REPORT OF THE DEFENSE SCIENCE BOARD

July 1968

Report of the Panel on Tactical Aircraft

Office of the Under Secretary of Defense
for Acquisition, Technology, and Logistics
Washington, D.C. 20301-3140

DECLASSIFIED IN FULL

This report is a product of the Defense Science Board (DSB).

The DSB was established in 1956 as an advisory board to the Secretary of Defense. Statements, opinions, conclusions, and recommendations in this report do not necessarily represent the official position of the Department of Defense (DoD). The report was cleared for open publication by the Washington Headquarters Services Records and Declassification Division on March 07, 2011

This report is unclassified and cleared for public release.

DECLASSIFIED IN FULL

~~SECRET~~

Log No. 68-5217
Copy No. 2

Report of the Panel on TACTICAL AIRCRAFT

23 June – 5 July 1968

1968 SUMMER STUDY

Defense Science Board - National Academy of Sciences
Woods Hole, Massachusetts

~~SECRET~~

~~SECRET~~

Report of the Panel

on

TACTICAL AIRCRAFT

Defense Science Board - National Academy of Sciences
1968 Summer Study
Woods Hole, Massachusetts

23 June - 5 July 1968

ROSTER

Panel on Tactical Aircraft

Members

Dr. John L. McLucas, Chairman
Dr. Thomas S. Amlie
Dr. Thomas P. Cheatham, Jr.
Mr. Harry Davis
Dr. Richard L. Garwin
Mr. Wayland D. George
Mr. Terrell E. Greene
Dr. Albert C. Hall
Mr. Milton Lohr
Dr. Ellis Rabben
Colonel Garth Reynolds, USAF
Dr. Leonard S. Sheingold
Colonel Bill G. Smith, USA
Captain L. A. Snead, USN
Mr. Pierre Sprey
Lt. Colonel Jasper A. Welch, Jr., USAF
Mr. Billy Joe Workman

DoD Liaison Member

Mr. Robert E. O'Donohue
Office, Assistant Director (Tactical Aircraft Systems), ODDR&E

Ex Officio Members

Mr. Charles A. Fowler
Deputy Director (Tactical Warfare Programs), ODDR&E

Mr. T. C. Muse
Assistant Director (Tactical Aircraft Systems), ODDR&E

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

1. INTRODUCTION (U)

(U) The subject treated by the Tactical Aircraft Panel was that of finding and hitting ground targets. Thus, we were concerned in the near-term (from the present to 1972) with:

a. Upgrading the operational employment of tactical aircraft and, to a lesser extent, with looking at other ways of finding and attacking ground targets,

b. Proposed fixes to existing aircraft and equipment, and changes in the ways that existing aircraft and equipment are used.

c. The level of maintenance of existing systems, whether systems perform as well in the field as they do in the laboratory, and with tactics and techniques which could be used to improve their operational employment.

(U) For the 1972 to 1980 time frame, we were concerned with the mix of aircraft available and whether the force levels are moving in the right direction to match the estimates of the future threat(s).

(U) Throughout this report a large number of techniques and equipments to implement them are proposed. It should go without saying that the Panel endorses these programs for inclusion in the inventory only if the equipment works under combat circumstances. However, it is an unfortunate historical fact that many past programs for similar equipments have not worked out well or have not been tested well, or both, and nevertheless have been produced. To repeat, for emphasis, the Panel proposals for development concern only equipments that have been demonstrated to work under realistic combat-like conditions.

(C) The activities of the Tactical Aircraft Panel have been influenced by a number of different factors. Some relate to the environment in which DoD finds itself today. For example, Southeast Asia costs have been above, and continue to exceed, budget provisions. Thus, there is great pressure to reduce costs everywhere and this affects R&D, even R&D related to Vietnam. In order for programs to be considered favorably, they often must show some payoff in the immediate Southeast Asia environment.

(U) Some factors relate to pressures which seem to be as much political as military; e. g., there are sanctuaries and other constraints on attacking targets. These constraints are related either to geography or to target type or both.

(C) In the interdiction mission area, quantitative data on the effectiveness of the effort in Southeast Asia were not available to the Panel. However, in the last two years North Vietnam has demonstrated the ability to mount an increasing level of operations in South Vietnam, the buildup of NVN operations demonstrating that the inflow of supplies and equipment has not been stopped, and perhaps not seriously degraded. During this period, road traffic moving south has progressed from sporadic movements, taking maximum advantage of concealment, to heavy flows. One concludes that under the existing difficult circumstances in Vietnam, tactical air as it has been used is a very inefficient way of performing interdiction.

(C) Therefore, as long as the current Southeast Asia political constraints and rules of engagement remain essentially unchanged, it seems apparent that attempts must be made to make tactical air markedly more effective, or it must be supplemented or replaced by some more effective method which does not depend on interdicting the flow of supplies down the road network.

(U) There is a comparable story concerning operations in the South. In the case of close air support, ways must be found to significantly reduce the delays between the request for air strike and the delivery of the ordnance on the target.

(U) In addition to Southeast Asia, there are many other situations in which tactical air may be called on; e. g., a limited conventional war in the temperate zone involving the usual tactical air missions of reconnaissance, interdiction, and close air support. In such operations, there are many similarities with Southeast Asia, as well as obvious differences. Similarities include:

a. The need to carry out basically the same functions; i. e., find the targets, penetrate defenses, release weapons which will kill targets,

b. Operation in conjunction with, and in support of, friendly forces.

Measures of effectiveness are similar:

a. Timeliness of response,

b. Amount of percent degradation of enemy capability,

c. Losses sustained (not per sortie but per effect on enemy operations).

Differences relate to relative importance of various factors:

a. Distance from airbases to principal engagement areas with resultant needs for inflight refueling, communication relay, etc.

b. Strength of defenses and need for countermeasures.

In some areas, the terrain, the weather, and vegetation are significant factors favoring either offense or defense.

(U) In examing the problems of tactical air, the Panel first looked at its employment in Southeast Asia and then described ways to improve it. Second, we examined the application of those fixes to a more generalized tactical situation.

(U) Section 1.1 contains a brief list of key R&D items.

(U) The Panel was organized into four subpanels: Penetration, Reconnaissance, Weapons, and Command and Control. Sections 2 through 5 are organized along these same lines and give the results of subpanel activity in summary form. Section 6 gives general conclusions of the Panel as a whole. Following the basic report are individual appendices prepared by each subpanel.

1.1 Summary (U)

~~(S)~~ Of the many items discussed in this report, the Panel feels the following are deserving of priority attention:

a. Establish a development and test program with a single designed executive office in each Service to find preferred configurations and combinations of optical systems, including sensors, sights and display for reconnaissance and reconnaissance-strike operations. (See Appendix A, Page 37.)

b. Efforts to bring about a common position navigation grid system for tactical application should be accelerated. This capability should be augmented with one which permits automatic, periodic aircraft position reporting. (See Appendix A, Page 39.)

c. Tactical systems should include a capability to display an all-source, near-real-time activity indication of enemy movement. An OSD-coordinated program is needed in this area which gives each of the Services the authority to pursue an active development program. The Activity Indicator program should include airborne MTI radars, methods for rapid handling of visual reconnaissance data and new ways of displaying such data. (See Appendix A, Page 40.)

d. DDR&E should request the Department of the Army to prepare an overview of concepts and corollary plans of action for "instrumented battlefield" situations to include sensors to be evaluated, test procedures, tactics to be examined, and analysis and evaluation programs. (See Appendix A, Page 41.)

e. A quiet aircraft program, with aircraft payloads considerably beyond those of QT-2 and QT-3 should be initiated. (See Appendix A, Page 42.)

f. A high-level OSD task force should examine in detail the existing and proposed Service fuze programs with the view of achieving substantial technical improvements and cost savings in the development and procurement of fuzes. (See Appendix A, Page 43.)

g. A family of stand-off missiles, with the capability of employing alternate warheads, should be acquired to permit striking heavily defended targets while minimizing aircraft losses. Available warhead options should be provided which consider point, area, hard, and soft interdiction targets.

h. Procurement of the A-X as described in the USAF, June 1968, CFP should be initiated. In addition, plans should be made for a two-seat version for night operation. (See Appendix B, Page 51.)

i. The Department of the Air Force and the Department of the Navy should be requested to prepare "white papers" on aircraft/strike concepts that include explicit consideration of

multiaircraft strike tactics and equipment, multiple threat environments, and support and auxiliary aircraft. (See Appendix B, Page 59.)

j. Cameras should be provided for strike aircraft, and other strike assessment sensors and techniques should be developed. (See Appendix E, Page 114.)

k. An urgent program should be undertaken to provide an early interim airborne overland surveillance radar capability for Southeast Asia. (See Appendix E, Page 118.)

2. PENETRATION (U)

(C) The most striking feature of known, successful solutions to the problem of penetrating enemy air defenses is the close interrelationship between the strike function and the purely penetration function. Nevertheless, there continues to be widespread neglect of this essential coupling, between strike and penetration, by those groups charged with providing "penetration aids." Indeed, the mere fact that these are different groups responsible for "penetration" and for "strike" equipment is symptomatic of the essential decoupling that exists.

(S) One outstanding example is the emphasis on the lone penetrator approach (with a new black box added for each new threat) whereas tactical aircraft invariably penetrate in groups, the larger the better. The two reasonably successful penetration concepts in Vietnam combat (the QRC-160 pod formation and the Wild Weasel exploitation of Shrike) were born of operational necessity and innovation—they were not part of the R&D plans. Without the multiple aircraft employment, furthermore, neither piece of equipment would be worthwhile.

(U) The need for integration goes deeper than just tactics and includes the strategic considerations of building equipment specifically designed to attack an existing formidable air defense net or, better yet, to prevent its being fully deployed.

(U) In the recommendations listed below, and in those listed in later sections on weapons per se, we have tried to suggest specific equipments as well as some concrete management steps that ODDR&E can take to ensure that strike and penetration are considered conjointly. A fuller explanation of these fundamental concerns is to be found in the Penetration Subpanel report. (Appendix B, Page 58.)

2.1 Interdiction (U)

(U) The following conclusions and recommendations are made:

2.1.1 Conclusions (U)

(S) a. High performance aircraft have reasonable survivable capability against heavy anti-aircraft artillery (57-mm or higher) at slant ranges greater than about 15,000 feet by use of maneuver and radar countermeasures.

A standoff air-to-ground missile of range of about 25,000 feet would permit attack of AAA-defended targets.

(S) b. To attack targets in areas defended by radar-directed SAMs (surface-to-air-missiles), an air-launched, 20-50-mile-range standoff missile capability is required.

(S) c. When the enemy has area defenses including AAA, radar-directed SAMs and fighter aircraft, the needed standoff missile range is from 200 to 500 miles.

2.1.2 Recommendations (U)

(S) a. Provide three classes of missiles (see Section 4.3) which can be accurately delivered from standoff ranges of:

1. 3 to 5 miles
2. 20 to 50 miles
3. 200 to 500 miles
4. Include alternate warheads for operational capability against broader array of targets.

(C) b. Continue to provide electronic countermeasure equipments and techniques for those aircraft which must continue to penetrate enemy defenses (see Section 2.3).

2.2 Close Air Support (U)

2.2.1 Conclusion (U)

(C) The present emphasis on reduced physical vulnerability, agility, and IR suppression for close support aircraft is appropriate. The Panel finds, however, that full exploitation is not being made of visual countermeasures in view of the substantial reliance that field army defenses place on visual acquisition and tracking.

2.2.2 Recommendations (U)

(C) a. An experimental program should be initiated to develop adaptive visual camouflage for aircraft.

(C) b. Continued emphasis should be placed on aircraft hardening, infrared suppression, and agility.

(C) c. The above capabilities, if available, should be incorporated in the A-X. A version of the A-X specialized for night operations (see Section 4.1) should be developed.

2.3 Electronic Warfare (U)

2.3.1 Conclusions (U)

(U) The Panel has not attempted to duplicate or improve upon the work of the DSB Electronic Warfare Task Force. However, a few techniques are singled out below for special attention.

2.3.2 Recommendations (U)

(S) The Panel recommends special attention, as noted, be focused on the following items:

a. Distributed jammers; test in field, reorient design program,

b. Surveillance radar jamming; evaluate utility,

c. IR deception countermeasures; establish DSB subpanel,

d. Visual countermeasures; expand exploratory development,

e. Evaluation of penetration aids; call for concept papers,

f. Combat data; develop flight recorders, improve quality,

g. Towed jammers.

2.4 Penetration Concepts (U)

2.4.1 Conclusions (U)

(S) The Panel is alarmed at the growing tendency of the electronic warfare community to dominate penetration concept planning and to rely upon large amounts of on-board equipment and lone penetrator concepts.

(S) The Panel is concerned that there is a lack of balance and that defense avoidance, defense destruction, and improved delivery techniques are not being properly considered in relation to the "black-box penetration aid" approach.

2.4.2 Recommendations (U)

(C) The Panel recommends that ODDR&E call upon the Department of the Navy and the Department of the Air Force to prepare "white papers" on comprehensive aircraft penetration/strike concepts that include explicit considerations of:

a. Multiple threat environments (guns, missiles, aircraft, etc.),

b. Support and auxiliary aircraft for electronic warfare, defense destruction, command and control and warning,

c. Strike tactics and equipment.

3. RECONNAISSANCE (U)

(U) Effort in this area was concentrated on reconnaissance for targeting and strike-assessment purposes. Reconnaissance for other purposes has been considered only with regard to the contribution it makes to targeting and strike assessment.

3.1 Procedures, Techniques and Hardware (U)

3.1.1 Conclusions (U)

(C) a. Tactical reconnaissance and surveillance operations typically have low effectiveness, especially in other than classical, set-piece operations against fixed targets and conventional forces in open terrain. Even in operations of this type the system tends to become inundated with more data than are needed or can be used.

(C) b. The concept and practice of tactical reconnaissance and surveillance are not adequately matched to operational information requirements for the type of war that is being fought now, except for occasional special efforts and some relatively small-scale reconnaissance-strike programs.

(C) c. There is a gross imbalance between the hardware employed for collection of data, and the techniques, procedures, and capabilities for processing the data collected.

(C) d. There is also a gross imbalance in the amount of data collected and the amount which can be exploited. While improvements in exploitation are urgently needed, it is more important to reduce the amount of data collected by several orders to match our exploitation capabilities. A better understanding of the need for low detail, large volume collection supplemented by selective, high quality, but very low volume data is needed and hardware and procedures using this principle must be introduced.

(C) e. Operational and R&D emphasis has been on the collection of imagery and other raw data. In comparison,

data handling and data exploitation have been underemphasized.

3.1.2 Recommendations (U)

(C) a. Implementation is needed of a comprehensive and specific concept of reconnaissance operations that (1) emphasizes techniques and procedures, (2) is based on specific information requirements and characteristics needed to support combat operations and which (3) integrates technology, all-source collection means, processing, interpretation, data handling and information exploitation.

(C) b. Requirements for reconnaissance and surveillance should be stated in terms of specific information needed for an operation or program, rather than in terms of the area to be searched and the scale and resolution of the desired coverage.

(C) c. A major effort should be made to reorient reconnaissance concepts and operations, to produce a better match than now exists between the stated requirements for data gathering and (1) the operational needs of air and surface commanders, (2) the technical capabilities of sensors and platforms, and (3) capabilities for processing, display, distribution and use of reconaissance information.

(C) d. Personnel selection and training criteria which are demonstrably related to the operational task should be developed and enforced for imagery interpreters.

(C) e. Reconnaissance crews, especially those operating low-speed FAC observer, Hunter, and reconnaissance-strike aircraft, should be selected on the basis of suitability tests and should have more training in visual reconnaissance. Such training should be conducted in realistically simulated operational environments, using image interpretation techniques and systematic search and recognition patterns.

(C) f. Communication procedures should be arranged to facilitate transmittal of reconnaissance and surveillance information from reconnaissance air crews to the

intelligence gathering facility and to strike control centers. The system implications and desirability of extending this improved capability to all air crews over enemy territory should be studied.

3.2 Reconnaissance Sensors (U)

3.2.1 Conclusions (U)

(U) a. Direct visual reconnaissance can and should continue to be one of the most valuable means for daytime area surveillance and target detection, and for targeting in daylight reconnaissance-strike operations. Much can be done to improve the process of sensing, collection, display, and use of visual data from reconnaissance aircraft. In addition, it would be important to improve the latent visual reconnaissance capabilities of those aircraft on sorties not specifically designated for reconnaissance that are operating at speeds and altitudes permitting effective visual observations.

(U) b. An improved navigation system, operating in the same coordinates as the navigation system used by strike aircraft, would be an extremely valuable aid to both visual and non-visual reconnaissance systems.

(U) c. Photographic reconnaissance will continue to be the basic means for detailed targeting of preplanned air and ground strikes against fixed targets. Photography should be used to provide definitive coverage of points or small areas selected for examination by such means as visual reconnaissance, ELINT, radar indication of activity, ground operations, etc., rather than to provide area surveillance. Area coverage by photographic sensors for purposes such as area mapping and weather forecasting can often be provided efficiently by other than tactical systems.[1]

[1]Strategic reconnaissance systems, the SR-71 for example, might provide mapping service during a continuing phase of a war in which tactical reconnaissance systems are fully employed in targeting and strike assessment operations. At other stages of a war, the tactical systems could and undoubtedly would be employed in area coverage photographic missions.

d. Passive infrared reconnaissance sensors should have an increasing potential for night-time use in both real-time viewing and permanent imagery. This type of system has demonstrated capability not only for detecting man-made heat sources, but for providing real-time viewing of terrain and cultural environments with imagery approaching that of photographic quality.

e. Real-time, passive night observation devices operating in the visible spectrum should also grow in importance for reconnaissance-strike and definitive spot-coverage missions. Both low-light-level television (LLLTV or L^3TV) and direct-view image intensification devices show useful capabilities at present and have a considerable growth potential for the future.

f. Overt and covert active illumination devices should play an important role in night reconnaissance and reconnaissance-strike operations. Floodlights, pulsed flashers, and laser scanning devices along with infrared and ultraviolet illuminators can have uses in various environments and tactical situations.

g. Because of the many options available and the rapid growth in technology, the Reconnaissance Subpanel is not at present in a position to recommend a specific set of optical systems for reconnaissance and strike aircraft. However, it is concluded that a comprehensive study, development, and test program is needed to determine preferred configurations and combinations of sensors, sights, displays, illuminators, and designators.

h. Moving target indicator (MTI) radar could be extremely useful as an area surveillance device to indicate enemy activity. Its significance as an activity indicator appears considerably greater than its capability for ground mapping and high-resolution detection of stationary targets. MTI radars for area surveillance may be suitably installed on aircraft, helicopters, balloons, or towers in various situations. With such systems, the goal of continuous area surveillance may be achieved.

i. There should be a continued and expanding role for ground-based remote sensors that send information on

enemy activity via airborne relays. This information should be increasingly useful for real-time tactical intelligence gathering and for quick-reaction strikes.

3.2.2 Recommendations (U)

(S) a. Provide an improved navigation and position-indication and recording system for use in visual and nonvisual reconnaissance aircraft that operates with as good accuracy as that required for navigation on strike missions (say, 0.1 to 1.0 km accuracy). The reconnaissance navigation system should operate in the same coordinate system as the strike navigation system. (See Section 5.1.)

(S) b. Develop a simple automatic time and position reporting system, along with a secure voice link, for use in reporting visual reconnaissance information. When a reconnaissance report is given in real time or on a recording, the time and aircraft position should be inserted automatically into the report. Such a system would also have utility for nonvisual reconnaissance and for other than reconnaissance operations. (See Section 5.4.)

(C) c. Study the design, cost, and operational utility of a helmet-mounted sight coupled with a laser ranger to provide range and bearing information on targets sighted by visual reconnaissance.

(C) d. Support continued development of covert and overt battlefield illumination systems and laser scanning devices for covert photography.

