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IDENTIFICATION OF PROBLEM AREAS IN THE WEAPONS DIRECTOR FUNCTION THROUGH CRITICAL INCIDENTS

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I. INTRODUCTION

As a part of the Weapons Director Workload Analysis Project (Ref. 1), an application of the critical incident technique (Ref. 2) was made to obtain data which could be analyzed in identifying problem areas of the Weapons Director (WD) function. Identification of these areas provided a basis for recommendations in improving the effectiveness of the Weapons Director's operations. The specific recommendations generated as a result of this study are not reported in this document, but have been published in the final report (Ref. 3) of the project group.

In approaching the task set forth, it was decided to examine three aspects of the WD function. These aspects were:

1. The performance requirements of the position.
2. The WD's interactions with the Senior Weapons Director (SWD) and the Intercept Directors (INDs).
3. The console equipment, communications equipment, computer programs and standard operating procedures with which the WD is concerned.

More specifically, the study sought to accomplish the following objectives:

1. To obtain incidents of effective and ineffective behaviors in the performance of the WD position.
2. To obtain incidents of effective and ineffective behaviors of the SWD and the INDs in their interactions with the WD.
3. To obtain incidents concerning situations in which the WD was hindered in the effective performance of his job by limitations or constraints imposed by the console equipment, communications equipment, computer programs and standard operating procedures related to his position.
4. To systematically collect and analyze these incidents in identifying problem areas and to provide a basis for recommendations in improving the function.

II. PROCEDURE

A. Data Source

Critical incidents were obtained from respondents (SWDs, WDs, and INDs) at six SAGE Air Defense Sector (ADS) Direction Centers: Duluth ADS, Chicago ADS, Seattle ADS, Portland ADS, New York ADS, and Washington ADS. These sites were selected to obtain an incident

sample which would represent the different sites operating in various environments and geographical locations.

B. Preparation of the Questionnaire Form

A review was made of some studies in which the critical incident technique was used. These studies furnished ideas on the construction of forms for the collection of incidents. For the present study, a form developed by Wagner (Ref. 4) was adapted for use. The forms contain one section for the reporting of the incident and a second section for questions regarding the respondent, the incident, and the person involved. The questions used in the second section were constructed so the anonymity of the respondent and the person(s) involved could be maintained. The items contained in this section permit the analysis of the relationship between the reported behaviors and certain characteristics of the respondent, the person involved, etc.

Six questionnaire forms were constructed for use in the present study. Five of the forms were designed in the general manner described above, while a sixth (the WD Operational Procedures and Equipment Questionnaire) was constructed without the sample control data section.

An example of the critical incident form is contained in Appendix A. Table I, shown on the next page, presents a list of the forms used, their purposes and the appropriate respondent for each of the forms.

C. Preliminary Administration and Checkout

Prior to the administration of the questionnaires at the sites mentioned earlier, an initial set of the forms was administered to Weapons personnel at the Los Angeles Air Defense Sector. As a result of this preliminary administration, several suggestions were obtained regarding the interview procedure and the questionnaire forms. On the basis of these suggestions, several changes were incorporated in the final questionnaire forms and interview procedure.

D. Data Collection Method

1. Administrative Arrangements

The Field Operations Department (FOD) representative in the project group established liaison with the sites involved. SDC field site personnel were furnished with the appropriate incident forms, a guide to the administration of these forms and a suggested briefing outline. See Appendix C for the guide and briefing outlines. A supporting memorandum from FOD outlining the objectives and the purpose of the study accompanied the package of forms.

TABLE I

FORMS USED IN THE COLLECTION OF CRITICAL INCIDENTS

Form Name	Purpose	Respondent (Person to whom questionnaire was administered)
1. Critical Incident Form WD-SWD-(E) (I)	To collect incidents of effective (E) and ineffective (I) WD behavior.	Senior Weapons Director
2. Critical Incident Form WD-IND-(E) (I)	To collect incidents of effective and ineffective WD behavior.	Intercept Director
3. Critical Incident Form WD-(E) (I)	To collect incidents of effective and ineffective WD behavior.	Weapons Director
4. Critical Incident Form IND-WD-(E) (I)	To collect incidents of IND behaviors which helped or hindered the WD in performing his job effectively.	Weapons Director
5. Critical Incident Form SWD-WD-(E) (I)	To collect incidents of SWD behaviors which helped or hindered the WD in performing his job effectively.	Weapons Director
6. Weapons Director Operational Procedures and Equipment Questionnaire	To collect incidents in which the WD was hindered in the performance of his job due to constraints or limitations of equipment, computer program, or standard operating procedures.	Weapons Director

D. Data Collection Method (Cont'd)

A letter from the Air Defense Command Computer Programming and System Training Office was issued to the military commander at each of the selected sites. The letter was intended to inform the military personnel of the purpose of the study and to elicit their cooperation in the accomplishment of the study's objectives.

2. Interview Procedure

A group briefing followed by individual interviews was suggested to the field site interviewers as a procedure in gathering the data. This procedure was found to be more effective in incident production from the preliminary tryout at LAADS. If a group briefing did not occur, the interviewers were instructed to give the briefing individually prior to the administration of the questionnaires.

