-amplifiers
Frequency Sources	RF Switches

The following figures show, examples in color, of the AXQ-14 and ZSW-1 RF key components that will require modification if a migration to a different frequency band is required.

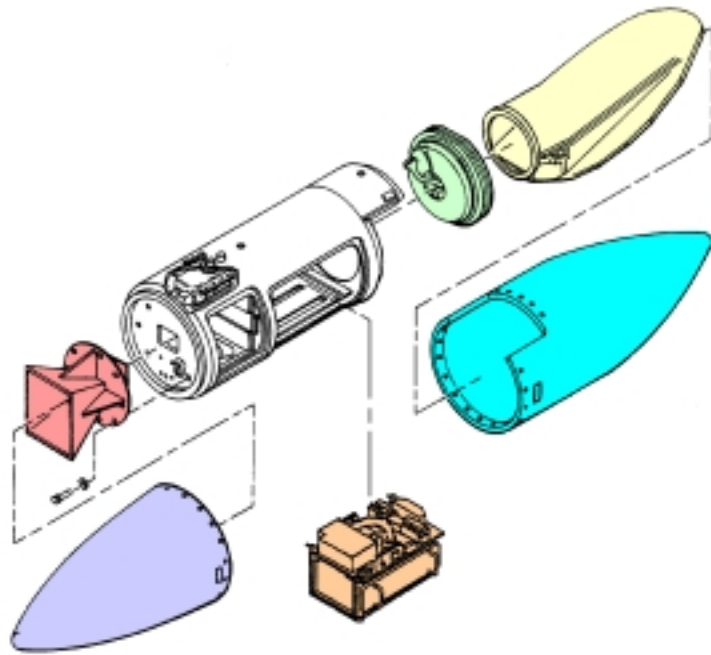


Figure 1. AN/AXQ-14 Weapon Control Pod

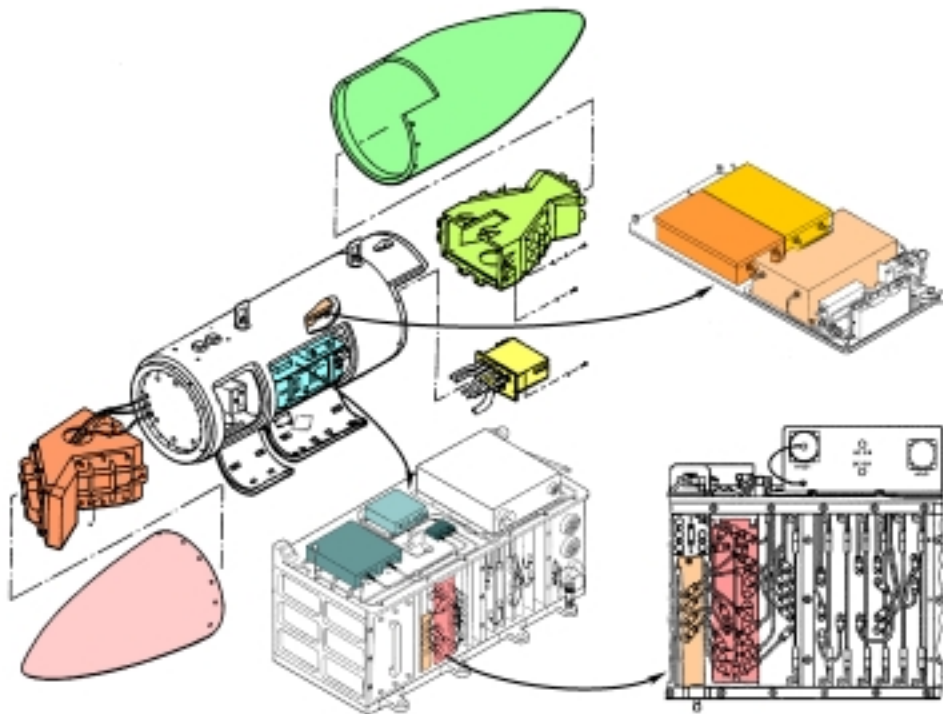


Figure 2. AN/ZSW-1 Weapon Control Pod

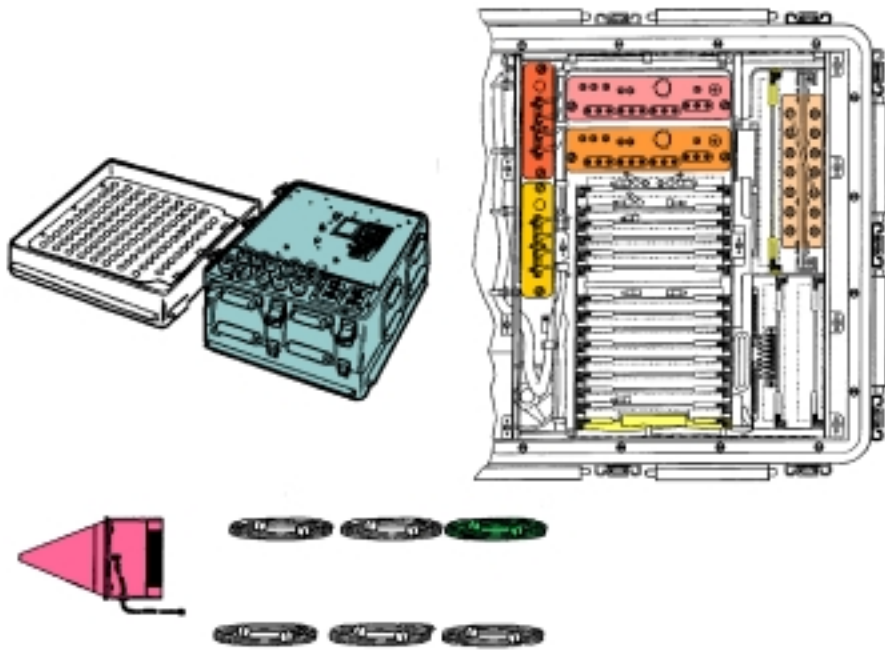


