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REPORT II OF THE ARMY SCIENTIFIC ADVISORY PANEL
AD HOC GROUP ON WHITE SANDS MISSILE RANGE INSTRUMENTATION

Army Scientific Advisory Panel
Washington, D. C.

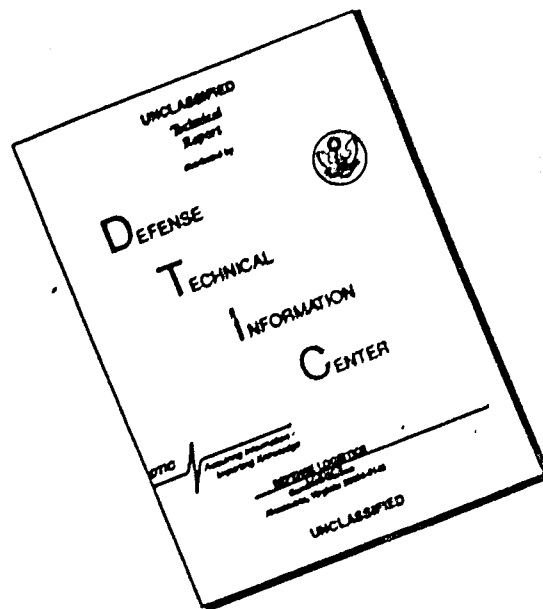
November 1975

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) At the request of the Commander, US Army Materiel Command (AMC), an Army Scientific Advisory Panel ad hoc group was convened to review and assess the requirements and funding level for instrument at White Sands Missile Range (WSMR) to maintain an adequate test facility. The ad hoc group's efforts focused on reviewing the WSMR workload, WSMR range-modernization plans, priorities for instrumentation in order to identify significant deficiencies in technical approach, lack of definitive planning information, and shortages of funds.		

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In the report an assessment of the FY 1974 report was provided with additional recommendations to insure that the test range can provide the test support required for the next five years. The recommendations include continuing to upgrade the range in accordance with the recommendations made in 1974, additional funding to procure instrumentation, the achievement of a better balance between manpower, capital investment and maintenance of facility, and intensified efforts to identify future user requirements earlier.

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**REPORT II
OF
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1975 ARMY SCIENTIFIC ADVISORY PANEL
AD HOC GROUP REVIEW OF WSMR INSTRUMENTATION

I. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. The management of the WSMR has carefully reviewed and implemented most of the recommendations of the 1974 ASAP Report on WSMR Instrumentation. Serious consideration was given to those which were not implemented. The Group is satisfied by the response of WSMR, both by the spirit of the response and the execution. The overall program in range control, safety, data acquisition and data reduction has made significant strides in the one year interim.

2. The 1974 Report recommended an increase in the WSMR instrumentation budget from approximately \$8M to approximately \$13M to maintain existing capability and procure new capability. The budget for instrumentation at WSMR was reduced to \$0.9M; however, two additional end of year increases of \$2.3M and \$0.7M increased the total instrumentation budget to \$3.9M. Most of the \$3.9M was spent for new capability; as a result the existing instrumentation capability has deteriorated.

3. Because of the long lead time associated with manpower reductions, unexpected range budget reductions are handled primarily by sharp curtailment of funds for instrumentation, contracts, maintenance, repairs and supplies; long term range capabilities suffer.

4. The annual budget of WSMR is approximately \$100M. Approximately 4 percent was invested for capital improvements, a figure too low to maintain and update instrumentation valued in excess of \$150M.

5. While WSMR has devoted significant effort to identifying User requirements early (highlighted as the significant operational problem in the 1974 report), positive results are not yet apparent. Further requirements are not formalized by Users early enough to provide WSMR with time to obtain the required instrumentation capability.

6. The new DOD requirement for cost reimbursement by the User for range support appears to have reduced the amount of testing and the requirements for instrumentation and data reduction. The full impact of these reductions is not yet known.