(C) e. Establish a development and test program with a single designated executive office in each Service to find preferred configurations and combinations of optical systems—including sensors, sights, displays, target locations, and designators—for reconnaissance and reconnaissance-strike operations.

(C) f. Support continued development, testing, and system studies of remote, ground-based sensors for reporting enemy presence and activity.

(S) g. Emphasize MTI (rather than high-resolution ground maps) with real-time readout in reconnaissance radars.

(S) h. Study use of tethered-balloon-borne and helicopter-borne MTI radars for continuous area surveillance.

3.3 Reconnaissance Platforms (U)

3.3.1 Conclusions (U)

(C) Continued study, research and development are warranted on reconnaissance platforms, with emphasis on unmanned vehicles, quiet manned aircraft, and low-to-zero-speed platforms such as helicopters and tethered balloons.

(S) Drone fixed-wing reconnaissance aircraft have proven their worth in Southeast Asia on penetration missions against heavily defended areas. It is noted, however, that on long-range penetration missions covering several targets, fixed wing drones (even while flying low altitude) are vulnerable if their flight profile is essentially level and straight except when in a navigation turn. Tactical usage, therefore, dictates more frequent use on shorter programmed missions with a flexible degree of mission program maneuvering.

(S) Drone reconnaissance helicopters will be useful for local area surveillance and targeting.

3.3.2 Recommendations (U)

(S) a. Study requirements for and design characteristics of at least two classes of drone reconnaissance vehicles. One should be a relatively long-range cruise vehicle with emphasis on maneuverability and control as a follow-on to the SPA-147. The other should be a short-range VTOL device (probably a helicopter) for use in local area surveillance and targeting by air and ground commanders.

(S) b. Study requirements for and design characteristics of quiet aircraft, and conduct supporting research aimed at development of quiet manned aircraft with considerably greater payload than current quiet aircraft can carry.

(S) c. Study requirements and design characteristics for helicopters to be used as MTI radar platforms for use in area surveillance; conduct experimental tests of helicopter-borne MTI radar.

(S) d. Study requirements and design characteristics, and conduct research, development, and test of tethered-balloon-supported area surveillance sensors such as MTI radar.

3.4 Transmission and Display of Reconnaissance and Surveillance Information (U)

3.4.1 Conclusions (U)

(C) a. Systems and techniques are needed for timely, selective presentation of reconnaissance and surveillance information in the basic command and control displays used by operational commanders and decision-makers at various levels. The displays should permit presentation of visual, photo, IR, radar, ELINT, and other reconnaissance information, including both definitive target coverage and area activity information in real time. Design of the system should emphasize operational and human engineering considerations, but may require sophisticated hardware techniques. It does not appear necessary to use wide-band data link in the operation of the system.

(C) b. Data link developments should emphasize minimal amount of data to be transmitted. The trend should be toward a minimal amount of secure voice transmission plus narrow-band digital data link. Broadband systems for real-time transmission of unevaluated sensor data do not appear operationally necessary or even desirable. The type of sensor data that should be transmitted air to ground includes MTI and hot-spot IR target coordinates and selected single-frame video pictures. Selected digitalized target type and coordinate information, as required, should be transmitted between ground stations for display purposes.

3.4.2 Recommendations (U)

(C) a. Develop a system for assembling and displaying reconnaissance and surveillance information from multiple sources to meet the needs of operational commanders at various levels. Area activity information as well as definitive spot information must be accommodated in the display.

(S) b. Orient data-link developments toward narrow-band (e.g., 15 to 25 kc at most), secure voice transmission and processed sensor data in digital form. In particular, reorient the JIFDATS program toward narrow-band data link.

4. WEAPON AND WEAPONS SYSTEMS (U)

4.1 Close Air Support (U)

4.1.1 Conclusions (U)

(S) The aircraft with the best performance in close air support in South Vietnam appear to be the slower, propeller-driven aircraft. The Air Force has proposed a low-speed, highly maneuverable platform (see the A-X CFP, June 1968) to replace the obsolete aircraft now being used. We believe such an aircraft is needed to more adequately perform the close air support mission.

4.1.2 Recommendations (U)

(S) The A-X as defined in the June 1968 CFP should be vigorously pursued. We agree that it should be a one-place airplane for daytime operation. It should have an austere avionics package dedicated to providing daylight, clear weather bombing in the near vicinity of friendly maneuver elements. In addition, a night version of the A-X should be planned. It should be a two-place airplane. The avionics package should have good night sensors and a useful radio navigation system.

4.2 Interdiction of Mobile Targets (U)

4.2.1 Conclusions (U)

(C) a. The capability is needed to interdict mobile targets (primarily vehicle) during both day and night. In particular, the night battlefield interdiction mission is an extremely difficult and specialized task.

(C) b. Gunships have good applications in relatively permissive environments. Gimbaled guns may add greatly to their effectiveness.

(S) c. Drone helicopters may be useful for penetration and interdiction in a light defense environment—under covert and quiet conditions.

4.2.2 Recommendations (U)

(S) a. Two versions of the A-X as described above in 4.1.2 should be planned for in response to the requirement for the interdiction of mobile targets.

(C) b. The gunship platforms should be tested and subsequently equipped, if successful in test, with gimbaled guns.

(S) c. Conduct feasibility demonstration of armed drone helicopters, determine suitability for operational use and initiate development plan consistent with the test and evaluation results.

4.3 Interdiction of Fixed Targets (U)

4.3.1 Conclusions (U)

(S) The destruction of significant deep fixed targets, generally associated with areas in which there are heavy antiaircraft artillery and surface-to-air missiles, has recently required that the strike aircraft be equipped with penetration aids and be accompanied by high performance aircraft dedicated to escort, SAM and AAA suppression, and electronic warfare. On occasion the aircraft striking the target have been less than 20% (and overall on the order of 50%) of the force of high performance aircraft in the target area. Even with this force of high performance supporting aircraft, the cost of losses has been significant. Because of the CEP associated with free-fall munitions, the target kill per sortie has been less than desirable. In potential future environments, improved surface-to-air missiles and more enemy fighter aircraft may be encountered which will further limit the effectiveness of strikes in which free-fall ordnance is dropped.

4.3.2 Recommendations (U)

(S) a. Provide missile systems (if these missile systems can be produced at such cost that cost of introduction is decreased) which can be launched in the target area such that aircraft do not have to penetrate closer than about 15,000 feet of the target (for use in target areas not protected by SAMs or enemy aircraft). For the short term (about 12 months to IOC), extend the useful range of Bullpup (AGM-12) by equipping the launch aircraft with a stabilized telescope, such as ATAR, through

which to view the target and missile for the final phases of flight. This is envisioned as a two-man operation. Also, continue to explore longer term solutions with greater operational flexibility. For example, consider augmentation of the current AGM-79 design to improve accuracy and range by storing a magnified scene (from the stabilized telescope) in the correlation guidance.

(S) b. To provide the needed 20- to 50-mile standoff from targets defended by radar-directed surface-to-air missiles, or the missile system directly, the Panel recommends:

1. For guidance, the use of STEER (see Section 5.1) plus optical terminal homing (correlation or real-time TV command). This combination should provide about 10ft. accuracy.

2. For airframe/propulsion, provide a rocket missile fired on a semi-ballistic trajectory from a high-altitude launch aircraft.

(S) c. To provide 200- to 500-mile standoff from areas defended by a combination of aircraft, the Panel recommends:

1. For guidance, the same as for the standoff missile for SAMs only; namely, STEER plus optical terminal homing.

2. For airframe/propulsion, a high subsonic cruise missile using pulse jet, or turbo fan as proves best in availability/cost tradeoffs.

4.4 Air-to-Air Combat (U)

4.4.1 Conclusions (U)

(U) Without air superiority, it is difficult to envision an effective ground strike capability. A good air-to-air combat capability is therefore a necessity.

4.4.2 Recommendations (U)

(C) Independent of the outcome of current considerations on the proper choice and sequence of airframes for air-to-air combat, the Panel recommends proceeding with the following equipments and support capabilities:

a. Helmet-mounted sights and displays,

b. Improved fighter-to-fighter ordnance including agile missiles and new, high-velocity guns and ammunition.

c. Improved identification capabilities to include telescopes such as ATAR (at least in two-man aircraft)

d. Situation awareness information to include detailed and specific air-to-air warning consisting of both self-contained equipment and combat support systems such as AWACS.

4.5 Bombing Systems (U)

4.5.1 Conclusions (U)

(U) a. Free-fall munitions are optimum for area targets. The size and value of the target at which free-fall munitions can compete with guided munitions is a function of the accuracy which can be achieved with free-fall bombing systems.

(C) b. Automatic release systems to date have left much to be desired. However, an angle rate bombing system does promise greater accuracy in automatic systems by performing all computations in the target coordinate system.

4.5.2 Recommendation (U)

(C) Develop the angle rate bombing system using an ATAR-type telescope for long-range acquisition and tracking of the target.

4.6 Munitions and Fuzes (U)

4.6.1 Conclusions (U)

(S) a. Southeast Asia experience has shown deficiencies in some of the munitions and fuzes available and also the need for additional types.

(S) b. No satisfactory all-terrain air burst fuzing of bombs and bomblets is available.

(S) c. The number of duds in present bombs and bomblets form an important munitions source for the enemy.

(S) d. Many of the weapons are not adequately effective in heavy foliage.

4.6.2 Recommendations (U)

(S) a. A high-level OSD task force should examine in detail the existing and proposed Service fuze programs, with the view of achieving substantial technical improvements and cost savings in the development and procurement of fuzes.

(S) b. There has been a trend toward increasing the function options in new fuzes causing cost increases and degradation in reliability and aircraft safety. Minimizing the number of functions should be enforced for every fuze type.

(S) c. There has been a tendency to develop a new fuze when new weapons are produced. The most successful fuze elements (e.g., VT fuze radars, deceleration sensors, pressure sensors, etc.) should be standardized and only repackaged for new applications.

(S) d. Priority should be given to development of low cost, reliable air burst fuzes for bombs and bomblets.

(C) e. Dive-deliverable cluster bombs should be developed.

(S) f. Improved bombs, including a large penetrator, more efficient small fragmenter, better blast weapons, and more types of cluster weapons are needed.

4.7 Guns and Rockets (U)

4.7.1 Conclusions (U)

~~(S)~~ a. Present rockets are ineffective against small area or point targets because of inaccuracies. They are ineffective against large area targets because of small warhead size. The inaccuracy problems appear incurable at reasonable cost.

~~(C)~~ b. Recoilless rifles and guns offer good accuracy and should be used if sufficient standoff range from the target can be achieved.

4.7.2 Recommendations (U)

~~(C)~~ a. Develop recoilless rifles for:

1. target marking and personnel targets, and
2. for hard targets (e.g., bunkers, AAA supression)

~~(C)~~ b. Develop liquid monopropellant for high velocity (5000 to 7000 feet per second) projectiles,

~~(C)~~ c. Develop high velocity (5000 to 7000 feet per second) flechette rounds.

4.8 Target/Weapon Matrix (U)

4.8.1 Conclusions (U)

(U) The Panel took an initial look at a matrix of target types versus weapon types. (See Figure 1.) It can be seen from the figure that no single weapon is a panacea across all or even many target categories; as a consequence, weapons developments must be carefully tailored to special purposes where most needed in the target spectrum.

4.8.2 Recommendations (U)

(U) a. DDR&E should sponsor an in-depth study of the characteristics of targets and the weapons features (by target type) which maximize target destruction.

(U) b. Based on a comparison of the target types and weapons characteristics, necessary weapons development should be initiated in appropriate areas.

Figure 1. Present Technology Status in Weapons

	Bombs Frag Bombs (VT Fuze Optional)	Rockets	Guns and Recoilless Rifles	Cluster Bombs	EO, IR and Command Missiles (1)	Stand-Off Missiles (2)
Troops Prone	2	3	1	1		
Troops in Foxholes	1		1	3		
Point-Tanks, APCs, Arty			1	3	1	
Area-Tanks, APCs, Arty			2	1		
Point & Area-Bunkers, Emplacements	1		2		2*	
Point-Trucks	2	3	1	2	1	
Area-Trucks	1		2	1		
Hard Bridge	1					1**
Soft Bridge	2				1	1**
Small Buildings	1				1	
Large and Area Buildings	1					1**

KEY: Unaccompanied numbers in table apply to permissive and battlefield defense level, numbers with one asterisk (*) apply only to permissive environment, and with two asterisks (**) apply to heavy, static defenses.

1 - best choice
2 - acceptable choice
3 - marginally useful
blank - not useful

NOTES: (1) Applicable in moderate defense environments only if tracking time can be reduced to 6 seconds.
(2) There was incomplete agreement that standoff missiles were as limited in application as shown here.

5. COMMAND AND CONTROL (U)

5.1 Navigation and Position Fixing (U)

5.1.1 Conclusions (U)

(C) An integrated position grid system is required which will ultimately provide the capability of (a) locating the position of friendly troops, vehicles and aircraft, (b) the precise location of enemy fixed and mobile targets, and (c) precise controlling of aircraft and missiles. Sufficient attention has not been devoted to extracting and using velocity information from radio-navigation techniques.

5.1.2 Recommendations (U)

(C) a. Provide the necessary emphasis to ensure that a common position grid capability is made available to the tactical forces. LORAN should serve as the common position grid in the near-term.

(C) b. Continue emphasis on the current Army manpack LORAN program to provide receivers for ground units.

(C) c. Emphasize lighter, smaller and less expensive LORAN receivers in subsequent Air Force procurements to the current AN/ARN-92 buy.

(C) d. Conduct flight tests to definitively evaluate LORAN error sources before proceeding with procurement of LORAN-based systems for blind bombing. These tests should be conducted in several geographic areas to ensure that eventually world-wide performance can be predicted with statistical confidence.

(S) e. Augment the LORAN common position grid capability with STEER where higher accuracy is needed in certain interdiction missions.

(C) f. Continue Air Force 621B design studies for long-term common position grid with emphasis on a light-weight receiver for maneuver elements of the ground forces.

5.2 Bomb Damage Assessment (U)

5.2.1 Conclusions (U)

(C) A most pressing problem in the command and control area is our limited ability to determine whether or not targets are actually destroyed by air and artillery strikes.

5.2.2 Recommendations (U)

(C) Investigate the use of special tactics and sensors in combination with the common position grid capability specifically for the potential of assisting in the evaluation of the effectiveness of air and artillery strikes. One action that should be taken immediately is to equip strike aircraft with cameras.

5.3 Instrumented Battlefield (U)

5.3.1 Conclusions (U)

(S) Ground-based and remote sensors have proven to play an important role in close air support and interdiction. Both DCPG and the Air Force have demonstrated that the multimillion dollar investment in a "barrier" has provided new tactical air capabilities. The "instrumented battlefield" concept should be expanded to include several new and different military tactics and operations. Particular emphasis should be given to providing small decentralized military units with sensors and devices for detecting enemy activity.

5.3.2 Recommendations (U)

(C) DDR&E should request the Army to prepare a plan of action within 90 days to include:

a. Various types of sensors to be evaluated,
b. Test procedures,
c. Specific tactics to be examined,
d. Analysis and evaluation programs,
e. Integration of such capabilities into the combat units' decision process.

5.4 Airborne Surveillance Radar for Vietnam (U)

5.4.1 Conclusions (U)

(S) A few months ago there was intense interest in and concern for our ability to acquire and detect MIG-17s and MIG-21s in North Vietnam. Basically, the main problem was our inability, due to lack of appropriate sites for ground-based radars and inability of EC-121/E-2A to detect targets over land in critical areas, to detect low flying MIG-21s at ranges of 150-200 miles. The early "detection" of enemy aircraft has had to be attempted by collateral techniques. At present, there are still substantial gaps in our radar coverage, and we cannot detect nor track enemy aircraft over large areas of North Vietnam. We believe that there is an urgent need to provide an interim airborne surveillance radar capability for Vietnam as quickly as possible.

5.4.2 Recommendations (U)

(S) a. An early airborne radar surveillance capability should be provided in response to the Vietnam MIG-17 and MIG-21 threat. Immediate use of the E-2A aircraft with a digital data link to TACC(NS) will allow a coherent air surveillance picture with ground/air communications to provide improved MIG warning and should be implemented. Further flexibility in coverage with the E-2B/C system could be achieved and should be exploited.

(S) b. An immediate evaluation should be made to determine the feasibility of a helicopter or balloon-borne MTI radar with a data link to TACC(NS) as a possible supplement to the coverage provided by the E-2A/B/C approach.

(C) c. AWACS is a longer-term solution to the airborne surveillance and control problem and should be pursued with continued attention and emphasis on advanced airborne radar prototype development.

5.5 Control of Tactical Air Force (U)

5.5.1 Conclusions (U)

(S) The planning for close air support and interdiction mission in Southeast Asia has been hampered by (a) lack of aircraft status information and delays in preparation and dissemination of frag orders,

(b) lack of knowledge of location of strike aircraft when strikes are to be diverted, and (c) inability to closely coordinate near-real-time target information and strike operations.

5.5.2 Recommendations (U)

~~(S)~~ a. Rapid improvement of TACC capability in Southeast Asia is required in the area of preparation and dissemination of frag orders. Source data automation is also required.

~~(C)~~ b. Locate targets and friendly units in the common position grid system (discussed under 5.1). The common position grid capability should be augmented by periodic transmission of aircraft position as presently planned in the LORAN Integration Equipment Program.

~~(C)~~ c. Integration of intelligence and operations functions should be employed for rapid response to near-real-time target information.

6. GENERAL OBSERVATIONS AND RECOMMENDATIONS (U)

6.1 Special Management Procedures (U)

~~(C)~~ The Panel is concerned over the exorbitant amount of time taken for concepts to be transformed into operational hardware. This is not the usual concern over Quick Reaction Capability for specific black boxes. Rather, the Panel believes that the development cycle of even major subsystem programs, such as the standoff missiles described above, can be significantly shortened.

~~(C)~~ To achieve this acceleration, we propose the following guidelines:

a. Use competitive development of flight hardware—contract definition based on equipment, not just paper.

b. Use of only two review cycles at ODDR&E level. If the concept is sound, develop it; if the equipment works, produce it. Be prepared to accept a few more failures as the price for progress.

c. Keep the equipment simple. Do not ask for ultimate efficiency. Do not ask for a wide variety of functions.

d. Construct the program so as to have an orderly growth, to expanded capabilities, that makes use of prior year developments. This allows subsequent programs to also have short cycle times.

e. Base the decision process outlined above on the concept paper approach described in Section 2.4 in order to provide an agreed framework. This avoids holding up hardware while discussing concepts.

f. Include training and initial cadre personnel in the development organization so that a smooth transition to operational use ensues.

6.2 First Line Versus Auxiliary Air Forces (U)

~~(S)~~ We note a tendency in both present and future force plans to concentrate on a sort of classic air force made up principally of aircraft types of traditional design. Force structures should take more account

of the need to deal with requirements such as gunships or an equivalent replacement, and airplanes for close support in wars without front lines Quiet aircraft, helicopters and balloons all have a place in the types of wars which we believe will be the pattern of the future.

6.3 Upgrading Existing Systems (U)

(C) We note that many systems are not well-maintained in the field, that levels of training are in general too low, that minor changes could make systems much more effective. We believe that the R&D portion of the military should do a better job of follow up to see that systems do work in the field. The ODDR&E Directorate for Operational Test and Evaluation may be of help in seeing that this problem gets attention. It appears that often it is easier to get money to buy new equipment than to repair and/or make minor modifications to existing systems.

6.4 Application of Experience (U)

(S) Due to the high turnover in the theater, much valuable experience in tactics and techniques is lost. A better memory, better way of transferring valuable experience both horizontally and vertically, in the system is needed.

6.5 Activity Reports (U)

(C) Our brief exposure to COACT data indicates a need for continued effort on refining the requirements and processes for reporting activity data. Care should be taken to understand ahead of time why the data is to be reported. Also, in specifying requirements for activity reporting, one should not request data from a source which may not have it, since people are prone to checking off items on a form whether they have factual information or not. Duplication of reporting requirements should be minimized.

