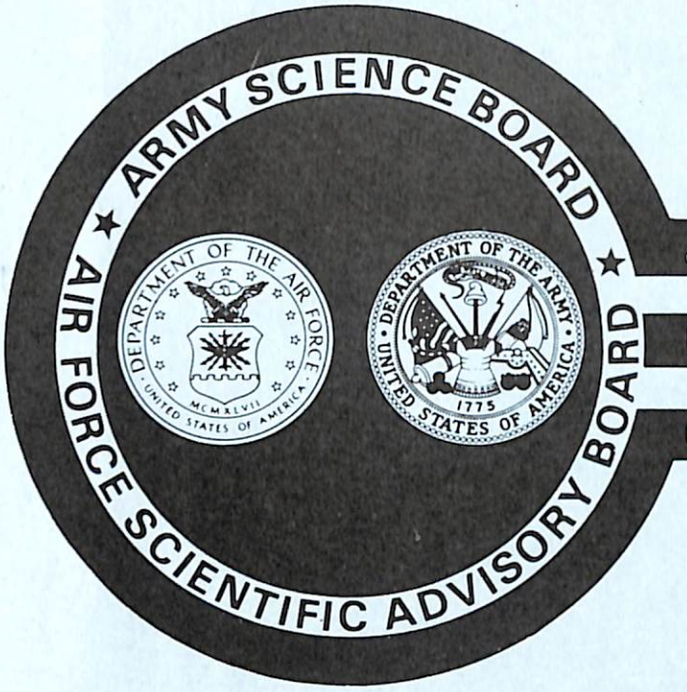
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JOINT SUMMER STUDY 1978

U.S. AIR FORCE ACADEMY

COLORADO SPRINGS, CO

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FINAL REPORT

Classified by Exec Sec'y SAB
Subject to General Declassification
Schedule of Executive Order 11652
Automatically Downgraded at Two Year
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31 December 1990.

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UNCLASSIFIED

ARMY SCIENCE BOARD/
AIR FORCE SCIENTIFIC ADVISORY BOARD

JOINT SUMMER STUDY

U.S. AIR FORCE ACADEMY

JULY 1978

(S) "TACTICAL BATTLEFIELD SYSTEMS" (U)

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Subject to General Declassification
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31 December 1990.

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Mr. R. Mike Lockerd	Study Co-Chairman	ASB
Mr. Terrell E. Greene	Study Co-Chairman	SAB
Dr. Edwin B. Stear	Chairman, Task Group I	SAB
LTG(Ret) Glenn A. Kent	Chairman, Task Group II	SAB
Mr. David Shore	Chairman, Task Group III	ASB
Mr. Kent Kresa	Chairman, Task Group IV	ASB

(S) EXECUTIVE SUMMARY (U)

(U) The Joint Summer Study of the Army Science Board and the Air Force Scientific Advisory Board prepared this report during their working session at the Air Force Academy in Colorado Springs from July 17 through July 28, 1978. This study, the first combined effort of the two Boards, addressed four topics that were identified by TAC and TRADOC as high-priority items for combined Air Force/Army attention:

- Reliable IFF of aircraft by ground-based AD systems
- Improved capability to provide supporting firepower by systems of either Service, using target acquisition means of either Service
- Effective capability to interdict enemy command and control
- Accurate location and reliable classification by type, or identification by specific unit, of enemy AD systems

(See Annex C for more detailed initial task statements.) All topics were addressed in the NATO Central European context and included assessments of their C^3 implications.

The classification of the principal report is SECRET, but several important conclusions from the study areas are contained in a smaller set of separate appendices of a special classification.

(C) The topics studied have the common elements that they require closely coordinated actions by ground and air forces, that they are of great importance, in some cases of critical importance, to a successful defense

of NATO, and that major deficiencies exist in current operational capability. The Task Groups considered both technological and procedural aspects of the problems, and provided recommendations for action that would provide improved operational capabilities in two time frames: near-term i.e., from now through 1983; and longer-term, after 1983.

(U) The study was conducted by four Task Groups composed of members of both Boards and full-time Service participants, with guidance from the summer study steering group including a general officer participant from each Service. (See Annex A for a list of participants.) Preparation before the study session at the Air Force Academy included briefings and discussions at a general meeting of all Task Group participants, plus a number of separate meetings of the individual Task Groups from May through early July, and a visit to major U.S. defense headquarters in Europe by a small subset of the participants in late June. (See Annex B for list and topics of pre-study meetings.) Findings and recommendations were briefed to members of the Department of the Army staff, Department of the Air Force staff, and general officers of the Army and Air Force on July 28 at the Academy. (See Annex D for schedule, agenda, and names of principal attendees at the July 28 briefing.)

(U) In overview, the summer study developed four major themes:

- Identification of potential joint Air Force/Army program initiatives
- Emphasis on "short-loop" systems
- Classification of recommendations by timeliness of operational utility
- Definition of impact on NATO C^2/C^3 requirements

(S) The emphasis on joint programs was aimed at highlighting aspects of combined arms operational capability where TAC and TRADOC need to combine their efforts to gain synergism from their efforts. The "short loop" concept was intended to focus attention on relatively simple, highly productive "fixes", where a close tie between, e.g., a sensor and a weapon, would minimize response times, communications load, vulnerability, etc., as contrasted to "big system" approaches with massive central data bases. Examples of short loop concepts considered include direct EIFF at the HAWK battery; in-theatre reprogramming of EW assets; integration of PLSS and AGTELIS; and a PLSS-TACFIRE loop for artillery targeting.

(U) Each of the Task Groups considered their analysis and recommendations in two distinct time frames. Near-term items were those which could provide some enhanced capability before the end of 1983; longer-term fixes would be operational after that date. Substantial emphasis was placed on the near-term category, where innovative use of existing or programmed assets could minimize the cost of added capability.

(U) Although not directly identified as a separate task area, command and control was one of the common themes for the study. Although definition of the associated C^3 system architectures and implementations was beyond the scope of the Task Groups' efforts, each group made an attempt to scope the implication of their recommendations on the European C^3 system of the future. In this area, several common perceptions were held by all of the Task Groups:

(S) 1. That the NATO (and U.S.) C^3 system is extremely marginal, especially the communications dimension, and will largely fail under realistic wartime stresses, particularly REC by the WP.

(S) 2. That major improvements are urgently needed before any more load can be added to the system or any higher reliability expected. Examples include:

- Higher mobility of assets
- Shortened response times
- Data orientation
- Reduction of bandwidth requirements
  - o Discipline
  - o Preplanning (e.g. Creek Braille)
- AJ on all major links
- Fail-safe network geometries
- Acceleration of DSCS III

NATO IMPLICATIONS

(U) All of the Task Groups addressed their topics in the context of Allied operations within the NATO Central area. It was recognized that in any of the areas studied -- aircraft identification, supporting firepower, C-C^3, or countering enemy ADs -- a U.S. only capability would be of limited value.

(U) The NATO-wide implications of the problem of aircraft identification are self-evident. Multi-national, multi-Service aircraft operations in offense and defense, along with multi-national surface-based defenses clearly demand a theater-wide identification system, and the findings and recommendation of Task Group I are presented in this light.

(U) In the area of supporting firepower for friendly forces, the most obvious basis for the requirement for NATO-wide solutions to current

deficiencies pertains to CAS. NATO tactical airpower in the central region operates under the central control of AAFCE and aircraft of any NATO country in the region may be assigned to close support targets in support of any country's troops. Artillery and attack helicopters have relatively shorter ranges than CAS aircraft and are organic assets of ground units rather than being centrally controlled. However, even these shorter-range firepower assets may be applied in support of a neighboring Division and that Division may well belong to another nation. Thus, inter-Allied systems interoperability and procedural interoperability are important across the whole spectrum of fire support.

(S) The subject areas of Task Groups III and IV are somewhat different from the other two subject areas with respect to NATO implications in that both tend to depend more heavily on compartmented information. Nevertheless, operations to counter enemy C^3 and to negate enemy defenses must be viewed on an Alliance-wide basis. During peacetime, the U.S. can assist the Alliance by leading in the development of concepts, doctrine, and tactics for these operations. During wartime, some security restrictions on disclosure of the sources of targeting and order-of-battle information may be relaxed. Even if this is not the case, target nominations for $C\text{-}C^3$, counter AD operations may be exchanged among Allies without compromising sources. New sensor systems coming into the U.S. inventory, such as PLSS, AGTELIS, SOTAS, etc., can provide a basis for specifying sourees of information at collateral security levels.

(U) The consensus of the participants in the joint summer study was that the DoD should actively pursue implementation of pertinent recommendations with the NATO Allies, and that the most effective way to do so would be to bring the Allies early into the discussion and implementation process.

OBSERVATION ON THE JOINT STUDY

(U) In the view of participants and reviewers, significant benefits have accrued from the combined activity among Army and Air Force scientific advisors, military staff, and Department staffs.

(U) The principal findings and recommendations of the four Task Groups are presented in the following pages.

TASK GROUP I: IDENTIFICATION OF AIRCRAFT IN THE NATO AIR DEFENSE ENVIRONMENT

(U) Task Group I addressed the problem of reliable identification of aircraft in the NATO AD environment with the main emphasis on identification of aircraft by surface-based defenses. Two classes of identification were considered: direct identification at the point of fire, i.e., identification by the AD gunner or missile operator; and indirect identification, i.e., identification performed elsewhere than at the point of fire and communicated to the firing unit. In addition to considering the technological aspects of identification, the Task Group undertook a review of some major aspects of the operational procedures and rules of engagement pertaining to aircraft identification.

(U) The key operational needs in aircraft identification by surface-based defense are that identification must be timely and highly reliable, and must not significantly compromise the engagement opportunities or engagement range of the defenses. Reliability is of critical importance not only to increase the probability of successful engagement to enemy aircraft but to avoid fire against friendly (or conceivably in some contexts, neutral) aircraft.

(S) The study found that a number of critical deficiencies currently exist in the identification capability of the NATO AD system. These may be summarized as follows:

- The MK X/MK XII cooperative, direct IFF system has a variety of widely known weaknesses, including susceptibility to jamming, exploitation, spoofing, saturation, and equipment failure

- Visual direct identification, the only method available for many AD fire units, is severely range-limited, provides relatively low confidence, is subject to significant variability depending on operator skill and training level, and is strongly dependent on cueing

- The AD ground environment does not provide for adequate transfer of tracks and related identities; does not realize the potential to be gained through netting of appropriate AD radars and lacks adequate secure, reliable data links for operation in an environment of heavy battle damage and EW

- Current procedures and rules of engagement are not compatible with the capability of equipments, are not well accepted by aircrews, and in wartime are likely to lead to unacceptable levels of fratricide and/or to inadequate defense

(S) The study explored a number of approaches to improving aircraft identification in the NATO environment. The following actions are recommended as being of the highest priority:

- Implementation in Europe of effective communications and data processing for parallel and redundant exploitation of AWACS data for indirect identification

- Development of a data-link for coupling DAD weapons to the HAWK C^3 system

- Implementation in Europe of a capability for exploiting certain SIGINT information for aircraft identification

- Consideration of a JTIDS-like system as the basis for the future NATO direct target identification system

- Initiation of advanced development of a millimeter-wave coded retro-reflector identification system for short-range applications

- Advanced development and test of TDOA systems as adjuncts to radar detection and tracking systems

- A concept definition study of widespread radar netting for identification purposes

(S) Also recommended, but of somewhat lower priority are:

- Addition of JEM equipment to the HAWK CW acquisition radar

- Implementation of Mode 5 of the MK XII IFF system

- Study of the feasibility and cost-effectiveness of a passive identification system for use with short-range and man-portable AD weapons

- Addition of EIFF equipment to HAWK

(U) Technology initiatives in the 6.1, 6.2 and 6.3 program areas were also recommended, as discussed in the Task Group report.

TASK GROUP II: SUPPORTING FIRE FOR FRIENDLY FORCES

(U) Task Group II investigated potential improvements in procedure, systems and interface equipment to enhance the timely application of firepower from artillery, fixed-wing aircraft and attack helicopters.

Particular emphasis was given to improving the capability of Air Force ground-attack assets in support of the ground commander's mission. Improved use of either Service's weapon systems with either Service's target acquisition or cueing systems was another major topic.

(U) Key operational needs identified by the Task Group were the need to provide an effective and timely means for allocating ground attack assets and assigning them against specific targets; the need for effective target cueing and target hand-off; and the need for fast, accurate and survivable communications and position location for coordination of Army and Air Force firepower.

(C) Critical deficiencies now exist in the capability for providing supporting firepower. The Task Group singled out the following for emphasis:

- OAS capability is quite limited at night, in reduced visibility and in heavy defenses
- Current procedures for allocation of sorties to OAS are too cumbersome for high-intensity, fluid operations
- An adequate common or interchangeable coordinate system is not available for coordinated application of Army/Air Force firepower
- The Army and Air Force do not fully exploit each other's target acquisition sensors
- Army/Air Force target handoff techniques need to be improved to provide successful fire-pass mission accomplishment by ground attack aircraft at low altitude and in poor visibility
- New equipment is not introduced early enough in the development cycle of the equipment to meet the needs for joint and combined testing and training

- The A-10 lacks equipment for navigation under IFR conditions and for effective weapon delivery at night

(C) After considering a menu of approaches to improved capability for coordinated fire support in joint Army/Air Force operations, the Task Group recommended the following actions:

- The process for allocation of sorties to OAS missions and for assignment of these sorties against specific targets should be streamlined and clarified. The system should emphasize a "push" process of allocating OAS sorties to Corps and below in lieu of the current "pull" system for preplanned and immediate requests

- High priority should be placed on creating and fielding a common Army/Air Force position-locating and digital communication system; a common digital targeting language system should be provided

- New equipment, including prototypes, should be introduced early into joint Army/Air Force OAS training and testing programs to obtain early feedback between development of tactics and procedures and development of equipment

- To improve target handoff, the following systems are needed:

  - o a common coordinate based-cueing system
  - o improved-accuracy beacon bombing
  - o burst digital communications
  - o improved sensors for acquisition of targets at night by air-crews and ground observers

- To improve joint target acquisition, data exchange should be provided from PLSS to TACFIRE; between AGTELIS and TPQ-37 and PLSS; and from SOTAS to ground attack aircraft

- An inertial navigation system, a FLIR, and a radar altimeter should be added to the A-10; a JTIDS or PLRS terminal should be added to the A-10 when available; a forward-firing cannister weapon should be provided for the A-10

TASK GROUP III: INTERDICTION OF ENEMY COMMAND/ CONTROL.

(C) Task Group III treated the topic of the utility of and capability for NATO detection, identification location, and neutralization of WP C^3 assets in a European war environment. Capability assessments were made for existing assets and both technological and program initiatives recommended.

(S) The principal finding in this task area is that the WP has a much stronger capability to interdict NATO C^3 than NATO has to interdict the WP's C^3. In addition to substantial numerical superiority in types and fielding equipments, WP doctrine integrates $C\text{-}C^3$ into their overall offensive warfare plan. Both physical attack and REC are not only called for in doctrine, but are also supported by dedicated organizations trained in these disciplines. This potent advantage over NATO is also enhanced by the WP probably having the attack initiative in any first battle, with the obvious advantage of being able to fight from "fixed" plans for some period. On the other hand, both historical trends and observations of current training WP exercises indicate a substantial disinclination toward initiative actions without higher chain-of-command authorization; which implies a potentially substantial benefit to be obtained from disruption of this chain.

(S) The study indicated that NATO needs to critically assess possibilities and priorities for $C\text{-}C^3$ separately for pre-war and for active wartime

phases; and WP REC assets/capabilities were identified as potentially very high yield targets in terms of retained NATO effectiveness. Attacking these targets was assessed as much less costly than fully "jam-proofing" and otherwise protecting our own C^3 assets. The Soviet SVOD Navigation System was also identified as another extremely attractive target.

(S) A major study ground rule was that recommended $C\text{-}C^3$ asset requirements not represent a major percentage of total assets - from development through fielded sensors and deliverable weapons - available to NATO. Analysis based on this concept indicated that this is a feasible approach because C^3 targets are generally "softer" than the weapon systems they support; and frequently may be effectively neutralized by harassment tactics requiring an order of magnitude less assets - location accuracy; number, size, and accuracy of weapons, etc. - than outright destruction.

(S) Some of the major current NATO $C\text{-}C^3$ deficiencies included:

- Failure to treat $C\text{-}C^3$ as the important element of combined arms warfare it is
- Failure to extract and process $C\text{-}C^3$ information from data regularly collected by National assets
- Failure to focus development priority on $C\text{-}C^3$ systems or equipment
- Failure to develop the important ability to perform C&D actions
- Extreme non-survivability of the sparse assets available for $C\text{-}C^3$ activities

(S) Near-term (pre-1983) approaches for improved $C\text{-}C^3$ capability included:

- Provision of focused organization responsibility for $C\text{-}C^3$, supported

by appropriate strengthening of the associated doctrine

- Development of a joint Air Force/Army $C\text{-}C^3$ intelligence screening activity

- Influencing of current developments (PLSS, BETA, ASAC, TIPI-II, etc.) and National Systems to force provision of functional $C\text{-}C^3$ capabilities

- Development of specific C&D activities for NATO

- Careful evaluation of existing sensors and weapons and future systems such as RPV's as to their applicability to $C\text{-}C^3$ activities

(S) Recommendations for longer term (post-1983) improvement of capability included:

- Initiation of $C\text{-}C^3$ anti-radiation weapon development

- Implementation of EW fingerprinting to enhance C^3 location/identification

- Incorporation of EW capability into PLSS

- Fielding of RPV-borne sensors for $C\text{-}C^3$ and specific $C\text{-}C^3$ weapons

(C) Additional, detailed recommendations may be found in the Task Group report; including some of major significance in an appendix of special classification.

(S) Overall, the crucial recommendation from this study is for the establishment of strong doctrinal and specific organization responsibility for making $C\text{-}C^3$ a major element of our combined force warfare concepts. This must also lead to the evolution of systems architecture, tactical doctrine, and identified assets for survivable $C\text{-}C^3$ implementation.

TASK GROUP IV: TEMPLATING AND COUNTERING SOVIET AIR DEFENSE ON THE BATTLEFIELD

(S) Task Group IV addressed the ability of NATO to detect, locate, classify and target WP AD units in a European war scenario. The principal current deficiencies in this regard were analyzed and proposed solutions were developed for the near (pre-1983) and longer (post-1983) term operational introduction. Two major topical areas were considered - AD battlefield "templating" and AD countermeasures.

(S) In reviewing NATO operational needs for locating and C-AD, the key items were identified as:

- Numbering (+20%) and correct classification (90%) of AD weapon systems in the FEBA +10 kilometer zone

- Location of AD units (including uncommitted assets) with a few kilometer accuracy and determination of their affiliation to Army echelons for battlefield management purposes

- Short-term (few minutes) location to 50 meters CEP for strike direction

- Capability for physical and electronic attack of critical AD system elements, including radar and communication links

- Rapid and accurate detection and analysis of WP AD emission changes to support appropriate on-site reprogramming of NATO self-defense systems such as radar warning receivers, ARM's, etc

(S) Assessment of NATO ability to meet these requirements indicated critical deficiencies when exposed to realistic wartime threats. In the location aspect, NATO is currently relatively unable to determine which AD assets, observed at different times, are new versus re-observed units. Further, current NATO assets would rapidly saturate

in the expected target-rich wartime environment. NATO ability for C-AD is similarly limited, particularly because it does not attack the AD system, but generally concentrates on spot self defense actions against limited targets. Further, many of NATO's potential C-AD assets are woefully out of date, and are effective only against relatively unsophisticated, immobile (e.g., SA-2, SA-3) threats.

(S) The overall recommendations of this study may be generally summarized:

- NATO must consider systematic attrition and jamming of the enemy's AD system by the use of our EW arsenal as a system to broaden the applicability of our "area" EW systems

- It is necessary to configure NATO's EW support system to accept in theatre reprogramming of equipments based on inputs from survivable collection system which can rapidly observe the surprises which the WP has in store

- Specific recommendations for the pre-1983 time include:

  - o Development of special purpose collection systems and processor for AD data links

  - o Emphasis on developing "off-line" FMOP processing for use against known threat radar

  - o Development of a precise PRI data base on WP AD radar

  - o Provision of in theatre reprogramming of critical EW assets - RWR, jammers, etc

- o Modification of ALQ-131 pod to attack Flat Face

- o Rapid development of techniques to defeat "scan with compensation" technique for AJ

- Recommendations for longer range (post 1983 introduction) capability actions include:

  - o Urgent determination of integrated modes for PLSS and AGTELIS by a joint Air Force/Army team

  - o Addition of an AD data link capability to PLSS and AGTELIS

  - o Phase out work on Quick Look II and TEREC in favor of AGTELIS and PLSS; and evaluate adding airborne AGTELIS

- Numerous other recommendations are contained in the Task Group report; and some particularly important ones are contained in the specially classified appendix to that report

REPORT OF TASK GROUP I

(S) IDENTIFICATION OF AIRCRAFT IN THE NATO AIR DEFENSE ENVIRONMENT (U)

Dr. Edwin B. Stear, Chairman	SAB
Dr. Nicholas Yaru, Vice Chairman	ASB
Dr. Harry I. Davis	SAB
Mr. Marvin R. Holter	SAB
Dr. Richard C. Honey	ASB
Dr. Richard O. Hundley	ASB
COL Arthur J. Gillette	TAC
MAJ David Oakes	AFTEC
COL Jack L. Rinehart	TRADOC
Mr. Theodore A. Pfeiffer	DARCOM

ABSTRACT

(U) This report addresses the problem of identification of air vehicles in a NATO combined AD environment. Special emphasis is placed on the identification of targets for surface-to-air AD operations. The operational needs for aircraft identification are reviewed, the present/programmed capabilities are assessed and the critical deficiencies are identified. A number of near-term (available by 1983) and longer-term concepts and approaches for improving the aircraft identification capabilities and reducing or eliminating the known deficiencies are identified, together with a number of recommendations for technology initiatives.

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(S) I. SUMMARY (U)

(U) A. DESCRIPTION OF TOPIC

(U) This Task Group addressed the problem of reliable identification of air vehicles in a NATO combined AD environment. The emphasis of the Task Group was focused on the joint Army/Air Force aspects of the topic (in consonance with the joint nature of the summer study). As a result, the primary effort was devoted to the identification of targets for surface-to-air AD operations. Air-to-air defense operations received only secondary emphasis. Extension and/or possible fallout applicable to identification of ground vehicles was not considered because of lack of time.

(U) The Task Group investigated both potential short-term (1978-1983) and potential longer-term (1983 and beyond) improvements in air vehicle identification technology, concepts, and systems. Based on this investigation, the Task Group identified and recommended those potential improvements which were deemed to represent doable, effective, and affordable contributions to solution of the problem of achieving reliable identification of air vehicles. Finally, the first-order impact of the recommended improvements in technology, concepts, and systems on operational procedures and rules of engagement was explored by the combined scientific and military representatives in the Task Group.

(C) B. KEY OPERATIONAL NEEDS (U)

(C) In order to maximize AD system effectiveness and minimize fratricide in a combined AD environment, it is essential that the combined AD forces have equipment, operational procedures, and rules-of-engagement which assure very high confidence of proper identification of all air vehicles which can be potentially engaged by the individual fire units/interceptors. This identification has to be made available, either directly or indirectly, to the individual fire units/interceptors in a timely manner that does not significantly compromise their capability and effectiveness (e.g., range capability, engagement opportunities).

(C) For maximum operational flexibility, it is desirable to be able to accomplish the identification of the air vehicles at the point-of-fire (i.e., by the gunner). Under circumstances in which this is not possible with the necessary confidence, it is essential to have complementary high-confidence identity information available elsewhere and to be able to reliably communicate it to the point-of-fire in a useful form and in a timely fashion. (These two previous sentences "define" what are called direct and indirect identification, respectively.) In this context, it is implied that the necessary communications must be effective in a severe EW environment, must degrade gracefully under battle damage, and must operate effectively throughout the NATO theater. Finally, it is essential to have simple, easily understood procedures and rules-of-engagement which accommodate the limitations of the identification system(s) and which minimally compromise the effectiveness of the AD weapons systems.

(S) C. CRITICAL DEFICIENCIES (U)

(C) The current "overall identification system" operational in the NATO theatre involves appropriate combined use of several subsystems. These consist of the MK X/MK XII, cooperative, direct system; visual, largely noncooperative, direct identification; an ADGE system with indirect identification capability; and a set of procedures and rules-of-engagement compatible with NATO airspace control doctrine. Each of these subsystems has critical deficiencies as outlined below:

(S) Critical deficiencies in the MK X/MK XII systems are:

- o Jamming susceptibility
- o Exploitation susceptibility
- o Spoofing susceptibility
- o Saturation susceptibility
- o Low equipment reliability

- o Anomalous interrogation/reply blackout
- o Lack of proper training, exercises and data for quantitative evaluation of performance
- o Operational use limitations

(S) Critical deficiencies in visual direct identification are:

- o Fair weather, daylight only
- o Severely range limited and subject to terrain masking; hence, not compatible with new beyond-visual-range weapons
- o Relatively low confidence and subject to significant training variability (overflight of many separate AD firing units leads to low overall probability of all identifications being correct)
- o Results strongly dependent on cueing for MANPADS

(S) Critical deficiencies in the ADGE are:

- o Does not provide for adequate redundancy or alternate routing of essential traffic message
- o Does not provide for adequate transfer of tracks and related identity to AAD firing units
- o Does not permit ground units to take full advantage of the low altitude surveillance and track history capability of the AWACS with its strongly synergistic effect on maintaining track and identity
- o Does not realize the potential to be gained from netting of the appropriate AD radars (both airborne and ground-based) as regards track/identity continuity

- Inadequate secure, reliable communication links for proper netting in a severe EW and heavy battle damage environment

(S) Critical deficiencies in current procedures and rules-of-engagement are:

- Procedures not compatible with the equipment capability
- Safe passage procedures (including use of MK X/MK XII) not well accepted by pilots
- Complexity and variability of procedures throughout NATO region which reflect IFF and related equipment variability
- Unsatisfactory wartime rules-of-engagement which will likely lead to either unacceptable levels of fratricide or an inadequate defense

(S) D. PROPOSED APPROACHES FOR IMPROVING CAPABILITY (U)

(U) Proposed approaches for eliminating air vehicle identification deficiencies and improving capability are listed and briefly described in this section. They are divided into near-term (1978-1983) approaches which could lead to improved operational capability prior to 1983 and longer-term approaches (1983 and beyond) which could not lead to improved operational capability until after 1983.

(S) 1. Proposed Approaches for Near-Term Improvements (U)

(U) a. Direct Identification Approaches. Proposed near-term approaches which have potential for improvement of direct identification capability are:

(S) (1) The addition of JEM classification capability to the HAWK ICWAR acquisition radar. This would provide an added, non-cooperative direct identification capability which is complementary to the current MK X/MK XII cooperative, direct, interrogation-reply capability. Such an added capability would also provide identification in case of MK X/MK XII failure or anomalous blackout, could provide identification in the near-FEBA area where it might be dangerous to use MK X/MK XII, and could be used synergistically if the short-term radar netting recommendation is implemented. The range of JEM on HAWK is reasonably compatible with the HAWK missile range, and, since the proposed installation is limited to HAWK, it should not be too expensive (on the order of $2-3M acquisition costs for all HAWKS in NATO).

(S) (2) Elimination of the vulnerability of the MK XII to direct exploitation by the enemy through addition of Mode 5 which uses very rapid time synchronized interrogator code changes. This would allow more confident use of the MK XII in the far forward areas where our air vehicles are engageable by the enemy's ground-based AD weapons and possibly some of his interceptors. However, even if the exploitation possibility were removed, the enemy could still render the MK X/MK XII ineffective by direct jamming and this still might be a better tactic for him.

(S) (3) Incorporation of a passive point of fire system identification system for SHORADS and MANPADS weapons. Many types of aircraft operating at low altitudes in the ground attack role radiate electro-magnetic signals while performing their mission. Examples of such signals are those from terrain following radars, radar altimeters, attack radars, doppler navigation systems, etc. These emissions can be detected with relatively simple detectors and relatively small antennas. Since most such systems are modulated at audio frequencies, the simplest concept would be to envelop-detect the signal and feed the detected audio signal directly to the operator via earphone. Preliminary calculations suggest that detection of a 16 GHz signal from a terrain following radar using a 4-inch antenna could produce a practical system design. The features of this technique are:

- Passive
- Simple, compact and inexpensive
- Many different friendly and enemy aircraft are distinguishable by their RF signatures

(S) (4) Addition of equipment to the HAWK batteries which is capable of exploiting the enemy's IFF system. Equipment for the active tactical exploitation of EIFF has been developed and installed on the F-15 and on some F-4E aircraft. Since the interrogation code for the Soviet transponder SRO-2 is well known, the present U.S. systems can readily interrogate and receive a coded reply from the SRO-2. There is reason to believe that the wartime modes of Soviet IFF may change. Nevertheless, addition of flexible EIFF capabilities to the HAWK radar merits consideration if it is believed that the enemy will use his IFF when in the range of HAWK batteries. The maximum HAWK engagement range extends 35 kilometers beyond the FEBA and the active EIFF exploitation systems can operate at longer ranges. It appears that the cost of the EIFF addition to HAWK may be relatively low.

(S) b. Indirect Identification Approaches. Proposed near-term approaches (which have potential for improving indirect identification capability) are:

(S) (1) Downlinking appropriate track reports from AWACS to all three MPCs for redistribution to firing units. When the E-3A AWACS is introduced in the European theater, this system will be extremely effective in eliminating low-altitude gaps in radar coverage, thereby maintaining track continuity on both friendly and hostile aircraft. Under current planning the utility of AWACS for indirect target identification will be limited by two factors. One is that on-board track processor is able to process a maximum of 100 aircraft tracks generated by its own radar. The second limitation is imposed by the traffic handling capacity of the links between the AWACS and the CRCs in the AD net.

Interim improvements are available by downlinking in parallel the appropriate radar data from AWACS to all three MPCs. From there it could be simultaneously relayed to the four CRCs in the 4th ATAF and to the four AAD groups. Under this arrangement the Master CRC at Boerfink, as long as it was operable, would direct the AD battle using AWACS data for overall force management. If Boerfink became inoperable the remaining CRCs could take over autonomous command of the AD battle in their area with the AWACS data still available to them. Finally, if the CRCs were rendered inoperable, the surface-based AD could operate autonomously.

(S) (2) Coupling of DAD firing units to the HAWK batteries. The kill potential of the new DAD weapons, STINGER, ROLAND and DIVAD Gun makes it imperative that coupling of these weapons to the overall AD C^3 system be improved as soon as possible. The technology to support such an interim capability is available. The Marines have developed a WDU to link the SHORAD and MANPAD weapon teams to the IHADP. The WDU employed a digital data link compatible with military VHF/FM radios to transfer alerting and pointing information from IHADP to the SHORAD and MANPAD weapons. Tests showed increased detections and launches by the MANPAD teams at increased average detection ranges. The WDU development has continued, and this work appears directly applicable to the DAD C^3 problem.

(S) (3) Exploitation of SIGINT data for identification purposes. There are a number of different types of SIGINT data (COMINT and ELINT) which could be useful as aids for identification of hostile aircraft. Soviet and WP aircraft carry emitting avionics equipment which can be exploited to yield aircraft identity and location information. It appears that the exploitation of a particular SIGINT source would be very useful and could be implemented in Europe in the near term. An exploitation system for this source could be assembled with the proper intercept receiver, collection platforms,

data links, processing centers (all straight-forward hardware requirements) and with the establishment of procedures for timely dissemination of the intelligence data to the various users. For adequate coverage of the AFCENT region, one ground processor and three to six aircraft could provide a quick-reaction capability. This system could provide identification and track data on WP aircraft of sufficient accuracy for AD battle management and weapon allocation purposes and for most weapon cueing purposes.

(S) 2. Proposed Approaches for Longer Term Improvements (U)

(S) a. Direct Identification Approaches. The Task Group proposes two longer-term approaches which appear to be able to jointly solve the direct identification problem.

(S) (1) Use of Advanced JTIDS type system. Advanced JTIDS type systems have three complementary modes of operation which could be used for identification purposes:

- A direct interrogation mode referred to as the RTT where a synchronous reply is sent immediately in response to an interrogation
- A position and identity mode whereby the users in the system issue identification and position in their time slots which is independent of interrogators or of radars which might desire to use such information
- A data link mode for secure transfer of position and identity data for indirect identification

Preliminary calculations suggest that by proper design of the RTT mode, by power control, and by multiple interrogation coupled to the frequency hopping and spread spectrum features already designed into JTIDS type systems, an identification system using an advanced JTIDS system could be designed which has a sufficiently LPI[1] that it can be turned on in the crucial combat zone. Specifically, such a system could be designed to have direct interrogation times of 0.1 seconds minimum with an LPI capability of 40 dB. A tradeoff between LPI and interrogation time exists with reduced interrogation times being available at reduced LPI. The AJ capability of such a system would be with an appropriate communication signal level. It could operate up to a range of 450 kilometers at reduced LPI and it would have the flexibility of solid state transmitter power control. Finally, position accuracies of the order of 70 meters would be obtainable at ranges of 120 kilometers.

With regard to the suitability of such a (modified) advanced JTIDS for the direct identification part of the NATO FIS, it is noted that such a system would (if properly designed):

- Meet all interrogation time requirements stated by NATO except the short range (500 meters) air-to-air requirement of 0.01 seconds, which is an overly severe requirement whose validity and utility is highly questionable
- Exceed the stated LPI requirement
- Provide substantial AJ (20 dB)
- Be ideally suited for use in any NATO FIS indirect subsystem

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(U) [1] An LPI communication system uses a variety of techniques - particularly spread spectrum - to reduce the signal perceived by the enemy to a level below the noise level, receivers recover the signal to intercept. Friendly receivers recover the signal out of the noise using special processing techniques.

- Provide much needed multi-function non-identity related capability without the necessity of using separate black boxes for these functions

- Meet all interrogation range requirements stated by NATO except the 850 kilometers AEW identification range requirement, which is also an overly severe requirement whose validity and utility is also highly questionable considering the AWACS capability

(C) (2) Use of a Millimeter wave direct IFF system for short range (MANPADS/SHORADS). Millimeter wavelength direct IFF applications systems have a number of advantages for short range applications. These include:

- Narrow interrogation beamwidths with small antennas

- Reasonable all-weather short range performance

- Difficult to exploit from a distance because of atmospheric attenuation

The concept proposed is to interrogate a passive retro-reflector antenna on the aircraft. The antenna reflects the energy back towards the interrogator, instead of broadcasting it in all directions. In addition, the reflection can be modulated with a suitably encrypted code if required. It is expected that current technology developments in the 90 GHz region could support a reasonable, short-range IFF system of this type for SHORADS/MANPADS weapons.

(S) b. Indirect Identification Approaches (U)

(S) (1) Use of TDOA systems for identification. Since all aircraft radiate in the communications and radar bands at some time, detection of these radiations could be used an an identification aid. In order for these radar or communications systems to be useful for aircraft target identification, TDOA or the radar/communications used must produce location accuracy good enough to positively associate a particular identification achieved through parameter association with a radar track. TDOA systems such as PLSS, AGTELIS and ELS have a potential for emitter location accuracies of 50 meters or so and are ideal for this purpose.

The specific concept proposed would make use of PLSS/AGTELIS data from moving radar emitters which is normally discarded. This data would be processed in a separate processor to obtain emitter identification and location information on friendly and enemy air vehicle radar emitters. This information would then be used to generate air vehicle identity and track association data of great value to AD units for target identification. The same approach would be used on friendly and enemy air vehicle communications, using ELS-like intercept systems.

(S) (2) Development and use of a highly netted radar/TDOA complex to maintain continuity of track and identity. Recent progress in advanced signal processing has now made possible automatic acquisition and tracking of all aircraft within a surveillance radar's field of view. The addition of low sidelobe antennas of inexpensive construction greatly reduces susceptibility to jamming. These advances make it practical to net together many radars with partially overlapping coverages into an overall system capable of maintaining very large area coverage, continuity of tracks and continuity of identification. These new techniques and the netting proposed would provide the following important advantages:

- Lessened vulnerability to enemy actions

- o Network less fragile to loss of individual radars
- o Individual radars less costly to replace
- o Good geometry to counter main-lobe jamming
- o Jammer location using DF and TOA
- o Emission control without loss of coverage (e.g., blinking against ARMs sector jamming burn-through)
- o Improved low-altitude coverage
- o Height finding using two or more radars
- o Incorporation of AWACS in the net to provide low altitude coverage and continuity
- o Maintenance of track and, hence, continuity once identification established

(S) E. RECOMMENDED ACTIONS (U)

(S) 1. Based on these proposed approaches for near-term and longer-term improvements in the current direct and indirect target identification capabilities of the NATO AD system, the following actions are recommended as being of the highest priority:

- o The implementation in Europe of a more effective and extensive communications and data processing architecture for the parallel and redundant exploitation of AWACS data for indirect target identification as proposed

- The immediate development of a data-link system

  - based on the technology base established in the Marine's WDU and TST/IDT programs -

  for coupling the DAD weapons (SHORADS and MANPADS) to the HAWK C^3 system

- The implementation in Europe of the capability for the exploitation of a certain specific SIGINT source for aircraft target identification

- A reconsideration by the DoD of its position relative to the direct element of the NATO FIS and the adoption of a multi-function (communications, navigation, identification) JTIDS/TDMA-like system as the basis for the future direct target identification instead of the current approach of a separate black box for identification

- The initiation of advanced development of a millimeter wave, coded retro-reflector IFF system for short range applications such as DAD

- The initiation of an advanced development and test program - using existing PLSS and AGTELIS advanced development hardware - to demonstrate the feasibility of using TDOA systems as identification adjuncts to radar detection and tracking systems

- The initiation of a concept definition study of the use of nearly complete radar netting to maintain track continuity and eliminate need for frequent identification. The

study should define appropriate new multifunction radars to be netted, the proper signal processing for effective and efficient passing of tracks and for incorporation of TDOA - derived identity with the tracks and the communication links required to complete the netting process

(S) 2. Also recommended, but of somewhat lower priority are the following:

- o The addition of JEM equipment to the HAWK CW acquisition radar
- o The implementation of Mode 5 on the MK XII IFF system
- o The conduct of a feasibility and cost effectiveness study of the use of a passive point-of-fire system with the SHORADS and MANPADS weapons. If the study results are favorable, the initiation of an advanced development program for such a system should be undertaken
- o The addition of EIFF equipment to the HAWK system

(C) 3. The following technology initiatives are also recommended:

(C) a. Basic Research (6.1) (U)

(C) (1) Continuation of research on computerized spatial pattern recognition and identification of two-dimensional target images in the plane normal to the viewing axis of visible, infrared and millimeter wave imaging sensors.

(C) (2) Initiation of research on computerized recognition and identification of targets observed by FLIR's.

(C) (3) Initiation of measurements and research on absorption bands in the ultraviolet, infrared and millimeter wave regions for use in the design of controllable short-range identification systems using such frequencies and which will not be observable or jammable at longer ranges.

(C) b. Exploratory Development (6.2) (U)

(C) (1) Continuation of advanced development of systems to perform identification using target range profiles using HRR radar data.

(C) (2) Continuation of advanced development of systems to perform identification using target range profiles using MFR data.

(C) (3) Initiation of development work to adapt for ground-to-air use and demonstrate feasibility for identification of a laser three-dimensional sensor coupled with a spatial pattern recognition computer which has been demonstrated in air-to-ground identity applications.

(C) (4) Initiation of developmental work on a system to perform helicopter identification using doppler-shifted radar returns from rotor blades. Belief in the practicality of this proposed technique is based on demonstrated recognition of helicopters by analysis of target acoustic signals from rotors which, however, is too short in range because of acoustic propagation.

(S) II. DISCUSSION (U)

(S) A. ANALYSIS OF OPERATIONAL AND FUNCTIONAL NEEDS (U)

(U) 1. General.

(U) a. The enormous challenge of providing effective identification of air vehicles operating in the Central Region during wartime has been stated by NATO as one of its most pressing problems. The current identification system employed in the Central Region (which consists of a combination of the direct interrogation reply system, direct visual identification, MK X/MK XII, various situation dependent operational procedures and rules of engagement) is clearly inadequate to satisfy operational requirements. The inadequacies of this system have been well-documented in DALFA Study 1-77.

(U) b. To overcome the deficiencies of the present system effective technological solutions are needed. These solutions must be highly reliable, real-time responsive, jam and exploitation resistant and most important, immediately available to the AD weapon system at the point of fire. The following discussion establishes the major operational needs which any effective solution to the NATO identification problem must meet.

(S) 2. Operational Needs. (U)

(U) a. Reliability. Ideally, both direct and indirect ID systems would function correctly 100% of the time. However, from a practical viewpoint, only some level of performance below 100% is achievable. Nevertheless, military commanders will operate with the best equipment available and compensate for deficient equipment performance by structuring rules of engagement and operational procedures most appropriate to the combat situation.

The consequences of incorrect ID are most immediate and severe at the point of fire. Reliable direct ID at the point of fire can serve as a final check or validation for indirect ID information. Therefore, some measure of error passed through the indirect ID channels can be corrected where it really counts- at the point of fire. It is most critical then that direct point-of-fire ID systems have a very high degree of reliability and it is not inappropriate to state the operational need as very close to 100% (e.g., 9.99 to .999). It is possible to accept somewhat lower reliability in the indirect ID system as long as the point-of-fire system is highly reliable. The amount of ID error permissible in the total AD C^3 system is not quantified in this study, but levels of ID error which would seriously impede the threat prioritization and allocation process would be unacceptable.

(S) b. Responsiveness. Because of the nature of the air interception problem, time is a critical factor in any ID process. If the ID process uses a direct electronic interrogation reply system, some small increment of time must exist between interrogation and reply. Because of high closing rates and high maneuverability, an air vehicle target may escape the engagement envelope in a fraction of a second. NATO has expressed an operational need for ID elapsed times no greater than 10 milliseconds. The 10 millisecond requirement apparently is driven by a stated need for air-to-air identification at an initial range of 500 meters. It does not appear reasonable to the Task Group to insist on this very special, and probably unlikely, case as an overall system requirement. It is especially inapplicable for surface-to-air IFF.

The flow of ID information through the C^3 system is through many channels and it is used for many purposes, e.g., alerting, advising, directing, etc. The necessary speed of transmission obviously varies with the purpose. When the purpose is authorizing engagement the speed of transmission requirements are as stringent as the point-of-fire interrogation-reply time requirement stated above -- 0.1 seconds.

However, when ID information is passed for other purposes, it is sufficient that the user receive the information in sufficient time to take appropriate action.

(U) c. Security. In a general sense, it is important to deny the enemy any information which he could exploit. Certainly there is an operational requirement to deny the enemy the panoramic view of the air battle as it exists in our C^3 system. Thus, there is a valid operational requirement for an airborne or ground-based weapons system to receive ID information and instructions over secure communications channels. Security aspects of the ID process as it applies to airborne systems conducting interceptions are more complex. If the ID process is active, it may alert the target vehicle, whether the process is secure or not. It may also highlight the presence of the interrogating aircraft and be susceptible to exploitation by enemy defensive systems. This leads to the need for LPI active ID systems. If the airborne ID process is passive, it is automatically secure. While the relative advantages of a passive system over an active system for airborne interceptors are apparent when the interceptor is operating in enemy airspace, there are disadvantages to such a system when the interceptor is operating in his own airspace. Thus, there appears to be an operational need for both active and passive ID capabilities in interceptor aircraft. Much the same rationale can be used to support the inclusion of both active and passive ID capabilities in ground-based systems where location by the enemy increases the probability of destruction by enemy firepower.

(S) d. Discrimination. The current and proposed WP air attack capabilities will sorely tax NATO's limited AD resources. NATO will have to operate at a high level of efficiency to keep air attack damage to acceptable levels. Thus, there is an operational need to identify enemy air vehicles by type at ranges where engagement choices are open.

NATO air defenders could then concentrate their resources on the highest priority targets among the attacking enemy air vehicles. JEM systems are representative of the type of technology pertinent to this operational need.

(U) e. Range-Continuity of Tracks. "Birth-to-death" tracking is approaching feasibility as demonstrated by AWACS technology and new technology for use in radar netting. The point of origin of an aircraft is a positive ID cue and may well contribute also to type classification of the target. Moreover, continuous tracking reduces the magnitude of the ID problem, since there would be no or few air vehicle tracks which would have to be reidentified. Thus, there appears to be an operational need for birth-to-death tracking of air vehicles in the forward area, and, if feasible, for birth-to-death tracking of air vehicles in the Western Military Districts of the Soviet Union.

(U) f. Communications/Interoperability. The integration, correlation, and identification of radar data from multiple sources such as the E-3A, ground radars, and TDOA systems, must occur in real time. To meet this need, standard message formats such as established under the TACS/TADS program must be developed within NATO. The transmission media must be secure, jam resistant, and possess a suitably high data flow rate with multiple redundant path options. These considerations lead directly to requirements for the AD C^3 system.

(C) g. Capacity. The AD C^3 system and its ID subsystem must have a high volume capacity if it is to function effectively in the Central European theater. The total system track/ID loads could be as high as several thousand in a peak activity hour. Subsystem track loads will vary from sector to sector, but system capacities and range should accommodate anticipated loads when adjacent subsystems are not operational. These considerations lead to operational needs regarding track capacity and for redundancy and survivability of the overall C^3 system.

(U) h. Environmental Compatibility. The AD C^3 system and the weapons systems it controls not only have to satisfy the operational needs cited earlier in a benign environment, they also must satisfy those needs in the anticipated theater wartime environment. Thus, there is an operational need for the system, and its ID subsystem, to function day or night, in all weather and in an intense EW environment. The system must also continue to operate despite anticipated combat damage, and it must interoperate effectively with various national subsystems.

(S) B. ASSESSMENT OF PRESENT CAPABILITIES AND DEFICIENCIES (U)

(U) 1. General. There are two fundamental ways in which aircraft target identification can be carried out: directly, by means of interrogator-transponder or non-cooperative IFF techniques carried out at the point-of-fire; or indirectly, by means of target identification data generated by sensors located elsewhere in the battle area and relayed to the fire unit via the AD C^3 system. Neither of these approaches, direct target identification or indirect target identification, can be relied on to do the entire aircraft target identification job by itself under the wide variety of circumstances that may be encountered on the NATO battlefield. Rather, a judicious combination of direct and indirect techniques must be employed, which hopefully will produce an overall target identification system with viable, useful performance over the wide range of expected combat situations. This section addresses the indirect component of this overall system.

(S) 2. Current Indirect ID Capabilities and Deficiencies. (U)

(C) a. There are a number of potentially useful sources of indirect target ID data which currently exist in the 4th ATAF area. These include:

- Radar tracking data generated by 412L radars, 407L radars, the air surveillance radars at the AAD BOC, the Hercules and HAWK radars, and the TAAR.
- Flight plans and in-flight updates for Blue Air, for both the AD aircraft and the strike and CAS aircraft.
- Air space control procedures.
- SIGINT data.
- MK X/MK XII identifications generated by the IFF interrogations collocated with the various air surveillance and AD radars.

(C) b. There are a number of different elements of the overall AD C^3 system which could exploit some or all of these data sources for indirect target identification. These elements include the Air Force CRC, the AAH GOC and BOC, the Hercules and HAWK batteries, the Chaparral/Vulcan fire units, and the REDEYE teams. Figure I-2-1 presents a wiring diagram showing the way that these elements, plus a number of others that are only indirectly involved in AD, are interconnected in the current 4th ATAF C^3 system. Figure I-2-2 shows which of these elements, as a result of these interconnections, get which of the classes of indirect target identification data.

(S) c. Insofar as indirect target identification is concerned, there are several problems or limitations with the current C^3 system. The principal ones appear to be:

(S) (1) Sensor Limitations. Against low flying aircraft, the current radars provide rather incomplete coverage, with major gaps being commonplace. Because of this, it is

(S) 4TH ATAF C^3 SYSTEM (U)

SECRET

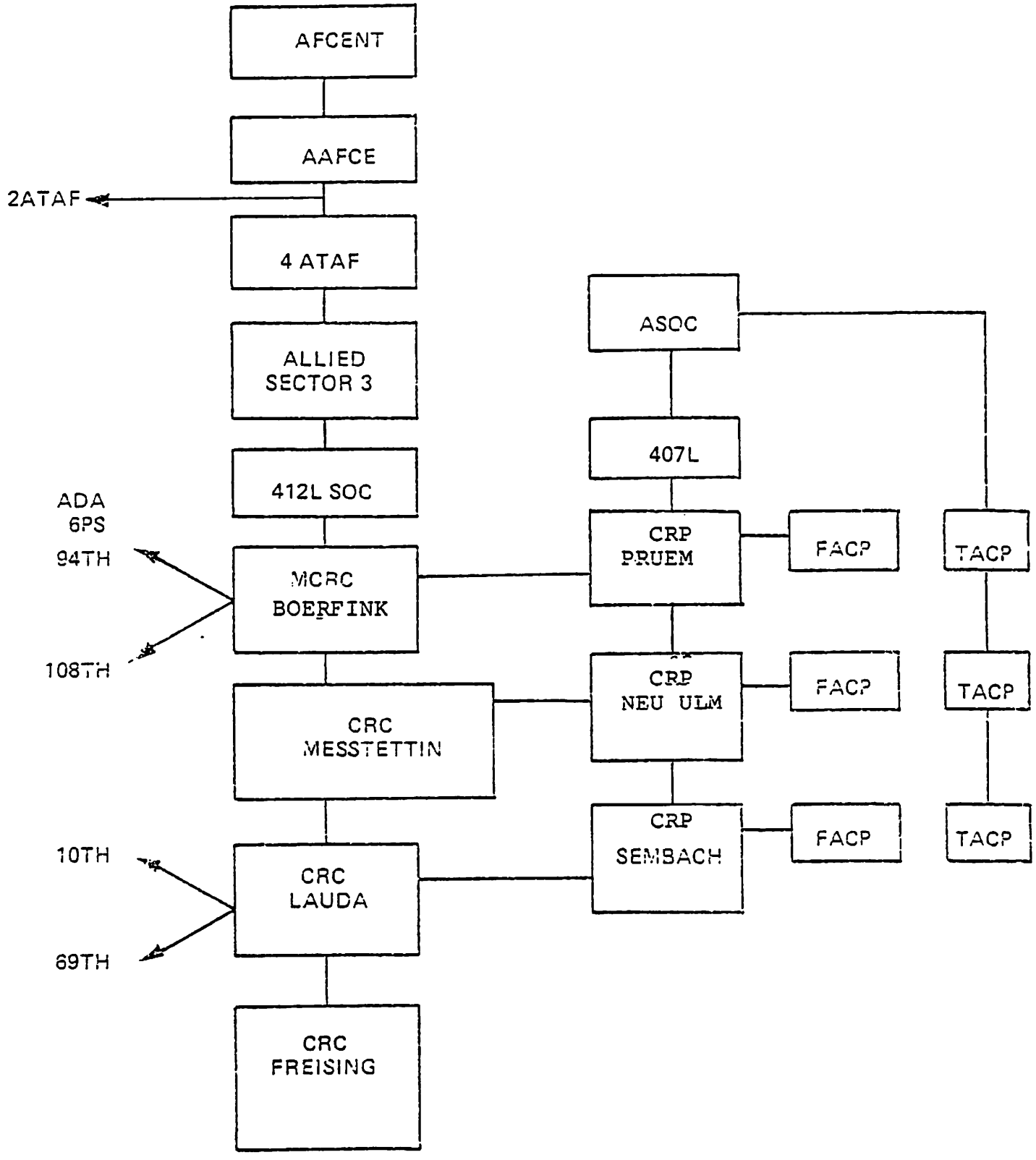


FIGURE I-2-1

SECRET

(S) Data Availability Matrix (U)

FIGURE I-2-2

Air Defense System Elements \ Data Types/ Sources	Radar Tracks & Mark 10/12 Interrogations						Flight Plans & In Flight Updates		Air Space Control Procedures	SIGINT
	412L Radars	407L Radars	BOC Radars	Hercules	Hawk	FAAR	Air Defense A/C	Strike & CAS A/C		
CRC	X	X Salty Net			(X)		X	X	X	
GOC/BOC	X	X	X		(X)				X	
Hercules	X	X	X	X					X	
Hawk	X	X	X		X				X	
Chaparral/Vulcan			Limited		Limited	X	Limited	Limited	Limited	
Redeye						X				

(X) ⟹ Data availability that will be present when TSQ-73 is operational

impossible to maintain track continuity on low altitude air vehicles, which leads to loss of ID and the subsequent need for reidentification when the air vehicles again come into the radar's field of view. So, not only is there loss of coverage which limits the performance of the C^3 system, there is also loss of the ID which leads to further loss of performance of the C^3 system.

(S) (2) Traffic Handling Capacity Limitations. The various nodal elements in the AD C^3 system have limited target handling capacity. Specifically, their capacities at the present time are:

412 L System----------100 tracks per CRC
407 L System----------256 tracks per CRP
TSQ-73----------256 tracks per TSQ-73

In the 1982-1984 time period, the current 412 L system will be replaced by the GEADGE system. This new system will have an improved track capacity of 400 tracks per GRC.

On the other hand, during a NATO/PACT conflict there may be more than a thousand aircraft plus large numbers of helicopters operating at the same time in the 4th ATAF air space. This number of air vehicles will certainly produce local traffic saturations of the AD C^3 system, and may also produce saturation across the entire 4th ATAF region. In such a situation, the various nodal points of the AD C^3 system will be unable to process and disseminate all of the friendly/hostile air vehicles tracking and identity information presented to them. They will instead attempt to disseminate aggregate data on groups of air vehicles, and, under current 4th ATAF/32nd ADCOM procedures, will probably cease the downward dissemination of most data on friendly air vehicles. As a result, in such a saturated environment the AD C^3 system will have only a very limited capability for indirect identification of enemy aircraft and essentially no capability for indirect identification of friendly aircraft.

(S) (3) Limitations in the Coupling of DAD Firing Units to AD C^3 Systems. Currently, the DAD weapons -- Chaparral, Vulcan, and REDEYE -- are almost completely uncoupled from the rest of the AD C^3 system. Their only tie-in is a VHF single channel voice link from the BOC in the Division area to the Chaparral/Vulcan Battalion CP. Considering the large number of friendly/enemy air vehicles which may be operating in the Division area at one time -- scenario studies have shown average loads of 40 to 60 and peak loads of 150 -- this voice link will be totally inadequate for the transmission of air vehicle tracking and identity data which the AD C^3 system may possess to the DAD firing units.

In this situation, the only source of air vehicle tracking and identity data available to the DAD weapons will be that from the FAAR relayed via the TADDS. Because of the manual operation of the FAAR radar, the manual interface between the radar and the TADDS digital data link and the gross nature of the aircraft position data that is relayed (± 2.5 kilometers), the aircraft location and identity data passed to the Chaparral, Vulcan and REDEYE fire units via the FAAR/TADDS system are of only marginal utility.

This situation -- the lack of adequate coupling of the DAD weapons to the AD C^3 system -- will become critical in the early 1980's, as a series of new weapons, Stinger, Roland and DIVAD gun, are added to the Division inventory. These new weapons have greatly increased performance. Their potential for shooting down enemy aircraft (on purpose) or friendly aircraft (by mistake) is considerably greater than that of the weapons they replace and much more effective ID capability will be essential for DAD firing units.

(S) (4) Limitations in the Exploitation of SIGINT Data. There are a variety of types of SIGINT data -- radar emissions from enemy aircraft, GCI communications, etc. -- which

may be potentially useful as an identification and tracking aid for hostile aircraft. Currently, the 4th ATAF AD C^3 system makes no use of these data for indirect target identification. They are retained at a high level within the command system -- the master CRC at Boerfink -- and used only for indications-and-warning purposes.

(S) 3. Current Direct ID Capabilities and Deficiencies. Current direct ID capabilities are limited to the MK X/MK XII systems plus visual ID. The capabilities and deficiencies of these techniques are discussed below.

(U) a. Capabilities of the Current MK X/MK XII system. The MK X/SIF system is widely used throughout the U.S. and NATO for normal peacetime air traffic control. The MK XII system, which consists of the MK X plus the Mode 4 crypto-secure interrogation link, is widely used in current NATO-based U.S. and Canadian military aircraft and in all U.S. and German 4-ATAF Nike and HAWK units and one Netherlands Nike unit. It will be implemented also in all German aircraft in the near future. However, the UK and Belgium have not adopted the MK XII system, principally because of its many limitations.

Chart I-2-1 briefly outlines some of the important system characteristics of the MK X/MK XII systems. In most normal installations, the MK XII will operate at ranges substantially in excess of the ranges of the radars with which it is associated.

The basic MK X/MK XII system incorporates technology and techniques that are 15 to 20 years old, and it has been estimated that a total of $2-4 billion has been spent over the years in its development and fielding. There have been sporadic attempts to update the system and a number of different equipments are now in the field. As a result, the system suffers from a variety of equipment reliability and field maintenance problems, as well as a few interoperability problems.

CHART I-2-1

(C) CURRENT MKX/XII CHARACTERISTICS (Ref 1,2) (U)

(Interrogate 1030 ± 0.2 MHz; reply 1090 ± 3 MHz; vert. polar.)

"MK XII IMPROVEMENT"

MK XII

MK X (SIF)

MODE	CHARACTERISTICS
1	Double-pulse interrogation, 0.8 ± 0.1 μs pulses, 3 ± 0.1 μs spacing. 32 reply codes changed at 30 ± min. intervals 0.45 ± 0.1 μs pulses a/c mission reply
2	Double-pulse interrogation, 0.8 ± 0.1 μs pulses, 5 ± 0.2 μs spacing. 4096 reply codes set on ground, changed when required. 0.45 ± 0.1 μs pulse. Tail No. reply (in formations only lead a/c replies).
3A*	Double-pulse interrogation, 0.8 ± 0.1 μs pulses, 8 ± 0.2 μs spacing. 4096 reply codes changed at 30 ± 1 min. intervals. 0.45 + 0.1 μs pulses. Military function and special ID reply.
C*	Double-pulse interrogation, 0.8 ± 0.1 μs pulses, 21 ± 0.2 μs spacing. 1278 reply codes. 0.45 ± 0.1 μs pulses. Altitude reply.
4	Multiple-pulse interrogation, 0.5 ± 0.1 μs pulses, 32 pulse positions spaced 2μs, randomly occupied under crypto control. Three-pulse reply, 0.45 + 0.1 μs pulses, 1.8 + 0.2 μs spacings. 16 possible time delays, 4 μs spacings, crypto selected.
5	Improvements, such as rapid code changes, improved decoders and decision logic, diversity and monopulse antennas, to reduce vulnerability to exploitation, jamming, saturation, and spoofing.

*Extensively used by the FAA for air traffic control

In addition, present MK XII systems have a variety of widely-known weaknesses such as relatively easy exploitation and jamming and spoofing susceptibility. These weaknesses could prove disastrous, or, at best, make the system useless in a sophisticated ECM environment.

Extensive studies of the various deficiencies of MK XII have been undertaken and a variety of improvements have been proposed for many of these. It is clear that the operational impact of these various deficiencies is highly scenario dependent - but the Task Group has restricted its considerations to those of greatest concern in the NATO AD environment. The following pages discuss deficiencies of the MK XII system; a somewhat expanded discussion is presented in Appendix A.

(S) b. Deficiencies of MK XII, Mode 4: Reliability. Three forms of reliability will be distinguished:

(C) (1) Equipment Reliability. Serious equipment reliability problems have been cited which not only impair operational utility, but reduce operator confidence in the system. No complete quick-check field equipment appears to have been developed to satisfy this need. The interrogators, in particular, appear to be a weak link in the system due to some highly stressed components in the transmitter.

It must be noted that this problem is being addressed by the MK XII Technical Improvement Program at Warner Robins Air Force Base and the MK XII Improvement Program at the Naval Research Laboratory.

It should also be noted that a greater commonality among the equipments fielded by the various users could lead to improved reliability, improve interoperability and probably reduced costs and logistic problems.

(S) (2) Interrogation Reliability. In addition to equipment reliability, the MK XII system has problems with the reliability of a single interrogate/reply round trip, called "round-reliability." Round-reliability is a function of a great many variables including scenario-dependent factors such as multi-path propagation, range, numbers of interrogators and transponders, ECM environment, etc.; as well as equipment characteristics such as antenna sizes and locations, decision logic, etc. It should be noted that "round-reliability" is not to be confused with the reliability of a complete interrogation sequence, which usually consists of a number of rounds, depending on equipment design and decision logic. This is often called "interrogation reliability."

Inadequate transponder antenna installations on aircraft have been credited with causing wide variations in interrogation reliability. The F-4 aircraft is noted to be particularly vulnerable in this area. The problem of adequate system testing (as opposed to testing of interrogators or transponders separately) needs further attention in order to pinpoint system problems and/or improve user confidence.

There is serious concern that even if the interrogation reliability, or probability of correct ID is fairly high (> 0.95), there is still a good probability that in an environment of dense AD weapons, at least one ground weapon will not correctly identify and will engage a friendly aircraft.

(C) (3) Operator Reliability. In addition to the hardware reliability and interrogation reliability problems mentioned above, there are reliability problems associated with human operators. For instance, the crypto codes in some transponders can be zeroed (destroyed) by shocks such as those associated with rough landings unless a "hold" switch is activated. The operator is also required to see that the proper codes are set into the equipment before takeoff and that the MK XII is

switched to the proper code for that day. (Typically, two sets of codes, or two days of operation, can be sustained without inserting new codes on the ground.)

These problems are severely aggravated by the fact that operators only rarely have a chance to train and exercise with the MK XII, Mode 4 equipment. As a secondary result of the lack of controlled exercises, there is also a paucity of data on the effectiveness of the complete system in realistic environments.

(S) c. Deficiencies of MK XII, Mode 4: Exploitation. (U)

(C) (1) It is felt that possible exploitation of the MK XII Mode 4 is one of its chief weaknesses in a sophisticated ECM environment. This exploitation can be done in several ways, either passive or active. Obviously the enemy can passively DF and track a squawking transponder or interrogator. In addition, the enemy can record one or many valid interrogations that can be used to trigger any of our MK XII, Mode 4 transponders, enabling him to interrogate and thus identify and track his targets. This interrogation is useful for up to 24 hours, although one of the fixes proposed for Mode 5 is to change codes so rapidly that this form of exploitation could be negated, unless the enemy almost continuously monitored and repeated our interrogations. It is noted that it would be relatively easy for the enemy to receive AWACS interrogations from well behind the FEBA.

(C) (2) Even without recording one of our interrogations, if the enemy understands the system, he can guess at our interrogation code with a probability of guessing correctly in 1 of 256 tries. Once found, this code would be correct for up to 24 hours. Again, techniques have been developed, such as that described above, to limit the utility of this form of exploitation.

(S) (3) Several WP countries are now known to have a ground TDOA system similar to AGTELIS which is used in their AD system. It has been known for some time that the Czechs have had systems deployed and, more recently, it has been established that the Hungarian AD have at least one system. The Soviets have two models deployed in the Baltic. In addition, the Romanians are known to have a system under development. With this established trend, it is easily concluded that the entire WP will be so equipped and will be able to TDOA on the current MK XII IFF system.

(C) d. Deficiencies of MK XII, Mode 4: Jamming. (U)

(C) (1) Although either the interrogator or transponder receivers can be degraded or inactivated by the enemy by any form of jamming, CW and AM- or FM-modulated CW jamming requires the most assets, pulse-width and amplitude noise jamming is easier and intelligent jamming is easiest of all.

(C) (2) For instance, a series of pulse triplets could be sent to the interrogators appearing as a series of synchronous or invalid replies (fruit). This would overload the system and reduce the probability that friendlies will be properly identified. In addition, the instantaneous side-lobe suppression circuitry in the transponder can be inhibited by suitable pulse sequences, also reducing the time available for or preventing valid interrogations.

(C) (3) Another form of intelligent jamming simply over-interrogates Modes 1 to 3 (SIF). Although the transponder will not reply to these modes when set on Mode 4, it forces the receiver to separate these interrogations from valid Mode 4 interrogations. This, too, can load up the system and the design of this decoder directly affects round-reliability.

(U) (4) Even in a friendly environment, over-interrogation, caused by a multiplicity of over-active interrogators and/or transponders (garble), can be considered a form of self-jamming, reducing receiver sensitivities (hence range) and reducing round-reliabilities.

(C) e. Deficiencies of MK XII, Mode 4: Spoofing. (U)

(C) (1) Spoofing, or pretending to be what you are not, appears to be one of the least likely threats in the NATO environment. For instance, since the reply code is fixed and well known (3 equally spaced pulses), and only the time delay is coded, an enemy aircraft could guess at the time delay associated with each round and be correct 1 time in 16. In fact, he would be correct on the average 1 time in 16 with a fixed time delay. However, if a given reply evaluator logic requires n correct replies, then the probability of guessing all of them is only 1 in 16^n. Such logic is incorporated into the MK XII system specifically to eliminate such spoofing.

(C) (2) A more likely tactic is for the enemy to repeat the reply of a nearby MK XII transponder and appear as a "friend" to the interrogator. Since the enemy can measure the time difference between the interrogation and the reply from a nearby transponder, he can determine the appropriately delayed response to that interrogation. A fix to this called "Wooden Duck" has been implemented for the AN/APX-103 interrogator for AWACS. In this case, an incorrect interrogation and reply are transmitted by the interrogator; the enemy repeats, the friend does not.

(C) (3) Another possible form of spoofing repeats interrogations so that a nearby MK XII transponder is triggered to reply properly. If the timing and geometry are correct, the reply arrives at the friendly interrogator in time to make the enemy appear as a friend.

(C) f. Visual Identification. Visual identification is used instead of MK XII for DAD firing units and in certain other situations, but it is not a very satisfactory technique. High performance aircraft operating in the very low altitude regimes expose themselves for a period of time far too short for reliable identification. Furthermore, training under realistic conditions is almost impossible. Thus, despite best efforts, a significant percentage of misidentifications do occur using visual identification. Further, it does not possess the night/all weather capability of the new radar directed DAD weapon such as Roland and DIVAD guns.

(S) 4. NATO Considerations (U)

(S) a. Aircrew/AD Operators Perspectives. Aircrew comments on deficiencies in current safe passage and recovery procedures are grouped into two categories:

(S) (1) IFF/SIF Equipment and Procedures:

(a) Not all aircraft, as stated previously, are MK XII Mode 4 equipped. British and Belgian aircraft and U.S. LORAN-equipped F-4Ds are examples of aircraft without a Mode 4 capability.

(b) In a high ECM environment, aircrews question the likelihood of ground-based interrogators being able to properly interrogate airborne transponders.

(c) Verification that the aircraft's transponder is working properly is impossible without extensive communications with a ground-based interrogator.

(d) The tactical soundness of operating the IFF/SIF transponder in the vicinity of the FLOT is questionable. The IFF turn-on lines, 10 NM and 30 NM, on the enemy sides of the FLOT, for low and high altitude, for homebound aircraft

respectively, is of real concern to aircrew members because of enemy exploitation.

(S) (2) SFL Procedures:

(a) The present SFL bands are 10,000-15,000 feet and 40,000-45,000 feet. In order to use sanctuary altitudes, aircraft are required to climb over enemy territory in order to cross the FLOT at 5000 feet. Aircrews are concerned that this places the aircraft in a very vulnerable position in respect to enemy forward AD.

(b) SFL bands do not allow recovering aircraft to operate at altitudes optimum for fuel conservation. Returning from a mission with sufficient fuel for a safe recovery is always a concern for the aircrew. Fuel used to climb and fuel flow figures, extracted from the performance data section of the F-4 Flight Manual, show that after nine minutes of cruise at 12,000 feet total fuel used is greater than if the aircraft had climbed and cruised at 25,000 feet.

(c) Aircrews question the validity of their information on the location of the FLOT. Considerable time elapses from the time Army ground position is transmitted to the wing, the aircrew is briefed for the mission and then the mission is actually flown. In a highly fluid situation, it is possible that the FLOT may have moved considerably during this timeframe. Secondly, the FLOT is not a well defined line on the ground or a map.

(S) b. AD operators' comments have been addressed to three areas of concern:

(S) (1) Engagement Restrictions: Current plans require HAWK units to deploy "as far forward as possible" and to engage hostile aircraft "at maximum effective range." Many of the HAWK positions provide engagement capability east of the FLOT. However, HAWK units are not allowed to engage aircraft east of the FLOT. The reason given for

this restriction is to allow a weatbound aircraft to show a friendly maneuver west of the FLOT. This restriction is reinforced by the forward edge of the LOMEZ. A HAWK fire unit, without an operational IFF/SIF is not allowed to fire unless target identification is provided by a controlling agency or an adjacent fire unit.

(S) (2) SFL System: (U)

(a) The sanctuary flight bands are too thin. Each flight level band is only 5000 feet. This allows only six possible SFL combinations. An aircraft flying at a random altitude between 8000 and 17,000 feet is at a friendly sanctuary altitude 44% of the time. Between 10,000 and 15,000 feet the aircraft is at a friendly sanctuary altitude 60% of the time. Thus, the probability that a foe can successfully use the sanctuary altitude ranges to avoid being engaged is too high.

(b) Both the HAWK and NIKE systems must lock-on and track a target to determine altitude and speed. Each fire unit has only one tracking radar; hence, another target cannot be engaged while determining altitude on the first aircradt. Additionally, neither the NIKE nor HAWK systems display height with the accuracy required by the SFL procedures.

(S) (3) FLOT. Dissemination and the plotting of FLOT information is a time consuming process that is vulnerable to error. The FLOT is not a well defined line but rather a zone. For these reasons, the FSCL has been proposed as a better alternative for use in NATO.

(S) c. Studies and Initiatives (U)

(S) (1) Several studies in the past have highlighted the shortcomings in the Central Region procedures to insure passage at minimum risk through AD. As early as 1975, a tri-nation (GE, UK and US) combined working group identified

several deficiencies with the SFL procedures. This study proposed a minimum risk routing system as an alternative to the SFL procedures. In addition to this study there have been numerous initiatives brought forth in an attempt to resolve the problem of minimum risk passage. The following is a discussion of the more pertinent of these initiatives.

Feasibility of the Sanctuary Flight Level System, 22 July 1977. This is an AAFCE study which looked at the validity of the SFL procedures.