7. WSMR has established a priority system for instrument acquisition. The system gives first priority to meeting a User's range requirement and maintaining existing capability and thus tends to emphasize short range objectives. If this procedure (and limited funds for instrumentation) continues the range will continue to deteriorate.

8. The current impact statements provided to Headquarters (TECOM, AMC and DA) are inadequate in that they reflect changes in input resources to the range instead of the output service provided to the User.

B. RECOMMENDATIONS

1. WSMR should continue the program to upgrade the operation of the range in response to the 1974 WSMR Instrumentation Report.

2. Additional funds must be made available for instrumentation, a minimum of \$12-13M per year for the next 5 years.

3. Recognizing that total funds constraints will continue, WSMR must achieve a balance between manpower, capital investment and maintenance of facility capability. To accomplish this, WSMR must develop a resource allocation system that will program its funds between operation and investment based on a long term strategy. This allocation procedure should facilitate contingency planning to minimize the impact of different fund allocation on the service provided to the customer. Although many objectives can be stated, we believe the range should develop instrumentation to provide versatility and responsiveness to take care of User's requirements in the future. This may require that the range reduce personnel to obtain funds so that new less labor intensive instrumentation can be provided.

4. WSMR allocation procedures should provide the data on which to base statements of impact on capability to meet both existing and potential requirements if funds are reduced or specific items of instrumentation are denied.

5. AMC and WSMR should intensify their efforts to identify future User requirements at an earlier time.

II. INTRODUCTION

Part of the 1974 ASAP group on WSMR Instrumentation (Bonder, Gates, Montgomery, Reese, and LTC Humphrey) visited WSMR on 10-11 July 1975 to respond to the 1975 "Terms of Reference" (Appendix A). Those terms of references essentially requested a review of the response to the 1974 ASAP report and the WSMR five year range modernization plan, within defined constraints. The Group received a series of briefings that noted the changes at the Range since Summer 1974 and the Range's response to the ASAP report. Three Users discussed the Range's support of their programs. The Group visited the range control center and witnessed a playback of the latest SAM-D firing. The list of briefings and a list of the reference document furnished to the Group is presented as Appendix B. A copy of the presentations is available in LTC Humphrey's office (DAMA-PPM-T).

The report responds to the terms of reference and consists of Section I - Conclusions and Recommendations; Section II - Introduction; Section III - Implementation of the Recommendations of the 1974 ASAP Ad Hoc Group on WSMR Instrumentation; Section IV - Allocation for FY 75 Funds; Section V - Resource Planning and Allocation of Future Funds. There are five appendices: Appendix A, Terms of Reference; Appendix B, Briefing Outline; Appendix C, Technical Suggestions; Appendix D, Flow Chart for Allocation Procedures, Appendix E, Reference Documents; and Appendix F, Distribution List.

The results of the 1974 investigation by the ASAP Group were briefed to the Commanding General, Army Materiel Command, and the information was transmitted to other groups and elements of the testing community. There appears to be adequate understanding of the intent of the recommendations, and the Group is gratified by the whole-hearted response and enthusiastic implementation of many of those recommendations, and the serious consideration given to those which were not implemented. It is appropriate to commend WSMR on the following significant changes and programs which partially resulted from the ASAP Report.

A. The efforts to collect range requirements from Users and potential Users of WSMR have been formalized. The conferences and data exchanges that have occurred and are scheduled to continue should enhance WSMR's ability to predict instrumentation requirements and to provide information on capabilities to potential Users. For example, WSMR is preparing a brochure on WSMR capabilities. The brochure is supplemented by two volumes of detailed capabilities, along with explanations of how the WSMR works with the User. It is too early to determine whether this approach will significantly increase the inadequate lead time highlighted in the 1974 Report as the significant operational problem. Additionally, it appears that a better procedure for forecasting range workload from these requirements is needed.