6.6 Equipment Design (U)

(C) Equipment design philosophy should be matched to employment philosophy. In general, aircraft are designed on the (apparent) assumption that they will be employed singly and autonomously. In fact, they are almost always employed in 2s, 4s, or larger groups. Improvements could be made in operation if aircraft were specifically designed to support each other directly by sharing responsibilities in ECM, navigation, target location, and strike.

6.7 Organization (U)

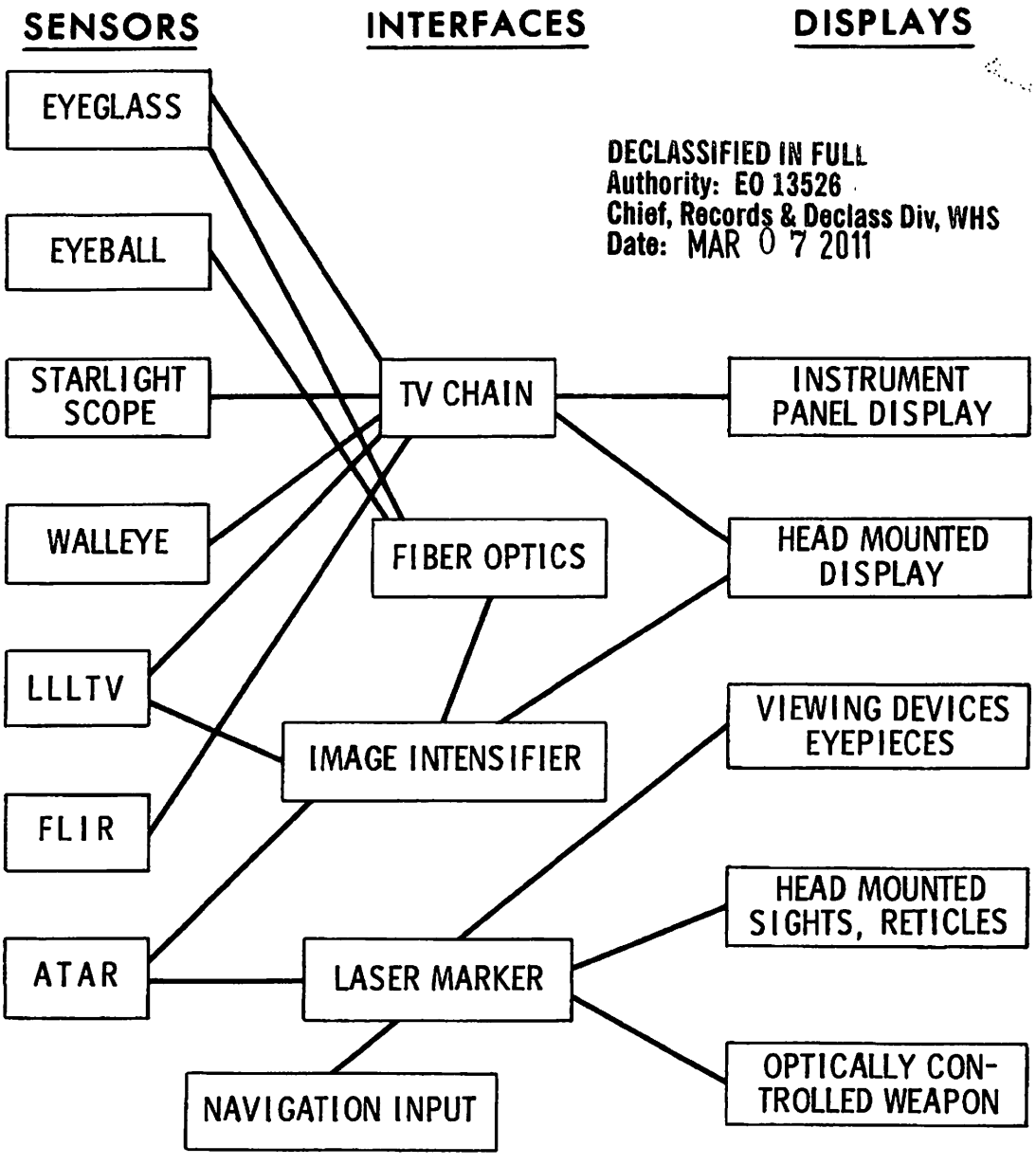
~~(S)~~ The process of dealing with requirements for fixes, R&D requirements, etc., related to Southeast Asia is still clumsy, especially when compared to the urgency of the demand for improvements. A streamlined way of handling Southeast Asia requirements has not evolved and is badly needed. The task force approach used in DCPG could be applied by the Services for those programs which are of the highest priority.

APPENDIX A

SPECIFIC SUGGESTIONS

OPTICS DEVELOPMENT PROGRAM

for coordinated use of optical aids



DEVELOPMENT NEEDED
- HEAD-COUPLED SIGHTS AND DISPLAYS
- AIDS TO TARGET ACQUISITION AND TRACKING
- TARGET MARKING AND DESIGNATING
- HOMING HEADS FOR GUIDED WEAPONS
- STABILIZED SIGHTS AND MOUNTS
- TIE ALL TOGETHER AS NECESSARY - e.g., USE LASER
- TO MARK TARGET SEEN LLLTV ON HEAD-MOUNTED DISPLAY

OPTICS DEVELOPMENT PROGRAM (U)

~~(S)~~ The application of optics to target acquisition constitutes a vast underdeveloped area. Some applications have been made (e.g., ATAR, WALLEYE, TROPIC MOON, TRIM, SEANITEOPS, Project PAVEWAY) but, in general, a systematic approach to integration of sensors, displays and weapons delivery is lacking. Because of the many options available, we do not believe it is practical to recommend specific implementation of optical aids for specific aircraft. Rather, we strongly urge that a development and test program be carried out which has the objectives of finding the best configuration and combination for reconnaissance, reconnaissance/strike and attack aircraft. Many promising combinations of sensors, display and designators would be tested in the laboratory and the best would be field tested in tactical aircraft in a simulated environment.

~~(C)~~ We feel that such a development and test program should be oriented from the beginning toward flexibility to combining sensors and display and in integrating new sensors and displays with minimum retrofit of aircraft. In a recent AFSC mission analysis on improved accuracy in non-nuclear ordnance delivery, a "core" concept was introduced. We believe that this concept is also applicable in the integration of optical sensors and displays. This concept would require standardization of outputs from sensors and inputs to displays such that a given display may present data from more than one sensor. In addition, when a better sensor is developed, it may be integrated into the sensor/display system without requiring modifications.

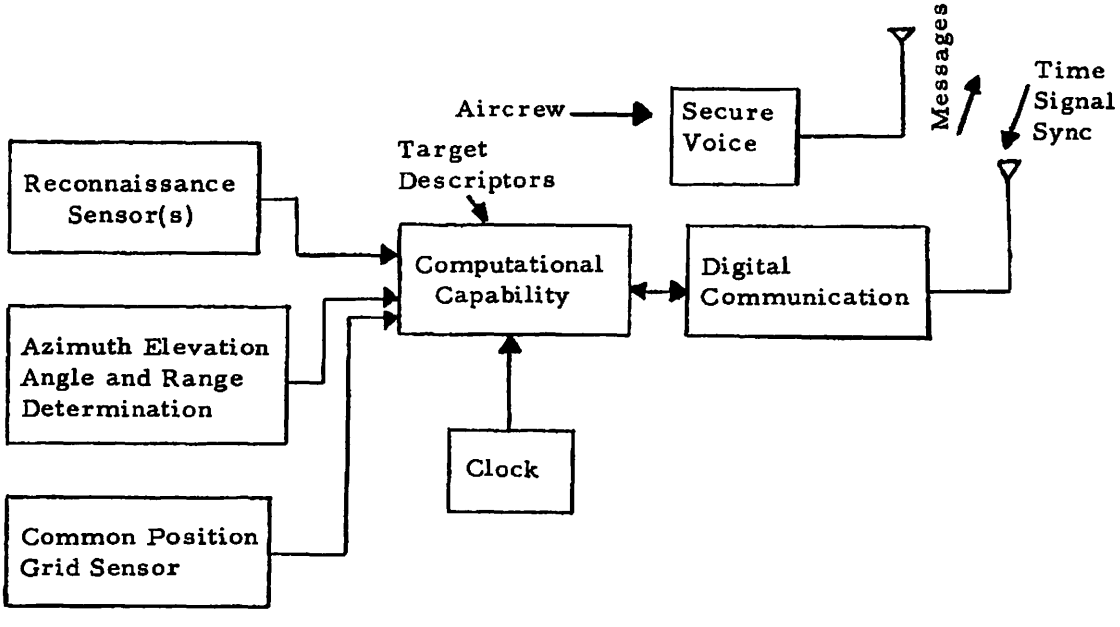
(U) DDR&E should ensure that a systems concept is established, all appropriate techniques are considered and that joint tests are conducted at appropriate times.

AUTOMATIC TIME AND POSITION REPORTING

SYSTEM FOR VISUAL RECONNAISSANCE (U)

~~(C)~~ For those aircraft equipped to work in a common grid position, such as LORAN, STEER, or NAVSAT, the system would provide automatic time and position keyed to the observations made. For recce and FAC aircraft, the system would provide for digital data transmission of reconnaissance information (target designation, time, location).

~~(C)~~ Varying levels of capability can be provided depending on the missions of aircraft. The minimum common equipment would be the common grid position sensor, voice link, and timing capability.



ACTIVITY INDICATOR DEVELOPMENT PROGRAM (U)

(C) An activity indicator is a surveillance system which maintains an overview of the whole battle area and displays at a control central evidence of activity, mainly enemy activity. The output is used for assignment of recce, recce/strike and strike missions platforms.

(S) The primary source of data is MTI radar on elevated platforms. Secondary sources are distributed sensors, other radar, visual sightings, and ELINT (particularly TOA or its equivalent at lower frequencies).

(U) A development program is needed to ensure that all elements of the activity indicator are brought along.

(S) Key elements are:

MTI radars including foliage penetration types

Distributed sensors

Displays—separate for each type of sensor plus combined displays.

(C) Related elements are those which would automate the visual reporting process so that sightings are given accurate time, position and descriptive tags.

(U) Since these components are or should be pursued in all three Services, an OSD-coordinated effort is needed which gives each Service the authority to pursue an active development effort on its own. ODDR&E should ensure that the pieces go together and that joint tests are conducted at appropriate times.

SUGGESTED CONTENT OF A MEMORANDUM FROM

THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

TO THE ASSISTANT SECRETARY OF THE ARMY FOR

RESEARCH AND DEVELOPMENT (U)

~~(S)~~ 1. The Tactical Aircraft Panel of the Defense Science Board/ National Academy of Sciences Summer Study Group has identified a possible command and control problem in the sensors developed by the Defense Communications Planning Group.

~~(C)~~ 2. The Panel believes that a truly integrated and automated system that provides for information collection, intelligence production and display, operational decision making and near-real-time exploitation is feasible and required by ground and air commands. Further, they believe that immediate testing of such a system should be initiated.

(U) 3. It is requested that the Army develop a concept of such an integrated system to determine its feasibility and its applicability at Company, Battalion, Brigade and Division level. This concept should include effective use of the information by tactical air commanders (perhaps via the Air Force Direct Air Support Center), and the Army is requested to develop their concept with the assistance and participation of the Air Force. Further, it is requested that the Department of the Army submit a plan for the testing of this concept to DDR&E prior to 1 November 1968.

QUIET AIRCRAFT AND DRONE PROGRAM (U)

~~(C)~~ Quiet aircraft and drones have application in medium threat situations for both FAC and recce purposes and perhaps recce/strike. The QT-2 program is interesting but has limited payload. To carry adequate packages of sensors and/or ordnance, heavier payload is needed. Quieting of engines and propellers to 500 h.p. seems feasible. Aircraft of this power would be extremely useful for FAC for night work and also for recce/strike.

~~(S)~~ The QH-50 drone helicopter has been under development for some time; first for ASW, then for artillery spotting, and now for night FAC. This program should be supported to configure optimum payloads and control systems. Reliable operation out to distances of 100 miles should be the goal.

(U) Since Navy and ARPA are already supporting the program, this support should continue. Air Force should determine whether reliability goals are likely to be met to see if a parallel development would be advisable.

FUZE DEVELOPMENT PROGRAM (U)

~~(C)~~ Fuze technology is available one place or another for many uses in missiles, bombs, rockets, artillery, etc. However, many current weapons do not have satisfactory fuzes available. There is thus a mismatch between available fuzes and available requirements. A tri-Service, OSD-managed study is needed, performed by a task force of knowledgeable people who can:

1. Assess existing requirements,
2. Survey existing developments,
3. Match the needs of (1) and (2),
4. Point up gaps requiring further R&D, with recommendations on how to close the gaps,
5. Recommend changes in existing procurements,
6. Recommend a method for continual monitoring of the fuze R&D and procurement programs so that dud rate is reduced, unsafe weapons are eliminated and latest technology is applied in all three Services.

~~(C)~~ One of the recommendations of several recent studies is that we develop an air burst capability for cluster weapons. One objective of the study would be to determine whether such weapons can be produced economically and how much effectiveness would be improved thereby.

APPENDIX B

PENETRATION SUBPANEL

Lt. Col. Jasper A. Welch, Jr.,
Subpanel Chairman
Dr. Thomas P. Cheatham, Jr.

1. INTRODUCTION (U)

(C) It is recognized that the projected trouble areas of the world spell out a dominant trend for continued wars and conflicts of the nature we observe in Southeast Asia. The character of these conflicts are that they involve an intimate blend of military, political, psychological and economic factors which create a complex mixture of constraints on technological and military management solutions. The end result is a greater emphasis on the operational flexibility and sophistication of "whole system" options where tactical superiority is achieved through innovative real-time solutions created from an inventory of techniques, systems and subsystems on a professional basis.

(C) Emphasis is given here to the problem of defense penetration for fighter bombers in those tactical air operations characterized by high explosive ordnance, repeated missions, multiple aircraft formations and multiple, diverse defenses.

(S) Analysis shows that for most tactical situations a single penetration aid or tactic only reduces losses by at most a factor of two or three. However, appropriate combinations of different penetration aids and tactics can reduce losses by factors of over 100 against defenses consisting of an integrated deployment of automatic weapons, anti-aircraft artillery, advanced heat-seeking surface-to-air missiles, and radar guided surface-to-air missiles of the SA-2 type. This type of environment exists in North Vietnam and other projected trouble areas. We feel that significant improvement factors on penetration losses per target destroyed are achievable at modest cost and within approximately two years.

(U) To delineate the objectives for penetration aids and/or penetration schemes, systems or broader penetration options, we find that actual (or projected) aircraft loss rates for a campaign as a whole (as now published and used) is not a useful or instructive measure of either the strength of defenses or the utility of aggregated penetration efforts. The basic difficulty is that the overall loss rate (in terms of aircraft lost per thousand sorties), being an average over attacks on lightly and heavily defended targets, can be easily adjusted by varying the fraction of sorties flown against heavily defended targets or the fraction of desired destruction used in the preparation of flight mission orders. This point is analogous to a well known factor of business management practice that costs always rise to meet the budget.

(S) The point of this discussion is the realization that in actual campaigns, attacks on heavily defended targets, though they occur and must occur, are inhibited by the very real pressure to keep the overall loss rate down to something acceptable to the country's resolve and to its production rate for both pilots and materiel. Thus the objective for penetration aids and systems emerges as the providing of the opportunity to attack more often and more effectively those high value targets that are heavily defended. The numerical objective for penetration aids is to reduce the loss rates for high value, heavily defended targets by a factor of 10 to 100. The leverage of a modern and dynamic penetration capability is therefore seen to impinge not so much on the cost of materiel losses as upon the viability of a powerful strategy for execution of the war.

(C) From these and other considerations of the role of an integrated system of penetration aids in the whole context of tactical air operations, several implications for R&D planning are evident. We single out the following three for special understanding and attention:

a. An appropriate measure of merit for penetration effectiveness is the reduction in aircraft attrition per target destroyed so that ordnance delivery accuracy and other improvements to tactical air effectiveness are validly considered on a "whole system" basis.

b. Attention should be focused on the more powerful options of attacking highly valued and hence highly defended targets since they determine the dynamic range of our available strategies and options both to win and negotiate in a complex military, political, psychological, and economic environment.

c. Combinations of penetration aids are needed with the flexibility of quick reaction to alternate configurations of varying composition to cope with varying levels of defense and tactics.

2. GENERAL FINDINGS (U)

(S) Within the context of first providing various levels of response to allow achievement of a degree of air superiority and/or control in the terminal target area, we find that the single most important improvement to current capability, in terms of reducing aircraft losses per target destroyed, would be to improve the probability of target acquisition and accuracy of weapon delivery—particularly at night, in bad weather, and from low-level flight—and to do so in a manner that does not increase aircraft vulnerability.

(S) The acquisition of an accurate standoff missile that functions well in poor visibility and has utility for defense site destruction would add tremendously to our penetration capability and reiteratively affect the dynamic range of our tactics and strategic options. Three types of missiles are called for—one to stand off from and attack anti-aircraft artillery, one to stand off from and attack radar directed, surface-to-air missiles, and one for deep penetration through integrated surface-to-air missile and interceptor defenses.

(S) The substantial reliance of field army air defenses on visual acquisition and tracking places strong emphasis on penetration and striking capability at night and under conditions of poor visibility.

(S) Aircraft maneuver limits (with realistic ordnance loads) will continue to be important to avoid low altitude anti-aircraft ground fire and will continue to be the more critical item in air-to-air combat and in avoidance of "g" limited and command limited defense missiles.

(S) Electronic countermeasures will continue to be critical not only for their direct utility against surface-to-air and air-to-air defenses but also for allowing higher altitude flights to avoid low altitude defenses such as guns and small, IR-seeking SAMs.

3. SPECIFIC FINDINGS AND RECOMMENDATIONS (U)

3.1 Air Superiority (U)

3.1.1 Finding (U)

(S) There is an urgent need to upgrade the tactical air capability with regard to an advanced tactical fighter and corollary combat support systems such as AWAC, IFF, support jamming, search and rescue systems and tankers.

3.1.2 Recommendations (U)

(C) Independent of the outcome of current considerations on the proper choice and sequence of airframes for air-to-air combat (to which discussions the Panel as a whole does not feel competent to contribute), the Panel recommends proceeding with the following equipments and support capabilities:

a. Helmet mounted sights and displays.

b. Improved fighter-to-fighter ordnance including agile missiles and new, high velocity guns and ammunition.

c. Improved identification to include telescopes such as ATAR.

d. Situation awareness information to include detailed and specific air-to-air warning divided between self-contained equipment and combat support systems such as AWAC.

3.1.3 Discussion (U)

(C) The Panel did not investigate the choice and sequence of future air-to-air fighters. However, the work of the DSB Task Force on Tactical Aircraft was reviewed with regard to the sub-systems useful in improving penetration.

(C) The Panel was particularly impressed with the flexibility and time savings afforded by the use of helmet mounted sights and displays. Vigorous effort should proceed for both air-to-air and air-to-ground applications.

~~(C)~~ The Panel sees the need for improved air-to-air ordnance —especially those that tend to improve the effective "performance" of the aircraft/weapon system. Tests of the guided gun should go at a brisk pace with the first objective being to validate the principle. Improved average gun velocity (through muzzle velocity and flechette ammunition) should be pursued as should agile missiles, useful for a short range and for off angle attacks.

~~(C)~~ There is a broad but important requirement for real-time situation awareness/response equipments and systems. Some of these equipments such as ATAR, IFF, IR detector, and RHAW are self-contained in the basic fighter-bomber aircraft; others are contained in more general combat support vehicles, the information to be delivered via an addressable data-link of adequate reliability, security and data rate. A near- and long-range plan for equipment and systems that is balanced and specific is needed. Compatibility between Navy/Marine Corps/Air Force tactical air programs and equipment is a must. All the systems mentioned above should be supported through a comprehensive test and evaluation phase.