Briefings were given to the respondents for the following purposes:

- a. To explain the nature and purpose of the study.
- b. To give instructions for filling out the questionnaires.
- c. To give examples of well written and poorly written incident reports to aid the respondents in identifying and writing out the critical incidents.

By directing the respondents' attention to specific outcomes of effective or ineffective behaviors, it becomes possible to isolate and describe the behavior(s) responsible for that outcome. The "meaning" of critical incidents as well as the requirements for writing the reports can thus be made clear.

III. ANALYSIS OF THE DATA

A. Treatment of the Data Obtained from the Behavioral Reports

The treatment of the data obtained from the questionnaire forms on which behavioral reports were made (i.e., Forms 1 through 5 in Table I) is described in this section. The data obtained from the WD Operational Procedure and Equipment Questionnaire were treated separately and are discussed in the section to follow.

1. Transcription and Coding of the Data

Each incident from the questionnaire form was transcribed and

typed separately on a 5 X 8 McBee Keysort card. After all incidents had been transcribed, the sample control data (information from the lower section of the questionnaire) were coded on the cards and the appropriate columns were punched in accordance with a coding scheme. The cards were numbered consecutively in the same manner as the questionnaire forms from which the incidents were transcribed.

2. Isolation of Critical Behaviors and a Check for Usability

Each of the incidents on the McBee cards was read and the critical behavior underlined. In cases where several different behaviors were involved in an incident, each of the separate behaviors was underlined and noted. This allowed an incident card containing different behaviors to be classified under more than one category.

During the process mentioned above, a check was made to eliminate those incident reports which were judged not usable. These included reports that: 1) were unclear in meaning, 2) listed traits rather than actual behaviors observed in specific situations, 3) contained incidents in which equipment or procedural deficiencies were substituted for behaviors.

3. Formulation of Crude Categories of Behavior

The usable incident cards with the behaviors underlined were reread for the purpose of identifying those incidents in which similar behaviors were involved. These cards were grouped together and a description of the behavioral similarities was written on a sheet of paper. The appropriate card numbers were written beside the description. Cards with more than one behavior underlined were then removed so they could be included in other groupings. These groupings constituted the initial formulation of crude categories. The process was repeated until all cards were categorized. After the initial sort had been made in the manner described, the entire procedure was repeated for the following purposes: 1) to insure that the categories were as mutually exclusive as possible, 2) to make any necessary corrections or revisions of the category descriptions, and 3) to check on any errors (e.g., placing cards in the wrong category, etc.) in the initial sort.

4. Refining and Forming the Final Categories

Four members (3 civilian, 1 military) of the project group sat in conference to review the category descriptions and the placement of incidents in each category. Essentially, the procedure constituted a third sorting of the behaviors into categories. The incidents

were read and a consensus was obtained in regard to the placement of any card in a given category. The category descriptions were checked for use of correct terminology and for appropriateness. Categories were combined and new categories were made when necessary.

B. Treatment of the Data from the WD Operational Procedures and Equipment Questionnaire

The incidents obtained from this questionnaire were typed on 5 X 8 McBee cards and coded with respect to the relevant problem area (e.g., console equipment, communication equipment, computer program and standard operating procedures). The cards were then submitted to the project group representatives of the Requirements and Design Branch (RDB) for analysis.

Each of the incidents was read and a list (Ref. 5) of the different problems and the corresponding suggestions for improvement was compiled. The list of problems and the related suggestions were divided into three categories. The first category included those problems and suggestions on which action had been taken through appropriate SPCs (SAGE Program Changes) or ECPs (Engineering Change Proposals). The second category contained those problems which were not covered by current changes and for which corrective actions would be recommended. The final category included the problem statements and suggestions that were rejected. Appropriate comments indicating the reason for rejection were attached to each of the statements.

IV. RESULTS

A. Categories of Job Performance Behaviors

From a total of 158 usable incident reports, 188 behaviors were obtained and categorized. For the job performance behaviors of the Weapons Director position, 115 behaviors were placed in 22 categories. For the Senior Weapons Director position 35 behaviors were obtained and 9 behavior categories were formed. Thirty-eight behaviors were obtained concerning the IND position and 12 categories of behaviors were formed. The final set of categories of performance behaviors obtained in the study is presented in the pages to follow.

Ineffective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source		
		SWD	WD	IND
<p>1. <u>Made poor assignment of interceptors to INDs for control.</u></p> <p>He assigned interceptors to an IND without regard to area, causing the IND to continually switch his display to different sections of the sector; restricting the IND's use of the X8 expanded mode; and necessitating the IND to switch to different radio sites to maintain effective voice control.</p>	10		3	7
<p>2. <u>Made inappropriate commitments of interceptors to targets.</u></p> <p>He made inappropriate interceptor-target commitments by neglecting to utilize the Weapons Assignment displays and made pairing which immediately resulted in impossible intercept conditions according to program calculations; he exercised poor judgment, selecting aircraft in a less advantageous position to effect an intercept prior to the bomb release line.</p>	6		1	5
<p>3. <u>Failed to distribute assignments and maintain even loads on the INDs.</u></p> <p>He distributed interceptors for control and/or intercept missions unevenly among his INDs, causing an overload on some INDs, while other INDs were available with little or no work to do.</p>	8		3	5
<p>4. <u>Did not pass on important information required by others in the performance of their functions.</u></p> <p>He failed to provide others with information about an impending situation, changes in prior instructions or plans, or important factors in the current situation when being relieved from duty.</p>	5	1	3	1