B. FY 75 was the first year of operation of the new requirement for cost reimbursement by the User for range support. Many of the problems encountered in pricing and budgeting by the User were defined, and it is expected that many of these problems will be reduced in FY 75. WSMR has published a "Guide for Estimating User Costs" which will improve the ability of the User to provide adequate funds in his budget and they are to be commended on this effort. A decrease in User demands during tests have apparently resulted from implementation of the cost reimbursement policy; the long term effects of the reduction are not clear but it appears that there is a trend to more efficient use of the range instrumentation and selective data reduction with little loss of essential information. There also appears to be a reduction in the number of tests being conducted, which may have more serious consequences. However, the Single Integrated Development Test Cycle Policy should reduce duplication in testing and the reduction in testing if part were, in fact, duplication may not seriously impact the quality of the weapon system.

C. In 1974 the Group was concerned about the procedures utilized to insure that the range safety instrumentation and support systems are operative for tests. These procedures have become more "formal" and the overall program in the range control, data acquisition, and safety areas has made significant strides in the one year interim.

D. One of the persistent complaints from all range Users is the lapse of time between the test and the availability of test results. Table 1 indicates that significant progress has been made in this area.

TABLE 1

Average Data Report Delivery Times (Days)

	<u>1974</u>	<u>1975</u>
Cinetheodolite	22	14
Miss Distance	20	9
Telescope Roll	14	7
Telescope Attitude	20	15
Radar FPS16/MPS36	8	6
DOVAP	25	5
Velocimeter	10	4

Availability of the new film processing facility should further reduce optical data processing time. Modernization of data collection and processing equipment will further improve the timely availability of test results and will permit a reduction in costs by the substitution of automated equipment for hand labor.

IV. ALLOCATION FOR FY 75 FUNDS

The funding to WSMR and the budgeting of those funds by WSMR to support a national test range is, at best, hectic. Both qualitative demands by Users are not provided to the range early enough to allow a well thought-out reaction, especially if new types of instrumentation are required. This makes it difficult to plan for instrumentation since most of the new instrumentation needs are long lead time items (more than 18 months if engineering development, procurement, installation and checkout are included). The allocation of funding resources is equally difficult to manage since the budget is continuously being reviewed and revised. The Range Commander has little flexibility, in the short term to accommodate reductions in the budget, except to reduce new purchases, primarily instrumentation.

Personnel numbers, and hence personnel costs, are not amenable to short term control. All the long lead time planning and general upgrading/ replacement of equipment is set aside to be able to meet the "must" (short term) requirements that have been imposed. The inability to replace instruments that are old, and frequently labor intensive, causes increasing costs in maintenance and manpower, degraded accuracy, and decreasing reliability. For those cases where new capability requirements have been identified, the reduction in the budget may delay program testing because test objectives cannot be met as equipment needed has not been procured on a timely basis.

The 1974 ASAP ad hoc Group recommended WSMR be provided \$12-13M per year for the next five years in order to upgrade/replace (approximately \$8M) and procure new instrumentation (\$4-5M). However, the budget reduction in the FY 75 as shown in the funding profile in Table 2 did not allow for even the "must" instrumentation needs until the last month of the FY 75.

TABLE 2

Funding Profile FY 75
(million dollars)

Instrumentation

	<u>ASAP Recom.</u>	<u>Army Allocation</u>	<u>Total WSMR RDT&E</u>
Init FY 75	13	8.4	86.1
1st Rev		1 Jul 8.4	84.1
2d Rev		Sep 5.6	80.2
3rd Rev		31 Dec 1.6	75.0
4th Rev		Mar 0.9	74.8
Final FY 75		Jun 3.9	77.2

(Note that \$3M of FY 74 funds was spent in FY 75 to procure the Drone formation control system, but is not included in Table 2.)

The "planned" instrumentation funding ranged from \$8.4M to 0.9M. Additional end of year funds were provided to increase the procurement of instrumentation to \$3.9M. The "seesaw" effect on the funding seriously impedes the capability for effective management.