3.2 Close Air Support (U)

3.2.1 Finding (U)

~~(C)~~ The present emphasis on reduced physical vulnerability, agility, and IR suppression for close support aircraft is appropriate. The Panel finds, however, that full exploitation is not being made of visual countermeasures in view of the substantial reliance that field army defenses place on visual acquisition and tracking.

3.2.2. Recommendation (U)

~~(C)~~ Present emphasis in hardening, agility and IR suppression should continue. In addition, we propose an experimental program to develop adaptive visual camouflage and the development of ordnance delivery schemes that can operate in poor visibility. In particular, we propose development of a two-place version of the A-X type (as in Air Force CFP of June 1968) from the outset, with night sensors and special day telescopes in addition to the basic one-place version for clear daylight.

3.2.3 Discussion (U)

~~(S)~~ During World War II a successful flight test was made, under the code name Yehudi, that demonstrated feasibility of substantial

reduction in visual acquisition range by employing closely spaced lights on the front aspect of B-24 aircraft on low-level anti-submarine patrol. The implementation was somewhat awkward then but could work more easily now. Some work was sponsored by the Army recently to investigate use of luminescent panels. Because of the variation in sky background brightness, protection from multiple aspects requires monitoring of the sky and continuous adjustment of light color and intensity.

~~(S)~~ The most familiar poor-weather bombing mode, level with long bombing runs, actually serves to increase aircraft vulnerability to some defenses, notably radar-directed guns and surface-to-air missiles. What is needed are more flexible flight profiles, but with poor visibility sensors. One example now under investigation involves bombing during turns or other maneuvers. Coupling this with angle-rate measurements obtained from night sensors or haze filtered daylight telescopes will provide accuracy, flexibility, and a net visibility advantage to the air crew over the ground defensive crew.

3.3 Standoff Missiles for AAA Environment (U)

3.3.1 Finding (U)

~~(S)~~ The best specific countermeasures to anti-aircraft artillery (57mm and larger) is standoff. A minimum range of 15 to 20 thousand feet is needed with up to 30 thousand feet being useful.

3.3.2 Recommendations (U)

~~(S)~~ For the short term (about 12 months to IOC) extend the useful range of Bullpup (AGM-12) by equipping the launch aircraft with a stabilized telescope such as ATAR through which to view the target and missile for the final phases of flight. This is envisioned as a two-man operation.

~~(S)~~ Continue to explore longer term solutions with greater operational flexibility (launch, leave, and forget). For example, consider augmentation of the current AGM-79 program to improve accuracy and range by storing a magnified scene (from the stabilized telescope) in the correlation guidance.

3.3.3 Discussion (U)

~~(S)~~ For attack of targets well defended by anti-aircraft artillery (57 mm and larger) or for direct attack on these gun systems, a standoff range of about 15 to 20 thousand feet is needed.

(S) For the short term we propose to extend the useful range of the current Bullpup (AGM-12) by equipping the launch aircraft with a stabilized telescope through which to view the target and missile for the final phases of the Bullpup flight. The same basic telescope that was proposed above for air-to-air identification (ATAR) can be used if it is augmented with an auxiliary zoom telescope for aid in target acquisition. This is envisioned as a two-man operation. A production rate (for the telescope system) of several systems per month could be established in about 9 months. Improved performance in range and accuracy can be achieved by augmenting the missile control gas supply and refining the autopilot at a later time.

(S) For the longer term, missiles with additional flexibility (launch, leave and target) are desired. One interesting approach is an upgrading of the current AGM-79 program. The current missile design is limited in standoff and accuracy (10 to 20 thousand feet and 100 to 200 feet respectively) by the rolling airframe and the use of missile optics to store a reference scene just prior to launch. The proposed modifications would store, simultaneously, a second, highly magnified scene derived from the telescope described above and would stabilize the missile in roll.

(S) With these modifications an accuracy of about 10 feet at full standoff (20 to 30 thousand feet) from AAA should be possible. With this accuracy the standard high explosive Bullpup warhead could be used instead of the dispersed munition now planned for the AGM-79. (Even the dispersed munition could be improved by developing an air burst capability.) We estimate the first production article of this modified AGM-79 could be available in about two years.

(S) The acquisition of guns or targets (whether AAA or field artillery defended by AAA) is today largely through photographic reconnaissance with attendant problems of camouflage and delay. A useful improvement would be a sensor (for gun flashes) to locate the gun for subsequent attack or avoidance. Several developments in this area look promising but are not now an integral part of the attack/penetration planning.

3.4 Standoff Missile for SAM Environment (U)

3.4.1 Finding (U)

(S) It is not prudent to expect, always, to have adequate ECM or other countermeasure against future generation surface-to-air missiles. A standoff missile of 20 to 50 mile range is needed with

the specific capability to attack the SAM system as well as targets defended by it.

3.4.2 Recommendations (U)

(S) For guidance, the use of STEER (Microwave DME through airborne relays) plus optical terminal homing (correlation or real-time TV command). This combination will provide about 10-foot accuracy in nearly all weather.

(S) For airframe/propulsion, adaptations of a current rocket missile fired on a semi-ballistic trajectory from a high-altitude launch aircraft.

(S) This combination will provide IOC in about two years.

3.4.3 Discussion (U)

(S) For attacks on targets defended by radar-directed surface-to-air missiles (or on the missile systems directly), a standoff range of 20 to 50 miles is needed. Considering various alternatives for guidance, the Panel recommends the use of microwave distance-measuring equipment from ground beacons through airborne relays. This concept, called STEER by the Air Force, is attractive not only for its inherent accuracy (50 to 100 feet) and low cost (probably about 5 to 10 thousand per missile for guidance), but particularly for its integral relationship to the time-of-arrival scheme. (Time of arrival solves both of the current and long standing problems in locating and attacking ground radars: accuracy and radar shutdown.) Non-radiating targets would be located in the beacon coordinates by registering the reconnaissance materials with the same system.

(S) Furthermore, this guidance equipment can be used on aircraft for blind bombing (with an accuracy 200 to 300 feet), is compatible with the advanced navigation satellites (Program 621 B) and with Integrated Communication, Navigation, and Identification (ICNI) proposals.

(S) For many targets, even more accuracy is desired and the Panel recommends the use of optical terminal homing. An area correlator with stored photographic imagery would be suitable. Alternatively, a commanded TV guidance like Condor can be used if a low cost data and command link is developed.

(S) By giving the missile a slow (600 fps), near-verticle descent and by virtue of the good mid-course basket (50 to 100 feet), a correction to about ten feet can be made below cloud formations as low as two to three thousand feet. Such ceilings are available more than 85 per cent of the time in most parts of the world. Northern Europe in winter is one notable exception.

(S) The Panel is concerned that over-emphasis on missile speed, range and low-altitude launch in the current AGM-X-3 planning will result in a sophisticated airframe and propulsion development with a four to six year lead time, whereas a two-year program (with special management arrangements) is feasible using ballistic rockets or subsonic cruise missiles adapted from existing airframe and propulsion. The proposed guidance can also meet the two-year time scale and, of course, the need for the missile is here today.

(S) Part of this over-emphasis results from concern for the vulnerability of the missile per se. However, it appears that high subsonic speed or better is adequate to ensure that enough missiles will penetrate gun defenses. (The missile has only about one per cent of the vulnerable area of an airplane and can afford about one hundred times the attrition rate; these factors more than compensate for the aircraft's ability to maneuver.) If the defense allocates a missile against an ASM (about an even trade in cost), the offense wins in the long run because it delivers missiles selectively to given areas and can saturate the defenses at each target in turn.

3.5 Standoff Missiles to Avoid Deep Penetration (U)

3.5.1 Finding (U)

(S) As an alternative to deep penetration with manned aircraft, the Panel investigated the use of a subsonic cruise missile with 200 to 500 mile range in both surface-launched and air-launched versions. Such a system appears feasible within the current state of the art and could be developed in a few years with special management procedures.

3.5.2 Recommendation (U)

(S) To provide 200 to 500 mile standoff through combined SAM and air-to-air defenses, the Panel recommends:

a. For guidance, the same as for the standoff missile for SAMs only; namely, STEER plus optical terminal homing.

b. For airframe/propulsion, a high subsonic cruise missile using pulse jet, or turbo fan as proves best in availability/cost tradeoffs.

3.5.3 Discussion (U)

(S) The recent experience in North Vietnam, especially Route Packages V, VI-A and VI-B, renews the old adage that air operations without air superiority are a costly and hazardous undertaking. In this case the existence of sanctuaries for MIGs, SAM sites, and supply channels and ground radars, together with some deficiencies in anti-radar weapons and air space command and control, led to operations in which the vast majority of combat sorties were in support of a very few bomb carrying aircraft.

(S) In the future, it may again be necessary to deliver ordnance deep into defended territory without the option or capability to first destroy their defenses. The use of deeply penetrating missiles is a viable alternative to the enormous operations needed to allow manned aircraft to penetrate undegraded with acceptable loss rates.

3.6 Electronic Warfare (U)

3.6.1 Finding (U)

(U) The Panel has not attempted to duplicate or improve upon the work of the DSB Electronic Warfare Task Force. A few techniques are singled out below for special attention.

3.6.2 Recommendation (U)

(S) The Panel recommends special attention, as noted, be focused on the following items:

a. Distributed jammers: test in field, reorient design program.

b. Surveillance radar jamming: evaluate utility.

c. IR deception countermeasures: establish DSB subpanel.

d. Visual countermeasures: expand exploratory development.

e. Evaluation of penetration aids: call for concept papers.

f. Combat data: develop flight recorders, improve quality.

g. Towed jammers.

3.6.3 Discussion (U)

(S) The emergence of dispersed or distributed jammer technology calls for a serious evaluation of their utility. We heartily endorse the Electronic Warfare Task Force's call for an immediate series of field tests prior to development of miniature, deployable equipment.

(S) In reviewing the current plans for building such jammers, we note that the simple versions now in the program (wideband, continuous noise) while adequate for Soviet VHF and L-band radars are inadequate for Barlock and other, more powerful S-band radars and for C-band and X-band fire control radars. For these radars, more sophisticated jammers will be needed using automatic or commanded frequency set-on or retro-directive antennas, or both. The design program should be reoriented in this light.

(S) The Panel notes with concern the lack of a comprehensive evaluation of the utility of jamming surveillance radars both as to the degradation in air-to-air capability that results and the relative utility in competition with destroying the radars outright.

(S) In the field of IR deception countermeasures, the Panel feels the need for a developed stockpile of jamming techniques with several designed for each of the possible IR homing detectors and logic. The current development planning appears somewhat fragmented. We recommend that the DSB Electronic Warfare Task Force establish a subpanel to provide continuing assurance that all possibilities are covered. There is a special concern in the IR area, as opposed to radar, in that the seekers are small and passive and can, therefore, be introduced suddenly into a conflict on short notice with little specific prior intelligence.

(S) The field of visual camouflage and countermeasures continues to be neglected, even though the bulk of Soviet defensive weapons rely heavily upon visual acquisition and tracking. Aggressive exploratory research should be started in this area. Particular attention should be paid to smoke trails and active methods for reducing aircraft contrast with lights or luminescent panels.

(U) Our ability to evaluate a comprehensive penetration scheme (equipment and tactics for both strike and protection) is very deficient. Part of this is due to emphasis on one penetrator versus one penetrator analysis whereas combat is flown with gaggles against netted defenses. Part of it is due to over-emphasis on popular threats, for example, the SA-2 to the neglect of visually aimed guns. Part is due to the lack of combat data in sufficient detail to allow engineering evaluation of the actual employment of penetration aids and tactics. We recommend that DDR&E take steps to ensure that the substantial monies now being spent in this area achieve better results.

(U) Among the first steps is to request the Services to develop concept papers that lay out the whole penetration/strike scheme for each of their generic missions (see Section 3.7 below). The main purpose of these papers is to provide a framework against which to judge the adequacy and completeness of our penetration/strike programs.

(U) Another step is to improve the detail and quality of combat data. (The Panel was exposed to one briefing based on the current reporting system that, at face value, implies a very sad quality indeed.) One suggestion is to equip at least some combat aircraft with detailed in-flight recorders (much as the FAA does and for the same reason—to find out why aircraft are lost). Crosstell recording between two aircraft would ensure recovery of the most pertinent data. Another suggestion is to involve the R&D community more deeply in the data acquisition procedures. We see too much attention to quantity and statistics, and too little attention to accuracy and understanding of the data.

3.7 Penetration Concepts (U)

3.7.1 Finding (U)

(U) The Panel is alarmed at the growing tendency of the electronic warfare community to dominate penetration concept planning and to rely upon large amounts of on-board equipment and lone penetrator concepts.

(S) The Panel is concerned that there is a lack of balance and that defense avoidance, defense destruction, and improved delivery techniques are not being properly considered in relation to the "black-box penetration aid" approach.

3.7.2 Recommendation (U)

(C) The Panel recommends that DDR&E call upon the Services to prepare "concept papers" that lay out comprehensive penetration/strike concepts for each generic mission. They should include explicit considerations of: (1) multiple threat environments (guns, missiles, aircraft, etc.); (2) support and auxiliary aircraft for EW, defense destruction, command and control, and warning; and (3) strike tactics and equipment.

3.7.3 Discussion (U)

(C) The papers should be prepared in two phases. Phase I will be qualitative in nature with the purpose of identifying preferred concepts, missing data needed to conduct a quantitative analysis in Phase II, and appropriate measure of merit by which to judge competitive penetration/strike concepts. For the latter, consideration should be given to (but not limited to) the following criteria: (1) targets destroyed per sortie; (2) the wartime costs per target destroyed; (3) the 10-year peacetime costs per target destroyed per day; and (4) the number (cost) of aircraft lost per target destroyed. Phase II will proceed after review and evaluation of Phase I.

(C) The purpose of these concept papers is to provide a framework against which to judge the adequacy, completeness and balance of the penetration/strike development programs.

3.8 Management Procedures to Reduce Lead Time (U)

3.8.1 Finding (U)

(C) The Panel is concerned over the exorbitant amount of time taken for concepts to be transformed into operational hardware. This is not the usual concern over Quick Reaction Capability for specific black boxes. Rather, the Panel believes that the development cycle of even major subsystem programs, such as the standoff missiles described above, can be significantly shortened.

3.8.2 Recommendations (U)

(C) To achieve this acceleration, we propose the following guidelines:

a. Use competitive development of flight hardware—contract definition based on equipment, not just paper.

b. Use of only two review cycles at ODDR&E level. If the concept is sound, develop it; if the equipment works, produce it. Be prepared to accept a few more failures as the price for progress.

c. Keep the equipment simple. Do not ask for ultimate efficiency. Do not ask for a wide variety of functions.

d. Construct the program so as to have an orderly growth, to expanded capabilities, that makes use of prior year developments. This allows subsequent programs to also have short cycle times.

e. Base the decision process outlined above on the concept papers described in Section 3.7 in order to provide an agreed framework. This avoids holding up hardware while discussing concepts.

f. Include training an initial cadre personnel in the development organization so that a smooth transition to operational use ensues.

3.8.3 Discussion (U)

(C) The Panel recognizes, through long experience, that outsiders always are dismayed at how long it takes the establishment to get things done. The suggested guidelines are offered, nevertheless, because the Panel feels that the bold actions embodied in them: (1) will really help; and (2) can be implemented by DDR&E within the current regulatory structure.

(C) The actions will very likely result in some failures and bad decisions, but it must be admitted that the current guidelines are no guarantee against misjudgment.

(C) Perhaps the most difficult guideline to follow is the matter of a limited number of ODDR&E review cycles. The purpose of this is to allow for a more thorough review at the critical points and to place greater reliance on implementation by the field organizations. Furthermore, the other guidelines, if followed, will go far toward providing an adequate basis for the two essential decisions—to develop and produce. For equipment where the production cost exceeds the development cost, these two decisions can honestly and realistically be separated.

(C) The call for equipment simplicity results from a long, hard look at a host of program difficulties. It is not a call for crudeness or improvisation or settling for obsolescent technology. Rather it is a call for elegance in design and fabrication that is focused toward performing goals that are clearly related to military utility. This is where the need for concept papers on penetration/strike is so clearly seen. Unless there are clear performance goals, then the designer is forced to "put in something for every man's taste" and the result often falls of its own weight.

(C) In planning for growth, the game of penetration and counter-defense must recognize the importance of surprise upsets from either side. The acquisition of a look-down/shoot-down capability by the enemy to negate our current lower level penetration, the ability to interrogate our IFF system, are but a few of the important advances the enemy could make that would throw a transient into our penetration capability posture. It is not our simple recommendation that these possibilities should be worked on—because indeed they are in one place or another. Our finding and our deep concern is that the intelligence community and the R&D community are not sufficiently aroused and sufficiently connected through a responsible management element of the Government to provide hard engineering and design response on a quick reaction basis. Too much of this real life determination of the enemy's tactical capability is done behind tightly closed doors, on an on-the-cuff basis by privileged amateurs at a low level of activity. Recent changes in ODDR&E are a step in the right direction, but there remain substantial opportunities to improve the coupling.

APPENDIX C

RECONNAISSANCE SUBPANEL

Mr. Terrell E. Greene,
Subpanel Chairman
Mr. Harry Davis
Dr. E. L. Rabben

1. SCOPE OF THIS REPORT (U)

(U) Reconnaissance is conducted to supply information for a variety of uses in tactical operations. Typical uses include determining enemy order of battle, targeting, strike assessment, weather forecasting, mapping, and providing intelligence on new enemy weapons. In keeping with the general topic of the Tactical Aircraft Panel—finding and hitting targets—the Reconnaissance Subpanel has concentrated on reconnaissance for targeting and strike assessment. This has resulted in emphasis on real-time sensor and display systems for reconnaissance-strike and fast-reaction strike operations, and on nonreal time systems providing response within the times required for preplanned strikes and damage assessment in continuing tactical operations, i.e., times of the order of a few hours to a few days. As in the work of other Subpanels, the Reconnaissance Subpanel has considered only questions related to non-nuclear limited war. More specifically, this panel has concerned itself primarily with problems of reconnaissance in operations like those in South Vietnam and Laos.

(U) Important reconnaissance functions in tactical operations can be conducted by strategic systems. Discussion of these systems is outside the scope of this report. This omission is generally consistent with the focus of the Subpanel's interest as stated above. Two additional limitations of subject matter are the lack of explicit consideration of reconnaissance for naval surface and antisubmarine warfare and the very limited treatment of reconnaissance against electromagnetic radiation emissions (ELINT).

(U) Several comprehensive studies have been conducted in recent years and are still valid; it was appropriate to build on their foundation rather than to cover the entire subject again. In particular, TAC RISE and WSEG Report 86 and its supporting WSEG Staff Studies provide a valid starting point for current investigations. The objectives of the Subpanel were to make use of the experience accumulated in tactical warfare and counterinsurgency operations since the publication of these reports, to take into account the impressive advances that have occurred in technology during this period, and to emphasize those topics on which current R&D and future operational decisions must be made.

(U) Topics on which the Subpanel presents conclusions and recommendations are listed below and discussed in the following pages.

- The relative significance of improvements in procedures, techniques, and hardware.
- Reconnaissance sensors: visual, photographic, infrared, laser, passive and active aids to visual sensors, radar, ground-based remote sensors.
- Reconnaissance platforms.
- Transmission and display of reconnaissance information.

2. PROCEDURES, TECHNIQUES AND HARDWARE (U)

2.1 The Problem (U)

(C) Reconnaissance and surveillance in tactical operations as exemplified by experience in Southeast Asia, particularly in operations outside of North Vietnam, have a low effectiveness, in that (1) enemy targets and activities are not known routinely in a timely way, and (2) information in general is qualitatively and quantitatively inadequate to support military and political operations, even though vast amounts of raw data are collected.