Figure 3. AN/ZSM-1 Guided Missile Remote Control Component Test Set

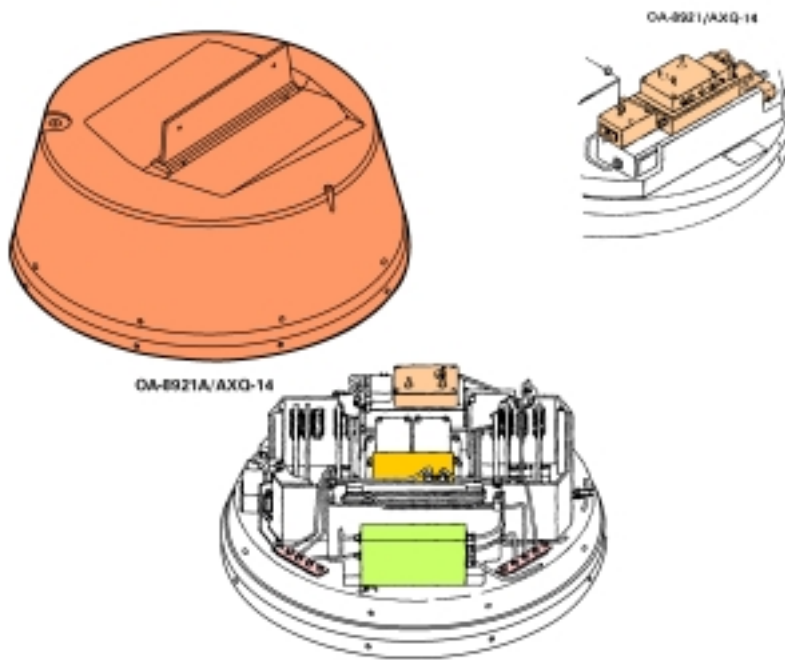


Figure 4. AGM-130 Weapon Data Link

PROGRAM FUNCTIONAL ASSESSMENTS

The Precision Strike System Program Office's Data Link Team developed the cost estimate to change the data link system's operating frequencies. This team includes members from all functional disciplines. Raytheon Technical Services Company assisted in the development of this study.