A. Provision of Funding. The FY 75 funding shown in Table 2 allowed very little flexibility in the execution of that budget. Since the budget reductions were made in the September-March time frame, it was not possible to make a balanced reduction. As an example it would have been impossible

to realize a large saving from a reduction in force (RIF) action because of late implementation. The late budget reduction was further complicated by the fact that by the time the final budget was approved by Congress more than 30% of the planned budget had been spent. However, because of the instrumentation program priority system set up by WSMR (as a response to the 1974 ASAP review), WSMR was able to allocate the funding that was made available very late in FY 75 for "must have" items of instrumentation.

B. Use of Funds. The Group does not find fault with the utilization of funding and procurement of instrumentation. A priority procedure was developed and followed. The priority system includes a small percentage of the total funds for quick response to "unknown" requirements and for the procurement of short term "must have" items of instrumentation. It is the opinion of the Group, however, that totally inadequate funds were available to maintain and upgrade the existing capability. This will be discussed in further detail in V.

The budget was so low in FY 75 that off the shelf stock supplies were reduced below acceptable levels and the FY 76 budget year will begin with a \$4-5 million shortfall of these items. Some necessary maintenance and repair were not accomplished in FY 75 because of the reduced budget and the catch-up costs will be greater in the future because of price escalation.

C. Impact of the Reduced Budget. The range reacts to ensure that the "must" testing is accomplished in as effective and efficient manner as possible with funding resources available. However, WSMR does not appear to have developed an adequate procedure to provide a persuasive statement or outline of the long term impact on the test programs of dropping items planned for upgrading the Range. Rather, their impact statement reflects anticipated shortfalls in input resources (instrument, maintenance, etc) which do not convey to Headquarters the shortfalls in service to the User which are expected to occur. These impact statements must make clear the impact of inadequate instrumentation funding on the capability of the range to meet current and future needs.

V. RESOURCE PLANNING AND ALLOCATION OF FUTURE FUNDS

There is a great difficulty in the preparation of five year program plans when neither the requirements nor funding is known. From the overall view it would appear that, given the \$150M instrumentation inventory, there is inadequate investment for future "business" when the allocation is of the order of \$4M in a total budget of the order of \$100M, particularly in a high technology business. It is the belief of the Group that investment in capital improvements at this low level (4%) will result in the loss of WSMR as a viable national resource. As noted in the 1974 Report, the minimum for upgrading/replacing existing instrumentation is \$8M/year.

The current planning and allocation procedures do not adequately support the long term requirements. Certain salient requirements for new capability-multi-target, multi-missile; low altitude tracking - probably will be met, but the long term requirement to keep and upgrade the present capability, and to operate the equipments that provide this capability without substantial cost escalation, is in serious danger. This loss of existing capability as the equipment wears out or becomes nonrepairable, along with the manpower intensive operation of these equipments has been pointed out to higher Headquarters by WSMR and has been acknowledged. The difficulty in obtaining funds is partly due to the inability to quantify the long range impact of not modernizing these equipments. More WSMR effort must be devoted to the quantification of the impact of the absence of long term instrumentation investments and in developing an optimum balance between investment and operations at any total budget level; i.e., WSMR should develop procedures for contingency planning. WSMR, in the absence of additional funding, must specifically address the problem of planning manpower reductions in the long term in order to make available funds for the introduction of manpower saving modern instrumentation.

The Group is concerned about the methods of planning the allocation of future funds for range modernization. As done now, the planning is based on a set of priorities as follows:

- IA - Tasks which must be done to meet a range requirement.
- IB - Tasks which must be done to maintain existing capability.
- IIA - Tasks which need to be done to increase efficiency, capability, and cost effectiveness.
- IIB - Tasks which need to be done to keep pace with and develop instrumentation technology.
- III - Tasks which are not directly supportable by external or internal requirements, but which are logical extensions of WSMR capability based on experience, data and forecasting methods.