Draft Central Region Airspace Control Plan, 16 June 1977. Primary objective of the plan is to provide an airspace control system composed of a minimum number of procedures which will guarantee, as much as possible, the free use of the airspace by all users under all combat conditions.

2D BN 62D ADA Aircraft Recovery Study, 25 May 1977. This study was conducted in early 1977 to examine the recovery procedures in effect in the Eifel Region.

Safe Recovery of Homebound Aircraft Penetrating the Battlefield and Rear Combat Zone, 23 May 1977. This 2D ATAF paper, after discussing the disadvantages of the current procedures, attempts to answer the question "Is there any way of identifying our own aircraft that does not rely on vulnerable equipment and communications and which does not force those aircraft to adopt tactically unsound profiles?"

Effect of SAM Hold Fire for HAWK Units Within Low-Level Transit Routes (LLTR), 3 August 1977. This study was conducted in mid-1977 by 4th ATAF. The study addressed the impact on HAWK units of the weapon control order SAM Hold Fire for LLTR.

AAFCE Routing and Recognition Work Group. This work group is endeavoring to bring together in a single document the pertinent information needed by the various users of the Central Region airspace.

Airspace Control in the Combat Zone Minimum Risk Procedural Control System, 12 October 1977. This document is a draft of procedures for the BALTAP (Baltic Approaches) area developed by Headquarters, Tactical Air Command Denmark. Its purpose is to prescribe procedures for minimum risk to friendly aircraft operating in the BALTAP area while maximizing freedom to AD weapons systems, even during heavy jamming conditions (radar/IFF/SIF) and including situations of no communication to controlling agencies.

(S) (2) These initiatives concluded that the use of the SFL system for minimum risk passage depends on the ability of the defensive radars to accurately measure and display the altitude of aircraft flying at a SFL. Tests conducted in 2D and 4th ATAF show that defensive radars are incapable of displaying aircraft altitude with sufficient accuracy (plus or minus 2000 feet) for the effective use of the current SFL system as a minimum risk passage procedure.

(S) (3) The Central Region Airspace Control Plan was developed in an effort to provide safe passage of friendly aircraft without impeding AD employment. LLTR and Transit Corridors are prescribed in the Central Region Airspace Control Plan as the primary procedures for insuring minimum risk passage. The joint Task Group analyzed the LLTR and Transit Corridor procedures as contained in the Central Region Airspace Control Plan. These procedures were determined not to be the solution to the minimum risk problem for the following reasons:

(a) The LLTR procedure as written does not provide minimum risk passage of aircraft between the FLOT and the FSCL.

(b) Forward SHORAD is overly restricted by the 10 kilometer wide funnel on the eastern end of each LLTR.

(c) LLTR by their design seriously impair the effectiveness of Improved HAWK in the Central Region.

(d) A 5 kilometer wide LLTR overly restricts aircrews during adverse conditions.

(e) Recovery routing is constrained by the procedures.

(f) The procedures do not compensate for AD spatial display inaccuracies.

(S) (4) A more recent effort, DALFA Project 1-77, Safe Passage in Air Defense, sought to determine "How do friendly aircraft operate in the NATO AD environment at minimum risk while allowing the AD system maximum effectiveness to engage hostile aircraft?" The joint Task Group concluded:

(a) Present procedures used in the Central Region for safe passage through friendly AD are inadequate.

(b) Total reliance on IFF/SIF procedures for safe passage is not feasible.

(c) Procedures for optimum offensive and defensive operations are not compatible; therefore, any procedures developed will restrict both offensive and defensive systems.

(d) The minimum risk passage problem is most acute in the forward combat zone.

(e) Minimum risk passage procedures must accommodate equipment capabilities.

(f) The FSCL is a better reference line than the FLOT for operations involving air and land forces.

(g) The Travel Route concept is the most advantageous of the minimum risk passage concepts analyzed.

(S) C. ASSESSMENT OF PROGRAMMED CAPABILITIES AND DEFICIENCIES. (U)

(C) 1. In the near term, four systems will be introduced in the 4th ATAF area which offer capability improvement and enhancement of identification process. These are AWACS, AN/TSQ-73, GEADGE and F-15 JEM which are discussed below:

(S) a. AWACS (U)

(C) (1) With the introduction of the E3A into the European theater, a powerful tool will be available for eliminating the current large, low altitude gaps in the NATO radar coverage. AWACS has the potential of enhancing ADA operations by providing:

- o Continuity of early warning information
- o More reliable identification, since the E3A has a continuous track of low altitude targets versus the intermittent tracks from ground radars which have to be reidentified
- o Faster and more effective reactions due to the longer time available for decision making by the CRC and ADA group
- o A form of radar netting to pass identified tracks, resulting in fewer interrogation by ground units

(S) (2) Under current planning, however, the utility of AWACS for indirect target identification to ADA will be significantly limited by three factors:

- Track data will be processed only on board each E3A aircraft and each of the E3A will only be able to process a maximum of 100 to 200 aircraft tracks generated by its own radar. When larger numbers of aircraft are in the radar field of view, maintaining track continuity on individual aircraft will be impossible. (This is a limitation of the on-board track processor, not a limitation of the radar.)

- E3A information will be available to ADA units only by means of the "Salty Net" interface, i.e., E3A to MPC to 412 L CRC to Group AN/TSQ-73. Use of the E3A data by ADA units will be denied should the vulnerable 412 L CRC become non-operational.

- The number of tactical radio links that can be established from the E3A may restrict the extent and effectiveness with which the E3A can inter-operate with other systems as prescribed by deployment concepts.

(S) b. AN/TSQ-73 (U)

(S) (1) The AN/TSQ-73 Missile Minder ADA Command and Control System will replace the obsolescent AN/MSG-4 equipment in Europe during the 1978-1979 timeframe. The AN/TSQ-73 will be deployed at the ADA Group and Battalion levels. It is a highly mobile, automated system capable of maintaining data on 256 aircraft. The Group level system maintains data on aircraft provided by its subordinate Battalions and the CRC. The Group level system is not colocated with an acquisition radar and therefore does not generate local data.

(S) (2) The Battalion system will be associated with either NIKE Hercules or Improved HAWK Batteries. It is capable of maintaining data on 128 targets received from the Group AN/TSQ-73 and two remote radars. The remote radar capability is not exploitable at this time due to the lack of an Army program to procure required remote radar processing equipment. The Battalion system has the capability to automatically acquire 64 targets from its local radar and to automatically track up to 128 targets simultaneously. Its ability to exploit this capability is determined by the type of acquisition radar with which it is colocated. Radars currently available in the ADA inventory are the AN/MPQ-43 (HIPAR), AN/MPQ-50 (IPAR) and the obsolescent AN/GSS-1/7 radars. The AN/GSS-1/7 radar is a variant of the AN/TPS-1D which was developed in the late 1940s. It has no ECCM capability and was designed against 10 square meter targets.

(S) (3) Current plans are to colocate the Hercules Battalion AN/TSQ-73 with Batteries so that it can utilize the AN/MPQ-43 as the Battalion sensor in lieu of the AN/GSS-1/7. This will allow exploitation of AN/TSQ-73 processing capability in support of NIKE Hercules operations. Colocation with the Hercules Battery has minimal tactical impact due to the relative immobility of the Hercules system.

(S) (4) However, the colocation of the HAWK Battalion AN/TSQ-73 with a HAWK Battery to permit interface with the Battery AN/MPQ-50, is considered to be inadvisable due to the limited range of this radar. The ability to exploit the AN/TSQ-73 processing capabilities when employed with HAWK will be limited due to the lack of a suitable mobile radar. The Army has initiated action to procure an "off the shelf" three-dimensional radar to overcome this deficiency in the near term.

(S) c. GEADGE. The 412 L command and control system will be replaced by the GEADGE system. While each 412 L CRC has a local track capacity of

100 tracks, a GEADGE CRC local track capacity will be 400 tracks. It is anticipated that it will incorporate message standards which are incompatible with those utilized by AWACS, 407 L, MPC and AN/TSQ-73. Message processing incompatibility will require the employment of translative devices, i.e., buffers, to permit data exchange.

(S) d. F-15 JEM Non-Cooperative Target Recognition. The F-15 employs a DMR method of identifying aircraft by means of its JEM. It has the potential of positively identifying all friendly aircraft and a fraction of enemy aircraft. It is capable of identifying aircraft within $\pm$ 45° in the head-on aspect and within $\pm$ 35° in the tail-on aspect. It is effective at 50-70% of maximum tracking range of the radar (approximately 50 miles).

(S) 2. Summary. AWACS provides an order of magnitude improvement over the current ground environment systems due to its capability to provide continuity of identified air tracks in an ECM environment particularly in the low altitude spectrum.

The AN/TSQ-73 by its capability to automatically track and report targets detected forward of the ground environment radars provides a valuable source of track identification and update as the C^2 network is degraded due to battle damage. This capability also represents an order of magnitude improvement in comparison to the obsolescent AN/MSG-4.

GEADGE provides a general evaluationary improvement to the 4th ATAF ground environment system by increasing its track handling capacity and capability to correlate information provided by other sources, e.g., ADA units. This capability may be degraded due to the lack of definition of interfaces to 407 L, AWACS, AN/TSQ-73, etc.

F-15 JEM provides a non-cooperative means of positively identifying hostile aircraft when engaged in air-to-air operations.

However, in spite of these programmed improvements, serious, perhaps total discussion in air vehicle identification will continue to exist in NATO.

(S) D. PROPOSED NEW CONCEPTS (U)

(U) 1. A number of system concepts have been identified which, if implemented, could serve to alleviate the deficiencies identified above and improve the overall target identification capability in NATO to an acceptable level. These system concepts are discussed below. For easy discussion, they are divided into near-term and longer-term categories which are further subdivided into direct and indirect target identification concepts.

(U) 2. The near-term concepts are additions and/or modifications to the current AD system which, if implemented, could provide relatively quick improvements to the system's capability for target identification. A key, and very limiting, criteria in their selection was their operational availability in Europe by 1983. In many cases, the items in this near-term category are quick fixes, intended to provide NATO with an improved interim capability to be used until a more permanent and more effective system is available.

(U) 3. The longer-term concepts discussed are systems which, when used in a complementary way, could solve the NATO target identification problem, but which could not be available until after 1983.

(S) a. Near Term, Direct Concepts. (U)

(S) (1) Adding JEM to the HAWK Acquisition Radar. Identification of aircraft by JEM of radar signals was described in "Report of the Army Scientific Advisory Panel Ad Hoc Group on Non-Cooperative IFF" (Confidential), February 1975 and in "Defense Science Board Task Force on Identification Friend, Foe or Neutral (IFFN)" (Secret) Final Report, 31 March 1976. This identification and classification by type scheme is based on the doppler spectrum of the radar return from an aircraft which consists of the airframe doppler

return plus intermodulation lines and doppler returns from compressors and turbines. The latter are related to the number of blades and the shaft speed and can serve to help classify aircraft by type according to the engines they use.

Three different processing and classification schemes have been considered for extracting ID: (1) TRISAT; (2) DMR; and (3) SPECS. The last exists only as a computer software package with no dedicated hardware having been implemented, so it will not be considered further.

The DMR uses Fourier analysis to derive the blade counts of the first and second compressor or turbine stages, the symmetry of and the shaft rotation rate. These derived values are correlated with stored values of known engines to extract ID. This method requires less storage capacity than does TRISAT and exhibits good ID performance in regions approximately 40° to 45° around both nose and tail aspects. As compared with TRISAT, however, DMR (which is an Air Force sponsored development) is not in as advanced state of adaptation to the HAWK radar. However, DMR is being implemented on the F-15.

TRISAT has been under development by the Naval Electronic Center Lab Center at San Diego for over a decade and has been operated experimentally in conjunction with the Improved HAWK High Power Illuminator Radar with very high probability of correct ID against a number of aircraft. TRISAT correlates the direct doppler returns with stored returns from known engines and thus requires more memory capacity than does DMR. Furthermore, TRISAT functions only in a region of 40° to 45° around nose aspect. However, it is judged that TRISAT is sufficiently advanced in development and field testing that it could confidently be fielded with the HAWK system in the immediate near term. The Army has a program at the level of $500K per year to produce a fieldable model of TRISAT for use with the HAWK radar to be available in FY 1979 or FY 1980. This program should be accelerated.

The TRISAT should provide HAWK with an important supporting ID mechanism usable around nose aspect out to ranges of 50% to 60% of the radar detection range. Identification capability degrades proportionate to detection range in the presence of jamming. TRISAT gives a non-cooperative, day, night, all weather, relatively long range capability which can be made available in the near term.

The above recommendation to implement the TRISAT version of JEM on the HAWK radar is based on information presently available to the Task Group; particularly the fact that TRISAT has been operated with the HAWK radar. The Task Group does not have information regarding the degree of difficulty in adapting DMR to the HAWK radar. However, since the addition of tail aspect capability would be valuable, the Task Group recommends that the Army study this question. If it should be found the time and costs do not differ significantly, the Task Group recommends that DMR, rather than TRISAT, be implemented with the HAWK radars.

(U) (2) MK XII Mode 5. The term Mode 5 loosely includes a variety of improvements to the MK XII system that are being developed in several government laboratories and under contract. In addition to equipment reliability problems and the lack of training required to operate the equipment, the MK XII Mode 4 system can be readily exploited, jammed or spoofed. It is felt that the exploitation problem is the most serious of these and contributes significantly to its lack of use in Europe, as well as the reluctance of the UK (and others) to adopt the system.

Therefore, the techniques that have been proposed to rapidly and synchronously change encryption codes, a technique that would significantly reduce the possibility for enemy exploitation, should be implemented. This assumes that the development of a FIS is in reality many years off.

It may well be that in the course of implementing the above, several other improvements can be made

at minimal additional cost. These are improvements that could reduce susceptibility to jamming, simplify coding procedures and improve greater equipment reliability. (See Appendix A for more details.)

(S) (3) Passive Point-of-Fire System for SHORADS and MANPADS Weapons. Virtually all aircraft operating at low altitudes in close support of ground operations must radiate electromagnetic signals in order to successfully accomplish their missions. Examples of such would be terrain following radars, radar altimeters, attack or bombing radars, doppler navigation radars and voice or digital communications. At the relatively close ranges needed for SHORADS and MANPADS weapons (> 10 kilometers), these emissions can be detected with relatively simple receivers and with relatively small antennas. Since most such systems are pulse modulated at audio frequencies, the simplest concept would be to envelope-detect the signal and to amplify and feed the detected audio signal directly to the operator via earphones. Even without encoding the radar pulse repetition frequency, it is anticipated that different radars will have distinctly different audio signatures.

To be attractive, such a system must be able to operate with a relatively small antenna. As an example, consider a small, 4-inch square receiving antenna used to sense the approach of the terrain-following radar on an F-111. This is a 16 GHz, 30 kilowatt radar with a prf of 4045 Hz. The power received from the radar, Pr, can be approximated by

$$P_r = P_t \frac{g_t A_r}{4 R^2}$$

where

P_t = peak transmitted power

g_t = directivity of transmitting antenna in the direction of the receiver

A_r = area of receiving antenna (pointed in direction of radar)

R = range

The beamwidth from a 4-inch receiving antenna at this wavelength is about 10° and it is easy to point manually in the direction of a moving target. The power received by this small antenna can be estimated from the above equation to be -36 dB at 10 kilometer range at the $g_t = 1$ or unity gain level, which is often far out in the side-lobe region of radar antennas. Closer to the main lobe the signals would be even stronger. This is to be compared to the -55 dB minimum detectable signal that is typical of simple crystal-video detectors. It can be seen that such a radar might be detectable to ranges as great as 100 kilometers under favorable conditions.

If the signatures of friendly and enemy radars were not sufficiently distinct, it should be possible to apply very small amounts of jitter to the radar's prf and pass this through a suitable audio filter or a very simple spectrum analyzer to distinguish the superimposed modulation. It is anticipated that very little sophistication will be required in the spectral filtering, although it is certainly possible; in any case, the human brain is remarkably good at sorting out what it wants to hear in a cluttered environment (the cocktail party syndrome).

The attractive features of this technique include the facts that it:

- is passive (i.e., cannot be detected; requires no significant power)
- is simple, compact and inexpensive
- can distinguish many different friendly and enemy aircraft radars by their audio prf signatures and antenna scan rates or sort them by wavelength bands
- requires no additions or modifications to the aircraft, but capitalizes on existing mission-related radiations

- o is difficult to jam because of directivity of receiving antennas and proximity to source
- o has all weather, day or night, capability
- o is compatible with many of our air vehicles. Many of our current aircraft (F-111, RF-4, A7D) have terrain following radars and/or attack, multimode, weapon delivery or navigation radars in the 16-17 GHz band with distinctive prf's and antenna scan rates in the audio range. Others (F-15, F-16, F-4) have similar X-band systems in the 8.7-10 GHz band.[1] The laser doppler navigation system on the AAH is an FM/CW system operating in the 13.25 to 13.40 GHz band
- o is perhaps useful for simple search or cueing, since the radars can probably be seen at much greater ranges than visual range, and in all weather

(S-NFD) (4) EIFF on HAWK.(U)

(S-NFD) (a) Equipment for the active tactical exploitation of EIFF has been developed and installed on the F-15 (AN/ALQ-128) and on some F-4E aircraft (AN/APX-81A). Similar equipment has also been developed for Naval use (AN/ALQ-91) and was considered for possible use on AWACS (AN/ALQ-108).

(S-NFD) (b) Since the interrogation code for the Soviet SRO-2 transponder is well known (a pulse triplet at 668 MHz or a single pulse coincident with the radar pulse), these systems can readily interrogate SRO-2 transponders and receive a coded reply at the same frequency.

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[1] R.F. Lemon, Jr., "Current Airborne Radar Systems Handbook," TR-PTE-77-102, AFAL/PTE Wright-Patterson AFB, OH 45433 (1 July 1977 SECRET/NOFORN).

(S-NFD) (c) These systems can also operate in the receive only mode for the SRO-2 transponder replies, as well as for the SOD-57M (730, 740 or 750 MHz) air traffic control beacon replies, giving approximate bearings to any targets emitting such signals.

(S-NFD) (d) There are reasons to believe that the wartime modes of the Soviet IFF may be different and they are kept under tight security restrictions. Several possible changes of mode have been suggested (Reference 1, Chapter VI and Appendix B) which could negate the use of the EIFF equipments on U.S. aircraft unless provision is made in the equipment to rapidly change to new interrogation codes.

(S-NFD) (e) Nevertheless, the addition of these capabilities to HAWK radars merits serious consideration if it is believed that the enemy will not turn off his IFF when in range of HAWK batteries. Based on available intelligence data, including Soviet/WP practices during penetration and AD exercises in East Germany and the procedures employed by the Syrian Air Force (Soviet equipped and trained) during the 1973 war, there appears to be a substantial possibility that this will indeed be the case: i.e., the enery will not turn off his IFF. Given this possibility, together with the fact that the EIFF hardware is already developed, it would appear that the addition of EIFF to HAWK is a relatively low cost add-on which could provide enemy air vehicle identification in some tactical situations of interest.

(S-NFD) (f) Furthermore, the active EIFF exploitation (i.e., active interrogation and response) can operate at longer ranges than the HAWK radar itself. For the AN/APX-81A, SRO-2 transponders have been detected at ranges of 150-180 miles, although more usual performance is "in excess of 100 miles." This is well in excess of the normal HAWK acquisition range and could represent an additional, useful augmentation of the HAWK capability.

(S) b. Near-Term, Indirect Concepts. (U)

(S) (1) Exploitation of AWACS Data. With the introduction of AWACS into the European theater, a powerful tool will be available for eliminating the low altitude gaps in radar coverage and for maintaining track continuity on both friendly and hostile aircraft. Under current planning, however, the utility of the AWACS for indirect target identification will be significantly limited by two factors:

(S) (a) Track data will be processed only on board each E3A aircraft and each of the E3As will only be able to process a maximum of 100 to 200 aircraft tracks generated by its own radar. When larger numbers of aircraft are in the radar field of view, maintaining track continuity on individual aircraft will be impossible. (This is a limitation of the on-board track processor, not a limitation of the radar.)

(S) (b) AWACS tracking data will be downlinked to the MPC collocated with the CRP at Pruem and will be relayed from there to the MCRC at Boerfink. It will be relayed from there to the other CRCs and to the ADA Groups. Because of the finite traffic capacity of the Boerfink CRC, it may act as a bottleneck in dense air vehicle environments on the transfer of AWACS tracking data to the ADA Groups where it could be of value for indirect target identification. Furthermore, if Boerfink and/or its communications were knocked out by enemy action, the various ADA Groups and their HAWK and Hercules fire units would be completely decoupled from this valuable AWACS data.

Interim fixes are available to eliminate both of these limitations. The on-board track processing bottleneck can be eliminated by downlinking the appropriate radar data and doing the track processing on the ground where a much greater processing capability could be made available. The Boerfink "bottleneck" can be eliminated if the AWACS data are downlinked to several locations in parallel. If

these locations are judiciously chosen, the result would be an AWACS data exploitation system with significantly greater traffic handling capacity and one that would degrade much more gracefully as key nodes are knocked out.

As one illustrative example, the AWACS data could be downlinked in parallel to all three of the 4th ATAF MPCs (Pruem, Neu Ulm and Sembach) where the ground-based track processing would be performed. From there it could be simultaneously relayed to the MCRC at Boerfink, to the three other 4th ATAF CRCs at Lauda, Messtetin and Freising and to the four ADA Groups at either their peacetime locations (Kaiserslautern/Bonn for the 94th and 108th Groups, Darmstadt for the 10th Group and Wurzburg for the 69th Group) or their wartime, tactical locations. Under this arrangement, as long as the MCRC was operable, it would direct the AD battle, using the AWACS data for overall force management. In this non-degraded mode of operation the other CRCs and the ADA Groups would execute the AD decisions determined by Boerfink using the AWACS data for their sectors to assist in detailed target identification and weapon assignment decisions. When Boerfink became inoperable, for whatever reason, the remaining CRCs could take over autonomous command of the AD battle in their areas and they would still have AWACS data available to them. Finally, if all of the CRCs were rendered inoperable, the ADA Groups could operate autonomously using the AWACS data from the MPC closest to their sectors to assist in target identification and weapon assignment within those sectors.

In order for AWACS data to be used in this fashion and, in particular, for it to be useful to the AAD units deployed in the field, the current position uncertainty with which AWACS tracking data is supplied to tactical users must be reduced. This position uncertainty -- usually quoted as two nautical miles -- is not a result of the basic tracking accuracy of the AWACS radar since the 75 meter range resolution and 0.1 degree angular resolution of the radar should lead to a basic tracking accuracy of 0.3 nautical miles or better. Rather it appears to be the result

of uncertainties in determining/reporting the E3A aircraft position. This position uncertainty could be eliminated by careful use of LCPAN or ground beacons and errors introduced during the various coordinate conversions that are carried out could be eliminated by more careful numerical procedures.

(S) (2) Improved Coupling of DAD Weapons to the Overall AD C^3 System. In view of the increased aircraft kill potential of the new weapons -- Stinger (IOC 1980), Roland (ICC 1983), DIVAD Gun (IOC 1983) -- being introduced into the DAD inventory, it is imperative that the coupling of these weapons to the overall AD C^3 system be improved as soon as possible. Ultimately, a PLRS plus JTIDS type system as envisaged in the ADDS program is probably the best solution to this problem. However, such a system could not be available in Europe until the mid 1980s at the earliest. Thus, it would be very useful -- if not essential -- to deploy a quick fix solution to this problem to provide an interim DAD C^3 capability to be used until more permanent and effective solutions are available.

The technology to support such an interim capability is almost certainly available. During the 1974-1976 time period, the Marines developed a WDU designed to link the SHORAD and MANPAD weapon teams to the IHADP. The WDU employed a 1200 bit/second digital data link compatible with standard military single-channel VHF/FM radios to transfer alerting and pointing information from the IHADP to the SHORAD and MANPAD weapons. In 1976 the Marines field tested the developmental hardware using an Improved HAWK and two MANPAD weapon sites. These tests indicated that the WDU provided warning and pointing information, increased the percentage of detections and launches achieved by the MANPAD teams and increased their average detection range.

Since 1976 the Marines have continued work in this area, developing a TST to process HAWK track data messages and reformat them for transmission to the MANPAD teams and a hand-held IDT to serve as an

improved data read-out device for the MANPAD teams. The IDT weighs 3.6 pounds, uses a light-emitting-diode display to present aircraft warning, pointing (range, azimuth and altitude) and identification data and -- like the WDU -- uses a digital link compatible with standard military single-channel VHF/FM radios for connection to the TST. During 1978 field testing of the IDT and TST, it was determined that: (a) the IDT adequately demonstrated the feasibility of operating as an early warning, pointing and identification device for the MANPAD teams, (b) the HAWK unit currently provides the AD data most effective for the MANPAD early warning, pointing and identification needs, but that (c) a number of minor deficiencies exist in the TST for which further design effort is required.

Obviously, further refinement of the TST/IDT equipment design is possible and an extended development program could be structured which would ultimately -- in the mid to late 1980s -- provide the DAD fire units with a superior C^3 system. However, it would appear that the Marines WDU and TST/IDT programs have substantially developed the technology base and engineering designs required to provide the Army with an interim, near-term, quick-response solution to their DAD C^3 problem. (Such a quick response solution could incorporate minor, but not major, changes to the existing IDT and TST designs.) One advantage of the TST/IDT approach is that it uses existing military single-channel VHF/FM radio equipment of the type already employed by the maneuver units and AD fire units. New channel assignments may be required, but a new communication system is not required. This means that once the TST/IDT hardware is developed and produced, it can be quickly introduced into the operational units as a supplement or, more probably, a replacement for the TADDS equipment. (AAD personnel have often referred to this TST/IDT system as the TADDS update.)

(S) (3) Exploitation of SIGINT Data. There are a number of different types of SIGINT data, both COMINT and ELINT, which could be useful as an aid for the identification and tracking of hostile aircraft. In particular, Soviet

and WP aircraft carry certain types of avionics equipment which can be exploited to yield aircraft identity and location information. The details of this equipment and the nature of the exploitation are discussed in a specially classified appendix.

It appears that the exploitation of this particular SIGINT source could be implemented in Europe in the near term, since the detailed analysis of the source has already been completed. All that is required now is the assembling of the proper intercept receivers, collection platforms, data links and processing centers and the establishment of procedures for timely dissemination of the intelligence product to the various users.

The requirements for intercept receivers, collection platforms, data links and processing centers are outlined in the specially classified appendix. Suffice it to say here that these requirements are not particularly pressing. The receiver requirements are straightforward. An airborne collection platform is preferred for wide area coverage. A number of existing airborne collection platforms could be adapted for this mission but they would require new receivers, etc. If this proves to be inconvenient, or causes conflicts with other SIGINT collection missions, additional airborne platforms would have to be obtained. These could be either RF-4C, RC-135 or U-2R; the selection would be on operational grounds, not technical collection considerations. The requirements for the data link from the collection platform to the processing center are also straightforward; a number of existing data links could be adapted for this purpose. A new, special purpose processing center would be required but this is a development which is well within the state-of-the-art.

Since all of these hardware requirements are straightforward and since only a limited number of units need be procured for adequate coverage of the AFCENT region -- three to six aircraft and one ground processing center would provide a minimum capability-- it should be possible to deploy a quick-response system to Europe within about three years. This

would provide an interim, near-term capability which could be augmented later by additional collection platforms and processing centers.

When deployed to Europe, this system will provide identification and tracking data on WP aircraft with an accuracy sufficient for all AD battle management and weapon allocation purposes and most AD hostile target identification and weapon cueing purposes. The establishment of procedures for the timely dissemination of this data to the various AD users, with the appropriate sanitization, is a key requirement for the realization of full military utility of this data source.

This sanitization and dissemination process can take many forms. Two examples, chosen from current SIGINT practices in Europe, are illustrative of the range of dissemination architectures available:

(a) In AAFCE the dissemination of SIGINT and other compartmented intelligence data is limited to the USAFE TFC in the Boerfink bunker. This information, in sanitized form, is used as an assist in updating the current peacetime WP air order of battle, as well as in the conduct of AD exercises and other exercises. In sanitized form this data can be discriminated throughout the 4th ATAF/17th Air Force/32nd ADCOM AD net and used as an additional source of information on enemy activity.

(b) In USAREUR each of the U.S. Corps and Division has peacetime access to SIGINT and other compartmented intelligence data. There are special intelligence sections -- sometimes called All Source Intelligence Centers or ASAC - in each U.S. Corps and Division headquarters, both in garrison and in the field and a significant number of the commanders and G-2/G-3 staff have access to the unsanitized data. The Divisions and Corps each have organic SIGINT collection assets. They are all interconnected with special intelligence-secure communication channels and they are connected via the Corps with the NSOC. This system is used in

peacetime training and exercises -- during REFORGER '77 for example, commanders as low as Brigade level made tactical decisions based on real SIGINT data -- and it is intended that it operate in wartime exactly the same as it functions in peacetime exercises. When new collection systems such as TACELIS and AGTELIS are deployed to Europe they will be coupled directly into this Corps/Division tactical SIGINT system.

The proper architecture and procedures for the dissemination of data from the particular SIGINT source under discussion here is obviously a complex question. On the one hand the desire for protection of the source leads one to a highly centralized system with extremely limited peacetime dissemination, little or no use, in either real or simulated form, in training or exercises. On the other hand, the desire for efficient tactical utilization of the data during wartime, in a manner which degrades gracefully with enemy attrition of the U.S. C^3 system, leads one to a somewhat decentralized system with parallel dissemination to more than one command element and with peacetime utilization in at least simulated form in training and exercises. A judicious combination of these approaches must be selected in order to maximize the tactical utility of the data, commensurate with protection of the source and the various multi-national NATO constraints.

(S) c. Far Term Direct Concepts. (U)

(S) (1) NATO FIS and JTIDS/PLRS Plus. Some NATO nations will not adopt the MK XII system because its signal can be exploited and jammed. Indeed, the WP nations are gradually deploying a ground TDOA system which is now capable of accurately tracking many signals including our IFF replies, whether these replies are enemy-induced or are valid replies to valid friendly interrogations (see Appendix A).

(S) (a) NATO FIS. In order to combat the enemy exploitation of our identification systems, the NATO nations have published a STANAG dealing with a FIS which is called "NATO FIS." It was published by the UK on 3 February 1978.

While the specifications for the NATO FIS are still being refined, it is fairly certain the direct interrogate-replay element in the system will rely on a spread-spectrum signal both to defeat jamming and to reduce the radiated spectral density below noise level at expected intercept ranges. The specification is based on the hope that a 33 dB processing gain can be achieved through spread spectrum techniques.

(S) (b) The Dynamic Range Problem in LPI Signals. In order to achieve a low probability that hostile forces will be able to intercept our signals we must be sure that the spectral power density of our signals is below the noise at expected enemy interrupt equipment ranges. The power of our signals at the receiver can be made smaller by reducing the radiated power. However, power cannot be reduced to such an extent that we cannot receive a useable signal and if no processing gain were used, the power required would be such that the hostile forces would be able to receive and use the same information as we do.

Unfortunately, we would like to receive our signals when our aircraft are at a great distance and where an interceptor may be close by. Also, to read the contents of a message requires about 10 dB more signal to noise ratio than to detect it with some reasonably useful probability of detection like 0.5.

To illustrate the above, assume we had a communication system with 30 dB processing gain. Subtracting the 10 dB more we need to read the contents than the hostile does to detect it leaves a 20 dB margin. This means that if the transmitter power is adjusted so that we can just read the reply message, the enemy can detect our reply when he is one tenth the distance away from the transmitter as we are. (Ten times in range is a 20 dB signal level decrease.)

However, we may want to interrogate out to 100 miles. In this instance, the enemy could intercept when ten miles from the transmitter. While this may be satisfactory most of the time, we certainly would like more margin than 20 dB margin.

From the foregoing we see that the NATO FIS specified processing gain of 33 dB would be quite useful, it probably would not assure us the degree of protection against enemy exploitation we want or need.

(S) (c) Separate Communication, Navigation and Identification System versus an Integrated System like JTIDS/PLRS. The NATO FIS system is directed toward achieving a new interrogating reply identification system-one that has LPI, excellent jam resistance and is not exploitable nor spoofable. These four "security" attributes, LPI, AJ, anti-exploit and anti-spoof are also desired for position location systems and communication systems. To achieve these "security" attributes requires sophisticated signal processing. To benefit from these attributes for the three functions separately--CNI -- would require a triplication of these sophisticated signal processors if three separate systems were installed. This certainly would be an expensive and space consuming course to pursue.

Not only would three separate black boxes entail triplication of signal processing, but they would probably entail triplication of antennas, receivers, transmitters and power supplies if they were developed independently. In an integrated system which furnished all three functions, it would be possible to avoid the triplication of signal processing and by adding minimum redundancy in power supplies (the receivers and transmitters are now multiple units) to achieve a very reliable three-function CNI system.

An important cost often forgotten by engineers is the cost of installation. Installing three boxes may cost from two to three times as much as single-box installation. Space limitation in the aircraft, along with training and maintenance requirements also tend to argue for a single, integrated multi-function system.

(S) (d) Using Advanced JTIDS for Identification. Advanced JTIDS has a good likelihood of being adopted as a DoD standard for communication and position location. While the Army plans to use a different system called PLRS, it is possible to have interface boxes and make slight modifications to PLRS to make it quite compatible with Advanced JTIDS.

Advanced JTIDS has three possible modes of operation for identification purposes:

- Indirect Mode. Each aircraft's position message is determined by AWACS or netted ground radars and the advanced JTIDS communication capability is used to transmit the identity information to JTIDS-equipped interceptor aircraft and ground-based fire units

- Direct Mode in a Net. In this mode, Advanced JTIDS issues identification and position reports asynchronously. Its report is not related to a radar or an interrogation. The position is then processed through a co-ordinate transformation at the fire unit site to provide useful identity and location information

- RTT Mode. The JTIDS sends out a reply to an interrogation in a separate net. This reply is synchronous with an interrogator. The RTT Mode is the mode emphasized in the proposed use of our Advanced JTIDS system for the direct element of the NATO FIS

While JTIDS has about 30 dB of processing gain, in general, it would not create a sufficiently LPI signal to prevent enemy exploitation as discussed above. This occurs because the normal transmitter power is much larger than that required to assure

an adequate signal-to-noise ratio at 300 miles range whereas identification in the corbat zone may only require 30 miles range or less.

One possibility to enable use of reduced power is to control the transmitter power as a function of the range. The home radar station desiring identification of a given radar return could send a power control signal based on the air vehicle (transponder's) known radar range and actual measured signal quality.

An Advanced JTIDS system can provide secure-jam resistant identity directly in two distinct manners. One utilizes its position-determining capability called its relative navigation. In the other, identity is obtained by using the RTT transponding capability of the JTIDS system.

Relative navigation is the ability of a JTIDS family of users to navigate relative to an arbitrary navigation grid designated by a navigation master. In this scheme, primary and secondary navigation references are used. The primary navigation references are users whose terminals contain high quality clocks. All navigation references and users periodically transmit their identification, position and velocity using a position (P) message. Pseudo-range measurements to users radiating these P messages enable the computation of a terminal's own position relative to the navigation grid designated by the master. An aircraft surveillance radar in the same relative navigation grid as JTIDS will correlate all active users with its own radar tracks. All active users are friendly; consequently, all tracks which are friendly can be so labeled.

RTT in JTIDS is utilized to transfer system time. RTT is a transponder mode whereby a user transmits a unique interrogation message. The recipient replies in the same time slot in which the interrogation was transmitted. The reply message contains the TOA of the received signal, the serial number of the interrogator and the serial number of the transponder. The interrogator thus performs a two-way range measurement. A typical interrogate and respond RTT message format is illustrated in Figure I-2-3.

INTERROGATOR

SYNC	TIME REFINE	HEADER	INTERROGATOR SERIAL NUMBER	ADDRESS IN TRANSPONDER (used in addressed RTT

TRANSPONDER

SYNC	TIME REFINE	HEADER	INTERROGATOR SERIAL NUMBER	TRANSPONDER SERIAL NUMBER	TIME OF ARRIVAL

FIGURE I-2-3

(S) RTT MESSAGE FORMAT (U)

RTT transponding is performed utilizing a choice of two message types. These are the "all-call" message and the addressed message. The all-call is used when little is known about other users in the area. An interrogator using the all-call will accept the first transponded signal to be received. For identity the interrogator will range gate the receiver to synchronize the reply of the target with the range measurement of the radar. Large numbers of targets can either be isolated and identified one at a time based upon a single message reply or multiple acceptor circuits can be incorporated so that multiple interrogations can be used and the multiple replies can be integrated to build up the system.

The addressed RTT is normally used to measure distance to users with known high quality clocks. The surveillance radar will also use the addressed RTT to identify expected friendlies with known flight plans. If no reply is transponded, then the all-call RTT is used.

The only modification required to Advanced JTIDS receivers is the addition of range gating to the RTT replies in the interrogator so to enable the sorting out of many unknown friendlies. This situation of many unknown friendlies will probably be a very rare occurrence with an Advanced JTIDS.

Relative navigation will provide essentially 100 percent of the identity function unless the users are in radio silence. A suggested change to the terminal is the addition of a warning indication that alerts the pilot to interrogations. Once alerted, he could switch to the RTT low power mode to be described later.

The turn-around time of the RTT interrogation by the transponder is approximately two milliseconds. The message error rate of RTT interrogations and replies is 1 out of 400 at a J/S of 20 dB without range gating. Other JTIDS messages have a message error rate of 1 out of 100 at the same J/S. The addition of range gating could also permit improvement in performance by changing correlator detection threshholds.

The use of range gating reduces the cumulative probability of false alarm, thus enabling adequate RTT detection probability at higher jamming powers. This added performance due to incorporation of range gating could be utilized to advantage by controlling and reducing the aircraft transmitter power to the bare minimum. By transmitting with the minimum power which allows the friendly interrogator to decode a reply, a typical enemy interceptor, without the Advanced JTIDS processing gain would receive a signal below his noise level. If necessary, many simultaneous replies could be recovered with additional receivers in the interrogator. The use of range gating does not preclude reception of such other replies. Also, each reply could be tagged if the one expected is not received.

(S) (e) LPI Considerations. In Advanced JTIDS, the processing gain of the preamble matched filter (having 32 pulses) is 11 dB above the processing gain of a single pulse, after implementation losses are subtracted. Theoretically, the processing gain of a single pulse is 15 dB. The 15 dB is reduced by 2 dB due to correlator side lobe losses. The total realizable processing gain of the matched filter is thus 24 dB. Increasing the processing gain for a special identity response can be achieved by adding more pulses to the preamble. This approach is feasible without changing the basic matched filter because the associated radar requesting identity furnishes range and thus permits the updating of frequency and code every 13 microseconds. Each doubling of the sync preamble provides a 2.2 dB increase in processing gain because binary addition is used. Thus, a single 128 pulse identity pulse train provides a processing gain of 28.4 dB. Repetitive transmissions of this response to additional interrogations provide further improvements of 2.2 dB for each doubling factor. Thus, 32 replies provide an additional 11 dB of processing gain resulting in 39.4 dB after all implementation losses are subtracted.

The identity response for high processing gain and therefore LPI is achieved by randomly using all 51

JTIDS frequencies. The transmitted power of the identity response will be under control of the surveillance radar. The interrogation signal will command the transponder to reduce power so that the received response is at the minimum discernable level. The objective of this technique is to minimize the probability of intercept receivers detecting the replies to the interrogations. Additional improvements are feasible in multiples of 2.2 dB by doubling the number of pulses if necessary. The maximum number of pulses in a response is 600 in one time slot. Therefore, a 512 pulse response will provide an additional 4.4 dB of processing gain over a 128 pulse response bringing the total to 43.8 dB. However, the 128 pulse response is probably adequate. It is important to note that hardware in the transponder is not affected by the use of more pulses. The incorporation of power control, however, would represent a change. Also, the detection logic in the interrogator would have to be changed to measure the preamble matched filter output over a longer pulse sequence and with multiple detections.

(S) (f) TDOA on JTIDS LPI Signal. Just as hostile forces can perform a TDOA correlation on the proposed NATO FIS, so can they perform such an operation on a JTIDS LPI pulse. To make TDOA measurement, the hostile TDOA sensor must have an adequate signal-to-noise. Our discussion so far has emphasized the reduction of signal strength to minimize intercept and effective use of enemy TDOA systems. A similar effect could be achieved by an increase in the general noise background.

In the case where an Advanced JTIDS system were used to perform the direct identity function, an increase of noise background would be present as a consequence of system design and loading. If there are multiple users in an Advanced JTIDS system normal signals tend to begin to look like interference noise, especially if the number of simultaneous users and messages are large. Also, some JTIDS users will be operating in the friendly zone. They would not need LPI and would have full power. Thus, they

also would add to the background noise but in such a way that it would not affect the terminals with the proper codes. In this connection, it appears that DTDMA or HTDMA may have an advantage over ATDMA in that the random dispersal of the pulses in time, frequency and code space may lead to a noise-like background at a lower density than with ATDMA.

This gratuitous background noise results from the multiple-function capability of JTIDS. When transmitting data, or position reports or voice, it adds to the background entropy. A separate identification system would not have this natural background noise cover which is inherent in a multifunction system.

(S) (g) JTIDS RTT Antenna Gain. In the RTT Mode, a directional antenna would be planned for use on the interrogation and reply mode. The directional antenna would be made to lock in the same direction as the radar which it serves. For LPI purposes, this directional antenna need not have high gain on interrogation. However, high gain would be needed for AJ purposes.

At L band a gain of about 23 dB in the azimuthal direction and about 18 dB in the elevation is feasible. These would be the gains from a 2^{o} pencil beam which is agile in elevation. Since it is to be agile in receive only, the antenna should be a significant cost contributor. Moreover, radar and JTIDS position and altitude reports would yield the data necessary to steer the beam used to receive the identification replies.

It should be noted that this antenna gain is available to the friendly side and not to the hostile TDOA system. The NATO FIS system could also have antenna gain but it would need position and altitude information to be able to steer in elevation. It is important to note that increasing the antenna gain (decreasing antenna beamwidth) reduces the number of pulses which would be available for integration so that increasing gain in LPI by increasing antenna gain does not help the LPI problem. However, it does help in the AJ mode.

(S) (h) JTIDS RTT Traffic Handling Considerations. It might be noted that a good deal of the gain in LPI performance comes from a long message. The proposed message length is long enough so that the return from multiple aircraft will overlap. However, this is not a serious situation. The interrogator must have multiple receivers and tracking loops. The overlapping replies would then look like multiple nets and the degree of interference would be minimal.

(S) (i) JTIDS Visibility and Detection Vulnerability. One of the questions which has not been resolved is the exposure of the normal non-RTT TDMA mode to enemy exploitation. All the previous discussions considered the RTT in the LPI mode. In the TDMA mode, it has been feared by some people that the regular occurrence of the synch and the discrete occupation of a slot by a single user enables a hostile TDOA system to easily track every user. DTDMA should not be so vulnerable. This should be investigated in depth. If the vulnerability to enemy TDOA is significantly different, then use of DTDMA would be preferable.

(S) (j) Reliability. The identity function in JTIDS can have a high MTBF. Identity in JTIDS is performed mainly in the RF and signal processing elements of the terminal. Both the transmitter and receivers utilize redundancy. For example, a high AJ JTIDS fighter terminal utilizes eight receivers and a transmitter containing sixteen transitor power modules. Failures of receivers and transitor power modules cause graceful degradation in performance. The power supply in JTIDS, however, is common and its failure will disable the terminal. Power supply backup via multiple power supplies is feasible. For example, half of the transmitter power modules and half of the receivers could be split and powered by two separate power supplies. Since the signal processor consumes only a small fraction of the total power, each power supply could furnish the power for the processor. The reliability of the signal processing elements is high and redundancy here should not be necessary.

JTIDS uses solid state technology throughout. Its basic reliability should exceed 600 hours MTBF. By providing redundancy, the users should have an identity box they can trust. The MK XII reliability is considered by users not to be great enough for confidence in positive identification. A JTIDS-based system with its basic high reliability and minimum redundancy should be able to furnish the needed confidence.

In summary, it appears that by proper design of the RTT mode, by power control, by multiple message integration and by use of the frequency hopping and spread spectrum capability already designed into Advanced JTIDS, an Advanced JTIDS system should be able to accomplish the direct identity function for the NATO FIS with sufficiently low LPI that pilots could keep turned on in the crucial combat zone.

However, we do not believe that LPI operation is possible for aircraft engaged in deep interdiction. They will have to shut off their JTIDS box and rely on AWACS tracking (which should be feasible) and only turn their JTIDS box on as they near the firing envelope of friendly fire units. When they do that, all the LPI advantages of the JTIDS structure should be exploitable.

The use of JTIDS for identity is preferable to a new FIS being considered by a NATO study group because:

- o it can be available sooner
- o it can evolve from present assets
- o it can perform other functions
- o some NATO nations are interested in an integrated CNI system; the former system is much like JTIDS

(C) (2) Short-Range, Millimeter-Wavelength, Coded Retro-reflector ID System for Short Range DAD Use. Retro-reflectors can have very large radar cross-sections if they are many wavelengths

in size. In addition, they reflect incident energy directly back to the source, instead of broadcasting it in all directions. In order to capitalize on these properties to develop a short range direct ID system and still keep the physical size reasonably small, it is necessary to go to short wavelengths. However, in order to maintain reasonable all-weather capability for the newer weapons systems, it is necessary to utilize millimeter-wavelengths as opposed to optical wavelengths. Millimeter wavelengths allow narrow antenna beamwidths with small antennas. In a direct IP system, this also results in good spatial discrimination of multiple targets. Such a system should be very difficult to exploit from a distance because of the significant atmospheric absortpion at millimeter-wavelengths, especially if the system operated on the skirts of the transmission windows. The region around 90 GHz is seeing considerable developmental activity for a variety of applications. Hence, components for a millimeter-wavelength direct ID system should become readily available in the longer-term which suggest 90 GHz as a good frequency for such systems.

For a diffraction-limited system and neglecting atmospheric absorption, the round-trip loss from interrogators to retro-reflector and back can be approximated by:

$$\frac{P_r}{P_t} \quad \frac{P_{rec}}{P_{tr}} < \frac{A_i^2 \quad A_t^2}{4 \quad R \quad 4}$$

Where P_r = received power

P_t = transmitted power

A_i = aperture of interrogator antenna

A_t = aperture of retro-reflector at transponder

For a baseline system at a wavelength of $\lambda = 3.2$ millimeter (94 GHz) and 4" x 4" antennas, the minimum round-trip loss is 128 dB at a range of 5 kilometers (it is 116 dB with 8" x 8" antennas).

Kilowatt peak powers are available at 94 GHz (25% duty cycle), using coupled-cavity travelling wave tubes and mixers with ~ 10 dB noise figures are also available. If -80 dBm (-110 dBw) can be detected, the system should have enough margin to operate satisfactorily.

On the aircraft, it would be highly desirable to develop flat, flush-mounted retro-reflectors, rather than deep antennas, such as corner-cubes and Luneburg lenses. It is conceivable that printed-circuit versions of the Van Atta array could be developed for this purpose. Such arrays could also be rapidly modulated with diode switches along the feed-through lines behind the radiating elements.

(S) d. Far Term - Indirect Concepts. (U)

(S) (1) Use of TDOA Systems as Identification Adjuncts. Since all aircraft radiate in the communications and radar bands at some time, detection of these radiations could be used as a very effective means for identification of both friendly and enemy air vehicles. For example, a particular type of radar could be identified as friendly because of its frequency (or frequency agility pattern), pulse width, pulse repetition rate, scan characteristics and the like. We could also positively identify enemy radars using similar signatures. Likewise voice communications could also be used as immediate identification aid.

In order for these radar or communications signatures to be useful for air vehicle target identification, the radar/communications intercept system being used must have emitter location accuracy good enough to positively associate a particular identification achieved through parameter association with a radar (or visual) track. Generally speaking, DF systems will have inadequate accuracy for this purpose. TDOA systems such as PLSS, AGTELIS and ELS however have potential emitter location accuracies of 50 meters (ELS) against targets moving at typical tactical air vehicle velocities and should be ideal for this purpose.

At present, the PLSS system -- an airborne TDOA system for theater-wide coverage of enemy radar emitters -- and the AGTELIS system -- a ground-based system to be deployed in the Corps/Division areas for local coverage of enemy radar emitters -- are intended to be employed exclusively against fixed emitters (SAM radars, etc.). Intercepts on moving radar emitters will not be processed.

In the concept proposed here, these moving-emitter intercepts would not be discarded. Rather, they would be exploited to provide air vehicle identification (from the radar parameter association) and radar track association (from the PLSS/AGTELIS emitter location) on friendly and enemy air vehicles.

The PLSS system has already demonstrated its ability to track aircraft in simulation tests. In the particular simulation used, five aircraft targets were simultaneously tracked. Clearly, maintaining PLSS track on the much larger number of friendly and enemy aircraft to be expected in a NATO/WP air war will be a considerably greater data processing problem and will undoubtedly require an augmentation to the PLSS processing capability. This is even more true since currently the PLSS system throws away all of the moving targets it sees and devotes its entire processing capacity to the fixed emitters.

When employed in this fashion, the PLSS system -- being airborne with a theater-wide coverage area -- has the potential capability, assuming adequate augmentation of its processing capacity, to obtain identity and track association data on essentially all friendly and enemy air vehicles in the 2nd ATAF/ 4th ATAF region who have their radars turned on. This has the advantage of providing theater-wide aircraft target identification. It has the disadvantage of having to cope with extremely large numbers of aircraft targets.

AGTELIS, employed in the same emitter-identification/ track-association mode, would provide very useful and complementary capability to the PLSS system. The AGTELIS system, being ground-based with its

intercept receivers located in the forward area, would provide detailed coverage and aircraft target identification, over a much more limited area of the battlefield. Since the AGTELIS coverage area is approximately the same as the HAWK coverage area, the aircraft identifications, emitter locations and track associations, provided by AGTELIS could be of direct utility to the HAWK batteries.

This same approach could be used with communications intercept systems which have TDOA correlation systems (e.g., ELS) attached. The language of the intercepted communications will provide a rapid indication of target identification. The TDOA correlation processing of the modulated CW communications signal will provide the location of the moving emitter. The principal difference, compared to the PLSS/AGTELIS case, is that the correlation processing takes a much longer time (of the order of 1 second per emitter) than did the pulsed emitter processing (of the order of 10^{-3} seconds per emitter). This has two effects: fewer targets can be processed and tracked by a given data processing capacity and larger location errors are introduced due to target motion during the correlation processing. (For a Mach 1 aircraft and a 1 second correlation time, this error would be about 300 meters.)

In summary then, this proposed concept is to use PLSS/AGTELIS, with suitably augmented data processing capability, to obtain emitter identification and location information of friendly and enemy aircraft which have their radars turned on. This information would then be communicated to appropriate AD units where it would be used to generate aircraft identity and track association of value to AD units for target identification. The same approach could be used on friendly and enemy aircraft communications, using ELS-like intercept systems.

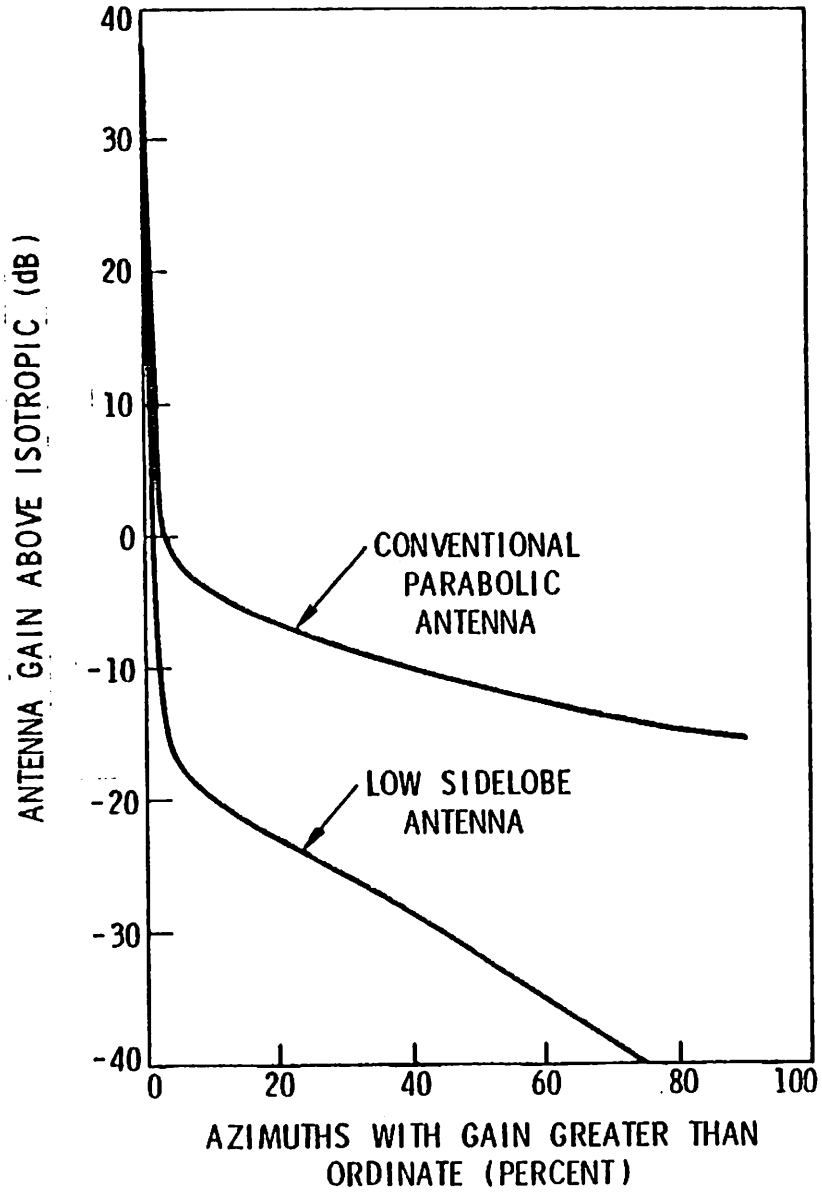
(S) (2) Netting of Radars and TDOA Systems. Recent progress in advanced digital signal processors has now made possible the automatic acquisition and tracking of all aircraft within a surveillance radar's antenna field of coverage. Tests of the Lincoln Laboratory Moving Target Detector Radar in an environment of moderate jamming and heavy chaff show only a small degradation in the sidelobe region and complete visibility through passive chaff.

The addition of a low sidelobe antenna and modern digital signal processing greatly decreases the utility of sidelobe jamming. This is illustrated by Figures I-2-4 and 5. Figure I-2-4 shows the cumulative distribution of a normal parabolic antenna sidelobes and that of a low sidelobe antenna such as AWACS. Figure I-2-5 shows the required jamming power for two levels of jamming against such a radar. Notice that a stand-off jammer at 50 nmi range requires about 107 watts ERP to be effective against such a radar. This is an impractical amount for an airborne jammer.

The above results led to a radar-anti radar technique study which concluded that sidelobe jamming and other deception techniques can be easily countered so that the enemy will eventually have to resort to mainlobe jamming using either large numbers of distributed jammers (e.g., small parachute or balloon-borne jammers with 1 to 10 watts of power) or noise illuminated chaff (see Figure I-2-6). About the only sensible counter to a distributed jamming threat is a distributed network of radars.

Figure I-2-7 shows one possible network. Several advantages are given in Figure I-2-7 and stressed in Figure I-2-8. In addition to the many advantages against possible enemy action, the network and radar parameters were chosen to give good low-altitude coverage. Studies show that a typical range against low flying aircraft is only about 35 kilometers due to shielding by undulating terrain.

(U) ANTENNA GAIN DISTRIBUTION FOR VARIOUS RADAR ANTENNAS



(S) SIDELOBE JAMMER EFFECTIVENESS (U)

Figure I-2-5

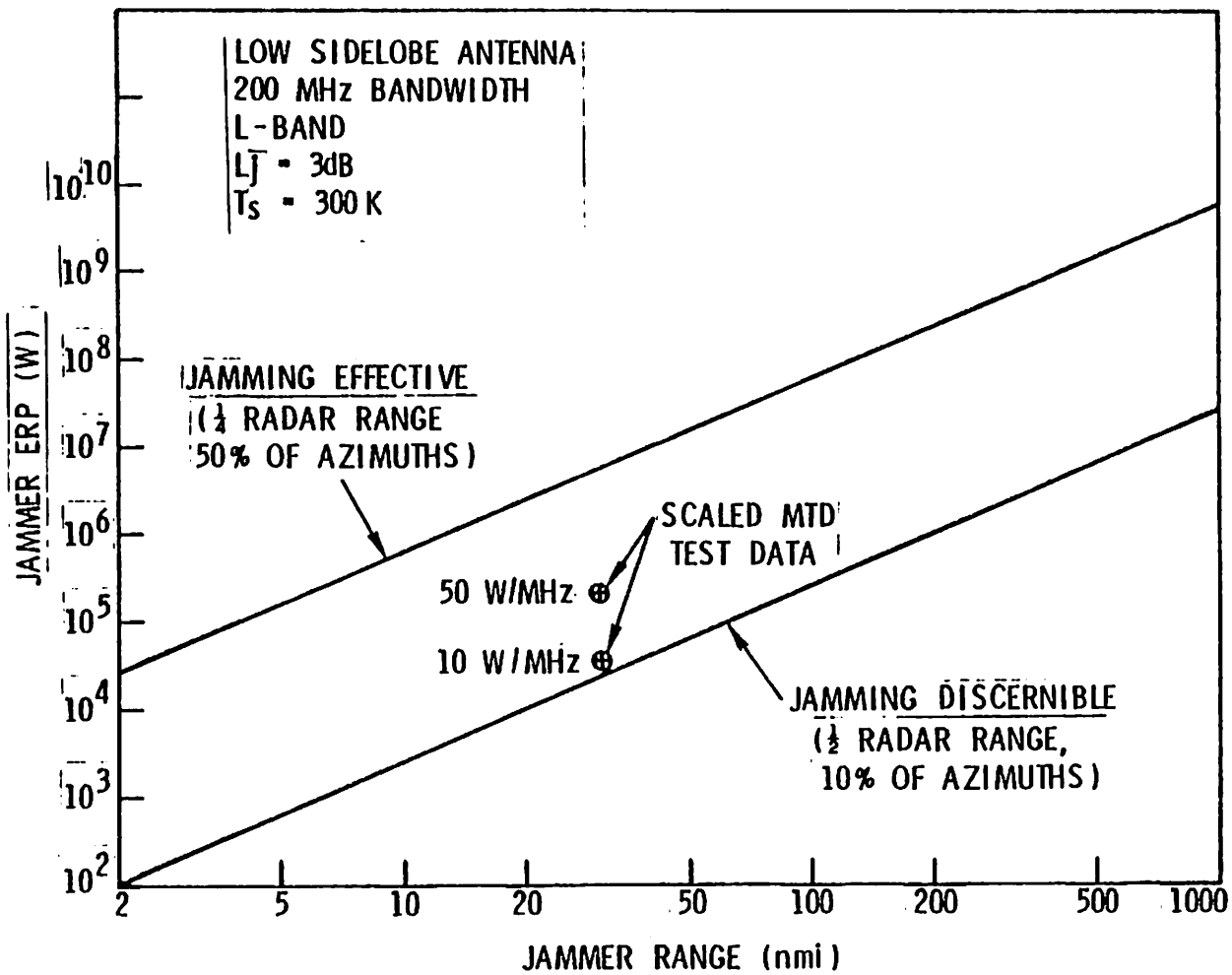
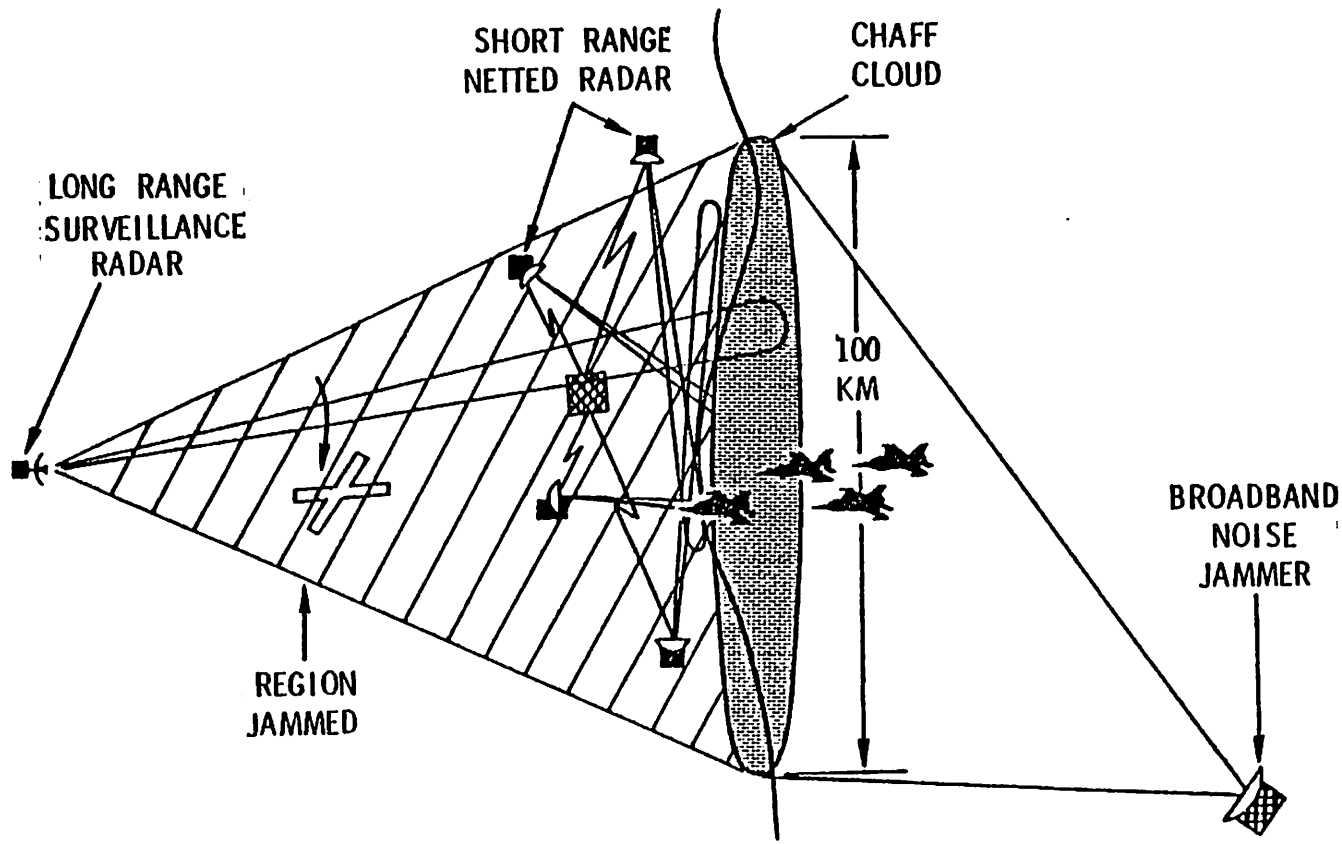


Figure 1-2-6

SECRET

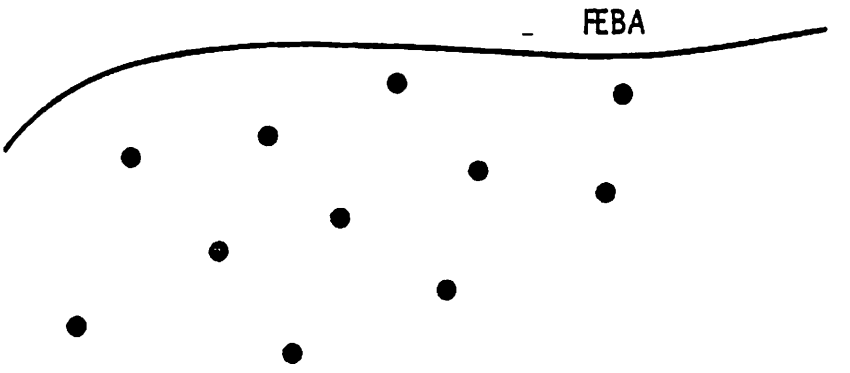
(S) NOISE ILLUMINATED CHAFF (U)



SECRET

Figure I-2-7

(U) RADAR NETWORK



AVERAGE SPACING: 30-60 KM

SPACING NEEDED FOR:

- LOW ALTITUDE COVERAGE (AIRCRAFT AND HELICOPTERS)
- ANGLE DIVERSITY AGAINST JAMMERS
- PASSIVE DF AND TOA ON JAMMERS
- REDUNDANT COVERAGE

FIGURE I-2-8

ADVANTAGES OF NETTED RADARS

LESSENED VULNERABILITY TO ENEMY COUNTERACTIONS

- NETWORK LESS FRAGILE (self-healing)
- LOW-COST RADAR REPLACEMENT
- GOOD GEOMETRY TO COUNTER MAIN LOBE JAMMING
- JAMMER LOCATION USING DF AND TOA
- EMISSION CONTROL WITHOUT LOSS OF COVERAGE (e.g., blinking against ARMs, Sector Jammer burnthrough)

GEOMETRY

- IMPROVED LOW-ALTITUDE COVERAGE
- HEIGHT FINDING USING TWO OR MORE RADARS

A completely developed radar network should include the output of as many radars as possible. A great diversity of radars and radar types is to be encouraged because enemy action will usually be selective. Specific radars (e.g., AWACS) will probably receive a lot of attention by the enemy. They will be subject to physical and electronic attack. Some radars suggested for inclusion in the network are AWACS, TPS-43s, HAWK PARS, PATRIOT Radars, FAAR, Roland's surveillance radar. Many of these will require improvement to be able to automatically acquire and track all aircraft. Few presently have that capability, but the technology is here.

The importance of automatic acquisition and tracking cannot be stressed enough. When faced with the ID problem in a hostile environment, the netted system can maintain track and identification and pass on track data information that any particular air vehicle is a friend or foe. The enemy will make a great effort to jam everything on the battlefield including radar, communications and possible ID systems. The output of any equipment which is still effective must be carefully gathered and distributed. Thus once an aircraft is identified in a netted radar system, its track can be maintained and does not have to be reidentified when it reappears at any given radar. In addition, the use of radar netting to pass identified tracks results in fewer interrogations by ground units.

In conclusion, a properly designated set of multi-functional radars uses the outputs of a multiplicity of sensors, each of which may be fragile on the battlefield. However, the network can be employed to maintain and make maximum use of any information which is available. AD systems should consist of netted multi-function radars for which identification can be considered a major function in addition to surveillance and tracking. The maintenance of continuous tracks due to effective netting of the radars and TDOA systems provides a major contribution to indirect identification capability.

(C) e. Proposed Technology Initiatives. In this section some techniques which the Task Group feels are promising for research at the 6.1, 6.2 and 6.3 levels are briefly discussed. The techniques discussed are those for which the Task Group sees some specific use and hope of success. Other directions of research may also be worth pursuing but are not mentioned because they have not come to the attention of the Task Group or fall outside the competence of the Task Group members. Therefore, just because a technique or area of research is not mentioned, it should not be concluded that the Task Group feels it should not be pursued. Also, some obvious technologies of potential future use to ID operations, such as two dimensional infrared detector arrays and very large scale integrated circuit chip technology, are of such importance in many other applications that their primary justifications were assumed to come from the other applications.

(C) (1) 6.1 Technology Programs. There exist two computerized shape recognition techniques which appear sufficiently promising to be deserving of continued support at the basic research (6.1) level. They are as follows:

- Computerized Visible Spectrum Shape Recognition.

The Electrical Engineering Department at the Ohio State University under AFOSR support has demonstrated some success at computerized shape recognition of aircraft silhouettes in a plane normal to the optical axis of an electro-optical sensor such as TISEO. The results evidenced a misclassification rate equal to or slightly better than that of trained human observers. Performance of the computerized system is independent of the training and skills of the human operator. This technique appears to be applicable to short range vehicle mounted, fair-to-good visibility weapons such as Vulcan and Chaparral.

- Computer Shape Recognition from FLIR Data.

Work at the U.S. Army Night Vision Laboratory (NVL) has demonstrated some success at identification of aircraft silhouettes by human observers from FLIR images. The successes in computer identification of visible images suggests that the technique should be tried with FLIR images. If successful it would be applicable to short range, vehicle-mounted, daylight, fair-to-good visibility weapons such as Chaparral and Vulcan and extend their utility to night, fair-to-good visibility conditions. A FLIR is presently being developed for Chaparral.

- Optical and Millimeter Wave Absorption Band Structure and Effects.

By operating in the wings of an atmospheric absorption band, attentuations much greater than $1/\text{range}^2$ can be obtained. This permits operation at some short ranges with high immunity to detection, exploitation and jamming at longer ranges and with a relatively short transition between the two regions. The range at which the transition occurs is adjustable by selection of how far into the wing of the absorption band operation is positioned. Such absorption bands occur in the ultraviolet, the infrared and the millimeter regions. Operation of identification devices in these regions can deny an enemy the ability to detect, exploit and interfere. At the basic research (6.1) level, where needed, measurements should be made of the characteristics of these bands and analyses should be made of the performance achievable by operating in the wings of these bands, i.e., the ranges at which operation can be had, the position and width of the cut-off region and the degree of protection obtainable in the beyond-cut-off region.

- Radar Identification of Helicopter Rotor Doppler.

In the early 1970s the Environmental Research Institute of Michigan (ERIM) (then called the Willow Run Laboratories (WRL) of the University of Michigan) under DARPA support built and demonstrated a system which identified helicopters from their acoustic signals. In the presence of a CH47

helicopter and two propeller drive aircraft good recognition was obtained on UH 1 and OH 6 helicopters. At one kilometer range 100% recognition of UH 1 and OH 6 helicopters was demonstrated with no false alarms. At 2 kilometer range 85% recognition was obtained with no false alarms. At 7 kilometer range occasional recognition was obtained with no false alarms.

The same rotor motions causing the acoustic signals will certainly cause doppler shifts in reflected radar signals. It seems probable that these doppler shifted signals can be analyzed to produce identification. If successful, this technique should be applicable to many of the existing doppler radars. It is recommended that this technique be investigated at the exploratory development, feasibility measurements (6.2) level. It may provide identification capability for helicopters for which there exists no present alternative other than visual methods.