The Weapon Data Link System would require all new RF components, power supplies, antennas, and some circuit cards installed in the Weapon Control Pods, the Weapon Data Terminals, and supporting equipment. This modification of existing assets would not result in an enhancement to the system.

The following describes the functional impacts, a tentative schedule, and a breakout of costs:

Program Management and Control:

1. The Precision Strike System Program Office shall establish a Frequency Realignment Data Link Program Team and assign a Program Manager (PM) to execute the program. The PM shall establish, implement, and maintain a management organization which will plan, organize, control, coordinate, and oversee activities relating to the AGM-130/GBU-15 Weapon System Data Link Frequency Realignment.
2. The PM will set up necessary administrative functions and record keeping processes. The PM will establish internal processes to track and execute all program actions. Program Office Master and Sub-level schedules with critical path data shall be established and updated as necessary. Perhaps five or more separate contracts will be required to accomplish this task. The PM will secure personnel resources as necessary to carry out administrative control and reporting functions.
3. This effort would require the establishment of a PM position (either a major (O-4) or civil service GS-13) plus two additional acquisition project specialists (support contractors). These three additional manpower requirements will be required from program approval through successful fielding.

Engineering:

1. Due to the anticipated IMT-2000 frequency auction, it will be necessary to change the operating frequencies of the AN/AXQ-14 and AN/ZSW-1 systems from L band to 6-8 GHz. In order to accomplish this task the RF components of the pods, weapon data links, test sets, etc., will need to be changed.
2. The AN/AXQ-14 pod and WDL change will be relatively easy to accomplish except for the antenna systems. The pod RF components (frequency source, mixers, band pass filters power amplifiers, cables, relays and preamplifier) are contained on a plate above the electronics unit and can be changed easily. The antennas, however, will have to be

redesigned, and since at the new frequencies atmospheric absorption is increased, the gain of the antennas will also have to be increased in order to maintain the maximum range. The four antenna programmer/motor control printed circuit cards will also have to be redesigned to work with the new antennas. The WDL antenna is a fixed dual dipole antenna, and the only considerations that need to be taken into account in the redesign are maintaining the gain and reproducing the antenna patterns. Although the redesigned antennas will have patterns similar to the old antennas, they will not be the same. This will require antenna pattern measurements on the F-15E aircraft and changes to the Air Force Mission Support System (AFMSS) weapon planning module and the F-15E technical manuals.

3. The AN/ZSW-1 system will be extremely difficult to migrate since it is built as a jam resistant system plus provides a backward capability with the AXQ-14 WDL. Because of the complex design of the pod and its complete built-in test capability, not only will the RF components need to be redesigned and replaced, but also additional IF cards will have to be redesigned and replaced.

4. The test equipment for both AXQ-14 and ZSW-1 contain both the pod and weapon circuitry and will require 50% more engineering to modify than a pod or weapon data link. In addition, the factory and depot test equipment has commercial equipment that will not operate at the new frequencies and therefore will have to be replaced.

Contracting:

1. Frequency Reallocation Contract:

a. A Source Selection of this complexity, and at this dollar value, will take 1 year from time of identification of the requirement to contract award. Contracting assumptions are; full up-front funding and a firm fixed price contract. The contractor will assume all risk for testing. Therefore, the government will rely upon the contractor's testing schedule.

b. The initial phase from requirement to release of the Draft Request for Proposal (RFP) will require one GS-12 Contract Specialist working 30% of the time for 8 months. The next phase, release of the Draft RFP to RFP release will require one GS-12 Contract Specialist full time, one GS-12 Contracting Office 30% of the time, and one GS-12 Price Analyst 30% of the time for one month. The last phase of RFP Release until Contract Award will require three full-time GS-12s including a Contract Specialist, a Price Analyst, and a Contracting Officer for three months. If there are protests, the contract specialist and contracting officer time could be extended full time for one month.

c. Required major documentation will include an Acquisition Strategy Plan, an Acquisition Plan or SAMP, a draft RFP, and a RFP. The Designated Acquisition Commander (DAC) (currently AAC/CC) will act as the Source Selection Authority and sign the major documentation as long as the dollar value is less than the \$500 million dollar threshold. Agency procedures apply to the source selection.