2.2 Conclusions (U)

(C) Tactical reconnaissance and surveillance operations typically have low effectiveness, especially in other than classical, set-piece operations against fixed targets and conventional forces in open terrain. Even in operations of this type the system tends to become inundated with more data than is needed or can be used.

(C) The concept and practice of tactical reconnaissance and surveillance are not adequately matched to operational information requirements for the type of war that is being fought now, except for occasional special efforts and some relatively small-scale reconnaissance strike programs.

(C) There is a gross imbalance between the hardware employed for collection of data, and the techniques, procedures, and capabilities for processing the data collected.

(C) There is also a gross imbalance in the amount of data collected and the amount which can be exploited. While improvements in exploitation are urgently needed, it is more important to reduce the amount of data collected by several orders to match our exploitation capabilities. A better understanding of the need for low detail, large volume collection supplemented by selective, high quality, but very low volume data is needed and hardware and procedures using this principle must be introduced.

(C) Operational and R&D emphasis has been on the collection of imagery and other raw data. In comparison, data handling and data exploitation have been underemphasized.

2.3 Recommendations (U)

(U) Implementation is needed of a comprehensive and specific concept of reconnaissance operations that (1) emphasizes techniques and procedures, (2) is based on specific information requirements and characteristics needed to support combat operations and which (3) integrates technology, all-source collection means, processing, interpretation, data handling and information exploitation.

(C) Requirements for reconnaissance and surveillance should be stated in terms of specific information needed for an operation or program, rather than in terms of the area to be searched and the scale and resolution of the desired coverage.

(C) A major effort should be made to reorient reconnaissance concepts and operations, to produce a better match than now exists between the stated requirements for data gathering and (a) the operational needs of air and surface commanders, (b) the technical capabilities of sensors and platforms and (c) capabilities for processing, display, distribution and use of reconnaissance information.

(C) Personnel selection and training criteria which are demonstrably related to the operational task should be developed and enforced for imagery interpreters.

(C) Reconnaissance crews, especially those operating low-speed FAC observer, hunter, and reconnaissance-strike aircraft, should be selected on the basis of suitability tests and should have more training in visual reconnaissance. Such training should be conducted in realistically simulated operational environments, using image interpretation techniques and systematic search and recognition patterns.

(C) Communication procedures should be arranged to facilitate transmittal of reconnaissance and surveillance information from reconnaissance air crews to the intelligence gathering facility and to strike control centers. The system implications and desirability of extending this improved capability to all air crews over enemy territory should be studied.

2.4 Discussion (U)

(C) It is clear that the emphasis in reconnaissance and surveillance operations and R&D has been almost entirely on hardware, and on hardware for collection of data; this is substantiated by many reports, presentations and discussions made available to the Panel. Very capable

hardware systems are in field use as a result, and increased capability is available from the R&D pipeline. However, this emphasis has been at the expense of the development of techniques and procedures, so that inadequate "software" frustrates reconnaissance effectiveness.

(C) The tactical reconnaissance systems currently operating possess the capability for acquiring, processing (slowly) and disseminating vast quantities of data. Although many worthwhile improvements may be made in reconnaissance hardware, it appears to the Panel that significant improvements in system effectiveness can only be made, and should be made, via changes in procedures and techniques.

(C) It appears, for example, that the operational concept for reconnaissance and surveillance operations now in effect is a simple one which begins, and essentially ends, by using all available hardware to collect as much data as possible. The data handling systems therefore become inundated, because the data handling systems and the control of collection missions are grossly mismatched. Moreover, neither has been demonstrated to be matched to operational information needs. Consequently, it is usually impossible, for many needs, for information to be timely or qualitatively or quantitatively adequate despite the volume collected.

(C) It is evident, from omissions in presentations to the Panel and from reports and studies, that the information characteristics and dimensions needed to support combat operations are not determined systematically or specifically, nor are they used as a basis for the employment of hardware and the assignment of missions (with rare exceptions).

(C) As a result of the emphasis on generalized, intensive collection, without equivalent attention to processing and exploitation, today's reconnaissance operations are characterized by enormous volumes of data (collected at considerable cost and risk) that are never examined or are converted to information too late to be operationally significant. This is not a new situation; the same situation occurred in the Korean War. Good and useful intelligence, targets, and combat support information is undoubtedly lost in the clogged pipeline. Rather than try to unclog the pipelines by a tour de force in faster processing, procedures must be adopted to circumvent the clogging before it occurs. One of the most promising ways to prevent the data indigestion is to collect low-quality information suitable for an activity indicator. From this display, the commander can determine the regions where selective, high-quality reconnaissance is necessary.

(C) The Vietnam reconnaissance problem, in common with many others, appears to be characterized by a need to maintain continuous surveillance over large areas and, at the same time, to be able to obtain definitive and timely information about many pinpoints. There does not appear to be a reconnaissance control organization[1] that receives information requirements for which the relation to a specific operation is clear, that can consider all of the available ways to obtain the information (by aerial and all other means), that knows how soon the information is really needed, and then has the technical and operational expertise to order satisfaction of the need as well as later follow-up to learn whether the technique used was the proper one.

(C) A critical and persistent weak link in the reconnaissance process is image interpretation. The primary problem is in the mass flow of data. During World War II, PIs of the RAF often had hours or days to pore over a single series of photographs; today's PI in Vietnam has only minutes, and there is no Ruhr Valley complex with well-defined targets to work on. In addition to reducing the workload to reasonable proportions, significant improvements in interpretation could be made via improved selection and training of personnel and techniques of operation. Despite high-level awareness of this lack, selection is still largely on an as-available basis without other than a chance match between personnel and task. Training is too brief and in general only suitable for trainees who already have considerable military experience and who know the enemy. The techniques of use do not incorporate proficiency checks of interpretation as a routine procedure, and rely almost entirely on recognition of configuration.

(C) [1]Except in special instances such as Operation Niagara in support of Khe Sahn.

3. RECONNAISSANCE SENSORS (U)

3.1 The Problem (U)

(U) Rapid advances in technology during the past decade provide the current system designer with a wide variety of choice as to the basic sensors for reconnaissance data gathering. It is important to choose sensor types and performance specifications on the basis of operational needs, exploiting the specific capabilities of the various kinds of systems available, rather than to try to develop and deploy hardware of each type that pushes technology to the limit. This is required not only in the interest of saving money, but also to conserve payload on reconnaissance platforms and to orient the procedures and techniques of the operational system along the most productive lines.

3.2 Conclusions (U)

~~(C)~~ Direct visual reconnaissance can and should continue to be one of the most valuable means for daytime area surveillance and target detection, and for targeting in daylight reconnaissance-strike operations. Much can be done to improve the process of sensing, collection, display, and use of visual data from reconnaissance aircraft. In addition, it would be important to improve the latent visual reconnaissance capabilities of those aircraft on sorties not specifically designated for reconnaissance that are operating at speeds and altitudes permitting effective visual observations.

(U) An improved navigation system, operating in the same coordinates as the navigation system used by strike aircraft, would be an extremely valuable aid to both visual and non-visual reconnaissance systems.

~~(C)~~ Photographic reconnaissance will continue to be the basic means for detailed targeting of preplanned air and ground strikes against fixed targets. Photography should be used to provide definitive coverage of points or small areas selected for examination by such means as visual reconnaissance, ELINT, radar indication of activity, ground operations, etc., rather than to provide area surveillance. Area coverage by photographic sensors for purposes such as area mapping and weather

forecasting can often be provided efficiently by other than tactical systems.[2]

(C) Passive infrared reconnaissance sensors should have an increasing potential for night time use in both real-time viewing and permanent imagery. This type of system has demonstrated capability not only for detecting man-made heat sources, but for providing real-time viewing of terrain and cultural environments with imagery approaching that of photographic quality.

(C) Real-time, passive night observation devices operating in the visible spectrum should also grow in importance for reconnaissance-strike and definitive spot-coverage missions. Both low-light-level television (LLLTV or L^3TV) and direct-view image intensification devices show useful capabilities at present and have a considerable growth potential for the future.

(C) Overt and covert active illumination devices should play an important role in night reconnaissance and reconnaissance-strike operations. Floodlights, pulsed flashers, and laser scanning devices along with infrared and ultraviolet illuminators can have uses in various environments and tactical situations.

(C) Because of the many options available and the rapid growth in technology, the Subpanel is not at present in a position to recommend a specific set of optical systems for reconnaissance and strike aircraft. However, it is concluded that a comprehensive study, development, and test program is needed to determine preferred configurations and combinations of sensors, sights, displays, illuminators and designators.

(C) Moving target indicator (MTI) radar could be extremely useful as an area surveillance device to indicate enemy activity. Its significance as an activity indicator appears considerably greater than its capability for ground mapping and high-resolution detection of stationary targets. MTI radars for area surveillance may be suitably installed on aircraft, helicopters, balloons, or towers in various situations. With such systems, the goal of continuous area surveillance may be achieved.

(C) [2]Strategic reconnaissance systems, the SR-71 for example, might provide mapping service during a continuing phase of a war in which tactical reconnaissance systems are fully employed in targeting and strike assessment operations. At other stages of a war, the tactical systems could and undoubtedly would be employed in area coverage photographic missions.

(S) There should be a continued and expanding role for ground-based remote sensors that send information on enemy activity via airborne relays. This information should be increasingly useful for real-time tactical intelligence gathering and for quick-reaction strikes.

3.3 Recommendations (U)

(S) Provide an improved navigation and position-indication and recording system for use in visual and nonvisual reconnaissance aircraft that operates with as good accuracy as that required for navigation on strike missions (say, 0.1 to 1.0 km accuracy). The reconnaissance navigation system should operate in the same coordinate system as the strike navigation system.

(S) Develop a simple automatic time and position reporting system, along with a secure voice link, for use in reporting visual reconnaissance information. When a reconnaissance report is given in real-time or on a recording, the time and aircraft position should be inserted automatically into the report. Such a system would also have utility for nonvisual reconnaissance and for other than reconnaissance operations.

(C) Study the design, cost and operational utility of a helmet-mounted sight coupled with a laser ranger to provide range and bearing information on targets sighted by visual reconnaissance.

(C) Support continued development of covert and overt battlefield illumination systems and laser scanning devices for covert photography.

(C) Establish a development and test program with a single designated executive office to find preferred configurations and combinations of optical systems—including sensors, sights, displays, target locations and designators—for reconnaissance and reconnaissance-strike operations.

(C) Support continued development, testing, and system studies of remote, ground-based sensors for reporting enemy presence and activity.

(S) Emphasize MTI (rather than high-resolution ground maps) with real-time readout in reconnaissance radars.

(S) Study use of tethered-balloon-borne and helicopter-borne MTI radars for continuous area surveillance.

3.4 Discussion (U)

3.4.1 The Task of Finding Targets (U)

(C) One of the most striking aspects of target acquisition is the limited extent to which it can be done truly autonomously. The target acquisition process relies extensively on maps, photo reconnaissance, stand-off radar surveillance, continuing intelligence on order of battle, etc. When aircraft pilots do acquire unbriefed targets, it is often the case that they cannot identify them and evaluate immediately the desirability of a strike against them. In such cases they must instead report the description and location of the targets as a basis for later targeting, which means that the target must be reacquired for definitive evaluation and/or strike purposes. Targets so acquired on visual reconnaissance missions have been shown by JTF-2 to have a standard deviation in location of some three to five kilometers with respect to the map on which the observer noted the position, given current navigational aids to the reconnaissance pilot. Against mobile or actually moving targets the follow-up must be immediate if the target is not to be lost. In many cases visual contact must be maintained continuously after the initial sighting. Even fixed tactical targets like supply dumps, command posts, or SAM sites do not remain in one position forever, and a cycle time on the order of one or two days at most should be the aim from observation to strike upon those targets.

(U) The target acquisition process is thus a composite of several operations, in which time is of the essence:

- o theater-wide reconnaissance and surveillance
- o individual airborne and ground-based sighting of reconnaissance targets
- o specific reconnaissance and identification means assigned to identify targets which could be acquired but not precisely evaluated on the basis of the area reconnaissance, and
- o reacquisition of these assigned targets by the strike aircraft or missiles.

(C) For fixed targets, and for most moving targets, the primary link among surveillance, reconnaissance, and strike is navigation. Perhaps the most important single hardware improvement for reconnaissance collection systems, both visual and non-visual, would be an

improved navigation system. The navigation system used by reconnaissance systems should use the same coordinate system as is used for navigation by strike aircraft.

~~(C)~~ A system for precisely locating visual reconnaissance targets with respect to the observer might also be valuable in some situations. For this purpose a head-coupled sight[3] could be used to measure angles with respect to the aircraft, and range could be determined either from a laser, or from two successive angle measurements together with the known velocity of the aircraft. The laser could, of course, be coupled to the sight.

~~(C)~~ A highly effective target designation scheme to guide a strike pilot to acquire his target visually at long distances would be a head-coupled display, in which a target designating circle could be driven by the navigation system and by the known target location to fix the pilot's attention. If a full head-coupled display[4] is not available, driven cursors in a head-coupled sight could be arranged relatively easily by means of a galvanometer type movement.

~~(C)~~ Thus, a strike aircraft sent against a specific target needs an accurate navigation system and could be aided by a means of displaying target location relative to the aircraft. A reconnaissance aircraft also needs an accurate navigation system, using the same coordinates. For visual reconnaissance, there should be a narrow-band, secure voice and digital data link for transmitting intelligence to the theater intelligence central. The communication system should include automatic reporting of the time and location of the observation. Depending on added cost and complexity, a means for measuring location of the target itself in the coordinate system used by strike aircraft might be provided.

~~(C)~~ The coupling of reconnaissance and strike against moving targets is still in its infancy. The Mohawk aircraft (OV-1) has a side-looking radar with MTI, but it gives reconnaissance and not surveillance. To cover a strip 100 miles long at 100 knots aircraft speed

(U) [3]Like the Sperry or Minneapolis-Honeywell pilot's sight in the AH-56. It presents a sight reticle, focused at infinity, before the pilot's eye for use in aiming ordnance or sensors, but does not display any other form of information.

(U) [4]A "full head-coupled display" is one capable of displaying imagery (L[3]TV, FLIR, radar, ATAR, or closed-circuit TV) via a cathode ray tube mounted on the pilot's helmet.

requires one hour, and even if the aircraft flies continuously and repetitively over that same trip, we have snapshot information each hour rather than real-time surveillance. It is urgent to proceed with tests of balloon-borne or helicopter-borne theater MTI,[5] which can give PPI presentation of moving vehicles within its area of coverage several times per minute. Recording a frame of movie film for each PPI scan would then provide an invaluable document for intelligence exploitation, not only for real-time strike against moving targets by vectoring of ready resources against these targets (via a navigation system),[6] but also by the analysis of the lines of communication so revealed and the identification of depots, truck parks, etc. The coupling to the strike aircraft should be via a precise navigation system, giving the location of the target to within a few hundred meters from which it could be picked up by visual or augmented visual sensors. There is some use for an MTI capability on the strike aircraft, but its primary function would be to aid the search in bad weather over a limited area for the target designated to the strike aircraft by the theater MTI.

(C) In many situations it is desirable to use a forward air controller (FAC). The FAC platform may be manned or a drone with video link; it may be fixed-wing or rotary wing. The FAC can make good use of image intensifiers, L^3TV, FLIR, but he needs a navigation system to tell him where he is so that he can relay to the theater commander his position and that of any targets that he finds. In the terminal area, the FAC can perform another service by designating the target so precisely with a laser beam that laser-guided bombs, missiles, etc., can be accurately delivered. The FAC, too, could use a head-coupled sight for target designation and even the ATAR (high-magnification telescope slaved to the sight) for a target identification at considerable range.

3.4.2 Visual Reconnaissance (U)

(C) Without doubt the most important potential source of moving targets in daylight is a fully exploited visual reconnaissance system. While more targets can be discovered in a given small area by looking at a photographic image than by direct view in real time, the number of aircrews looking at enemy territory or actions so far exceeds the number of photographic observations that the product of eyeball opportunities times target discovery potential can be greater than the similar product for photography.

(U) [5]Flown from ships or secure base regions.
(U) [6]The MTI radar being essentially self-locating with respect to ground beacons or corner reflectors.

(C) Little has been done to improve the timeliness, accuracy, volume, and utilization of visual reconnaissance. Accurate navigation and target location hardware, as discussed earlier, could result in significant improvements. Equally important is improvement in the system for collecting, displaying, and using visual reconnaissance data. More will be said on this topic in Section 5 of this appendix.

3.4.3 Photography (U)

(C) Photography, with its high resolution, and potential for accurate mensuration can be used most profitably for detecting and locating fixed targets, for detailed targeting against them, and for damage assessment. It can also play a useful role in providing indications of enemy capabilities by monitoring order of battle, new construction, new communication or transportation routes, or changes in activity patterns. However, to avoid swamping the important imagery with unimportant imagery, photography must be used selectively and judiciously. Photography has been misused in the past and continues to be. Rather than attempt to process and digest millions of feet of film, we must carefully select the areas to be photographed. As in the case of visual reconnaissance, to be most useful, photography should be collected with an extremely accurate navigation system to provide data for subsequent strike.

(C) Photography has the distinct disadvantage of not providing immediate information. Attempts to speed up the process by on-board processing and image transmission are usually not productive because the bulk of the time delay occurs in other portions of the reconnaissance cycle. Photographic imagery can be of high quality. It is reasonable to expect six-inch resolution (with targets of reasonable contrast) from low-altitude photography and two-feet resolution from high-altitude photography. The latter value is useful for practically all reconnaissance purposes.

3.4.4 Image Intensification Devices (U)

(C) The so-called "Starlight Scope" and the "Eye Glass" are examples of additions to visual reconnaissance which are beginning to show significant new capabilities. These devices, which use image intensifiers as part of a direct view optical system, are more sensitive than binoculars by about two orders of magnitude and permit effective observations under some conditions down to light levels as low as starlight. At very low light levels, these devices are inherently limited to use at low airspeeds. Other difficulties encountered include those associated with the mounting of large optical elements, inability to

scan a wide field of view, the inducing of vertigo or nausea from prolonged use, loss of dark adaption, etc. Developments are needed to provide a large scan angle—preferably 360°—together with the ability to read out automatically position of targets.

(C) Image intensifiers may be used with direct viewing optical systems, with systems that transmit the output of the image intensifier to the eye via fiber optics, or with TV displays. The use of image intensifiers is bringing us close to the limits of photon noise so that additional amplification may not provide more signal-to-noise ratio. However, the displays on which the outputs of low-light-level TV is normally presented leave much to be desired both in contrast and resolution. However, television display, as contrasted with direct view or fiber optics system, offers the option of multiple displays to a number of operators, and the same displays can be driven by a number of detection devices (IR, vidicon, Walleye missiles, etc.).

(C) A broad optical aids development program is needed which would permit the gradual exploitation of a variety of techniques for dealing with low-light levels, both active and passive. We should be able to select from a number of sensors and optical aids those best suited for a particular mission. For example, for a hunter aircraft, we will want to equip the observer with devices for detecting targets, for reporting accurately their position, and for designating them to a strike aircraft. For the operator in the recce-strike aircraft, we will want him to find a target, track it, and launch a weapon against it. For the strike pilot, we will want a system which helps designate the target to him accurately so that he does not have to search a wide angle of view, thus reducing search time and allowing lock-on at longer ranges. Thus the development programs should encompass optical systems of wide scan angles, image intensifiers, LLLTV cameras, fiber optics, high resolution displays, head-mounted displays, target ranging devices, and target marking devices. The aim should then be to incorporate these elements into integrated systems for hunter, recce-strike and strike aircraft.