(C) (2) 6.2 Program. (U)

- Optical Spectral ID for Use with Optically-Sighted Weapons.

Optical identification methods are not all-weather devices, but do match the regimes of applicability of optically-sighted weapons such as Stinger and REDEYE. Work has been done on using distinctive spectral signatures in jet engine plumes due either to naturally occurring trace constituents or to deliberate additives as a basis for identification. All the methods known suffer from marginal available spectral power to work with. For purposes of optical spectral identification, it would seem always preferable to mount on the aircraft narrow-band active optical sources such as lasers, flash lamps, etc. These have the advantages of adequate spectral power density and being capable of modulation or coding. As individual components, all elements required for such a system exist such as sources, receivers and modulation or coding mechanisms. The receivers are inherently small enough to be carried by Stinger and REDEYE operators and the sources are small and lightweight enough to be mounted on aircraft and helicopters without undue

difficulty. It is recommended that a 6.2 level design and developmental effort for such an identification device should be initiated for a small, lightweight identification capability matched to the range and regime of operation of Stinger and PEDEYE type weapons. Because of their inherent short-range and narrow bandwidths, they have reduced vulnerability to enemy interference. They are self-contained at the point of fire and can be turned off over enemy territory to avoid exploitation. No such program is presently known to exist.

(C) (3) 6.3 Programs. (U)

o Range Profiles by HRR.
The Naval Electronics Laboratory Center at San Diego has demonstrated some success in aircraft identification by analyzing range profiles of the aircraft using high range resolution (high bandwidth) radars. If successful, the technique would be long range, all weather, day and night in operation. The technique appears very promising and may be competitive to TRISAT/DMR with the advantage that performance would extend more nearly to the full detection range of the radar.

o Range Profiles by MFR.
The Ohio State University under AFOSR support has shown that aircraft range profiles can be derived from analysis of radar returns at several different frequencies. This is a multiple frequency analog of the HRR technique described immediately above. It would be long range, all weather, day and night in operation. The multiple frequency requirement is not compatible with most existing radars. However, the multiple frequency aspect may be of advantage in multiple-aspect signature sorting identification processing and jam resistance.

o Three-Dimensional Laser Imaging.
Within the last two years ERIM under Air Force and DARPA sponsorship has demonstrated a three-dimensional laser sensor coupled with a new shape recognition computer and associated shape recognition algorithms which can identify ground targets from aircraft

platforms in real time. This technique should be explored for the ground-to-air identification problem. It would be applicable to short range, fair-to-good visibility, daytime weapons such as Chaparral and Vulcan and, when cued, could possibly extend operation to night, fair-to-good visibility conditions.

(U) f. Impact of Proposed Improvements on Procedures. Current procedures within the Central Region are driven by the lack of an effective technologic solution to the identification problem and to the lack of position control over the SHORAD system. Although some procedures will always be required, major breakthroughs in technology for both direct and indirect identification systems such as those proposed above will significantly overcome procedural dependence.

In working toward this overall objective, there will be a number of programs which could be introduced to improve current operations. Such programs as JEM and EIFF added to SAM systems are examples which could improve immediate point of fire capability.

As a result of these anticipated short-term technological innovations, including command and control, procedures will be in a continual dynamic state of change. In developing these procedures, it is essential that provisions be included for allowing immediate fire by the weapon system upon identification.

With the advent of a truly effective identification system in the late 1980s to early 1990s, it is likely that current, cumbersome safe passage and sanctuary procedures could be eliminated altogether. Improvements in the area of point-of-fire identification reliability, automated data exchange and processing and communications will permit this important shift away from dependence on the current unrealistic and cumbersome procedures used and rules-of-engagement used to achieve the best compromise between AD systems effectiveness against enemy air vehicles and fratercide using the current systems with their serious deficiencies.

(S) III. APPENDICES. (U)

(S) APPENDIX A. (U)

(S) A. CURRENT MK X/MK XII CAPABILITIES. (U)

(U) The IFF MK X SIF system is widely used throughout the U.S. and NATO for air traffic control. The MK XII system, consisting of the MK X plus the Mode 4 crypto-secure interrogation link, is widely used in current U.S. and Canadian military aircraft and will be implemented in German aircraft in the near future. However, the remainder of NATO has not adopted the MI XII system, principally because of its many limitations.

(U) Chart I-A-1 briefly outlines some of the important system characteristics. In most normal installations, the MK XII will operate at ranges substantially in excess of the ranges of the radars with which they are associated.

(U) The basic MK X/MK XII system incorporates technology and techniques that are 15 to 20 years old and it has been estimated that a total of approximately $2 billion has been spent over the years in its development and fielding. There have been sporadic attempts to update the system and a number of different equipments are now in the field. As a result, the system suffers from a variety of equipment reliability and field maintenance problems, as well as a few interoperability problems.

(S) In addition, present MK XII systems have a variety of widely-known weaknesses such as relatively easy exploitation, jamming and spoofing; weaknesses that potentially could prove disastrous or, at best, make the system useless in a sophisticated ECM environment.

(U) However, because of limited funding, the need for continued peacetime air traffic control and the probability that many years may elapse before a new system could be deployed, it is important that a

CHART I-A-1

(C) CURRENT MKX/XII CHARACTERISTICS (Ref 1,2) (U)

(Interrogate 1030 ± 0.2 MHz; reply 1090 ± 3 MHz; vert. polar.)

	MODE	CHARACTERISTICS
MK XII IMPROVEMENT	1	Double-pulse interrogation, 0.8 ± 0.1 µs pulses, 3 ± 0.1 µs spacing. 32 reply codes changed at 30 ± min. intervals 0.45 ± 0.1 µs pulses a/c mission reply
MK XII / MK X (SIF)	2	Double-pulse interrogation, 0.8 ± 0.1 µs pulses, 5 ± 0.2 µs spacing. 4096 reply codes set on ground, changed when required. 0.45 ± 0.1 µs pulse. Tail No. reply (in formations only lead a/c replies).
MK XII / MK X (SIF)	3A*	Double-pulse interrogation, 0.8 ± 0.1 µs pulses, 8 ± 0.2 µs spacing. 4096 reply codes changed at 30 ± 1 min. intervals. 0.45 + 0.1 µs pulses. Military function and special ID reply.
MK XII / MK X (SIF)	C*	Double-pulse interrogation, 0.8 ± 0.1 µs pulses, 21 ± 0.2 µs spacing. 1278 reply codes. 0.45 ± 0.1 µs pulses. Altitude reply.
MK XII	4	Multiple-pulse interrogation, 0.5 ± 0.1 µs pulses, 32 pulse positions spaced 1µs, randomly occupied under crypto control. Three-pulse reply, 0.45 + 0.1 µs pulses, 1.8 ± 0.2 µs spacings. 16 possible time delays, 4 µs spacings, crypto selected.
MK XII IMPROVEMENT	5	Improvements, such as rapid code changes, improved decoders and decision logic, diversity and monopulse antennas, to reduce vulnerability to exploitation, jamming, saturation, and spoofing.

*Extensively used by the FAA for air traffic control

hard look be given to the possibilities for gracefully upgrading the present MK XII system so that it will remain downward compatible with existing systems and control facilities.

(S) B. DEFICIENCIES OF MK XII, MODE 4. (U)

(U) 1. Introduction. Extensive studies of the various deficiencies of MK XII have been undertaken and a variety of improvements have been proposed for many of these. It is clear that the operational impact of these various deficiencies is highly scenario-dependent - but the Task Group has restricted its consideration to those of greatest concern in the NATO AD environment. Many of these deficiencies are being tackled by the Tri-Service/NSA MK XII Technical Improvement Program begun less than a year ago and coordinated out of the AIMS Systems Program Office.[4]

(S) 2. Reliability. Three forms of reliability will be distinguished:

(C) a. Equipment or Hardware Reliability. (U)

(U) (1) Equipment reliability questions have been raised which not only impair operational utility but reduce operator confidence in the system. No complete quick check-field equipment appears to have been developed to satisfy this need. The interrogators, in particular, appear to be a weak link in the system due to some highly stressed components in the transmitter.

(C) (2) It must be noted that this problem is being addressed by at least two groups:

(a) MI XII TIP at Robins AFB:

- failure statistics
- replacement of hi-failure module (contractor: Hazeltine)
- development of a new LWI

(b) MK XII Improvement Program at the Naval Research Laboratory:

- developmental E.B.S. solid-state power amplifier (contractor: Watkins-Johnson)

(U) (3) It should be noted that a greater commonality among the equipments fielded by the various users could improve reliability, improve interoperability and probably reduce costs and logistic problems.

(S) b. Interrogation Reliability. (U)

(U) (1) In addition to equipment reliability, the MK XII system has problems with the reliability of a single interrogate/reply round trip called "round-reliability." Round-reliability is a function of a great many variables including scenario-dependent factors such as multipath propagation, range, numbers of interrogators and transponders, ECM environment, etc., as well as equipment characteristics such as antenna sizes and locations, decision logic, etc. It should be noted that round-reliability is not to be confused with the reliability of a complete interrogation sequence, which usually consists of a number of rounds, depending on equipment design and decision logic. This is often called "interrogation reliability."

(S) (2) To obtain a better insight into the effect of round-reliability on interrogation-reliability, it is interesting to quote from Reference 11, Volume I, page 43, regarding the HAWK interrogator: "To obtain a friend-acceptance probability of 99%, E_T (round-reliability) must be higher than 70%. Although the figure of 99% friend acceptance probability appears high, it does mean that an average one out of each 100 friends will be attacked by each HAWK missile they approach." Typically, friend-acceptance reliability drops rapidly when round-reliability drops below 70 or 75%.

(C) 3. Exploitation. (U)

(C) a. It is felt that possible exploitation of the MK XII, Mode 4, is one of its chief weaknesses in a sophisticated ECM environment. This exploitation can be done in several ways, either passive or active. Obviously the enemy can passively DF and track a squawking transponder or interrogator. In addition, the enemy can record one or many valid interrogations that can be used to trigger any of our MK XII, Mode 4 transponders enabling him to identify and track his targets. This interrogation is useful for up to 24 hours, although one of the fixes proposed for Mode 5 would change codes so rapidly that this form of exploitation could be negated unless the enemy almost continuously monitored and repeated our interrogations. It would be relatively easy for him to receive AWACS interrogations from well behind the FEBA.

(C) b. Even without recording one of our interrogations if the enemy understands the system he can guess at our interrogation code with a probability of guessing correctly one in 256 tries. But once found, this code would be correct for up to 24 hours. Again, techniques have been developed, such as that above, to limit the utility of this form of exploitation.

(C) 4. Jamming. (U)

(C) a. Although either the interrogator or transponder receivers can be degraded or inactivated by the enemy by any form of jamming, CW and AM or FM modulated CW jamming requires the most assets, pulse width and amplitude noise jamming is easier and intelligent jamming is easiest of all.

(C) b. For instance, a series of pulse triplets can be sent to the interrogators appearing as a series of asynchronous or invalid replies (fruit), overloading the system and reducing the probability that friendlies will be properly identified. In addition, the instantaneous sidelobe suppression circuitry in the transponder can be

inhibited by suitable pulse sequences, also reducing the time available for or preventing valid interrogations.

(C) c. Another form of intelligent jamming simply over-interrogates Modes 1 to 3 (SIF). Although the transponder will not reply to these modes when set on Mode 4, it forces the receiver to separate these interrogations from valid Mode 4 interrogations. This, too, can load up the system and the design of this decoder directly effects round reliability.

(U) d. Even in a friendly environment, over-interrogation, caused by a multiplicity of over-active interrogators and/or transponders (garble), can be considered a form of self-jamming, reducing receiver sensitivities (hence range) and reducing round reliabilities.

(C) e. The design requirements specify an interrogation rate control on the transponder for Mode 4, adjustable from 1500 to 3000 interrogations per second above which the sensitivity is gradually reduced. It is noted that in NATO, STANAG 5017 recommends that this ACC be set at 1200 replies/second.[11] These rates are rarely exceeded in estimates of the NATO environment without ECM.[11]

(C) 5. Spoofing. (U)

(C) a. Spoofing, or pretending to be what you are not, appears to be one of the least likely threats in the NATO environment. For instance, since the reply code is fixed and well known (3 equally spaced pulses) and only the time delay is coded, an enemy aircraft could guess at the time delay associated with each round and be correct 1 time in 16. In fact, he would be correct on the average 1 time in 16 with a fixed time delay. However, if a given reply evaluator requires n correct replies, then the probability of guessing all of them is only 1 in 16^n.

(C) b. A more likely tactic is for the enemy to repeat the reply of a nearby MK XII transponder and appear as a "friend" of the interrogator. Since the enemy can measure the time difference between the interrogation and the reply from a nearby transponder, he can measure the appropriately delayed response to that interrogation. A fix to this called "Wooden Duck" has been implemented for the AN/APX-103 interrogator for AWACS. In this case an incorrect interrogation and reply are transmitted by the interrogator; the enemy repeats, the friend does not.

(C) c. Another possible form of spoofing repeast interrogations so that a nearby MK XII transponder is triggered to reply properly. If the timing and geometry are correct, the reply arrives at the friendly interrogator in time to make the enemy appear as a friend.

(S) C. PROBLEMS OF THE NEAR-TERM FIX TO MK XII IFF. (U)

(S) 1. While the fixes to the MK XII IFF can deny replies to unfriendly interrogators and thus deny their exploitation of our MK XII signals, it will not prevent other than "interrogation-type" exploitation.

(S) 2. A "non-interrogation-type" exploitation occurs when hostile forces track our MK XII signals by passive means. One such means is by a direction finder. In a not too dense environment this would be sufficient. In a dense environment, TDOA techniques can be used. If hostile forces use TDOA techniques every signal radiated by our aircraft will be tracked and tracked accurately.

(S) 3. Our intelligence informs us the Czechs have had an AD TDOA system for two years. The Soviets are believed to have two mobile systems in the Baltic area. We know its Soviet nomenclature. The Hungarian AD has one system just completed. The romanians are believed to be starting one system. Certainly in five years we can expect to see widespread deployment of the TDOA system.

(S) 4. When the deployment of the TDCA system is completed, the MK XII signal will be exploitable, with or without the proposed fixes tentatively called Mode 5. The value of the MK XII fixes which appear to have only limited life is thus questionable.

(U) D. RECOMMENDED ACTIONS.

1. If technical improvements of MK XII are not deemed worthwhile, it is still necessary to overcome the hardware and operator reliability problems associated with the peacetime use of present equipment. Therefore, it is recommended that more complete statistical studies of failure modes be undertaken and appropriate corrective measures begun. It is also recommended that greater equipment standardization among the various users be strongly encouraged. Furthermore, it is recommended that greater testing of the complete system be undertaken and present deficiencies such as those associated with inadequate antenna installations corrected if they significantly affect operational capabilities. Some of these may already be in progress[4] under the MK XII Technical Improvement Program.

2. Greater system testing is compatible with a recommendation that substantially more training and exercise with the MK XII, Mode 4, be undertaken to increase operator familiarity with the equipment, both its capabilities as well as its limitations. Only in this way can the capabilities, limited though they may be, be used to maximum benefit in the event of war. If distrust and unfamiliarity are allowed to persist, the equipment will never be utilized.

3. If technical improvements to the MK XII are deemed worthwhile, then, in addition to the reliability improvement program recommended above, it is recommended that the following efforts be accelerated:

a. Anti-exploitation techniques:

- rapid, synchronized code changes

- reexamination of coding strategy, (perhaps negating the need for code changes)

b. AJ and spoofing techniques, if they can be done at minimal cost and in connection with circuit modernization and/or miniaturization efforts for future systems.

(S) APPENDIX B. (U)

(S) A. AIR DEFENSE IN THE 4th ATAF. (U)

(U) 1. Introduction.

a. The purpose of this paper is to provide background information on the execution of AD in NATO as it is today with emphasis on wartime identification of friend from foe. The NATO Central Region further delineated to the 4th ATAF area was selected due to its importance and location of major U.S. forces.

b. AD in the Central Region is based upon the principle of total integration of Allied Air Defense Forces. Operational control of these forces has been delegated by Commander AAFCE from his location at Boerfink Bunker to Commanders, 2nd ATAF at Maastricht, The Netherlands and the 4th ATAF at Kindsbach, Germany. Organized structure as in Figure I-B-1. The functional responsibilities of the 4th ATAF Air Defense Command and Control Agencies is at Attachment 1.

(S) 2. Mission. Commander, 4th ATAF AD mission is:

(S) a. In Peacetime. (U)

(S) (1) To preserve airspace integrity by conducting AD operations against un unauthorized intrusion, within the scope of higher NATO headquarters' directives.

(S) (2) To assess and provide early warning of attack.

(S) (3) To direct a state of readiness of 4th ATAF command forces commensurate with the development of the air situation and which will ensure an immediate and effective reaction.

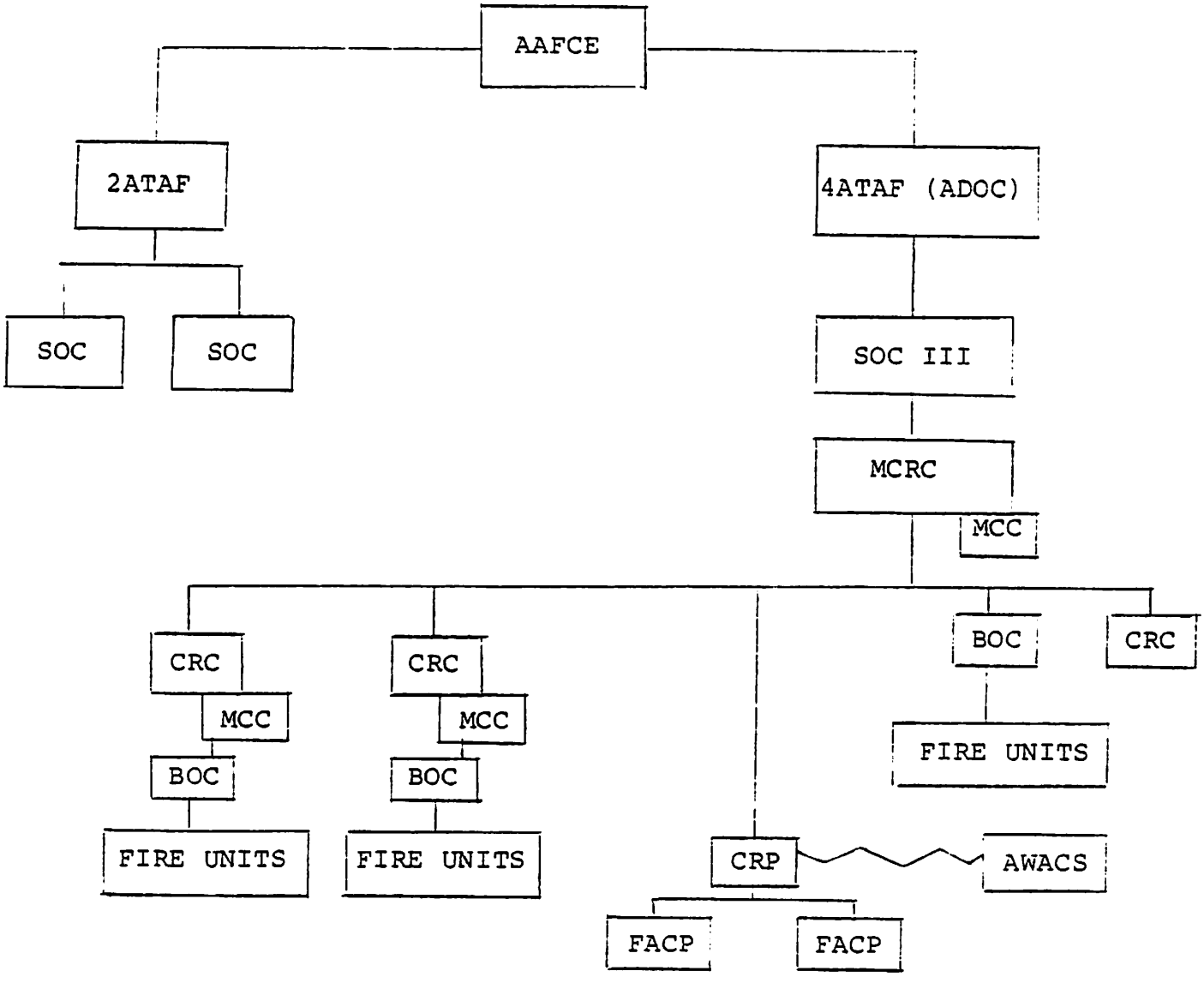


Figure I-B-1

Figure 1

(S) b. In Wartime. (U)

(S) (1) To defend the 4th ATAF area against air attacks with the first priority given to protect the nuclear counter offensive forces and installations.

(S) (2) To impose the maximum attrition on enemy air.

(S) (3) To provide a favorable air situation to designated times in specified areas.

(S) 3. Command and Control. The command and control of 4th ATAF are vested in ATAF Modes of Control which establish the level at which the authority to order engagement of AD weapons exists. The mode of control will be declared by Commander, 4th ATAF, the Sector Commander, or by the highest authority retaining communications with subordinate formations in the event of communications loss. These modes of control have the purpose of retaining control of AD operations at the highest level.

(S) a. ATAF Mode of Control may be designated at any time by Commander 4th ATAF for the purpose of retaining tactical control of all AD forces. Commander, 4th ATAF will direct tactical operations from the 4th ATAF ADOC. This mode may be implemented to cope with specific political or military complications which may escalate to a limited action and, subsequently, to general war.

(S) b. SOC Mode of Control is the normal mode of control. The SOC Commander exercises tactical control of AD operations from the primary or alternate SOC locations. This mode will be maintained as long as possible in peace and war. This is the normal operational mode for HAWK and NIKE forces during Phase "A" and "B". See Attachment 2, SACEUR's Rules of Engagement.

(S) c. MCRC Mode of Control will maintain centralized management of forces and defensive weapons. It will be in effect when SOC mode of control is not possible from the SOC or its

alternate, or when directed by the SOC Commander, or when communications are lost to the SOC. The Commander of the MCRC or alternate MCRC will be the battle commander and will exercise tactical control over the assigned/available AD forces within Allied Sector Three. During Phase "B" and wartime, when MCRC mode of control is implemented because of loss of all communications to higher authority, Commander 4th ATAF automatically authorizes the MCRC battle commander to direct engagement within the 4th ATAF area.

(S) d. CRC Mode of Control is the highest decentralized mode of control. It will be implemented when directed by the Sector Commander or when MCRC mode of control can no longer be maintained or when communications are lost with higher authority. The purpose is to retain as much control as possible over AD forces under degraded conditions. When implemented, the Master Controller of each CRC will become the AD Controller responsible for AD operations within his area of responsibility. All AD forces under the control of a CRC will be responsive to the AD Controller. During Phase "B" and wartime, when CRC mode of control is implemented because of loss of all communications to higher authority, Commander 4th ATAF automatically authorized the CRC AD Controller to direct engagements in his area of responsibility.

(S) e. Wing/Squadron, Battalion/Battery Mode of Control. In the event no control of AD forces can be maintained above unit level, the local unit commander may assume control of AD operations. The Battalion or Battery commander, as appropriate, exercises control over SAM engagements. The following procedures apply:

(S) (1) Communications with higher NATO authority exists. The Battalion/Battery commander will:

(a) Take necessary tactical action to employ forces under his control in

accordance with the effective WEZ and weapons/warhead control order established by the higher NATO authority.

(b) Order engagement of hostile aircraft in accordance with the applicable Rules of Engagement.

(c) Request permission from the controlling NATO authority to establish the Battery mode of control when deemed necessary. (Applicable to Battalion mode only.)

(S) (2) All communications with higher NATO authority are lost. The Battalion/ Battery commander or highest authority retaining communications with these levels of command will:

(a) Establish appropriate WEZs.

(b) Declare appropriate DEFREPs.

(c) Issue appropriate weapons/warhead control orders.

(d) Order engagement of hostile aircraft in accordance with the applicable Rules of Engagement. It is emphasized that so long as SACEUR's Rules of Engagement are in effect (i.e., until General Alert or Cancellation of SACEUR's Rules of Engagement) Battalion/Battery commander will order engagement only in self-defense.

(S) 4. Identification. (U)

(S) a. IFF/SIF (MK X or MK XII) is the primary means of identification of friendly aircraft within the Central Region. Any aircraft not possessing an operational IFF/SIF set should avoid overflying the Central Region unless accompanied by an aircraft which does have operational equipment. Within the Central Region a mixed IFF/ SIF MK X/MK XII environment will exist until such time as a common NATO-wide identification system has

been fully implemented. During this time, units must challenge on MK X (SIF) and, if fitted, Mode 4. The IFF MK XII equipment is a crypto secure identification system. It consists of IFF MK X (SIF) and cryptographic mode of operation, Mode 4. Mode 4 may be employed by itself in a designated area or it may be employed in conjunction with Mode 1, 2 or 3 in a mixed environment. The aircrew has complete control over the Mode 4 operation and may select it individually or in conjunction with any of the other available codes.

(S) b. Procedures have been developed for implementation to help ensure safe passage of returning friendly forces crossing the FLOT to include MK X IFF/SIF, Minimum Risk and Sanctuary Levels.

(S) (1) MK X IFF/SIF Procedures. All IFF/ISF (MK X) equipped friendly aircraft are to reply the allocated code to Mode 3 interrogation whenever electronic identification is required.

(a) Allocation Tables. IFF/SIF MK X Mode/Code selection is to be changed every 30 minutes in accordance with NATO allocation tables. At each change-over time there is one minute tolerance before and one minute tolerance after this time. During the 2 minutes tolerance period the old and the new setting is correct.

(b) Implementation. IFF/SIF operational procedures will be in force automatically at the declaration of REINFORCED ALERT or STATE ORANGE.

(S) (2) Minimum risk procedures for friendly aircraft during times of alert and war become effective throughout Central Region upon declaration of REINFORCED ALERT or STATE ORANGE or declaration of the individual measure ROI. They are to be deactivated automatically with the cancellation of the state/stage or individual measure. The common reference line from the minimum risk procedures of combat aircraft is the FLOT which indicates the most forward positions of friendly forces in any kind of military operation at a specific time (see Figure I-B-2).

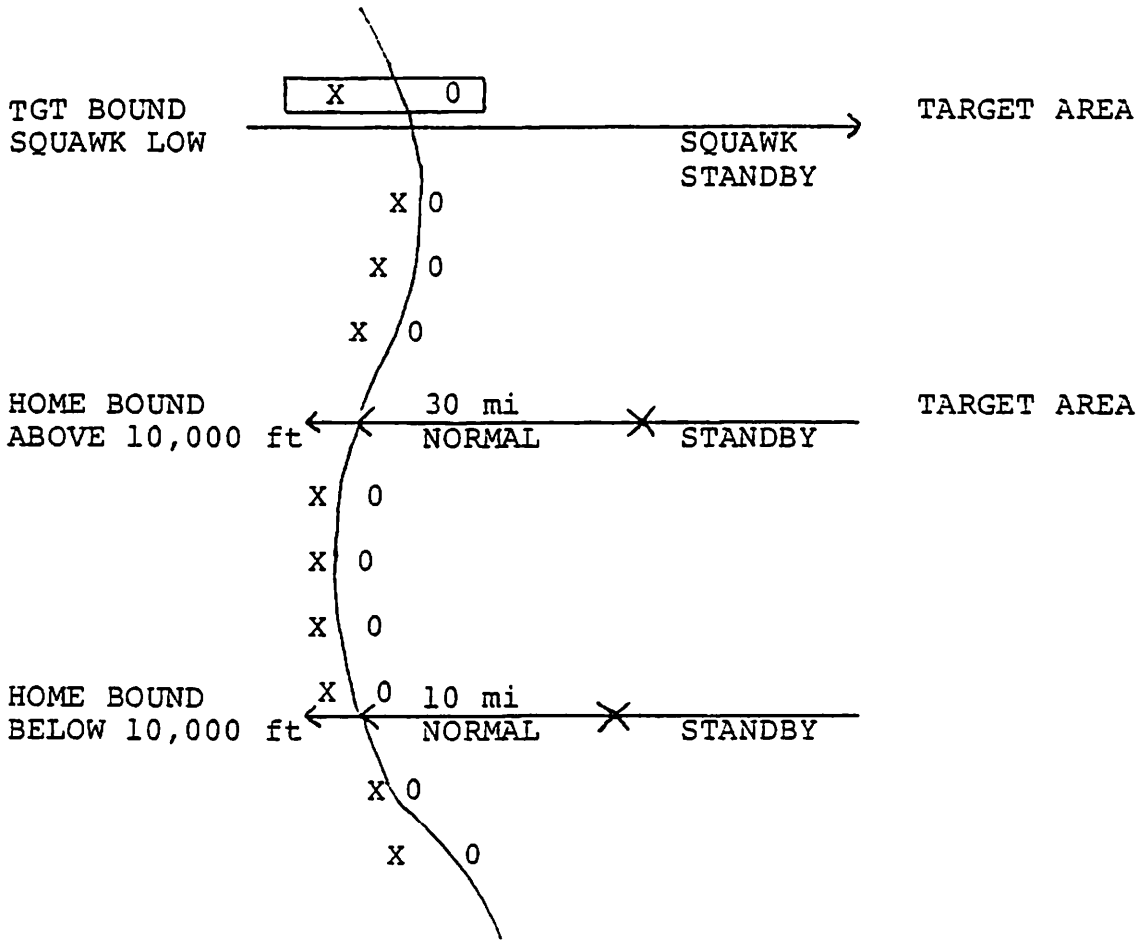


Figure I-B-2
Minimum Risk Procedures (U)
Figure 2

(a) Target Bound Aircraft. Target bound aircraft are defined as friendly aircraft which will be crossing the FLOT into hostile territory. They will squawk "LOW" from the start of the mission until they cross the FLOT. Transponders will be set on "STANDBY" when passing the FLOT.

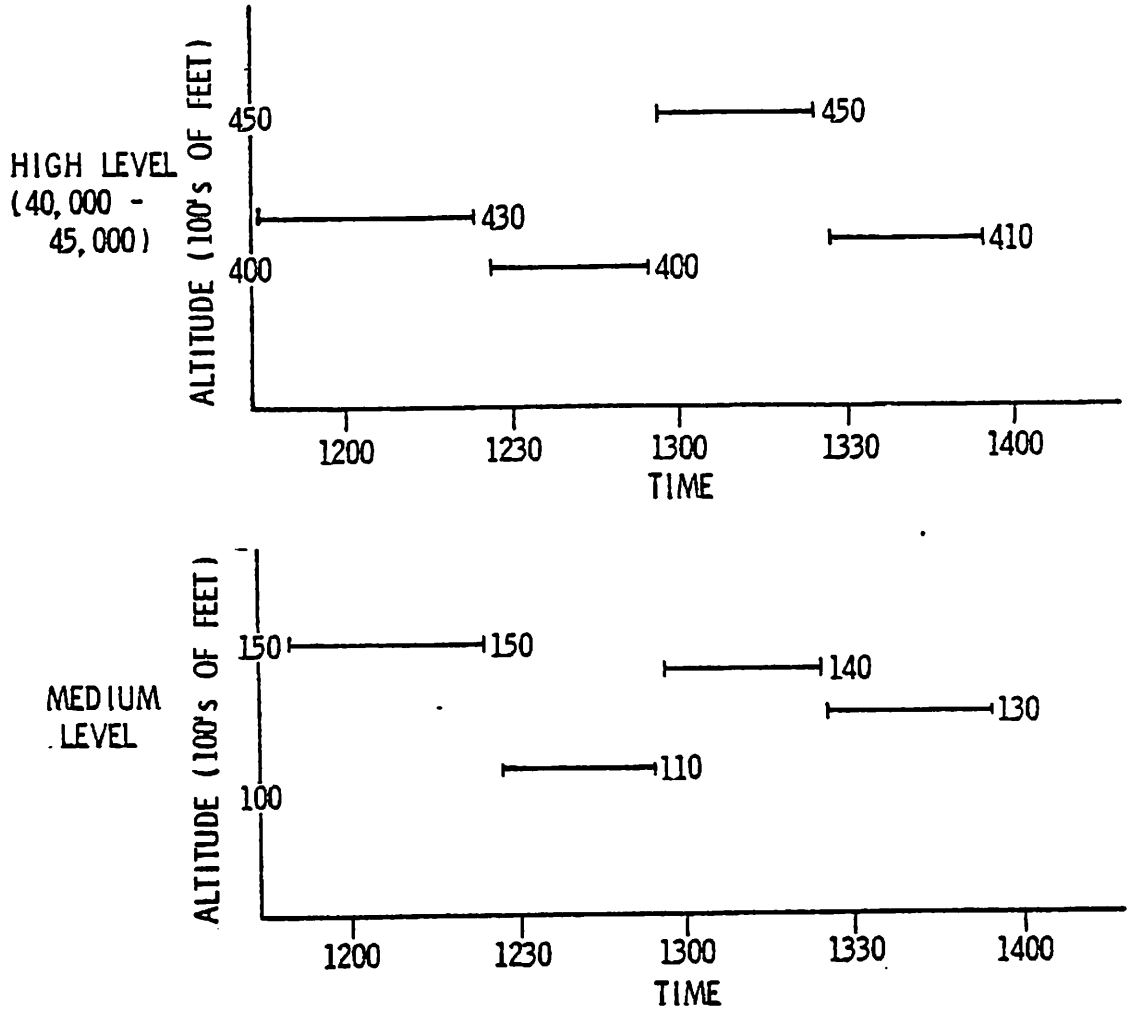
(b) Home Bound Aircraft. Home bound aircraft are defined as friendly aircraft returning from a mission over enemy territory. Aircraft returning at medium or high altitudes (10,000 feet and above) will display the appropriate IFF/SIF codes at least 30 NM prior to crossing the FLOT and will cross the FLOT at the appropriate sanctuary level unless there is evidence that the IFF/SIF is working properly. Aircrews returning at altitudes below 10,000 feet will turn their IFF/SIF to the required codes 10 NM prior to crossing the FLOT and will cross the FLOT at or above 5,000 feet. Provided that the IFF/SIF is functioning properly aircrews may proceed at any altitude above 5,000 feet mean sea level until they have reached their let-down point or crossed the western boundary of the HIMEZ. Aircrews will avoid flying below 5,000 feet mean sea level to prevent inadvertent engagement by friendly SHORAD weapons.

(S) (3) SLP. It is very probable that many friendly aircraft will be returning during periods of intense ECM activity when radar and missile sites will be unable to interrogate the airborne IFF/SIF equipment. Sanctuary levels will provide an additional capability for ground environment facilities to identify home bound friendly aircraft and preclude inadvertent engagement. These procedures will also assist aircrews returning without an operating transponder to over-fly missile defended areas. (See Figure I-B-3.)

Definition. A sanctuary level is a flight level at which an aircraft will not be subject to engagement unless positively identified "HOSTILE" by other means.

Figure I-B-3

(S) SANCTUARY LEVEL PROCEDURES (U)



(a) Sanctuary levels are activated automatically with all other minimum risk procedures at REINFORCED ALERT/STATE ORANGE or declaration of the individual measure ROI. They are to be deactivated automatically with the cancellation of the state/stage or individual measure. However, during the time minimum risk procedures are in force, a situation may arise that SFL procedures may not be desirable for the Central Region.

(b) Aircrew procedures.

1. Aircrews returning at low level, i.e., below 10,000 feet, with the exception of CAS missions and Army aviation, will cross the FLOT above 5,000 feet. If a sanctuary level must be used for protection, a second climb will be initiated so that the sanctuary level is reached 10 NM west of the FLOT. This behavior will be recognized as friendly by missile units.

2. Aircrews returning at high level, i.e., above 10,000 feet will fly at the appropriate sanctuary level when crossing the FLOT unless they rely on IFF/SIF for identification.

(c) HAWK and NIKE Execution.

1. Units will consider and subsequently designate as friendly all aircraft flying on a westerly heading at an activated sanctuary level including buffer of plus and minus 2,000 feet, except when there is evident misuse of sanctuary levels.

2. Sanctuary levels are valid for the same half-hour time periods as IFF/SIF Codes and will be changed concurrent with SIF codes for Mode 3 outlined in ACP 160, NATO SUPPLEMENT 2(A).

(S) 5. AD Weapons Systems Employment. (U)

(S) a. Weapons Systems. In the 4th ATAF area, the AD weapons systems include:

(S) (1) Interceptor aircraft.

(S) (2) SAM systems.

(S) (3) SHORAD weapon systems.

(S) b. Weapons Employment. The weapons systems will be employed as follows:

(S) (1) SAM units are deployed to provide defense of the battle area against enemy aircraft from low to high altitudes and to complement the defense provided by aircraft and SHORAD weapons in the engagement of targets at all effective altitudes.

(a) HAWK units, in conjunction with interceptor aircraft, will be employed in an area termed the FMDZ close to the NATO WP boundary, sometimes called "the belt." When considering redeployments of units for defense of 4th ATAF rear areas, the need to preserve the integrity of the FMDZ must be realized.

(b) Selected HAWK units, together with interceptor aircraft and SHORAD weapons systems, will primarily protect strike bases and other vital areas.

(c) NIKE units, in conjunction with interceptor aircraft, will be employed above the forward SAM and SHORAD weapons systems to engage the enemy at medium and high altitudes.

(S) (2) Interceptor aircraft will be employed in conjunction with SAM forces to provide a flexible weapon system for continuous active AD. The interceptors will normally be employed utilizing CAP patterns located above and west of the FMDZ forming a strong defensive barrier as dictated by the tactical situation. When accomplishing the peacetime air policing tasks, AD fighters are the only weapons that can be used for interrogation/intervention. In wartime, when engagement has been authorized, interceptor aircraft

will normally be employed to destroy enemy aircraft that penetrate through the forward SAM defenses. In addition, they will be utilized to defend areas no longer defended by SAM forces due to destruction by enemy action, denial actions or redeployment of units. Whenever the tactical situation warrants, defensive fighters may be employed in any of the SAM WEZs, in the airspace of WP and neutral countries after border crossing authority has been granted by SACEUR or General Alert has been declared and in the airspace of adjacent sectors after coordination has been effected.

(S) (3) SHORAD weapons will normally be deployed to defend priority point targets, small vital areas and forward divisional areas.

(S) c. WEZs. (U)

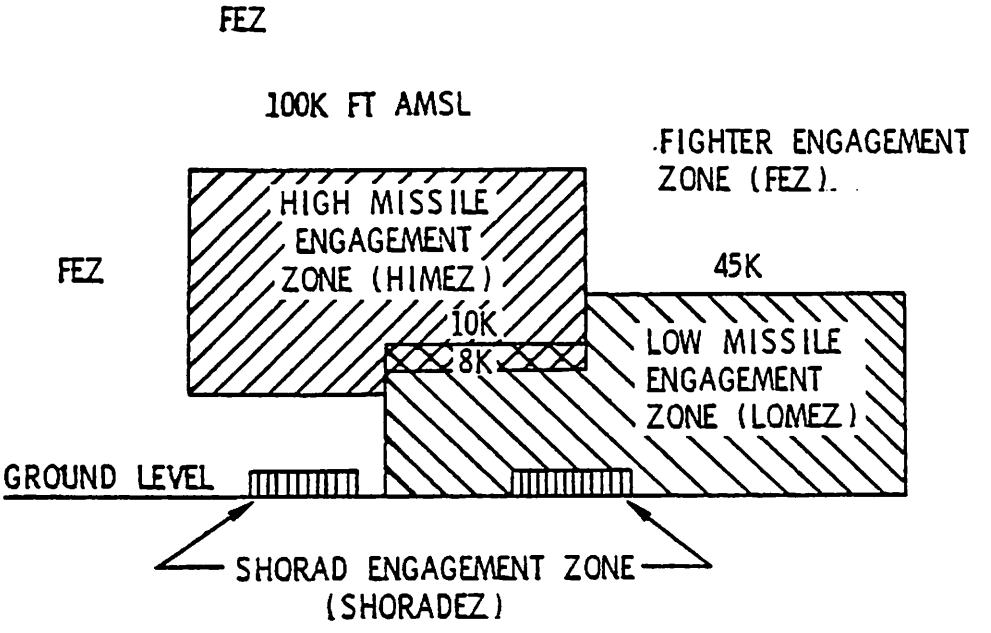
(S) (1) Employment of the AD weapon systems is to ensure that maximum attrition of enemy aircraft is achieved as far from the defended area as practicable and that maximum benefit is obtained from the mixed weapons inventory. As one valuable method of weapons control, each type of weapon system will normally have a predesignated WEZ. (See Figure I-B-4.)

(S) (2) The WEZs provide the AD commander with an orderly and flexible means of coordinating airspace and controlling engagements while a centralized method of operation is in effect. When decentralized or autonomous methods of operation are effective, these zones help to ensure a system within which the weapons can continue engagements in an effective manner.

(S) (3) When a weapons system is assigned a designated WEZ, that weapon has priority of engagement in that zone. Engagements outside the designated WEZ are authorized only under the following circumstances:

Figure I-B-4

(S) TYPICAL WEAPONS ENGAGEMENT ZONES (WEZ) (U)



(a) AD fighter aircraft may engage as directed by the responsible AD commander.

(b) SAM may engage under SAM DISCRETE FIRE.

(S) (4) Commander 4th ATAF or Commander, Allied Sector Three, may activate or modify WEZs for the 4th ATAF area.

(S) d. Simultaneous Engagements. In a centralized method of operation simultaneous target engagements by SAM and interceptor aircraft are normally not authorized. If the situation dictates, the AD commander may, however, specifically direct simultaneous target engagement. In this case, SAM units will insure positive identification of the hostile aircraft prior to engagement.

(S) 6. Interceptor Control Classes. Interceptor control classes advise interceptor aircrews that their operational objectives will be governed by close, loose, broadcast or no control. Interceptor classes are class 4, class 5, class 6 and class 7.

NOTE 1: Classes 1, 2 and 3 are intentionally not used to prevent any misunderstanding with SAM Weapons Control Order Case I, II and III.

NOTE 2: In any of the following control classes, airborne interceptors (especially the F-15) may provide significant assistance to the ground environment system by providing advisories on radar contacts not seen by ground-based radars.

(S) a. Class 4. All intercepts will be accomplished under Close Control, which is defined as an interception in which the interceptor is continuously controlled to a position from which the target is within visual range or airborne radar contact. It is the normal control class and need not be identified as class 4 except when a ground radar unit has been temporarily operating in class 5 or 6 and has returned to class 4.

(S) b. Class 5. All control of interceptors will be conducted by Loose Control, which is defined as a control method in which interceptor aircrews are given information on their allocated target and required to effect their own interceptions with only limited further control. It will be implemented when Close Control is not possible. Constant radio contact will be maintained between aircrews and ground intercept controllers.

(S) c. Class 6. All control of interceptors will be conducted by Broadcast Control, which is defined as a control method in which interceptor aircrews are given information about target movements, enabling them to effect their own interceptions without further control. It will be implemented when Close or Loose Control is not possible. Target information will be broadcasted in the blind giving the following details:

(S) (1) Position of target (raid) in GEOREF.

(S) (2) Heading of target (raid).

(S) (3) Altitude in thousands of feet.

(S) (4) Speed.

(S) (5) Number of targets, if possible.

(S) (6) Any other relevant information.

The acknowledgement of receipt of broadcast control information will be that interceptors move toward the broadcasted targets. This does not preclude the ground radar sites from requesting acknowledgement of broadcast information by a radio response, IFF/SIF FLASH squawk or by an identification maneuver.

(S) d. Class 7. When ground radar sites are unable to provide any control of interceptors, class 7 will be implemented. It requires aircrews to conduct preplanned independent actions within preallocated lanes. If no radio contact can be established with a ground radar site, aircrews will attempt contact with their units and operate in Wing/Squadron mode of control. F-15 aircrews may provide assistance to F-4 and F-104 interceptors in HCAPs and LCAPs by broadcasting any raid information observed on their airborne radar.

(S) 7. Control of HAWK and NIKE Weapons. (U)

(S) a. General. Weapons employment is controlled by establishment of modes of control (paragraph 3 above), weapons control orders, warhead control orders, fire control orders and WEZs (paragraph 5c above).

(S) b. Weapons Control Orders. Weapons Control Orders are used to establish or modify the responsibility for engagement limitations. Definitions of Weapons Control Orders are as follows:

(S) (1) SAM Discrete Fire. Units will only engage those targets allocated by the authority authorized to order engagements. This order is not applicable to the Battery Mode of Control. Units will assist in target detection. As an exception to the Discrete Fire restrictions, improved HAWK fire units initially detecting ADP designated Category I targets within 20 kilometers of the unit location may immediately engage such targets without further reference to higher control authority. This exception is authorized only when the following conditions exist:

(a) General Alert has been declared or SACEUR's Rules of Engagement have been cancelled.

(b) No restrictive Fire Control Order has been imposed for the area wherein the engagement is to occur.

(c) The target is approaching the unit from an easterly direction.

(S) (2) SAM Normal Fire. Units will engage all aircraft which are within the applicable activated missile engagement zone and which have been designated hostile by higher echelons or positively identified by the unit as being hostile (SACEUR's Rules of Engagement prior to General Alert or SACEUR's Rules of Routing and Recognition subsequent to General Alert). Ordinarily, SAM Normal Fire will be used in conjunction with the Battery Mode of Control. Higher tactical control facilities will monitor engagements while capable of doing so. Targets allocated by higher echelons (SOC/CRC/MCC/ BOC) subsequent to SAM Normal Fire will take engagement priority.

NOTE: It is reemphasized that so long as SACEUR's Rules of Engagement are in effect (i.e., until General Alert or Cancellation of SACEUR's Rules of Engagement), on loss of communications, Battalion/ Battery commanders can only order engagement in self-defense.

(S) (3) Implementation of Weapons Control Orders. Fire control of HAWK and NIKE will be retained by the highest tactical control authority capable of exercising centralized direction of engagements. As long as communications exist, only the Sector Commander or his duly authorized representative is authorized to issue weapons control orders. When communications are lost, weapons control orders will be implemented and/or modified as indicated below:

(a) If the weapons control order previously issued was for a prescribed time period, it will remain in effect for the time period specified. At the end of the specified time period, the highest commander who has communications and is authorized to order engagement (MCRC/CRC/MCC/ Battalion/Battery) will issue the appropriate weapons control orders until communications are restored.

(b) If a weapons control order was not issued or was issued without tire limitations, the highest commander who has communications and is authorized to order engagement (MCRC/CRC/MCC/Battalion/Battery) will issue the appropriate weapons control order until communications are restored.

(c) Warhead Control Orders. Warhead Control Orders control the use of NIKE nuclear warheads in the AD role and are discussed at Attachment 3.

(d) Fire Control Orders. These orders are used to direct or inhibit fire and/or to exercise constraints during tactical activity. Fire Control Orders normally apply to engagements on a case-by-case basis and are implemented by ADL and/or telephonically. Definitions of these orders are as follows:

1. Engage. An order issued to a unit by a higher controlling agency directing it to engage/reengage a specific target.

2. SAM Hold Fire. An emergency order issued to prevent engagement of a specific target (friendly or otherwise). When received, the following actions will be taken:

- If a missile has been fired, do not fire and cease tracking.
- If a missile has been fired, destroy the missile immediately, without causing a nuclear burst and cease tracking.

NOTE: Under exceptional circumstances a SAM HOLD FIRE may be applied to a number/variety of AD weapons systems in a specified area for a specified time.

3. SAM Cease Fire. An order directing units to disengage a particular target to preclude simultaneous engagement by

interceptors and HAWK and NIKE, or by two or more HAWK/NIKE units or to prepare for engagement of another target of higher priority. When received, the following actions will be taken:

- If a missile has been fired, permit it to continue to intercept; continue to track the target; do not fire an additional missile; stand by for a subsequent fire control order.

- If a missile has not been fired, do not fire; continue tracking the target; stand by for a subsequent fire control order.

- If the target has to be reengaged, an engage order will be issued; if the target has to be abandoned for engagement of a target of a higher priority, "Hold Fire" will be orderd.

(S) 8. SHORAD. SHORAD weapons include all light anti-aircraft artillery and light surface-to-air missile systems employed in the AD role. Specifically excluded are HAWK and NIKE weapons systems.

(S) a. General Employment.

(S) (1) SHORAD weapons have two principal roles:

(a) To protect the commander's priorities as identified in his concept of operations.

(b) To close the low to very low altitude corridors which are masked to NIKE and HAWK defense because of terrain relief.

(S) (2) SHORAD weapons will, where applicable, be employed in a SHORADEZ when specific ground forces, areas or vital installations of particular importance have to be protected, the criticality of the area warrants so and the possibility exists that other AD means will not be adequate to avoid unacceptable levels of damage to the defended asset. A SHORADEZ is a designated part of the airspace which should be avoided by all friendly air traffic unless sufficient coordination with the local SHORAD commander has been effected.

(S) (3) SHORAD weapons will normally be granted "Weapons Free" against air targets flying inside an active SHORADEZ. However, the SHORAD commander may amend the weapons control orders locally to meet specific coordination requirements of friendly aircraft exceptionally cleared into a SHORADEZ.

(S) (4) Some basic considerations concerning SHORAD employment are as follows:

(a) To receive benefit from the increased effectiveness of modern SHORAD weapons, maximum freedom of action must be permitted them.

(b) Positive identification is of the utmost importance. Therefore, every effort must be made to ensure friendly aircraft are not erroneously engaged.

(c) The primary means of identification in Central Region is IFF/SIF. As most SHORAD weapons systems currently do not have an adequate IFF/SIF capability and radar, visual recognition will remain as essential means of identification.

(d) SHORAD rules of engagement and implementation of SHORAD weapons control orders take into account the fact that currently most SHORAD weapons do not have adequate IFF/SIF.

(e) Establishment of zonal measures and permissive and restrictive weapons control orders will be based primarily on friendly air activity in the given area. Due consideration will be given to employing SHORAD weapons system at maximum efficiency.

(f) When the presence of friendly aircraft in a given area cannot be determined due to lack of effective communications, "Weapons Free" will not normally be authorized.

(S) (5) SHORAD weapons systems will be employed in the SHORAD mode of control utilizing pre-established hostile criteria, weapons control orders and engagement procedures.

(S) (6) SHORAD weapons have been categorized in terms of their capabilities.

(a) CATEGORY 1. This category includes those blindfire capable weapons that fulfill all requirements listed below.

1. Equipped with operational IFF/SIF which enables correlation of all individual targets with IFF/SIF responses received.

2. Have an intercept capability in the height band between 5,000 feet/ 1,500 meters and 10,000 feet/3,000 meters above mean sea level.

3. Can measure target heights below 10,000 feet/3,000 meters above mean sea level.

4. Have effective communications with a command and control agency (SOC, CRC, BOC, ATOC, DASC/ASOC) able to receive and disseminate directives and information on the air situation in the area of concern.

(b) CATEGORY 2. This category includes SHORAD weapons (including self-defense) which through design or loss of capability do not fulfill all the requirements of Category 1 weapons.

(S) (7) SHORAD weapons systems currently employed in 4th ATAF or programmed for future employment in 4th ATAF are indicated below by category:

TYPE	USER	CAT 1	CAT 2
Gepard	Ger	X	
Roland	Ger	X	
40mm L60	Ger		X
40mm L70	Ger		X
40mm Boffin	Cdn		X
Chaparral			
Vulcan	USA		X
20mm Twin-Barrel Gun	Ger		X
20mm Single-Barrel Gun	Ger		X
REDEYE	USA)		
	Ger)		X
Blowpipe	Cdn		X
Machine-Gun of any	USA)		
calibre	Ger)		X
	Cdn)		

(S) (8) All SHORAD units are encouraged to establish communications/liaison with any integrated AD unit able to disseminate necessary information on the air situation.

(S) b. SHORAD Weapons Control Orders. SHORAD weapons control orders are issued to direct or inhibit the fires of SHORAD weapons systems. Inherent in each weapons control order are the constraints which apply to SHORADEZ and weapons systems.

(S) (1) Weapons Free. An order used to indicate that SHORAD weapons will engage all of the specified types of targets within the designated airspace, other than those identified as friendly.

(S) (2) Weapons Tight. An order used to indicate that SHORAD weapons will engage those specified types of targets in the designated airspace which are identified as hostile, or which commit a hostile act.

(S) (3) Weapons Hold Fire. An order used to indicate that SHOPAD weapons will terminate or withhold fire, except in self-defense against a direct attack.

(S) c. General Applications and Restrictions. (U)

(S) (1) To allow for the flexible use of the different weapons control orders, engagement ceilings have been introduced for SHORAD fires. Their application is explained elsewhere in this paragraph.

(S) (2) Whenever practicable, fire restrictions will be minimized on those aircraft with a westerly component (181 to 359 degrees) and maximized on those aircraft with an easterly component (0 to 180 degrees).

(S) (3) "Weapons Free" may either be applied to a specific category of targets (jet aircraft, helicopters, etc.) or to an airspace designated by the NATO AD Commander (SOC-3 or higher). The following prerequisites must be met:

(a) General Alert must have been declared.

(b) "Weapons Free" must be valid for a specific time period.

(c) No friendly air activity in the airspace or specified area during the specific time period "Weapons Free" is in effect.

(d) Operational communications from the engaging unit to a command control agency (organic or external) which has the capability to receive air activity information from knowledgeable authorities (DASC/ASOC, CRC or higher) and disseminate appropriate weapons control orders.

SHORAD units/weapons operating under "Weapons Free" will immediately revert to "Weapons Tight" after loss of communication with its command and control agency.

(S) (4) "Weapons Tight" will be implemented prior to and after declaration of General Alert for all aircraft whenever:

(a) Communications are not available which enable the command and control agency to receive information on the air situation and disseminate directives and necessary information to its SHORAD units/weapons.

(b) Warranted by the employment of friendly aircraft within range of friendly SHORAD.

(S) (5) "Weapons Hold Fire" may be issued by any friendly element which has an identification capability. This order is normally applied to specific aircraft. In an emergency, it may be applied to an airspace.

(S) (6) Category 1 SHORAD weapons will normally be permitted to operate under "Weapons Free" if conditions specified in Attachments 1 and 2 are met.

(S) (7) Category 2 SHORAD weapons will normally operate under "Weapons Tight." Exceptionally, Category 2 weapons may operate under "Weapons Free" in designated areas, against certain target types and directions, for specific periods of time, when authorized by Commander 4th ATAF.

(S) (8) SHORAD/self-defense units weapons deployed with the field army without operational IFF/SIF and lacking two-way communications to the NATO Integrated AD, but having two-way communications to the OAS organization (ASOC, ATOC) may, after ascertaining that communications are operational and that no friendly OAS mission is due, go to "Weapons Free" within a specified area and for a limited time period under Standard Friendly Criteria and the following restrictions:

(a) In an area extending till 10 NM west of the FEBA.

(b) On westbound aircraft (181 to 359 degrees).

(c) On high-speed jet aircraft (more than 300 kts) or armed helicopters visually identified as hostile.

(d) Below 5,000 feet above mean sea level.

(S) (9) SHORAD self-defense units/weapons without operational IFF/SIF but having communications to the NATO Integrated AD will be responsive to weapons control orders issued by the NATO AD Commander. The SOC Commander will issue "Weapons Free" any time the air situation permits to maximize effective employment of SHORAD weapons.

(S) (10) Whenever the air situation or the availability of SHORAD units/weapons with operational IFF/SIF permits the implementation of the weapons control order "Weapons Free," the Commander, Allied Sector Three, will issue this order.

NOTE: Regardless of the status of communications, Commander 4th ATAF can authorize "Weapons Free" for SHORAD/self-defense units/weapons without operational IFF/SIF.

(S) d. Friendly/Hostile Criteria for SHORAD. (U)

(S) (1) The weapons control order "Weapons Free" indicates that SHORAD will fire on all aircraft other than those identified as friendly. An aircraft will be considered friendly if one or more of the Standard Friendly Criteria for SHORAD listed below apply.

(a) Complying with Safe Passage Procedures.

(b) Visually recognized as friendly.

(e) Any aircraft conforming to safe passage procedures but detected committing a hostile act.

(f) Any aircraft being engaged by neighboring friendly organic SHORAD weapons in case communications are operational between the two units or in conjunction with another hostile criterion.

NOTE: An aircraft which is visually recognized by configuration or markings as a friendly aircraft will nullify hostile criteria (c) and (d).

(S) (3) The hostile criteria listed above will be applicable after declaration of General Alert or after cancellation of SACEUR's Rules of Engagement. The fundamental right of a unit to self-defense against any aircraft making a direct attack against the unit remains.

(S) (4) The Commander, Allied Sector Three, may extend hostile criteria with respect to areas and/or times.

(S) e. Safe Passage Procedures. (U)

(S) (1) Basic Means of Identification. It is of the utmost importance to ensure that home-bound friendly aircraft can transit safely through engagement zones of SHORAD weapons. Rapid, reliable and secure means of identification are a desirable objective. To this effect, Safe Passage Procedures have been established consisting of:

(a) IFF/SIF Procedures.

(b) SFL

(S) (2) Information of Friendly Air Activity. All agencies possessing information concerning friendly air activity over the Forward Combat Zone will provide pertinent data to SHORAD commanders. To avoid inadvertent engagement of friendly aircraft, the appropriate SHORAD commander

authorized to issue the weapons control order "Weapons Free" will establish communications/liaison and cooperate closely with those agencies controlling or having information concerning friendly offensive and defensive air activity. Agencies which have this information are CRCs, HAWK BOCs, DASC/ASOCs, TACPs, HLT/ADOLTs, CPs of the LLRS and the Army aviation air traffic control element.

(S) (3) Aircraft Recovery. To facilitate safe recovery and departure of friendly aircraft to SHORAD-defended airbases, standardized procedures will be established by Commander 4th ATAF for his area of responsibility. Each base commander will be responsible for the coordination of the base AD and the recovery of aircraft with the SHORAD commanders. Where several air bases are defended as one vital point, the SHORAD commander will ensure that organizational means for recognition are coordinated for the vital point as a whole. The dimensions of the SHORADEZ as well as approach and departure corridors will be detailed. If the situation so requires, the base commander has the authority to order "Weapons Hold Fire" or "Weapons Tight" in order to safeguard friendly aircraft.

(U) 9. Summary of AD Engagement Controls. (See Figure I-B-5.)

(S) 10. Communications. Communications to interceptor aircraft are, with few exceptions, by voice via UHF radios. Communications from the CRC through the Group level and Battalion level operating centers to HAWK and NIKE fire units are digital and voice via point-to-point, multichannel, UHF radios. All SHORAD C^3 are via voice, although SHORAD units can receive limited alerting data via a one-way digital link from forward area alerting radar.

(U) 11. Conclusions.

a. Current control concepts and procedures are generally adequate within the constraints imposed by existing equipments. Current weapon system abilities to accept and implement currently available control procedures

Figure 1-B-5

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(S) NATO (4ATAF) AIR DEFENSE ENGAGEMENT CONTROLS (U)

INTERCEPTORS	SAM (HAWK, NIKE)	SHORAD
MODE OF CONTROL: WHO HAS ENGAGEMENT AUTHORITY		SHORAD MODE OF CONTROL
WEZ: FEZ	HIMEZ, LOMEZ	SHORADEZ
INTERCEPTOR CONTROL CLASSES: CLASS 4, CLOSE CONTROL CLASS 5, LOOSE CONTROL CLASS 6, BROADCAST CONTROL CLASS 7, AUTONOMOUS	WEAPON CONTROL ORDERS: DISCRETE, VERY CENTRALIZED NORMAL, ENGAGE HOSTILES IN WEZ FIRE CONTROL ORDERS: ENGAGE HOLD FIRE, TO PROTECT FRIENDLIES CEASE FIRE, TO PREVENT SIMULTANEOUS ENGAGEMENTS	WEAPONS CONTROL ORDERS: WEAPONS FREE, ENGAGE NONFRIENDLIES WEAPONS TIGHT, ENGAGE HOSTILES WEAPONS HOLD, ENGAGE ONLY IN SELF DEFENSE

SECRET

are marginal in some areas. Although current procedures can be changed or modified to degrees, they approach maximum potential to enhance integrated employment of AD weapon systems. Equipment improvements are required to achieve further enhancement.

b. Future equipment improvements in the areas of point-of-fire identification reliability, automated data exchange and processing, displays suitable for correlating data with ongoing air activity and communications, would permit a shift in procedural philosophy from avoidance of conflicts between weapons types to enhancement of mutually supporting tactics.

ATTACHMENT 1

(S) FUNCTIONAL RESPONSIBILITIES OF 4th ATAF COMMAND, CONTROL AND REPORTING AGENCIES. (U)

(S) a. 4th ATAF ADOC. The ADOC is the agency through which Commander, 4th ATAF exercises operational control over 4th ATAF AD forces. The ADOC will be manned by 4th ATAF ODO personnel on a full-time basis when the 4th ATAF SWHQ is operational during times of tension and hostilities. When the 4th ATAF SWHQ is not fully manned, SOC-3 personnel will perform the following ADOC functions:

1. Assessing the air threat in the 4th ATAF area.

2. Maintaining appropriate displays of the current AD situation, status of all AD forces, states/stages of alert, DEFREFs and Air Raid Warnings.

3. Evaluation and dissemination of Early Warning information in accordance with SHAPE and AFCENT directives. (This function is performed by SOC-3 at all times.)

4. Ensuring Headquarters 4th ATAF ODO, AFCENT/AAFCE SWHQ and SHOC are informed of possible violations and incidents as outlined in appropriate NATO documents.

5. Execution of other tasks as required by other directives and instructions.

(S) b. SOC-3. AD tactical operations will be conducted from the designated SOC at Kindsbach or the alternate SOC facility at Boerfink. The Commander, Allied Sector Three, is appointed on 4th ATAF General Orders and responsible for allied tasks as listed below. He and other U.S. General Officers have been designated by CINCUSAFE to make Phase "A" tactical decisions. The authority for these decisions in the 4th ATAF area is charged to

CINCUSAFE under MC 66/1 in conjunction with the technical arrangements for the application of SACEUR's Rules of Engagement. The SOC is responsible for:

1. Commander, 4th ATAF's executive agent for AD and is charged with the tactical employment of 4th ATAF AD forces.

2. Exercising tactical control of all AD forces under the operational control of Commander 4th ATAF and fire control of non-assigned SAM and SHORAD units.

3. Exercising tactical control of augmenting AD units in the Sector.

4. Exercising tactical control over French forces may be made available.

5. Coordinating AD activities with Commanders of the adjacent Allied Sectors and the French Zone Air Defense Northeast as necessary to support principles of integrated AD.

6. Disseminate to subordinate units the release of nuclear weapons, alert states/stages, air raid warnings, DEFREP's and other information.

7. Declare, disseminate and display air raid warnings, DEFREPs, modes of control and SAM engagement orders for the 4th ATAF area in accordance with existing instructions.

(S) c. MCRC. The MCRC manages the ground environment system, employs AD weapons and implements tactical actions under the supervision of the Sector Controller. The MCRC will:

1. Manage all ground environment units in the 4th ATAF area.

2. Ensure the ground environment system presents an accurate and complete air picture through the use of scheduled maintenance and judicious use of alternate cross-tell data line routings or manual tell operations.

3. Initiate and implement tactical actions in accordance with applicable directives with final approval granted by the Sector Controller.

4. Notify the SOC of emergency maintenance outages as they occur.

5. Correctly apply and efficiently manage the radar system surveillance, detection, tracking, identification and display resources including SAM units and LLRS inputs.

ATTACHMENT 2

(S) SACEUR'S RULES OF ENGAGEMENT. (U)

(S) a. SACEUR's Rules of Engagement are based on MC 66/1, "Rules of Interrogation, Intervention and Engagement for Air Defense Forces in Allied Europe in Peacetime," and are applicable throughout SACEUR's area of AD responsibility.

1. Within the Integrated Air Defense of NATO Europe, the Regional Commanders, i.e., COMAAFCE for the Central Region, are responsible for the application of SACEUR's Rules of Engagement within their areas of responsibility. However, this responsibility is limited by particular political implications in the Central Region.

2. In the Central Region, the application of these rules over the territory of the FRG by Allied AD Commanders is subject to modifications posed by special political provisions of the Bonn Convention. Under these provisions the three powers (France, UK and U.S.) retain the right to control Soviet aircraft utilizing West German airspace. Following the withdrawal of French armed forces from ACE, France has stated her intention not to use her forces for safeguarding FRG airspace, but has reserved the right to do so.

3. In order to comply with the Bonn Convention and at the same time to safeguard effectively the integrity of the airspace over Central Europe, since France had decided not to participate in the air policing of FRG, the responsibility to apply SACEUR's Rules of Engagement will be vested in normal peacetime in the national Air Force Commanders of the UK and US, stationed in the FRG. However, in time of imminent emergency, provisions have to be made to use all AD forces placed under the operational command or control of the Allied AD Commanders responsible for AD of Western Germany.

(S) b. In accordance with MNC's Alert System, there are three peace to war phases for AD operations. These phases and the associated application of SACEUR's Rules of Engagement are as follows:

1. Phase "A". Normal peacetime defined as up to and including SIMPLE ORANGE. SACEUR's Rules of Engagement apply (MC 54/1).

2. Phase "B". Imminent emergency defined as beginning with the declaration of REINFORCED ALERT and/or STATE SCARLET. SACEUR's Rules of Engagement apply and are expanded for this phase (MC 54/1).

3. Wartime Phase. Effective on declaration of General Alert, SACEUR's Rules of Engagement are automatically cancelled.

(S) c. SACEUR's Rules of Engagement are based on the following principles:

1. Defensive actions taken must be in consonance with international law and the sovereign right to take action in self-defense.

2. Allied defensive reactions should neither prove nor result in a more dangerous situation than it attempts to safeguard.

3. Every action must be taken to avoid mistaken, unwarranted or unnecessary destruction of any aircraft.

4. Action to engage and destroy other aircraft can be justified only:

(a) If the present action or previous similar actions provide sufficient indication of intent to commit a hostile act and then only after taking into account all the prevailing circumstances, including the behavior of the aircraft probable origin, their position and pattern and any failure to respond to clear signals given by our defense forces; or

(b) If they commit a hostile act.

5. Rules and signals contained herein do not apply to naval forces operating over or in international waters; however, these rules and signals do not apply to such forces when operating in European NATO airspace.

6. Declaration of an aircraft as hostile must be tempered with judgment and discretion. There may be circumstances in which the destruction of Communist Bloc aircraft would be contrary to Allied interests. Any available intelligence of such circumstances must be considered in determining the action to be taken.

7. However, in times of imminent attack, defined for this purpose as after the declaration of REINFORCED ALERT or STATE SCARLET, the application of these rules will be more rigid in accordance with the prevailing situation than in Normal Peacetime, defined as prior to the declaration of "Simple Alert" or STATE ORANGE.

8. In consonance with the strategic concept for defense (MC 14/3) the application of the Rules of Engagement must be flexible to deal with all forms of aggression. Consequently, when multiple hostile acts have been committed in 4th ATAF area after declaration of REINFORCED ALERT or STATE SCARLET, Commander 4th ATAF through COMAAFCE, may request SACEUR for authority to cancel all or part of the Rules of Engagement for ACE AD Forces to meet a particular situation in Central Europe or in 4th ATAF area.

9. On declaration of General Alert the rules and signals will be cancelled automatically and 4th ATAF Wartime Operational Procedures will be applied.

(S) d. Hostile Act is committed when:

1. One aircraft:

(a) fires on an intercepting aircraft or clearly and persistently maneuvers into position to attack; or

(b) in European NATO Airspace and without proper clearance releases or is unmistakably preparing to release bombs or fires missiles, rockets or guns other than on a recognized range; or

(c) conducts minelaying operations in the territorial waters of an European NATO nation; or

(d) attacks friendly forces.

2. Two or more aircraft:

(a) individually or collectively commit a hostile act as defined in subparagraph 1(a) above; or

(b) in European NATO airspace and without proper clearance drop paratroopers or land troops; or

(c) penetrate European NATO airspace at speeds above 200 knots and an altitude below 10,000 feet in direct flight from Soviet or Soviet Satellite territory without proper clearance. This action will only be considered a hostile act after the declaration of REINFORCED ALERT or STATE SCARLET.

NOTE: Reconnaissance as such is not included in the definition of a hostile act in MC 66/1. However, if one or more unidentified aircraft indicates beyond a reasonable doubt that routine or recurring reconnaissance is being conducted, it may be declared hostile by Commander 4th ATAF or higher authority.

(S) e. Wartime AD Operations. The wartime phase is effective on declaration of General Alert and SACEUR Rules of Engagement are automatically cancelled. The 4th ATAF OPLAN 34001 in its entirety is implemented and Commander 4th ATAF is responsible for all AD operations in the 4th ATAF area.

1. Procedures for identification and engagement will be in accordance with ACP 160 and 4th ATAF Routing and Recognition instructions as contained in 4th ATAF SUPPLAN 34001 T.

2. 4th ATAF Hostile Criteria are implemented. They are expanded to include:

(a) All hostile criteria as listed in paragraph c.1. above.

(b) One or more aircraft observed flying at a ground speed greater than 250 knots and not complying with IFF, SIF or SLP.

(c) One or more aircraft observed emitting ECM and not complying with IFF/SIF or SLP, regardless of speed.

3. Commander 4th ATAF may declare all targets hostile in a specific area where hostile aircraft cannot be separated from friendly aircraft.

(S) f. During Phase "A" the responsibility to apply SACEUR's Rules of Engagement in Central Region will be subdivided with regard to:

1. The airspace over West German territory and

2. The airspace over Central Region Integrated AD area outside West German territory.

(a) Airspace over the FRG. During this phase, it is the responsibility of the UK and U.S. to safeguard the integrity of West German airspace. Therefore, by delegation by their national governments, Commander-in-Chief, RAF Germany and Commander-in-Chief, USAFE, will be responsible for the application of SACEUR's Rules of Engagement in Western Germany. These commanders will use for this purpose the active AD forces of the UK and U.S. but will technically be assisted by the Allied Ground Environment of Central Region. They will closely coordinate their activities, based on their

geographical areas of responsibilities as Allied AD Commanders. German AD controllers may be used for directing interceptors or other active AD units of NATO forces stationed in Germany if the decision for initiating operational AD missions which may lead to opening fire and for the fire order itself, is taken by the responsible U.S. or U.S. AD Commander in Germany or, on his behalf, by the appropriate Sector Commander or a Sector Controller of U.S. or UK nationality.