2. Other Contracts:

a. Maintenance Contract: Changes will require a J&A, legal review, negotiation and contract modification. One contract specialist will be required for 2 months at 50% of the time, and one contracting officer will be required for 2 months at 10% of the time.

b. Technical Services Contract: A contract exists for changes to the technical orders. Changes will require a modification to the contract. One contract specialist will be required for 2 weeks at 30% of the time, and one contracting officer for 2 weeks at 10% of the time.

c. AN/GJM-65 Test Set Contract: A contract exists for changes to the Test Set. However, the changes required for the frequency change will involve building new Radio Frequency Interface Assembly (RFIA), software, and cable interface components. This will require a new contract. It is anticipated that this contract will be sole source. This will require a synopsis, RFP, J&A, legal review, business clearance, proposal analysis, negotiation and new contract. One contract specialist will be required for 3 months full time, one price analyst will be required for 1 month, (full time), and one contracting officer will be required for 3 months at 10% of the time.

d. Mission Squadron Trainer: A contract exists for changes to the MST. Changes will require a J&A, legal review, negotiation, and contract modification. One contract specialist will be required for 2 months at 30% of the time, and one contracting officer will be required for 2 months at 10% of the time.

Flight Test:

1. Engineering tests will focus on radio frequency measurements at Rome Air Development Center (RADC) in Rome, New York, and the PRIMES facility at Eglin AFB, Florida. The Guided Weapons Evaluation Facility (GWEF) at Eglin AFB, will be used to run hardware-in-the-loop simulations, or modeling, of the weapons systems.

2. Once these engineering tests are completed, a development and an operational flight test program will be conducted at Eglin AFB, Florida. These tests will consist of ground mounts, captive flights, and live launches to demonstrate system performance and to determine operational effectiveness and suitability.

3. The AGM-130 Development Test & Evaluation (DT&E) will be conducted by the 46th Test Wing at Eglin AFB to demonstrate data link performance in a real-world environment. This flight test effort will be conducted with representative production hardware installed on AGM-130s, GBU-15s, and in the AXQ-14 and ZSW-1 Data Link Pods.

4. Second, an Operational Test and Evaluation (OT&E) will be conducted at Eglin AFB by Det 2, AFOTEC. These tests will be conducted with production hardware and will demonstrate operational effectiveness and suitability.

Integrated Logistics Support (ILS)

A significant ILS effort will be required to successfully beddown and sustain the modifications resulting from a frequency change. A combination of SPO and Ogden ALC/WMG efforts will be necessary to accomplish this project. A summary of the impacts (cost and manpower, where available) follows:

Technical Orders:

1. The following summarizes the technical order requirements needed for changing the frequency on the AXQ-14 and ZSW-1 data link pods. This effort will drive changes on 29 technical orders, affecting approximately 1803 pages, with a cost of approximately \$475,000 a contract will be required to update 14 aircraft technical orders consisting of approximately 372 pages. AFMETCAL will update the calibration technical order for the advanced support equipment. OO-ALC and the Program office will work in conjunction with prime contractors to update all associated weapon, data link pods, and associated test sets and equipment consisting of an additional 14 technical orders with a page count of approximately 1,419 change pages. Funding for this effort includes personnel and transportation for the In Process Reviews (IPR). There will be a need to conduct three separate reviews for the major end item systems at the 35%, 75%, and 100% stages of the program. These systems are the Weapon Control Pods and associated test equipment, weapons and associated equipment, and F-15E technical orders. These reviews require a technical order manager, contractor representative, equipment specialist on the particular piece of equipment, an Air Combat Command representative, and the functional user to be present at the IPR. Defense Automated Printing Office will print and distribute approved technical orders to the users.

Support Equipment Modifications:

1. AN/GJM-59 Pod Test Sets (15) – These test sets would require replacement of the RF components to include the frequency source, mixers, band pass filters, power amplifiers, cables, relays, and pre-amps.

2. AN/GJM-64 Weapon Components Test System (27 + 15 spare RFIA circuit cards and cables) – These test systems would require both hardware and software changes.

a. The Radio Frequency Interface Assembly (RFIA) will require a complete redesign due to the change in frequency.