Our particular concern is that the fixed priority ordering has a tendency to direct the allocation of resources toward meeting identified User demands to the neglect of other needs. As noted earlier, WSMR must be responsive because of the large costs of weapon system development delays, but the long term viability of WSMR may depend much more on other factors, such as:

- a) Ability to accomplish its mission tasks within a fixed budget or one that, in real dollars, is declining because of wage and instrumentation cost inflation.

b) Acquisition of increments to the instrumentation array that will accommodate not just expressed User requirements but, integrated over time, will satisfy the testing needs that are implicit in future systems, i.e., the range must be versatile.

c) Achieving an appropriate balance between capital investment and manpower (operating) costs, so as to meet range objectives.

The frustrations inherent in long term planning for the balanced allocation of resources are recognized when eventual implementation of the plans may be impeded by:

- a) Erratic and unforeseeable fluctuations in the available money,
- b) Political or other restrictions on reduction or increase in manpower, and
- c) Unanticipated range User requirements.

To meet the problem of budget fluctuations, planning needs to generate a set of alternative increments to the range instrumentation array that will match the several possible budget levels and at the same time be consistent with the selected planning strategy with respect to reduction or increase in manpower. It is important, of course, that the manpower plan not be considered separately from the instrumentation plan in higher headquarters, which means that the plan and its objectives must be well understood. To eliminate the surprise in User requirements continuing and intensive liaison with the research and development world to anticipate the market for range capabilities is essential.

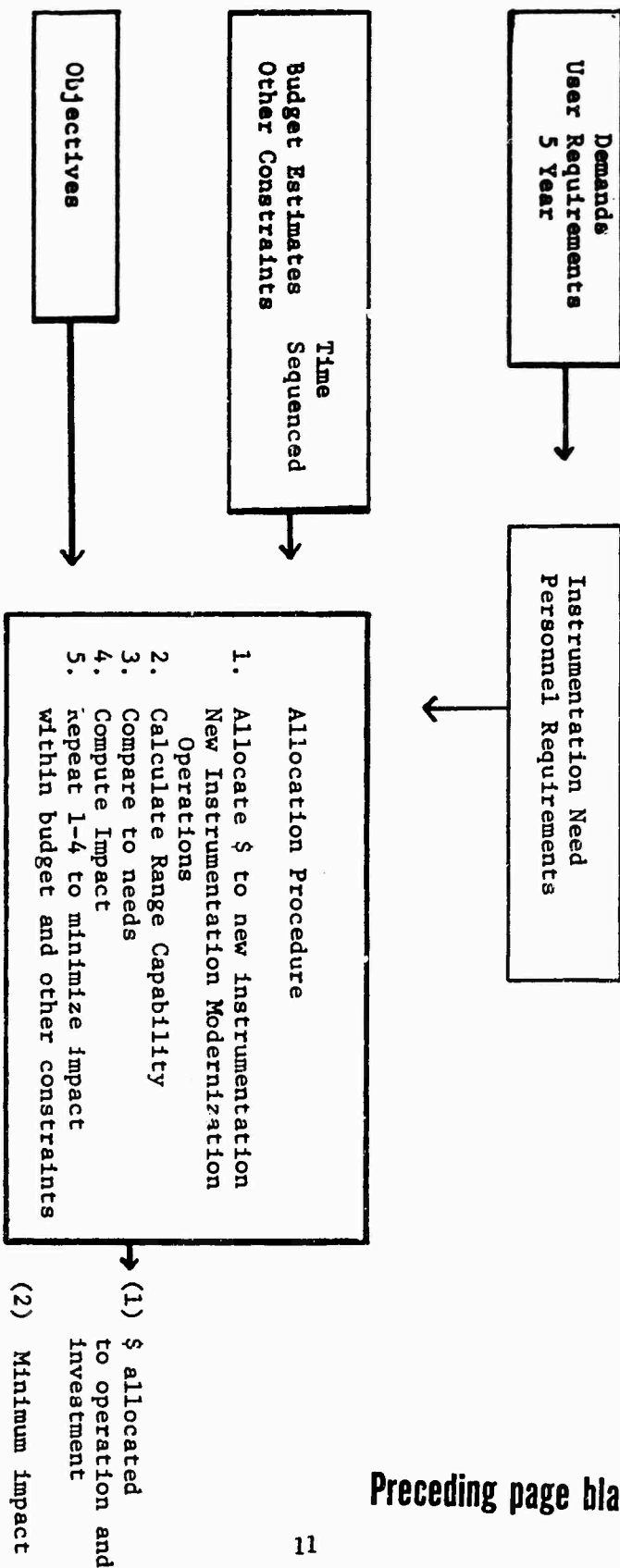
To restate, for purposes of emphasis: planning the expenditures for instrumentation modernization and new capabilities and planning the manpower levels and expenditures should be done together, not separately, in order to achieve the appropriate allocation between them. But because there is a time constant associated with incrementing or decrementing manpower levels if political "hassles," morale impacts, and other disruptions are to be avoided, the manpower plan and the corollary plan for instrumentation must be long range, well understood and well advertised both within and external to WSMR.