(b) Airspace of the Integrated Air Defense Area of Central Region Outside Western Germany. During Phase "A", it is SACEUR's responsibility to safeguard the integrity of the airspace of the Integrated Central European Air Defense area outside Western Germany. Therefore, by delegation through allied channels to COMTWOATAF and COMFOURATAF these commanders are responsible for the application of SACEUR's Rules of Engagement within their areas of responsibility as Allied AD Commanders outside the FRG.

(S) g. Phase "B". (U)

1. As soon as REINFORCED ALERT or STATE SCARLET has been declared by competent Allied authorities, COMAAFCE will, by delegation from SACEUR, be responsible for the application of SACEUR's Rules of Engagement throughout Central Region Integrated Air Defense Area.

2. COMTWOATAF and COMFOURATAF will assume their responsibility for application of SACEUR's Rules of Engagement within their respective AD area. They will use, for this purpose, all appropriate AD forces and facilities available to them in accordance with the prevailing air situation to safeguard effectively the integrity of the AD responsibility.

ATTACHMENT 3

(S) WARHEAD CONTROL ORDERS. (U)

(S) a. Warhead Control Orders are prescribed to conduct employment of AD nuclear and high explosive warheads in the surface-to-air role. Warhead Control Orders Case Codes are defined as follows:

1. CASE ONE. Use of nuclear warheads against targets above the MNBA for the nuclear warhead specific is authorized.

2. CASE TWO. Use of nuclear warheads against targets at all altitudes is authorized (authority to declare/order is retained by Commander 4th ATAF).

3. CASE THREE. Use HE warheads only. Nuclear warheads are not to be used.

NOTE: Combination Warhead Control Orders. A Warhead Control Order of CASE ONE and TWO could be issued with the letters "BXS" or "BXL" added to indicate to which warhead the order applies. For example: The order "CASE ONE - BXL or BXS", "CASE TWO - BXS" would mean that nuclear warheads can be used, but that only "BXS" would be used below MNBA. In addition, warhead control orders in force may be related to specific areas, thus providing flexibility to adjust fire distribution for varying tactical situation.

(S) b. As long as communications exist, the Commander, Allied Sector Three is authorized to implement CASE THREE at any time. He may also implement CASE ONE after receipt of selective or general release (R-Hour). Commander 4th ATAF retains sole authority to implement CASE TWO after receipt of selection of general release and after the lifting of SACEUR's constraints pertaining to MNBA.

(S) c. Five minutes after loss of communications with higher authority, the highest commander who has communications and is authorized to order engagement (MCRC/CRC/MCC/Battalion/Battery) may implement CASE ONE provided that general release had been received, but not yet implemented by the Commander Allied Sector Three prior to the communications loss and provided the tactical situation is so critical as to warrant CASE ONE.

ATTACHMENT 4

(S) WALK THROUGH EXAMPLE OF AIR DEFENSE IN 4ATAF (U)

- Wartime Rules of Engagement in effect
- Aircraft detected in 4ATAF Air Defense area of responsibility
- Identification officer at MCRC attempts to identify TRACK
  - -- MK X/MK XII Interrogation
  - -- MK X IFF/SIF procedures
  - -- Minimum risk procedures
  - -- SLP
- Aircraft identified hostile
  - -- Weapons Assignment Office at MCRC allocates to
    - --- Fighters - in fighter engagement zones
    - --- SAMS - in missile engagement zones - Hi or Low
- Aircraft not detected by RADAR Ground Environment System and/or System degraded to antonomous operations
  - -- SAM Operations
    - --- Battery mode of control
    - --- Weapons fire control orders
    - --- Weapons warhead control orders
    - --- Identification procedures if capable
      - ---- MK X/MK XII Interrogation
      - ---- MK X IFF/SIF Procedures

---- Minimum risk procedures

---- SLP

-- SHORAD Operations

--- No minute-to-minute control

--- Preplanned weapons control orders

--- With communication - weapons control orders from SOC III

--- Identification procedures

---- Apply safe passage procedures if capable

---- Visual recognition

ATTACHMENT 5

(S) 4ATAF AIR DEFENSE RESOURCES (U)

TFS
BITBURG 3 SQ = 72 F-15
RAMSTEIN 1 SQ = 18 F-4E
NEUBURG 2 SQ = 30 F-4F

MCRC/MCC BOERFINK

5 NIKE BATTALION
1 NIKE BATTALION
2 C/V BATTALION (US)

CRC/ALT MCRC MESSTETTEN

CRC/MCC FREISING

3 HAWK BATTALION

CRC/MCC LAUDA & MCC DARMSTADT

7 HAWK BATTALION

RP - DOEBRABERG
RP - WASSERKUPPE
EWRP - BURGLENGENFELD

TACS
CRP PRUEM, NEU-VLM, SEMBACH
FACP PRUEM, WIESBADEN, WUERZBURG, GRAFENWOEHR, ALZEY, BAD KREUZNACH

LLRS = LAUDA, NAILA, ULM, ROTHENBURG/F.

(U) APPENDIX C.

REFERENCES

1. "Technical Standard for the ATCRBS/IFF/MARK XII Systems (AIMS) (U)", Spec. No. DOD AIMS 65-1000 1 June 1965 (CONFIDENTIAL REPORT)

2. COMFOURATAF SUPPLAN 34001 D
(Air Defense Operations)
File No. 1220.01/ODO-1/S-001/78
1 March 1978 (NATO SECRET)

3. INTERACTION OF MILITARY/CIVIL POSITION LOCATION AND REPORTING SYSTEMS
Final Report, NSIA Serial 18-75, National Security Industrial Association, Tactical Command & Control Advisory Committee
30 July 1975

4. DOD AIMS SYSTEM PROGRAM OFFICE
Warner Robins ALC/MMIME
Robins AFB, GA 31098
ATTN: Joseph Smith, Autovon 468-2994

5. Naval Research Laboratory
Washington, D.C.
ATTN: Walter Bishop/Carlyle V. Parker, (202) 767-3396/AV 297-3396

6. "USAF Abbreviated Program Management Plan (PMP) for the MK XII Technical Improvement Program (TIP) (U)"
ASD/AEAC Aeronautical Systems Division, Wright-Patterson AFB, OH 45433
1 June 1978
ATTN: Major David L. Welton, AV 785-5859/5705
Ed Barthel (513) 255-5339

7. HOSTILE AIRCRAFT IDENTIFICATION, Science & Technology Objectives Guide (STOG), FY 78, Priority II (Critical Modernization Capability)
ATTN: Mr. S. J. Grossman, ERADCOM/CSTA Lab
Fort Monmouth, NJ, AV 996-5526

8. US Navy NAVELEX, Code 52030
Mr. Joe Weiss, 692-8234

9. R. A. Marnell, "Customer Test of Chaparral Identification Friend or Foe (IFF) Product Improvements (U)", Final Report, TRADOC Project 3-F1-7-OTN338-04, US Army Air Defense Board, Ft Bliss, TX 79916
July 1977 (SECRET REPORT)

10. G. J. Moussally and J. H. Priedigkeit, "IDENTIFICATION, FRIEND OR FOE (IFF) SYSTEMS TESTING METHODOLOGY STUDY (U)", Final Report, US Army, Electronics Proving Ground, Ft Huachuca, Arizona, Contract DAE 18-21-A-0204/0014, SRI International, Menlo Park, CA
January 1978 (CONFIDENTIAL REPORT)

11. D. M. Aykor, J. Eendebak, and J. B. Murdock "Evaluation of the Present Aircraft Identification Systems in the Central Region of ACE (U)", Vols I and II, Technical Memorandum STC TM-388, SHAPE Technical Centre, P.O. Box 174, The Hague, Netherlands
September 1973 (NATO SECRET REPORT)

12. J. G. Colyer "Possible Saturation of MK XII Mode 4/IFF by Friendly Interrogators," DOA Technical NOTE 78-1, Directorate of Operations Analysis, DCS/Operations & Inelligence (DO), US Air Forces Europe
June 1978 (SECRET REPORT)

13. J. A. Beam and S. D. Port, "Assessment of Red IFF (U)", Final Report Contract MDA903-76-C-0282, ODDR&E, SRI International, Menlo Park, CA 94025 (Dec 1977). (SECRET/NOFORN Report)

REPORT OF TASK GROUP II

(C) SUPPORTING FIRE FOR FRIENDLY FORCES (U)

Lt Gen Glenn A. Kent, USAF (Ret), Chairman	SAB
Dr. David Fried, Vice Chairman	ASB
Dr. John Blair	ASB
Dr. Philip E. DePoy	ASB
Dr. Richard C. Gibson	SAB
Mr. Robert R. Everett	SAB
Dr. William G. McMillan	SAB
Dr. James J. Renier	ASB
Col John Donahue	TRADOC
Mr. Manfred Gale	Army
Maj Roger Hegstrom	AFTEC
Maj Jack May	TAC

(C) ABSTRACT (U)

(U) This section treats the subject of coordination of supporting fire. The principal problem areas and areas of opportunity for improvement are identified, discussed in some detail, and proposed solutions are presented. The areas identified concern:

(1) the procedure for allocation and assignment of CAS sorties,

(2) the need for an electronically-based common position location system,

(3) the need for a digital message capability for targeting,

(4) the need for improvement interplay in the development of new tactics, training, and new equipment,

(5) the need for improved target handoff with reduced exposure for both the strike element and the unit designating/handing-off the target, and

(6) the need to be able to handoff targets acquired with one Service's electronic sensors for rapid servicing by the other Service's strike assets.

(C) Among the principal recommendations are the following four:

(1) CAS sorties should be allocated downward, with full authority to assign the strike to a target retained at the allocated level.

(2) The move to a PLRS/JTIDS system be given high priority, as it can provide both the common electronic coordinate system and the digital targeting message capability.

(3) Laser designator/FLIR and upgraded avionics/visionics should be deployed, and special tactics/procedures be established, as described, to facilitate target handoff and reduce exposure.

(4) Joint training and tactics development exercises for coordination of supporting fire should be conducted, with prototypes of equipment still in development, to establish feedback between equipment development and development of tactics.

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Appendix A II-A-1

(C) I. SUMMARY (U)

(U) A. DESCRIPTION OF TOPIC

(U) The topic for Task Group II was fire support for friendly forces. The Task Group investigated potential improvements in procedures, systems, or interface equipment to enhance the timely application of firepower, from artillery, fixed-wing aircraft, and attack helicopters, on enemy maneuver units. The combat missions involved are concerned primarily with weapon allocations, communications and target standoff. Particular emphasis was given to improving the capability of Air Force strike assets in support of the ground commander's mission. The improved utilization of either Service's weapon system with either Service's target acquisition or cueing procedures for some battlefield applications was another major topic.

(U) B. DEFINITIONS

(U) Terms commonly used for offensive and CAS are defined in Appendix A.

(C) C. KEY OPERATIONAL NEEDS (U)

(U) Three key operational needs were identified by the Task Group. The need to provide the ground commander with timely and effective means to assign ground and air weapons to specific targets, including the assignment of fixed-wing strike aircraft in support of the land-air battle, and provide the information and flexibility at higher headquarters so that these can be allocated effectively as the developing battle requires.

(U) The need to provide for target handoff and cueing capability which will assure a high probability of successful target engagement by either Service's fire-strike system from either Service's target acquisition/location process.

(C) The need to provide fast, accurate, survivable communication and common position location means to all appropriate elements in the combined-arms loop to coordinate Air Force/Army firepower within the total target development and engagement cycle.

(C) D. CRITICAL DEFICIENCIES (U)

(C) The existing OAS capability is quite limited at night, in reduced visibility and in heavy defenses--particularly in an intensive reactive situation.

(C) Current procedures for allocation of sorties to OAS missions, which are based primarily on requests from the bottom up for "pre-planned" and "immediate" scheduling, are too cumbersome and time-consuming for high intensity, fluid operations. They place a high demand on Army/Air Force communications; they stress the decision-making process (particularly at the DASC); and they have a high likelihood of breakdown during critical times.

(C) Effective joint operations are totally dependent on secure, reliable, prompt, flexible, interoperable communications. Existing communications rely heavily on voice and are both slow and vulnerable to enemy counteractions. Interoperability between Army and Air Force elements is poor and security is lacking.

(C) The effective coordinated employment of Army and Air Force firepower assets is not achievable until a common or interchangeable coordinate system is established for targeting missions involving joint assets.

(C) The Army and the Air Force do not fully exploit each other's target acquisition sensors. For example, the effectiveness of Army fire or emitters, especially in the suppression of enemy AD weapons by artillery and rotary wing aircraft, could be improved by more direct coupling with Air Force's PLSS for targets within the zone of interest.

(C) Because of heavy enemy air defenses, attacking aircraft on OAS missions must fly low and accomplish their missions on their first pass. Low altitude greatly complicates the problem of seeing the target even under good conditions and there is little time for search during pop-up. For this reason, Army/Air Force hand-off techniques need substantial improvement especially in conditions of poor visibility.

(U) New equipment is not introduced early enough in the development cycle of the equipment to meet the needs for joint and combined testing and training.

(C) E. PROPOSED CONCEPTS (U)

(C) 1. Streamline and Clarify OAS Allocation Process

(C) Approach. The Joint Force Commander should make a master apportionment of sorties for the OAS mission for a particular time period. A portion of these sorties should then be allocated to Corps Commanders, who may then, as they see fit, suballocate to subordinate units. These allocations may be changed as the situation requires, normally over time intervals of hours, rather than minutes or days. All the sorties that are allocated to Corps (or suballocated below Corps) will be on an "on-call" basis. As targets develop or are identified by ground elements on the scene, requests for the assignment of allocated sorties to specific targets and the execution of the mission will then be made by the requisite ground commander. There is no comparable allocation problem with Army's attack helicopter, since the battle commander has control of those assets as part of his maneuver forces.

(C) Expected Accomplishments. The above procedure will simplify both the allocation process and the engagement process, but more importantly it will facilitate the availability of Air Force strike support to the Corps Commander. Within allocated sorties, this approach will allow for assignment of sorties to targets by the commander, without recourse to higher headquarters. Furthermore, adoption of this concept will reduce the congestion of messages and decisions (particularly at the DASC) during critical times, since it will replace much of the "pre-planned" or "immediate" requests. In addition, the simplified allocation procedures will reduce the communication required by coordinating elements of the Army and the Air Force. Such a concept is particularly appealing in an environment where: (1) there may be more targets appropriate for strike by CAS than there will be OAS sorties; (2) there is apt to be confusion exacerbated by the rapid dynamics of a Soviet attack, and (3) the enemy will be placing a major emphasis on preventing meaningful communications--either by attacking or jamming our communications elements.

(C) 2. Improve Joint Capabilities for OAS (U)

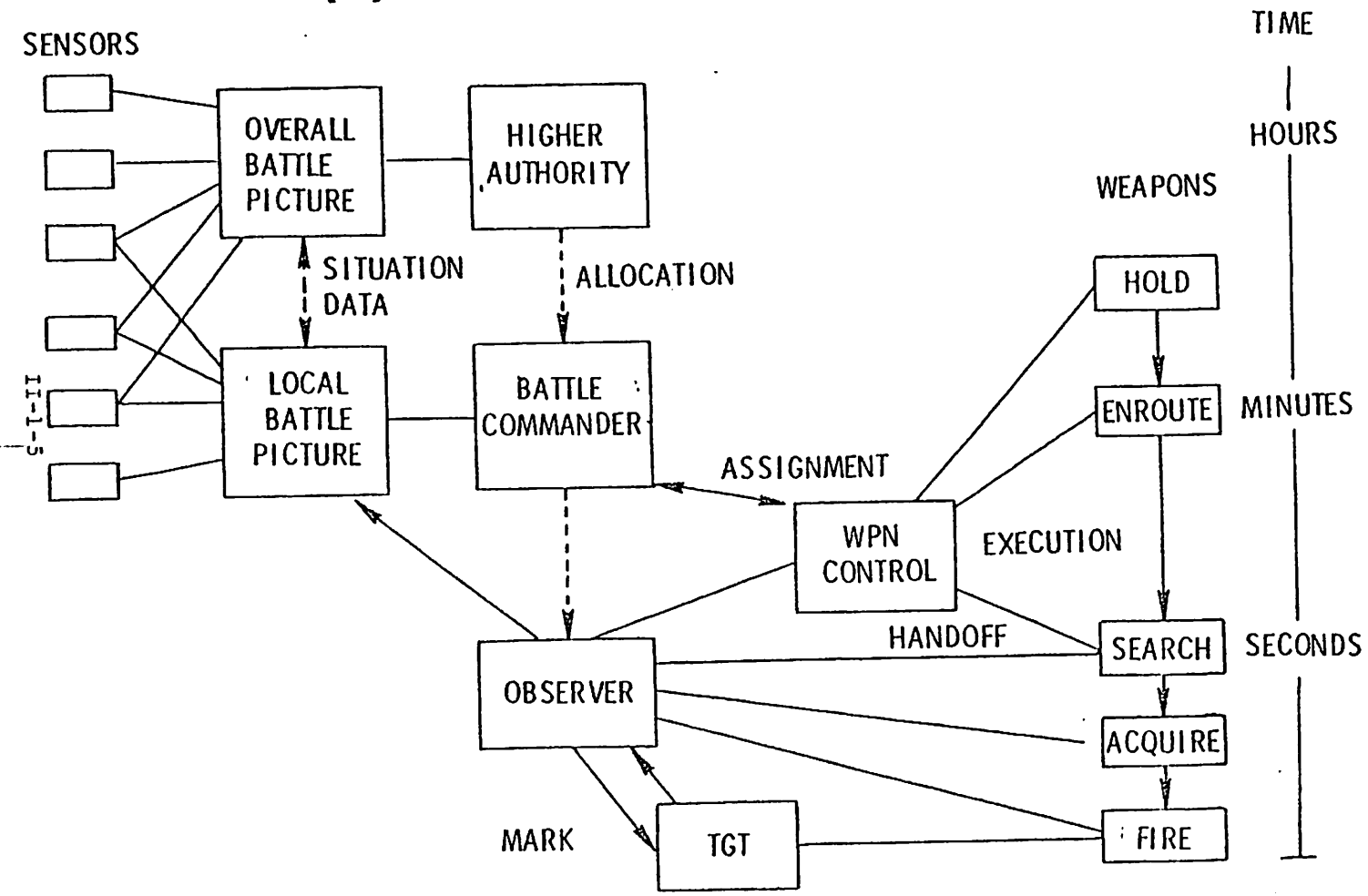
(C) Approach. The Task Group's view of OAS is shown in simplified form in Figure II-1-1. It was evident to the Task Group that flexibility and rapid response are of utmost importance, especially in high-intensity, defensive war in which we are reacting to enemy actions, and therefore, precisely where the times and places in which fire support must be applied will not be predictable. The Task Group saw the problem in terms of closed-loop feedback systems where system response time is critical to success. The process, therefore, is viewed not as a single loop but as several loops corresponding to several different time scales--allocation assignment, execution.

(C) Expected Accomplishments. Continued emphasis on joint tactics, procedures and training will evolve a more effective OAS capability so that all elements of these feedback systems work well and are properly integrated into a real capability. Sensors must detect, locate, and identify the targets at night and in adverse visibility and weather conditions if OAS is to work under such conditions. Communications must be able to deliver the needed imformation. Command and control posts with data processing and display aids must be available to the decision-makers. Weapons must be able to navigate, survive, see the target directly or indirectly, and communicate immediately and rapidly. All must operate in common, accurate position coordinates. Munitions must have high probability of kill over wide areas. All must continue to operate in the presence of intensive enemy defenses. No one of these features is enough by itself, no matter how good it might be. When all of these contributing functions work well together, and our tactics and training have been developed to the point where they make full use of the equipment's capability, and work around the equipment's deficiencies and weaknesses, then will it be possible to achieve a probability of target kills in accordance with needs of the ground commander's mission.

(C) 3. Improve C^3 and Target Handoff for Army/Air Force Supporting Fires (U)

(C) Approach. The Task Group believes that the most critical deficiency of the OAS capability lies in its C^3. Therefore, the structure of OAS should be thought out to define the sensory and communication

(C) TASK FORCE VIEW OF OAS (U)



II-1-5

Figure II-1-1

needs to provide the kinds of information and response times needed to make OAS effective in fluid situations. The concepts of allocation as previously discussed, and as being developed in Europe, are encouraging first steps in this direction. All possible emphasis should then be placed on providing a common or interoperable digital communications and position-location system of the PLRS/JTIDS-type as a basis for evolving a joint/ combined capability.

(C) The target hand-off process for strike aircraft and helicopters must be improved in timeliness and accuracy. The availability of digital, secure communication and common grid systems is essential for this mission. Furthermore, the capability must be enhanced for target acquisition and cueing at night and in reduced visibility. More opportunities should be exploited to provide for joint target acquisition to enable each Service to apply its weapons to important targets located by the other Services.

(C) Expected Accomplishments. These approaches would enhance the probability of a successful engagement while reducing the exposure time of weapons platforms and the man on the ground. Implementation of the proposed approaches will collectively contribute to significant improvements for hand-off procedures, including those which depend on target acquisition by eye, marking rounds, ground reference points, target offset techniques and laser cueing. Because of the improved C^3 responsiveness and overall increased effectiveness of the target engagement phase which will result, the ground commander would be afforded a more realistic choice of the appropriate ground/air weapons system in the combined arms battlefield. The above approaches would further enhance the capability of the AAH and minimize time on station; without these approaches the joint Service CAS mission would be of limited utility under all but good visibility conditions.

(C) F. RECOMMENDED ACTIONS (U)

(C) 1. Sortie Allocation and Execution (U)

(C) The current 24-hour preplan/immediate FRAG cycle for OAS is inadequate for high intensity

warfare. The preplan and immediate request system is a "pull system" from the lowest level (Battalion) to the highest level (Corps).

(C) The Task Group sees the requirement to emphasize the improvements now underway in some elements of NATO to create a "push system" of allocating OAS sorties to Corps and below in specified time blocks to allow real-time fire support decisions at all echelons. With current intelligence/reconnaissance systems and automated fusion centers, Corps has a better view of the overall battle and fire support assets than do lower echelons. Scarce OAS assets must be provided to commanders (suballocated) in specific time blocks to reduce the air request communications requirements, increase the confidence of OAS availability to subordinate commanders, reduce the time for execution of OAS missions, and enhance the flexibility of OAS assets.

(C) Within these allocated OAS sorties the commander should be allowed to assign sorties to targets, without recourse to higher headquarters. The commander doing the assignment must have directly available the near-real-time sensor data from systems such as SOTAS in his area of interest.

(C) 2. Common Position Location and Digital Communication (U)

(C) Expedite the creation and fielding of an integrated joint digital communications and common-grid positioning system based on the use of PLRS for the Army and JTIDS for the Air Force. If one of the systems is delayed or not implemented, the other should be used by both services for OAS. The Task Group also urged development of a common digital targeting language for joint Army/Air Force use. This language should have enough flexibility to accommodate later NATO standardization, but such standardization must not be allowed to delay joint development.

(C) 3. Joint Training and Testing (U)

(C) The Task Group recommends the introduction of new equipment (even prototype) early into joint Army/Air Force OAS training and testing programs to obtain early feedback between the development of tactics and

procedures and development of equipment. Start now! Use existing equipment such as PLRS terminals, JTIDS in pods, SOTAS, lasers, and ground beacons in promising combinations to support an overall OAS capability. The NATO nations should also be invited to participate.

(C) 4. Improved Handoff (U)

(C) In order to enhance the probability of engagement and reduce exposure of strike aircraft, attack helicopters, and the man on the ground; develop a common coordinate-based cueing system which will:

- generate target coordinates (periodically)

- enter classification of target

- route (transmit) data to weapons platform

- cue the pilot through his head-up display.

(C) To improve the effectiveness of ground beacons, provide attack aircraft with accurate ($\sim$ 100 ft CEP) range and bearing from beacon to target. To reduce the probability of detection, screen the beacon from the enemy (e.g., by using a directional antenna).

(C) Burst digital transmission is required to reduce vulnerability to jamming and to enhance the reliability of communications. The Services should provide--"tomorrow"--ancillary devices for digital burst entry into existing tactical radios (such as an IDT-like system).

(C) Improved sensors are required to enhance the acquisition of targets by pilots and ground observers at night and in reduced visibility. Accelerate the provision of FLIR for the ground-mounted laser locator device (GLLD) and hand-held laser target designator (LTD). Expedite the development of long-wavelength infrared lasers and seekers for designation and weapons guidance. Accelerate exploration of millimeter wavelength technology (6.2) for target acquisition, designation, and homing.

(C) 5. Joint Target Acquisition (U)

(C) In order for each Service to be able to apply its unique strike assets to high priority targets located by the other Service, provide direct two-way data links for transmitting PLSS located targets to TACFIRE for possible strike by artillery, and for transmitting target locations determined by AGTELIS and FIRE FINDER (TPQ-37) to PLSS for possible guidance of aerial ordnance. Provide a means for direct input and use of SOTAS data and other near-real-time data at the levels in either Service's C^3 hierarchy that need the information for allocation, assignment, or control.

(C) 6. Improved Strike Assets (U)

(C) Present aircraft and helicopters have a limited capability to conduct OAS at night or in adverse weather. This situation must be improved. The AAH development program is well underway, but the A-10 requires provision of an inertial navigation system (INS), FLIR, and a radar altimeter in the near term and JTIDS or PLRS terminals in the future. A forward firing canister weapon for delivery of area munitions is also required. (The only modification to the A-10 needed in order to employ this weapon is a laser ranger.) Finally, the Services should accelerate the decisions regarding the development of night/adverse weather OAS capabilities in high threat scenarios.

(C) 7. Weapons/Munitions (U)

(C) Considerable improvement in weapons/munitions is both possible and needed. This subject deserves an in-depth study in its own right.

(U) A summary of above recommendations is shown in Figure II-1-2.

(C) SUMMARY OF RECOMMENDATIONS (U)

RECOMMENDATION		TIME SCALE
I.	FURTHER STREAMLINE/CLARIFY ALLOCATION	NOW
II.	"COMMON" POSITION LOCATION AND DIGITAL COMMUNICATIONS	NEAR/MID TERM
III.	JOINT TRAINING AND TESTING	NOW
IV.	IMPROVE HANDOFF	
	A. COMMON COORDINATE CUEING AND WEAPON DELIVERY	MID TERM
	B. GROUND BEACONS	NEAR TERM
	C. BURST DIGITAL TRANSMISSION	NOW
	D. IMPROVED SENSORS	
	1. FLIR FOR GLLD AND LTD	NEAR TERM
	2. LWIR LASERS AND SEEKERS	FAR TERM
	3. MILLIMETER WAVELENGTH TECHNOLOGY	FAR TERM
V.	JOINT TARGET ACQUISITION	NEAR TERM
VI.	IMPROVED STRIKE ASSETS	NEAR TERM

FIGURE II-1-2

CONFIDENTIAL

(C) II. DISCUSSION (U)

(C) A. INTRODUCTION (U)

(C) Ground forces in high-intensity conflicts require responsive, coordinated, intense, and effective fire support against many types of targets, including personnel, vehicles, weapons, facilities, C^3, etc. Both the Army and the Air Force are equipped to provide such fire; the Army by artillery, cannons, rockets, and missiles, attack helicopters; the Air Force with the A-10, F-4, A-7, F-16, and to some extent, with the F-111 and F-15. For some missions, tactical air can be thought of as a kind of artillery, of which the total firepower is not large compared to the total Army assets but with the advantages of the ability to concentrate fire both in space and time (i.e., to provide very high rates and densities of fire in limited critical areas) and the ability to reach beyond Army firepower into the back areas of the enemy.

(U) It is evident that such a scarce but flexible asset should not be frittered away as a simple adjunct to artillery but must be skillfully applied to the points of greatest leverage in support of the ground battle. Close coordination between ground and air forces is of the highest importance.

(C) Conversely, Army firepower can help in overcoming the enemy AD, which are the greatest problem for the tactical air forces. The combined use of Air Force and Army assets for best effect is an important but difficult problem.

(U) This problem of the integration of these various forms of firepower in a NATO environment is the issue with which this Task Group was concerned; specifically, to examine what potential improvements in procedures, systems, or equipment might enhance the timely application of firepower on enemy maneuver units. Particular emphasis was given to improving the capability for the weapons systems of either Service to use the target acquisition and cueing assets of either Service.

The Task Group did not examine in detail the performance of individual weapons and delivery systems, with the exception that tactics of individual systems often had to be considered in order to understand the problems of handoff and coordination.

(C) The Task Group considered that the Soviets will attempt breakthroughs which will be countered initially by Army covering forces (including tanks, mechanized infantry, field artillery, and attack helicopters), and engaged later by our main force at times and places that afford us every possible advantage. During the cover force and main battle area fighting, the Air Force provides the ground forces with CAS, attacking targets such as armored vehicles, artillery, troops, command posts, and air defense units to contain the first echelon enemy forces. At the same time, the Air Force will engage in battlefield air interdiction (BAI) missions to impede, blunt, and destroy the second echelon Soviet forces so that they cannot exploit any potential breakthroughs by the first echelon forces. CAS missions are differentiated from BAI missions on the basis of location of the targets, as illustrated in Figure II-2-1.

(U) For purposes of this study, the application of firepower was divided into three parts corresponding to three very different time scales. The first part involves the allocation of OAS sorties by higher authority (Theater, Corps, etc.) to subordinate elements which actually fight the battle. It is assumed that the higher authority has an accurate picture of the overall battle provided by an ASAC, and thus can make an appropriate allocation of resources. The allocation process is considered to be dynamic, but is made and altered in times on the order of hours. The allocation procedures and recommendations for their improvement are discussed in Section IIB.

(U) The second part of firepower application is the assignment by the Battle Commander of his allocated weapons to the available targets. In this process, times are on the order of minutes. The assignment includes the communication of the necessary targeting

(U) BATTLEFIELD DEFINITIONS

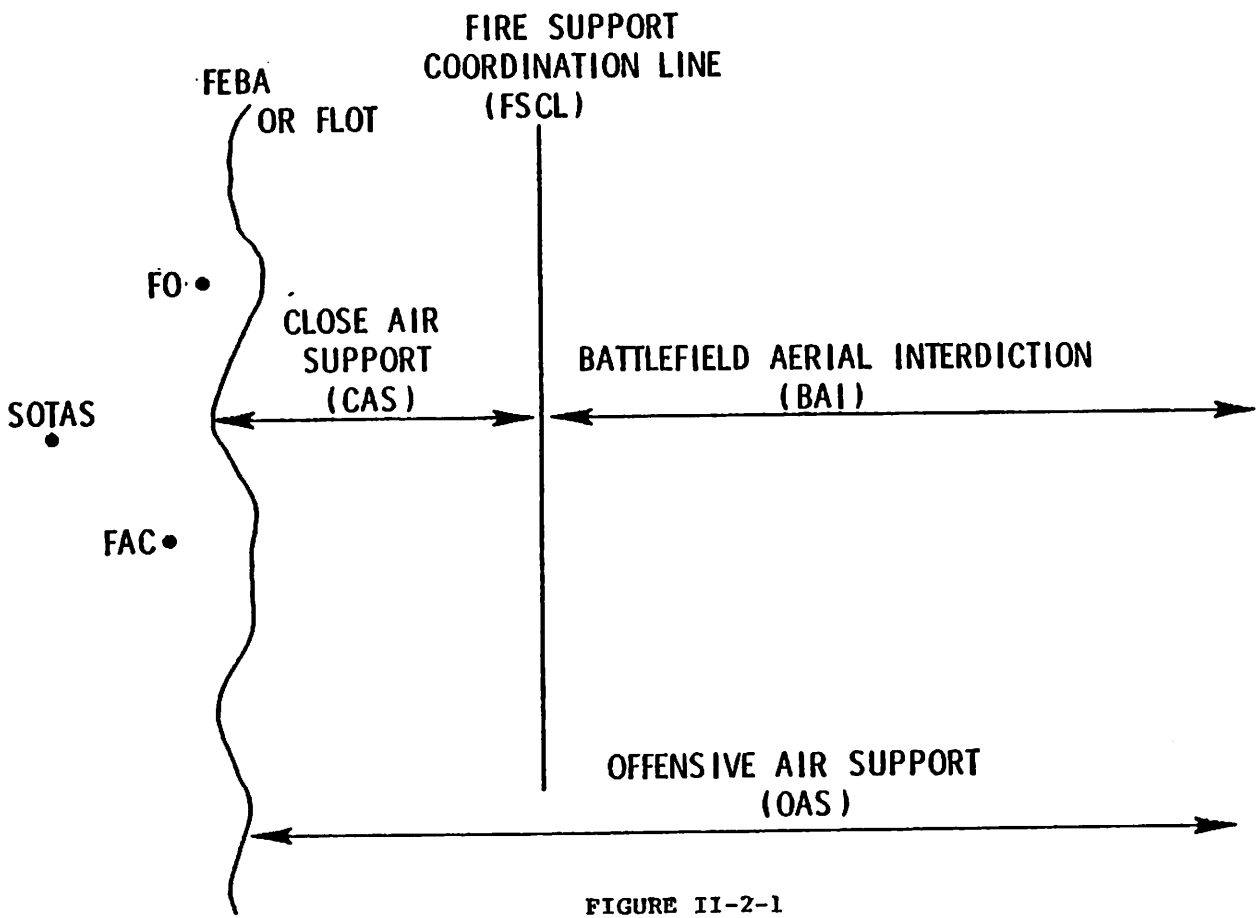


FIGURE II-2-1

information (target type, location, etc.) to the attack systems (artillery, helicopters, or fixed-wing aircraft). Recommendations for improvement of the very critical problems of battlefield communications and position location are proposed in Section IIC. Potential improvements in joint Service training and testing are discussed in Section IIC, and some recommendations for improving the transfer of target information between Services are presented in Section IIF.

(C) The third part of firepower application is the engagement, i.e., the process of delivering fire to the target. In most instances, the target is handed off from a forward observer (FO) or forward air controller (FAC) to the attack system. Critical times of this process are on the order of seconds. The handoff may involve only the communication of targeting information, or it may require active participation of the observer or controller such as laser illumination of the target. Recommendations for the improvement of some types of handoff are discussed in Section IIE.

(U) In order to have an effective fire support capability, a large number of individual elements must survive, work well, and be fully integrated. Sensors, C^3, and weapons systems must be highly survivable and reliable, and must function in night and adverse weather conditions (a shortcoming of OAS in this regard is discussed in Section IIF). Handoff systems must be reliable and as undetectable as possible.

(U) The Task Group is painfully aware that one of the very critical elements of fire support is the effectiveness of the munitions. Time has not permitted an adequate examination of this subject in this effort. However, there is general agreement that considerable improvement is both possible and needed. It is felt, therefore, that this element deserves a full-scale study by itself.

(C) B. ALLOCATION OF OAS SORTIES (U)

(C) 1. The Problem (U)

(C) There is a need to simplify the OAS allocation process and make it more responsive to the

battlefield commanders. In a war of high tempo the OAS process needs, as never before, centralized management of the advance allocation of OAS sorties to ground commanders, coupled with an essential flexibility achievable only through decentralization of execution. With the advent of the ASAC based on the BETA concept, higher level commanders will have a better picture of the battle area. These new developments thus both support and demand a greatly improved and streamlined management of the allocation of OAS sorties in support of the battle.

(C) 2. Discussion (U)

(U) Success in countering a massive Soviet attack in the Central Front in Europe will require joint Army/Air Force procedures for OAS allocation that assure the delivery of firepower in a rapid and responsive manner.

(C) There is presently a program underway to provide the commanders of Tactical Air Forces and Army Corps and Divisions with the "big picture" of what is happening on the battlefield. The BETA project has been inititated to demonstrate the techniques and equipment to underwrite the ASAC, which will be responsible for providing this picture. The ASAC concept is to "fuse" the streams of information from many sensors and sensor platforms--TEREC, GUARDRAIL, RF-4Cs, AWACS, SOTAS, unattended ground sensors, ground observers, UPD-X (when available), and so on. The output of the ASAC will provide information on the disposition of various enemy units, where they came from, and a forecast of their future movements and actions. The principal areas of enemy activity will be identified.

(C) Based on information and assessments from the ASAC, commanders at Corps and Air Tactical Operations Centers (ATOCs) will allocate OAS assets to be available to attack these enemy maneuver units within some specified time intervals and specified geographic areas. In the vernacular, this constitutes part of "battlefield management." This management involves the allocations of certain strike assets to particular ground units for a particular span of time.

(U) The engagement phase extends from the time a specific aircraft is assigned a specific target until the strike asset has delivered its weapon(s) on target and, in the case of strike aircraft, has exited the area.

(U) The current OAS allocation process is difficult to define accurately since it has been found that the process, as practiced, is different than the one described in current documentation. In many instances, the approach being recommended by this Task Group already has been accepted, or at least advocated, by some planning elements of both the Army and Air Force. Therefore, rather than describe the present process, the approach herein is to propose an improved OAS allocation process which, in our opinion, further streamlines and clarifies the current allocation process.

(C) The proposed process is: first, the Joint Force Commander makes an apportionment of sorties to: (1) counter air, (2) interdiction, and (3) OAS. Then, Tactical Air Force (TAF) and Army Group Commanders allocate their OAS sorties to particular Corps for time blocks in the planning horizon. It is important to note that allocation of sorties is dynamic and is an integral part of battlefield management. The time interval between changes is expected to be hours--not minutes or days.

(C) A portion of the OAS sorties is retained at TAC level for BAI mission. Those OAS sorties allocated to the Corps can be used by the Corps Commander for BAI targets that the Corps has nominated, with the remainder of the OAS sorties being used for CAS. The distinction between BAI and CAS is that CAS is defined as attacks upon targets in the area between the FLOT and the FSCL, while BAI applies to attacks beyond the FSCL. The Corps Commanders may suballocate OAS sorties to Division and perhaps down to Brigade. The important point here is that the OAS sorties allocated to Corps for a particular time period belong to the Corps, and in turn, sorties are utilized as the Corps Commander deems necessary.

(C) The apportionment/allocation process among these missions is, of course, based ultimately on the success of containing the enemy thrust. It is important to note that the decision to apply OAS assets in BAI and CAS must be based on a choice of disrupting enemy forces prior to the time they pose an immediate threat to our front line ground units and of support in these front line units when the enemy is an immediate threat. This perception is at times at odds with the concept of placing emphasis on responding to requests for CAS by beleagured commanders.

(C) OAS sorties will be allocated to a ground unit for use during a specified period of time. Those OAS sorties allocated to the Corps and subordinate divisions will be on call to the unit which received the allocation. The strike aircraft for these on-call missions will be loaded with appropriate munitions and placed in an appropriate alert condition and committed when requested by the unit to be supported, within the specified time period. A unit commander will commit sorties and assign these sorties to strike particular targets at particular times when these targets and times have been identified. In such a concept, the process of "immediate requests" becomes moot. There will be no purpose in generating such requests and having them processed for approval; Corps has already made tentative allocations of on-call missions in anticipation of enemy actions and where they plan to engage the enemy. Authority to finally commit strike aircraft (either from strip alert or air alert) would be delegated, for instance, to the Brigade Commander who exercises that authority through the airborne FAC-A.

(C) The above concept does not make the distinction between "pre-planned" and "immediate" requests with respect to OAS sorties. It would seem that such a distinction with regard to requests is somewhat beside the point and only leads to the requirement for additional decisions and congestion of message traffic at critical times. Typically, most of the so-called "pre-planned" missions are changed (diverted) to "immediate" requests. What should be pre-planned is the allocation and suballocation) for specific periods of time of OAS sorties to ground commanders at different

echelons. Targets are attacked as they develop and are identified. The timing of when specific aircraft are "committed" and assigned specific targets is determined by the ground commander on the scene; but presumably these attacks would be executed as soon as possible--once the target has been identified.

(C) The proposed approach will simplify both the allocation and the execution process and facilitate the availability of strike support to the Corps commander. This concept will reduce the congestion of messages and decisions during critical times; it will also significantly reduce the required communication by Army/Air Force elements. Such a concept is particularly appealing in an environment where there will be OAS sorties; there is apt to be much confusion exacerbated by the rapid dynamics of a Soviet attack; and the enemy will be placing a major emphasis on preventing meaningful communications--either by attacking or jamming our communications elements.

(U) The proposed concepts are complementary to the Air Fire Support System. The FSS permits all nominated targets to be analyzed as to the appropriate means of engaging the target, be it OAS, artillery, or attack helicopter.

(C) The planned Army attack helicopter employment as a separate maneuver force complements the combined arms engagement in that the attack helicopters are constantly engaged in the battle, while OAS is required at critical times and places where victory or defeat may hang in the balance. Thus, the allocation process is not applicable to the attack helicopter as it is employed as a maneuver unit already committed to the battlefield.

(C) 3. Proposed Solution (U)

(C) The following approach and concept appear to be a better process of allocation of OAS sorties in support of ground commanders.

(1) The Joint Force Commander makes a master apportionment of sorties for the OAS mission for a particular time period. A portion of these OAS sorties

are then allocated to Corps commanders by the Air Force and Army component commanders. Corps commanders may then, as they see fit, suballocate to subordinate units. The allocations and suballocations are "for planning purposes" and may be changed as the battlefield dynamics dictate. The time interval between changes is expected to be hours--not minutes or days. Inherent in the OAS allocation is a specified time period in which the sorties are to be executed. When that time period arrives, the allocated OAS sorties are on an "on-call" to the ground commander. As targets are identified by ground elements on the scene, the OAS sorties are executed with no recourse to higher levels of command.

(2) The execution of attacks within the limits of the on-call sorties allocated may be arranged by the FAC-A via direct communication to the air units that are on-call--either on strip alert or air alert.

(3) No distinction is to be made between "immediate" requests and "pre-planned" requests. The allocation and to a large extent the suballocations are planned; execution of attack by those sorties allocated will generally be "immediate" when battlefield targets are identified by ground elements on the scene.

(C) 4. Recommendation (U)

(C) Establish a process for the allocation of OAS sorties in a fluid, highly intensive environment along the following guidelines:

Top-down for allocation--higher authorities must have timely information for battlefield management; ASAC is a large step in this direction.

Simplified (with respect to both decisions and communications).

TAF/Army makes the allocation of sorties between

- sorties allocated to a particular Corps for each time block in the planning horizon

- sorties retained by the ATAF level.

Corps commander may suballocate sorties to the Division and perhaps down to the Brigade levels.

Allocation of OAS sorties is dynamic and is an integral part of battlefield management.

Centralize allocation of sorties to commanders--decentralize assignment of sorties to targets.

(C) C. COMMON POSITION LOCATION AND COMMUNICATIONS (U)

(C) 1. The Problem (U)

(C) The specification of target location in a NATO battle environment is very difficult due to the use of many different coordinate systems by the different NATO countries and the several Services. Delays and errors are introduced when coordinates must be transferred from one frame of reference to another. Furthermore, there is a great deal of reliance on voice communications links in the battlefield. These voice links can be jammed and intercepted, and are too vulnerable for reliable command and control. To solve these problems, it is necessary that a system be provided for secure, jam-free communications and position reporting using interoperable coordinate systems for all maneuver units, including air.

(C) 2. Discussion (U)

(C) There are currently under consideration two developments that could meet the need for a common position location and communications system: (1) The JTIDS under development by the Air Force; and (2) The PLRS, in engineering development by the Army. Both of these systems offer position location capability together with secure (Incrypted) digital, AJ, burst communications. This dual capability would greatly facilitate the OAS process--especially navigation, target location, handoff from forward observers, etc.--and promises significant simplifications in the C^3 process associated with the OAS mission.

(C) It should be recognized that neither PLRS nor JTIDS was originally conceived or designed explicitly for the OAS mission. But the designs of both are sufficiently general and flexible--PLRS for ground combat control, and JTIDS for air superiority and air interdiction operations--that the adaptation of these systems for joint OAS operations can be accomplished without technical modifications. Moreover, the two systems can be made interoperable. Starting with a sketch of the OAS scenario, the operation of PLRS and JTIDS and their dual positioning/communications capability will be explored as applied to a CAS sortie regardless of whether this is accomplished by fixed wing or rotary wing aircraft.

(C) Sketch of the Engagement Phase of CAS. This description is concerned with the engagement part of the CAS scenario only, which is recognized to have been preceded by the resource allocation process described in the previous Section IIB. We begin with the OAS aircraft on strip alert. The pilot is in possession of information to take him to the general area of the forward observers in the combat zone, here designated as the Contact Point in Figure II-2-2.

(C) One may divide the mission into two parts:

(I) Travel from the airstrip to the combat zone, i.e., to the contact point.

(II) Travel from the contact point to target engagement.

(C) The major difference between the two parts is that the pilot is on his own and left to his own resources and instruments to navigate part I. In part II of the mission, the aircraft performs cooperatively with the resident supporting elements, the FAC-A, the FAC, and/or the FIST Chief.

(C) Based on information obtained from the FAC and/or the FIST Chief who are in visual contact with the target, the FAC-A designates to the pilot (by voice communication) the Initial Point (IP), the Pull-Up Point (PUP), and the bearing and range of the target relative to the PUP.

(C) OFFENSIVE AIR SUPPORT FINAL ENGAGEMENT MISSION PROFILE (U)

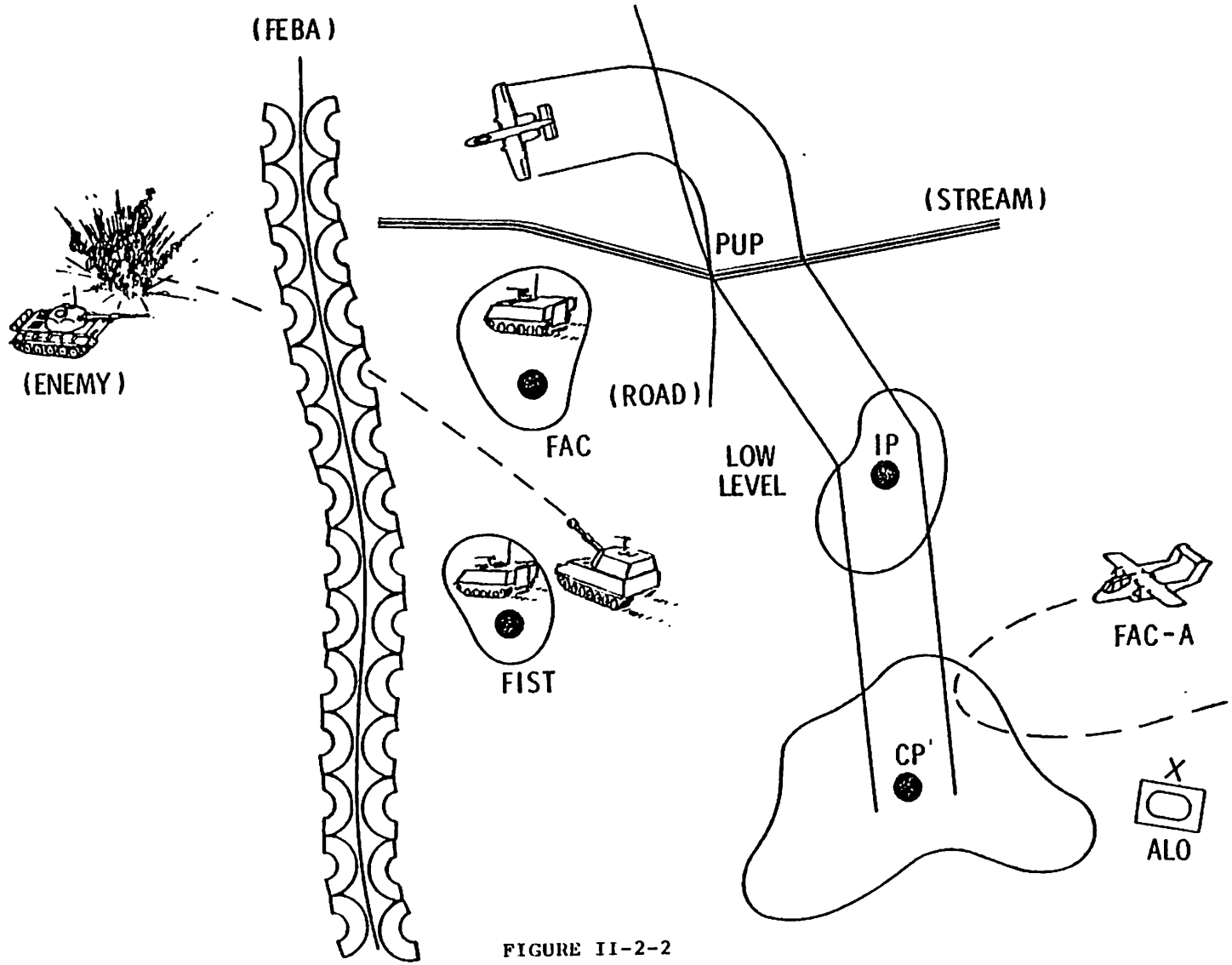


FIGURE II-2-2

(C) As the aircraft approaches the PUP, the FIST Chief designates the target location to the pilot either verbally with reference to terrain features, or by a marker, usually smoke; in either case the pilot must be given a clear description of the relative position of the target to the reference marker. Once the aircraft has pulled up and visually acquired the target or the attacker, and is headed in a direction safe for friendly troops, the FAC and/or the FIST Chief clears the pilot for weapon delivery.

(C) Figure II-2-2 depicts part II of the mission and shows the terminal engagement phase of the mission profile.

(C) An inherent difficulty of the engagement phase resides in the number of support participants: the FAC-A, FAC, and FIST Chief, all of whom have to coordinate among themselves and with the pilot with split-second timing relying entirely on voice communications. Since the strike aircraft radios are in some instances still incompatible with those on the ground and usually require line-of-sight, it is sometimes necessary for the FAC-A to act as intermediary relay. Interference or jamming at the wrong moment, communication outage, or human error brought about by natural distractions on the battlefield, can result in misunderstandings or lack of essential information that cause a miss or even failure to release the weapon.

(C) The communications problem is further aggravated by the lack of FM (i.e., Army standard) communications capability in the F-4 and F-16. Only the A-7, A-10, and A-37 are equipped with FM radios, the lack of which precludes direct communication with the FIST Chief, should he be required to carry out the ground control mission in the event that the FAC is unavailable. Figure II-2-3 shows the current communications interoperability for OAS.

(U) Description of PLRS and JTIDS Operation and Capabilities. To prepare the way for showing the improvements which a PLRS/JTIDS capability introduces into the OAS mission, we first review the essential characteristics and functional capabilities of these systems.

CURRENT COMMUNICATIONS INTEROPERABILITY FOR OAS

AIR FORCE [a,b]	AIR FORCE FIXED-WING AIRCRAFT [a,b]						ARMY HELOS[c]	
	F-4 (4)	A-7 (2&4)	A-10 (2&4)	F-16 (4)	A-37 (2&4)	F-100 (4)	SCOUT (1,2&4)	AAH (1,2&4)
FAC (1,2,3,4)	4	2&4	2&4	4	2&4	4	1,2&4	1,2&4
FAC-A								
OV-10 (1,2,3,4)	4	2&4	2&4	4	2&4	4	1,2&4	1,2&4
O-2 (1,2&4)	4	2&4	2&4	4	2&4	4	1,2&4	1,2&4
DASC (2,3&4)	4	2&4	2&4	4	2&4	4	2&4	2&4
ARMY[c] FIST (1&2)	-	2	2	-	2	-	1&2	1&2
FSE (1&2)	-	2	2	-	2	-	1&2	1&2

Radio Frequency & Modulation Codes: 1 - VHF/AM; 2 - VHF/FM; 3 - HF/SSB; 4 - UHF/AM

NOTES: a - Air Force air request net uses HF/SSB as the primary communications link.

b - Air Force air-to-ground communications are primarily UHF and VHF/FM.

c - Army air support requests use the local Army VHF/FM command net.

FIGURE II-2-3

(C) Both PLRS and JTIDS derive their position location capability through the principle of multilateration by measuring the TOA of signals among the multiple-interconnected user stations of the system. Synchronous TDMA techniques are used to transmit the distance measuring signals. Additionally, TDMA is used to superimpose message-carrying channels on the distance measuring signals.

(C) Both systems use spread spectrum, frequency hopping techniques to provide AJ and low probability of detection or intercept for both the TOA measurements and message transmission. Messages in both systems are transmitted in encrypted digital code to assure communications security. Figure II-2-4 depicts the common features of the two systems for the purpose of illustrating the possibility of integration. JTIDS is designed primarily for airborne use. It is a fully distributed system in the sense that the user units operate among themselves independently from a central control. As a result, JTIDS user units are more sophisticated technically and consequently more costly, than PLRS user units.

(C) By contrast, PLRS employs a central master control unit which provides the housekeeping function of routing signals and messages among users, in addition to providing a centralized computational function for the purpose of user unit position calculations. Since PLRS was designated as a battlefield control system, the information available to the user units is integrated in the central unit, and user positions can be centrally displayed and monitored. This capability provides the Division commander with a real-time picture, and facilitates control of his forces on battlefield.

(C) JTIDS and PLRS operate basically in their own relative coordinate systems. It is, however, a simple matter to transform these coordinates into any other reference frame (e.g., lat-long, UTM, map coordinates) for which a common fiduciary point and direction can be established. In the case of JTIDS, this can be accomplished by locating two stations on the ground to provide a properly surveyed-in baseline. In the case of PLRS, a baseline, defined by the absolute locations

CHARACTERISTIC	PLRS EDM	JTIDS	COMPARISON
BASIC CONCEPT	SYNCHRONOUS TDMA	SYNCHRONOUS TDMA	SAME
TIME SLOTS/SEC	512	128	PRECISELY 4 TO 1 RATIO SIMPLIFIES SYNCHRONIZING
PN CHIP RATE	5 MPPS	5 MPPS	ALLOWS COMMON CIRCUIT ELEMENTS
FREQUENCY SPACING	3 MHz	3 MHz	POTENTIALLY SIMPLIFIES TRANSLATION BETWEEN RF BANDS
USER TERMINAL DATA RATE	75 BITS/MSG X 2^n MSG/SEC	225 BITS/MSG X 2^n MSG/3 SEC	DATA RATE COMPATIBILITY (IE, 75, 150, 300 BPS.)

COMMON FEATURES OF PLRS AND JTIDS

FIGURE II-2-4

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of the master unit and the auxiliary unit, can be surveyed-in to make the system operate in map coordinates. Consequently, not only coordinate commonality between the two systems is achievable, but this coordinate system can be chosen to correspond to standard coordinates used for all other operations, for example, artillery.

(C) CEP for station location for PLRS are shown in Figure II-2-5 classified by user unit type. While no test data are as yet available on JTIDS, CEPs corresponding to those of fixed-wing airborne units shown in Figure II-2-5 for PLRS are the design goals.

(C) Interoperability between PLRS and JTIDS is facilitated by the fact that both systems operate on the same physical principles. Important design features are common to both or are at least mutually compatible, as shown in Figure II-2-4. To achieve operational commonality, PLRS/JTIDS interface equipment together with the attendant communication gear has to be provided to the PLRS master units. Such modification will establish a common grid positioning system between Army and Air Force command and operating units and provide a secure and jam-resistant redundant path communication network accessible to and interoperable between the two forces.

(C) PLRS is well along in engineering development. Production start is projected for 1981. It is very probable that forward elements of the Army will be equipped with PLRS. OAS elements must be able to communicate with forward ground elements, whether by equipping OAS aircraft, FAC and FAC-A with PLRS terminals, or interfacing PLRS net and the Air Force units. Since a digital communications link to OAS aircraft is essential to every proposed handoff system, and JTIDS will not be available as soon as PLRS, it may well be that each aircraft assigned to OAS should be equipped with PLRS. The alternatives of communicating via PLRS interfaced with UHF/IDT, and later, PLRS interfaced with JTIDS must be carefully studied and compared--soon. Note that the position determination feature of PLRS (and after, JTIDS) would be an attractive addition to the present A-10.

(C) In summary, OAS aircraft or other elements which can communicate in the PLRS net are provided in the short term with:

COVERAGE AREA/VOL	USER UNIT TYPE	EDM REQUIREMENT (CEP)	DEMONSTRATED (CAMP PENDLETON) ACCURACY (X,Y)	
			LOS	NLOS
PRIMARY	MAN-PACK UNIT (MPU)	10-30 M	7 M	13-26 M
	SURFACE VEHICULAR UNIT (SVU)	10-30 M	NO TEST DATA	20 M
	AIRBORNE UNIT (AU)			
	ROTARY WING	25-100 M	17 M	16-44 M
	FIXED WING	25-100 M	28 M	NO TEST DATA
EXTENDED	AU	100-200 M		

LOS - LINE OF SIGHT NLOS - NON-LINE OF SIGHT CEP - CIRCULAR ERROR PROBABLE

*PER EL-NV0001-0001A, 12 JAN 1976

PLRS EDM POSITION LOCATION ACCURACY REQUIREMENTS*/PERFORMANCE

FIGURE II-2-5

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(1) Secure and jam-resistant transfer of messages in the near FEBA through air-ground and ground-ground links with improved message transfer reliability.

(2) Improved jam resistance and lower probability of intercept.

Further, those elements equipped with PLRS or JTIDS terminals are provided with:

(3) Centralized real-time, automatically reported and displayed location data on other tactical ground airborne elements.

(4) Real-time position and navigation data to platoon-level ground elements and individual aircraft for FEBA operations.

(C) The scenario at this point assumes that PLRS is deployed on the ground, and that the OAS aircraft (say the A-10), the FAC-A, FAC, FIST Chief, and the FO are all equipped with compatible terminals.

(C) The OAS aircraft navigates part I of the mission from the airstrip to the general area which is controlled by a PLRS master unit. Once entering the range of the PLRS net, the pilot has accurate positioning and navigational information to proceed to the contact point. Even before reaching the contact point, with the assurance that he will accurately arrive at the pre-designated position, the pilot can be in contact with the FAC-A through PLRS to assure the availability of updated target information on arrival. Upon arrival of the contact point or even well before, FAC-A defines the approach corridor to the IP and PUP and gives either absolute target coordinates or relative bearing and range with respect to the PUP as digital messages.

(C) There is no further communication needed as the aircraft approaches the FEBA. If equipped with PLRS terminal, he is cued to the approach corridor and target by coordinates within a CEP of 25 meters or so.

(U) With the target coordinates defined to which he can navigate, there are two options available:

(1) Coordinate cueing. In this mode, the pilot is led to the target by his HUD, visually acquires the target, and delivers ordnance such as Maverick by conventional techniques for pinpoint kill.

(2) Coordinate weapon release. In this case, a bearing with range limits may be defined for the pilot to fly and release ordnance, such as Rockeye for saturated area coverage.

(C) The advantages of this procedure are several. Since meaningful communications operations can begin once the pilot enters the PLRS net, precious time is gained. With the pilot's ability to navigate, his entire mission profile can be pre-determined accurately before he approaches the FEBA, thus removing the need for split-second ground-to-air coordination in the final leg of the mission. The target positioning can be delegated to lower organizational levels such as an FO who is equipped with a laser range finder and a PLRS terminal to communicate the coded message to the FAC-A; and finally, the ability to communicate and navigate accurately to target coordinates can replace conventional and vulnerable cueing measures such as smoke.

(C) This scenario can be carried over to helicopter maneuver missions as well. Target designation and coordinate entry into the PLRS by a scout can result in the dispatch of Cobras or AAHs through a pre-determined safe corridor to a PUP for target engagement.

(C) 3. Conclusions (U)

(C) It is very likely that PLRS or a system of similar potential will be deployed with Army forward elements in the early 1980s. JTIDS will be deployed later for use with Air Force elements. OAS aircraft FACs and FAC-As should be equipped to operate compatibly with whatever system is deployed to Army ground elements and helicopters, and use whichever system is fielded first. Specifically (assuming early Army deployment of PLRS) it is concluded that OAS would be significantly improved by:

(1) The equipping of A-10 and other OAS aircraft with PLRS or compatible terminals.

(2) The equipping of the FAC-A, FAC, FIST, and FO with PLRS.

(C) 4. Recommendations (U)

(C) Expedite the creation and fielding of an integrated joint digital communications and common-grid positioning system based upon use of PLRS for the Army and JTIDS for the Air Force. If one of these is delayed or not implemented, the other should be used by both Services for OAS.

(C) Develop a common digital target language for joint Army/Air Force use.

(C) NATO standardization is not difficult to implement technically and should not be used as a reason for delay.

(C) D. JOINT TRAINING AND TESTING (U)

(U) 1. The Problem

(U) Joint training and testing of OAS components and systems is required in an operational environment.

(U) 2. Discussion

(U) During the course of the study, several deficiencies in current OAS capability have been identified. The Task Group has recommended candidate components and systems to redress these deficiencies and thus improve the effectiveness of OAS. An essential concomitant is to develop a program to exercise these various components and systems in an operational feedback to the systems and component developers and to allow early procedures and tactics development. But this is not enough; to be effective, these exercises must be joint. With a few notable exceptions, joint operational exercises in the tactical arena have addressed fairly narrow operational test and evaluation (OT&E) issues. Recent examples include GUNVAL, EWCAS, AIMVAL/ACEVAL, etc. Of the attempts to establish broader and more permanent joint test agencies, JTF-2 was short-lived and ineffectual; and

the USDR&E(OT&E) Directorate fell far short of its aim to integrate the various Service OT&E activities into the Continental Range concept.

(U) Most of the joint (multi-Service) character of these exercises has been imposed upon the Services from the OSD/USDR&E levels, which have not been notably successful in eliciting unreserved Service participation and support. One evident reason for this restrained enthusiasm has been the Service perception that any deficiencies revealed by such joint exercises would be glaringly exposed not only to its sister Services but also to the highest DOD/OSD levels, and that corrective measures would not be left to Service prerogative. In such an atmosphere the Services see themselves in a no-win situation.

(U) In addition to these limitations, most joint operations--even extensive field exercises--have largely ignored the need for training in the joint arena. This need is nowhere more evident than in joint Army/Air Force OAS operations.

(U) From this history two clear lessons emerge:

° If the Services do not voluntarily undertake joint exercises to resolve joint interoperability problems of equipment, tactics, and doctrine, they will be forced to do so by higher authority and under less than optimal conditions.

° Field exercises must pay increasing attention to training in conjunction with joint operations.

(U) Fortunately both of these critical factors were perceived and agreed upon by the recent commanding general of TRADOC and the TAC, who established several joint groups to study such common problems as the Suppression of Enemy Air Defenses (SEAD).

(C) 3. Proposed Solution (U)

(U) Currently, the Air Force has two operational training programs which lend themselves, in terms

of facilities and expertise, to expansion into the joint Army/Air Force tactical arena: RED FLAG, conducted in the Nellis Air Force Base/Fort Irwin complex, offers an operational feedback opportunity; BLUE FLAG, conducted in the Eglin Air Force Base complex, offers the opportunity for OT&E of Command, Control, Communications and Intelligence improvements with operational battle management feedback. Although both of these "Flag" programs were conceived as unilateral TAC vehicles for operational training, joint participation of the Army has begun and is growing.

(C) For example, a joint exercise could be run in the fairly near future to explore the coordinate-based cueing scheme discussed elsewhere in this report. Such an exercise could make use of elements already in existence or underway including the Army SOTAS, the Air Force JTIDS in a pod, operational A-10s with heads-up display, ground observers, PLRS terminals, etc. manned by operational personnel. The exercise should close the weapons loop and actually attack targets under realistic conditions.

(U) Now is the time for TAC and TRADOC to combine forces to develop a joint OAS training and testing program using either or both of these facilities. A spirit of free-play, unencumbered by higher authority (above TAC/TRADOC), is required to encourage innovation.

(U) 4. Recommendation

It is recommended that TAC and TRADOC develop a joint OAS training and testing program, incorporating early use of new hardware (including prototype equipment when applicable), to provide operational feedback to equipment developers and to begin early definition of operational procedures and tactics.

(C) E. TOWARD IMPROVED OAS HAND-OFF (U)

(C) 1. The Problem (U)

(C) In a high-threat battlefield environment, a fundamental problem in conducting OAS is to reduce to an acceptable level the attrition rate of all elements--

the ground FO, GLLD, FAC, FAC-A, FIST party, designator aircraft (if any), and strike aircraft. The GLLD and the strike aircraft are particularly vulnerable in their normal mode of operation. A key element in reducing their vulnerability is the accomplishment of target hand-off (and/or target designation for terminal guidance) in minimum time with sufficient accuracy and facility to permit first-pass munitions delivery with very brief aircraft exposure.

(C) Based on exercise experience with laser designators, the critical time period for vulnerability to enemy weapons appears to be about 10 seconds. If the laser operates for more than this time, it appears that it can be found and fired on. For shorter periods of operation, it should be safe from immediate fire, though it will probably be necessary for the laser unit to displace regularly. How frequently it has to displace will probably depend on how long the laser has operated since its last displacement.

(C) For the attack aircraft or the attack helicopter, it appears that if they remain exposed to detection within enemy gunfire range on the order of 20 or more seconds, they will probably be taken under fire. The key to survivability is to remain unmasked for less than 20 seconds--if possible for as little as 10 seconds. As a corrollary to this, for attack aircraft near the FEBA, it is necessary that the flight path be as close to the ground as possible.

(C) In general OAS requires target detection and acquisition, a task whose difficulty stems from the need to minimize exposure. The problems of target detection and acquisition from the air are greatly compounded in conditions of low visibility. Without the ability to see the target through smoke, for example, the attack aircraft is not able to accept target hand-off, despite the fact that the ground observer is providing it with a fairly accurate indication of the target's location.

(C) 2. Discussion (U)

(U) It is convenient to separate our discussion of target hand-off into two parts. First, some

of the more pertinent features of our present capabilities are reviewed. Then, new technical means of enhancing our target hand-off capabilities, relative to the preceding problem statement, are discussed.

(C) Present Target Hand-off Capabilities. Present capabilities fall into four categories. These are: (1) use of prominent ground features and/or smoke marking, (2) Creek Braille, (3) radar beacon bombing, and (4) laser cueing and laser target designation. These are discussed in the following sections.

(1) Prominent Ground Features and/or Smoke. This is the most basic method of target hand-off. Its nature is sufficiently well known. Here we shall comment on its limitations. To acquire the target in this way, the aircraft cannot, in general, fly very close to the ground all the way. The aircraft must pop-up in the last 20-plus seconds of the attack, at which time it is dangerously exposed. Moreover, it is difficult with this method to clearly indicate target areas for weapons such as Rockeye when the targets are masked. This system is highly dependent on air-ground voice communication, which near the FEBA, is susceptible to jamming.

(2) Creek Braille. Creek Braille is a concept initiated within United States Air Forces Europe for conducting offensive air support against predetermined target areas and involves minimum communication/coordination with controlling agencies. The concept is based on peacetime planning for navigation and weapons delivery in target areas where our ground forces are given target coordinates and TOT prior to takeoff, and can conduct the mission without any airborne communications. The concept as initially set forth has a lot of merit. It has been enthusiastically embraced in some areas, to the extent that target areas numbering in the thousands have been identified, thus making realistic pre-planning most difficult. A concept is currently being worked in USAFE and AAFCE to provide for common pre-determined contact points and IPs throughout the central region, from which aircraft can be "fanned" to attack time-sensitive or predetermined "kill zone"-type targets. "Kill zone" target areas would be located by the pilot with the assistance of a 5 kilometers by 5 kilometers template which

will overlay his cockpit chart. Coordinates of the centroid of the template would be specified.

Creek Braille could deteriorate rapidly in a dynamic battle scenario due to a lack of depth, but in the important early hours of an attack it should be quite effective. It could assist in CAS but would require additional communications to more fully define the target location. In this case, depending on how close to the FEBA this communication takes place, it might be subject to jamming. Creek Braille is clearly not the whole answer.

(3) Radar Beacon Bombing--Present Capabilities. Ground-based radar beacons provide a limited current capability to direct strikes at night and in bad weather. Target offset information (bearing and range from the beacon) is passed verbally to the strike aircraft by the FAC and the pilot is thus cued to the target. Using a radar offset bombing mode, the pilot may then fly to a computed weapons release point without actual target acquisition.

(C) There are several deployable radar beacons currently operational. The primary one is the PPN-18A, a J-band beacon which is used with the F-111, A-6, and A-7. Other beacons, in the I-band, are in limited use with the F-4 and F-16. The disadvantages of having different beacons for the different types of aircraft are obvious. A new, dual-band (I and J band) beacon, the TPN-28, has been developed. This beacon can be used with the F-4, A-6, A-7, F-16, and F-111 aircraft. Obviously, none of the beacons can be used with the A-10, since it has no radar.

(C) When a beacon is used the FAC must communicate to the strike aircraft the beacon type, code and coordinates (within 2 miles); together with the range and bearing from the beacon to the target, and the target elevation. This information is transmitted by voice. The offset information is entered manually into the aircraft bombing computer.

(C) If the terrain is flat, the run-in altitude of the attack aircraft need not be significantly higher than for other types of attack. If, however, the terrain is hilly, the attack aircraft may be forced to a

significantly higher run-in altitude in order to acquire the beacon, thus increasing its vulnerability to enemy weapons. Also, because of its detectability, the beacon itself may be subject to enemy artillery fire.

(C) The accuracy of beacon offset bombing is largely dependent on the accuracy of the computation of the range and bearing of the target from the beacon. In most cases, the error in this estimate is much larger than the delivery error of the equipment. (An exception is the F-4 which, due to a limitation in updating the computer for 30 seconds prior to weapon release, has much poorer delivery accuracy with offset beacon bombing than do the other types of aircraft.) With current equipment, overall bombing accuracy might be on the order of 300-500 feet CEP for the F-111 and A-7 and 1500-2000 feet CEP for the F-4. These accuracies obviously do not give a reasonable probability of kill against individual point targets, but do permit attacks on area targets. The accuracies (with the possible exception of the F-4) may permit cueing of other acquisition systems such as visual, laser, Infrared imagery, and even radar detection of the target itself in some cases.

(C) To sum up, the deficiencies of beacon bombing with present equipment are: lack of accuracy, beacon detectability by the enemy, excessive aircraft exposure in hilly terrain, accuracy limitations, and inability to be used with the A-10.

(4) Laser Cueing and Laser Target Designation. Present equipment in the form of GLLD and the LTD allow target cueing for the A-10, F-16, AAH and AH-1S. These laser designators can indicate target position through indication on a HUD or other display unit on the aircraft. As soon as an unobstructed line-of-sight exists between the aircraft or helicopter and the target, the display will indicate the target location to within a few meters. This will permit an aircraft like the A-10 to approach low, and when within line-of-sight, detect the target and deliver gunfire. Similarly, it allows an attack helicopter to unmask, rapidly detect the target, and deliver fire.