3.4.5 Infrared and Laser Devices (U)

(C) Forward looking infrared (FLIR) devices are being developed which have adequate frame rates—20-30 per second and rather high angular resolution—1/4 mil. Breadboard devices now in flight test that operate in the 8 to 14 u region are providing excellent ground-painting of natural and cultural targets, with displays that closely resemble high-quality TV. Proposals have been submitted for even higher resolutions—0.1 mil. Such systems are expected to be extremely useful;

they are already finding application to recce-strike systems such as the Air Force Gunship II and Navy TRIM programs. Work should be continued on these systems. We do not yet know when the practical limit will be reached in increasing complexity to yield higher resolution pictures, but we may be approaching it already. IR systems are both competitive with and complementary to LLLTV and should be considered as such. The tones in an LLLTV are more natural, aiding in identification. Infrared can provide a different kind of information about the target, e.g., by looking for hot spots in a target complex to aid in detraction. Laser scanning devices have not seen much use; laser line scanners do not give real-time imagery of good quality and raster scanners are only now being developed. Their exploration ought to be encouraged as part of an overall optics development program.

3.4.6 Radar (U)

(C) Ground-painting radar has not been competitive to date with photography for targeting because of its lower resolution. However, high-resolution radars now in development may find a role as a cueing sensor and perhaps as a substitute for photography for bomb damage assessment against large, high-contrast objects such as bridges when weather prevents photography. Systems demonstrated by the University of Michigan have achieved 10-20 ft. resolution out to ranges of 8-10 miles using synthetic-aperture side-looking techniques.

(C) The advantage of MTI radar is, of course, that it reduces the data-processing job by not reporting background information such as terrain, cultural features, etc. Compared to photography, where all such features must be examined for targets, MTI radar offers the potential of screening out everything except moving vehicles, and in many military situations vehicular movement is very important. In such situations, MTI radar can be used to provide at the operations center a picture of vehicular activity throughout the battle area. Patterns of activity can indicate where an enemy action is about to take place, can show where forces are being massed and hence constitute an attractive target.

(C) MTI radars should be able to cover the battle area one or two hundred miles on a side from one or two locations. For such operations to be practical, line of sight considerations dictate that the antenna be elevated. Platforms which can be considered include airplanes, helicopters, and balloons. In some cases, high terrain can be used, but to get coverage over the kinds of areas we have in mind, the antenna should be at an elevation of 10,000 to 30,000 ft.

(C) Aircraft are, of course, the most versatile platforms, are easily kept on station, can retreat before being attacked, can be quickly deployed, and equally significant, can look at the area of interest from a variety of aspect angles, thus eliminating many blind spots. On the other hand, they are not only the most expensive, but also create problems for themselves in that MTI radars work best when stationary with respect to the ground.

(C) Helicopters have several of the advantages of the airplane except that their altitude is limited to about 10,000 ft. and their mobility is relatively limited. A helicopter has the added advantage of being able to maintain essentially zero ground speed. But long endurance helicopters do not really exist. A development program to increase the life of critical dynamic components would be necessary if we want to field a system based on helicopters.

(C) Tethered balloons have many advantages—low cost, quiet operation, quite low speeds relative to the ground. Their principal disadvantage is the real one that their tethering cables create a flight hazard throughout an area surrounding the tether point. The balloon can, of course, carry an IFF beacon and lights can be placed at intervals on the cable if desired. Tethered balloons may also be fairly vulnerable to enemy attack. Balloon development is under way, notably by ARPA sponsorship, and radars which could be used on balloons are now under test in helicopters. Because of the great savings in operating cost which might accrue, it would be desirable to test balloon-borne MTI radars as area surveillance devices.

3.4.7 Ground-Based Sensors (U)

(S) Recent experience with ground-based sensors indicates that such devices—acoustic, seismic, and other—may have a great potential for future reconnaissance and surveillance purposes. It seems clear that they can be used profitably as activity indicators. Given an adequate command and control system plus designated FAC and strike (or recce-strike) aircraft, such sensors can play an important role in targeting against moving interdiction targets. Similarly, they can be extremely useful as aids to the defense of fixed installations. The full implications of such sensors are not fully understood, at present, but it appears that they may well have a revolutionary effect on tactical ground and air operations. The concept of an "instrumented battlefield" offers intriguing possibilities.

3.4.8 ELINT for Locating Enemy Radars (U)

(C) While the Panel has not examined ELINT in detail, we feel that systems which locate radars should do so with sufficient precision to permit an effective strike. For cataloging radars, gross accuracies are good enough. We should not invest heavily in systems which have higher accuracy than needed for cataloging but not good enough to serve to guide a strike. For cataloging radars, the SR-71 can be more effective than many shorter range aircraft. Its high altitude and long range enables it to collect data on radars over an entire battle-front. For effective strike, time-of-arrival systems are required.

4. RECONNAISSANCE PLATFORMS (U)

4.1 The Problem (U)

(U) Most of the current Air Force and Navy tactical reconnaissance platforms are adapted either for high-speed flight to collect permanent imagery (principally photographic) or for low-speed unaided visual observation. The Army's Mohawk OV-1B and OV-1C platforms are multisensor, low speed conventional aircraft. There are several programs to develop and use other, less conventional types of reconnaissance platform; drone helicopters (e.g., DASH and Nite Panther), drone fixed-wing aircraft (SPA-147), manned conventional fixed-wing aircraft (e.g., the Bias Hunter and Hunter II C-130s) and quiet manned aircraft (PRIZE CREW QT-1s and QT-2s).[7] Further exploitation of unconventional platform types will be important for future use.

4.2 Conclusions (U)

(U) Continued study, research and development are warranted on reconnaissance platforms, with emphasis on unmanned vehicles, quiet manned aircraft, and low-to-zero-speed platforms such as helicopters and tethered balloons.

4.3 Recommendations (U)

(S) Study requirements for and design characteristics of at least two classes of drone reconnaissance vehicles. One should be a relatively long-range cruise vehicle as a follow-on to the SPA-147. The other should be a short-range VTOL device (probably a helicopter) for use in local area surveillance and targeting by air and ground commanders.

(S) Study requirements for and design characteristics of quiet aircraft, and conduct supporting research aimed at development of quiet manned aircraft with considerably greater payload than current quiet aircraft can carry.

(U) [7]The systems noted do not have a weapon-delivery capability, but are used only to find and in some cases designate targets. Reconnaissance-strike systems include the Tropic Moon AIEs and B-57s, Blackspot C-123Ks, and Gunship AC-130s and AC-119s.

(S) Study requirements and design characteristics for helicopters to be used as MTI radar platforms for use in area surveillance; conduct experimental tests of helicopter-borne MTI radar.

(S) Study requirements and design characteristics, and conduct research, development, and test of tethered-balloon-supported area surveillance sensors such as MTI radars.

4.4 Discussion (U)

(S) The high cost of penetrating local defenses with manned aircraft may require use of long-range standoff missiles for striking fixed targets in future operations, as noted elsewhere in the Tactical Aircraft Panel's report. Such operations will by no means diminish the need for accurate and timely reconnaissance for targeting and damage assessment. For the same reasons that may force the use of long-range unmanned missiles as strike vehicles, there will be a need for long-range unmanned reconnaissance vehicles. The options as to mission range, launch and recovery modes, flight path characteristics, recovery of data or data link, propulsion and guidance systems, etc., should be studied carefully to determine desired design characteristics, with a subsequent development program to produce operational long-range drone reconnaissance vehicles.

(C) Ground commanders and airbase commanders have a strong requirement for local area surveillance in a no-front war like the one in Southeast Asia. Ground commanders of forward units need such a capability in wars with conventional front lines. Systems for this purpose should be developed on a continuing basis. Optical, infrared, and image-intensifier sensors with TV link should be considered, using small helicopters or other VTOL devices as platforms. Acoustical, optical, infrared, and radar quietness of the vehicle should be emphasized. Balloon systems for supporting local area surveillance sensors should also be investigated.

(S) For certain types of interdiction and close support missions it will be desirable to have a hunter aircraft detect, identify, and designate a target that is to be hit by ordnance delivered by another aircraft, a missile, or artillery. The separate hunter may be needed because target detection and identification require a considerably closer approach to the target and longer time in the vicinity of the target than required for weapon delivery. Quiet aircraft appear particularly needed for the hunter task. Such aircraft should be capable of long loiter time, should carry a variety of visual and aided visual or IR sensors, and target designators. They should rely for their own protection on suppression

of visual, acoustic, radar, and IR signals. Research and development are needed to determine the upper limits of propulsion power consistent with quietness at operationally useful altitudes and to produce quiet aircraft with considerably increased payload capacity beyond that now carried by the QT-2 aircraft.

(S) The use of helicopters and tethered balloons as platforms for reconnaissance and surveillance sensors has been discussed in several parts of this report. It was suggested that MTI radar for area surveillance is a candidate as payload for such platforms. Studies supported by ARPA have indicated the feasibility of using staged tethered balloons to support payloads at altitudes upwards of 50,000 ft. Such applications of staged balloons should be studied further, both from a technical feasibility viewpoint and from the viewpoint of operational problems in handling and controlling high-altitude balloons, minimizing their interference with friendly aircraft traffic, and vulnerability of such systems to enemy attack.

5. TRANSMISSION AND DISPLAY OF RECONNAISSANCE AND SURVEILLANCE INFORMATION (U)

5.1 The Problem (U)

(U) As noted in the discussion of the importance of procedures and techniques in reconnaissance operations, major improvements can be made without increases in the amount of data gathered and, indeed, without providing better hardware for collecting information. On the other hand, considerable improvements are needed and can be made in the way that reconnaissance and surveillance information is assembled, displayed and made useable to the decision-maker and operator in tactical warfare.

5.2 Conclusions (U)

(C) Systems and techniques are needed for timely, selective presentation of reconnaissance and surveillance information in the basic command and control displays used by operational commanders and decision-makers at various levels. The displays should permit presentation of visual, photo, IR, radar, ELINT, and other reconnaissance information, including both definitive target coverage and area activity information in real time. Design of the system should emphasize operational and human engineering considerations, but may require sophisticated hardware techniques. It does not appear necessary to use wide-band data link in the operation of the system.

(C) Data link developments should emphasize minimal amount of data to be transmitted. The trend should be toward a minimal amount of secure voice transmission plus narrow-band digital data link. Broad-band systems for real-time transmission of unevaluated sensor data do not appear operationally necessary or even desirable. The type of sensor dat that should be transmitted air-to-ground includes MTI and hot-spot IR target coordinates and selected single-frame video pictures. Selected digitalized target type and coordinate information, as required, should be transmitted between ground stations for display purposes.

5.3 Recommendations (U)

(C) Develop a system for assembling and displaying reconnaissance and surveillance information from multiple sources to meet the needs of operational commanders at various levels. Area activity information as well as definitive spot information must be accommodated in the display.

(S) Orient data-link developments toward narrow-band (e.g., 15 to 25 kc at most), secure voice transmission and processed sensor data in digital form. In particular, reorient the JIFDATS program toward narrow-band data link.

5.4 Discussion (U)

(C) It should be possible to make basic improvements in the command and control of tactical air and ground forces by making the wealth of information from various sources that potentially is available to commanders, available in fact and in a useful form. Use of the information potential of visual reconnaissance, ELINT, remote ground-based sensors, and MTI radar for timely attack on fleeting targets will require vastly better techniques and systems for assembling and displaying information than are now being used. The emphasis in developing new systems should be on techniques and procedures; the design should strive for hardware simplicity, narrow-band data links, portability, compatibility among displays at various levels, and selective data presentation to suit the needs of the various levels. The design should be chosen on the basis of its utility to the operator and decision-maker rather than to the intelligence collection and processing system; the installation should be designed as an integral part of the operational command control system.

(C) One feature of such a display system should be an activity indicator, displaying data from visual sightings, MTI radars, ELINT, ground-based sensors, and other sources. The purpose of the activity indicator system would be to furnish to the Army and Air Force information concerning the movements and deployments of enemy forces. It would also serve to indicate areas where detailed search should be conducted and where strikes might be most effective.

(C) While there are several forms this activity indicator could take, one possible implementation will serve to indicate the general idea. The end product could be a large map with display of activity information by means of grease pencil overlays or by lights. At the highest level of command, this map would encompass the entire region of hostility. At lower levels, the display would include the area of direct concern to the regional commander, plus enough adjacent territory to permit him to operate effectively. Visual, ELINT, and other data could be entered manually. Radar inputs could be shown on a PPI indicator behind the map or superposed on the map by lights showing moving vehicles. The moving vehicles could be displayed in real-time when desired, so that a commander can note where there are significant activities, trends, and changes.

(C) While the development of such combined displays should be initiated, an interim capability could be based on the use of simple PPI scopes which present MTI radar outputs with superposed map overlays.

(C) The value of the activity indicator lies in the use of patterns of activity which a human observer will make. The observer will soon learn the activity pattern of the region he monitors, recognizing repeated activities in certain areas due to usual, normal human activities. Increased activity in a given area, particularly at night, or changes in activity patterns will alert the observer to suspected build-up of enemy forces. As noted earlier, in some military situations vehicular traffic can give important indications of enemy activity. A large scale diversion, such as at Bastogne in World War II, might not have escaped detection before the attack was launched, since the convergence of vehicles could have been noted. Even situations like Con Thien might have been eliminated by means of an activity indicator by observing movement of artillery and ammunition at night. Further, the observation of trucks entering or leaving otherwise seemingly empty areas would indicate camouflaged or hidden bivouac or supply areas.

(C) Depending upon the type of radar and scan pattern used, the display would be updated periodically, perhaps as rapidly as several times per minute if PPI display and stationary radar, or every ten minutes or perhaps every half hour if side-looking radar is used. The display should retain the information from previous passes; perhaps a fading logic should be used where old information is caused to fade out gradually. Perhaps several displays are needed, one showing long-time trends. Whether this is desirable could be learned by experience.

(C) For PPI-type displays, it is possible to take frame by frame movies for rapid reshowing. A 24-hour record shown at 24 frames per second would be reviewed in 3 to 5 minutes, and could give good indication of enemy intentions by noting long-term movement trends.

APPENDIX D

WEAPON AND WEAPONS SYSTEMS SUBPANEL

Dr. Thomas S. Amlie,
Subpanel Chairman
Dr. Richard L. Garwin
Mr. Milton Lohr
Captain L. A. Snead, USN
Mr. Pierre Sprey

1. INTRODUCTION (U)

(U) The Weapons Subpanel meetings were very stimulating in that the discussions were spirited and many divergent points of view were represented. The definitions of the problems were generally agreed upon although the rank-ordering of importance of the various problems was not always unanimous. The problems in attack aviation can be listed in an oversimplified way as follows:

(U) (1) Finding the target.

(U) (2) Having a suitable aircraft with weapons available to attack the target.

(U) (3) Placing ordnance close to or on the target.

(U) (4) Having the right kind and amount of ordnance to match the target being attacked and the (in) accuracy of the delivery method.

(U) (5) Having the aircraft and its attacking maneuver designed so that it will survive the target defenses.

(U) (6) Efficacy, cost and reliability of the weapons systems.

~~(S)~~ (7) A problem which was not specifically identified in the meetings but which is becoming critical is the large number of different kinds of weapons in the system and the burden they impose on the logistic and training requirements. Indeed, an officer in CNO (OP-506F) drew up a list of 191 different air-to-ground weapons and bombing systems which are either in the Fleet now or are in active development and are scheduled to be introduced within three years. This list did not include the anti-radiation missiles. There were, for example, 16 programs aimed at developing weapons to be competitors for WALLEYE/CONDOR. The burden imposed on the system by such a variety of weapons with overlapping capabilities must be given intensive management attention.

(U) The problems of finding the target and of having an aircraft available have been ably covered by the Reconnaissance and Command and Control Subpanels and will not be addressed herein.

2. CLOSE AIR SUPPORT (U)

2.1 Conclusions (U)

(S) The Panel felt that air power should not be planned, developed or deployed simply for general economic harassment of an enemy, rather it should be applied to the destruction of specific enemy military capabilities. They felt our air power is weakest in the destruction of two most important enemy capabilities: (1) his ability to confront our troops with battlefield weapons and troops and (2) his ability to supply and reinforce these battlefield units, especially at night and in bad weather using trucks, rail and watercraft.

(C) It was further concluded that specialized capabilities such as FAC and image interpretation had been seriously neglected in peacetime training, which greatly impaired our combat effectiveness. Greater emphasis should be placed on training and other means of improving our operational capability in these areas, together with appropriate career incentives.

2.2 Recommendations (U)

(S) The Panel concurred in recommending development of the A-X as proposed in the Air Force CFP of June 1968 as soon as possible, with the caveat that a night version with two men and "good" night sensors, together with a "useful" electronic navigation system be included in the development. The Panel members especially singled out for emphasis as desirable characteristics the features of high survivability vs. dense small arms fire (up to 14.5), excellent low-speed maneuverability, high stability as a weapons delivery platform, high load carrying capability (many passes), long loiter, low-wing loading, high thrust-to-weight ratio, producibility (low cost) and battlefield repairability. It also appeared that A-X had excellent potential for MAP sales, and this aspect deserved some design consideration.

(S) Continued development and deployment of limited quantities of Gunship platforms, based on cargo aircraft and/or helicopter airframes, was recommended, to the extent that more permissive-environment anti-vehicle fire-power is required in 1972-80. It was recommended that an alternative to the more vulnerable side-firing tactic be investigated for accuracy (e.g., a downward-firing flexible gun).

3. MOBILE TARGETS (U)

3.1 Conclusions (U)

(C) It was noted that air power consists of a series of specialized tasks, and that both R&D and planning must recognize that the destruction of mobile ground targets at night (exactly as destruction of aircraft at night) require both special equipment and very specifically trained crews. To install such equipment in the bulk of the attack force and subject all attack pilots to the requisite training was felt to be inefficient and degrading to combat effectiveness.

3.2 Recommendations (U)

(S) It was noted by some members of the Panel that A-26 and B-57 truck kills per sortie were higher than those of faster aircraft, which led them to conclude that battlefield interdiction aircraft should have largely unattenuated downward vision, both eyeball and optical (night), coupled to a relatively slow, long endurance, survivable airframe, using best present anti-vehicle munitions (guns, possibly TOW) and specialized mission crews (for the night portion of the vehicle interdiction mission). Others on the Panel held that survivability requirements dictated a faster aircraft for penetration and recce, using an MTI radar for target alert, at which time the aircraft would slow down so that LLLTV, FLIR or other shorter-range night sensors would be effective. Others espoused a hunter/killer system, but recognized the problems of target handover, suggesting laser target designation for the present, but recommending that further work be done toward providing a target marking capability that enables the hunter to continue his mission without waiting in the target area for the killer to acquire the target.

(C) Where the theater air environment is secured, large, centralized airborne sensors (such as AWACS) may prove effective, although operationally effective overland radar capability has yet to be proven. Where only altitude and not mobility is needed, balloons, (such as Silent Joe II) appear to be the most efficient sensor platform, and deserve serious consideration. The military aviators on the Subpanel took violent exception to the prospect of having thousands of feet of steel mooring cable as a hazard to aircraft. The Panel agreed that a manned blimp was probably a better solution than a tethered balloon.

(S) The Weapon Systems Subpanel endorsed previous recommendations for serious effort on silent aircraft, silent drones and forward-area, tactical-sensor drone platforms (e.g., Night Gazelle, Silent Joe II).

4. FIXED TARGETS (U)

4.1 Conclusion (U)

(S) It was concluded that interdiction over heavily defended air space (SAM, AAA, MIG) with manned aircraft has proven to be increasingly expensive per target killed, with attack aircraft becoming progressively more expensive and complex, and large numbers of support aircraft being required to accompany day strikes, each with likewise increasingly sophisticated and expensive equipment. There was also data (on which there was incomplete agreement) that indicated that night interdiction, though usually accomplished in small groups or by lone penetrators, results in greater losses per target killed due to larger inaccuracies of our present blind bombing systems. In view of this, and in light of missile and seeker technology that appears to be available, development of a low-cost cruise missile (as discussed under Penetration Subpanel) was recommended as an alternative to manned aircraft interdiction. A majority of the Panel recognized that the missile could not replace manned aircraft for all interdiction.