Because of the complexities associated with simultaneously planning for operations and investment, and the erratic nature of appropriations, a formalized total resource allocation procedure should be developed. This procedure should give explicit consideration to the impact on service to the User of alternative funding plans and allow for reprogramming as the sequence of forecasted budgets change over time. The impacts might be measured by (a) delays imposed on weapon system developments or (b) confidence in the data provided, or (c) other User oriented measures. The objective of the

allocation procedure should be to minimize the detrimental impact on present and future Users. Appendix D depicts the general flow of information that should be included in such an allocation procedure.

APPENDIX D

FLOW CHART FOR ALLOCATION PROCEDURE



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APPENDIX C

TECHNICAL SUGGESTIONS

1. The need for instrumentation radars capable of low altitude, multiple object tracking has been stated by WSMR personnel. While it is not known whether the SAM-D and the Air Force AWACS radars will meet accuracy or data rate requirements imposed by the range, both radars have been designed to track multiple targets in ground-clutter backgrounds. It is suggested that the capabilities of both these radars be reviewed with the object of determining their applicability to range use. (The concept is to locate the AWACS radar on a mountain side giving clear line of sight.)

2. The difficulty of very precise simultaneous tracking of several missiles and drone targets in the terminal phase of flight has been indicated by WSMR personnel. Steps are being taken by WSMR to assure that space, weight and power are provided in missiles and drones for transponders or beacons to ease the tracking problem. It is suggested that precise multiple object tracking could be provided by using on-board pseudonoise modulated transmitters, with several receivers located at known points on the ground to provide position determination of the on-board transmitters by multilateration. The transmitters, though operating on the same nominal radio frequency, would be distinguished one from the other through the assignment of a different orthogonal pseudorandom code to each. Each ground receiver would require a separate code tracking loop corresponding to each transmitter to be simultaneously tracked. Position of each transmitter would be computed from time-of-arrival differences at the several receivers; thus it would be necessary to have range time at each receiver to a precision corresponding to the position accuracy required (for example, 15 nanosec). The transmitted code rate would also correspond to the required position accuracy (e.g., 100 megachips per second for 5 foot accuracy). The length of the pseudorandom code sequence would have to be enough to eliminate possible range ambiguities; a code length of 2 milliseconds, or 2×10^5 chips would be adequate. Thus a 19 bit register would suffice for code generation. The number of orthogonal code sequences that can be generated with a 19 bit register is not at hand at this writing, but should be ample to accommodate multiple-tracking requirements of WSMR. The r.f. operating frequency would need to be high enough to accommodate the 100 MHz modulation bandwidth: for example, S- or C- band could be used.