(C) The basic problems with this form of target cueing have to do with reduced visibility, in which the aircraft cannot see the target even though the cueing is perfectly accurate, and controlling the laser to turn on and turn off for minimum on-time presents a coordination and communication problem.

(C) Laser target designation (as distinct from laser cueing) can be performed with the ground-based laser unit, to allow the attacking aircraft (firing Laser Maverick) or the attacking helicopter (firing Laser Hellfire) to break-off and remask without waiting to guide the missile to impact. Here the basic problem is with the communications link needed to obtain laser turn-on with minimum total on-time. The link's susceptibility to jamming is an obvious problem.

(C) One particularly interesting use of the laser designator sidesteps most of the problems of target cueing and entirely eliminates aircraft exposure. The AAH has the ability to fire Laser Hellfire in an indirect fire mode; for example, from behind a hill. The missile will first climb and then fly straight and level, toward the target. (Given the proper target coordinates, the AAH on-board navigation and fire control computer has the ability to determine the correct launch heading.) The laser designator operator, informed of missile launch, must turn the designator on so that the Laser Hellfire missile will receive a minimum of about five seconds of terminal guidance to the target. With good synchronization, not only will the helicopter avoid exposure, but the laser designator's exposure will be considerably reduced. The need for good communications is again emphasized.

(C) Technical Means of Enhancing Target Hand-Off Capability. We have identified four areas in which new technology can be applied to enhance our hand-off capability. These are: (1) Coordinate-Based Cueing; (2) Improved use of Ground Beacons; (3) Burst Digital Communications; and (4) Reduced Visibility Sensors. The technical aspects of these are discussed below:

(C) Coordinate Based Cueing: Looking ahead to the advent of better target designation, INS in the strike aircraft, a common position location system such as PLRS or JTIDS, and an on-board computing capability, we can synthesize a cueing system for strike aircraft which is not dependent on voice communications (thus being able to work in multilingual environment) and which can take advantage of remotely located target sensors.

(C) In the scheme proposed here, coordinates of the moving or fixed target would be passed digitally to the strike aircraft, where they could be combined with the

coordinates of the strike aircraft and the strike aircraft attitude to drive HUD on which location of the target is indicated. Even under poor visibility conditions, such a display would allow the pilot to approach the target with complete flexibility in flight path, perhaps glimpsing the target near the HUD symbol if visibility permitted. Range and range rate or other necessary inputs could be provided to the fire control computer and would permit area-ordnance delivery under adverse conditions without direct acquisition of the target by the pilot. The proposed system minimizes the need for self-contained target sensors and could be of considerable help to aircraft such as the A-10 in the OAS role.

(C) Improved Ground Beacon. Several improvements would increase the effectiveness of deployable beacons for cueing or bombing. Among these are:

a. Improving the accuracy with which the FAC can locate the target relative to the beacon. A laser range finder would improve significantly the estimation when the FAC can see the target. The Analytical Photogrammetric Positioning System (APPS) should improve accuracy when the beacon and target can be located accurately on a map. It is understood that both systems are being tested currently.

b. A directional antenna, instead of the omnidirectional antennas on the beacons now available, would reduce significantly the vulnerability to enemy detection and location, and would increase the beacon signal strength in the sector toward which it is directed.

c. A data link for the beacon to transmit target location would reduce the requirement for voice communications.

d. The possibility of mounting the beacon on a helicopter in which the ground FAC could operate should be examined. This would improve the flexibility of the system and in many cases, permit lower run-in altitudes for the attack aircraft.

(C) Burst Digital Communications. There is really only a very small amount of information involved in defining a CAS strike. The time-bandwidth product consumed in conventional voice communications between the ground observer and the strike aircraft or attack helicopters

is vastly in excess of what is required. If strike coordination information is reduced to its most compact form in accordance with a preformatted message, this message could be transmitted in digital form over the same (voice) link with relatively high anti-jam capability. To accomplish this, three things are needed: (1) a message format flexible enough to be information efficient and simple to use, (2) a message entry device which can interface to a radio in place of a microphone, and (3) a message display unit that can interface to a radio in place of a speaker. The entry/display unit would be designed to "expand"/encode the strike information to make full use of the available time-bandwidth product on the voice link, in a way that would provide jam resistance. The technology for these improvements is straightforward. Experience with existing equipment (i.e., the Litton IDT) indicates that the human factors aspects are acceptable.

(C) In addition to the ability of this type of communications to work in a jamming environment where voice communications would fail, using the same voice communication link equipment, it is significant to note that with a well-designed message format the target message will be independent of national language. The implications of this for NATO operations are significant.

(C) Reduced-Visibility Sensors. Problems associated with night operations, operations in reduced visibility, and operations in smoke will interfere with target acquisition, with target hand-off, and with terminal guidance. There are a number of new technical developments which can be applied to these problems such as thermal infrared and millimeter wavelength sensors. Some of this technology is well developed and can be applied in the near future. Other parts of the technology are still developmental; all that we can do at present is push the basic research and development needed to support the potential future applications. In the following paragraphs, we discuss some of these.

(C) Target acquisition and tracking at night, in moderately limited visibility, and in a moderate smoke environment can be accomplished by use of a ten-micron FLIR. In these conditions, laser cueing and laser terminal guidance with the conventional 1.06 micron laser designators can be done. What is needed is to have a FLIR capability on the designator unit, and also on the weapons platform for cueing. For the GLLD, the addition

of the AN/TAS-4 FLIR, developed for the TOW missile launcher, would provide the appropriate capability. (We understand that this is presently planned.) Similarly, for the LTD addition of the AN/TAS-5 FLIR, developed for the DRAGON missile launcher, would provide the appropriate capability. (In each case, i.e., GLLD/TOW and LTD/DRAGON, there is a good match of operating range and target types.) Aircraft that have been cued to the target with a laser device, some self-contained seeker is required to provide an autonomous attack capability. Such a FLIR is planned for the AAH, but is significantly absent from the A-10, which would require it for use with the GAU-8 gun in limited visibility conditions.

(C) For conditions of even poorer visibility or heavier smoke, it may still be possible to detect targets with a thermal infrared FLIR, while the 1.06 micron laser beam would not be able to penetrate effectively. Under these conditions the laser beam from a 10.6 micron laser would be able to penetrate. (For most obscurants, the attenuation coefficient is only about one-tenth as much at 10.6 micron as it is at 1.06 micron.) This suggests the desirability of performing laser cueing and laser designation at 10.6 micron. The technology for CO_2-lasers for the designator is well in hand, and because of the greater power/efficiency such a unit may be smaller/lighter than the present 1.06 micron laser designators. Any design problems for a 10.6 micron laser designator should be straightforward. The technology problems that force us to view the use of 10.6 micron laser designation as a research and development matter pertain to the seeker head and its detector. We have to cool the detectors, probably to about liquid nitrogen temperature, but we know how to do this. More seriously, however, there is a basic incompatibility between detector sensitivity and detector size/field-of-view. It will probably be necessary to make use of current development on two-dimensional infrared detector arrays to resolve this incompatibility. The detector arrays will probably require on-chip high-frequency pulse-detection circuits. Technical developments in this area are moving fast enough that it is reasonable to expect eventual development of such a capability. With reasonable emphasis, technical feasibility could probably be established in about five years.

(C) For particularly severe conditions of low visibility or very dense smoke, ten-micron operation will not be possible, either for target acquisition or missile guidance. In this case it becomes interesting to consider the potential of millimeter wavelengths such as the 3 millimeter, 94 GHz atmospheric "window." For moderate ranges (i.e., several kilometers) penetration will be reasonable, but because of diffraction/resolution effects detection ranges may be as little as one kilometer. With special techniques three kilometers range may be possible. With a 3 millimeter radar it may be possible to pick out targets such as a moving tank by its doppler signature at 3 kilometers range. Other promising techniques include active imaging (principally at 1 centimeter and 3 millimeters), fire control pointing and tracking (principally at 3 millimeters), beam riding missile guidance (principally at 3 millimeters) and passive short range detection and homing (principally at 1 centimeter). Some of these cases are being explored. The pay-offs are uncertain in the sense that we are not sure how much the clutter, low resolution, ground-plane reflections, etc., will limit performance. But concern for our military position if some of these techniques are possible and we do not develop the ability to exploit them while others do, argues strongly for a fairly broadly based exploratory effort in this area.

(C) 3. Recommendations (U)

(C) In order to enhance probability of engagement and reduce exposure of strike aircraft, attack helicopters and man on the ground:

Develop a coordinate-based cueing system which will:

a. Generate target coordinates (periodically).

b. Enter target classification.

c. Transmit (route) data to weapons platform.

d. Display target location on a HUD, based on target coordinates.

To improve operations with ground beacons:

a. Improve accuracy by providing accurate (~100 ft CEP) range and bearing from beacon to target.

b. Reduce probability of detection by screening the beacon from the enemy.

Develop burst digital transmission, to reduce vulnerability to jamming and enhance reliability of communications. We should plan to provide, "tomorrow", ancillary device for digital burst entry into existing tactical radios. (This should be an IDT-like system.)

In order to enhance acquisition of targets (by pilots and ground observers) at night and reduced visibility, we should:

a. Accelerate provision of FLIR for GLLD and LTD and other equipment.

b. Expedite development of long wavelength IR lasers and seekers for designation and weapon guidance.

c. Accelerate exploration of millimeter wavelength technology.

(C) F. CROSS-SERVICE UTILIZATION OF TARGETING INFORMATION (U)

(C) 1. The Problem (U)

(C) It must be anticipated that many targets located by the sensors of one service would be appropriately struck by weapons of another service. For example, enemy AD units found by the Air Force's PLSS to be located within reach of Army artillery might well be priority artillery targets. Conversely, those located by the Army's AGTELIS or the FIREFINDER AN/TPQ-37 backtracking radar--especially those targets beyond artillery range--might well be struck by the Air Force.

(C) The problem is to assure that time-urgent and perishable targeting information immediately reach the appropriate strike forces independent of Service origin.

(C) 2. Discussion (U)

(C) The PLSS system utilizes three high-altitude airborne platforms (probably U-2 aircraft) deep in friendly territory which are accurately located in "electronic coordinates" tied (through distance measuring equipment) to a network of fixed ground stations. These aircraft overlook the whole battlefront, and receive and relay signals from enemy emitters to a ground master station/computer. For pulsed emitters, the TOA at the aircraft receivers uniquely determine the emitter location; for CW emitters, a correlation of the relayed signals at the master station determines the TOA data and again provides a unique solution for the emitter location.

(C) Once the emitter location is determined in the PLSS electronic grid, this information can be used to direct/guide a strike weapon--such as Wild Weasel aircraft, GBU-15 guided glide bomb, artillery, etc.--to the target location. Rapid strike response is clearly necessary for time-urgent targets such as mobile enemy air defenses.

(C) The Army's AGTELIS system also uses TDOA location of enemy emitters but, being ground-based, surveils a much smaller area (e.g., a Division front 40 kilometers wide and 30 kilometers deep) and thus needs only a smaller data-handling capability. The location information provided by AGTELIS can be used by PLSS to guide strike weapons, but AGTELIS itself has no self-contained weapons-guidance capability.

(C) The Army's AN/TPQ-37 FIREFINDER radar designed for backtracking artillery projectiles, will also see AAA shells and SAMs. Location information on these AD weapons is, of course, of great interest to the Air Force. Moreover, SAM-launcher/AA-gun location information augments and complements that on the associated AD radars provided by PLSS and AGTELIS. However, to backtrack accurately nonballistic projectiles, such as SAMs or rocket-assisted projectile (RAP) artillery rounds, requires a special nonballistic backtracking algorithm. Development of such an algorithm is now being considered by TAC.

(C) 3. Proposed Solution (U)

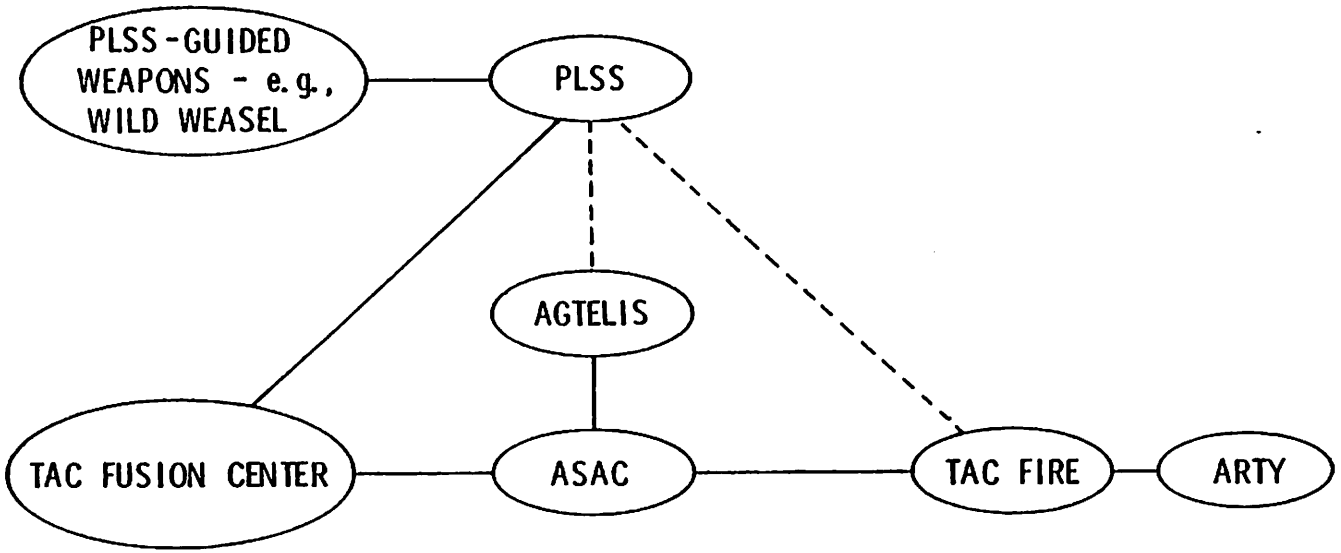
(C) The solution proposed for expediting the inter-Service flow of targeting information is illustrated in Figure II-2-6. Here the solid lines indicate the data links presently planned. The dashed lines represent the proposed additional direct inter-Service cross-links, which would tie AGTELIS to PLSS and PLSS to TACFIRE without any intervening nodes.

(C) At present there is no plan to establish commonality of the coordinate grids used respectively by the Air Force (PLSS) and Army (AGTELIS FIREFINDER) systems. With reference to its fixed ground stations, PLSS establishes an "electronic coordinate system." By contrast the coordinate system for AGTELIS and FIRE-FINDER are planned to be based on fiduciary points whose locations are determined using conventional artillery survey means and maps. At the very least, these two coordinate systems must be tied together. This problem will, of course, be solved once PLRS and JTIDS are made interoperable and deployed. However, in the near term a simple and inexpensive expedient would be to use jeep-deployable tethered balloons containing corner reflectors (metallized-films) that could be located by the TPQ-37 radar. Such balloons have already been developed under the Navy Science Assistance Program (NSAP). Equipping the jeep with a PLSS transponder would then allow tying together both the PLSS electronic grid and the FIREFINDER grid in the simplest and most direct fashion.

(C) Previously in this report, the recommendation was made to preallocate sorties to Army Corps commanders for upcoming time blocks and for subsequent suballocation of these sorties down to Division and perhaps down to Brigade. But there still remains the problem--at these levels--of assigning these sorties to specific targets in a timely manner and of engaging these targets with the strike aircraft. This is particularly relevant in the case of mobile targets beyond line of sight of forward observers and are in reduced visibility.

(C) One approach to enhance the assignment of sorties to targets (and the engagement of these targets) under the conditions described above is to use the data from SOTAS. The use of SOTAS in the execution phase of

(C) FLOW OF TARGETING INFORMATION (U)



——— PLANNED LINKS

----- PROPOSED ADDITIONAL DIRECT CROSS-LINKS

Figure II-2-6

strike aircraft was tested in Reforger '77. SOTAS derived data was provided to the crew of an F-111A via the Air Liaison Officer who was in the SOTAS ground station.

(C) The use of SOTAS should be emphasized as a means of providing sensor data directly to those who need it most in the execution phase--both to the ground commander in assigning aircraft to specific targets and to crews in strike aircraft to assist in the engagement of targets.

(C) 4. Recommendation (U)

(C) In order for each Service to be able to apply its unique strike assets to high-priority targets located by the other Services, it is recommended that:

direct two-way data links be provided for transmitting PLSS-target locations to TACFIRE for possible strike by artillery; and for transmitting target locations determined by AGTELIS and FIREFINDER (TPQ-37) to PLSS for possible guidance of aerial ordnance;

pending deployment of a common inter-Service coordinate grid system, the Army/Air Force utilize "survey jeeps" equipped with PLSS transponders and deployable tethered corner-reflector balloons whose positions (at artillery batteries, AGTELIS fiduciary points, etc.) can be readily determined by the FIREFINDER TPQ-37 radar.

provide data from SOTAS directly to ground commanders (down to Brigade) to assist in the assignment of allocated sorties to specific targets.

provide data from SOTAS to strike aircraft to assist in the engagement of these aircraft against targets to which they have been assigned.

(C) G. TOWARD AN IMPROVED A-10 AIRCRAFT (U)

C) For OAS over the central European battlefield the U.S. Air Force is counting heavily on the Fairchild A-10, with a planned buy of over 700. This aircraft is especially designed for the CAS role, with heavy armor, high maneuverability at low altitudes and extended range/loiter time. The principal armament of the A-10

includes the very competent 30mm GAU-8/A gun and up to six AGM-65C Electro-Optic (EO) MAVERICK air-to-surface missiles.

(C) Recognizing that the high density of Soviet battlefield AD systems expected in the ETO would preclude air operations of the A-10 at all but very low altitudes, the TAC is conducting the development of low-level tactics and training with the A-10 at attitudes of 60 m under the Red Flag exercises at Nellis Air Force Base. Although this commendable program has proved quite successful and has won the enthusiasm of the A-10 pilots, it is evident that these demanding low-level tactics leave little pilot attention to spare for the main mission and are anyway limited to VFR conditions--i.e., clear visibility and daylight. Moreover, the imposition of low-level flight precludes use of bomblets in dispensers. For example, the ROCKEYE II submunition and even several of the candidate Wide Area Antiarmor (WAAM) submunitions being developed by ADTC may require deployment altitudes of several hundred feet to achieve proper submunition impact orientation. This demands either a pop-up maneuver which increases the exposure of the A-10 or the development of a loftable or powered submunition dispenser that can climb to the requisite altitude.

(C) The above considerations constitute serious limitations for VFR operations. A more serious limitation is the lack of capability at night and under IFR due to adverse weather. Under IFR, the A-10 has limited navigation capability and also is deficient in its ability to search, acquire and engage a ground target.

(C) One further observation may help clarify the night/all-weather problem: namely, that linking the much easier nighttime-capability problem to the much more difficult all-weather problem discourages taking those relatively simple and inexpensive steps that could result in a fairly competent night capability. This appears very much worthwhile for the A-10 even if an all-weather capability is infeasible (or unaffordable). For example, the possibility (mentioned in Section II-F) of utilizing the SOTAS capability to bring an aircraft track into coincidence with a ground target might make a significant improvement in the nighttime capability of the A-10.

(C) To enhance the survivability of the A-10 and to provide a modest capability to operate at night, the following ideas -- some of which are already underway -- seem worthy of support:

1. Adapt the HUD/MAVERICK cockpit display to a FLIR/IR MAVERICK system to provide a clear-nighttime capability;

2. Provide an inertial navigation system;

3. Provide a radar altimeter/warning system;

4. Adapt a PLRS/JTIDS location and communication system to the A-10 platform;

5. Provide chaff/flare dispensers;

6. Consider modifying the A-10 to a 2-seat version to reduce pilot workload;

7. Alternatively, provide an autopilot;

8. Accelerate procurement of the I^2R MAVERICK system;

9. Modify the HUD to include a projected map display;

10. Provide (in pods) additional mission and survival aids (e.g., ECM gear); and

11. Provide a simple powered free flight dispenser weapon for delivery of bomblets like ROCKEYE.

(C) Since the time available did not permit a properly informed consideration of such possibilities, the Task Group strongly urges that a special group of knowledgeable individuals--consisting of avionics specialists, A-10 engineers, A-10 pilots and appropriate SAB members--be convened to consider these and other possible A-10 improvements.

(C) On the premise that virtually any measures would be welcome that can help the A-10 fulfill and survive its difficult assignment, several members of the Task Group discussed the possibility of an expedient modification that might make the use of CBU ordnance

feasible in the near term. The concept involves adapting an existing rocket motor, such as the 5" ZUNI, to propel a ROCKEYE II canister ahead and above the A-10 vector so as to disperse the CBUs over the target area. The reasoning underlying this proposal is that:

(1) Although ROCKEYE II may be only marginally effective against tanks, it has the highest effectiveness of any weapon currently in the tactical stockpile; it is quite effective against lightly armored vehicles--e.g., APCs and trucks; and, moreover, has an antipersonnel mode.

(2) A drawback in using ROCKEYE II at the very low AGLs (e.g., 60 m) now being practiced by the TAC and USMC A-10 pilots is that the bomblets must be released from the canister above ~300 m AGL to allow sufficient time and fall to achieve proper (i.e., near-vertical) bomblet orientation.

(3) This requires a lofting or pop-up maneuver which increases A/C exposure by overflying the target and is limited to strictly VFR conditions.

(4) By contrast, a canister having its own propulsion could be fired with a kilometer or two stand off and without any special aircraft maneuver other than navigation to the proper range and heading to the target.

(5) If the A-10 had a radar altimeter, a navigation system (either inertial or externally vectored) and a FLIR it might be possible to deliver such ordnance over a designated target point even under conditions of low visibility.

(6) The canister could be opened in the standard way using a fuze triggered either on a fixed time setting or on motor burnout.

(C) Although the mating of mismatched components not designed to interface seldom yields a satisfactory solution, we are driven to consider such a kluge here simply because of the desperate lack of any suitable A-10 CBU ordnance, especially for the immediate future.

(C) Two further recommendations, relating to A-10 operations rather than modifications, are to:

Examine the possibility of utilizing SOTAS location information to bring the A-10 ground track into coincidence with a SOTAS target and thus facilitate A-10 target acquisition--or even conduct the target engagement (e.g., for blind delivery of an area-type cluster bomb unit weapon).

Evaluate by an actual field exercise, joint with Army RED teams, the degree of threat posed by an internetted system of GRAIL missileers to aircraft like the A-10 (or COBRA-TOW) operating at low altitudes over the battlefield, as described above.

(U) H. NATO IMPLICATIONS

(U) The fusing of multi-nation army and air components under command of a given nation has indeed a number of recognized problems - namely doctrinal differences, cultural and training, as well as an array of time-tested national procedures unique to a given Service component. In NATO, the problem is compounded by currently incompatible communication systems and language differences.

(U) While NATO does sponsor a number of operational exercises to help train and fuse components into an effective force, the process is a two-way affair; that is, the U.S. should participate in NATO exercises as well as vice-versa. There should be a mutual effort among the allies to develop scenarios for exercises that iteratively test and evaluate new techniques, tactics and procedures oriented to achieve interoperability.

APPENDIX A

DEFINITIONS

1. ALLOCATION - The distribution of offensive air support (OAS) sorties among the Army units. (A portion of the total OAS sorties are retained by the Air Force component commander for battlefield air interdiction.) The allocation process starts at the Corps and may extend down to Brigade through suballocations. The allocation process is dynamic and will be adjusted as battlefield requirements dictate, up to an established time window when the allocation is considered to be firm and the sorties are on-call to the Army unit.

2. APPORTIONMENT - The division of air assets according to mission, i.e., counter-air interdiction and offensive air support. The apportionment is done by the Joint Force Commander.

3. ASSIGNMENT - The identification of a specific attack asset to fire on a special target. The responsibility for assignment resides with the unit to which the attack asset is allocated.

4. BAI - Battlefield air interdiction. Operations against targets beyond the fire support coordination line but which are of imminent concern to the ground forces. These operations require coordination with ground forces, normally of Corps level.

5. CAS - Close air support. Operations against targets located between the furthest line of friendly troops and the fire support coordination line. These operations require close coordination and integration with the fire and maneuver of the ground forces.

6. OAS - Offensive air support. Operations involving attacks against targets which, due to their nature and location, require some degree of coordination with ground forces. The operations are subdivided, according to target locations, into close air support and battlefield air interdiction.

REPORT OF TASK GROUP III

(S) INTERDICTION ENEMY COMMAND AND CONTROL (U)

Dr. David Shore, Chairman	ASB
Dr. Alexander H. Flax, Vice Chairman	SAB
Dr. Joseph V. Braddock	ASB
Dr. Daniel B. DeBra	SAB
Dr. Jack R. Tooley	ASB
Dr. Willis H. Ware	SAB
Lt Col Charles Tatum	TAC
Maj James Richards	AFTEC
Col B. Bindrup	TRADOC
Dr. Robert Wiseman	Army

(S) ABSTRACT (U)

(C) This section treats the topic of the utility of and capability for NATO detection, identification, location, and neutralization of WP C^3 assets in a European War environment. The current principal deficiencies in capability are identified and proposed solutions for both near-term (pre-1983) and longer-term (post-1983) are presented. The needs are also considered in light of two time "zones":

- pre-war (collection, confusion and deception)
- post-attack (identification, localization, neutralization).

(S) The principal deficiency identified is an almost total absence of current emphasis on the C-C^3 mission and a corresponding lack of organizational tasking. There is a major failure to extract and utilize existing data collected by both national and theater assets.

(S) Proposed approaches and recommendations for solution include:

(C) (a) Provision of an essential organizational and doctrinal focus for C-C^3.

(C) (b) Development of a joint Air Force/Army activity to screen existing data for C-C^3 uses.

(S) (c) Development of C-C^3 as a major functional element of BETA and its descendants.

(S) (d) Implementation of "fingerprinting" techniques to enhance location.

(S) (e) Emphasis on countering Soviet C-C^3 by deception of REC pre-attack and by destruction after a war starts.

(S) (f) Incorporation of EW capability into PLSS.

(S) (g) Concentration on ARM C-C^3 weapon development, particularly for use against the SVOD system.

(U) In addition to the recommendations in this section, some are available in a specially classified appendix.

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(S) I. SUMMARY (U)

(S) A. TOPIC (U)

(S) This study assessed the capability of US forces to detect, identify, locate, and neutralize key WP tactical C^3 elements in engaged and reserve forces, with particular emphasis on mobile command posts. Initial attention was focused on evaluation of capabilities possible through the use of existing or programmed US assets; then projections of technical and other improvements were considered. A principal point of departure was the 1977 Defense Science Board study of this topic.

(S) B. KEY OPERATIONAL NEEDS (U)

(S) In a comparison of NATO and WP capabilities in C^3 assets, the present balance is strongly in favor of the WP. In addition to substantial numerical superiority in number of types and fielded equipments, WP doctrine integrates C-C^3 into their overall offensive warfare doctrine. Both physical attack and electronic countermeasures are not only called for in doctrine, but are also supported by REC, a dedicated organization trained in these disciplines. This potent advantage over NATO is further enhanced by the WP having the attack initiative in any first battle, with the obvious advantage of being able to fight from "fixed" plans for some period. On the other hand, both historical trends and observations of current training WP exercises indicate a substantial disinclination toward initiative actions without higher chain of command authorization; which implies a potentially substantial benefit to be obtained from disruption of this chain.

(S) NATO operational needs for C-C^3 must be categorized by war phase, i.e.:

(S) Active pre-war confusion and deception. C-C^3 activities may be very profitable if they are able to cast doubt on the validity of WP pre-plans and/or to indicate NATO ability to frustrate these plans. Useful results might include uncertainty, hasty re-planning, delay or cancellation of the attack. Such a capability is, however, rather fragile in the sense that it

requires some warning time and any repeated use would probably sharply reduce its effectiveness. Passive pre-war C-C^3 actions would largely be confined to building data bases to support not only indications and warning and electronic order-of-battle (EOC); but also to maintain updated wartime C-C^3 plans and possibly, "pre-loaded" capability.

(S) Initial attack and "steady state" phase activities may differ somewhat in target prioritization and time-line requirements but are functionally essentially the same, with focus on disrupting WP ability to coordinate key forces for either offensive or defensive actions by cutting the chain of command. It is important in this connection to recognize that most C^3 assets, probably more so than other weapon systems, can be disrupted as effectively by temporary neutralization as by outright destruction. In general, such harassment also requires at least an order of magnitude less expenditure of assets - accuracy of location, number and size of delivered weapons, etc. - than destruction.

(C) Because of the WP doctrine and practiced capability for skipping one inactivated level of command, it is necessary to make coordinated attacks on at least two adjacent levels - with Army Main and Division Main the most likely targets.

(S) Two other potential C-C^3 target types must also be considered as primary, high yield modes. These are the particular C^3 assets associated with the offensive REC (jamming, destruction, etc.) units, and the Soviet SVOD Navigation System. The first of these is important because of the necessity for protecting our own C^3 ability, which the WP plans to neutralize to about 30% of nominal. "Jam-proofing" if technically feasible and physical protection of these assets will cost several $100M and require 5-10 years to complete; while counter-force to REC may be obtainable much more readily and cheaply. The SVOD is an extremely attractive target because it is not only the basic centralized guidance system for WP airborne platforms, but also is interlinked into many target designation and fire-control systems.

(U) A major requirement for C-C^3 capabilities is that they not require diversion of a major percentage of assets - from development investments through delivered weapons - available to NATO. The investments for C-C^3 must also be justified on the basis of pay-off compared to the attack of other targets. Furthermore, the C-C^3 measures should not significantly degrade NATO C^3.

(U) Table III-1 summarizes the candidate US/Allied actions as a function of the war phase.

(S) C. CRITICAL DEFICIENCIES (U)

(C) The major current deficiency in NATO C-C^3 is the lack of awareness of its importance and its potential payoff. There has been little effort to implement C-C^3 planning by the JCS (although this is now underway), the Services and the using commands. No definitive doctrine which considers C-C^3 as a "system" exists, and no one commander or organization has the assigned responsibility for it.

(U) From a system and technology standpoint the following are the most important current deficiencies:

(S) 1. There is a failure to extract and process C-C^3 intelligence data which is already regularly collected in the National Intelligence Centers, and to a lesser degree in theater Interdiction and Warning (I&W) intelligence.

(S) 2. Both current and developmental collection systems tend to emphasize radar rather than communication frequencies.

(C) 3. As a result of 2 above, NATO C-C^3 location accuracy is low.

(S) 4. Dedicated C^2 for C-C^3 is non-existent.

(S) 5. There is very little focus on development of systems or equipments to destroy or harass C^3.

TABLE III-1-1

(S) CANDIDATE U.S. ALLIED ACTIONS (U)

TIME PERIOD

SOVIET FUNCTION	PRE H	POST H	STEADY STATE
RECONN	C&D ACTIONS	DESTROY REC C^3	DESTROY REC C^3
ARTILLERY	H-12 TO H MASK REAL LOCATIONS CREATE MANY FALSE TARGETS	DESTROY ARMY & DIV MAIN - IF POSSIBLE HARASS AND FORCE MOVEMENT - IF NOT FORCE LOAD ON FORWARD CPS DESTROY FWD CPS H TO H + 12	H-12 TO H + 12
AIR	H-1 TO H + 1 DECEIVE REC SVOD	H + T FOR ECHELONS DESTROY SVOD	H-1 TO H + 1 H + T FOR ECHELONS
MANEUVER	H-4 TO H + 1 MASK REAL LOCATIONS CREATE MANY FALSE POSITIONS	DESTROY RGT MAIN - IF POSSIBLE HARASS AND FORCE MOVEMENT - IF NOT FORCE LOAD ON FWD CPS H TO H + 12	H-r TO H + 12

(S) 6. There is an almost total lack of a US cover and deception activity.

(S) 7. The existing assets and C^3 structure for detecting, locating, identifying, deciding on C-C^3 actions, and implementing these actions are neither survivable, nor do they produce data which is timely for C-C^3 use.

(S) D. PROPOSED APPROACHES FOR IMPROVED CAPABILITY (U)

(U) This section contains a summary of all Task Group outputs. Additional recommendations are contained in a specially classified appendix.

(C) Near Term (78-83). The first need is to provide the essential focus, organizational responsibility, and planning for C-C^3 within the US and in NATO. Detailed recommendations for achieving this is beyond the scope and capability of this Task Group, but deserves the highest priority in the US command structure.

(U) The following approaches merit consideration for joint action by the Air Force and the Army.

(S) 1. A joint C-C^3 intelligence screening activity. Since much useful data is already being collected regularly, a small staff (possibly augmented by contracted services) could develop a C-C^3 target identification service for European Command without need for major additional resources in sensors, etc.

(C) 2. A C-C^3 tailored C^2 system could provide a nearer term capability than will be demonstrated in BETA and operational systems that follow-on after BETA. When these follow-on systems are operationally available, the C-C^3 command system could provide a redundant back-up.

(C) 3. Evaluation should be made of RPV/Drone use to provide low cost (compared to aircraft) platforms for locating C^3 systems, for providing target marking for attack by assets and for either harassment or destruction.

(S) 4. Influence the requirements specified for planned developments such as PLSS, BETA, Tactical Fusion Center (TFC), TIPI-II to provide important C-C^3 features.

(C) 5. Upgrade existing and programmed collection systems, e.g., National assets and other location systems, to provide better means to detect, identify and accurately locate enemy C^3.

(S) 6. A confusion and deception (C&D) capability (as practiced by the British in World War II) should be developed by establishing a covert group for this purpose.

(S) 7. A specialized anti-REC capability is needed, but this Task Group lacks adequate information to specify the best form of their action. It must however, be clearly established as an element of the combined arms team.

(S) 8. Categorize and evaluate munitions and devices to counteract enemy C^3 either harassment or destruction. FAE, for example, could be used to destroy enemy C^3 hidden in forests when the location of individual elements in the C^3 are not known. Expendable jammers, mines, and Have Name weapons may so disrupt the C^3 that it would be forced to move prematurely.

(S) 9. Initiate development of specific C-C^3 weapons of the ARM type.

(C) Longer-Term (Post-1983).

(S) 1. Implement EW "fingerprinting" techniques to enhance C^3 location and identification.

(S) 2. Incorporate EW location capability into PLSS.

(C) 3. Field expendable jammers and decoy transmitters for aircraft and artillery emplacement.

(S) 4. Field RPV/Drone carried sensors for close targeting/localization of C^3 assets.

(C) 5. Characterize and allocate wide-area munitions types for C-C^3 useage.

(S) 6. Field specific C-C^3 ARM weapons, with first priority on the SVOD.

(S) E. RECOMMENDED ACTIONS (U)

(U) Near-Term (78-83).

(C) 1. Establish C-C^3 responsibilities at appropriate Service and user organizations and develop the systems architecture and doctrine for a survivable C-C^3 implementation.

(C) 2. Develop C-C^3 plans at all appropriate organizations -- coordinate between Air Force and Army.

(C) 3. Task National assets and other activities to produce C^3 target parameters.

(C) 4. Field a C-C^3 command system in Europe to provide EUCOM, USAREUR and USAFE C-C^3 target data, to prove feasibility, and to support development.

(S) 5. Develop an initial C&D capability aimed at REC and Soviet Intelligence Collection Assets.

(C) 6. Test the capability of C-C^3 applications of RPV/Drones.

(S) 7. Initiate a counter-SVOD ARM development.

(C) 8. Develop special C-C^3 disruption devices such as FAE, mines, and expendable jammers.

(U) Long-Term (Post-1983).

(C) 1. Develop new systems to identify functional elements, e.g., artillery CP, within a concealed and dispersed Army or Division main command center.

(C) 2. Develop a family of low cost (under $100K including payload) RPV/Drones for selected C-C^3 activities - detect, identify, locate and destroy.

(S) 3. Develop "Expels" and other systems with enhanced C-C^3 target parameter capability especially for communications emitters.

(S) 4. Develop other special C-C^3 devices and technology.

a. Disposable jammers with friendly frequencies to confuse enemy REC.

b. Automated fingerprinting, templating techniques.

c. Improved ARMS and other stand-off munitions for use against communication emitters and other C^3 assets.

(S) II. DISCUSSION (U)

(S) A. ANALYSES OF OPERATIONAL AND FUNCTIONAL NEEDS (U)

(C) 1. BACKGROUND (U)

(U) The WP buildup of their forces in Central Europe, particularly over the last 15 years, has put them into a position of overwhelming numerical superiority in most categories of weapons. Qualitatively they have also greatly improved their position relative to NATO, and although NATO is still qualitatively ahead in some categories, it is behind in others. Qualitative factors are by no means significant in affecting the Pact numerical advantage.

(U) WP doctrine calls for carrying on combined tactical nuclear and conventional operations if and as necessary, and their planning is based on the assumption that their forces may be attacked by nuclear weapons at any time. Therefore, there is emphasis on avoiding dense concentrations of forces which would constitute lucrative targets for tactical nuclear weapons except for as short a time as necessary to achieve a breakthrough. Thus, their plan for offensive operations is to be carried out on a relatively tight time schedule for the convergence and effective integration of combined arms forces along axes of attempted breakthrough whether the operation employs conventional weapons only or both conventional and nuclear weapons.

(U) The WP emphasis on the offensive and the breakthrough of armor at high rates of advance has lead them to develop high mobility in equipment and concepts for all force elements including infantry, artillery, armor, air defense and the associated command and control. A collateral benefit of the mobility of these elements is that their movement reduces their vulnerability by reducing the time available for the identification, location and attack sequence. In addition, there is emphasis on vulnerability reduction through sufficient redundancy of critical force elements and supporting systems, including C^3.

(C) The WP concept for sustaining a major offensive is based on the use of echelons at each force level which follow the first echelon forces at the appropriate time to bolster flagging efforts and/or exploit openings which have been developed. In the initial phases of the attack, the time phasing of lower-level force echelons (second echelon Battalions of the first echelon Divisions) is more or less preplanned. However, the employment of higher-level echelons (second echelon Divisions) depends on the relative rates of progress along various axes of attack. There is considerable dependence on C^3 in the event of significant deviation from the initial plan or in any case when the time for commitment of second echelon Divisions. Moreover, the Soviet doctrine of centralized high-level control of military forces places substantial demands on C^3 in assuring success of major attacks.

(C) The NATO military plan for Europe is primarily defensive in nature. The primary threat is a WP surprise attack since NATO in its peace-time posture is not properly armed and deployed to meet a major Soviet thrust. It depends on a postulated minimum of 48-hours warning to posture itself against an aggressive threat. Moreover, because of its numerical disadvantage, NATO forces are heavily dependent on the entry of additional assets such as some Canadian troops and US aircraft and supporting resources from their home bases. Because surprise attack is such a formidable threat, NATO places emphasis on intelligence to provide the earliest possible I&W of increased Soviet mobilization. This reliance tends to drive all near real-time sensors and intelligence collection efforts to support this objective to the possible detriment of others.

(C) NATO, because of its numerical inferiority in weapons across the board, must place great reliance on C^3 as a "force multiplier" so that its more limited fire power resources may be applied at the right place at the right time. By the same token, NATO effectiveness, particularly the disposition of reinforcement to reach anticipated strike points, is extremely vulnerable to degradation of its C^3 which, in comparison with Soviet C^3 is lacking in redundancy and mobility.

(C) As a matter of doctrine, which is probably reinforced by the perception of the extreme vulnerability of NATO to deterioration of its C^3, the WP is thoroughly

committed to an extensive plan for aggressive suppression of NATO C^3. This plan is roughly characterized by the objective of destroying about 30% interference with NATO C^3 by jamming and 30% by destruction. This total of 60% interference with NATO C^3 is deemed by the WP, to be adequate to render it almost totally ineffective. The responsibility for Soviet C-C^3 operations rests with dedicated REC forces. REC units are attached and controlled at front and Army levels and assigned to other locations and forces and levels at times required by the attack plan.

(C) On the NATO side, given limited resources and the difficulties of assessing and predicting C-C^3 value and effectiveness, there is no plan or major organizational responsibility for integrated C-C^3. Except for certain communications jamming activities, there are few, if any, discrete plans or capabilities for countering specific elements of Soviet C^3 affecting selected force elements (e.g., artillery). In the contest for scarce NATO resources, C-C^3 has thus far proved to be non-competitive, not only in acquisition of specialized capabilities, but also in planned priorities for allocations of firepower by operational commanders.

(U) Of late, the growing awareness of the degree of Soviet emphasis and commitment to C-C^3 has forced NATO to reconsider existing attitudes and positions on the value of C-C^3. The present study departs from the 1977 Defense Science Board study and identifies and examines in greater detail a number of areas of C-C^3 which are of high potential value in ground-air operations in countering a WP thrust in Central Europe.

(C) 2. CRITERIA FOR ESTABLISHING C-C^3 PRIORITIES (U)

(U) Although convincing quantitative measures for the effectiveness of various C-C^3 actions are very difficult to come by in most cases, there are a number of factors which can be used to assess how such actions might be prioritized and to indicate that they may represent reasonable levels of effort relative to the results which may be anticipated. The major factors are:

(U) a. Effectiveness in stopping or slowing the Pact Offensive Threat. Here the time criticality of the operation controlled in relation to the time-line

of the attack is a major consideration. Also the size and function of the forces being controlled and their essentiality at a given phase of the attack (artillery and aviation in the early phases of attack).

(C) b. Feasibility of locating the target within its time cycle of movement. Most US sensor systems have only periodic access to targets (an airborne SLAR sweeps out its swath over the period of its flight mission time and then lands). Even if the sensor is directly data linked to a processing and interpretation center, these operations take additional time. Equally critical is the time required for an operations staff to evaluate data and to recommend the most lucrative targets for the commander to attack. Further, if positive target identification or refinement of location requires correlation of several sensor outputs, then several may require transmission to analysis center for further processing and decision making. The time cycles for these activities at present may be as long or longer than the times between movements of WP C^3 elements, especially at lower levels. More advanced sensor systems and information processing systems for analysis and distribution in the future should improve the time cycles. For some classes of targets, and some phases of the attack, the time cycle will always be a critical limiting factor.

(U) c. Response time for C-C^3. After a C-C^3 target has been detected, identified, located and evaluated, there remains the question of whether it can be attacked in the time remaining within the target movement cycle. This factor will often be a deciding one in selection of specific weapons for specific targets. The other controlling variables, being the availability, range and accuracy of the selected weapon and its delivery systems.

(C) d. Firepower resources required in relation to the total available. If C-C^3 operations are to prove practical during peak surge periods in requirements for firepower support (artillery and tactical air) such as would occur, for example, during the initial phases of attempted Soviet armored force breakthrough, the firepower for effective C-C^3 action will be necessarily limited to a small fraction of the total available. This factor will often lead to a decision to harass (with mines and expendable jammers) rather than to destroy enemy C^3 targets.

(C) e. Capability of assessing effects of counteraction and restoration of C^3 targets. In order to sustain suppression of C^3 targets, particularly when the counteraction is less than total destruction, some means of periodically assessing the operating status of progress toward restoration of the target is highly desirable (periodic readthrough of communications links being forwarded to determine if alternate frequencies are being used or relocation of CP forced to move by harassment). C^3 targets for which such assessments cannot readily be made, could lead to excessive expenditures of resources for suppression.

(U) f. Synergism with other friendly force actions in defense and counterattack. This factor is a counterpart of the concept of selection of specific targets on the basis of their roles in the time planning of the attack. For example, suppression of Soviet AD C^3 becomes especially valuable in NATO CAS or interdiction operations.

(U) 3. THE VALUE OF C-C^3 ACTIONS

(U) One might characterize the value of C-C^3 actions by considering the following:

(U) a. Soviet functional vulnerabilities and their exploitation.

(U) b. The impact of such actions on degrading Soviet force effectiveness.

(U) c. The impact on the degradation of Soviet REC capabilities.

(U) d. The size of required and available US and Allied resource allocation to effect C-C^3 actions.

(U) e. An examination of the situation through those measures of effectiveness which the US normally uses in justifying its own C^3 systems.

(U) Clearly the value of C-C^3 is dependent upon the time during an operation when it is put into effect. To this end it is worthwhile examining that particular issue in a broader context.

(U) The circumstances under which C-C^3 could be valuable includes both the arena of deterrence and that of defense should deterrence fail. It is clearly in our best interests to determine what C-C^3 actions will enhance deterrence. These, whatever they may be, would either render more uncertain the Soviet assessment of the outcome of a particular military action, or in a better case, present them with problems such that they would be sure that the outcome was unfavorable before such actions were ever taken.

(U) Should deterrence fail and defense be required, there are three sets of general circumstances. The first occurs in the period of time prior to the initiation of hostilities after it is clear they will be initiated. This is the so-called pre-H hour time frame, and might extend for twelve to twenty-four hours prior to the commencement of hostilities.

(U) The second time period is the post-H hour time period when preplanning on the Soviet side may be substantially fulfilled in terms of actions which they expect to take. This period of time extends from H-hour until any pre-set plans must be substantially modified to compensate for deviations arising during the attack.

(U) The third general condition applies in the so-called steady state after the initiation of hostilities. Here it is expected that NATO will carry on both defensive and offensive actions and will counter attack to regain lost territory in a manner consistent with the charter and policy of the alliance.

(U) All of the circumstances must be considered in examining the value of C-C^3. They will be addressed as they are appropriate in the examination of the five general topics which were previously stated.

(C) 4. WP FUNCTIONAL VULNERABILITIES (U)

(U) Functional vulnerabilities derive from the nature of operations, the organization which the Soviets employ for their execution, the tasking given each organization, and the training which underwrites all of the above. A detailed examination of these interdependent issues has been carried out. It is reported in a specially classified appendix to this report.

(C) This analysis uses as its focus seven basic Soviet combat operations:

a. The operational breakthrough controlled by Army and involving several divisions along with Army and Front assets.

b. The Division level attack against a defending enemy.

c. The meeting engagement.

d. Pursuit operations.

e. River crossing operations.

f. Tactical and approach marching which are key features of all operations.

g. Defensive operations.

(C) The analysis concludes that there is substantial potential to disrupt various portions of these on-going operations by degrading the effectiveness of command and control and taking advantage of the inflexibility associated with Soviet preplanning. This analysis also points out that two levels in the zone of the main attack must be countered. This does not mean all CPs or all command functions must be engaged with C-C^3 action. It is rather focused on a relatively small subset of the total. In general, though, two levels of command must be negated - either Army and Division and Regiment or the other.

(U) The details of the vulnerabilities and the impact of C-C^3 actions are outlined in the special appendix.

(C) 5. C-C^3 IMPACT ON WP FORCE EFFECTIVENESS (U)

(U) The effectiveness on WP forces in operations is dictated by the manner in which echeloning and combined arms operations are carried out. To a large extent, echeloning can be preplanned but its effectiveness will ultimately be dictated by the "fine tuning"

exercised by command at the time of commitment of successive echelons. Therefore, command impact is crucial for the success of echeloning operations.

(U) This is also true in conjunction with combined arms operations. WP doctrine calls for concerted action on the part of suppression assets (artillery, multiple rocket launchers, surface to surface missiles, and fixed and rotary aircraft) which will deliver fire in support of attacking troops; maneuver forces whose coordination with fire through co-location of commanders and through the implementation of Battalion operations which form the cutting edge of the combat unit; and AD which provides the major protection required to prevent NATO air forces from successfully attacking and destroying Soviet units as they prepare for and execute operations.

(U) $C\text{-}C^3$ actions may cause echeloning to be poorly executed in time and space, and, under best of circumstances, may essentially lead WP echelon forces into traps where their destruction can be effected. The combined arms operations which are necessary on the modern battlefield require that the various means of suppression operate in concert with maneuver and defensive forces in order to provide the maximum synergism between these elements against the defenses which are to be penetrated.

(C) Loss of artillery, for example, or the miss-timing of air attacks which would cause both conflicts with artillery and with AD units, thereby breaking the stride and momentum of the attack. Artillery setup times are substantial. The employment of air is carried out through the employment of critical time windows. Maneuver forces depend upon fire suppression of active defenses for the successful completion of their mission. Modern day anti-tank defenses and main guns on tanks can effect such attrition against attacking forces that these must be suppressed by artillery to a substantial degree before assault conditions are favorable. Soviet battalion operations in assault are commanded through very few nets at battalion level. The Soviets place great emphasis on electronic means of communications between elements. These can be disrupted and, in addition, false information can be fed into the system.

(C) Finally, the Soviet AD, which are thick and numerous, can be denetted through proper action against the command and control elements. This would cause semi-autonomous or fully-autonomous operations. Under these conditions each unit may have to use its own organic acquisition equipment and be acceptable to ARM attack; lacking that, have substantially reduced fire-power capability. A key factor in causing Soviet air defenses to become degraded would be to destroy the SVOD navigation, and control system to disrupt the safe corridor recovery of AD and tactical aircraft through their own defense systems.

(S) 6. THE IMPACT OF SOVIET REC ON NATO C^3 (U)

(S) It is clear from the evidence at hand that successful Soviet REC operations through deception jamming and electronic warfare and through the control of firepower based upon direction finding will cause serious degradation in US and Allied C^2. It may, in fact, achieve well above its advertised target 30% neutralization of NATO C^3, particularly near the FEBA zones. Any degradation which can be effected by NATO C-C^3 action against REC units and assets will have a double effect. Soviet capability will be lessened and US and Allied C^3 will be less degraded.

(S) 7. THE IMPACT OF C-C^3 ON NATO RESOURCES (U)

(C) C-C^3 actions can only represent attractive alternatives if their impact on NATO resource allocation is modest and the return is substantial. To provide a simple assessment of some possibilities, a zero order analysis was conducted. It addressed the composition and disposition of the CPs, how often they move, how long they are fixed, what capabilities are required to destroy or harass them, what are reconstitution procedures should certain CPs be degraded, what is the impact of harassment on CP operations, some sizing calculations to quantify the various processes and finally, a potential concept of operations and its related impact on resources.

(S) Table III-2-1 displays the relevant parameters for the deployment distances of various CPs, and their size (in km^2, personnel, and vehicles). It is seen that there are really three classes or kinds of CPs. They are

TABLE III-2-1

(S) CHARACTERISTICS OF WP C^3 ELEMENTS (U)

ECHELON & TYPE	LOCATION FROM FEBA (KM)	DEPLOYED AREA (KM^2)	VEHICLES	PERSONNEL
BATTALION	3	SGV*	4	10
REGIMENT				
Main	5	0.4	20	40
Rear	10	*SGV	8	20
DIVISION				
Main	15	3	80	175
Forward	5	SGV	8	15
Alternate	15	0.3	8	25
Rear	20	0.4	20	130
ARMY				
Main	50	15	250	750
Forward	20	SGV	12	25
Alternate	50	0.5	20	50
Rear	75	10	120	550
AIRBORNE DIVISION CP	FEBA to 20	NA	1 (Helicopter)	4 (Estimated)
FORWARD OBSERVER	FEBA	NA	1	4 (Estimated)
REC CP	50-100	0.2	**20	**6-100
AIRCRAFT CONTROL	30	SGV*	3	15

*SGV - Small group of vehicles
**These are estimates and these resources could be integrated into the Army and Front and CPS.

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either large, such as the main or rear CP; they are small in size (2km^2), such as forward or alternate CPs; or they are represented by a small group of specialized communications vehicles occupying an extremely small area (~1 hectare).

(S) Table III-2-2 characterizes the movement and residence time of these units as derived from an examination of Soviet operational time lines. It is seen that the largest of the Army CPs might be in place for 36 or more hours; Division Main CP, 10 or more hours; regimental main CP, 4 or more hours. This gives one rough measures to estimate the C-C^3 system parameters needed against each type.

(S) Figure III-2-1 displays the availability of the larger headquarters if they are forced to move. It is seen that the availability of the larger headquarters is approximately 0.7 under normal conditions. As they are forced to move, the Army, Division, and Regimental headquarters degrade in availability by a factor of 2 to 3 with several moves, because the setup and tear-down time is so substantial. Should these headquarters be forced to move because of either harassment by munitions or jamming which prevent their successful use, then either movement must be effected or operations must be shut down until interdiction can be overcome.

(S) Table III-2-3 presents sizing calculations for the destruction of CPs. This table and the accompanying Figure III-2-2 display the depth of various kinds of CPs and the tonnages (and related sorties or artillery rounds) required to produce a 60% level of damage. Sixty percent was chosen since this is the Soviet norm for damage levels requiring replacements of units. It is seen that very large asset allocations are required to destroy Army and Division and Regimental main headquarters while only very modest allocations of resources are needed to destroy the forward or alternate CPs. In addition, the tonnages and related delivery requirements for either mining or jamming with expendable jammers near CPs are very modest, and can be carried out with a few tons of munitions which are variants of those in development today.

TABLE III-2-2

(S) SOVIET COMMAND POST OPERATIONAL FACTORS (U)

COMMAND POST TYPE	MOVEG PER UNIT TIME	TEAR DOWN TIME HR	MOVEMENT DIST/TIME KM / HR	SET UP TIME HR	ACTION TIME HR/DAY	FRACTION OF TIME FIXED	FRACTION OF TIME MOVING	OPN AVAIL
ARMY MAIN	1/48 HR	3	30/2	8				
DIV MAIN	2/24 HR	1	10/1	2	16/24	22/24	2/24	0.6T
RGT MAIN	4/24 Hr	0.5	5/0.5	1	16/24	22/24	2/24	0.6T
DIV FWD	6/24 HR	0.1	1-2/0.1	0.1	22.2/24	23.4/24	0.6/24	0.91

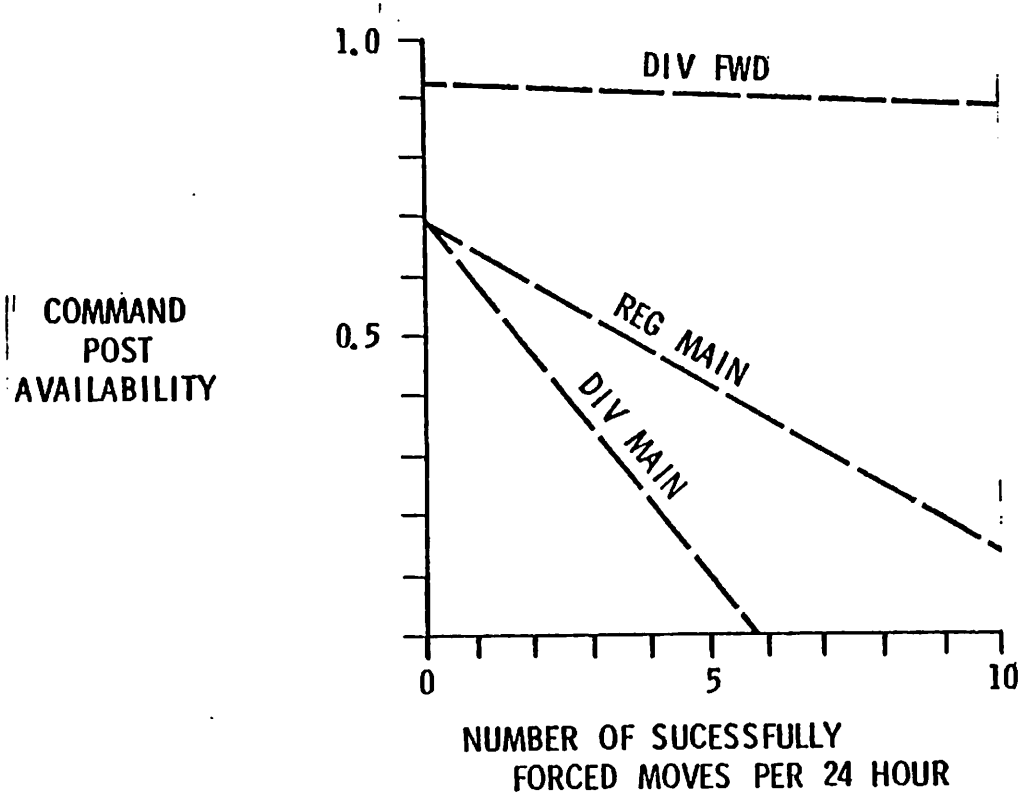
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FIGURE III-2-1

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IMPACT ON EFFECTIVE "HARASSMENT" ON CP AVAILABILITY (U)



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TABLE III-2-3

(S) MUNITIONS SIZING FOR COMMAND POST TARGETS (U)

- suppress 2HA
- suppress 0.25 km^2
- suppress 1.0 km^2
- suppress 5x1.0 km^2

} Achieve Damage Probabilities of 50% to 60%

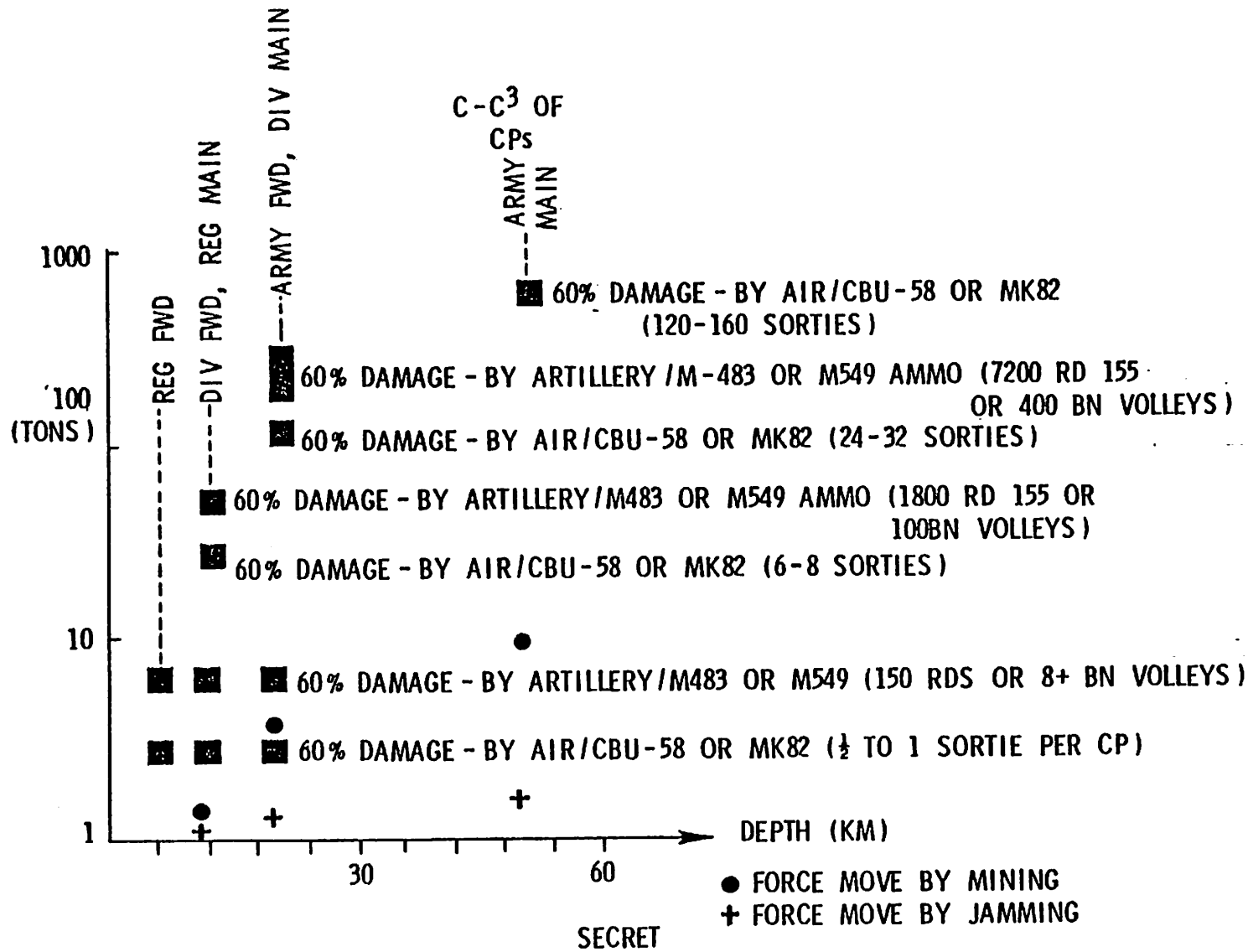
° soft targets - trucks, vans, people
° stored energy - fuel, munitions

		Army Fwd / Div Fwd / Reg Rear / Btn 2 HA TGT	Army Alt / Div Rear / Reg Main 0.25 km^2 TGT	Div Main 1.0 km^2 TGT	Army Main / Army Rear 5x1.0 km^2 TGTS
CBU-58	air delivered	2 tons	25 tons	100 tons	500 tons
ROCKEYE	air delivered	2.5 tons	32 tons	130 tons	650 tons
MK-82	air delivered	2.5 tons	32 tons	130 tons	650 tons
M-483	artillery	4.5 tons	54 tons	216 tons	1080 tons
M-549	artillery	5.4 tons	65 tons	260 tons	1300 tons
FAE (1000 lb)	air delivered	2 FAE	25 FAE	100 FAE	500 FAE

FIGURE III-2-2

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COMMAND POST INTERFERENCE/DESTRUCTION (U)



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(S) A potential concept of operations should involve selecting the key CPs controlling a given main attack or successfully mounted secondary attack. This will be generally one Army main, one Division main, and one or two Regimental main CPs. These could be "mined" with the Artillery Delivered Anti-Personnel Mine (ADAM) mine, the ROOK, and possibly small FAE, although they are not currently optimized for this task. The success of such mining operations would require that the Soviets move the CP or face the destruction of personnel and equipment when these mines are detonated. Optimized munitions would create fires in fuel tanks and surrounding forests.

(C) Movement of these CPs would cause general nonavailability and force the load from main CP to alternates and forward. The communications capability of main CPs are substantial, but forward and alternate CPs have much less capacity. In general, communication levels at these smaller CPs would rise substantially; so it should be possible to locate them with greater accuracy for attack, reduce their effectiveness because of overload.

(S) It may be seen from the preceding tables and figures that the munitions requirement necessary for destroying these small CPs are very modest. It is therefore concluded that a modest allocation of resources (some approximately 3-10% of one day's expected firepower expenditures) would substantially negate selected C^3 assets with a combination of harassment and destruction of the target CPs.

(S) 8. MEASURING C-C^3 EFFECTIVENESS (U)

(C) The effectiveness of C^3 is generally evaluated through wargaming techniques and measures of effectiveness which involve the timeliness and quality of information and its impact on combat situations measured through FEBA movement and rate of attrition; but it is not clear that a two-sided analysis can be done to include effects of degrading C-C^3 WP capability with presently available or projected modeling and gaming techniques. While it is to be expected that such efforts would generally show the effects which have been topically outlined in the previous sections, it would be worthwhile to carry out such assessments to search for results

substantially different from those stated here and to quantify sensitivities associated with actions stated previously. Such assessments would be supported and illuminating, if achievable.

(S) Pending the development of suitable techniques it is recessing to consider more heuristic or intuitive assessments of the probable impact of effective C-C^3. The following are some observations made by the Task Group in this connection:

(C) The true test of overall C-C^3 effectiveness is only possible in actual combat.

(S) C&D can be practiced in peacetime. Its success can possibly be ascertained through intelligence sources.

(S) Experiments can and should be conducted with existing and improved collection assets to measure their ability to identify and locate WP C^3 elements during training maneuvers or force rotations.

(S) Measuring can and should be conducted with existing and improved condition assets to measure their ability to identify and locate WP C^3 elements during training maneuvers or force rotations.

(S) Measuring the effectiveness of C-C^3 harassment or destruction techniques remains the most significant problem. Field exercises can provide only very crude measures. U.S. experiences where EW so disrupted field exercises that the jamming was discontinued to permit any productive training, bolsters confidence that C-C^3 is indeed very important (and also that U.S. is highly vulnerable); but does not yield quantitative values of results versus assets invested.

(C) Rough quantitative "force-divider" ratios are, however, available such as:

- one artillery CP controls 18 tubes
- one armor CP controls 43 tanks
- one SVOD controls 100's of aircraft

(S) In addition, one can compare the cost to provide AJ to our ground radars and our communications versus the cost of disabling REC.

(S) Finally, the essential value of our own C^3 survival can be balanced against the cost in weapon assets to disable WP C-C^3. A desired end result of such an analysis would be to provide a sharper focus on the C^3 elements to be given greatest attention in C-C^3.

(S) B. CURRENT AND PROJECTED CAPABILITIES (U)

(U) 1. OVERVIEW

(U) The input briefings and data provided this Task Group supported by the wealth of information contained in the Defense Science Board report and the recently completed "in-house" Air Force study made it abundantly clear that considerable C-C^3 capability exists today. The need is to "get our act together." This situation is summarized in Table III-2-4. The many assets involved were, of course, developed for other objectives. The fact is that C^3 centers are, indeed, softer and fewer in number than the targets, e.g., tanks, SAM systems and artillery, against which most NATO weapons have been dedicated.

(U) Certainly improvements are desirable and will be addressed in subsequent sections of this study.

(S) 2. ASSESSMENT OF ARMY CAPABILITIES TO DESTROY OR HARASS WP C^3 ELEMENTS (U)

(S) C^3 associated with any combat force is a key element to the success of the battle; however, because of the priority to destroy hard targets (maneuver forces) in the first and second echelon forces, this segment of the WP force structure has not been specifically targeted. The US has clearly defined, as high priority, the investment of major resources to insure that our C^3 is secure and functional throughout the battle. This is imperative if we are to fight out-numbered and win the first battle. Common logic would indicate that if the US has placed key emphasis on their own C^3 elements, then WP forces would require these same ingredients to win the first battle and make the significant gains that their doctrine dictates.

TABLE III-2-4

(S) SCORE BOARD (U)

ITEM	PRESENT STATUS	DEFICIENCIES
Location & Identification	Considerable data for C^3 Location adequate for harassment	Not utilized for C-C^3 Few tailored for C-C^3 Accuracy deficient for destruction
Analysis & Correlation	Several centers in operation	Data collection not coordinated Lack timeliness for most C-C^3
Delivery Systems	Many assets: Aircraft, artillery, Missiles	Aircraft survivability Quantity limitations Range limitations except aircraft
Payloads	Many effective payloads	No disposable jammers Cluster/wide area munitions not optimized

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(C) Locating and identifying WP C^3 elements at all echelons from regiment through Army is a major task when considering the large numbers that are deployed at each echelon. At first glance it would appear that to be successful in degrading the WP forces C^3 elements, a high percentage should be destroyed. Destruction would require the WP to reconstitute the element with both equipment and personnel with the major penalty being the loss of valuable time during critical phases of the battle. Even though destruction appears to be the best and most permanent approach, it is costly in terms of resources required and time to execute. It also requires very accurate data concerning the location of major components of the C^3 element.

(C) In view of the high cost to locate key components of WP C^3 elements and the large tonnages of munitions required to effect destruction, other alternatives were examined. NATO currently has capability to locate C^3 elements only to a degree that our jamming capability may intermittently disrupt the WP C^3 capability. In addition, NATO has the capability to harass WP C^3 elements with firepower with minimun impact on the available firepower.

(C) The current US Army capabilities to harass and destroy WP C^3 elements are depicted on Table III-2-5. These capabilities are adequate to maximize the impact on all C^3 elements from the FEBA up through the Division echelon. The available firepower is timely and accurate enough to put maximum pressure on the C^3 elements and cause the WP commander to take alternate courses of action to sustain the momentum of the battle. Each change that must be made by the WP commander could delay the battle and in some cases could overload some C^3 elements to a point that would render them ineffective. If this happens, we have accomplished the mission without the high cost of critical resources. See Table III-2-6 for an overview of the US capabilities and the C^3 systems that can be impacted.

(C) Even though it appears that we have the present capability to put substantial pressure on the WP C^3 elements, we have deficiencies in our total C^3 effort. Aside from the lack of C-C^3 doctrine or organization, the Army's principal deficiency is that our current systems cannot put adequate firepower on C^3 elements beyond 40 kilometers. The C^3 elements beyond current

TABLE III-2-5

(S) ARMY WEAPON SYSTEMS AND CAPABILITIES (CURRENT & NEAR TERM) (U)

SYSTEM	RANGE (KM)	*EFFECTIVE RANGE (KM)
105MM		
- M101A1(T)		
Conventional	11	7.5
Range Augmented Projectal (RAP)	14.5	9.7
- M102		
Conventional	11.5	7.7
RAP	15.1	9.8
155MM		
- M114AI(T)	14.6	9.8
- M109A (SP)		
Conventional	14.6	13
RAP	19.4	13
- M109A (SP)	18.1	12
- M198 (T)		
Conventional	22-24	15
RAP	30	20

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TABLE III-2-5 (Continued)

SYSTEM	RANGE (KM)	*EFFECTIVE RANGE (KM)
8 Inch		
- M110	16.8	11.2
- M110A1	20.6	14.1
- M110A2		
Conventional	29.3	19.6
RAP	TBD	
175MM		
- M107	32.8	21.9
2.75 Rocket	4	4
4.2 Mortar	6	6

*Effective range is based on a planning factor of the weapon system being positioned about 1/3 of the maximum range of the weapon for the FEBA.

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TABLE III-2-6

(S) ARMY REPRESENTATIVE CAPABILITIES TO DESTROY OR HARASS WP C^3 (U)

C^3 ELEMENTS	CURRENT							FUTURE				
	105	155	8"	175	2.75 ROK	4.2 MOR	AIR DEF	GSRS	LANCE	RPV	SCAT MINE	U/E JAM
REGIMENT												
MAIN	x	x	x	x	x	x		x	0	x	x	x
REAR	x	x	x	x				x	0	x	x	x
DIVISION												
MAIN-ALT		x	x	x				x	0	x	x	x
FWD	x	x	x	x	x	x		x	0	x	x	x
REAR		x	x	x				x	0	x	x	x
DIV ABN CP							#					
REC CP												
AIRCRAFT CONTROL										x		
FO VEHICLE	x	x	x	x	x	x		x	0	x	x	x
ARMY												
FWD		x	x	x				x	0	x	x	x
MAIN-ALT												
REAR									x			

NOTE: # If high enough to observe and within range of AD weapons.

X Weapons which impact on C^3 elements.