(1) These RFIA's would require replacement of the RF components to include the frequency source, mixers, and filters.

(2) Redesign of the new card(s) will require developmental testing to insure the card and its components meet the current specified requirements, including temperature, ruggedization, and transportability among others.

b. Two RF cables will require replacement and two TPS cables will require modification. In addition to the cable changes, the cable tester will require some modifications.

c. The Test Set Coupler will require a new design, major modification, or elimination.

(1) The attenuators and antennas in the current test set coupler design will not meet the requirements of the new frequency band.

(2) Changes to the antenna hat on the data link may force changes to the electronics in the coupler due to antenna pattern changes.

(3) Modification or design of the coupler will be accomplished by the prime contractor.

d. There will be software changes to the Calibration Verification Test, Self-Test, Test Module Adapter, GBU-15(V)1C/B, GBU-15(V)1C(T-1)/B, GBU-15(V)2C/B, GBU-15(V)2C(T-1)/B, GBU-15(V)31A/B, GBU-15(V)31A(T-1)/B, GBU-15(V)32A/B, GBU-15(V)32A(T-1)/B, AGM-130A/C-11, AGM-130A/C-12, CATM-109, CATM-110, WCU-8A/B, WCU-8C/B, WCU-8(T-1)/B, WCU-8(T-3)/B, WCU-20(V)3/B, WCU-20(T-1)/B, OA-8921C/AXQ-14 and Cable Test TPSs.

3. AN/FSM-57 Depot Automated Test Station (1) – This test station would require replacement of the RF components to include the frequency source, mixers, band pass filters, power amplifiers, cables, relays, and pre-amps. In addition there are several pieces of commercial test equipment that would require replacement in the RF Bay.

4. AFMSS Weapon Planning Module (Software Upgrade) – The AFMSS changes would be made to accommodate flight profiles and data link range and coverage changes due to the redesign of the antenna and impacts to signal strength. This software would also need to be updated with a new 6 DOF module, produced by the prime contractor, for each AGM-130 and GBU-15 variant.

5. Mission Squadron Trainers (Software Upgrade) – The software for the MST will require incorporation of the updated 6 DOF modules produced by the prime contractor. The software will also require some change due to the weapon flight profile changes.

6. The Goldpan Rapid Targeting System is a ground station that communicates with the weapon data link. It will require similar modifications as the weapon control pod. All RF, and power supply components will require replacement to change frequencies.

Supply Support:

1. New Nomenclatures, Designators, and NSNs will be required for newly modified weapon/component configurations and new spares.
2. Initial spares will be provisioned for all new pod, data link, and support equipment sub-components. Spares Acquisition Integrated with Production (SAIP) will be used to the maximum extent possible to minimize cost.

Inventory Management:

1. Significant effort will be required by the Ogden ALC/WMG IM to coordinate and direct the movement of pods and data links from the field to modification facilities and return. An additional effort by SPO personnel will be required to closely track status of assets through the modification lines.
2. The sub-system IM will direct the shipments of failed pod and support equipment repairable components to and from the repair facility.

Packaging, Handling, Storage, and Transportation:

A extensive, complex transportation effort will be required to move the pods, data links, and test sets to the modification facilities and return to the field. The estimated cost for surface transportation (truck and sealift) is \$940,000. Costs will be higher if airlift is needed to meet contractual delivery dates or beddown dates.

Interim Contractor Support (ICS):

ICS will be required to accommodate base-level repairs and problem solution during the beddown time period.

Training:

Contractor training will be required for the AF Depot personnel. Contractor-provided training material will be required for back shop avionics FTD instructors.

Beddown and Field Modification Planning:

An ILS Management Team (ILSMT) will be formed to manage all aspects of the beddown, fielding, and sustainment planning for this effort. A minimum of two meetings per year is envisioned. Membership will include not only the SPO and Ogden ALC, but also, the MAJCOMs, field units, AETC, and the respective contractors.

GFM Management for Modification Efforts:

Government Furnished Material (GFM) management will be required for applicable assets at contractor facilities.