The advantages of such a system are:

- 1) Small size of the on-board transmitter, code generator and modulator
- 2) Simultaneous operation of all transmitters on a single frequency
- 3) Accuracy appropriate to the problem
- 4) Portability of the receivers and (unlike interferometers) independence of angular orientation

APPENDIX A

TERMS OF REFERENCE

ASAP AD HOC WORKING GROUP ON WHITE SANDS MISSILE RANGE INSTRUMENTATION

1. Background.

During the summer of 1974, an ASAP Ad Hoc Group reviewed the adequacy of White Sands Missile Range (WSMR) to support current and future technological requirements. The review was conducted at the request of the Commander, Army Materiel Command, as an aftermath of the inadvertent destruction of SAM-D, CTV-1, in December 1973, and the subsequent investigations into the cause. It was estimated that the loss of CTV-1 incurred a loss of approximately \$0.75 million to the Army.

The major findings of the Group were:

- a. The range was well managed and operated efficiently within limits of instrumentation and geography.
- b. The instrumentation was adequate for current types of tests, but needs to be maintained (and replaced) in order to keep that capability.
- c. There was inadequate funding, time and planning for future instrumentation requirements. An instrumentation budget of \$12-13 million per year for at least 5 years was recommended to address upcoming technology. This represented a \$4-5 million per year increase over previous, usual, \$8 million per year budgets.

As a result of the Group's recommendations, the Commander, AMC, requested that:

- a. The WSMR budget be increased.
- b. An implementation plan responsive to the ASAP Group's recommendations be prepared, and
- c. That the ASAP Group review progress in the summer of 1975.

In the interim, over-all drastic reductions in the FY 75 Army RDTE budget reacted on WSMR, cutting its instrumentation funds from \$8.0 million to less than \$1.5 million.

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2. Terms of Reference.

a. Assess the implementation plan prepared in response to the previous Group's recommendations, the progress achieved thereunder, and furnish comment on items of major significance.

b. Within funding guidance to be furnished, review the WSMR, 5-year range-modernization plans with respect to adequacy of planning, priorities, and ability to meet proposed objectives. Identify significant deficiencies in technical approach, lack of definitive planning information, or shortages of funds.

c. With respect to unfunded requirements, identify and comment on future programs, or major related technological interests within DOD, which may be affected by lack of definitive decision data derived from, or dependent upon, the mensuration capabilities of WSMR.

3. Termination.

The Chairman of the Ad Hoc Group is requested to conclude his efforts at an early date. However, a final report is desired about 15 October 1975.

APPENDIX B

BRIEFINGS - ASAP AD HOC GROUP 10-11 July 1975

Welcome and Opening Remarks	COL F.C. Schoen
Update on White Sands Missile Range	Dr. J.C. Davies
Review of WSMR Actions	Dr. J.C. Davies
Review of TECOM Actions	Mr. J. Phelps
Engineer and Scientist Update	Mr. J. Cates
Range Modernization	Dr. R. Paul
ARMTE Modernization	COL B.B. Safar
Army SAM-D Testing	LTC W. Donner
Air Force Air to Air Missile Testing	LTC F. Holstead
Navy User Testing	Captain H.E. Davies, Jr.
Range Control Philosophy	Mr. Bart A. Goode
Diagnostic Procedures	Mr. Bart A. Goode
Data Reduction	Mr. T. Katsura
Standard Cost	Mr. C. Bustamante
Play-back of SAM-D Firing	Mr. Bart A. Goode
WSMR Programs	MG R.J. Prudfoot

APPENDIX E

Reference Documents:

Review of the Adequacy of Department of Defense Test Resources,
Report to the Committee on Appropriations U.S. Senate by the
Comptroller General of the United States CONFIDENTIAL April 30, 1975.

Implementation Plan, ASAP ad hoc Group Recommendations on USAWSMR
Instrumentation USATECOM 13 February 1975.

Future Programs, National Range Operations WSMR, April 1975.

Guide for Estimating User Costs, National Range Operations, WSMR,
Effective period 1 July 1975 through 1 January 1976.

Report of the Army Scientific Advisory Panel Ad Hoc Group on White
Sands Missile Range Instrumentation 19 November 1974.

Development Plan, USAWSMR RCS CSCRD-21 R1 June 1975.

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