(S) Some of the Panel felt that deep interdiction was very ineffective, primarily since LOCs were so heavily redundant in most cases, and also, that there were usually only a few militarily significant deep targets. Others felt that most deep targets of primary interest shared the characteristic of being both fixed (e.g., transhipment points, factories, rail lines, bridges, power plants, etc.) and, especially in a stabilized conflict area such as North Vietnam, heavily defended. Thus their location could be precisely pinpointed by recce aircraft in the common position grid system discussed under the Penetration Subpanel results, allowing strike via a STEER-guided missile when terminal-area visibility was good enough to allow optical terminal homing. It was further reasoned that since the targets were fixed, it made little sense to strike them in bad visibility with relatively inaccurate techniques such as radar, when E/O (or FLIR) techniques could be used the moment good terminal-area visibility existed. A detailed description of the STEER guidance concept is in Command and Control Subpanel results.

4.2 Recommendations (U)

(S) Long-Range Cruise Missile - The arguments above indicated the increasing cost and complexity of deep interdiction with manned aircraft. While there was wide disagreement on the value of deep

interdiction, there was agreement that most targets of military significance in heavily defended areas could best be attacked by standoff guided weapons. The Panel endorsed the concept of a family of standoff weapons discussed under Penetration, emphasizing low cost ($20-40K) and large warhead with capability for point or area type targets.

(S) Short-Range ASMs - The Panel concluded there would be many situations in anti-air environments up to and including AAA, where destruction of targets such as tanks, APCs, command posts or bridges will be necessary, but a moderate standoff would be desirable to avoid local air defense. Where such targets are optically prominent and defenses are not too severe, there will be a continued need for E/O guided weapons of the WALLEYE class.

(S) There is also a need for a guided weapon which will function at night. Guidance by a laser target designator, using cues from a night vision device appears to be appropriate. The primary area for new development is reduction of tracking time to the order of six seconds or less, to reduce vulnerability of the delivery aircraft.

(S) The use of the BULLPUP airframe, coupled with a telescope (day and/or night capability), as discussed under Penetration, should be expedited, since it appears to be a low-cost and near-term enhancement of the capability now embodied in WALLEYE (with its restrictions as regards target contrasts, shadows, etc.).

(S) Time of Arrival Missiles - Use of TOA guidance techniques to destroy/suppress enemy radars was considered to be the most significant improvement that can be envisioned over SHRIKE and ARM-type systems, the advantage of TOA systems being retention of a strike capability after emission ceases. It was felt that the active terminal guidance approaches presently being pursued will also be susceptible to relatively simple countermeasures. Passive angle tracking schemes, such as are being developed for the A-6 and evaluated by Air Force, do not appear to offer sufficient accuracy (about 500 feet CEP at best) to warrant their expense.

(C) The Panel strongly recommended expedited development of this approach, with resources to come from the other approaches listed above, which are felt will be considerably less effective.

(C) Discussion of the TOA guidance scheme is given in the Command and Control discussion.

(C) System Testing - Regarding the flight testing of tactical air weapon systems, the Panel found the following deficiencies:

- The actual tactical environment is not properly simulated in test and should be duplicated better in both contractor and Service tests. For example, air-to-ground delivery testing should include realistic tactics, such as jinking, short tracking times, high altitude delivery as used vs. AAA (e.g., 5000-7000 feet release altitude), absence of special target acquisition aids, such as corner reflectors and/or bullseyes, prohibition of use of data from multiple passes, recording of all data, including wild shots and/or hung or jammed ordnance.

- Similar considerations apply for air-to-air missiles. Tests should be declared inconclusive unless they include a cluttered environment, unaugmented, maneuvering targets instead of classical augmented, nonmaneuvering drone targets, etc.

- Difficulty in obtaining a timely response, particularly to small-scale but critical testing requirements.

- Lack of suitable and simple in-theater test instrumentation, such as gunsight and scope cameras.

(C) The Panel also noted that too many decisions to proceed with development and production have ignored well-documented results of stringent testing, often with the excuse: "It's that test center's business to 'crab' every little detail they can find." The Panel strongly recommended that decisions to produce either air-to-air or air-to-ground weapon systems should not be made without first performing realistic tests as outlined above. This will require the Services to direct their contractors (and themselves) to eliminate the "classical" methods of taking this type of test data together with changes in the manner in which contract correction of deficiency clauses are written. The Panel considered this to be a point of critical importance.

(C) Finally the Panel recommended that more emphasis be given to CONUS testing. Too many systems have been deployed to SEA, ill supported and insufficiently tested in CONUS, for an "in-theater opeval," when a large percentage of the data ultimately gathered could have been obtained Stateside. The Panel recognized, however, that delay in deployment to allow sufficient testing must be weighed against the severity of the operational need that the new system is intended to satisfy.

5. AIR-TO-AIR WARFARE (U)

5.1 Conclusions (U)

(U) The Panel came to the obvious conclusion that unless air superiority were achieved and maintained the attack aircraft could not be utilized without totally unacceptable attrition. A case in point is that of the German Stuka which had things all its own way until the appearance of Allied fighters.

5.2 Recommendations (U)

(U) Our recommendations are as simplistic as our conclusions. The Services will have to show that they are pursuing design and procurement plans which will permit having air superiority. It was not the task of this Panel to address air-to-air warfare any more deeply than this.

6. BOMBING SYSTEMS (U)

6.1 Conclusions (U)

(C) Aided-Visual and Radar Bombing Computers - Computational accuracy, per se, was not concluded to be a problem (except that ballistic trajectory fits for a wide variety of weapons and conditions are still a problem). However, presently mechanized systems require excessive maintenance and also require many data inputs, including ranging, angle of attack and angle to target, angle to vertical and velocities in three coordinates. Most of these data must go through complex coordinate transformations to enable weapon release. The Angular Rate Bombing System is a most promising new development which should eliminate the need for large amounts of input data (especially velocity of inertial quality and ranging, both of which have required usually sensitive and unreliable sensors in the past) and complex coordinate transformation.

6.2 Recommendation (U)

(S) The Panel strongly recommended development and realistic testing of the Angular Rate Bombing System in both E/O and manual tracking modes. A successful program could enable cancellation or redirection of the many expensive "classical" computed weapons release systems now in development (e.g., Mk II, A-7D/E).

(C) Free-Fall Bomb Accuracy Improvements - Given that improvements in computed weapons release systems can actually be realized in the field (vice unrealistic testing, as discussed above), the following sources of bomb accuracy degradation must be eliminated to achieve the required delivery accuracies (under 100 feet) to yield high single-pass kill probabilities against most targets. The Panel strongly recommended immediate increase of RDT&E emphasis in these areas:

- Multiple Ejection Racks and Pylons - Present MER/TER type racks are so flexible and have such large station-to-station variation that both accuracy and pattern spacing are severely degraded. New designs incorporating more rigid individual or tandem or glove carriage stations (in fuselage or wing areas of lower drag and cleaner airflows, if possible) should be developed, but only after suitable wind tunnel investigations.

- Bomb Fin Design/Packaging - Fin design should be more rigid and protective packaging design should be improved to avoid serious problems now being experienced caused by wild bombs due to bent fins. The Panel was shown an NATC (Patuxent River) film depicting this problem which should be required viewing in the Pentagon.

- Sensitivity to Sideslip and Angle-of-Attack Errors - Present low-drag bombs experience considerable perturbation of ballistic trajectories when launched at other than design conditions; substantial angle of attack and sideslip errors are common in bombing. The Panel felt that carefully designed blunt noses would reduce this sensitivity without major drag increases, and recommended expedited work in this area.

7. MUNITIONS AND FUZES (U)

7.1 Conclusions (U)

(C) GP Bombs - GP bombs will continue to have an important role against soft area targets and point targets with weak signatures (e.g., bunkers) requiring blast damage. However, the Panel concluded that major improvements are required in providing shapes less sensitive to angle of attack for the Mk 82-84 family, plus either elimination of the M-117 type or development of a low-drag shape. The Mk 81 in its present form was considered too small to be effective as a blast weapon.

(S) Fuzes - The Panel, after a somewhat detailed look into the fuze situation, concluded it was deplorable, and that considerable savings in procurement dollars could be realized by increased top-management attention to this neglected area by OSD and the Services. Fuze problems include high cost vs. job to be done, reliability, producibility and performance, and encompass fuzes for both guided and unguided weapons.

(S) The need for greatly increased attention to this area, coupled with a considerable increase in related R&D, is underlined by examination of the Panel's understanding of approximate FY-69 RDT&E and Procurement funds in the fuze area for unguided weapons alone:

FY-68 BUDGET*

Service	RDT&E ($\times 10^6$)	Production ($\times 10^6$)
Army	$ 4	$290
Navy	11	260
Air Force	3	290
Total	$18	$840

*Excludes fuzes for guided missiles.

7.2 Recommendations (U)

(C) Fragmentation Bombs - The Panel felt that development of fragmentation casings for GP bombs has been seriously neglected since

World War II and requires greatly expanded support. Specifically, it recommended the following:

- o Mk 81 bomb production should be converted to a fragmentation version. (World War II 260-pound frag bombs were very effective in close air support in Korea.)

- o Consideration should be given to licensing the Swedish Virgo 270-pound frag bomb as an Mk 81 replacement (frag radius equals that of the 750-pound M-117) and possibly adding a 500-pound version. Such weapons are considered to give considerably greater effects coverage against area trucks and supplies than present GP bombs.

- o Provision of VT fuzes for these frag bombs should be investigated. This appears to be the best near-term solution to increasing bomb effectiveness against troops in foxholes at a lower cost than CBUs.

(C) Penetration Bombs - The Panel concluded that our present GP bombs are inadequate for any type of heavy concrete structure (e.g., bridge piers, dams, large power stations), usually collapsing before achieving any appreciable penetration. The Panel recommended expedited development of 1000- and 2000-pound penetration bombs, together with a reliable fuzing system tailored to the application.

(C) Cluster Bombs and Dispensers - The Panel made the following recommendations for this type of weapon:

- o Since a wide range of dispensers has now been developed, but the tactical opportunities for low-level deliveries are limited (and inaccurate, when dropped this way, due to great difficulty in target acquisition in low-level, high-speed delivery), emphasis should be shifted from development and production of dispensers to that of dive-deliverable cluster bombs.

- o Emphasis should be placed on sub-munitions for the Rockeye-type container rather than the CBU-24, due to absence of the "hole" in the sub-munition pattern in Rockeye.

- Four crucial problems must be solved in anti-personnel (fragmenting) and anti-material (shaped charge or large fragment) sub-munitions:

  - Cost - Cost of present fuzes and frag cases are so high they essentially preclude stockpiling. Strict cost goals should be enforced in basic design. Cast iron (Soviet-style) frag cases should get serious consideration.

  - Duds - Present bomblets and bombs are sufficiently unreliable that they form an excellent munitions source for insurgents. Considerably greater emphasis on fuze reliability and self-destruct than the Panel was able to find in present programs is required.

  - Foliage Penetration - Better delay fuzing and larger, higher velocity fragments are required to assure destruction of targets under heavy foliage.

  - Foxhole Coverage - A satisfactory solution to the three to six foot air burst problem remains to be found, since pop-up schemes have proven to be unreliable and prox fuzes are too costly. VT-fuzed recoilless rifle rounds and frag bombs may be the best solution here. The impressively inexpensive Army 40-mm VT fuze could be adapted to this purpose. An alternative is the development of somewhat larger Fuel-Air Explosive (FAE) sub-munitions, which give excellent results against foxholes without special fuzing.

(C) Together with recommending a considerable increase in top-management visibility of fuze R&D (coupled with increased dollars) to improve performance and reliability, minimize the quantity of different fuze types and improve producibility, the Panel also recommended:

- Less Multi-Purpose Fuzing - Under the guise of logistics simplification, there has been a strong trend towards increasing function options in new fuzes. This has caused both large cost increases and even more serious safety/reliability decreases. A minimum number of functions should be enforced for every fuze type.

- Fewer New Fuze Types - Realizing a recommendation to limit new fuze types must be delicately balanced vs.

limiting multi-purpose fuzes, the Panel observed what appeared to be a strong tendency to develop a completely new fuze every time a modification is needed for a new weapon. In light of this, the Panel recommended that the most successful fuze elements should be standardized (e.g., VT fuze radars, deceleration sensors, pressure sensors, safety and arming elements, etc.) and only repackaged (not redesigned) for new applications. This was considered to be particularly important for VT fuzes, where high production rates on components are necessary to keep costs down.

8. GUNS AND ROCKETS (U)

8.1 Conclusions (U)

(C) Rockets and Recoilless Rifles - Present 2.75" and 5" rockets are ineffective against small area or point targets due to large dispersion. Since they carry insufficient HE, their effectiveness against large targets is limited. It was concluded that little could be done to improve this situation without great expense, thus the Panel recommended that design emphasis (and R&D money) be shifted to development of automatic recoilless rifles for aircraft carriage.

(S) It was concluded that development of these weapons should be expedited and, when proven successful, air-to-ground rocket production should be eliminated.

8.2 Recommendations (U)

(C) Two design approaches are recommended for investigation:

- o Standard vented breech of Army recoilless rifles.
- o Open-ended tube with ballast behind the charge.

(C) Two sizes, based on existing projectiles, were recommended for consideration:

- o A 50-75 mm weapon for smoke marking and personnel targets.
- o A 100-160 mm round for harder targets (e.g., bunkers, light structures, AAA suppression, etc.)

(S) Guns - In view of the continually-proven lethality of these weapons for all point targets up to the hardness of tanks, this was considered by the Panel to be the most seriously underfunded and underemphasized area of our weapons technology. The Panel strongly recommended that the following developments get the highest priority:

- o A gun suitable for trucks, APCs and tanks, based on existing rounds in the range of 25-35 mm and 3500-4000 fps muzzle velocity. Versions for internal carriage (A-X) and external pods (attack jets) should be developed. (It was specifically noted that A-X gun development appeared to

be proceeding much too slowly, as was F-X gun development.) Major emphasis should be placed on muzzle flash suppression for night attack survivability.

- o Technology feasibility demonstration of liquid monopropellant for high velocity projectiles (5000-7000 fps), either in standard spin-stabilized shapes or re-entry body shapes for smooth-bore firing. Two approaches recommended for investigation were:
  - Pumped liquids in guns feeding projectiles only.
  - As a fallback, standard cartridges using cased liquids.
- o Technology feasibility demonstration of high velocity flechette rounds (5000-7000 fps) to address the specific problems of dispersion and engine sabot injection. ARPA work in this area was particularly interesting and appeared to have application for FX/VFX as well as attack aircraft.

9. TARGET/WEAPON MATRIX (U)

9.1 Conclusions (U)

(U) This matrix is exhibited in the body of the report and will not be reproduced here. The matrix was prepared by the avid gun contingent of the Sub Panel and attention is directed to Note (2) accompanying the matrix.

9.2 Recommendations (U)

(U) Even though the matrix appears biased in favor of guns there was general agreement that present air-to-ground rockets are as marginally useful as shown and should be dropped as soon as possible. There was also general agreement that there is an important place for iron bombs and that the development of better bombs, release systems and fire control systems be continued.

APPENDIX E

COMMAND AND CONTROL SUBPANEL

Dr. Leonard S. Sheingold,
Subpanel Chairman
Dr. Albert C. Hall
Mr. Robert E. O'Donohue
Colonel Garth Reynolds, USAF
Colonel B. G. Smith, USA
Mr. Billy Joe Workman

INTRODUCTION

(C) The efforts of the Command and Control Subpanel were concentrated in determining the common factors relating to control of forces in the tactical environment. The two basic factors which appear to offer the greatest increase in effectiveness in control of forces are: (1) a common position navigation grid integrated into the command and control system, and (2) close integration of the intelligence and decision-making processes. In the material below, the options for a common position grid are examined first. Two suggestions for use of battlefield sensors in conjunction with the common position grid are then discussed. The problem of location of enemy aircraft and potential solutions is addressed next. Finally, some of the potentialities of better integration and improvement of the intelligence and decision-making processes based on the common position grid and digital communications are examined.

1. NAVIGATION AND POSITION FIXING (U)

1.1 Conclusion (U)

(C) An integrated common position grid system is required which will provide: (1) the position of friendly troops, vehicles, and aircraft; (2) the precise location of enemy fixed and mobile targets; and (3) the basis for precise controlling of aircraft and missiles. Within this common position grid system, the capability of extracting and using velocity information from radio-navigation techniques should be provided.

1.2 Recommendations (U)

(C) a. Provide the necessary emphasis to ensure that a common position grid capability is made available to the tactical forces. LORAN should serve as the basis for the common position grid in the near term.

(C) b. Continue emphasis on the current Army manpack LORAN program to provide receivers for ground units.

(C) c. Emphasize lighter, smaller and less expensive LORAN receivers in subsequent Air Force procurements to the current AN/ARN-92 buy.

(C) d. Conduct flight tests to definitely evaluate LORAN error sources before proceeding with procurement of LORAN-based systems for blind bombing. These tests should be conducted in several geographic areas to ensure that eventually world-wide performance can be predicted with statistical confidence.

(S) e. Augment the LORAN common position grid capability with STEER where higher accuracy is needed in certain interdiction missions.

(C) f. Continue Air Force 621B (NAVSAT) design studies for long-term common position grid with emphasis on a lightweight receiver for maneuver elements of the ground forces.

1.3 Discussion (U)

(C) A common position grid capability is needed to:

a. Locate friendly ground units with respect to each other and with respect to fire support means.

b. Locate targets with respect to means of striking those targets.

c. Provide aircraft navigation.

d. Provide information for command and control.

(S) A grid based on radio-navigation techniques appears to be the best means for providing the needed common position grid capability. LORAN appears to be the only feasible radio-navigation technique in the near term which can provide the capability of placing large numbers of aircraft and ground units over a wide area into a common position grid. The present LORAN C in Southeast Asia will provide daytime repeatable accuracies on the order of 100 feet CEP in location of ground units in South Vietnam when manpack LORAN receivers are made available. Another station will need to be added (possibly at Da Nang) to get the same degree of accuracy at night. Location of ground units to this degree of accuracy represents an order of magnitude improvement over the capability available today over wide areas. Because LORAN is passive and not line-of-sight limited, it is the best choice of a common position grid in the near term for use with maneuver elements of the ground forces. Therefore, we believe that the Army should proceed with all due haste in development, test and deployment of manpack LORAN. The Army is funding two versions of manpack LORAN through test as well as versions of remoted LORAN (whereby the LORAN signal is detected at a unit, modulated on VHF and received and processed at another location). Another version of manpack LORAN is being considered for development. In parallel, the Air Force should investigate the feasibility of application of Army-developed equipment to the tactical air forces. We agree with the Army approach and urge that production be undertaken as soon as adequate testing has been accomplished.

(C) LORAN should be the near term common position grid for all aircraft working in conjunction with the maneuver elements of the ground forces. (This should be noted when establishing the avionics package for the A-X.)

(C) The repeatable LORAN accuracy which can be achieved on moving platforms will not be as good as can be achieved on the ground. However, repeatable accuracy should be adequate for aircraft navigation and for visual acquisition of targets whose LORAN coordinates are supplied to a strike aircraft. We believe that it is unlikely that significant improvements in LORAN repeatable accuracy can be achieved over those presently available because of chain instability, propagation anamolies, skywave contamination, changes in index of refraction, dynamic lag in a moving vehicle and inherent errors in mechanization of LORAN-inertial integration. We believe that the aircraft positioning accuracy available with LORAN is not satisfactory for blind bombing against most targets. However, this viewpoint is not concurred in by all elements of the Air Force. Proposals exist in Air Force channels for a LORAN-based blind bombing system. Before implementing such a scheme further testing is needed. These tests should be conducted in several geographical areas to ensure that eventually world-wide performance can be predicted with statistical confidence. Terrain conditions from level to mountainous should be included. The static hyperbolic grid at ground level and at altitude should be known. Patterns should be flown to evaluate the effect of aircraft speed, heading and altitude on repeatability with respect to ground points. The accuracy in location of ground points offset—up to five miles from the aircraft—should be determined.