0 Has capability but cost and accuracy may be limiting factors.

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range limitations include some of the aircraft control and REC elements and the Army echelon (with the exception of the Army forward). In addition to the distance factor, another key deficiency is the amount and type of munitions that are available to support the C-C^3 mission. Some programmed capabilities include:

(C) LANCE Missile (Conventional). The LANCE was introduced into the Army inventory with only a nuclear capability. A decision has been made to develop a nonnuclear round for the LANCE which will provide a range of 70 kilometer, about a 50 percent increase in range for conventional weapons. Even though the additional range is a plus, the missiles are relatively high cost, and the accuracy does not lend itself to be effective against small targets such as groups of CP vehicles in a C^3 complex. Even with these limitations, however, the LANCE will be an effective harassment weapon system for delivery scatterable munitions and jammers.

(C) General Support Rocket System (GSRS). The GSRS is currently in the development stage and when fielded will provide a major increase in high volume of fire in a short period of time. This system appears to have high potential for harassing or destroying C^3 elements from the FEBA through the Division main C^3 elements. It is also programmed to have a capability to deliver scatterable mines which appear to have high potential for harassing C^3 elements.

(C) RPVs. Conceptual testing of Aquilla Mini-RPV was completed in 1978. There is a critical need for an unmanned vehicle of this type that can observe the enemy during day, night, and in all types of weather. The RPV will provide us with a significant improvement in our capability to locate and identify C^3 elements. The size of some C^3 elements makes it very difficult to identify specific key elements within the C^3 complex. The first generation Mini RPV will have a real-time, day-only TV capability with a built-in laser designator for directing cannon-launched guided projectiles. It will have a range of 20 kilometers beyond the FEBA which will limit our capability to observe the Army C^3 echelon. While the first generation Mini RPV has limitations as it is related to the total battlefield, it will provide the commander with the first

organic capability to observe the battlefield in real-time. This will also be a major factor in assisting the commander in moving his forces to maximize his assets to blunt an attack, put firepower on the right target at the right time, locate WP C^3 elements with precision. The advanced Mini RPV will be a follow-on effort with new sensors that will provide significant increases in capabilities. It will have a day/night and all-weather capability and about a 50 kilometers range. The concept of putting expendable jammers on the Mini RPV is currently being investigated. Other developmental sensor packages include FLIR, Radio Relay, and decoys.

(S) Unattended Expendable (U/E) Jammers. Conceptual test and evaluation of U/E barrage jammers will be completed in 1978. Initial testing has indicated that this type jammer, which is small and light weight, has a high payoff at a relatively low cost. Hand emplaced, air delivered, and artillery versions were evaluated. Their low power, short effective range, and our ability to deliver them among the WP forces will insure that they do not interfere with our own C^3 elements. The U/E barrage jammer will be packaged for remote deployment by artillery or other delivery means such as rotary/fixed-wing/RPV air drop, or hand emplacement. The U/E barrage jammers will be packaged for deployment by 155mm weapons systems to make maximum use of the high number of present and projected 155mm pieces in the field. Future efforts could easily adapt the payloads to the M509 carrier round for deployment by 8-inch weapons, or, for lower development costs, the item could easily be sleeved for suboptimum use of the approximately 2:1 volume increase available in the M483 family of base-ejected ammunition. No modifications to the existing base-ejected cargo round hardware are envisioned, resulting in low development and ballistic similitude.

(S) Capable of being packed nine per MM483 rounds the U/E barrage jammer payloads are essentially short cyclinders of 5-inch diameter and 2-3/8 inch height. The jammer becomes armed after sensing the setback and spin of launch. A borerider senses when the unit is free of the carrier. At this point, a timer is activated allowing sufficient time for the unit to fly, impact, and come to rest. After this elapsed time,

the antenna ground radials are deployed (to stabilize tipping of the vertical element) a small clearing charge unobstructs the antenna port (should the device spin into soft earth or land in weeds or snow), the vertical antenna element pops up, and the electronics are activated to begin the jamming mission. The jammer will remain active for approximately 60 minutes (minimum of 30 minutes under arctic conditions) before either a timer or battery sensor initiates an internal pyrotechnic network to destroy critical components rendering the item useless as a jammer. As a possible antidisturbance mechanism, a small percentage (say 5%) of dummy units could be deployed with explosive charges which would detonate upon any motion after the item comes to rest.

(S) The U/E barrage jammer will omit continuous noise across the 1.5 to 12 and 20 to 51.5 MHz bands. The transmitter is frequency modulated at rates to appear as FM ambient noise to the victim radio operator. Since the transmitter need not be periodically deactivated to determine if the victim signal is still on the air (lookthrough), the victim has no audio indication he is being jammed. Enemy use of alternate frequencies will prove fruitless, since the jamming covers the entire tuning range of his equipment. The logical assumption made by the victim is that either the other end of his link is inoperative or his equipment is malfunctioning. The U/E jammer has no effect on friendly communications or intercept receivers because normal deployment of the U/E jammers places it in close proximity to the threat receivers.

(S) ADAM - The Army has a major combat development program for a family of scatterable mines that will be effective against armored vehicles and personnel. The ADAM will be well suited for the $C\text{-}C^3$ mission. In order to increase its effectiveness it should be employed with a mix of HE and/or smoke. The ADAM is programmed to be configured in the 155mm round and will include 36 individual mines with trip wires. When it is activated it pops-up about shoulder height and has the capability of killing or injuring several people. Since scatterable minefields are not marked with any degree of accuracy they all have a self-destruct capability. This will make it possible for friendly forces to conduct offensive operations in areas previously mined without clearing the minefield.

(C) In addition to the future development of major systems there are programs to improve the munitions of selected weapon systems:

a. The current 2.75 inch rocket has a short range and is primarily effective against area targets. Improvements include extended range, better fire control and a more effective warhead against hard targets. Currently it is fired from helicopters which operate near the FEBA.

b. Extended range projectiles are being developed for the 155mm and the 8 inch weapon systems. These will provide more complete coverage of C^3 elements in the Division echelon.

c. Currently a vigorous smoke program is being pursued. At first glance one may wonder what effect smoke could have on C^3 elements. If used alone, it would have a very minor effect; however, if you combine this capability with HE and scatterable mines, it could impact heavily on the ability of the WP C^3 elements to operate effectively and/or remain in position. Our current artillery delivered smoke capability is limited because of the large number of rounds required to produce an effective smoke deterrent for any length of time. Ongoing developments in the WICK concept for smoke rounds will provide a significant improvement in our artillery and mortar smoke capability.

(S) 3. PRESENT AIR FORCE CAPABILITIES AND DEFICIENCIES (U)

(U) Air Force C-C^3 capabilities, such as they are, fall into two broad types of activities which can be best referred to as "lethal" and "non-lethal." Each of these categories will be examined in the background discussion which follows.

(S) US/NATO military reliance on electronic control is considered a major weakness by the Soviets. They have made disruption of this control a prime objective. As early as 1974, Air Force Special Comm Center Study "ECM vs 407L/412L...Analyses of Soviet Warfighting Posture" documented that the WP had gathered sufficient intelligence on US/NATO electronic equipment to support all of their major contingency plans. The emerging WP

objective is disrupting NATO electronic control systems centers on introducing further time delays in the control process so that if and when the information is finally surfaced it is obsolete. The generally established target priorities are as follows (descending order of importance):

1. Artillery, rocket and Air Force units that possess nuclear weapons, C^3.

2. CPs, Observations Posts, radio centers and radar stations.

3. Field artillery, TAF and AD units.

4. Reserve forces and logistic centers.

5. Point targets jeopardizing advancing Soviet forces.

Additionally, the Soviets focus much of their collection efforts on determining and updating the electronic order of battle. They have further prioritized jamming of US Division communications by establishing four levels of interest:

1. The common nets.

2. Artillery fire C^3.

3. Operational guidance and request nets for TACAIR support.

4. Reconnaissance and radar warning nets.

(S) Although present Soviet EW equipment technologically lags US systems development, they have effectively countered by developing doctrine which (1) exploits NATO capabilities; (2) establishes a massive yet effective organizational structure; and (3) fielded large numbers of adequate equipment.

(S) On the other side of the coin, current US/NATO non-lethal C-C^3 assets are extremely limited and are further degraded by the employment standoff distances required. The large number of WP back-up communication modes available and the lack of NATO abilities for

accurate and timely identification of critical links degrades the existing capability to a point approaching zero. Any WP growth in this area will result in future NATO C-C^3 capabilities being "even worse." At present only Coronet Solo poses an airborne communications jamming capability. Although this system's primary use is to counter hostile government TV and radio broadcasts, an incidental communications jamming function against ground links was discovered during exercises. The system is presently installed on a Pennsylvania Air National Guard EC-121 and has transmit and receive capabilities covering the 35-45MHz frequency range.

(S) Future applications of communications jamming (C-C^3 capability) operations are proposed in only two areas:

1. Retrofit EC-121 Coronet Solo equipment in C-130s. Enhanced systems to counter WP combined arms Army ground to ground and GCI links may also be included.

2. Continued design and development efforts for an AD communications jammer by Sylvania may produce capabilities in the areas of Red C^3 functions.

(C) Turning to the lethal aspects of Air Force C-C^3 efforts, tactical aircraft (F-4, A-7, A-10, etc.) are currently able to apply a variety of destructive weapons in C-C^3 roles against mobile and moderately fortified WP C^3 elements. The Table III-2-7 depicts the characteristics of representative destructive munitions needed for C-C^3 operations.

(C) The accuracy of Air Force tactical fighter weapons delivery systems against point targets ranges from CEPs of from 50 feet with visual systems to 400 feet for poor weather delivery.

(S) Present and future C-C^3 deficiencies in non-lethal and lethal air assets are readily apparent. The non-lethal capability is presently extremely thin. Even with the planned enhancements, Coronet Solo employment will undoubtedly continue to be through the use of standoff techniques to preserve the airborne platforms. The net result of this approach is less disruptive power reaching enemy C^3 elements. Constraints resulting from the small number of sorties available from the Coronet Solo force coupled with slow geographic movement times

TABLE III-2-7

(S) REPRESENTATIVE MUNITIONS (U)

PRESENT

Desired Characteristics	TACAIR Munitions	Principal C^3 Targets
High accuracy for use against point targets; Wide range of explosive/ destruction power.	M61 20mm Gun GAU-8 30mm Gun LGB's	Electronic/Comm Van, Generators, Support Vehicles
Area Destruction/Denial	GP Bombs (MK 82,84), with contact and time delay fusing; Air delivered mines Cluster Munitions Pyrotechnic Munitions	Revetted and lightly fortified command bunkers, personnel concentrations, support vehicle & truck parks

FUTURE

Comm and Data Link homing capability; Localized destruction	Unknown	Command radio transmission links, antenna sites

SECRET

and resulting in low time on station, points to the need to develop power jamming devices which can be implemented near or on the target C^3 sites. The result of this technique is higher disruptive power levels of jamming reaching the target elements even though the jammers are of lower power.

(C) The success of lethal attacks on C^3 elements is critically dependent on the ability to locate the specific targets so that they may be visually or electronically detected and attacked by the weapon delivery system. As was previously noted delivery accuracies are obtainable. What is missing is the wide area destructive/harassing munition which can economically reduce Soviet C^3 effectiveness.

(C) The bottom line is that, like the WP, NATO too can realize the maximum potential effect on the air-land battle only when a coordinated lethal/non-lethal doctrine, employment concept and support equipment development effort are combined in a coordinated effort.

(S) C. PROPOSED CONCEPTS (U)

(C) 1. CONCEPTUAL C-C^3 SYSTEM (U)

C-C^3 is truly a systems problem in which enemy C^3 assets must be located and identified, decisions must be made on the optimum actions to be taken, the actions must be instigated and the results must be evaluated. The flow of actions are shown schematically in Figure III-2-3.

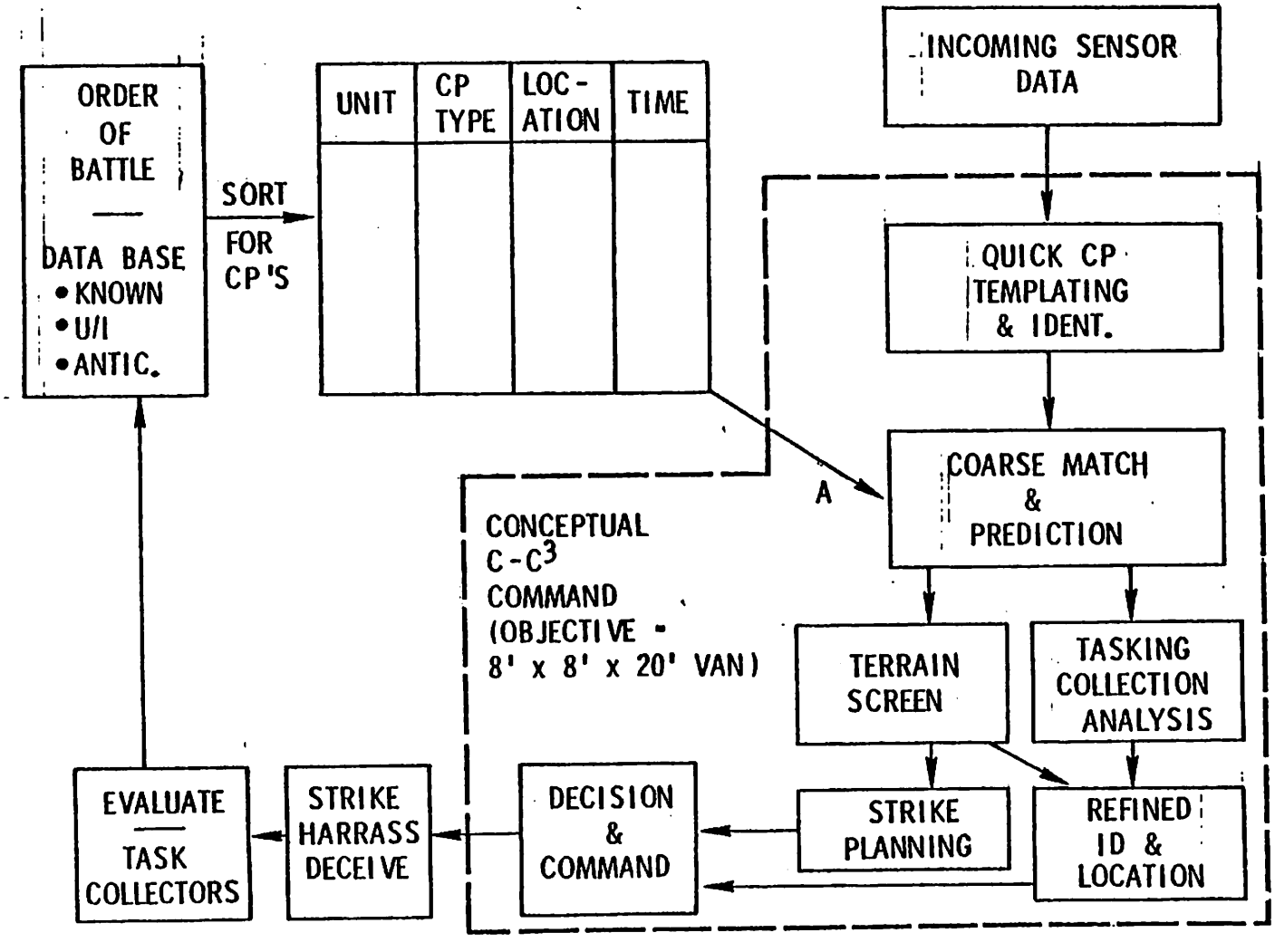
(S) It will be noted that the actions contained within the dotted lines essentially constitute a command and control system for C-C^3. As such the emphasis is placed on aids to identification, correlation with existing data, and timely decision making. We believe such a command and control system is of great value to C-C^3, can be fielded more quickly than an operational version of BETA and represents a smaller investment.

(S) 2. DETECTION-IDENTIFICATION-LOCATION (U)

(S) The targets of interest are the various CPs of Soviet military forces, Army Main, Division Main, Regimental Main or Alternate Forward. These posts are

FIGURE III-2-3

CONCEPTUAL C-C³ SYSTEM FLOW (U)



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UNCLASSIFIED

at depths of a few to 50 kilometers behind the FEBA and move on schedules of an hour or so to 36 hours. The larger posts -- such as Army Main or Division Main -- are characterized by a large area, remotely located antennas and many vehicles, a smaller area, vehicle-mounted antennas and only a few vehicles.

(S) $C\text{-}C^3$ location accuracy must be appropriate to the counteraction intended; for example, the location would have to be determined to 50-100 feet for precision or selective destruction. On the other hand, harassment (such as artillery fire, mining localized jamming accuracy to a fraction of a kilometer) is sufficient. However, there is also an important timeliness constraint. Detection/identification/location must be done on a time line that is consistent not only with the ability of US forces to respond and take the desired counteraction, but also with the typical move schedule of the appropriate CP target. For a small one that remains in place for an hour or less, the response time from initial location to completion of the counteraction must be a fraction of an hour; for larger ones, the corresponding figure is 10-15 hours.

(S) For such targets there are many signatures that can be exploited to locate and identify them; for example, there is the overall visual appearance, number of vehicles, gross area, type of vehicles, or special configurations of other equipment that may be present. Another signature is the pattern of radio emissions -- HF, UHF, multi-channel -- the pattern of radio traffic, details of the radio signals - voice radioprinter and fingerprints of either the radio signals or any nearby pulse emitters such as local defenses. For the large post, internal movement of vehicles or transient helicopter traffic is also a possible signature.

(C) The problem is in four parts:

- Detect and identify the presence of CPs in the pre-attack period.

- Know their customary pre-attack positions plus such characteristic parameters as set-up tear-down time, typical rate of movement, field emplacements and other signatures.

- Track the movement of a CP from position to position during exercises or in the post-attack period.

- Importantly, do the last two tasks with sufficient accuracy and timeliness for desired counter-actions.

(S) There exists today a variety of data sources that can be used to detect/identify CPs and to locate them by sensing typical signature parameters. Among them are:

- SLAR imagery such as UPD-4.

- Tactical SIGINT field assets such as Guardrail, RF-4C, TEREC,

- National technical means.

- QSR-infrared imagery.

- Rivet Joint collection

- SR-71 reconnaissance.

- MTI radar such as the Mohawk OV-1.

(S) The data collected by any one of these is by itself inadequate to establish location sufficient for an accurate destructive strike action, especially by artillery. However, location accuracy is adequate for such harassment actions as artillery-delivered mines, localized jammers or for cueing a tactical photo-reconnaissance mission.

(S) It is obviously possible in principle to combine data from several sensor-collection sources to improve accuracy. There are available today for this purpose:

- Tactical field intelligence staffs.

- The Boerfink bunker.

- The COIC.

- Tactical photo reconnaissance centers.

- National SIGINT centers.

- Centers for National Technical means.

(S) However, since enemy CPs do not now have a particularly high priority of concern, the timeliness with which such analysis and correlation activities can respond is generally inadequate for most C-C^3 purposes.

The conclusion is that there are in place today many assets that collect information pertinent to locating and identifying CPs, but such information is not routinely processed in a timely and appropriate manner for the purpose of planning against enemy C^2. Furthermore, in some instances the data is spread across different military Services or across systems subordinate to various agencies. Sharing of it is inhibited by traditional jurisdictional barriers.

(S) There are presently planned systems expected to be available by 1983 that can provide additional data for more accurate identification and location. Representative ones are:

- ASR SLAR.

- RPV/Drone sensors.

- PLSS.

- Improved tactical SIGINT support from National means.

- Improved MTI radar (SOTAS).

- CEFLY LANCER airborne emitter location system.

(S) There are also presently planned future analysis and correlation assets anticipated to be operational by the 1983 time period. Among them are:

- The Air Force TFC

- The Army ASAC.

In the interim, the BETA test bed and experiments will have provided valuable guidance and experience for combining data from different sources by new and innovative techniques; e.g., templating of targets.

(S) The concept of templating to locate CPs is particularly intriguing. The Army is presently studying this concept at Ft. Huachuca, where they are combining state-of-the-art sensor inputs and using regression analysis techniques to obtain location/configuration of CPs. This promising concept should be emphasized.

(S) Today, CP data are contained in the EOB that is maintained regularly by tactical intelligence staffs, but not in a uniquely identifiable form. Depending upon which sensors/collection systems happen to be operational, the rapidity with which an EOB can be updated will vary from a fraction of an hour to many hours. As noted previously, location accuracy is generally too poor for destructive counteractions (though, perhaps, adequate for harassment). With presently planned future sensor/collection systems and correlation/analysis centers, the accuracy with which CPs can be located will be adequate for all counteractions, and the response time can be made sufficiently fast. On the last point, there will be no technical limitations but organizational and jurisdictional interfaces (The "Green Door Problem") will have to be streamlined, including those with national centers. However, unless such information -- normally considered to be intelligence -- is made available to the operations and targeting staffs in a timely manner, it will still be impossible to adequately accomplish the C-C^3 mission. To encompass the full breadth of destructive and/or harassment counteractions against Soviet CPs at all levels, there must be full cooperation between Air Force and Army organizational elements, joint tasking of collection assets, and sharing of data by organizational elements for planning and allocation of resources. There must also be adequate transfer of relevant data from the intelligence staffs to the operational and planning staffs.

(S) 3. C-C^3 HARASSMENT AND DESTRUCTION (U)

(C) The US Army is currently undertaking an advanced development program for U/E jammers targeted at WP communications over the frequencies 2-12 MHz and 20-51.5 MHz. These take the forms of artillery-delivered, hand-delivered, and drone/RPV borne jammers operating in the barrage mode to effectively deny use of the HF and VHF portions of the WP communications spectrum within a very specific geographic area. In addition to continuing the current U/E jammer development program, it is proposed that two extensions to this program be initiated.

(C) The first extension is to adapt the U/E jammer technology to operate over the complete range of MHF, UHF, the frequencies used for the multichannel, wide area (TROPO), and the air-to-ground VHF single channel systems at Division and Army CP levels. Deployment of U/E jammers operating at all WP communications frequencies would effectively deny WP Division and Army level CPs communications long enough to either interrupt the WP C^2 and/or force a move. If used in conjunction with the scatterable mines, attempts to locate and remove U/E jammers would result in the detonation of the mines. Overall, their use alone or with mines would create the desired harassment and relocation of the CPs.

(C) Second, it is proposed that the expendable jammer technology currently under development be adapted to operate over the frequency range of friendly communications. These U/E jammers should be designed to be deployed (artillery or drone/RPV) against specific WP ground-based REC systems after they have been located by friendly intelligence and targeting assets.

(C) WP doctrine provides for the integration of EW and destruction of NATO C^3 as an effective method of battle action. The REC units tasked with the responsibility for these actions are intended to increase numerical superiority of WP forces and introduce delays in the ability of US forces to respond. REC units, especially associated CPs, have been identified as very high priority C-C^3 include: intercept, direction finding, and jamming. The majority of REC equipment is ground-based with a limited airborne complement.

(C) Critical to a REC unit's effectiveness is its ability to collect signals and information in the portions of the communications spectrum used by US/friendly forces. By deploying U/E jammers, operating at friendly frequencies, these devices would effectively prevent (or cover) enemy interception of friendly communications by transmitting noise modulation to degrade the effective sensitivity of the WP-REC collection systems while providing no recognizable signature or indication of jamming. Very importantly, the power levels can (and should) be sufficiently low to preclude interference with friendly communications.

(C) The Army Signals Warfare Laboratory estimates this program would require $6.5 million over five years.

(C) Various weapon mixes may be employed to achieve damage or imminent threat to the relatively soft targets presented by most tactical C^3 nodes. Such effects may include:

- death or injury of exposed personnel,

- penetration and damage of equipment or trucks,

- penetration and firing of vehicles and generator fuel tanks,

- starting of fires in forests and brush areas providing enconcealment,

- felling of small trees, etc., near vehicles/and personnel.

(S) The above requirements should be expanded to consider tradeoffs with scatterable jammers which may be almost as effective in forcing shutdown of communications, and the synergism of combinations of scatterable jammers and munitions.

(S) Two key actions to implement this proposal in the near term are a review of the Army ICM and Air Force WAAM programs to assess their C-C^3 weapon potential; and subsequent identification of changes appropriate to enhance C^3 capability. In the longer term, there should be joint funding of research and development efforts to provide tailored/optimized munitions for C-C^3.

(S) An example of a tailored, optimized weapon for C-C^3 could evolve from the Air Force Have Name program. Such technology has great promise for the C-C^3 mission. It would be particularly effective when employed from a cluster weapon containing a combination of mines, fabrication and pyrotechnic bomblets in the same canister.

(S) Another extremely attractive C-C^3 candidate would be development of a seeker for existing anti-radiation missiles (AGM-45, AGM-78, HARM) that would allow them to detect and home on signals from the Soviet SVOD navigation and control system. SVOD is an excellent example of the emphasis placed by the Soviets upon C^3. Its destruction, exploitation, or degradation would have a grave impact on their ability to control and employ their TAFs. It would appear that a relatively small technological and financial investment in countering SVOD would result in a great payoff for friendly forces, in particular NATO C^3.

(S) 4. RPV/DRONE TECHNOLOGY (U)

(U) Enemy C^3 targets have a wide range of replacement value and defenses. Not all are worth the risk of expensive aircraft. Vehicles with enough sophistication to perform significant parts of the C-C^3 mission at costs between 1/30 to 1/300 of the cost of a manned airplane are possible. RPVs operate with a two-way link with man in the loop for data evaluation and/or mission decisions whereas a drone is self-contained and may adjust its mission profile based on preprogrammed criteria.

(S) The United States and its allies are developing a number of fixed and rotary wing aircraft for use as RPVs. Gross weights of between 30 and 300 kilograms and of maximum dimension from 1.5 to 10 meters. Most have been developed for military missions but the technology developed, for example by NASA for remotely piloted research vehicles (RPRV), is also available. Each of the US Services has worked with one or more of these small airframes, the Army's Aquilla being the most tested with 190 flights, of which 150 were operated by Army crews. It is a reusable, relatively low cost airframe capable of carrying a variety of electro optical and radio frequency payloads.

Standing off 2 kilometers and beyond, it is capable of detecting (through signal analysis) and identifying C-C^3 targets. The target position can be measured electro-optically with respect to the RPV to typically 100 meters depending on range and possibly 10 meters at 1 kilometer. Ten meter accuracy of the RPV in the UTM reference system may be possible, whereas current bearing and range systems, should provide 100 meter accuracy at all useful ranges. Alternatively the target can be designated electro-optically by the RPV.

(C) In addition to an RPV for collecting information on emeny C^3, the same airframe is used with different payloads: for offensive C-C^3 ECM for example for jamming and for spoofing, or for carrying modest warheads to attack soft C^3 emitters.

(C) A variety of sensors, navigation aids, data links and payload systems are available, but not in production, with size, weight, power and cost goals set for RPVs. A variety of RPV RF, laser, EO payloads and warheads are under parallel development.

(C) A drone operates without a man in contact to make decisions. They can perform a number of missions including ECM or carrying a warhead to an emitter. The self-contained logic potential increases every year for a fixed outlay because of the rapid changes in electronic technology. Pulsed emitters can be distinguished more readily than CW. An interferometric technique under development by Lincoln Laboratories provides a CW target selection and homing with a miniaturized antenna installation compatible with an expendable drone and with capability below 100 MHz.

(C) We recommend that a set of RPV/Drones be developed with a mix of sensor/munitions specifically designed and optimized for C-C^3. Low cost, approximately $10 to $100k per vehicle, must be maintained for the RPV/Drone role to be justified. Initial procurements in lots of 50 units for technology and operational verification appear to be justified on the basis of studies and experience to date. This could be quickly followed by procurement and field deployment to provide the C-C^3 capability now sorely lacking in the European theater.

(S) 5. WIDE AREA ANTI-ELECTRONICS WEAPON (U)

(U) A wide variety of weapons has been proposed and/or developed by the US which exploit the electromagnetic radiation emitted or sensed by much of the C^3 electronic equipments. Such equipments, of course, are necessary components of modern CPs of every level. There are not, however, any weapons which are "anti-electronic" per se, i.e., weapons which are directed at exploiting intrinsic properties of all electronic equipment to obtain their destruction.

(S) It is proposed that a joint Army/Air Force investigation program be initiated to systematically analyze electronic components and equipment for intrinsic properties which could be exploited to develop an "anti-electronics" weapon. Since WP electronics appear destined to be built of semi-conductor devices, the search should probably concentrate on semi-conductor device properties. The property selected should be such as to permit the development of a low tonnage (under 100 lb.), wide area (1-10 Km^2) weapon.

(S) Two candidates for investigation are suggested. The first is the vulnerability of semi-conductor electronics to high electric fields such as those associated with the EMP of a nuclear explosion. Non-nuclear means of generating on EMP are known and may be adaptable to an anti-electronics weapon. The second is the set of phenomena associated earlier with the Have Name program. Other candidates might be obtained from semi-conductor device manufacturers by soliciting from them accounts of what have been problems to them and causes of numerous semi-conductor device failures.

(S) The weapon proposed is the "anti-electronic" analogy of chemical biological "anti-personnel" weapons. While we recognize the high risk associated with such a speculative proposal, we believe the unique worth of such a weapon for $C\text{-}C^3$ warrants the investigatory effort.

(C) 6. COVER AND DECEPTION (U)

(C) Soviet doctrinal statements, although they indicate serious intent to accomplish certain objectives, do not necessarily equate to a practical capability to do so - particularly under combat conditions. Thus C&D to protect real NATO targets from attack and to create at least some covering signatures and evidence of targets which are actually false serves to dilute and frustrate WP reconnaissance, target location activities and the weapon systems themselves.

(C) High on the target priority list are "enemy means of nuclear delivery." Thus emplacing decoys and creating false SIGINT and other signatures of nuclear capable artillery batteries, LANCE units and Air Force nuclear delivery units may be highly effective.

(C) C&D with regard to NATO C^3 by simulating, for example, false CP emissions from locations remote from actual high value targets will serve to blunt the Soviet objective of destroying 30 percent of NATO C^3. Similarly, multitudinous transmissions of dummy (taped) communications on actually unused channels will serve to dilute Soviet jamming capabilities and the SIGINT systems which, among other functions, serve to provide control information for the REC effort.

(C) C&D actions are particularly important during the hours preceding H-hour since they are "passive" in nature and hence acceptable as non-preemptive. They are, in fact, the only pre H-hour actions the NATO forces can undertake to blunt the WP attack.

(C) The Defense Science Board (DSB) 1977 Summer Study on Counter C^3 has an excellent discussion of C&D. The 1978 DSB study also makes several recommendations for C&D which we strongly endorse. In addition to these recommendations, we recommend that the NATO Allies be strongly encouraged to take responsibility for developing specific action plans for C&D. In particular, in view of the strong British history of successful C&D actions, we recommend they be encouraged to take the lead in this NATO effort.

(S) D. RECOMMENDED PROGRAM AND TECHNOLOGY INIATIVES (U)

(S) 1. DETECTION, IDENTIFICATION AND LOCATION (U)

(C) In the near term the principal technology limitation will be in regard to the accuracy with which a CP can be located. There is also a timeliness limitation, but it is largely one of organizational barriers and jurisdictional prerogatives. However, there are actions that can be taken by the Army and the Air Force, individually and jointly, to improve the viability of counteractions against the Soviet command/control structure.

(C) a. Create a counter-command/control targeting cell in both Army and Air Force tactical and operational staffs to exploit traffic coming from CPs, to locate them with direction finding and other presently available techniques, and to prepare appropriate pre-planned attacks against them on a continuing basis. In effect, CPs should be included in the target list with sufficient priority to assure that they will be attacked at the onset of hostilities.

(C) b. Dramatically improve the data base of knowledge on Soviet CPs of all kinds, for example, teardown time, setup time, rate of movement, site configuration, vehicle population, detectable signatures.

(C) c. Institute a field experiment to evaluate how Soviet C^3 can be continuously detected, identified, located and attacked or placed on target lists. This should be done on a time line basis for Pre-H, H-hour, Post H, and steady state situations.

(S) d. The non-pulse fingerprinting work presently funded by DARPA should be emphasized in scope and funding level, but directed toward signals of interest for C-C^3 mission. At the present, the work is concerned largely with the R-123 Soviet radio set whereas the equipments of interest for C-C^2 are the various transmitters and signals associated with each of the various CPs of interest, and with data links supporting weapon systems control.

(C) e. There is presently under consideration an action to add non-pulse capability in the Air Force PLSS system to be known as the ELS. However, the frequency range of this new feature has not yet been decided nor have appropriate programmatic and funding decisions been made. It is virtually necessary to expedite the needed funding and programmatic decisions to assure that a significant non-pulse capability for locating emitters will be added to PLSS in time for its operational testing and deployment.

(S) f. A technology program at Lincoln Laboratory is examining new signal processing techniques for improved ARM seekers. The same technique may have applicability to ground-based or airborne location systems for non-pulse emitters. This work should be vigorously continued, with the application of such techniques to ground-or air-based location systems also evaluated.

(C) g. A newly-funded study is examining artillery delivered expendable devices as part of a single-station emitter-location system, which may be a valuable capability to attach at various levels of the Army structure. Evaluate expansion of this program to a variety of artillery-delivered, single-based systems for detection and location of emitters.

(S) h. Establish a research effort to investigate the applicability of Bayesian statistical techniques to assist in tracking the movement of CPs from location to location. Such techniques have been successfully used in a simulation environment by the Air Force project CONSTANT LINK for similar purposes.

(C) i. Task the national and tactical intelligence resources to improve the understanding of Soviet CPs and their relevant behavior parameters, e.g., signatures, response time, movement rates.

(S) j. Assure that the experience and accomplishments of the two Air Force projects ATLAS and CONSTANT LINK are made fully available to the BETA test bed and experiments. Each of these has examined in a research simulation environment some aspects of data fusion that are relevant and pertinent to capabilities that BETA must have.

(S) 2. HARASSMENT AND DESTRUCTION (U)

(S) a. The Army expendable jammer program should be adopted to operate over friendly communication frequencies. This will deny WP REC units SIGINT vital to their effectiveness without interferring with friendly C^3.

(S) b. The Army expendable jammer program should be adopted to operate over all WP CP communication frequencies, including multichannel, UHF single channel and wide area tropo. These devices will deny critical division Army level C^3 and force CP relocation - the objective of harassment.

(S) c. The current Army ICM and Air Force WAAM programs should be jointly reviewed for potential technology initiatives and program modifications specific to C-C^3 munitions.

(S) d. Joint Army/Air Force research and development programs should be funded to identify and develop new wide area weapons such as Have Name, which are uniquely "anti-electronic" and low tonnage.

(S) e. The NATO Allies, led by the British, should be encouraged to take responsibility for developing detailed tactical plans for European C&D actions.

(S) f. The development of the US Army Mini-RPV program (Aquilla) should be continued, and the mix of payloads optimized for C-C^3 (Pre 1983).

(S) g. Develop a set of RPV/Drones and C-C^3 payloads maintaining low cost ($10K to $100K per vehicle). Continue development of Air Force harassment drone and the miniature interfermetric CW homing technique of Lincoln Laboratories (Post 1983 deployment).

(C) 3. NATO IMPLICATIONS (U)

(C) The importance of C^3 centers as targets increases significantly as the WP forces tend toward greater centralization of their C^3 functions. Within NATO (and the US as well) however, there is wide disparity among operators regarding the allocation of scarce resources to destroying or degrading the WP C^3

capability. The US appears directed toward a course of action which now recognizes the potential benefit derived from countering enemy C^3 but until NATO-made acceptance of this philosophy is brought about, it will be difficult to implement meaningful solutions to the C-C^3 problems. The difficulties associated with releasibility of sensitive information will likely compound the problem and considerable effort seems warranted to build the case.

(C) A key element in the effective interdiction of C^3 is the capability to work within the time-decision framework of the enemy. This requires NATO-wide rapid collection, evaluation, and dissemination of intelligence from all sources coupled with the means to quickly determine whether to exploit or disrupt particular enemy activities, and employ the appropriate systems on a new real-time basis.

(C) It is recognized that a US only C-C^3 capability would be of limited value in Europe. The capability must exist throughout a major portion of the NATO forces to have a large impact. Thus, it is of major importance that development of C-C^3 capability be done in active cooperation with our NATO allies.

(U) Implicit in this intent is the need to engage in briefings and dialogue with appropriate nations: for example, with SHAPE and NATO to solicit their reactions and support at the earliest possible time, to insure that their views are reflected in the end product of the study.

(C) Experiences in the past suggest that NATO is not willing to accept "fait accompli" studies on hardware by US. It is cautiously suspicious, and is reluctant to accept proposals pending their own analysis that weighs the proposal in terms of their perceptions of need, commitments and impact on their budgets, manpower/economic national impact, productivity by their nation, effective use of their limited technology and know-how. As a result, U.S. initiatives may be immersed under a cloud of rejection unless:

a. Early national involvement at the birth of the idea is actively achieved either by bilaterals or by NATO/PANEL/COMMITTEE agreement.

b. Proposal provides for a basis of national sharing of both manpower, industrial capacity, and technology with reasonable trade-offs.

(C) Fundamental to NATO are national prerogatives, hence, requirements must be based on scenarios that are nationally acceptable. Hence, proceeding into development prior to an established "need base line" is like a time-bomb if it is deferred. The U.S. tends to state solutions to requirements which may not be based on nationally or NATO approved scenarios. Yet, national requirements do exist based on discrete perceptions of the threat under a nationally conceived scenario. Inhibited by security aspects, portions of the threat within the terms of reference of this study may not be available to certain nations. This could result in lack of national interest and commitment, due to inability to properly assess the threat. Hence, a limited number of the big nations may recognize the threat. Their response, in an active and mutually supported effort is needed to develop a NATO-supported statement of operational need. This is an essential pre-cursor to achieving agreement on development effort. Experience in the past has shown that attempts to by-pass this step resulted in the "time bomb" delay. In the case of AWACS, after it was flying and demonstrated, it took three years to generate a set of requirements.

(U) Accordingly, if time is of essence, the threat must be recognized, and a set of scenarios developed that will permit national evaluation and pave the way to generate a NATO statement of requirements.

(U) Action can be enhanced by bi-laterals of US with UK and FRG. Earliest possible involvement is essential to preclude national rejection and deferment of actions.

(C) The U.S. objective within NATO should be:

a. Promote U.S. objectives in NATO rationalization, standardization and interoperability.

b. To enhance credibility of both National and NATO needs.

c. Encourage early multi-national participation.

d. Precipitate action by NATO.

U.S. strategy should include:

a. Avoiding the impression that a study is complete.

b. Providing opportunity and time to get national reactions and recommendations.

c. Soliciting joint national execution and implementation.

d. U.S. contacting NATO SHAPE leaders to develop guidance and strategy.

(C) Possible courses of action include:

Alt 1. U.S. brief nations, NATO, SHAPE on study to include threat.

Alt 2. U.S. brief selected nations (UK, FRG) and consider bilaterals with each to be followed by briefs to NATO/SHAPE.

Alt 3. Arrange special session of Big 3 (US, US, FRG) to brief and develop strategy to implement U.S. proposal as pre-cursor to other two alternatives. It is assumed that France will not be included in this cooperative effort because of the security issue.

(S) 4. NEEDED IMPROVEMENTS IN NATO C^3 (U)

a. Each of the joint study task groups noted the importance of upgrading NATO and U.S. C^3 in all areas, the most important of which was survivability. In light of the great emphasis placed by the Soviets on using their REC units to destroy or neutralize NATO C^3, and in recognition of the reliance we place on our C^3, the recommendation is made that NATO concentrate upon C^3 survivability. The effort should focus on mobility for those elements which must remain above ground, or operate in the immediate

operational areas. The purpose of this should be to insure that frequency of movement, if only for short distances, will prohibit the Soviet REC effort from pinpointing and targeting unhardened C^3 elements.

b. It is also necessary that NATO C^3 demonstrate timely responsiveness to changing situations or conditions. The principle of flexibility must be continuously emphasized and exercised throughout NATO's spectrum of operations and planning. Although this Group stressed the need for timely responsiveness in the C-C^3 cycle of detection, identification, location, harassment, and destruction, it applies to all areas of C^3.

c. Stress must be put on continuing toward a goal of improving communications, particularly in the following areas.

(1) Reduction in bandwidth through the use of increased radio discipline, increased pre-planning such as the Creek Braille project, and the use of DMED techniques.

(2) Introduction of AJ/LPI on all important communications links.

(3) Development of fail-soft multi-path nets.

(4) Acceleration of the development of DSCS III.

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REPORT OF TASK GROUP IV

(S) TEMPLATING AND COUNTERING SOVIET AIR DEFENSE ON THE BATTLEFIELD (U)

Mr. Kent Kresa, Chairman	ASB
Dr. F. Robert Naka, Vice Chairman	SAB
Dr. Richard Montgomery	ASB
Dr. Allan Simon	ASB
Dr. Harold P. Smith, Jr.	SAB
Mr. Edwin Speakman	Army
Col Richard H. Koenig	TRADOC
Col Ralph Barrows	TAC
Lt Col Clifford D. Davis	AFTEC

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(S) ABSTRACT (U)

(U) This section treats the subject of NATO's ability to detect, to locate, to template (classify) and to counter, by direct and electromagnetic means, WP AD systems in a European war scenario. The principal current deficiencies in capability are assessed and summarized, and proposed solutions are presented for near (pre-1983) and longer-term (post-1983) operational introduction. The report separately discusses the two major topical areas (templating and countering) and in addition, presents the possible capability and advantages of determining the affiliation of individual radars to specific army units.

(S) The primary conclusions in this section are that the U.S. and NATO presently have an unacceptable capability to template and counter WP AD. This situation will dramatically improve in the longer term with the addition of systems specifically designed for the task (PLSS, AGTELIS, EF-111, etc.). It is concluded that, with the exception of PLSS, countering AD is not done on a systems basis, despite the fact that WP AD is highly netted, and organized for maximum effectiveness. Most recommendations attempt to attack the AD system from a top down basis, denying or degrading internetting to a maximum extent possible. Specific recommendations include inputs on the EF-111, APR-38, PLSS, AGTELIS, GUARDRAIL and other systems now in use or in development.

(U) Specially classified appendices contain material, including recommendations, not suitable for inclusion in this SECRET report.

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(S) I. SUMMARY (U)

(S) A. TOPIC (U)

(S) Critical tasks at the outbreak of hostilities will be the detection, location, and classification (by weapon type) of enemy AD. These are required (1) to assist in the planning of air operations both near to and well behind the FEBA, and (2) to pinpoint and to help prioritize strikes against the AD units themselves. A significant number of these are highly mobile, thus making timely detection, location, and classification a necessity. This overall process may be called templating the AD battlefield.

(S) There is strong evidence to suggest that WP forces will mount a sophisticated EW campaign to frustrate NATO attempts in this area; including the use of (1) alternate wartime frequencies and operating modes, (2) previously unobserved netting of AD elements to minimize the detection of particular radars until later in the engagement (EMCON), and (3) dedicated C&D.

(S) The U.S. EW arsenal designed to counter the Soviet AD network consists of collection systems, warning receivers, jammers, and special purpose equipment to facilitate destruction of Soviet AD units. The Task Group reviewed the capabilities of selected U.S. systems against the SA-4, SA-6, SA-8 and ZSU-23-4 systems in their latest modes of operation. This task is discussed in the section entitled "Countering the Air Defenses on the Battlefield."

(C) The operational task faced by the U.S. EW arsenal is to attrite and/or to degrade the Soviet AD system such that Army and Air Force helicopters and aircraft do not sustain unacceptably high attrition rates.

(U) The Task Group reviewed U.S. capability to achieve both the templating and countering tasks now and in the future, assuming a massive WP offensive against NATO. Both programmed systems and applicable research and development elements were included.

(S) A major effort was undertaken to understand how the Soviet electromagnetic environment would change in wartime, including the impact such changes would have on present and programmed U.S. ELINT, ECM, Radar Warning, and anti-radiation strike assets such as WILD WEASEL.

(S) Because of time limitations, only U.S. (and not the rest of NATO) capabilities were considered. Further, the study concentrated on radar directed systems only. As a result, a large number of other important air defenses, such as the SA-9, ZSU-23-4, SA-6, and SA-8 (in their autonomous optical modes) were not considered. Although this is an important limitation, forcing the enemy to rely on the optical tracking mode, as opposed to the highly netted radar mode, will significantly reduce his effectiveness.

(S) B. KEY OPERATIONAL NEEDS (U)

(S) To template the battlefield, the key needs were defined to be:

(a) Determination of the number of AD weapons within the primary zone to within 20% of actual number.

(b) Location of AD weapons to within a few kilometers for the battlefield management purposes (AD, avoidance, self-protection requirements, assessment of battlefield situation).

(c) Location within a few minutes of AD systems to within 50 meters for strike purposes.

(d) Correct classification of weapon system type (SA-6, SA-4, etc.) 90% of the time.

(e) Determination of the presence of previously uncommitted fighting units (and associated AD) in a timely manner to ascertain major lines of advance, reinforcements, or cross echeloning.

(f) Determination of the affiliation of WP AD assets to Army echelons to assist in providing senior U.S. and NATO commanders with indications of the trend of the battle.

(g) Determination of post-strike effectiveness against AD assets.

(S) To counter Soviet AD, the key needs are:

(a) Physical and electronic attack of the AD system elements which allow it to operate as an effective network; i.e., LONG TRACK and FLAT FACE radars and selected communications.

(b) Assurance of proper functioning of warning receivers to allow pilots to take evasive maneuvers when under the threat of imminent attack.

(c) Employment of self-protection jamming devices to foil SAM/AAA/AAM attack.

(d) Location of enemy radars to facilitate the above actions.

(S) C. CRITICAL CAPABILITIES AND DEFICIENCIES (U)

(S) Table IV-1-1 summarizes our present capability to meet the operational needs for "templating" the AD battlefield. Although marginally effective in exploiting major WP activity during exercises, our capability appears significantly deficient in all categories when matched against the wartime threat. This is due primarily to our inability to determine which AD assets, observed at different times, are actually units which have moved (multiple bookkeeping); an inability to obtain sufficiently unique signatures or data sets to identify weapon types; and a general problem of saturation of the limited assets presently available to handle the target-rich wartime environment.

(S) Table IV-1-2 summarizes our present capability to meet the operational needs for countering the Soviet AD system. Some of our deficiencies are directly related to the fact that many of our EW assets are dedicated exclusively to self protection of individual aircraft when threatened by the entire Soviet AD system. We have not dedicated enough assets to previously degrade the system integrating components (early warning, target acquisition radars and important communication links) of the enemy AD system. Further, many of our EW systems are updated versions of equipments used in the Vietnam War

TABLE IV-1-1

(S) TEMPLATING SOVIET AIR DEFENSE BATTLEFIELD (U)

REQUIREMENT	PRESENT U.S. CAPABILITY TO FILL REQUIREMENT
Determine the number of air defense radars arrayed to an accuracy of 20%	Inadequate; 50% to + 100%
Locate air defense radars to an accuracy compatible with battle management needs (500M-5KM) and compatible with strike needs (50M)	Marginal for battle management; 4-20 KM Inadequate for targeting; 4-20 KM
Determine the association between radar and weapon correctly 90% of the time	Inadequate in wartime; 50-60%
Determine the trends in the enemy air defense plan	Poor (assumes loss of Berlin and Augsburg stations)

TABLE IV-1-2

(S) COUNTERING SOVIET AIR DEFENSES (U)

REQUIREMENT	PRESENT U.S. CAPABILITY TO FILL REQUIREMENT
Deny the enemy his Early Warning, Target Assignment and Height Finder Radar Capability	Jamming - virtually none Attack - limited, with WILD WEASEL
Deny the enemy his data link communications among SAM elements	None
Assure proper functioning of warning receivers	Acceptable in medium density; unsophisticated environment; capability falls off rapidly in sophisticated, dense environment
Employ self-protection jamming devices to foil SAM/AAA/AAM	U.S. Army - none U.S. Air Force - marginally adequate, but with external pods
Locate enemy radars to facilitate above needs	Not accurate enough to target

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against a relatively unsophisticated, immobile threat characterized by SA-2 and SA-3 type equipments.

(S) D. PROPOSED APPROACHES (U)

(U) The Task Group has developed several detailed recommendations which are contained in the discussion section and summarized in Section III for reference. In this section are highlighted certain selected recommendations or proposed approaches which the Task Group felt were the most important and had the greatest impact and/or interactions with other systems.

(U) The proposed approaches are divided into two time phases:

Near Term - operational introduction in or before calendar year 1983;

Longer Term - operational introduction in or after calendar year 1983.

(U) Each of the proposed approaches is briefly described and assessed for potential capability and payoff and associated impact; and ball park estimate of the costs and time required to accomplish a prototype advanced development program is made. These approaches are summarized in Tables IV-1-3 and IV-1-4 and in the specially classified appendices.

TABLE IV-1-3

(S) PROPOSED APPROACHES (NEAR TERM) (U)

APPROACH	PAYOFF	DESCRIPTION	POTENTIAL CAPABILITY	ASSOCIATED IMPACT	DEVELOPMENT COST/TIME
Install Data Link recognition/ location capability on TEREC as an interim capability	H	Allows for immediate automatic recognition and location of crucial data link sources associated with SA-4, SA-6, SA-8; i.e., templating	Puts vital data link emitters at risk whenever they transmit; allows attack by destructive means	Minor	10M/24 months
Correlate MTI (e.g. SOTAS) data with ELINT (e.g. QUICK LOOK, TEREC, AGTELIS)	H	In fusion center match information on "movers" with information on emitters	Correlation of data facilitates "count" location and association on enemy air defense assets	Requires accurate common grid system. Should be tested in BETA program	Low
Install Data Link Jammers on EF-111	H	Jams crucial data links among key elements of SA-4, SA-6, SA-8 systems	Denies assignment strategy to SAM brigades and regiments. SAM batteries are relatively isolated from the rest of the battle. Denies EMCOM strategy	EF-111 tactics might be different with this payload than with radar jammer payload; adds programmatic impact to controversial program	20M/24 months

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TABLE IV-1-3 (Continued)

(S) PROPOSED APPROACHES (NEAR TERM) (U)

APPROACH	PAYOFF	DESCRIPTION	POTENTIAL CAPABILITY	ASSOCIATED IMPACT	DEVELOPMENT COST/TIME
Jamming of Early Warning, Target Assignment, Height Finder Radars	H	Select from 3 different options (ALQ-131, Hi Power EF-111 jammer, dedicated EF-111) to concentrate heavy jamming against LONG TRACK, FLAT FACE, THIN SKIN	Deny enemy his long range sensors so that he cannot easily assign SAMs to threats in an effective manner	Takes available jammers (ALQ-131, EF-111) away from certain threats and concentrates on selected targets	10M/12 months
Add Airborne Complement to AGTELIS and stop PIP on QUICK LOOK	M	Move quickly to the modern TOA system and away from the obsolete DOA system	Greatly improved location accuracy, reduced susceptibility to modern counter-countermeasures, less susceptibility to short on-time emitters	Improves system survivability and life cycle costs logistics, by trending to one fundamental type of system rather than two	20M/18 months
In-theater Rapid Reprogramming	H	Establish a limited European based capability to program EW assets quickly and responsively to PACT parameter changes	Minimizes impact of PACT "surprises" in terms of wartime frequencies and modes	Accelerates the trend toward field programmability of EW assets	4M/12 months

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TABLE IV-1-3 (Continued)

(S) PROPOSED APPROACHES (NEAR TERM) (U)

APPROACH	PAYOFF	DESCRIPTION	POTENTIAL CAPABILITY	ASSOCIATED IMPACT	DEVELOPMENT COST/TIME
"Probing" of Air Defenses	M	Selectable jamming and stimulation of enemy air defense systems by low cost, expendable decoys	Takes enemy radars out of EMCON; forces enemy to reveal some portion of his planned counter-countermeasure strategy	Collectors must be on-station during probes, to collect "take". C^2 implication minimum	Decoys 5M/24 months
Improve navigation accuracy for special purpose SIGINT collectors: e.g., TEREC, GUARD RAIL, RIVET JOINT	M	Tie into early configurations of GPS	Improve location accuracy by factor of 2 to 3; can be quickly fielded; immune to TACAN/LORAN destruction	Minimal	Funded

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TABLE IV-1-4

(S) PROPOSED APPROACHES (LONGER TERM) (U)

APPROACH	PAYOFF	DESCRIPTION	POTENTIAL CAPABILITY	ASSOCIATED IMPACT	DEVELOPMENT COST/TIME
Install Data Link Recognition/Location Capability with PLSS/AGTELIS	H	Allows for immediate, automatic recognition and location of crucial data link sources associated with SA-4, SA-6, SA-8; i.e., templating	Puts vital data link emitters at risk whenever they transmit; allows attack by destructive means	Programmatic impact on two important, on-going programs, but greatly broadens their application	20M/24 months
Exploit "Fingerprinting" Technology on PLSS and AGTELIS	H	Exploit Frequency Modulation on Pulse (FMOP)	Unique affiliation of fundamental radar characteristics with serial number; allows accurate count of all air defense radars; their associated affiliations with maneuver elements, including track histories	Impacts two on-going programs if successfully developed. Requires active 6.3 programmatic support; has the potential to reduce analytic intelligence manpower	8M/24 months
Integrate WILD WEASEL and PLSS	H	Provides a ready strike asset (F-4G)	WILD WEASEL would then have self-contained (APR-38) as well as external guidance	Requires beacon on F4G	10M/12 months

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TABLE IV-1-4 (Continued)

(S) PROPOSED APPROACHES (LONGER TERM) (U)

APPROACH	PAYOFF	DESCRIPTION	POTENTIAL CAPABILITY	ASSOCIATED IMPACT	DEVELOPMENT COST/TIME
Close couple PLSS/AGTELIS	H	Integrate data streams and ground processing stations	Hybrid configurations of ground and airborne elements permits maximum operational flexibility and contributes to survivability	Both programs are underway and would need modification. IOC's are different: AGTELIS IOC-1982 PLSS IOC-1985 makes C^3 easier	Unknown-may be large for AGTELIS-may delay development
Correlate SAR imagery with ELINT	M	In fusion center, match "Spotlight" imagery with ELINT	Provides ultimate in detailed association and count on enemy air defense assets	Dependent upon successful development of ASARS or UPD-X with one foot resolution and "zoom" capability; requires common grid; may be manpower intensive	Included in Development

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(S) II. DISCUSSION (U)

(U) As outlined in the summary, the Task Group considered two broad issues posed by the Soviet AD capability; how to detect effectively, locate and classify the major components and how to counter the formidable capability to assure that NATO air forces can continue to operate.

(U) We have labeled the former task as templating the AD battlefield. For all AD suppression objectives, it is adequate to know location (including any movement), type and wartime modes which can affect operation of EW assets. In reviewing this topic, however, the Task Group was intrigued by the broader importance of an even more detailed knowledge of an AD radar's genealogy, namely the ability to affiliate a particular radar with a specific army unit. Assuming technology will allow such a unique affiliation, and there is evidence that such is the case for a wide range of radars, then a radar signature would identify the specific Army unit location and act as a unique electromagnetic tag which is easily detected from even a short transmission. This intriguing possibility is discussed in more detail in Section IIB and Appendix C.

(U) Each discussion section is reasonably self-contained including a discussion of the operational and functional need, a capability and deficiencies assessment, proposed concepts, and recommendations.

(S) In the time available, the Task Group considered U.S. assets only, and hence did not consider ongoing or planned NATO developments which could be of interest. Further, the Task Group has not considered which specific assets would be held as unique National assets and which would be "chopped" directly to the NATO command. It appears clear, however, that the Mobile Air Defense Template, as it is known at the ASAC, would be immediately available to all NATO commanders for appropriate action. Therefore in essence, NATO will have the full capability of the system provided steps are taken to tie ASAC with appropriate NATO elements. Further, a detailed evaluation of supporting NATO collection systems should be undertaken to determine their utility in the ASAC.

(S) A. TEMPLATING WP AD ON THE BATTLEFIELD (U)

(S) 1. Introduction (U)

(U) The approach selected by this Task Group was first to assess information requirements on principal pact Soviet radar controlled AD systems in terms of numbers estimated in a given area, accuracy of location, and classification by type. This was done in order to establish a framework within which capabilities could be measured, deficiencies identified, remedies assessed, and specific prioritized action recommended.

(S) The primary threat systems considered for the near term are the SA-4, 6, 8 and ZSU-23-4. For the longer term the Task Group considered the SA-X-11 and expected improvements in counter countermeasures capabilities of present types of AD system radars.

(S) Existing and programmed U.S. collection systems considered including ELINT, COMINT, Radar Imagery of moving and stationary targets, and optical means. Infrared techniques were not included. We have included other u.S. developed assets owned or operated by other agencies than the theater forces (USAREUR and USAFE).

(C) The quantitative requirements used for reference are consistent with, but expand on the TAC/ TRADOC user requirements definition. The Task Group has chosen to include requirements for mission planning as included in battle management in the regions close to the FEBA (less than 150 kilometers). In these regions of interest the location accuracy requirements for mission planning approximate those for battle management.

(U) The discussion below, supported by the appendices and references, assesses our capabilities, and potentials for improvement, in effecting timely (snapshot) assessments of the AD situation as required in a wartime environment in Central Europe.

(C) 2. Operational and Functional Needs

(U) The general requirement for order of battle information is summarized in Table IV-2-1. A commander must know accurately the number of AD systems opposing his forces if he is to assess enemy capability

(C) TABLE IV-2-1 (U)

MOBILE AIR DEFENSE SYSTEM ORDER OF BATTLE REQUIREMENTS[5] (U)

	ACTUAL # OF ENEMY AIR DEFENSE SYSTEMS PRESENT	LOCATION ACCURACY BATTLE MANAGEMENT	LOCATION ACCURACY TARGETING	RADAR CLASSIFICATION BY TYPE
Zone 1 FEBA-5KM	Within 20%	500M	50M	90%
Zone 2 5KM-50KM	Within 20%	3KM	50M	90%
Zone 3 50KM-150KM	Within 20%	5KM	50M	90%

(S) TABLE IV-2-2 TACTICAL COLLECTION SYSTEMS (U)

TYPE	SYSTEM	ORGANIC TO	IOC CY	PLATFORM	OPERATING ALTITUDE (KFT)	MAX RANGE (KM)	FEBA STANDOFF (KM)	FREQUENCY COVERAGE	SYSTEM SENSITIVITY	ACCURACY
COMINT	TACELIS	CORPS	OR	TRUCK	0.5	30	2 to 5	0.5 to 500 MHZ		2°LOB
	QUICK FIX	DIV	OR	EH-1	10	55	5 to 15	2 to 100 MHZ		2°LOB
	GUARDRAIL II	CORPS	74	RU-21	15	280	15	20 to 70 & 100-150MHZ		2°LOB
	RIVET JOINT II	THEATER	78	RC-135	35	430	60	20 to 500 MHZ		1.7°LOB
	ELS	?	82	U-2R TRIAD	70	600	175	0.02 to 10 GHZ		60 M CEP
ELINT	AGTELIS	CORPS	79	TRUCK	0.5	30	2 to 5	0.5 to 18 GHZ	-80 DBM	50 M CEP
	QUICK LOOK	CORPS	77	OV-1D	10	230	15	0.5 to 18 GHZ	-85 DBM	0.5°LOB
	TEREC	#AF	OR	RF-4C	20	320	25	2 to 12 GHZ	-65 DBM	0.5°LOB
	RIVET JOINT II	THEATER	78	RC-135	35	430	60	0.5 to 12 GHZ	-83 DBM	0.5°LOB
	PLSS	THEATER	85	U-2R TRIAD	70	600	175	0.05 to 19 GHZ	-92 DBM	16 M CEP
IMINT	UPD-4	#AF	OR	RF-4	20	70	25	-	-	10 FT IPR
	ASARS	THEATER	81	U-2R	70	100	50	-	-	10 FT/1FT
	SOTAS	DIV	81	EH-1	2.7-7.5	80	30	-	MTI	80 M at 30KM
	SLAR	CORPS	OR	OV-1	15	50	15	-	MTI	50 FT IPR
KEY CHARACTERISTICS					SPATIAL COVERAGE			TARGET COVERAGE		ACCURACY

These systems are augmented by visual and IR systems

capability will depend upon the development of fingerprinting techniques to identify specific radars by serial number. Thus, even though there is no direct operational requirement for serial number identification, fingerprinting could make a significant contribution across the board, from identifying individual unit movement to the assessment of the entire battlefield situation. The proposed concepts for application of fingerprinting to assist in establishing affiliation are described in Section IIB of this report.

(S) 3. Existing and Programmed Capabilities and Deficiencies (U)

(S) The primary near and longer term gross capabilities are summarized in Table IV-2-2 and the specially classified appendices. The present capabilities cannot be significantly changed before 1983 except through better utilization of systems already near or in production. PLSS and AGTELIS are assumed deployed in quantity in the post-1983 time period. Currently U.S. collection systems deployed and operated in quantities planned, will generally provide adequate frequency coverage and revisit rates in the prewar period. Near term estimates, however, are dependent on detailed assumptions with respect to Soviet designs and operating procedures. The baseline prewar estimates are also based on the knowledge that each AD radar is now operated for a brief time after each move for purposes of calibration, clutter adjustments, and confidence.

(S) Prewar capabilities for numbers estimates, i.e., in the time period up to rapid mobilization for war, probably cannot be improved significantly by purely technical means. Numbers estimates are closely tied to our level of knowledge of deployments of major Soviet tactical units as Tables of Organization and Equipment (TO&E) are well understood. These estimates are based on integrated data over a long period from many sources.

(S) In the prewar period the relatively crude locations information provided by DOA systems can be refined by photographic map correlations and is adequate for battle management. Also prewar classification capabilities are believed to average close to the 90%-correct requirement. In a transition period or under wartime conditions, we have major degrading influences as follows:

(S) (a) Expected Wartime Alteration of Threat Characteristics. Present collection systems, even in aggregate, require a significant time to obtain a data base and cannot maintain continuous frequency and area coverage. Thus, a change-over of all AD radars to new wartime frequencies would require hours to reestablish the EOB. This action, coupled with physical movement, could introduce a factor-of-two or greater uncertainty in numbers within a short time unless movements into an area can be monitored and identified by other means.

(S) (b) Changes in WP Doctrine. The intelligence based perception is clouded. On the one hand it is believed that the Soviets will be constrained to a relatively rigid scheme of frequency allocations for both radar and communication systems. Further, the deployed AD radars are believed to have little flexibility for changes except to switch to a preassigned set of battle frequencies (one of several choices). The density of emitters, the tactical doctrine of armies passing through other armies, and observed training as well as known hardware limitations, support these conclusions. Running counter to this trend we are seeing an increasing amount of PRF agility on all radars. RF agility is being observed on LONG TRACK and with the newer systems presently in development. Further, the WP can be expected to exert a strict level of emissions control in wartime unless the tempo of the action forces frequent alerts and target track by AD engagement radars.

(S) (c) Vulnerability of Key Collection Assets. Under peacetime conditions many relatively vulnerable aircraft and ground systems contribute to both technical and operational intelligence. Under wartime conditions, much of this supporting capability, e.g., Augsburg and Berlin either cannot be counted on to survive or will be required for other priority tasks. The surviving assets have neither the signal processing sophistication nor the skilled manpower available to handle the increased load, resulting from the loss or diversion of non-organic assets.

(S) The increasing vulnerability of reconnaissance aircraft used in penetrating missions is reflected in the trend to greater reliance on stand-off COMINT and ELINT platforms and greater reliance on national assets. National systems are employed in Air Force and joint exercises in either live or simulated modes.

the ground-based AGTELIS - hence the data processing and communications bandwidth requirements are each increased by at least an order of magnitude. AGTELIS collects signals from low power radars deployed near the FEBA (such as the PPS-4 and 5 equivalents of the TPS-33 equivalent). PLSS will not detect these signals from the side lobes at its stand-off ranges.

(S) Viability of both systems will be crucial in the 1983-on time period (particularly as the QUICK LOOK II and TEREC will lose effectiveness against more sophisticated radars). They are needed to provide the location accuracy required for strike, to provide the technical collection capability against more complex Soviet systems, and to provide the ability to reconstitute the data base rapidly under wartime conditions.

(S) PLSS plans to have four aircraft (out of 18 total) airborne continuously in order to assure triple intercepts. The system is vulnerable to loss or malfunction due to base attack, in flight attacks and/or equipment failures. In addition, the ground data processing modes are vulnerable to direct attack. The AGTELIS ground stations also are vulnerable; however, the greater redundancy reduces the impact of a loss.

(S) When JTIDS is available, the ASAC should be able to receive PLSS data directly, thus providing system level redundancy to AGTELIS. Prior to JTIDS, such data exchange can be by TADIL B from PLSS to the Corps and by common communications from Corps to Division. This, however, is not true interoperability of the assets of the two systems to provide mutual support in the event of equipment losses.

(S) If one assumes that enough PLSS and AGTELIS assets survive physically to obtain numbers and locations, under wartime conditions, the systems should not be degraded unless the Soviets adopt extreme counter-countermeasures.

(S) 4. Proposed Concepts for Capability Improvement (U)

(C) Near Term. In view of our assessment of the current situation, it is important to utilize all

Tasking and data handling procedures are being developed. The scoping of the overall situation will be materially assisted through such use of national assets. This subject is described in the specially classified appendices.

(S) It is the Task Group's assessment, however, that despite the assistance provided by national assets, the combined impact of these factors is to degrade seriously the estimated near term (pre-1983) capabilities to provide the AD situation assessment. It is the conclusion of the Task Group that both the knowledge of total numbers of AD units and the ability to type classify these will be degraded by at least a factor of two from prewar capability. Estimated capabilities are:

		Capability	
	Requirement	Prewar	Wartime
Number	± 20%	± 20%	- 50% to + 100%
Location			
Planning	3-5 km	3-5 km	3-5 km
Strike	50 m	-	-
Association	90% correct	70-90%	40-60%

(S) PLSS and AGTELIS are the two major new programmed ELINT systems. They will be supplemented by new COMINT systems, e.g., ELS. PLSS and AGTELIS are both planned to have capabilities for precision location of emitters through TOA techniques. The intercept and location aspects of the two systems are similar in function and they will have comparable capabilities to handle complex signals.

(S) The PLSS system will have an integral defense suppression capability - AGTELIS does not, although AGTELIS data will be fed to artillery units through TACFIRE.

(S) Both systems have broader missions than AD radar intercepts and location. The airborne PLSS system collects information from a much larger area than

practical means to improve our capabilities for obtaining numbers, estimates, locations, and classifications or association of radar AD.

(C) Many concepts for improvements evolved from our discussions with Service, Industry, NSA and Intelligence community personnel. The recommended concepts (Table IV-2-3) for exploitation appear technically feasible, economically modest, and offer worthwhile improvement potential relative to their cost. Each concept is discussed in the following paragraphs.

(S) (a) AD Templating. AD weapons have distinctive electronic groupings on the battlefield. In many cases they can be precisely identified through a combination of ELINT (radars) and COMINT, which is a specialized form of templating. It is proposed that special purpose COMINT collection receivers be added to current and proposed ELINT collection assets to attempt to collect simultaneously and automatically associated COMINT during ELINT intercept. A more detailed description of this concept and the rationale is contained in the specially classified appendices. The payoff would be a capability to associate rapidly and correctly the radar with the weapon type. Technological feasibility of this concept has been demonstrated including the ability to collect and interpret the desired signals automatically. Development costs should run a few million dollars and initial operation at primary collection points should be possible within two years. Templating to a greater extent than weapon type, i.e., affiliation, is discussed in the specially classified appendices.

(S) Recommended Program (U)

(S) Develop special purpose collectors and processors which can automatically recognize AD associated COMINT, initially use with TEREC, later with PLSS/AGTELIS.

(S) (b) Improved Platform Navigational Accuracy. The emitter locating accuracies of existing airborne ELINT systems are determined by two principal factors: DF antenna beamwidth and aircraft navigation system accuracy. The design of the ELINT system antennas are limited by aircraft installation constraints and search rate requirements. The aircraft navigation system accuracies are limiting the emitter locating

TABLE IV-2-3

(S) NEAR TERM (U)

CONCEPTS	PAYOFF	TECHNOLOGICAL IMPLICATIONS AND FEASIBILITY	PROTOTYPE DEVELOPMENT COST/TIME	IMPLEMENTATION IMPACT
1. Air Defense Templating (Sec. II-A-2)	High	Requires development of special purpose VHF intercept module for ELINT PLATFORM. Technologically feasible -- has been developed in brassboard.	$20M/24 months	Allows association of Air Defense units to weapon type during EMCON situation.
2. Improved Platform Navigation Accuracy for SIGINT Collectors (Sec. II-A-3)	Med	None -- Uses Global Positioning System	Funded	Significantly improves airborne navigation accuracy thereby improving ELINT location data.
3. Movement Sensing and ELINT Correlation (Sec. II-A-4)	High	No technical feasibility issues - Application of SOTAS	--	Correlation of ELINT and MIT data will provide indication of Air Defense system movement.
4. Probing of Air Defense (Sec. II-A-5)	Med	May require use of penetrating decoys or extensive stand-off jamming (EF-111)	Decoys - $5M/24 months	Assist in locating and classifying Air Defense

accuracies of such systems as the TEREC equipped RF-4C and RIVET JOINT Automatic Electronic Emitter Locating System (AEELS). It could be improved by a factor of two if high accuracy navigation were possible.

(S) Replacement of the INS of these collection platforms by more accurate new navigation systems is straightforward, but would be expensive in each procurement and support costs and require significant time for aircraft modification and related training. The Air Force plans to have an operational Global Positioning System (GPS) in the early 1980s. This system is designed to support tactical as well as strategic systems. The addition, however, of a GPS receiver and integration of GPS data into existing INS systems could be achieved at relatively low cost and is recommended for platforms such as the RF-4C and RC-135V. An additional benefit would be to facilitate providing information in a common reference grid. As an alternate, PLSS might be employed as an inverse GPS. A possible limitation may be the potential vulnerability of either approach to jamming near the FEBA.

(S) Recommended Program (U)

(S) Utilize GPS or inverse PLSS to provide improved emitter location accuracy of airborne ELINT systems.

(C) (c) Tracking of AD Assets Using MTI Radar. (U)

(U) Movement Sensing Systems will be available in the near term. Those which can reach some distance behind enemy lines (approximately 30 kilometers) are the Army's OV-1D Mohawk SLAR and SOTAs. In the longer term, the ARPA/Air Force's ASSAULT BREAKER concept should have an equal or greater capability.