(C) We are concerned about the excessive amount of money the Air Force is devoting to installation of AN/ARN-92 receivers in aircraft. We feel that LORAN receivers could be available within a year that are cheaper, lighter weight and occupy less volume (by factors of two to five) than the AN/ARN-92. We are aware that present commitments for the purchase and installation of the AN/ARN-92 receivers probably could not or should not be affected, but we believe that comparative studies should be made between the AN/ARN-92 and the newer LORAN receivers before other LORAN procurements are initiated.

(S) To achieve the degree of positioning accuracy needed for blind bombing or missile guidance, it will be necessary to augment the LORAN common position grid capability with a highly accurate radio navigation technique. This capability has been proposed in STEER, which is an Air Force program to provide a repeatable common position grid extended from a baseline formed by two ground beacons. Relay aircraft would be located by trilateration techniques. These relay aircraft, in turn, would locate other aircraft by trilateration. The concept allows for the addition of a third relay aircraft; non-cooperative emitters can then be located in relation to the three aircraft by time-of-arrival techniques. STEER is to provide repeatable

positioning accuracy independent of approach azimuth and altitude, of under 100 feet CEP, at distances several hundred miles from a ground precision track radar or the beacon baseline. The common position grid can also be extended from a radar with a co-located beacon, but with decreased accuracy. We believe that STEER should be pursued to provide for missile guidance or blind bombing against fixed targets. Because of limited capacity in number of simultaneous users, STEER should be used in conjunction with LORAN. LORAN would be used for navigation of aircraft (reconnaissance and strike) to a target area and the trilateration technique used when the aircraft or missile is in the target area. LORAN would be the common position grid for all forces in the tactical area; STEER would be a special purpose common position grid for limited operations requiring better accuracy than would be provided by LORAN.

(C) To provide increased accuracy and wider areas of coverage, we believe that the Air Force 621B Program (NAVSAT) should be pursued with increased emphasis on equipments for the forward elements of ground forces. Receivers (including antennas) for the ground forces should be lightweight, small, rugged, reliable, and inexpensive. The Air Communications Navigation and Identification (CNI) development which incorporates the NAVSAT techniques should also take the same emphasis for lightweight equipment for ground force elements. Initial testing of the user equipment can be accomplished with the transmitters carried in aircraft rather than satellites (altitude and vertical velocity may not be as accurate as desired). Such a test program could evaluate user equipment and uncover the deficiencies without use of expensive satellites which may not be working when the user equipment became operational a few years later. It is likely that operational user equipment will not be available before 1975 and that LORAN will probably be the basic common position grid until 1980.

2. DAMAGE ASSESSMENT (U)

2.1 Conclusion (U)

(C) A most pressing problem in the command and control area is our limited ability to determine whether or not surface targets are actually destroyed by air and artillery strikes.

2.2 Recommendations (U)

(C) Investigate the use of special tactics and sensors in combination with the common position grid capability specifically for the potential of assisting in the evaluation of the effectiveness of air and artillery strikes. One action that should be taken immediately is to equip all strike aircraft with cameras.

2.3 Discussion (U)

(C) One of the most serious deficiencies confronting the military operator today is the lack of timely bomb damage assessment (BDA). Although a significant effort is being applied, the sensors currently available are inadequate. Selected strike aircraft are now carrying camera pods with both movie and still cameras. Reconnaissance aircraft with more sophisticated equipment are fragged in conjunction with strikes in an effort to exploit the best photo capability available in the inventory. Visual reconnaissance is employed extensively and primarily in many cases. In an effort to determine the effects of B-52 strikes in South Vietnam, ground follow-up is frequently utilized.

(S) If commanders are to exploit the favorable situations created by strikes, timely information concerning the enemy targets under attack must be available in the hands of responsible commanders. IGLOO WHITE type acoustic/seismic sensors, as well as other activity sensors, such as sniffers, etc., might be used to assist damage assessment. Sensors of this type might be air-delivered by B-52s upon completion of an ARCLIGHT sortie or by F-4Cs. Sensors might be delivered by other aircraft as well as by artillery and mortars. In addition, in the ground battle, sensors could be employed in conjunction with normal surveillance and reconnaissance means.

(S) It is recommended that action be initiated to develop sensors capable of being emplaced by air and artillery which would detect personnel, vehicle, and other activity in the target area. These sensors should be multi-purpose and should include an improved bomb damage assessment capability.

3. INSTRUMENTED BATTLEFIELD (U)

3.1 Conclusion (U)

(S) Ground-based and remote sensors have proved to play an important role in close air support and interdiction. Both DCPG and the Air Force have demonstrated that the multi-million dollar investment in a "barrier" has provided new tactical air capabilities. The "instrumented battlefield" concept should be expanded to include several new and different military tactics and operations. Particular emphasis should be given to providing small decentralized military units with sensors and devices for detecting enemy activity.

3.2 Recommendation (U)

(C) DDR&E should request the Army to prepare a plan of action within 90 days to include:

a. Various types of sensors to be evaluated,
b. Test procedures,
c. Specific tactics to be examined,
d. Analysis and evaluation programs,
e. Integration of such capabilities into the combat units' decision process.

3.3 Discussion (U)

(S) The Tactical Aircraft Panel feels that the selective utilization of all types of activity sensors in conjunction with traditional U.S. Air Force and U.S. Army reconnaissance and surveillance means will significantly increase the take of enemy information, and if properly evaluated and used should increase the combat effectiveness of combat units. The Army's efforts to develop and test the Battlefield Intelligence Control Center is a step in this direction.

(S) However, the Battlefield Intelligence Control Center, now under test in Southeast Asia, is only an information gathering and intelligence producing organization. In addition, it does not take advantage of other activity sensors which could be emplaced by artillery or air. It is not clear how this information and intelligence would be fed into the ground and air command and control systems to increase effective response and exploitation of the enemy information and intelligence. Timely intelligence is most useful if timely exploitation is possible.

(C) In this regard, we believe that some change in tactics may be required in order that full advantage be taken of the increased capability for the collection and production of intelligence and for near-real-time response. It appears that the concept of small unit air mobility could provide a reaction speed compatible with the increased speed of intelligence production.

(C) In view of the above, the Panel believes the Army should develop and test the integrated concept as a matter of priority. The test should include:

a. BICC operation with additional sensors in conjunction with a common position grid;

b. Information analysis and intelligence display;

c. Timely connection to air and ground combat units' decision process;

d. Exploitation of intelligence by all means of support including close air support and by the maneuver of ground combat units.

(C) The Panel recommends that a memorandum containing the following information be transmitted to the Assistant Secretary of the Army for R&D by the DDR&E:

(S) a. The Tactical Aircraft Panel of the Defense Science Board/ National Academy of Sciences Summer Study Group has identified a possible command and control problem in the use of sensors such as those developed by the Defense Communications Planning Group.

(C) b. The Panel believes that a truly integrated and automated system that provides for information collection, intelligence production and display, operational decision making and near-real-time exploitation is feasible and required by ground and air commands. Further, they believe that immediate testing of such a system should be initiated.

(U) c. It is requested that the Army develop a concept of such an integrated system to determine its applicability at Company, Battalion, Brigade, and Division level. This concept should include effective use of the information by tactical air commanders (perhaps via the Air Force Direct Air Support

Centers) and the Army is requested to develop their concept with the assistance and participation of the Air Force. Further, it is requested that the Department of the Army submit a plan for the testing of this concept to DDR&E prior to 1 November 1968.

4. AIRBORNE SURVEILLANCE RADAR FOR VIETNAM (U)

4.1 Conclusions (U)

(S) A few months ago there was intense interest and concern in our ability to acquire and detect MIG-17s and MIG-21s over some parts of North Vietnam. Basically, the main problem was our inability, due to lack of appropriate sites for ground-based radars and inability of EC-121/E-2A to detect targets overland in critical areas, to detect low-flying MIG aircraft at ranges of 150-200 miles. The early "detection" of enemy aircraft has been provided by collateral techniques. At present, there are still substantial gaps in our radar coverage, and we cannot detect or track enemy aircraft over large areas of North Vietnam. We believe that there is an urgent need to provide an airborne surveillance radar capability for Vietnam as quickly as possible.

4.2 Recommendations (U)

(S) a. Provide an early (desirable within 18 months) airborne radar surveillance capability to handle the Vietnam MIG-17 and MIG-21 threat. Immediate use of the E-2A aircraft with a digital data link to TACC(NS) will allow a coherent air surveillance picture with ground/air communications to provide improved MIG warning and should be implemented. Further flexibility in coverage with the E-2/B/C system could be achieved and should be exploited.

(S) b. An immediate evaluation should be made to determine the feasibility of a helicopter-borne MTI radar with a data link to TACC(NS) as a possible supplement to the coverage provided by the E-2A/B/C approach.

(S) c. AWACS is a longer-term solution to the airborne surveillance and control problem and should be pursued with continued attention and emphasis on advanced airborne radar prototype development.

4.3 Discussion (U)

(C) An airborne strike penetrating enemy territory must expect anti-air reaction in the form of surface-to-air and air-to-air ordnance. As a result of Southeast Asia experience, much has been spent since 1965 in dollars and effort addressed to providing air strike group protection

from the surface-to-air threat, such as RHAW, on-board ECM, Wild Weasel, SHRIKE, Standard ARM and other flak and SAM suppression systems.

(S) However, little new has been accomplished toward providing improved capability against air-to-air threats. The primary means to date is flights of four or eight MIGCAP aircraft, usually F-4s, that accompany each strike into airspace where MIG encounter is possible. (Note the stress on the word "possible.") North Vietnam practice has been to have periods of high MIG activity followed by up to 30 days or so of stand down, where little or no airborne MIGs are seen at all. Nevertheless, they have achieved their objective of reducing our strike effectiveness, since all strikes must have MIGCAP, on the possibility that today there may be MIG activity. This might cause one to suggest that forgetting about MIGCAP, and taking the possible extra losses, might result in more targets killed per sortie per aircraft lost, since the four to eight MIGCAP aircraft could be more usefully employed as strike aircraft. (Others might argue that reduced MIGCAP would lead to increased MIG activity, however, with greater losses.)

(S)-- Lately, when MIGs do appear, they are under very precise control from the ground and make high-speed, hit-and-run tail attacks on strike groups, the primary purpose of which seems to be breaking the integrity of the "pod formation" so that SAM and AAA will be more effective. It is for these latter tactics, against which MIGCAP appears to be ineffective, that drastic improvement is needed, should daylight, multiple-aircraft attacks into MIG-defended areas continue to be required. Although the current bombing restrictions have resulted in concentrating attacks in areas that have not yet been defended by MIGs, we should be prepared to operate in any area.

(S) It should be noted also, that while the MIGs are under close control, our MIGCAP and strike aircraft lack virtually any local command and control (except perhaps at the flight level) - certainly there is no strike group command and control, other than attempting to follow the frag order versus time. The primary complaint of strike and MIGCAP pilots against the PIRAZ/E-2A/EC-121 systems that currently attempt to fill the warning and control role is that these systems lack sufficient resolution and detection coverage to give them usable data. The identification problem in the face of inadequate data is compounded by the reluctance of our pilots to run their IFF transponders over enemy territory because they fear it enables the North Vietnam GCI net to track them, similar to our attempts to do the same via ALQ-91. Finally, there is the problem of getting the word, in terms the pilot can use without time-consuming interpretation and data conversion, over the overused UHF (or HF) voice links.

(S) Assuming all these problems can be overcome to a reasonable degree, some by hardware improvements and many by military tactics management changes, those airborne sensor systems that appear to offer potential means of providing the required data are:

a. E-2A/B/C (self-contained and data relay)

b. Helicopter-borne radar (data radio-relayed to surface for processing and display)

c. Balloon-borne radar (primary power supplied via tether, radar data radio-relayed to surface for processing and display)

d. SEAOR 53 (KC-135 + E-2C electronics +COMINT/ELINT)

e. AWACS

(S) The balloon radar offers the advantage of very long on-station time (days to weeks). Both the balloon and helicopter radars are relatively stationary with respect to the earth, making it possible to eliminate platform motion clutter effects. Obviously, the balloon and helicopter-borne radars would have to locate in areas less vulnerable to attack than the E-2A/B/C, which could at least retreat from threats at 300 knots, or KC-135/AWACS, which could retreat at about 400 knots (speed limited by rotodome). It should also be noted that the helicopter and balloon-borne radar solutions are aimed at defeating enemy attempts to fly under the net (line of sight limitations), as they would if only PIRAZ or ground-based warning radars were used. On the other hand, the E-2A/B/C, KC-135 and E-2C electronics and AWACS offer extension of coverage beyond the range limits of ground-based radars, as well as seeing low-altitude flyers.

(C) While conceptually balloon and helicopter radar could be available soon, it should be noted that the E-2A operates in the Gulf now. By flying at about 500-5000 feet, the E-2A can provide some immediate capability to detect small airborne targets flying over land at ranges beyond the clutter ring. The digital data link interface with TACC(NS) through NTDS/MTDS could provide an immediate input to the air surveillance picture and provide improved resolution and identity for MIG warning.

(S) Similar statements can be made about the EC-121s that fly over Laos and the Gulf. However, it should be noted that JTF-2 tests performed for STRIKE Command showed that when both the E-2A and

EC-121 were flying at 500-2000 feet trying to detect the same low-flying aircraft over land (mid-West, U.S.), the E-2A detected five times as many targets as the EC-121. The E-2A also has the advantage of an automated tracking system on IFF and radar data, whereas the EC-121s are manual detection-tracking. The improved version of the EC-121 (the Air Force College Eye) will be equipped with some automatic aids and collateral techniques as well as a digital data link to the TACC(NS).

(S) The range and capacity capabilities are improvements to the same air surveillance picture and should continue to be pursued at all speed. Presumably a few copies of the helicopter-borne Westinghouse radar now in test at Maryland could be deployed to Southeast Asia with strong contractor support. It would be foolhardy to expect larger quantities or competent military support and operation of such a system in less than two years.

(S) A large force of helicopter-borne radars seems impractical since such procurement would curtail other types of platforms which would probably have a better chance of survival. If we depended solely on helicopter-borne systems, the enemy could easily kill them rapidly if they became a nuisance.

(S) Similar considerations apply for the balloon radar system. A suitable balloon-radar combination could be put together in 9-12 months, off-the-shelf, based on ARPA's Silent Joe II, and the balloon could be tethered from the PIRAZ ship in the Gulf. However, again, its survivability from a land tether might be limited.

(S) With regard to the E-2A, it is proposed that the four-aircraft squadron on one Yankee-station carrier be assigned to operational control of the Seventh Air Force. In-flight refueling could be added to the E-2A in about 6 months, if done by NAS North Island as a mod. Thus, 6-8 hours of on-station time could be had (given that aircrew endurance and efficiency can be maintained that long) via the KC-135 tankers that are over the Gulf anyhow. We presume that the Seventh Air Force would explore the use of the E-2A in critical areas of North Vietnam other than the Gulf of Tonkin.

5. CONTROL OF TACTICAL AIR FORCES (U)

5.1 Conclusion (U)

(S) The planning for close air support and interdiction missions in Southeast Asia has been hampered by: (1) lack of aircraft status information and delays in preparation and dissemination of frag orders; (2) lack of knowledge of location of strike aircraft when strikes are to be diverted; and (3) inability to closely coordinate near-real-time target information and strike operations.

5.2 Recommendation (U)

(S) a. Provide rapid improvement of TACC capability in Southeast Asia including source data automation and preparation and dissemination of frag orders.

(C) b. Locate targets and friendly units in the common position grid (as discussed on page 110) and augment the common position grid capability by periodic transmission of aircraft position as presently planned in the LORAN Integration Equipment Program.

(C) c. Integration of intelligence and operations functions should be employed for rapid response to near-real-time target information.

5.3 Discussion (U)

(C) We believe that a sense of urgency should be imparted in 407L and ATCCC to provide for tactical source data automation.

(S) The PACAF integrated automated command and control system (PIACCS) will place input devices at the tactical units' operation centers and at selected airlift control elements. Switching computers are being installed at Saigon and PACAF to update the computer contained data base. SEEK DATA II is intended to provide display of this data at the TACC/AFCCP and ALCC at the Seventh Air Force. In addition, Seek View for the Seventh Air Force TACC/AFCC will provide current day air situation information from the TACC(NS) via the Seek Dawn capabilities at Monkey Mountain. These two programs will provide some interim capability in Southeast Asia; however, major problems are

associated with providing the needed communications capabilities to connect the tactical units and depots to the TACC. The design concept for supplying the needed communications capabilities is urgently needed and should be established immediately.

(C) It is recommended that management attention be focused on the interim automation in Southeast Asia to insure proper integration of communications, data processing and display in a manner most useful to the TACC.

(C) Allocation of resources can be made more effective if data on aircraft, crew, and munition status are available to the mission planners. With automation at centers, such as the Air Force TACC, preparation of frag orders can be greatly simplified and accelerated. These frag orders can then be selectively disseminated to appropriate units. This problem is being studied under 407L although no firm goals have been set which will provide such a capability to the tactical air forces before 1972.

(C) When the common position grid capability (LORAN) is available in aircraft, the position of that aircraft should be periodically transmitted to appropriate Tactical Air Control Centers (except in areas where such transmissions are detrimental to survival of the aircraft). This position information should be used to display the friendly air order of battle in near-real-time and provide the capability to divert missions as targets of opportunity occur. The Air Force is planning to apply LORAN integration equipment to perform this function in limited application for Southeast Asia and this should be vigorously pursued.

(C) Under the LORAN integration equipment plan, data transceivers (such as the AN/ARC-124) will be placed in aircraft equipped with LORAN units. The aircraft's identification, horizontal position and altitude will be transmitted periodically and received by centers or other aircraft interested in knowing that aircraft's location. The aircraft will also be able to send and receive digital messages other than those associated with aircraft position (such as target locations).

(S) The initial implementation of this concept is planned for a few aircraft in close air support operations and in hunter/killer operations in interdiction. Selected FAC aircraft will be equipped for target location, conversion of target location into LORAN coordinates, and digital transmission of those coordinates and other target description to approaching strike aircraft. Appropriate strike aircraft will be provided with the capability for receiving the target coordinates and,

in conjunction with the strike aircraft's LORAN coordinates, determining and displaying bearing- and distance-to-go. Where the capability exists in the strike aircraft, a reticle will be positioned on a heads-up display or a telescope will be pointed toward the target so that the pilot's area of search is contained within a 1-to 5-degree half-angle cone. This will significantly enhance the probability of acquiring and attacking the target on first pass. Based on position information transferred between the AFAC and strike aircraft, their relative location can be known during the attack permitting precise relative position for strike control and BDA.

(S) Assuming the Air Force plan for limited application in Southeast Asia is as successful as anticipated, other functional applications come immediately to mind, including: air refueling operations, diverting sorties, lift of artillery fire, enroute, traffic control, averting border violations and location of downed airmen. The near-term potential as conveyed in earlier sections of this appendix (Navigation and Position Location) is extremely high and a concerted overall program is urgently recommended.

(C) Another major problem in controlling tactical air forces is the increasing realization that near-real-time reconnaissance must be integrated with the air operations function to obtain effective use of air power against mobile targets. Realization of a common position grid reference will greatly improve relating ground and air targets with our own air operations against such targets. Digital communications of target data, strike results, BD estimates and other highly perishable intelligence/reconnaissance data (treated also under an earlier section, Instrumented Battlefield) into the air operations planning/replanning and dynamic diversion decision process will reduce reaction time and, we believe, improve kill effectiveness. The payoff in this area is directly applicable to various air operations centers (TACC, CRC) and particularly to mobile operations centers. The experience of ABCCC operations in Southeast Asia is particularly pertinent. We believe the limited use of such techniques in dedicated aircraft in Southeast Asia is a start in the right direction and should be expanded.