(U) Movement Sensing Systems (MSS) can be of value in resolving the enemy AD situation in two ways: first, by observing and reporting movement from known AD sites; and second, by observing and reporting rotating, rocking, or nodding radar antennas of AD systems.

(U) The Task Group intuitively believes that SOTAS is such a powerful tool that near continuous coverage should be planned -- and if so, this should be exploited for AD.

(C) In the second technique, the velocity gate of the moving target indicator (MTI) radar would be adjusted to detect and report moving objects (the radar antennas) which have motion but are not moving across terrain. A skilled radar technician or perhaps an automatic processor should be able to identify a radar antenna in motion from other moving objects. This technique would be particularly valuable for classification as well as adding much improved accuracy (100 meters). Prompt integration of this radar information with ELINT information in the ASAC for reporting and tasking is vital.

(C) Disadvantages are the limited depth of view beyond the FEBA and possible physical vulnerability of the SOTAS platform when near the FEBA and radiating.

(S) Recommended Program (U)

(C) Support to ELINT assets should be a priority task of SOTAS and appropriate communications should be provided. The techniques should be demonstrated both in REFORGER exercises and in the BETA experiment.

(S) (d) Probing of WP AD. Even in the near term, it can be assumed that the enemy will exercise strict emission control to minimize the opportunities for detection, location, and strike. Consequently, it may be necessary to find means other than real air strikes to force the radars and data links to emit. Such a capability would become even more important in the longer term when PLSS is operational and a comprehensive ELINT take obtained in a few minutes.

(S) Aside from the obvious tactic of carefully monitoring AD emissions during each NATO air strike, two other techniques appear to be useful: deception concerning NATO air strike missions, accompanied by massive stand-off jamming of the acquisition radars; and the use of low cost decoys (faithfully simulating threat aircraft), which penetrate the area of interest.

(S) It is assumed that Soviet SIGINT resources are used to alert the AD forces of pending strikes. Stand-off jamming of the acquisition radars, possibly accompanied by a C&D effort, may force a Soviet decision to operate the AD engagement radars autonomously looking for the threat.

(S) Decoys were successfully used by the Israelis during the 1973 war, and were developed further in the U.S.

(S) Recommended Program (U)

(S) The Air Force should immediately review the operational need for active probing to obtain AD situation intelligence during high intensity warfare. If active probing is found to be required, then both jammer and decoy approaches should be developed and evaluated.

(S) Longer Term Concepts (U)

(U) Concepts and programmatic aspects for longer term improvements in ability to assess the AD situation follows and are summarized in Table IV-2-4.

(S) (a) PLSS/AGTELIS Interoperability. The Task Group believes that a significant payoff in capabilities could be achieved by providing a functional capability to use elements of PLSS and AGTELIS in one or more of the following modes:

(S) (1) Processing of geographically selected PLSS emitter collection data in AGTELIS ground processing centers. This would require either that AGTELIS centers have dual capability to receive AGTELIS and PLSS sensor inputs or that the sensor data streams of PLSS and AGTELIS be in a common format. The strike calculations currently performed in PLSS need not be provided for in this AGTELIS mode.

(S) (2) Processing of AGTELIS sensor data in PLSS ground processing stations. This could be particularly valuable if the recommendation to consider an airborne extension of AGTELIS is implemented. Again this would require an AGTELIS data buffer at the PLSS ground station or a common sensor output format.

(S) (3) Combined use of sensor inputs in a flexible way. For example, an AGTELIS station (airborne or ground) output could be used in lieu of a third aircraft if only two PLSS aircraft were flying. By tying into multiple AGTELIS stations the whole front could, in principle, still be covered to a depth of 30 kilometers for ground based AGTELIS and much deeper for an airborne AGTELIS tie.

TABLE IV-2-4

(U) LONGER TERM

CONCEPTS	PAYOFF	TECHNOLOGICAL IMPLICATIONS AND FEASIBILITY	PROTOTYPE DEVELOPMENT COST/TIME	IMPLEMENTATION IMPACT
a. PLSS/AGTELIS Interoperability	High	May require common format for AGTELIS sensor data systems. Implies major change to AGTELIS ground stations. Judged feasible.	Major program change for AGTELIS. May delay development.	Provides redundancy for both PLSS and AGTELIS. Increases survivability, flexibility and availability.
b. ELINT/RADAR Imagery Synergism	Med-High	Dependent upon successful development of ASARS or UPD-X SAR system. Judged technically feasible.	--	Would provide information on location and actual numbers of deployed air defense systems.

(S) The programmatic implications may initially be severe but this is balanced by a potentially large increase in viability of both of these critical systems. The development time/cost implications will be relatively large for AGTELIS (as its overall program and unit costs are an order of magnitude lower than PLSS) but will not be large in terms of the aggregate cost of both systems. In fact use of some common components may contribute to cost reductions -- and development of a modular ground station capability appears very practical with modern data processing techniques.

(S) Recommended Program (U)

(U) The Task Group recommends formation of a joint Army/Air Force working group tasked to determine optimum integration solutions for PLSS and AGTELIS, not to debate the need.

(S) (b) Radar Imagery Correlation. Timely imagery, properly correlated with ELINT information, could provide a greatly increased capability to determine accurate locations and true numbers of moving enemy AD systems and possibly in classification by type. Photography and infrared imaging by airborne platforms is not considered herein because of the overflight problem. National imaging assets are of limited use for mobile AD EOB purposes because of relative priorities and timeliness. Synthetic Aperture Radar (SAR) imaging systems offer the potential advantages of night and all-weather operation, stand-off capability, and real-time down link of information.

(S) The current UPD-4 SAR is limited by range (30 nautical miles), resolution (10 feet), real-time down link (one data link system in Europe), relatively short on-station duration of the RF-4C, and possible ECM vulnerabilities. For these reasons imagery association is not considered a near-term capability.

(S) An Advanced Synthetic Aperture Radar System (ASARS) is now under development and designed to be carried by a U-2R aircraft. This U-2 system is planned to have a 100 nautical mile range and 10-foot area resolution with the capability to focus to a 1-2 foot resolution at a desired point. This resolution might even provide antenna size and shape information. The

Tactical Reconnaissance Data Link (TRDL) will provide real-time imagery and enhance command and control. If the currently planned ASARS development is successful, the U-2R or TR-1, with ASARS, would provide a long-duration, high-altitude platform contributing significantly to confirming continuing presence at a site, improving location accuracy, and providing an alternate type classification method.

(S) Recommended Program (U)

(S) Review planned ASARS program to assure incorporation of necessary interface capabilities.

(S) B. THE UTILITY OF AFFILIATION OF AD ASSETS TO ARMY ECHELONS (U)

(S) 1. Operational and Functional Needs (U)

(S) AD assets are uniquely tied to Soviet battle echelons by doctrine. If these assets can be related to Soviet Divisions, Armies or Fronts, a senior U.S. battle commander can deduce not only the trend of battle (or exercise), but also future intent from the structure and density of the units.

(C) Movement and deployment of AD units provide indicators of the battle plan of the enemy commander. Thickening of AD units in an area could indicate a planned massing of combat power in preparation for an attack or major breakthrough. Of particular interest is the deployment of the Frontal SA-4 Brigades. While SA-6 and SA-8 units are organic to the Divisions of that Army, more Army AD units may be supporting one Division than another in response to the current or planned situation.

(C) Continuity of knowledge of the movement and deployment of enemy AD units can provide the friendly ground commander with a good indication of the deployment and/or attrition of enemy divisions. Further, the movement of one battalion in a SA-4, 6 and 8 Regiment or Brigade, whether forward or to the rear, is a good indicator that major combat units will be, or are, moving in that direction.

(C) Considering the SA-4, 6, 8 and ZSU-23-4 threat (see Appendix IV-A) facing NATO in the Central Region (there are nine first echelon divisions along the approximately 180 kilometer line defended by the U.S. V and VII Corps), monitoring the order of battle is a monumental task, especially when considering the inherent ability of the enemy to move units quickly and often. Accuracy of approximately one kilometer will be required.* (Accuracy to 50 meters or less is desirable if the specific AD unit is to be struck by friendly resources.)

(S) A typical Soviet tank or combined arms Army, made up of four combat Divisions would have the following AD resources: 9 SA-4 Batteries each having 3 Transporter Erector Launchers (TEL); 10 SA-6 (4 TEL each); 10 SA-8 Batteries (4 TEL each); and 16 SA-9/ZSU-23-4 Batteries (4 TEL each). Figure IV-2-1 provides a typical deployment of the force.

(S) 2. Assessment of Capabilities and Deficiencies (U)

(S) SIGINT. The electronic signatures of the AD units described above, while sufficient to identify weapons type, are insufficient to identify affiliation and subordination. The specially classified appendices also discusses SIGINT techniques for determining affiliation.

(S) ELINT. The pre-hostilities ELINT capability will continue to be satisfactory. The addition of PLSS will greatly improve our wartime ELINT location capability and be more than satisfactory for affiliation, since the accuracy requirement for strike for which PLSS is designed is greater than for affiliation. Some attention to the survivability of PLSS airborne ground equipments is desirable. In addition, ground processors presently under development and demonstration/test in Air Force and joint exercises will provide the capability to handle downlinked data from national systems and thereby successfully implement the tactical/national interface.

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*to maintain resolution between units and continuity in tracking.

XX = DIVISION
XXXX = ARMY
4 - SA-4 BATTERY
6 = SA-6 BATTERY
8 = SA-8 BATTERY
9 = SA-9/ZSU-23-4 BATTERY

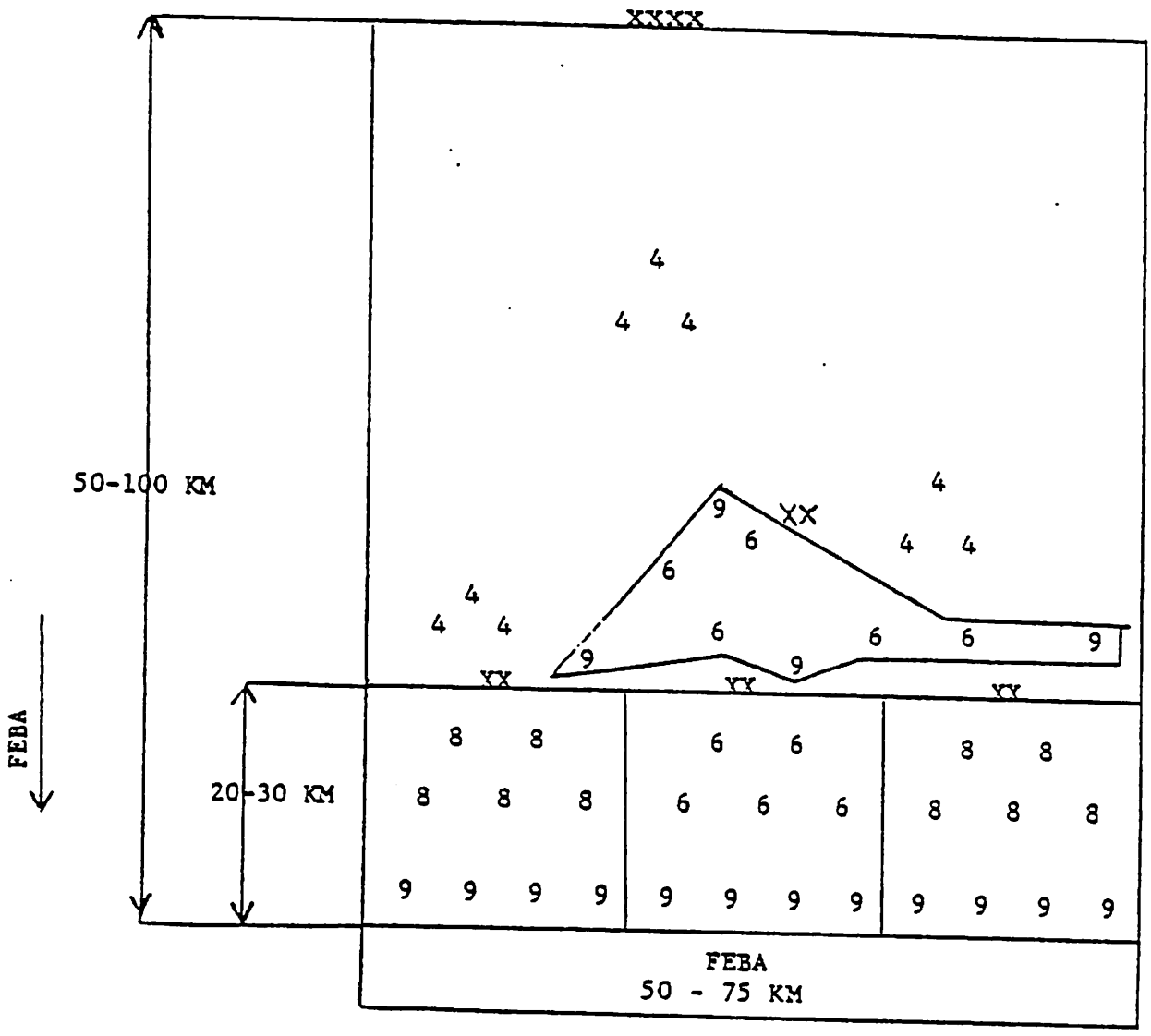


FIGURE IV-2-1

(S) Typical Air Defense Deployment in a Soviet Tank Army (U)

(S) Recommendation (U)

(S) Continue activities on both PLSS and national ground processors. See the specially classified appendices for detail.

(S) COMINT. The COMINT status is poor. ELS will provide the necessary location accuracy. However, it is unlikely that the required level of exploitation of AD-related communications can be accomplished with presently programmed capabilities. On the other hand, if tasking of COMPASS BRIGHT assets can be accomplished, some enhancement can be achieved.

(S) Recommendation (U)

(S) The ELS program should be continued, and a program for COMINT exploitation of AD-related communications must be vigorously pursued.

(SNF) Imagery. Another method for affiliating AD assets to Army units is the use of Imagery Intelligence (IMINT). The commonality and quantity of radars and associated vehicles of Brigade, Regimental, and Battalion headquarters can be used to identify specific headquarters affiliation. This affiliation is based on number and types of radars present and their distance from the FEBA (see Appendix B). Divisional associated AD Regimental headquarters (i.e., SA-6, SA-8 or S-60 Gun) can be expected to be about 20 kilometers from the FEBA in an offensive action and between 20-30 kilometers in a defensive action. Army and Front affiliated SA-4 Brigade headquarters will be located behind the Divisional units and about 40 kilometers in the offense and about 70 kilometers in the defense from the FEBA. The nearest SA-4 Battalion and its associated batteries will be from 25 to 50 kilometers from the FEBA.

(C) SAM and AA fire units will be more difficult to identify due to their mobility. However, each fire unit contains system peculiar equipment which will provide a positive identification for the SA-4 and SA-6 systems. The SA-8 associated vehicle provides a most unique signature for this system. The ZSU-23-4s will be difficult to identify; however, the GUN DISH radar, when erected, will help.

(U) The use of imagery as a stand-alone procedure for affiliation is not promising because it is largely inferential and manpower intensive. It will, however, provide collateral information when properly used by other systems.

(S) 3. A Proposed Concept for Rapid Affiliation (U)

(S) Fingerprinting. The communications exploitation procedures described above are extremely difficult to accomplish even though conceptually straightforward. If a simple, stable, unique signature could be found associated with a particular AD unit, it could be tracked wherever it went. If in addition, its affiliation with an echelon were determined, the trend of the battle would be more easily deduced. There are three fingerprinting techniques which are presently being pursued which merit increased attention: Frequency Modulation on PULSE (FMOP), Precision PRI (PPRI) and Channelization. A fourth, Radiation Intelligence (RADINT), is also discussed.

(S) (a) FMOP. Experiments have shown that radar pulses contain unintentional frequency modulation which is very stable. This phenomenon is most evident in magnetron transmitters but is also demonstrated by klystron transmitters. In fact, the modulation may remain phase coherent from pulse to pulse for klystron transmitters even when the radio frequency is slowly changed. The FMOP concept is important because it has been shown that Fourier coefficient association can be applied to identify and uniquely catalogue an intercepted pulse with high confidence (see Appendix C for a technical description of FMOP).

(S) One can envision two distinct modes of operation for FMOP. The first would add another dimension to the ambiguity space; RF, PRF, PW, scan type, scan rate, and (potentially) FMOP Fourier coefficients. It would find application in identifying particular radars that may have moved from previously determined locations. It could, therefore, insure that a single radar, by virtue of changing location, is not credited as two radars at two locations. This capability could also be used in the same mode to provide identification of established radars even after shifting to wartime parameters. Thus, the prior affiliation to numbered units will be retained.

(S) The second mode would be incorporated in equipment such as RWR and ALQ 119s. We estimate that the best method would be to load the data into the equipments from FMOP processing systems with their greater computational facilities.

(S) FMOP has been demonstrated in several brassboard configurations and has been shown to be effective against a class of U.S. and foreign radars.

(S) Recommendation (U)

(S) While there is much to be learned before operational equipment can be deployed, we recommend doubling the present FMOP 6.3 effort to the $2M level and begin development of brassboard equipment to assess performance against real AD radars. Development costs for a FMOP fingerprint system have been estimated at $10M nonrecurring, and $100K recurring (See Table IV-2-5(a).

(S) (b) PPRI. A simpler and more readily accessible signature is precision PRI. Experienced ELINT operators claim they can fingerprint radars by this method coupled with other data. Nevertheless the evidence is incomplete.

(S) Recommendation (U)

(S) Because of its potential, ease of access, and low cost we recommend careful collection, analysis, interpretation, and establishment of a PRI data base (See Table IV-2-5(b).

(S) (c) Channelization. See specially classified appendix for discussion.

(S) Recommendation (U)

(S) Research on Channelization deserves high attention (See SAB Appendix CD).

(S) Radiation Intelligence (RINT). RINT (sometimes called Unintentional Radiation Emission (URE)) is emitted from radars in synchronism with the main radar pulse, but at a much lower frequency (See specially classified appendix for a technical description of RINT). From radars operating at 3GHz the RINT emission is at

TABLE IV-2-5

(S) FINGERPRINTING SYSTEMS (U)

CONCEPTS	PAYOFF	TECHNOLOGICAL IMPLICATIONS AND FEASIBILITY	DEVELOPMENT COST/TIME	IMPLEMENTATION IMPACT
(a) NEAR TERM				
Precision PRI	High but Perishable	Feasibility based on emperical evidence. More information needed for higher confidence judgment	Low cost Done today	Provides finger-printing of some key AD radars. Requires data base
(b) LONGER TERM				
Exploitation of FMOP Technology	High	Sophisticated electronic equipment would be added to PLSS/AGTELIS.Validation required.	1-2M/yr for 3 yrs should provide proof of principle	May provide a unique radar signature for many Soviet air defense radars
ELS	High	Technically feasible	Funded/IOC-82	Provides real-time location on communications Emitters

frequencies from 0.1 to 0.5 GHz. Recent measurements show that some of these emissions can be ascribed to magnetron power oscillators, but modulators (both soft and hard tube) and high level timing circuits also produce these emissions, and they are difficult to shield.

(S) The importance of RINT is that these signals are present even when operational procedures severely restrict the emission of the main electromagnetic pulse energy. Thus there is the potential that the SA-4 PAT HAND, the SA-6 STRAIGHT FLUSH, and the SA-8 LAND ROLL target tracking radars can be identified and located even when not on the air.

(S) Recommendation (U)

(S) The technological implications of RINT are presently not understood sufficiently to make effective recommendations on program direction. Therefore, a modest 6.1, 6.2 effort should be continued.

(S) C. ASSESSING U.S. EW ASSETS vs WP AD (U)

(S) 1. Introduction (U)

(S) The U.S. EW arsenal consists of collection assets, radar warning receivers, jammers, and electronic equipments which facilitate destruction of enemy radars. Through close liaison with the intelligence community, the military tries to keep its EW equipments current with the changing nature of the enemy AD threat. This process, by its very nature, must lag Soviet developments, but need not lag Soviet deployments to the field. In spite of U.S. efforts to field countermeasures concurrently with Soviet deployments, we have not been able to react rapidly enough in spite of Quick Reaction Capability (QRC) programs in the past. Further, the QRC program has been relatively dormant in recent years.

(S) We have recently observed a series of counter-countermeasures on the part of the Soviet Union which may require a complete reevaluation and massive upgrading of our EW arsenal. These are:

(a) complex pulse trains

(b) increased frequency agility

(c) intrapulse modulations

(d) special antenna/processor configuration (e.g., scan with compensation)

(e) netted radars

(f) CW and pulse doppler radars

(S) Further, we fear that in the first few hours of hostilities we will be surprised by wartime tactics, procedures, and unforeseen modes on the part of WP forces. It is widely recognized that the current EW structure is not responsive to dynamic changes in the electromagnetic threat. The time lapse from detection/confirmation of a new operating mode of an enemy threat emitter to having a fix for Radar Warning Receiver (RWR) and/or ECM equipment in the field is unpredictable. The current system is plagued by a limited capability to collect radar parameter deviations, a loosely controlled system of reporting, a small cadre of personnel trained for analysis of data, a lack of adequate data automation to support software design and test, and a lack of dedicated secure communications to transmit changes to the theaters. It is necessary to configure our EW support system to accept in-theater reprogramming of equipments based on inputs from survivable collection systems which can rapidly observe the surprises which the WP has in store. To be effective, the collectors need to be active during the air strikes because many of the most effective WP radars will remain dormant (emission control) during intervals between strikes. Then, perhaps in a matter of a very few hours, the collector "take" must be converted to a format to allow for rapid insertion of new threat radar parameters into warning receivers, jammers, and other EW equipments before the next mission.

(S) In general, the U.S. EW arsenal has been designed primarily on a piecemeal basis; that is, the warning receivers, jammers, collection systems and radar-killing systems have not been integrated into an overall system for counter AD. On the other hand, the Soviet AD network (our target) is becoming increasingly formidable on a systematic, integrated and redundant basis. To counter this threat, we must look for and exploit synergisms in our EW arsenal. For instance, WILD WEASEL aircraft could be guided by PLSS while

being protected by EF-111s; similarly SOTAS and AGTELIS are complementary in tracking AD radars as follows: AGTELIS locates them when they are stationary and transmitting; and SOTAS locates them when they are moving but silent; thirdly, killing and/or jamming of the LONG TRACK and FLAT FACE radars will force the PAT HAND and STRAIGHT FLUSH radars out of EMCON making them easier to locate and attack. Our recommendation then is that we consider systematic attrition and jamming of the enemy's AD system by the use of our EW arsenal as a system; this recommendation broadens the applicability of our area EW systems such as PLSS, AGTELIS and EF-111.

(S) 2. Capability Assessment and Deficiencies. An accurate assessment of the capabilities and deficiencies of the U.S. EW arsenal against the Soviet AD system is clearly a difficult undertaking. However, the Task Group felt it was necessary to make a beginning. Thus, in Table IV-2-6 we present comprehensive charts which depict the capabilities of specific EW equipments in four generic classes against the SA-4, SA-6, SA-8 and ZSU-23-4 AD systems. The four generic classes evaluated are:

warning receivers

jammers

tactical collection systems (radar bands)

specialized radar killing systems

Details used in this assessment are summarized in the specially classified appendices. Before addressing the specific deficiencies of present systems, we would like to note that not all data were available to us and that errors in judgment may have resulted. We feel, however, that the methodology is valuable and should be preserved.

(S) (a) Warning Receivers. The follow- systems are included in the category of " present capability": Army: ALR-39(V)1; ALR-39(V)2; ALR-46A Air Force: ALR-46A, ALR-56, ALR-62, ALR-69.

(S) Assessment (U)

(S) The trends are adverse. As the enemy AD arsenal becomes more sophisticated, our warning receivers are being stressed to their realistic limits. Broader

TABLE IV-2-6 (a)

(S) LETHAL DEFENSE SUPPRESSION (KILLERS) (U)

EQUIPMENT APR -38

PLATFORM F4G WILD WEASEL

MISSION DESTROY DEFENSES: DETECT, CLASSIFY, LOCATE, ASSOCIATE

IOC 1979

EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	2, 4, 11 (RF AGILITY)	2, 4, 11
Flat Face (FF) Acquisition	YES	4	4
Thin Skin (TS) Heightfinder	YES	4	4
Pat Hand	YES		
Target Acquisition (TA)	YES	12 (EMCON)	12
Target Tracker (TT)	YES	12 (EMCON)	12
Missile Guidance (MG)	YES		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	2, 4, 11	2, 4, 11
Straight Flush	YES		
TA	YES		
TT	YES	5 (AGILITY)	5
Target Illuminator	YES		
Missile Receiver	N/A		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	2, 4, 11	2, 4, 11
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	3 (AGILITY)	3
General Net	NO		
Voice Radio	NO		

EQUIPMENT	SHRIKE (AGM-45)		
PLATFORM	WILD WEASEL		
MISSION	DESTROY TARGET		
IOC	FIELDED		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	11, 2	11, 2
Flat Face (FF) Acquisition	YES	OUTSIDE FREQ RANGE	DO NOTHING EXTENSIVE; R&D ON 7 WAS FAILURE
Thin Skin (TS) Heightfinder	YES		
Pat Hand	YES		
Target Acquisition (TA)	YES	12 (EMCON)	12
Target Tracker (TT)	YES	12	12
Missile Guidance (MG)	YES	OUTSIDE FREQ RANGE	DO NOTHING
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	2, 11; FF OUTSIDE RNG	2, 11; DO NOTHING
Straight Flush	YES		
TA	YES		
TT	YES	5 (AGILITY)	5
Target Illuminator	YES		
Missile Receiver	N/A		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	2, 11; FF OUTSIDE RNG	2, 11; DO NOTHING USE HARM
Land Roll	YES	OUTSIDE FREQ RNG	INCREASE FREQ RNG
TA	YES		
TT	YES		
MG	YES	OUTSIDE FREQ RNG	USE HARM
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	OUTSIDE FREQ RNG	INCREASE FREQ (HARM)
General Net	NO		
Voice Radio	NO		

EQUIPMENT	STANDARD ARM (AGM-78)		
PLATFORM	WILD WEASEL		
MISSION	DESTROY TARGET		
IOC	FIELDED		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	11, 2	SMALL QTY IN INVENTORY PRECLUDES UPGRADE
Flat Face (FF) Acquisition	YES	OUTSIDE FREQ RNG	USE HARM
Thin Skin (TS) Heightfinder	YES		
Pat Hand	YES		
Target Acquisition (TA)	YES	12 (EMCON)	SMALL INVENTORY PRECLUDES UPGRADE
Target Tracker (TT)	YES	12	SMALL INVENTORY PRECLUDES UPGRADE
Missile Guidance (MG)	YES	OUTSIDE FREQ RNG	USE HARM
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	2,11 FF OUTSIDE FREQ RNG	SML QTY IN INVENTORY PRECLUDES UPGRADE-USE HAR
Straight Flush	YES		
TA	YES		
TT	YES		
Target Illuminator	YES		
Missile Receiver	N/A		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	2,11 FF OUTSIDE FREQ RNG	SML QTY IN INVENTORY PRECLUDES UPGRADE-USE HARM
Land Roll	YES	OUTSIDE FREQ RNG	USE HARM
TA	YES		
TT	YES	OUTSIDE FREQ RNG	USE HARM
MG	NO		
Data Link	NO		
Voice Link	YES		
ZSU 23-4	YES		
Gundish	YES	OUTSIDE FREQ RNG	USE HARM
General Net	NO		
Voice Radio	NO		

EQUIPMENT	HARM (AGM-88)		
PLATFORM	WILD WEASEL		
MISSION	DESTROY TARGET		
IOC	1982-85		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	2, 11	2, 11
Flat Face (FF) Acquisition	YES	4	4
Thin Skin (TS) Heightfinder	YES		
Pat Hand	YES		
Target Acquisition (TA)	YES	12 (EMCON)	12
Target Tracker (TT)	YES	12	12
Missile Guidance (MG)	YES		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	2, 11	2, 11
Straight Flush	YES		
TA	YES		
TT	YES	5 (AGILITY)	5
Target Illuminator	YES		
Missile Receiver	N/A		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	2, 11	2, 11
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	3 (AGILITY)	3
General Net	NO		
Voice Radio	NO		

TABLE IV-2-6 (b)

(S) RADAR WARNING RECEIVERS (RWR) (U)

EQUIPMENT APR-39 (V) 1

PLATFORM UNIVERSAL ARMY HELICOPTER

MISSION WARN OF ATTACK, LOW SIGNAL DENSITY, LOW ALTITUDE

IOC FIELDED

EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	NO		
Long Track (LT) Acquisition			
Flat Face (FF) Acquisition			
Thin Skin (TS) Heightfinder			
Pat Hand			
Target Acquisition (TA)			
Target Tracker (TT)			
Missile Guidance (MG)			
Data Link			
Voice Link			
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	YES		
TT	YES		
Target Illuminator	YES	CAN'T WORK CW	ADD APR-44
Missile Receiver	NO		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES		
General Net	NO		
Voice Radio	NO		

EQUIPMENT	APR-39 (V) 2		
PLATFORM	SPECIAL ARMY ELECTRONIC MISSION AIRCRAFT: GUARD RAIL, MOHAWK, ETC.		
MISSION	WARN OF ATTACK MID-ALTITUDE/FRIENDLY AIRSPACE		
IOC	1981		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	NO		
Flat Face (FF) Acquisition	NO		
Thin Skin (TS) Heightfinder	NO		
Pat Hand	YES		
Target Acquisition (TA)	YES	1, 2	1, 2
Target Tracker (TT)	YES	1, 2	1, 2
Missile Guidance (MG)	YES		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	YES	1, 2	1, 2
TT	YES	1, 2	1, 2
Target Illuminator	YES	CAN'T WORK CW	ADD APR-44 AS INTERIM
Missile Receiver	NO		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	YES	1, 2	1, 2
TT	YES	1, 2	1, 2
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	1, 2, 3	1, 2, 3
General Net	NO		
Voice Radio	NO		

EQUIPMENT	ALR-56		
PLATFORM	F-15		
MISSION	WARN OF ATTACK		
IOC	FIELDED		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	NO		
Flat Face (FF) Acquisition	NO		
Thin Skin (TS) Heightfinder	NO		
Pat Hand	YES		
Target Acquisition (TA)	YES	2, 4	2, 4
Target Tracker (TT)	YES	2, 4	2, 4
Missile Guidance (MG)	YES		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	YES	2, 4	2, 4
TT	YES	2, 4	2, 4
Target Illuminator	YES	CAN'T WORK CW	INSTALL ECP (IN WORK) IOC 1980
Missile Receiver	NO		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	YES	2, 4	2, 4
TT	YES	2, 4	2, 4
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	4	4
General Net	NO		
Voice Radio	NO		

EQUIPMENT: ALR-69 AND ALR-62 **

PLATFORM: F-16, A-10, F-4, F-111, EF-111A

MISSION: WARN OF ATTACK

IOC: FIELDED

EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	NO		
Flat Face (FF) Acquisition	NO		
Thin Skin (TS) Heightfinder	NO		
Pat Hand	YES		
Target Acquisition (TA)	YES	2, 4	2, 4
Target Tracker (TT)	YES	2, 4	2, 4
Missile Guidance (MG)	YES		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	YES	2, 4	2, 4
TT	YES	2, 4, 5	2, 4, 5
Target Illuminator	YES		
Missile Receiver	NO		
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	YES	2, 4	2, 4
TT	YES	2, 4	2, 4
MG	YES		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	2, 4, 5	2, 4, 5
General Net	NO		
Voice Radio	NO		

TABLE IV-2-6 (c)

(S) ELECTRONIC COUNTERMEASURES (ECM);

SELF PROTECTION AND SUPPORT (U)

EQUIPMENT	ALQ-119		
PLATFORM	A-10, F-16, F-4, A-7, F-111		
MISSION	SELF PROTECTION JAMMING		
IOC	FIELDED		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	NO		
Flat Face (FF) Acquisition	NO		
Thin Skin (TS) Heightfinder	NO		
Pat Hand	YES		
Target Acquisition (TA)	NO		
Target Tracker (TT)	YES	CAN'T WORK SWC	7, DEV MONOPULSE TECHNIQUE
Missile Guidance (MG)	NO		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	NO		
TT	YES	6	6
Target Illuminator	NO		
Missile Receiver	YES	THREAT SENSITIVE	6
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	NO		7
TT	YES	CAN'T WORK SWC/MONOPULSE	7, DEVELOP TECHNIQUE
MG	NO		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	LACK OF POWER MGMT	DEVELOP POWER MGMT
General Net	NO		
Voice Radio	NO		

EQUIPMENT	ALQ-131		
PLATFORM	A-10, F-16, F-4, A-7, F-111		
MISSION	SELF PROTECTION JAMMING		
IOC	1979		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	PERHAPS		8, DETERMINE PAYOFF OF JAMMING
Flat Face (FF) Acquisition	PERHAPS		EW/ACQ/HF RADARS
Thin Skin (TS) Heightfinder	NO		
Pat Hand	YES		
Target Acquisition (TA)	NO		
Target Tracker (TT)	YES	CAN'T WORK SWC	7, DEVELOP TECHNIQUES
Missile Guidance (MG)	NO		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	PERHAPS	8	8
Straight Flush	YES		
TA	NO		
TT	YES	6	6
Target Illuminator	NO		
Missile Receiver	YES	THREAT SENSITIVE	6
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	PERHAPS		8
Land Roll	YES		
TA	NO		7
TT	YES	CAN'T WORK SWC/MONOPULSE	7, DEVELOP TECHNIQUE
MG	NO		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	LACK OF POWER MGMT	DEVELOP POWER MGMT
General Net	NO		
Voice Radio	NO		

EQUIPMENT	ALQ-99		
PLATFORM	EF-111A		
MISSION	SUPPORT JAMMING FOR PENETRATING AND STAND OFF TAC AIRCRAFT		
IOC	1982		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	MUST BARRAGE JAM TO COVER RF AGILITY	INVESTIGATE SPECIAL HIGH POWER JAMMER
Flat Face (FF) Acquisition	YES		
Thin Skin (TS) Heightfinder	YES		
Pat Hand	YES		
Target Acquisition (TA)	YES		
Target Tracker (TT)	PERHAPS		9
Missile Guidance (MG)	NO		
Data Link	YES	10	10
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	MUST BARRAGE JAM TO COVER RF AGILITY	INVESTIGATE SPECIAL HIGH POWER JAMMER
Straight Flush	YES		
TA	YES		
TT	PERHAPS		9
Target Illuminator	NO		
Missile Receiver	NO		
Data Link	YES	10	10
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	MUST BARRAGE JAM TO COVER RF AGILITY	INVESTIGATE SPECIAL HIGH POWER JAMMER
Land Roll	YES		
TA	YES		
TT	PERHAPS		9
MG	NO		
Data Link	YES	10	10
Voice Link	NO		
ZSU 23-4	NO		
Gundish	NO		
General Net	NO		
Voice Radio	NO		

EQUIPMENT ALQ-136 (V) 1***

PLATFORM

MISSION

IOC

EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	NO		
Long Track (LT) Acquisition	NO		
Flat Face (FF) Acquisition	NO		
Thin Skin (TS) Heightfinder	NO		
Pat Hand	NO		
Target Acquisition (TA)	NO		
Target Tracker (TT)	NO		
Missile Guidance (MG)	NO		
Data Link	NO		
Voice Link	NO		
SA-6	YES		
LT/FF/TS	NO		
Straight Flush	YES		
TA	NO		
TT	NO		
Target Illuminator	NO		
Missile Receiver	YES	CAN'T WORK CW	FIELD ALQ-162
Data Link	NO		
Voice Link	NO		
SA-8	YES		
LT/FF/TS	NO		
Land Roll	YES		
TA	NO		
TT	YES	CAN'T WORK SWC	DEVELOP TECHNIQUE
MG	NO		
Data Link	NO		
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES	THREAT SENSITIVE PRF AGILITY	1
General Net			
Voice Radio			

TABLE IV-2-6 (d)

(S) EMITTER COLLECTION SYSTEMS (U)

EQUIPMENT	QUICK LOOK II		
PLATFORM	FIXED WING (ARMY)		
MISSION	ELINT (EOB); DETECT, LOCATE, CLASSIFY, ASSOCIATE		
IOC	1979		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	11	SEE REPORT PAGE
Flat Face (FF) Acquisition	YES	13	SEE REPORT PAGE
Thin Skin (TS) Heightfinder	YES	13	
Pat Hand	YES		
Target Acquisition (TA)	YES		
Target Tracker (TT)	YES		
Missile Guidance (MG)	YES		
Data Link	YES	14b	DO NOT RECTIFY DEFICIENCY
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-6	YES		
LT/FF/TS	YES	11 -LT 13	SEE REPORT PAGE
Straight Flush	YES		
TA	YES		
TT	YES	3 (CLASSIFICATION)	SEE REPORT PAGE
Target Illuminator	YES	RANGE LIMITED	SEE REPORT PAGE
Missile Receiver	NO	PASSIVE	PASSIVE
Data Link	YES	14b	DO NOT RECTIFY DEFICIENCY
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-8	YES		
LT/FF/TS	YES	11 -LT 13	SEE REPORT PAGE
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	YES	14b	DO NOT RECTIFY DEFICIENCY
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
ZSU 23-4	YES		
Gundish	YES	3 RNG LMTD (CLASSIFICATION)	IMPROVED SENSITIVITY SEE RPT PAGE
General Net	NO	SEE NOTE ****	SEE NOTE ****
Voice Radio	NO	SEE NOTE ****	SEE NOTE ****

EQUIPMENT	TEREC ALQ-125		
PLATFORM	RF-4 (AIR FORCE)		
MISSION	ELINT (EOB): EWIRC SUPPORT, DETECT, LOCATE, ETC.		
IOC	FIELDED		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	4, 11, 13 (AGILITY)	4 SEE REPORT PAGE
Flat Face (FF) Acquisition	YES	4, 13 (ASSOCIATION)	4 SEE REPORT PAGE
Thin Skin (TS) Heightfinder	YES	13	SEE REPORT PAGE
Pat Hand	YES		
Target Acquisition (TA)	YES		
Target Tracker (TT)	YES		
Missile Guidance (MG)	N/A		
Data Link	YES	14	14, ON AN INTERIM BASIS PENDING PLSS
Voice Link	NO		
SA-6	YES		
LT/FF/TS	YES	11-LT(AGILITY) 4, 13 (ASSOCIATION)	4, SEE REPORT PAGE
Straight Flush	YES		
TA	YES		
TT	YES	5 (AGILITY)	5
Target Illuminator	YES		
Missile Receiver	N/A		
Data Link	YES	14	14 ON AN INTERIM BASIS
Voice Link	NO		
SA-8	YES		
LT/FF/TS	YES	1, 4, 13	1, 4 SEE REPORT PAGE
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	YES	14	14 ON AN INTERIM BASIS
Voice Link	NO		
ZSU 23-4	YES		
Gundish	YES		
General Net	NO		
Voice Radio	NO		

EQUIPMENT	AGTELIS		
PLATFORM	GROUND MOUNTED SENSORS AND PROCESSOR (ARMY)		
MISSION	DETECT, LOCATE, ASSOCIATE FEBA TO DEPTH OF 30km		
IOC	1982		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES		
Flat Face (FF) Acquisition	YES	13	13
Thin Skin (TS) Heightfinder	YES	13	13
Pat Hand	YES		
Target Acquisition (TA)	YES		15
Target Tracker (TT)	YES		15
Missile Guidance (MG)	YES		15
Data Link	YES	14b	MEET NEED THRU TACELIS/GUARDRAIL
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-6	YES		
LT/FF/TS	YES	13	13
Straight Flush	YES		
TA	YES		15
TT	YES		15
Target Illuminator	YES	RANGE LIMITED	
Missile Receiver	NO	PASSIVE	PASSIVE
Data Link	YES	14b	MEET NEED THRU TACELIS
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-8	YES		
LT/FF/TS	YES	13	13
Land Roll	YES		
TA	YES		15
TT	YES		15
MG	YES		
Data Link	YES	14b	MEET NEED THRU TACELIS
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
ZSU 23-4	YES		
Gundish	YES		
General Net	NO	SEE NOTE ****	SEE NOTE ****
Voice Radio	NO	SEE NOTE ****	SEE NOTE ****

EQUIPMENT	PLSS		
PLATFORM	AIRBORNE SENSORS AND GROUND PROCESSOR		
MISSION	ELINT/STRIKE: DETECT, LOCATE, ETC., FEBA TO LIMIT OF AIRPOWER		
IOC	1985		
EVALUATION	NEED*	DEFICIENCY	RECOMMENDATION
SA-4	YES		
Long Track (LT) Acquisition	YES	13 (ASSOCIATION)	13
Flat Face (FF) Acquisition	YES		
Thin Skin (TS) Heightfinder	YES	13	13
Pat Hand	YES		
Target Acquisition (TA)	YES		
Target Tracker (TT)	YES		
Missile Guidance (MG)	YES		
Data Link	YES	14a	14
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-6	YES		
LT/FF/TS	YES	13 (ASSOCIATION)	13
Straight Flush	YES		
TA	YES		
TT	YES		
Target Illuminator	YES	NO CW CAPABILITY	ADD CW
Missile Receiver	N/A		
Data Link	YES	14a	14
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
SA-8	YES		
LT/FF/TS	YES	13 (ASSOCIATION)	13
Land Roll	YES		
TA	YES		
TT	YES		
MG	YES		
Data Link	YES	14a	14
Voice Link	NO	SEE NOTE ****	SEE NOTE ****
ZSU 23-4	YES		
Gundish	YES		
General Net	NO	SEE NOTE ****	SEE NOTE ****
Voice Radio	NO	SEE NOTE ****	SEE NOTE ****

NOTES

* NEED: Need is defined by the Panel to mean that the equipment should counter/intercept/analyze the particular threat. The particular threat should be in the mission of the equipment. This does not imply that there exists a written requirement to counter the particular threat or that it is within the design capability to do so. Rather the Panel made a subjective assessment that a "need" exists and that meeting the need would be highly beneficial.

** ALR-69 AND ALR-62: The Panel did not assess the ALR-46, ALR-63, APR-25/36. The ALR-69 and ALR-62 were grouped together due to very similar capabilities and limitations.

*** SELF PROTECTION JAMMING: The Panel evaluated numerous systems; however, only four are reported as being representative. Systems not depicted include F-15/ALQ-135, F-111/ALQ-94, Army ALQ-162, EF-111A/ALQ-137. Additionally, effects of self protection chaff were not evaluated.

**** VOICE INTERCEPTION FOR COLLECTION SYSTEM: It is recognized that the collection of these signal are an overall collection requirement. Most link signals are outside of the collection capability of the radar collection systems; accordingly, COMINT collection systems exist. The Panel recognizes that combining both radar and COMINT collection equipments may overly complicate a single collection system. The Panel recognizes that this function may be performed by a central collection/processing center.

TABLE IV-2-6 (e)

DEFICIENCIES // RECOMMENDATIONS

DEFICIENCY NUMBER	DESCRIPTION	RECOMMENDATION NUMBER	DESCRIPTION
1	ELECTRONIC WARFARE INTEGRATED REPROGRAMMING CONCEPT (EWIRC) DEPENDENT. SOFTWARE PROGRAMMABLE SYSTEM, DEPENDENT UPON TIMELY RECEIPT OF CHANGED THREAT DATA. DEPENDENT UPON TIMELY SOFTWARE CHANGES.	1	SET UP ARMY EWIRC. SYSTEM NEEDS TO BE SET UP BY IOC OF 1981.
2	CLASSIFICATION AMBIGUITIES MAY EXIST. OTHER THREAT SYSTEMS WITH SIMILAR SORT CRITERIA WOULD CONFUSE THE SYSTEM.	2	ADD ADDITIONAL SORTING TOOLS. MULTIPLE SORTING CRITERIA (RPF, RF, INSTANTANEOUS RF, SCAN, AOA) SHOULD BE USED TO ELIMINATE AMBIGUITIES.
3	HEAVY PRF AGILITY IN DENSE ENVIRONMENT (JITTER WITH PATTERN WOBULATION) MAY CONFUSE THE SYSTEM.	3	ADD ADDITIONAL SORTING TOOLS.
4	EWIRC DEPENDENT.	4	IMPROVE EXISTING EWIRC. NEED TIMELY RESOLUTION OF THREAT CHANGES AND FIELD IMPLEMENTATION OF CHANGES.
5	HEAVY PRF AGILITY (MULTI-LEVEL STAGGER) CAN CONFUSE SYSTEM.	5	IMPROVE SOFTWARE, MULTIPLE SENSORS ARE AVAILABLE (TOA, AOA AND SCANNING RECEIVER); PROBLEM SHOULD BE WORKABLE IN SOFTWARE PROVIDED A DENSE, AGILE ENVIRONMENT DOES NOT OVERLOAD SYSTEM.
6	SA-6 TARGET TRACKER NOT BEING JAMMED DUE TO DIFFICULTIES (SWC, TRACK ON JAM, ETC). MISSILE RECEIVER BEING JAMMED AS EASIER LINK.	6	THREAT CHANGES IN MISSILE RECEIVER MAY PRECLUDE EFFECTIVE JAMMING OF MISSILE LINK. WORK SHOULD BE CONTINUED ON JAMMING OF TARGET TRACKER AS A BACK UP.
		7	TARGET ACQUISITION JAMMING TO DENY RANGE SHOULD BE INVESTIGATED DUE TO LACK OF EFFECTIVE SWC/ MONOPULSE TECHNIQUE FOR TT JAMMING.

TABLE IV-2-6 (e)

DEFICIENCIES // RECOMMENDATIONS (CONTINUED)

DEFICIENCY NUMBER	DESCRIPTION	RECOMMENDATION NUMBER	DESCRIPTION
8	DOES NOT JAM ACQ RADARS	8	THE PAYOFF OF JAMMING ACQ/HF/EW RADARS USING THE SELF PROTECTION JAMMER (ALQ-131) NEEDS TO BE INVESTIGATED. RANGE DENIAL, MULTIPLE STROBES FROM MANY AIRCRAFT AND CONFUSION FACTORS COULD NEGATE NET CONTROL.
9	IS NOT USED TO JAM TERMINAL THREATS FOR SUPPORT PURPOSES.	9	THE EF-111A ALQ-99 IS NOT BEING USED TO JAM TERMINAL THREATS ON PENETRATION MISSIONS. THE ALQ-99 COULD BE A CONSIDERABLE AID TO SELF PROTECTION JAMMING CONSIDERING KNOWN DEFICIENCIES OF SELF PROTECTION JAMMERS (E.G., MONOPULSE, SWC). ACCORDINGLY, USE OF SUPPORT JAMMING TO JAM TERMINAL THREATS NEEDS TO BE INVESTIGATED.
10	DOES NOT JAM DATA LINKS	10	INVESTIGATE PAYOFF FOR EF-111A DATA LINK JAMMING IN PENETRATION ROLE. CONSIDERATION SHOULD BE GIVEN TO A PRIORITY JAMMING (BARRAGE, NON-POWER MANAGED).
11	RF AGILITY MAY CONFUSE SCANNING RECEIVER AND PREVENT PROPER IDENTIFICATION AND CLASSIFICATION.	11	INSTALL ADDITIONAL SENSOR AS AN AID IN SORTING AND IDENTIFICATION.
12	ENEMY RF DISCIPLINE/EMISSION CONTROL (EMCON) WILL MINIMIZE THE TIME AVAILABLE TO IDENTIFY, CLASSIFY AND DESTROY.	12	JAMMING OF ACQUISITION NET WILL FORCE INCREASED AUTONOMOUS OPERATION; THEREBY REQUIRING LONGER PERIODS OF TARGET TRACKING OPERATION. JAM ACQUISITION NET USING EF-111A OR ALQ-131.
13	CANNOT ASSOCIATE A TYPE RADAR WITH A THREAT COMPLEX (E.G., LONG TRACK CANNOT BE ASSOCIATED WITH AN SA-4 COMPLEX DUE TO ITS USE WITH SA-6, ETC.	13	ADD SERIAL NUMBER IDENTIFICATION SUCH AS FMOP OR REQUIRES OTHER INTELLIGENCE ASSETS, E.G., COMINT COLLECTION, LRRP'S (LONG RANGE PATROL ACTION), PHOTO RECONN I.R., SLAR, ETC.

TABLE IV-2-6 (e)

DEFICIENCIES // RECOMMENDATIONS (CONTINUED)

DEFICIENCY NUMBER	DESCRIPTION	RECOMMENDATION NUMBER	DESCRIPTION
14	CANNOT RECEIVE AND PROCESS DATA LINKS.	14	EXTENDING CAPABILITY TO INCLUDE DATA LINKS WOULD ENHANCE MISSION CAPABILITY.
14a	CANNOT PROCESS DATA LINKS.		
14b	CANNOT RECEIVE AND PROCESS DATA LINKS BELOW 500 MHz. CAN RECEIVE AND LOCATE DATA LINKS ABOVE 500 MHz.		

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frequency coverage is required, more sophisticated processing to cope with frequency and pulse train agilities, pulse doppler and CW radars, dense signal environments, etc., is required; yet unit costs must be tightly constrained to allow this capability to be provided to lower cost aircraft such as helicopters, A-10s and F-16s. As a result, the warning receivers will be less likely to sort out imminent threat emitters from background signals; that is, there will be more and more ambiguities in threat identification and more and more unprocessed residue in warning receiver data processors. The strong trend toward very low altitude penetration on the part of air-to-ground aircraft and attack helicopters is an important mitigating circumstance in our favor. Low altitude greatly reduces the pulse density which must be handled by the warning receivers.

(C) Recommendations (U)

(C) Concentrate on the equipment and procedures for quick in-theater reprogramming of threat tables in the warning receivers' digital processors.

(C) Consider equipping air-to-ground low-altitude penetrating aircraft (i.e., F-16, A-10, AAH) with a less sophisticated, less expensive suite than the aircraft which must fly at high or medium altitude for mission success (i.e., F-15, GUARDRAIL, MOHAWK, SOTAS, QUICK LOOK, TEREC, PLSS).

(C) Continue to band-aid present radar warning receivers, but initiate an analysis to determine the pulse density and threat sophistication beyond which it no longer makes sense to stay with the present architectural design, perhaps requiring a whole new approach.

(C) Consider the utility of in-flight reprogramming of warning receivers through PLSS and JTIDS links, thereby somewhat unburdening the self-contained processors in our warning receivers.

(C) Consider a totally distributed aircraft and helicopter warning system, using a JTIDS-like communication system; in which early warning information is provided from stand-off sensors such as PLSS and AGTELIS with self-contained warning of only the missile launch itself.

(S) (b) Jammers. Included in the present capability of jammers are the Air Force ALQ-119 and ALQ-131 self-protection jamming pods, the ALQ-135 internal self-protection jamming system on the F-15 and the EF-111/ ALQ-99 support jamming aircraft. The nearest term Army radar jammer is the AN/ALQ-136(V)1, presently scheduled for an FY 81 IOC.

(S) Assessment (U)

(S) The Soviets have recently taken some significant steps to cope with our ECM program, which they apparently respect. These significant steps are: RF agility, home-on-jam, difficult-to-jam scan/processing techniques such as scan with compensation and forms of monopulse, and emission control with netting and optical tracking. This is a formidable array of techniques which tend to reduce the effectiveness of our ECM equipments. At the same time, the U.S. is moving very slowly in this area. Typical of the lack of ECM progress are the following:

(C) The EF-111 IOC is 1982, in spite of the fact that it is based on the EA-6B which went operational with the U.S. Navy almost a decade earlier.

(U) Much of our self-protection ECM capability is centered in externally-mounted pods which degrade aircraft performance, in spite of the fact that TAC has a requirement for internally-mounted ECM.

(U) The U.S. Army does not have an active airborne ECM jammer in the operational inventory.

(U) The Air Force QRC program has become dormant over the last four or five years as a reaction to the fact that it was abused prior to that time.

(C) Because of this evolving imbalance, the Air Force is being driven toward the ground, and must operate at extremely low altitudes where ground targets are difficult to find without external aids.

(S) Recommendations (U)

(C) Continue research and development to counter scan with compensation.

(S) Investigate the applicability of the AN/ALQ-131 to the mission of jamming the LONG TRACK/FLAT FACE as a supplement to EF-111.

(S) Evaluate the EF-111 in an exclusive role of jamming all LONG TRACKS/FLAT FACES and THIN SKINS in the area by concentrating all available Effective Radiated Powers (ERP) only against these radars in a barrage mode across the entire frequency ranges covered by the three radars.

(S) Consistent with Paragraph c above, investigate the applicability of a special-purpose narrow band, high power LONG TRACK jammer as an augmentation to the EF-111 suite.

(S) Investigate the possibility of including data link recognition and jamming equipment in the EF-111 suite.

(U) Support the Army development programs for light-weight jammers nomenclatured AN/ALQ-136(V)2, ALQ-162 and ALQ-XXX.

(C) Initiate an analysis to determine the threat sophistication level beyond which deception countermeasures are stressed to the point of reasonableness, and at which we should turn again to fundamental noise and random false target systems.

(S) (c) ELINT Collectors. (C) Included in the present capability of emitter collection systems are the Army QUICK LOOK II in the OV-1D aircraft and the TEREC ALQ-125 in the RF-4 aircraft. In the projected capability category are the Army AGTELIS system (IOC 1982) and the Air Force PLSS system (IOC 1985).

(S) Assessment (U)

(S) The QUICK LOOK and TEREC systems are DOA systems which must fly a baseline to obtain radar location information. This reduces their ability to locate accurately short on-time emitters, especially in case of the QUICK LOOK which is mounted on a slow-flying aircraft. The QUICK LOOK is further hampered by its inabilities to handle PRF jitter, stagger and wobulation. A Product Improvement Program (PIP) configuration will

not reach IOC status until 1984. TEREC has many of the same difficulties as QUICK LOOK in terms of its ability to handle advanced counter-countermeasures such as RF agility and severe jitter and stagger modes.

(S) The AGTELIS and PLSS systems are TOA systems which can rapidly and accurately locate even short on-time emitters. Further, being more modern systems, they are better able to handle the more complex signal modulations. Some deficiencies exist in these systems also, such as the ability to handle CW emitters; however, these deficiencies are not fundamental and can be corrected.

(S) None of the four systems has any capability against the various data links associated with the enemy AD systems.

(S) Recommendations (U)

(U) Plan a long range strategy for phasing out QUICK LOOK II and TEREC ALQ-125 in favor of AGTELIS and PLSS.

(U) Reconsider the merits of the QUICK LOOK II PIP which will not reach the IOC stage until FY 1984, two years after the planned IOC for AGTELIS.

(C) As a long range substitute for QUICK LOOK, evaluate the substitution of an airborne component of AGTELIS, which would extend the line-of-sight capability of AGTELIS beyond 30 kilometers beyond the FEBA.

(S) Add a data link recognition and location component to both the PLSS and AGTELIS systems. For further discussion see the specially classified appendices.

(C) Insure interoperability of PLSS and AGTELIS data streams and formats.

(S) (d) Specialized Radar-Killing Systems. This report will not deal with conventional means of killing radars, when the radar is viewed as just another target, like a tank or an armored personnel carrier. We are concerned however with special purpose radar killing systems such as WILD WEASEL, PLSS weapons, SHRIKE (AGM-45), STANDARD ARM (AGM-78), HARM (AGM-88),

and an advanced development of an anti-radar version of the COPPERHEAD and HELLFIRE systems.

(S) Assessment (U)

(U) The Task Group has not been able to evaluate the special purpose, radar-killing ordnance during the course of the summer study, including the Harassment Weapons System presently being planned by the U.S. and German Air Forces.

(S) The WILD WEASEL APR-38 system appears to rank in the marginal to adequate range in its ability to cope with the expected array of CCM.

(S) Recommendations (U)

(S) Upgrade the WILD WEASEL APR-38 to cope with the advanced threats in a self-contained manner.

(S) Integrate the WILD WEASEL fleet into the PLSS system so that WILD WEASEL strikes can be conducted under PLSS guidance.

(S) Determine the capability of the SHRIKE, STANDARD ARM and HARM missiles to operate against the advanced CCM techniques now postulated.

(S) Conduct an analysis to determine the level of seeker complexity beyond which it is unreasonable to expect that we can continue to home adequately in a self-contained mode, and at which we should rely on external guidance such as PLSS.

(S) 3. Proposed Concepts for Capability Improvement. The proposed concepts herein have been developed as recommendations in the previous section to overcome the deficiencies identified in the charts in Table IV-2-6(e). Our purpose here is to expand briefly the proposed concepts and assess their payoffs, technological implications, technical feasibility, estimated development cost/time and estimated implementation impact. Not all of the recommendations in the previous section will be translated into proposed concepts in this section; rather, we have sifted those recommendations down to a most important set expanded in Table IV-2-7.

TABLE IV-2-7

CONCEPT	PAYOFF	TECHNOLOGICAL IMPLICATIONS AND FEASIBILITY	DEVELOPMENT COST/TIME	IMPLEMENTATION IMPACT
In-theater* rapid reprogamming	Medium	Accelerates transition to software progammability; no question of technical feasibility	$2M/12 months	European Facility
Systems* Approach to Attack	High	Architectural and interoperability implications; no technical feasibility issue	$10M/18 months	Could be tied to All Source Analysis Center and Tactical Fusion Centers
Jamming of Early Warning, Target Assignment, Height Finder Radars	High	Three Options: (1) ALQ-131 expansion in role; (2) Spec. Purp. high power jammer on EF-111; (3) Tactical Emp. of EF-111 in exclusive role 1 and 2 must be judged for technical feasibility	1. $5M/12 months 2. $15M/18 months 3. Zero	Options 1 and 2 affect ongoing programs; weight, volume and power implication big effect on ALQ-131
Install Data Link jammers on EF-111	High	Need recognizers and jammers; Complete development program	$20M/24 months	Will have EMI, weight, volume and power implications on EF-111
Install Data Link Recognizer/ Location capability on PLSS and AGTELIS	High	Complete development program	$20M/24 months	Can be tied to ELS/ CELT programs

*Near Term Item

CONCEPT	PAYOFF	TECHNOLOGICAL IMPLICATIONS AND FEASIBILITY	DEVELOPMENT COST/TIME	IMPLEMENTATION IMPACT
Stop PIP* on QUICK LOOK; add Airborne component to AGTELIS	Medium	No question of technical feasibility	$10M/18 months (Should save money in the long run)	Not significant
Integrate WILD WEASEL and PLSS	Medium/ High	No question of technical feasibility	Minimum (Should save money in the long run)	Not significant

* Near Term Item

(S) 4. Technological Initiatives. On the assumption that we will continue to develop our EW arsenal along the same lines upon which it has been developed in the past, this Task Group suggests that the following compilation be used as a check list against which the technological base programs should be judged:

Receivers:	Super fast scan channelized Receivers Instantaneous Frequency Measurement (IFM)
Processors:	Agile Trackers One Million Pulse/Second Density Processors
Components:	Digital RF Memory Higher Power solid state power sources Electronic Scan Antennas

(U) This Task Group has not reviewed the technological base programs for relevancy to the identified deficiencies; this may be a worthwhile task at some future date. Further, the Task Group has not reviewed broad expansions of the frequency band including optical, laser, and millimeter bands.

(S) III. SUMMARY OF RECOMMENDATIONS (U)

(U) Table IV-3-1 summarizes the various recommendations made by the Task Group in the body of the report and appendices. It is included herein, in a prioritized tabular format and again summarized in terms of near and longer term programmatical impact.

TABLE IV-3-1 - RECOMMENDATIONS

(S) NEAR TERM IMPACT TIME FRAME (U)

PRIORITY	ACTION	BASIS
I	Develop special purpose collection and automatic processor for air defense data links..	Automatic association of COMINT will assist in rapid type classification of air defenses.
I	Emphasize rapid development of FMOP for "Off Line" operation against current radars.	FMOP has enjoyed sufficient success under a variety of conditions to warrant as rapid development as possible. This effort should be aimed at occasional (or off-line) checking for new locations of previously detected radars.
I	Develop a "precise" PRI data base on air defense radars.	The potential, ease of access, low cost and success of this approach in other arenas suggests that it receive careful evaluation. This requires a complete data base.
I	Provide for in-theater reprogramming of critical EW equipment such as RWR, jammers, etc.	It is apparent that the Warsaw Pact can change EW parameters faster than these systems can respond today -- an intolerable and repairable situation since NATO will have survivable collection systems that can observe such changes in near real term.

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PRIORITY	ACTION	BASIS
I	Investigate the applicability of a modified AN-ALP-131 POD to jam LONG TRACK FLAT FACE.	Denial of acquisition radars identified as extremely high priority task.
I	Evaluate the effectivenss and practicality of exclusively utilizing all jamming assets aboard EF-111 to barrage jam all LONG TRACKS/FLAT FACES in the threat area. Consistent with these results, investigate the applicability of a special purpose, high power jammer aboard EF-111 specifically designed to barrage jam the LONG TRACK band in a stand-off mode.	Denial of acquisition radars identified as extremely high priority task.
I	Develop and evaluate air defense peculiar data link detectors and jammers to augment the EF-111 suite.	Denial of critical data link operation can be virtually as effective as denial of the radar acquisition.
I	Rapidly determine if physical basis exists to overcome "scan with compensation" technique used to circumvent angle deception jammers.	Extend useful life of currently deployed angle deception equipment.
II	Support air defense location/movement detection ELINT with SOTAS; add direct communications if required.	SOTAS monitoring of both vehicle movements from air defense sites and antenna motions.

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PRIORITY	ACTION	BASIS
II	Determine need for active probing to activate air defenses and best approach to accomplishment.	Counter EMCON by jamming surveillance radar's or use of penetrating decoys.
II	Continue development of a "channelization" data base.	Although there is no known fundamental reason for the channelization that has been observed, our understanding of Soviet doctrine as well as EMI considerations suggest that this approach be continued.
II	Upgrade APR-38 as used in WILD WEASEL.	Cope with contemporary threats in self contained mode.
II	Analyze reasonable limits of Seeker complexity for ARMs.	Assist in future planning for balance between self guided vs. command guided arm developments.
II	Add GPS or Inverse GPS receivers to airborne ELINT platforms.	Significantly reduce major location error contribution of DOA systems at low cost.
II	Initiate analysis to determine the pulse density and threat sophistication beyond which new radar warning receiver architecture or approaches must be developed.	Future radar agility is tending to make present system architecture cumbersome and expensive.

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PRIORITY	ACTION	BASIS
II	The continued rapid development and deployment of lightweight Army jamming assets is encouraged, e.g., AN/ALQ-136(V)2, ALQ-162, ALQ-XXX).	Army presently has no modern systems available in inventory. May be essential for helicopter operation in the mid 80s.
III	Consider equipping low altitude penetrating aircraft (i.e., F-16, A-10, AAH) with less sophisticated, less expensive radar warning receivers than A/C forced to operate at higher altitude, in a more electronically dense environment.	May be more cost effective.
III	Initiate an analysis to determine the threat sophistication level beyond which deception countermeasures become less attractive than fundamental noise and false target generation.	Increased sophistication of threat radars may cause smart jamming to become overly complex and costly.
III	Continue investigations of RINT--but at a low level.	With only few exceptions, the power level of RINT emission is too low for fingerprinting. It may be sufficient for ARM terminal homing.
I	Urgent determination of integration modes for PLSS/AGTELIS. Recommend joint USAF/USA task team.	Viability of both PLSS and AGTELIS is crucial. Integration can enhance survivability, availability, and capability of both systems.

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PRIORITY	ACTION	BASIS
I	Add a data link recognition and location capability to PLSS and AGTELIS.	There is convincing evidence showing that these links provide highly significant--and largely nonperishable--information that complements the primary PLSS and AGTELIS product.
II	Phase out QUICK LOOK II and TEREC (ALQ-125) in favor of AGTELIS and PLSS. Then evaluate the feasibility and effectiveness of adding airborne elements to AGTELIS.	TDOA systems offer all the advantages of DOA systems plus considerably enhanced accuracy of location and, with respect to these particular programs, earlier IOC. Airborne platforms can extend the range of ABTELIS to 25km beyond the FEBA, a critical area of concern to the division commander. Such platforms would also be consistent with increased interoperability with PLSS.
II	Study the utility of in-flight reprogramming of warning receivers with information from PLSS, thru JTIDS.	The potential to unburden on-board warning receiver processors and hopefully reduce costs/complexity.
III	Study the utility of a distributed aircraft/helicopter warning system, using JTIDS-like communications to pass PLSS/AGTELIS derived threat emitters to involved units.	Potential to further simplify/restrict on-board warning receiver equipments. May not be practical for world-wide use.

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PRIORITY	ACTION	BASIS
III	Provide for use of ASARS to assist in air defense unit characteristics determination or confirmation.	If ASARS on U2R provide 1-2 foot resolution at designated points, configuration recognition may be possible.
III	Provide means to control WILD WEASEL by PLSS.	Use of PLSS guidance will increase WW effectiveness.

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* Priority Explanation

I Essential
II Urgent
III Important

APPENDIX A

(SNF) PROJECTED MANEUVER FORCE AIR DEFENSE CAPABILITIES (U)

TABLE IV-A-1

(SNF) GROUND MANEUVER FORCES - AIR DEFENSE CAPABILITIES FOR 1978 (U)

		GSFG	NGF	CGF	WESTERN MDS.
SA-4					
Army Bn (TEL)		21 (189)	3 (27)	3 (27)	31 (198)
Front Bde (TEL)	(6 Bn)	2 (54)	-----	-----	-------
Natl Bn (TEL [1]/		3 (27)	3 (27)	3 (27)	-------
		29 (270)	6 (54)	6 (54)	31 (198)
SA-6					
Sov Req (TEL)		9 (180)	1 (20)	3 (60)	4 (80) [2]/
Natl Reg (TEL) [1]/		1 (20)	2 (40)	2 (40)	--------
		10 (200)	3 (60)	5 (100)	4 (80)
SA-8					
Sov Reg (TEL)		2 (40)	-----	1 (20)	2 (40) [3]/
SA-9					
Sov Div (TEL)		20 (320)	2 (32)	5 (80)	29 (464)
Natl Divs (TEL)		6 (96)	13 (208)	10 (160)	-------
		26 (416)	15 (240)	15 (240)	29 (464)

1 Table A-14 NSWP DIPP

2 29 Divs in WMDs is 17% of total Sov Force .17 x 21 SA-6 Reg in Sov U = 3.5; SA-6 Reg in WMDs = 4 Reg

3 29 Divs in WMDs is 17% of total Sov Force. 17 x 9 SA-8 Reg in Sov U = 1.5; SA-8 Reg in WMD = 2 Reg

	GSFG	NGF	CGF	WESTERN MDS
S-60 AAA				
Frt Bde/Army AAA Reg (S-60)	2 Bde/6 Reg (264)	1 (24)	2 (72)	----
Reg (S-60)	----	----	----	
Natl Reg (S-60)	3 (72)	10 (240)	7 (126)	
	9 (336)	11 (264)	9 (198)	
ZSU-23-4				
Sov Div (Veh)	20 (320)	2 (32)	5 (80)	31 (496)
	6 (96)	13 (208)		
M-53/59-30 mm (Veh) Natl			10 (300)	
	26 (416)	15 (240)		31 (496)
SA-7				
Sov Div (Gripstock) 2/	20 (3500)	2 (320)	5 (890)	31 (5410)
Natl Div (Gripstock)	6 (432)	13 (936)	10 (720)	
	26 (3932)	15 (1256)	15 (1610)	31 (5410)

1 Continues assumption that Div S-60 will be moved to Front and Army

2 Assumes average TOE from DIPP 144-240 = 348 ÷ 2 = 192 (190) for MRD and 117 + 207 = 324 ÷ 2 = 162 (160)

TABLE IV-A-2

(SNF) GROUND MANEUVER FORCES - AIR DEFENSE CAPABILITIES FOR 1983 (U)

	GSFG	NGF	CGF	WESTERN MDS
SA-4				
Army Bn (TEL)	15 (135)	3 (27)	3 (27)	30 (270)
Front Bde (TEL)	2 (54)	---	---	2 (54)
Natl Bn (TEL) 1/	3 (27)	6 (54)	3 (27)	----
	24 (216)	9 (81)	6 (54)	32 (324)
SA-6				
Sov Reg (TEL)	11 (220)	1 (20)	3 (60)	11 (220)
Natl Reg (TEL) 1/	3 (60)	4 (80)	3 (60)	
	14 (280)	5 (100)	6 (120)	11 (220)
SA-8				
Sov Reg (TEL)	6 (120)	1 (20)	1 (20)	3 (60)
SA-9				
Sov Div (TEL)	20 (320)	2 (32)	5 (80)	31 (496)
Natl Reg (TEL)	6 (96)	13 (208)	10 (160)	----
	26 (416)	15 (240)	15 (240)	31 (496)

1 Assumes smallest # of regiments indicated in 83 column of Table A-14 NSWP DIPP

	GSFG	NGF	CGF	WESTERN MDS
S-60 AAA[1]				
Frt/Army Bde/Reg (S-60)[2]	2Bde/(216) 6Reg	1 (24)	2 (72)	-------
Reg (S-60)	9 (216)	1 (24)	1 (24)	23 (552)
Natl Reg (S-60)	5 (72)	10 (240)	7 (126)	-------
	20 (504)	12 (288)	10 (222)	23 (552)
ZSU-23-4				
Sov Div (Veh)	20 (320)	2 (32)	5 (80)	29 (464)
Natl Div (Veh)	6 (96)			
ZSU-57-2 (Veh) Natl		13 (46)		
M-53/59-30 mm Natl (Veh)			10 (300)	
	26 (410)			
SA-7				
Sov Div (Gripstock)	20 (2610)	2 (234)	5 (664)	29 (3798)
Natl Div (Gripstock)	6 (288)	13 (624)	10 (480)	

1 Based on TOE count minus divisions with SA-6/SA-8.

2 Assumes divisional S-60 replaced by SA-6 or SA-8 have been moved to Front/Army as independent AAA regiments of 36 guns each.

TABLE IV-A-3

(SNF) GROUND MANEUVER FORCES - AIR DEFENSE CAPABILITIES FOR 1993 (U)

	GSFG	NGF	CGF	WESTERN MDS
SA-4				
Army Bn (TEL)	15 (135)	3 (27)	3 (27)	30 (270)
Front Bde (TEL)	2 (54)	------	------	2 (54)
Natl Bn (TEL) 4/	6 (54)	9 (81)	6 (54)	------
	27 (243)	12 (108)	9 (81)	32 (324)
SA-6				
Sov Reg (TEL)	11 (220)	1 (20)	3 (60)	11 (220) 1/
Natl Reg (TEL) 4/	6 (120)	8 (160)	4 (80)	
	17 (340)	9 (180)	7 (140)	11 (220)
SA-8				
Sov Reg (TEL)	9 (180)	1 (20)	1 (20)	4 (80) 2/
SA-9				
Sov Div (TEL)	20 (320)	2 (32)	5 (80)	31 (496)
Natl Div (TEL) 3/	6 (96)	13 (208)	10 (160)	------

1 Assumes continued deployment of 2 reg per year through 93. Will probably be SA-6 follow-on, SA-X-11.

2 Assumes continued deployment of 2 reg per year through 93.

3 NSWP DIPP Table A-1.

4 Assumes largest number of reg indicated for 87 column on Table A-14.

APPENDIX B

(SNF) USE OF IMAGERY FOR AFFILIATION (U)

(SNF) USE OF IMAGERY FOR AFFILIATION (U)

(SNF) 1. Soviet AD organizations assigned to front and lower units have a certain commonality of equipment in command and control activities which will identify Brigade, Regimental and Battalion headquarters. Resolution of imagery utilized for identification must be able to distinguish major pieces of equipment, possibly as low as 3 feet. Table IV-B-1 shows the major equipment associated with each headquarters. Utilizing box bodied vehicles as identification indicators

TABLE IV-B-1 (S) HEADQUARTERS UNIT EQUIPMENT RELATIONSHIP (U)

HQ UNIT	LONG TRACK	THIN SKIN B	FLAT FACE	URAL 375 C&C	GAU 1	GAU 2	GAU 3	4
SA-4 Bde	2	1	0	1	0	1	1	1
SA-4 Bn	1	0	0	0	1	1	1	0
SA-8 Rgt	1	1	1	1	0	0	0	1
SA-6 Rgt	2	1	0	1	0	0	0	1
S-60 Gun (Div)	0	0	2	0	0	0	0	0
S-60 Gun (Army)	0	0	3	0	0	0	0	0

appears to be valid as the GAU series of vehicles are similar in configuration to other electronic associated box bodied vehicles. The presence of the URAL-375, 6x6, command and control vehicle will, if distinguishable, add creditability to the location of the SAM headquarters.

(S) a. The association of two LONG TRACK and one THIN SKIN B radars will indicate a SA-4 Brigade or a SA-6 Regimental headquarters. The absence of additional radars within a 350 meter diameter will eliminate the possibility that this sighting is that of an early warning radar site.

(S) b. The presence of a single LONG TRACK without other radars, and three box bodied vehicles (i.e., GAU 1, 2 and 3) in close proximity indicates the signature of a SA-4 Battalion headquarters. Three SA-4 fire units (Batteries) should be located 1-2 kilometers away.

(S) c. The SA-8 Regimental headquarters is unique in that its signature consists of a LONG TRACK radar, a new FLAT FACE variant radar, and a THIN SKIN B height finder radar. The use of the LONG TRACK and FLAT FACE variant, in the absence of other early warning and acquisition radars will be the key to identification.

(S) d. The presence of two FLAT FACE radars in close proximity of each other, without other radars being present is a high indicator for a Motorized Rifle or tank division S-60, 57mm AA gun Regimental headquarters. The S-60, 57mm AA gun Regimental headquarters assigned to an Army or Front are believed to have three FLAT FACE radars assigned. The field configuration of the Army and Front subordinated AA gun Regimental headquarters is not known at the present time.

(S) e. An additional key to SAM and AA headquarters subordination will be their deployment distances of the radars from the FEBA. Table IV-B-2 shows this relationship. This Table is a guide, as units will be deployed in accordance with the tactical situation.

TABLE IV-B-2 (S) LOCATION OF HEADQUARTERS FROM FEBA (U)

HQ UNIT	LOCATION FROM FEBA			
	OFFENSE		DEFENSE	
SA-4 Bde	18-70km	(40)*	45-95km	(70)*
SA-4 Bn	10-50km	(25)*	35-75km	(50)*
SA-8 Rgt	5-21km	(20)*	5-21km	(20)*
SA-6 Rgt	20-25km	(20)*	25-35km	(30)*
S-60 Gun (Div)	15-20km	(20)*	15-20km	(20)*
S-60 Gun (Army)	Unknown		Unknown	

*Optimum location

(U) 2. SAM and AA fire units will be more difficult to identify due to their mobility, which is their key to survivability. Each fire unit has system peculiar equipment with separate configurations.

(S) a. The SA-4 fire unit (Battery), consists of a full tracked PAT HAND fire control radar and three full tracked SA-4/GANEF TELs carrying two missiles on each. The three TELs will be pointing towards the direction of perceived threat, with the PAT HAND radar located up to 140 meters in the rear. The FIRE UNIT location will be an open area, clear of obstructions, with radar line of sight to the target and adequate room to launch the missiles. Field positions will initially be hastily prepared with berms and other improvements added with time. The most prominent identification feature of this fire unit will be the PAT HAND radar. The SA-4/GANEF vehicle chassis has been adapted to form the basic chassis for the armored mine layer and 152mm SP howitzer, both subordinate to divisions. Photo interpreter keys should be used to avoid confusion between the SA-4 TEL and other adapted chassis. The SA-4 wheeled transloader, on a URAL-375, 6x6 truck chassis, will provide an additional significant signature item within the fire unit area.

(S) b. The SA-6 fire unit (Battery) consists of a STRAIGHT FLUSH acquisition and fire control radar on a full track chassis. Four TELs of the SA-6/GASKIN system are also on a full track chassis and each mount three GAINFUL missiles. It is possible to confuse the canvas covered SA-6 TEL with the ZSU-23-4. The most prominent identification feature will be the STRAIGHT FLUSH radar. The SA-6 transloader, on a ZIL-131, 6x6, truck chassis has a unique rear mounted crane which will serve as an additional identification item.

(S) c. The SA-8 fire unit vehicle provides the most unique identification feature on the battlefield. The four SA-8 fire unit vehicles in a battery are mounted on an unusual amphibious wheeled 6x6 vehicle with three axles evenly spaced and acquisition, fire control, and launchers mounted on top. The transloader vehicle uses the same chassis except it has missile storage on top. This unusual vehicle, used as the basic chassis for the SA-8 battery components will provide a positive

identification of this unit on the battlefield. The BTR-60PA command and control vehicle is common to other combat units and will not provide a positive unit identification by itself. The only other known combat system presently in Soviet inventory utilizing the SA-8 6x6, three axle vehicle is the SS-21 missile, which is expected to be on the battlefield during this time period under consideration.

(S) d. The ZSU-23-4 SHILKA self-propelled anti-aircraft gun system will be difficult to spot on the battlefield. This weapon, four of which are organic to each motorized rifle and tank Regiment, will be in close proximity of other tracked and/or wheeled vehicles. The full tracked basic chassis, mounting a rotating turret, is capabile of firing at aircraft while on the move. The key identification feature of the ZSU-23-4 will be its GUN DISH radar, when it is erected, on top of the turret. Normal unit integrity of four vehicles in close proximity, with a normal interval of 150-250 meters between vehicles will be maintained. Two ZSU-23-4 configurations may be encountered. The four companion SA-9/GASKIN vehicles will be located about 1.5 to 3 kilometers behind the ZSU-23-4s. The SA-9 vehicle will be easily confused with similarly configured BRDM-2rkh and BRDM-2/AT-5 vehicles which will also be present on the battlefield. The BTR-60PA command and control vehicle is common to other combat units and will not provide a positive unit identification by itself. The ZSU-23-4 ammunition reload vehicle is based on a ZIL-131, 6x6 cargo truck, common item, and thus will not help in identification.

(S) e. The S-60, 57mm AA gun battery is organized with six towed guns and a FLAP WHEEL fire control radar. In march column the guns are normally towed by URAL-375, 6x6, cargo trucks with the FLAP WHEEL and mess vehicle bringing up the line. In the tactical configuration the six guns are normally arranged in a circle, with a maximum radius of 50 meters (cable limited) and the FLAP WHEEL radar displaced up to 500 meters from battery center. The FLAP WHEEL radar must be located in a position which is not more than 300 meters higher or 300 meters lower than the gun positions. The battery is capable of displacement in three gun echelons.

(S) f. Additional aid to subordination will be the location of the fire unit from the FEBA. Table IV-B-3 shows the relationship of each fire unit, however, this figure by itself will not prove positive subordination, and is presented here only as a guide.

TABLE IV-B-3 (S) LOCATION OF FIRE UNITS FROM FEBA (U)

	LOCATION FROM FEBA	
UNIT	OFFENSE	DEFENSE
SA-4 Btry	10-50 km (25)*	35-75km (50)*
SA-6 Btry	2-5km (3)*	5-16km (10)*
SA-8 Fire Unit	3-5km (4)*	3-5km (4)*
ZSU-23-4 Veh	.4-.5km (.4)*	1.5-2km (1.5)*
S-60 Btry	10-20km (10)*	10-20km (10)*

*Optimum Location

APPENDIX C

(S) UNINTENTIONAL EMISSIONS (FMOP and RINT) (U)

(S) FMOP is based on the premise that the time varying instantaneous frequency (FM) of a radar pulse is stable and unique to the particular radar. If the premise is true and if the FM waveform can be measured with sufficient accuracy, the technique can be usefully applied to certain areas of EW, as noted in the body of the report. Information to date suggests that the uniqueness is related to certain fundamental components of the radars, particularly to the power amplifier tube and PFN, rather than easily adjusted parameters such RF, PRF, etc.* Magnetron driven radars seem to be particularly vulnerable to FMOP identification, while other radars driven by TWTS or klystrons have, in fact, received little investigation. Obviously, FMOP identification of such radars deserves study.

(S) Of special interest is the fact that the FMOP is generally independent of operator adjustments. Tests indicate specifically that there is no significant change in the FMOP waveform with change in PRF. Tests have also been made with respect to operator adjustments to RF operating frequency, scan rate and pulse width with minimal effect on FM waveform. This is important since we are virtually certain that when war starts, the enemy will modify his operating parameters sufficiently to confuse standard emitter characteristics wherever possible. In practically all cases, FMOP could be uniquely associated with the radar in spite of these changes.

(S) Maintenance changes have been investigated by HRB Singer include the following:

a. Pulse forming network exchange.

b. Magnetron exchange.

* Recent work at RAND, not reviewed by this group, suggests that significant FM variation may occur as a function of antenna angle. Clearly, the allegation should be investigated.

c. Pulse transformer replacement.

d. Trigger thyratron interchange.

e. High voltage power supply exchange/ adjustment.

f. RF match adjustment.

g. Antenna change.

The first two of these, which are rather significant changes to the transmitter itself, produce significant changes in the FM signature. That is, given two transmitters of the same type with different FM waveforms, if both the pulse forming network and the magnetron were exchanged between the two radars, the FM signature from the first would appear at the second and vice versa. This test was actually conducted using the Army developed RSS (Radar Signal Sorter) system at Eglin AFB, Florida, and subsequently at the Naval Post Graduate School, Monterey, California, under Air Force sponsorship. As part of the same investigation, the rest of the items on this list were also investigated. The results show that changes in these devices, without changing the normal operation of the transmitter, do not effect FM waveform perceptably. Included in the antenna change, the last item on the list are cable length changes, polarization changes, and even intestigation of the main-lobe versus a back-lobe on the antenna. As long as the waveform could be identified - that is, as long as the receiver was capable of detecting the signal clearly - the waveform could be associated uniquely.

(S) FMOP should not be confused with unintentional emissions that are not directly associated with band pass modulations of the carrier frequency. Emissions outside the band pass (RINT) appear to be far too low for useful fingerprinting, whereas the energy contained in the unintentional modulations in the band pass (FMOP) are only 15 to 25 dB down from the total energy in the pulse.

(S) The essence of the concept is to convert the FM waveform to the Fourier domain using the FFT technique at sampling rates consistent with the pulse width and the desires to extract over 10 Fourier coefficients for each pulse. It appears that these coefficients, after suitable rotation in the complex plane to compensate for variation in sampling start time and when subjected to standard statistical analyses, provide (in many cases) a unique description of a particular radar. Subsequent measurement and comparison (presumably in less than 24 hours) of new coefficients to a library of coefficients should provide either (a) identification, or (b) recognition that an identification cannot be made, i.e., a false identification can often be avoided by (automatic) recognition that the uniqueness of the coefficients is insufficient for identification.

(S) Multipath could reduce the effectiveness of FMOP by distorting the received radar pulse. The effect has not been overly serious in past measurements, but additional study of multipath effects in a PLSS deployment in Europe should be made. Because it appears that the grazing angle for PLSS reception of the radar pulse is greater than 5° and because much of the FMOP information is contained in the leading edge of the pulse, it is anticipated that multipath distortion will not impose serious limitations. Figure IV-C-1 illustrates this pcint and is based on tests made by AIL.

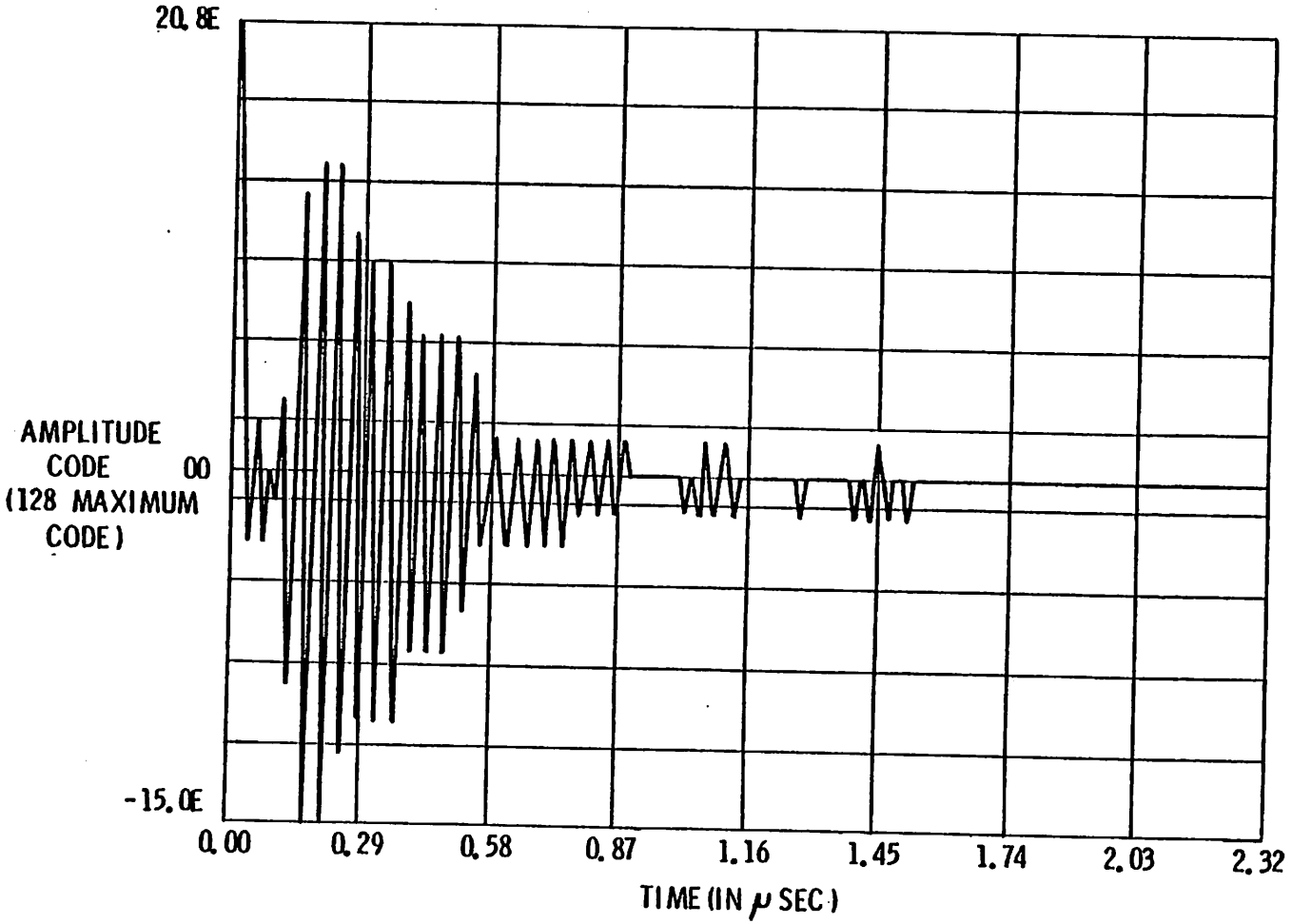
(S) The emperical evidence is encouraging. Bunker Ramo equipment has identified (84 to 100% of the time) particular US and Soviet radars during peripheral reconnaissance in various parts of the world. A representative number of FMOP unique signatures obtained in these tests is shown in Figure IV-C-2. Each of the six diagrams shown is a copy of what is displayed on the monitor scope. Comparison of the displays with respect to the AM, FM, and in particular, the coefficients of the FM pulse, serve to illustrate the unique signature obrained for each of the six radars intercepted and results obtainable by application of the FMOP technique.

(U) While there is much to be learned before operational equipment can be deployed, support in the 6.3 category at the $1-2M a year level appears justified. Unit cost has been estimated at less that $100K.

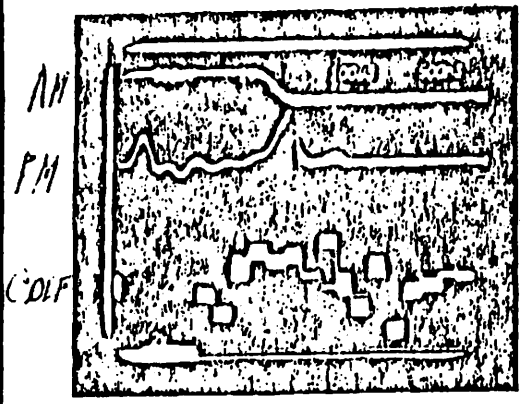
FIGURE IV-C-1

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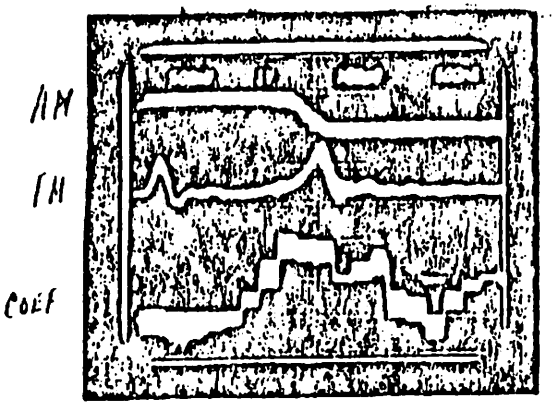
RECONSTRUCTED IF (PRE-DETECTION) INCLUDING TYPICAL MULTI-PATH EFFECTS



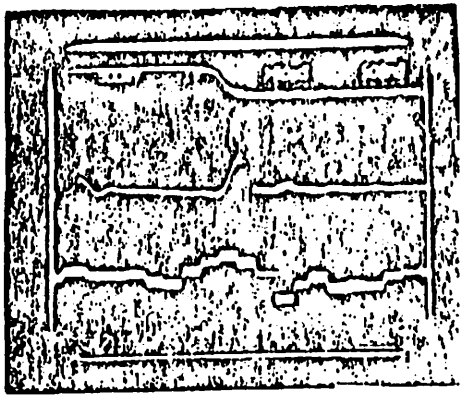
UNCLASSIFIED



KASHIN 514

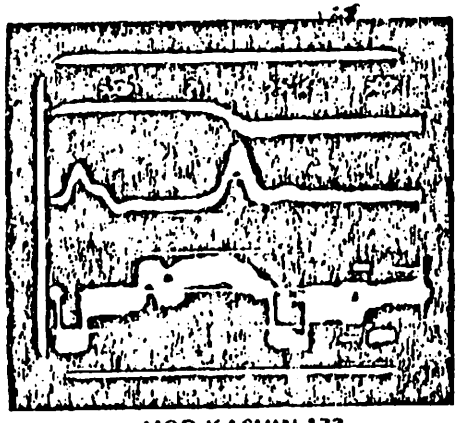


KRIVAK 203

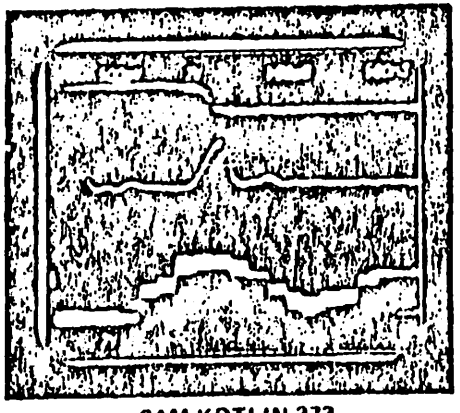


KRIVAK 502

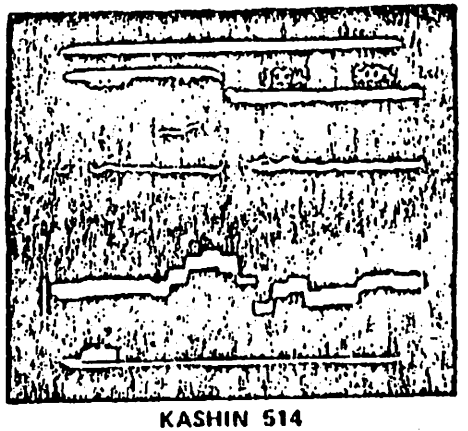
TEST DATA—UNIQUE EMITTER IDENTIFICATION BY FMOP



MOD KASHIN 173



SAM KOTLIN 373



KASHIN 514
KRIVAK 502

FIGURE IV-C-2

(BR)

APPENDIX D

REFERENCES

IV. (U) REFERENCES

1. DST-1170R-395-77-SI-SPR 4 SA-4 and SA-6 Command and Control Technical Vulnerability (U); DIA (MIA) December 1977.

2. DN-TCS-G-1001/78 Intelligence Capabilities for Theater Nuclear Warfare in Europe (U) (Review Draft); Defense Nuclear Agency January 1978.

3. Electronic Warfare Management Agility Task Force Minutes (U); HQ USAF Systems Command 8 December 1977.

4. "HYDRA", A Handbook on Soviet Ground Based Air Defense Systems (U); HQ USAFTAC/USATRADOC 15 June 1977.

5. Reconnaissance Mission Area Analysis (U); HQ USAFTAC/ USATRADOC 15 December 1977.

6. Defense Suppression Mission Area Analysis Threat Assessment (U) HQ USAFTAC/USATRADOC 15 December 1977.

7. DST-1060S-414-76 Soviet SA-4 Surface to Air Missile Systems (U); DIA (MIA) September 1976.

8. DST-1060S-307-76/77 SA-6 Surface to Air Missile System (U) Volumes 1-3; DIA (MIA) July 1976-January 1978.

9. DST-1060S-391-77 Soviet SA-8 Surface to Air Missile System (U); DIA (MIA) August 1977.

10. Defence Science Board Summer Study on Approaches to the Countering of Warsaw Pact Command, Control and Communications Systems (C^3), Vol III, December 1977.

11. Air Force/Army Reconnaissance Force Study, 1 December 1977.

ANNEX A

STUDY PARTICIPANTS

ANNEX A
STUDY PARTICIPANTS

Since this Summer Study was a joint activity of the Army Science Board and the Air Force Scientific Advisory Board, the participants and leadership for the study were originally selected from the two boards. To maintain the needed balance in perspective, the study was directed by co-chairmen -- one from each board. Each of the four Task Groups were similarly balanced between the boards, with each having a balance in chariman and vice-chairman assigments and in group membership. To this base were added a number of senior knowledgeable individuals from both Services -- civilian and military -- to provide the needed liaison, operationally-oriented experience, etc.

The final configuration of the study organization is shown in Table 1. The Steering Group was established to provide overall initial direction and progress reviews to the study and was ably assisted by the senior Service personnel listed for the Advisory Committee. In particular, the general officer participants on the Steering Group, Major General Dickinson and Major General Leaf, were of great value in attempting to vector the studies toward targets of practical value. Each Task Group Board membership was also supplemented by the Service personnel shown. All of the personnel listed spent a substantial amount of preparatory effort prior to the actual two-week study and made strong contributions to the final output of the study.

Table 2 lists other personnel who provided substantial additional inputs to the study, either to individual Task Groups or at an overview level.

TABLE 1

ASB - SAB SUMMER STUDY

ADMINISTRATION

COL McNutt, SAB
LTC Dunderville, SAB
LTC Sweeney, ASB
MAJ DeBerg, SAB
MAJ Jenne, SAB
CPT Beam, SAB
Mrs. Amundson, ASB
Ms. Barrett, SAB
Mrs. Lackey, SAB
Ms. Pernat, SAB
Mrs. Pipon, ASB
Ms. Thomas, ASB

CO-CHAIRMEN

Mr. Lockerd, ASB
Mr. Greene, SAB

STEERING COMMITTEE

Mr. Greene, SAB
Mr. Lockerd, ASB
MG Dickinson, GO Participant
MG Leaf, GO Participant
Dr. Naka, SAB
Dr. Yang, ASB

ADVISORY COMMITTEE

Dr. Kahal, SAF/ALR
Mr. Friedrich, OASA(RDA)
Dr. Lasser, ODCSRDA
Mr. Christman, TRADOC
COL Corum, TAC/DRC
Mr. Trask, AFTEC/XRH

TASK GROUP I
AIR DEFENSE

Dr. Stear, Chairman SAB
Dr. Yaru, Vice-Chairman ASB
Dr. Davis SAB
Mr. Holter SAB
Dr. Hundley ASB
Dr. Honey ASB

Mr. Pfeiffer
Army Tech Member
COL Rhinehart
TRADOC Member

COL Gillette
TAC Member
MAJ Oakes
AFTEC

TASK GROUP II
FIRE SUPPORT

LTG Kent, Chairman
Dr. Fried, Vice-Chairman
Dr. Blair
Dr. DePoy
Dr. McMillan
Dr. Renier
Mr. Everett
Dr. Gibson

Mr. Gale
Army Tech Member
COL Donohue
TRADOC Member

MAJ May
TAC Member
LTC Hegstrom
AFTEC

TASK GROUP III
C3 INTERDICTION

Mr. Shore, Chairman
Dr. Flax, Vice-Chairman
Dr. Braddock
Dr. DeBra
Dr. Tooley
Dr. Ware

Dr. Wiseman
Army Tech Member
COL Bindrup
TRADOC Member

LTC Tatum
TAC Member
MAJ Richards
AFTEC

TASK GROUP IV
AIR DEFENSE EXT

Mr. Kresa, Chairman
Dr. Naka, Vice-Chairman
Dr. Montgomery
Mr. Simon
Dr. Smith

Mr. Speakman
Army Tech Member
COL Koenig
TRADOC Member

COL Barrows
TAC Member
LTC Davis
AFTEC

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TABLE 2
ADDITIONAL PARTICIPANTS

Dr. Starr, IDA
Mr. Muehe, MIT Lincoln Lab
LTC Bender, USAFE
CW4 LeGere
Mr. Kennedy, ITT
COL Gagen, USMC
MAJ Ryan, USMC
LTC Mellon, ODCSRDA
COL Gorman, V Corps
COL Bryan, V Corps
LTC Hertel, V Corps
Dr. Mirman, STC
Mr. Fowler, MITRE
Mr. Dudley, NSA
LTC Cheney, PLSS PMO
Mr. Rueck, NSA
Mr. Hall, Bunker-Ramo
Mr. Schwartz, Loral
Mr. Larocca, Dalmo Victor
CPT Ritter, TAWC
MAJ Niebauer, Andrews AFB
Mr. Stephenson, ERADCOM
Mr. Giordano, ERADCOM
MAJ Cook, Field Station Berlin
Mr. Neighbors, Hughes

ANNEX B

BRIEFINGS AND DISCUSSIONS IN PREPARATION FOR THE JOINT SUMMER STUDY

ANNEX B
BRIEFINGS AND DISCUSSIONS IN PREPARATION FOR THE JOINT SUMMER STUDY

Members of the Joint Summer Study received a number of briefings and participated in various technical discussions to obtain background and detailed technical information pertaining to the study. A subset of the Study Group made a five-day visit to major U.S. Command Headquarters in West Germany to become familiar with the perceptions of the commanders and staffs currently most directly concerned with the topics addressed in the Study.

This Annex lists the briefings and discussions attended by Members of the Study Group and presents a brief report on the European visit.

FULL SUMMER STUDY BOARD MEETING

BRIEFERS

NAME	ORGANI-ZATION	TOPIC	DATE/PLACE OF BRIEFING
LTC Muschek	DLA	Threat in Central Europe	13-14 April, Pentagon
MAJ Tash	AF/XO	AF Checkmate	" "
MAJ Downer	AF/XO	Force Structure for late 1980's	" "
MAJ Barber	AF/RD	AF R&D Programs	"
LTC Martin	Army/ ODCSOPS	Army Concepts of Ops to counter the Pact Threat	" "
LTC Hoaas	Army/ ODCSOPS	US Army in 1988	" "

EXECUTIVE COMMITTEE MEETING

24 May 1978
Pentagon

No briefings held; planning session only

ATTENDEES:

Mr. Lockerd
Mr. Greene
Mr. Kresa
Dr. Stear
Mr. Shore
LTG Kent

MG Dickinson
Mr. Pfeiffer
Mr. Christman
COL Curry
Mr. Trask
COL Bryant
COL Corum

Dr.Yang
Dr. Naka
Dr. Kahal
Mr.Friedrich
COL McNutt
LTC Sweeney
CPT Beam

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SEMINARS HELD DURING THE SUMMER STUDY

Optional seminars on five topics of general relevance to the Summer Study were held after regular working hours at the US Air Force Academy. Speakers and topics are listed below.

Monday, July 17: Dr. Braddock, Soviet Military Operations

Wednesday, July 19: Dr. McMillan, The Battle of Kursk and Passive Defense

Monday, July 24: Mr. Greene, Attack Helicopter Operations; AWACS Testing

Tuesday, July 25: Mr. Greene, Dr. Braddock, Theater Nuclear Warfare Issues

Wednesday, July 26: Ms. Hoeber, Soviet Chemical Warfare

TASK GROUP I AIR DEFENSE

BRIEFERS

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
Cpt Baker	USAADS	Concept Paper,IFF	18-19 May, Ft Bliss,TX
Col Evans/Mr Grossman	USACSTAL	Materiel Dev,IFF & CS&TA LAB	" "
Maj Heebner	USAADS	AWACS/ADA Interoperability	" "
Maj Humphrey	USAADS	DADS-C^2	" "
Maj Jellett	USAADS	Army AD Systems	" "
Col Lawrence	USAADS	Tng Dev Overview	" "
Mr LoPresti/Cpt Scanlon	USAADS	Stand Off Jammer Killer	" "
Maj Moriarity	USAADS	C&C in NATO	" "
Cpt Morreale	USAADS	AD Doctrine & Air Space Mgt	" "
Maj Sewell/Cpt Knox	USAADS	Threat	" "
Dr Starr	IDA	C&C & How it Impacts	15-16 Jun, Pentagon
		Utilization of AD Resources; Evolution	" "
		of IFF; Major Issues of IFF	" "
Col Gillett	TAC	Role of CRC; Current of Engagement	" "
Maj Sakahara	AF/XOORT	Future ROE	" "
Maj Bourgies	AF/XOOIC	TACS/TADS	" "
Mr Robertson	TAFIG	TADIL-A&B	" "
Cpt Parkhill	AF/XOOIC	SALTY NET	" "
Mr Lidy	PLRS PMO	PLRS	" "
Mr Ellingson	MITRE	JTIDS	" "
Mr Greinkel	OSD	DSB Thoughts of AD/IFF	" "
Maj Pearce	AF/XOOIC	AWACS-Overview of Operl Procedures & Capabilities	" "
Cpt Lafamme	AF/RDPV	Non-Coop IFF	" "
Lt Col Carr	DAMO-TCD	JINTACCS	" "
*Dr Varona/Mr Tross/ Mr Boyd	DIA	Jet Engine Modulation	22 Jun, Pentagon
**Dr Singer	Hughes	PLRS/JTIDS	27 Jun, Pentagon
***Mr Bishop	NRL	Deficiencies & Future of Mark XII	10 Jul, Pentagon
Maj Humphrey	USAADS	DADS C^2	12 Jul, Pentagon

Maj Adams	ESD	Future ID Sys	12 Jul,	Pentagon
Mr Micol	ESD	"	"	"
Mr Boatman	ESD	"	"	"
Mr Barthel	ASD/XRE	"	"	"
Mr McKee	RADC/OCT	"	"	"
Mr Keller		Future NATO IFF	"	"
Mr Barley	MIRADCOM	Missile Millimeter Wave Tech	17-28 Jul,	USAFA
Mr Blanton	MIRADCOM	"	"	"
Mr Gould	FTD	Foreign IFF	"	"

*Only Mr. Holter received this briefing
**Only Dr. Davis and Mr. Holter received this briefing
***Only Dr. Davis and Dr. Honey received this briefing

TASK GROUP II FIRE SUPPORT

BRIEFERS

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
Dr. Dickinson	HDL	BETA	2 May Pentagon
Mr. Anderson	Hughes Fullerton	PLRS	" "
Mr. Entzminger	Rome Air Dev Cen/AFSC	Tgt Tck Wpn Guidance	" "
CPT Conroy	AF/TFWC	Offset Beacon Bombing	" "
COL Donohue	USAFACFS	FIST/FAC Ops	" "
Mr. Ellingson	MITRE	Common Elect Bombing	6 Jun Pentagon
COL Morgan	PM PLRS/ JTIDS	Common Elect Bombing	" "
COL Donohue	USAFACFS	Allocation & Engagement Proc	*22 Jun Ft Sill
Mr. Gale	ODCSRDA	Army Arch Studies	10 Jul Pentagon
COL Gagen/ MAJ Ryan	USMC	CAS	17-28 Jul USAFA
LTC Foley	TAC	FAC Ops	" "
LTC Mellon	ODCSRDA	AAH	" "

*Dr. Blair and Dr. Fried only

TASK GROUP III. C^3 INTERDICTION

BRIEFERS

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
Mr. Fowler	MITRE	DSB C-C^3 Summer Study	22-23 Jun Pentagon
MAJ Allman	DIA	Threat	" "
MAJ Grimes	ATSI-CS	Cmd Post Templating & European Demo	" "
Mr. Hayden	Sig War Lab	Current Army Assets	" "
COL Rhude	ESD	Countermission Analysis	" "
Mr. Stiglitz	MIT Lin Lab	CW Emitters	17-28 Jul USAFA
COL Riley	ESD	OASIS	" "
CPT Batie/ LTC Cheney/ Mr. Manard/ LTC Aube/ Mr. Haywood	PLSS PMO	PLSS	" "
CPT Barrazzatto	RPV PMO	RPV's	" "
LTC Russell	TACATA	TACATA	" "
Dr. Dickinson	HDL	BETA	" "
Dr. Starr	IDA	Need for IFF	" "

TASK GROUP IV. AIR DEFENSE EWI

BRIEFERS

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
LTC Nunn	DARCOM	Current cap to Identify SAM/AAA Emitters	17-18 May Pentagon
Mr. Taylor/ Mr. Allen	RDA TRW	Dev & Concepts Applic to Identifying Emitters (non-government)	" "
LTC Bannach	RDQM	TEREC	" "
LTC Frasher	RDPV	PLSS	" "
LTC Musak/ MAJ Bennet	DIA	Update of AD Threat	" "
Mr. Amato/ Mr. Reuck	NSA	Natl SIGINT Data Base Support to Tactical Ops	" "
Dr. Dickinson	HDL	BETA	" "
COL Federhen/ Dr. Foley	ARPA PAR	Emitter Identification	" "
Mr. Reuck	NSA	Expanded NSA Brf on SIGINT Data Base	19-20 Jun LA, CA
LTC Cheney	AFSC	PLSS	" "
Mr. Upton	USAADS	US AD Sys (OR)	" "
Mr. Sowell	Ft Hood	ELING Processor	" "
CPT Ritter	USAFTAWC	EW Reprograming	" "
MAJ Monteith	NSA	RUFFER	" "

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
Dr. Ewell	Ga Tech	RINT	19-20 Jun LA, CA
MAJ Kawski	AFSC	HAVE GLIB	" "
Mr. Colby	Lockheed	RPV's	17-28 Jul USAFA
CPT Batie/ LTC Cheney/ Mr. Manard	AFSC	PLSS	" "
LTC Russell	TACATA	TACATA	" "
Mr. Rueck	NSA	PLSS	" "
Mr. Shilkoff/ Mr. Wanty/ Mr. Melton Mr. Newberg	AIL	PLSS	" "
Dr. Foley/ Mr. Breda	PAR	PLSS	" "
Mr. Hall/ Mr. Nichols	Bunker-Ramo	PLSS	" "
Mr. Wood	AGTELIS PMO	AGTELIS	" "
Mr. Schwartz	LORAL	EW Reprograming	" "
Mr. Larocca/ Mr. Burkdall	Dalmo-Victor	EW Reprograming	" "
CPT Ritter	TAWC	EW Reprograming	" "
MAJ Cook	Fld Sta Berlin	SIGINT	" "
Mr. McFolin	Dalmo-Victor	EW Reprograming	" "

EUROPEAN FACT-FINDING TRIP

As the initial study activities proceeded through May 1978, it was recognized by members of the Steering Committee that exposure to the "real world" European environment would be of great benefit to the work of all Task Groups. Accordingly, a European fact-finding trip was set up, with the agenda shown in Table 1. The membership of the team making the trip was initially intended to include the chairman of each Task Group plus the study cochairman; and was finalized as shown in Table 2 after accommodating the short-notice availability of those concerned.

The major thrust of the trip was to allow each Task Group representative to collect needed inputs on current practices and requirements. To this end, the group received a minimum of "pre-packaged" briefings; and usually separated into working groups centered around the Task areas. Typically, the team left behind written question lists for later written reply by each hosting function. Informal discussions were also scheduled with the local commanders to obtain the command perspective; including very produtive sessions with GEN Blanchard at USAREUR, GEN Pauly at USAFE and GEN Heiser at EUCOM.

At the conclusion of this trip, the two study co-chairmen summarized their predominant impressions obtained from all the sources contacted, as shown in Table 3.

TABLE 1

EUROPEAN FACT-FINDING TRIP
ITINERARY

28 JUNE 1978	HQ USA V CORPS - HQ 3 AD	FRANKFURT DRAKE KASERNE
27 JUNE 1978	HQ USA - EUROPE	HEIDELBERG
28, 29 JUNE 1978	HQ USAF - EUROPE	RAMSTEIN AFB
30 JUNE 1978	HQ EUROPEAN COMMAND	STUTTGART
28, 29 JUNE 1978*	FIELD STATION	BERLIN

*SHORE, SMITH ONLY

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TABLE 2

EUROPEAN FACT-FINDING TRIP
TRAVELING TEAM

TERRY GREENE	SUMMER STUDY CHAIRMAN - SAB	
MIKE LOCKERD	SUMMER STUDY CHAIRMAN - ASB	
ED STEAR	CHAIRMAN - GROUP I	AIR DEFENSE
DAVE FRIED	VICE CHAIRMAN - GROUP II	CLOSE SUPPORT
DAVE SHORE*	CHAIRMAN - GROUP III	C^2 INTERDICTION
HAROLD SMITH	MEMBER - GROUP IV	RED AD
DICK TRASK	USAF TEC REPRESENTATIVE	
COL GLEN McNUTT	USAF SAB SECRETARIAT	
LTC LLOYD LANGSTON	USAF TAC REPRESENTATIVE	

*SPECIAL ITINERARY

TABLE 3

(C) EUROPEAN FACT-FINDING TRIP
KEY IMPRESSIONS (U)

GOOD ATTENTION ON MANY ASPECTS OF "REAL-WORLD" CAPABILITY IMPROVEMENT, E.G.:

- DALFA (DIRECTORATE OF AIR/LAND FORCE APPLICATIONS
- CENTER CHASE

MANY REMAINING SERIOUS, POTENTIALLY CRIPPLING PROBLEMS

- SURVIVABILITY OF BLUE C^2 IN INTENSE WAR
- LACK OF ADEQUATE IFF (GROUND-TO-AIR) - QUALITY AND QUANTITY
- LACK OF ADEQUATE TACTICAL COMMUNICATION
  - AJ CAPABLE
  - SECURE
  - DATA CAPABLE
- POSSIBLE LOSS OF FEBA-ZONE AIR SUPERIORITY
  - AD SUPPRESSION CAPABILITY
  - BLUE AIR SELF PROTECTION
  - AIR-TO-AIR VS ROTARY WING
- LACK OF COUNTER - C^2/C^3 CAPABILITY
  - PRIORITY AND DOCTRINE
  - ABILITY FOR (QUALITATIVE OR QUANTITATIVE)
- LACK OF REAL PLANS FOR USE OF NEW SYSTEMS, E.G.:
  - LASER DESIGNATED ORDNANCE
  - PATRIOT SYSTEM
  - ETC.

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EUROPE TRIP

BRIEFERS

NAME	ORGANIZATION	TOPIC	DATE/PLACE OF BRIEFING
Gen Berry/ COL Winn/ COL Stewart/ COL Gorman COL Bryan/ LTC Hertel	V Corps	V Corps Defense Plan; discussion of all study topics	26 Jun Frankfurt
LTC Sheridan/ LTC Swindells	3rd Armored Division	CAS Ops Div AD Ops	" "
Gen Blanchard/ MG Duqueman/ Staff Members	HQ USAREUR	USAREUR Org & mission; discussion of all study topics	27 Jun Heidelberg
COL Cottingham/ LTC Tutless/ Staff Members	32nd ADCOM DALFA	DALFA	" "
LTG Pauley/ MG Clement/ Staff Members	HQ USAFE	Detailed brfing & discussions on all study topics; brfings & disc at COIC	28-29 Jun Ramstein
LTG Heyser/ Staff Members	HQ EUCOM	Informal Brfings by Mr. Lockerd & Mr. Greene; discussions of study topics with staff	30 Jun Stuttgart
MAJ Cook	Fld Station Berlin	SIGINT	29 Jun Berlin*

*Dr. Smith and Mr. Shore only.

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ANNEX C

STUDY CHARTER AND STUDY PLANS

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ANNEX C
STUDY CHARTER AND STUDY PLANS

The four study topics as defined jointly by TAC and TRADOC are presented in this Annex. Following these task statements, the study plans developed jointly by the four Working Groups and the Executive Committees are presented.

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS TACTICAL AIR COMMAND
LANGLEY AIR FORCE BASE, VIRGINIA 23665

OFFICE OF THE COMMANDER

4 JAN 1978

Lieutenant General Alton D. Slay
Military Director, Scientific Advisory Board
United States Air Force

Dear Al

I indicated to Bob Naka in October that TAC would support a joint ASAP/SAB Summer Study on specific issues identified by TAC and TRADOC. Four issues--of concern to both TAC and TRADOC--are recommended for study. They are listed in the enclosure with an expanded discussion on each to aid you or Bob Naka in deliberations with the ASAP. A related requirement--also of joint concern--is described for consideration when proposing solutions to the study issues.

Solutions to the identified issues are technical; however, any SAB/ASAP effort to find joint solutions to Command, Control, and Communication issues in the European Central Region must consider the NATO/US interface. Therefore, I recommend that the proposed study be coordinated with EUCOM and that they be requested to participate in the study.

Tom McMullen and his staff--with TRADOC participation--will continue to work the issues and final task statement. Tom will also keep in touch with Bob Naka.

Sincerely

ROBERT J. DIXON, General, USAF
Commander

1 Atch
Recommended Joint Study
Issues

C/C Gen Evans USAFE/CC
Gen Richy, DCINCEUR
Gen Skantz, TACDC
Gen Rogers, TRADOC

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RECOMMENDED ISSUES FOR JOINT ASAP/SAB SUMMER STUDY

STUDY AREA I: COMBINED AIR DEFENSE

ISSUE: Passive capability to make identification of friendly vs enemy aircraft to provide "safe passage" and prevent fratricide.

ISSUE STATEMENT: Current rules of combat engagement normally call for visual identification of a target as hostile before weapon firing is initiated. The necessity for the visual rule is obvious; it is the only positive identification technique available. Because of this limitation many weapon systems cannot be operated at optimum range. This limitation reduces the probability of kill (P_k) and increases the vulnerability of the weapons delivery platform. This is especially true in air-to-air engagement. Tests with current weapons systems indicate that the first to acquire, identify and fire will be the victor. The problems of positive and early identification carry over to air-to-ground and ground-to-ground engagements. In fact, identification drives the engagement decision at all levels of combat. The inadequacy of current active and passive means to identifying friendly air and ground vehicles will probably result in a high fratricide rate. Current identification systems are inadequate because they are susceptible to countermeasures and enemy duplication. The proliferation of US and Allied arms among potential adversaries raises doubts as to the effectiveness of proposed technologies based on engine or system characteristics to provide positive identification of noncooperative aircraft. Active means of identification require actions by combat crews that may not be accomplished correctly. Therefore, a passive, positive capability to identify friendly and noncooperative aircraft is an essential and immediate requirement. It must be: integral to the weapon system's surveillance/acquisition/tracking system; 100 percent capable at optimum weapon effectiveness range; and, operate in a high Electronic Counter Measure (ECM) environment. Panel should review present identification developments and available technologies and identify the one(s) promising the earliest solution.

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STUDY AREA II: CLOSE AIR SUPPORT IN CONJUNCTION WITH FIRE AND MANEUVER

ISSUE: Improved line-of-sight capability for ground target acquisition and designation to enable employment of diverse weapons systems.

ISSUE STATEMENT: The lethality of mobile air defense typified by PACT Armies has drastically limited the use of inventory Forward Air Control aircraft and artillery spotter aircraft. This decreased capability of current systems to acquire and designate targets has a comparable impact on the effectiveness of munitions which require terminal guidance, constant target illumination, and/or precise target location. The enemy's increased mobile air defense capability also drastically increases the vulnerability of fixed-wing and rotary-wing aircraft when required to make multiple passes on targets. Improvement of enemy counter-fire systems and their numerical superiority make first-round artillery kills by Allied fire elements essential. Numerical superiority of enemy ground forces can only be countered by the most efficient use of all available fire support. Full utilization of the diverse weapons systems and munitions available requires a line-of-sight target acquisition, tracking and designation system. This system must be compatible with current and programmed surface and airborne platforms. This system must be capable of designating, and providing precise targeting data on moving targets. Target information must be transmitted directly to the strike weapon's (ground or airborne) fire control system in a form compatible with its real time requirements for target acquisition, munition guidance data or artillery fire coordinates. Panel should study inventory and programmed Air Force and Army sensor, targeting, strike and fire systems and determine how, or if, a current technology can be utilized to develop interface equipments/systems that will enable direct exchange of target data from either service's sensor/targeting systems to either service's strike/fire system.

STUDY AREA III: INTERDICTION WITHOUT FIRE AND MANEUVER COORDINATION

ISSUE: Capability to identify and negate key command and control elements of the enemy's engaged and reserve forces.

ISSUE STATEMENT: Soviet and PACT emphasis on the capability to mount a massive thrust indicates their strategy against NATO forces is to initiate rapid, deep penetration of Western Europe by overrunning initial and secondary defense lines before NATO can be reinforced by US-based ground and air units. In order to increase the overall capability of their Tank and Combined Army Armies, they have integrated Electronic Warfare (Electronic Countermeasure and Electronic-Counter Countermeasures) and signals intelligence (SIGINT) exploitation capability into all elements/echelons of their assault forces. To provide an air defense umbrella for their armor and Electronic Warfare and Intelligence (EWI) units, mobile surface-to-air missile and radar-controlled anti-aircraft artillery units are integral to lower echelon assault and maneuver units. Effective use of this highly mobile, combined offensive firepower, EWI and air defense capability requires continuous, positive command and control. A system capable of identifying and/or monitoring these mobile command and control elements would enable their destruction or exploitation and constitute a major force effectiveness multiplier. Such a system must be capable of providing real-time information to commanders/decision makers/planners at all operational levels from ground units in contact to the Joint Theatre Commander. Panel should review current inventory systems and study available technology to determine if present systems can be modified to accomplish this task; and, if not, recommend what technology should be pursued to develop such a capability in the near term.

STUDY AREA IV: ELECTRONIC WARFARE/INTELLIGENCE

ISSUE: Capability to identify; fingerprint, and track mobile, surface-to-air missile (SAM) units and radar controlled anti-aircraft artillery (AAA).

ISSUE STATEMENT: One of the immediate and critical tasks at the outbreak of hostilities will be to determine the new values and ranges of SAMs, AAAs, and other emitters so they can be "fingerprinted." If this task is not performed, the capability to suppress enemy air defenses, counter armor attacks and to determine the enemy's electronic order-of-battle (EOB) will be seriously impaired. The inability to identify and suppress integral air defenses will preclude effective concentration of airborne firepower against armored elements. This "fingerprint" capability is also essential to the maintenance of the threat data base for mission planning and the identification of enemy forces, their location and determination of probable employment. The current parameters programmed in the data processors of automated ELINT systems are from peacetime collection. At the onset of hostilities, SAM, AAA and other emitters are expected to switch to wartime modes of operation. These new signal parameters will not match the "in-program" parameters and will be declared "unknowns." A tactical sensor system capable of near real time detection and tracking of such emitters is required. The system must include an automatic data processing capability designed specifically to assist intelligence analysts in recognizing, analyzing, and identifying signals operating in previously undetected modes. Panel should review current inventory sensors and associated processors to determine improvements required to provide a solution. If modification of current systems is not feasible, then a new technological solution should be identified.

ADDENDUM

ISSUES IN C^3 CAPABILITY TO SUPPORT INTEGRATION OF TACTICAL BATTLEFIELD SYSTEMS

Command, Control Communications requirements for Battlefield Management have been repeatedly studied. Technological recommendations for improved C^3I systems have been made, validated and implemented. Current technology, with few exceptions, can provide the communications capabilities required, provided sufficient funds are made available. However, the universal availability of high-speed, high-volume, secure, anti-jam, point-to-point, ground-air-ground, air-air communications and data processing capability will not solve the problem of Command and Control of Land and Air Forces engaged in combined and/or mutually supporting operations. The final solution is dependent upon resolution of procedural and doctrinal issues. It is in those areas that the TAC-TRADOC effort can be most productive if allowed to proceed unrestricted by guidelines and direction from external sources. Payoffs will be realized in manpower and weapons systems costs by eliminating duplicative capabilities and functions. Final resolution of these issues is not in sight, but a firm roadbed for rapid progress is being laid. In the interim, all services have an immediate requirement for a system capable of assisting Battle Commanders at all operational levels in the decision-making process. The following is a description of factors bearing on the problem.

a. General: Modern technology has drastically improved the collection and reporting capabilities of various sensor and information systems; however, little assistance has evolved for the decision-maker forced to cope with increased volumes of data. Improvements can be effected in data handling systems, but they must be keyed to specific functions and command responsibilities of individuals being supported. Data selection and presentation must be matched with functional requirements to support decision-making in the areas of combined air defense, close air support/fire support, interdiction/fire support, and electronic warfare/intelligence.

b. Inferential Aids: Decisions can sometimes be made on the basis of a few, or even a single information input. Large volumes of information can cloud the significance of specific events. Decision-makers require assistance to draw realistic inferences from the patterns and trends recognized by analysis software. Data presented must encompass all aspects of resource management weighed in the decision-making process. Data presented must be keyed to the timeliness and response requirements of each echelon of command.

c. Computational Aids: Battle managers generally base decisions on personal experience and understanding of the operational modus operandi. Assistance is required to determine required level of effort, measure of anticipated effectiveness, and probable risk associated with different courses of action. A display capable of presenting probable tactical results as well as probability of success percentages for various alternative force deployments is required.

d. Option Aids: Rapid decisions must often be rendered on events or activities which are not critical to the ongoing combat situation. Decision-makers can ordinarily select from various options when dealing with such a situation; e.g., jam, exploit, or destroy. Weighing consequences and factors relative to the options delays the decision-making process. Assistance is needed to provide a "best" decision in situations involving multiple courses of action for noncritical events or activities. Such aids cannot replace the man in the decision process but can define consequences associated with each option and prioritize alternatives based on criteria imposed by the decision makers.

STUDY PLANS FOR WORKING GROUPS OF JOINT ASB/SAB SUMMER STUDY

Revised 31 May 1978

GROUP I: IFF in Combined Ground-to-Air and Air-to-Air Air Defense

General Issue: Reliable classification of aircraft as friendly, enemy, or neutral, by air defenses. Real-time classification at the air defense firing unit will be considered as the highest priority need. Collateral information from a variety of sources will be considered, but particular emphasis will be placed on the potential for passive means of performing this function.

Tasks will include the following:

1. Review Defense Science Board IFF study report (1978) and Army Science Board IFF study report (1975) and other relevant analyses of IFF issues.

2. Review technical characteristics of current IFF and other target classification systems, planned operational employment, and their effectiveness and limitations.

3. Review current and projected developments and available technologies which might be exploited to improve the ability to classify airborne targets reliably.

4. Identify those developments, technologies, and system concepts that promise effective solutions to the problem of reliable classification of airborne targets.

Primary emphasis will be on reliable classification of targets in surface-to-air air defense system

operations; secondary emphasis will be on air-to-air defense operations. Potential fallout or extension of concepts for IFF of ground vehicles will be considered if time permits.

GROUP II: Supporting Fire for Friendly Forces From Fixed-Wing Aircraft, Helicopter, and Artillery

General Issue: What are potential improvements in procedures/systems/interface equipment to enhance the timely application of fire power on enemy maneuver units. Particular emphasis will be given to improving the capability for airborne strike assets of either service to use the sensor/targeting assets of either service.

Tasks will include examination of the following types of operation:

1. Offset radar beacon bombing: improved accuracy; employment with various types of aircraft, especially the F-16; streamlining C^3 for this function; more effective munitions to support this concept; ways of reducing the exposure of the strike aircraft.

2. Delivering firepower on targets fixed in electronic coordinate systems. Delivery of a pattern of fire quickly at a time and place designated by the ground commander day/night/all-weather; choice of coordinate systems and interaction among systems such as JTIDS and PLRS; employment of various firepower assets--aircraft, helicopters, artillery.

3. Common reference systems for cueing: improvement of ability of the pilot in an aircraft or helicopter to acquire a target for weapon delivery; reduction of aircraft/helicopter vulnerability; adequacy of the Army's All Source Analysis Center (ASAC) and the Air Force's Tactical Fusion Division (TFD) for cueing; improving distribution of information for this function.

4. Use of the Air Force's Precision Location/Strike System (PLSS) to direct artillery fire at defenses; effectiveness of artillery in this role; handoff from PLSS to artillery.

5. Laser designation: adequacy of various ground laser designators for use with air and ground delivered weapons; impact of smoke and dust obscuration; value of (Long-Wavelength Infra Red) LWIR; communications and control for handoff; reducing exposure of ground laser operator.

GROUP III: Interdiction of Enemy C^2.

General Issues: Assessment of the feasibility and capability of existing assets to identify, locate, and neutralize key command and control elements of the enemy's engaged and reserve forces, with particular emphasis on mobile command posts; identification of means to improve the ability to perform this function.

Tasks include the following:

1. Review last year's Defense Science Board study on this topic plus follow-on efforts since that time and consult with key personnel of NSA; use this information base as the starting point for the study.

2. Assess criticality and vulnerability of potential enemy C^2 targets.

3. Assess alternative methods for locating, identifying, and negating--by jamming or physical attack--C^2 targets.

4. Recommend means of improving current capabilities to interdict enemy C^2.

GROUP IV: Air Defense Emitter Detection, Location, and Classification.

General Issue: A critical task at the outbreak of hostilities will be the detection and location of enemy air defense assets. The enemy will attempt to frustrate our ability to effectively counter his air defense radar capability by continuous rapid redeployment and by the use of wartime frequencies and operational modes unobserved in peacetime. There is concern that the allied ability to identify and locate these assets may be inadequate.

Tasks include the following:

1. Evaluate our understanding of the extent to which Soviet air defense radars and other electromagnetic signatures can realistically be altered in wartime and determine if present collection assets can adequately cope with these changes in a timely manner.

2. Based on (1), investigate the impact that variations in air defense wartime electromagnetic signatures may have on the effectiveness of aircraft ECM and Radar and Homing Warning devices.

3. Review U.S. capability to detect, locate and classify air defense assets. Determine to what extent unit classification is possible to aid in understanding which emitters have moved to new locations. Consider US capability in four cases: (a) present organic capability; (b) present optimum capability using both organic, other service, and National assets; (c) near-future optimum capabilities, and (d) future capabilities if new technologies are exploited.

4. Develop specific recommendations to improve capabilities for this function.

ANNEX D

STUDY SCHEDULE AND 28 JULY FINAL BRIEF
AGENDA AND GUEST ATTENDEES

ANNEX D

This Annex contains the overall Joint Study schedule, the agenda for the July 28 final briefing, and a list of guest attendees at that briefing.

ASB/SAB JOINT SUMMER STUDY SCHEDULE

JULY 1978

	MONDAY - 17	TUESDAY - 18	WEDNESDAY - 19	THURSDAY - 20	FRIDAY - 21
0800 to 1200	0800: All participants convene Room L-1 1000: Work Sessions	Work Sessions	Work Sessions	Work Sessions 1000: Progress Report Group I, Rm 4H45	Work Sessions 1000: Progress Report, Group III Rm 4H54
LUNCH	Mitchell Hall (Across from Fairchild Hall) or Officers Club				
1245 to 1630	Work Sessions	Work Sessions	Work Sessions	Work Sessions 1400: Progress Report Group II, 4H53	Work Sessions 1400: Progress Report Group IV, 4H62
1645 to 1800	Soviet Mil* Ops-Dr Braddock L-1		Battle of Kursk* & Passive Defense Dr.McMillan, L-1		
EVE	Get Acquainted Social: Officers Club	See Note 5	See Note 5	Dinner & Show Flying W Ranch	See Note 5
	MONDAY - 24	TUESDAY - 25	WEDNESDAY - 26	THURSDAY - 27	FRIDAY - 28
0800 to 1200	Work Sessions	Work Sessions	Work Sessions	Briefout Dry Run Room L-1	Final Briefout, Room L-1
LUNCH	Mitchell Hall or Officers Club				
1245 to 1630	Work Sessions	Work Sessions	Work Sessions	Briefout Dry Run Room L-1	Wrap-up Session 1500: Gen Session, Rm L-1
1645 to 1800	Videotapes* 1.Attack Helicop 2.AWACS Test	TNW Issues*(Joe Braddock, T. Greene), L-1	Soviet CW*(Ami Hoeber), L-1	Written Drafts of Report Sections Due at COB today	
EVE	See Note 5	See Note 5	See Note 5	Reception & Dinner Officers Club	

ROOM ASSIGNMENTS AT USAFA

Fairchild Hall (Bldg 2354)
General Sessions-Room L-1, 3rd Fl.
Working Sessions, 4th Fl.:
Group I-Room 4H45
Group II-Room 4H53
Group III-Room 4H54
Group IV-Room 4H62
ADMIN OFFICE FOR STUDY, 4th Fl., Room 4J12
LOUNGE FOR STUDY GROUP, 4th Fl., Room 4J10

GENERAL NOTES:

1. Ladies are invited to all social functions.
2. Casual dress for all work sessions.
3. Normal security level for Fairchild Hall sessions is SECRET.
4. Specially classified work areas will be at Chidlaw Bldg., Colorado Springs.
5. Evening work sessions may be arranged with prior notice to Captain Beam.

*Optional seminar for all participants.

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DETAILED AGENDA FOR BRIEFOUT
FAIRCHILD HALL, 3L3
Friday, 28 July

Time	Minutes	
0800	(5)	Welcomes - Security reminder - Thanks to AFA
0805	(10)	Introduction - Guests - Study Steering Group
0815	(10)	Scene Setting - Study Evolution - Task Summaries - Inputs/Sources - Study Schedule - Report Schedule
0825		Group I
	(5)	Introductions of Participants (by Study Co-Chairman)
	(30)	Presentation) Task Group
	(10)	Discussion/Questions)
0915	(45)	Group II
0955	(5)	Stretch Break
1000	(45)	Group III
1045	(45)	Group IV
1130		Closing Remarks
	(10)	- General Officer Participants
	(5)	- USA
	(5)	- USAF
	(10)	- Study Chairmen
1200		Special Supplementary Briefing, Group III and IV (Room TBD)

1245-1300	(10)	Enroute to Officers' Club
1300-1345	(50)	Lunch - Guests - Steering Group - All ASB and SAB participants

SENIOR OFFICIALS PRESENT
ASB/SAB BRIEFOUT - 28 July 78

ARMY

General Donn A. Starry
Commander
US Army Training & Doctrine Command
Fort Monroe, Virginia

General John R. Guthrie
Commander
US Army Materiel Development
and Readiness Command
Alexandria, Virginia

Dr. Percy A. Pierre
Assistant Secretary of the Army
(Research, Development & Acquisition)
Department of the Army
Washington, D.C.

Lieutenant General Edward C. Meyer
Deputy Chief of Staff for Operations
and Plans
Department of the Army
Washington, D.C.

Lieutenant General Donald R. Keith
Deputy Chief of Staff for Research,
Development and Acquisition
Department of the Army
Washington, D.C.

Lieutenant General Robert J. Baer, Jr.
Deputy Commander for Materiel Development
US Army Materiel Development and
Readiness Command
Alexandria, Virginia

ARMY (Cont'd)

Dr. Joseph H. Yang
Principal Deputy Assistant Secretary
of the Army (Research & Development)
and Executive Director, Army Science
Board
Office, Assistant Secretary of the Army
Department of the Army
Washington, D.C.

Major General Charles R. Myer
Director, Telecommunications and Command
and Control
Office, Deputy Chief of Staff for
Operations and Plans
Department of the Army
Washington, D.C.

Major General Hillman Dickinson
Commander
US Army Communications, Research & Development Command
Fort Monmouth, New Jersey

Mr. Norman Klein
Assistant Deputy for Science and
Technology
Office, Deputy Command for Materiel
Development
US Army Materiel Development and
Readiness Command
Alexandria, Virginia

Dr. J. Ernest Wilkins
Chairman
Army Science Board

MARINE

Lieutenant General Thomas H. Miller
Deputy Chief of Staff, Aviation
Headquarters, US Marine Corps
Washington, D.C.

MARINE (Cont'd)

Brigadier General William A. Scott
Director
Command, Control, Communications
and Computer (C^4) Systems Division
Headquarters, US Marine Corps
Washington, D.C.

AIR FORCE

General Wilbur L. Creech
Commander
Tactical Air Command
Langley AFB, Virginia

Dr. Kenneth L. Jordan
Principal Deputy Assistant Secretary
for Research and Development
Department of the Air Force
Washington, D. C.

Lieutenant General Thomas P. Stafford
DCS/Research and Development
Headquarters, US Air Force
Washington, D.C.

Lieutenant General Robert C. Mathis
Vice Commander
Air Force Systems Command
Andrews Air Force Base, Maryland

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ANNEX E

DEFINITIONS

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AAA	Anti-Aircraft Artillery
AAD	Army Air Defense
AAFCE	Allied Air Forces Central Europe
AAH	Advanced Attack Helicopter
ACE	Allied Command Europe
AD	Air Defense
ADA	Air Defense Area
ADAM	Artillery Delivered Anti-Personnel Mine
ADGE	Air Defense Ground Environment
ADTC	Armament Development and Test Center
AEELS	Automatic Electronic Emitter Locating System
AEW	Airborne Early Warning
AFCENT	Air Force Central Europe
AFOSR	Air Force Office of Scientific Research
AGTELIS	Automatic Ground Transportable Electronic Location and Identification System
AIMS	Altitude Identification and Military System
AJ	Anti-Jam
ALO	Air Liaison Officer
AOC	Automatic Overload Control
APPS	Analytical Photogrammetric Positioning System
ARM	Anti-Radiation Missile
ASAC	All Source Analysis Center
ASARS	Advanced Synthetic Aperture Radar System
ASB	Army Science Board
ASR	Airport Surveillance Radar
ATAF	Allied Tactical Air Force
ATDMA	Advanced Time Division Multiple Access
ATOC	Air Tactical Operations Center
AWACS	Airborne Warning and Control System
BAI	Battlefield Air Interdiction
BETA	Battlefield Exploitation and Target Acquisition
BOC	Battalion Operations Center

CAP	Combat Air Patrol
CAS	Close Air Support
CBU	Cluster Bomb Unit
C^2/C^3	Command and Control/Command, Control and Communications
C^3I	Command, Control, Communications/ Intelligence
$C\text{-}C^3$	Counter-Command, Control and Communications
C&D	Cover and Deception
CEP	Circular Error Probabilities
COIC	Combat Operations Information Center
COMINT	Communications Intelligence
CNI	Communication, Navigation and Identify
CP	Command Post
CRC	Control and Reporting Center
CRP	Control and Reporting Post
DAD	Division Air Defense
DALFA	Director Air Land Forces Agency
DEFREPs	Defense Readiness Postures
DF	Direction Finding
DME	Distance Measuring Equipment
DMED	Digital Message Device
DMR	Dual Mode Recognizer
DOD	Department of Defense
DSCS III	Defense Satellite Communication System
DTDMA	Distributed Time Division Multiple Access
ECCM	Electronic Counter-Countermeasures
ECM	Electronic Countermeasures
EIFF	Enemy Identification Friend or Foe
ELINT	Electronic Intelligence
ELS	Emitter Location System
EMP	Electro Magnetic Pulse
EOC	Electronic Order of Battle
ERIM	Environmental Research Institute of Michigan
ERP	Effective Radiated Power
EW	Electronic Warfare
EXPELS	Expendable Emitter Location System

FAAR	Forward Area Alerting Radar
FAC	Forward Air Controller
FAC-A	Airborne Forward Air Controller
FAE	Fuel Air Explosives
FDMZ	Forward Missile Deployment Zone
FEBA	Forward Edge of Battle Area
FIS	Future Identification System
FIST	Fire Support Team
FLIR	Forward Looking Infrared
FLOT	Front Line of Own Troops
FMOP	Frequency Modulation Pulse
FO	Forward Observer
FRG	Federal Republic of Germany
FSCL	Fire Support Coordination Line
FSS	Fire Support System
GCI	Ground Controlled Intercept
GEADGE	German Air Defense Ground Environment
GEOREF	World Geographic Reference System
GLLD	Ground Laser Locator Designator
GOC	Group Operations Center
HICAP	High Combat Air Patrol
HIMEZ	High Missile Engagement Zone
HIPAR	Hercules High Power Acquisition Radar
HRR	High Range Resolution
HTDMA	Hybrid Time Division Multiple Access
HUD	Heads Up Display
I&W	Indications and Warning
ICM	Improved Capability Missile
ICWAR	Improved Continuous Wave Acquisition Radar
IHADP	Improved Hawk Automatic Data Processor
IFF	Identification Friend or Foe
IFM	Instantaneous Frequency Measurement
IFR	Instrument Flight Rules
IMINT	Imagery Intelligence
INS	Inertial Navigation System
IP	Initial Point
IPAR	Improved Hawk Pulse Acquisition Radar
JTIDS	Joint Tactical Information Distribution System

LCAP	Low Combat Air Patrol
LLTR	Low Level Transit Routes
LOMEZ	Low Missile Engagement Zone
LPI	Low Probability of Intercept
LTD	Laser Target Designator
MANPADS	Man Portable Air Defense System
MFR	Multi-Frequency Radar
MNBA	Minimum Normal Burst Altitude
MNC	Major NATO Commander
MPC	Message Processing Center
MSS	Movement Sensing Systems
MTBF	Mean Time Between Failure
MTI	Moving Target Indicator
NSOC	NATO Sector Operations Center
OAS	Offensive Air Support
ODO	Defensive Operations Division
OSD	Office Secretary of Defense
OT&E	Operational Test and Evaluation
PIP	Product Improvement Program
PLRS	Position Locating and Reporting System
PLSS	Precision Location and Strike System
PPRI	Precision Pulse Repetition Interval
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval
PUP	Pull Up Point
QRC	Quick Reaction Capability
RAP	Rocket Assisted Projectile
REC	Radio Electronic Combat
RINT	Radiation Intelligence
ROI	Return on Investment
RPV	Remotely Piloted Vehicle
RSS	Radar Signal Sorter
RTT	Round Trip Timing
RWR	Radar Warning Receiver

SAB	Air Force Scientific Advisory Board
SAR	Synthetic Aperture Radar
SEAD	Suppression of Enemy Air Defense
SFL	Sanctuary Flight Level
SHORADEZ	Short Range Air Defense Equipment Zone
SHORADS	Short Range Air Defense System
SIF	Selective Identification Feature
SIGINT	Signal Intelligence
SLAR	Side Looking Radar
SLP	Sanctuary Level Procedures
SOC	Sector Operations Center
SOTAS	Stand-off Target Acquisition System
SPECS	Software Programmable Engine Analysis Techniques System
STANAG	Standardization Agreement
SWHQ	Static War Headquarters
TAC	Tactical Air Command
TACFIRE	Tactical Identification Fire System
TACP	Tactical Air Command Post
TACS/TADS	Tactical Air Control System/Tactical Air Defense System
TADDS	Target Alert Data Display Set
TAF	Tactical Air Force
TDMA	Time Division Multiple Access
TDOA	Time Difference of Arrival
TEL	Transporter Erector Launchers
TEREC	Tactical Electronic Reconnaissance
TFC	Tactical Fusion Center
TIPI-II	Tactical Information Processing and Information System
TISEO	Target Identification System Electro Optical
TOA	Time of Arrival
TO&E	Tables of Organization and Equipment
TRADOC	Training and Doctrine Command
TRDL	Tactical Reconnaissance Data Link
TRISAT	Target Recognition Through Integral Spectral
TST/IDL	Transmission Scheme Translator/Interactive Display Terminal

UE	Unattended Expendables
USAREUR	United States Army Europe
USDR&E	Under Secretary of Defense Research and Engineering
WAAM	Wide Area Anti-Armor Munitions
WDU	Weapons Direction Unit
WP	Warsaw Pact

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