Ineffective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source		
		SWD	WD	IND
<p>5. <u>Passed incomplete or incorrect information to others without making subsequent effort to complete or correct the information.</u></p> <p>He passed incomplete or incorrect information because he lacked sufficient knowledge of the requirements; did not know to whom he should direct the information; and did not understand the original information given to him.</p>	3	1	1	1
<p>6. <u>Interfered with the functions of the IND by excessive and inappropriate use of the tactical lines.</u></p> <p>He would call to check on items which were already accomplished and could be checked without making a call; to determine whether instructions had been carried out without allowing time for their accomplishment; and to inquire about information which could be more readily obtained from other sources (e.g., SIDs and DIDs). He would make "unnecessary" calls attributable to his own lack of knowledge.</p>	2			2
<p>7. <u>Operated switches and/or equipment incorrectly or failed to employ them properly while operating at his console position.</u></p> <p>He did not take the proper console switch actions because he lacked knowledge of standard operating procedures and/or regulations related to the operational functions of the console.</p>	5	1	1	3

Ineffective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source		
		SWD	WD	IND
8. <u>Lost control of a situation for which he was responsible.</u> He allowed a situation to get out of control due to the exercise of poor judgment, lack of knowledge about the situation, and inadequate use or lack of effective plans and actions in coping with the situation.	10	3	1	6
9. <u>Took action without informing personnel who would be concerned with or affected by the action.</u> He failed to inform relevant personnel before acting, causing a compounding of the original problem and/or creating new problems.	3		2	1
10. <u>Became preoccupied in performing a task which was the responsibility of another person and neglected to discharge his own responsibilities.</u> He assumed responsibility for performing a task ordinarily done by another person in an attempt to do it better or to improve a situation with which the performance of the task was concerned, but in doing so he neglected to adequately fulfill his own responsibilities.	2	1		1
Totals for Ineffective Job Performance of WDs	54	7	15	32

Effective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source	
		SWD	IND
<p>11. <u>Assisted INDs in handling emergency situations by taking prompt and effective actions.</u></p> <p>When an emergency situation developed he acted without delay, relieving the IND of the control of other aircraft; coordinating with the recovery area and ground/emergency facilities; providing a steady flow of pertinent information to the IND; and maintaining effective monitoring of the situation.</p>	7	1	6
<p>12. <u>Directed INDs to make their own commitments (pairings) when he anticipated or recognized a saturated display condition developing at his console position.</u></p> <p>He directed the INDs to make their own pairings to prevent the delay of timely and effective commitments which might result from the saturated display condition at his console.</p>	5		5
<p>13. <u>Effectively monitored the control of aircraft by the INDs.</u></p> <p>He effectively monitored the control of aircraft being conducted by his INDs by recognizing situations and/or conditions which would provide difficulties and by taking appropriate actions or passing pertinent information which would help alleviate these difficulties.</p>	10		10
<p>14. <u>Made effective assignment of interceptors to INDs for control.</u></p> <p>He assigned interceptors to INDs for control in areas of close proximity, enabling the INDs to monitor and conduct intercepts with a minimum amount of switch changing actions (e.g., expand modes, radio sites, etc.).</p>	2	1	1

Effective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source		
		SWD	WD	IND
15. <u>Distributed assignments and maintained even loads on the INDs.</u> He maintained efforts to distribute assignments and keep even loads on all INDs under his supervision.	6		3	3
16. <u>Made appropriate commitments of interceptors to targets.</u> He made appropriate interceptor-target commitments by utilizing the proper information displays and substantially reduced recommit actions; he exercised good judgment and selected aircraft in the most advantageous position to effect an intercept before the bomb release line.	4		1	3
17. <u>Formulated and executed an effective work plan for his weapons team.</u> He formulated a work plan for his weapons team and carried it out successfully by providing appropriate instructions to the personnel concerned; by effective scheduling; by effective monitoring of the operation of the plan; and by coordinating with the personnel concerned.	9	1	2	6
18. <u>Passed all information required by others in the performance of their functions.</u> He made sure that he provided others with all information regarding an impending situation; regarding changes in prior instructions or plans; or regarding the operation of a plan or a schedule.	3		1	2

Effective Job Performance of Weapons Directors	Total Frequency	Frequency by Reporting Source		
		SWD	WD	IND
<p>19. <u>Assisted another Weapons Director (WD) by effectively monitoring the "gross" air picture.</u></p> <p>By not confining his monitoring activity solely to his own area of responsibility, he was in a position to aid another Weapons Director by sharing the workload; by committing more advantageously positioned aircraft; or by supplying interceptor aircraft under his control to another WD for commitment.</p>	10	2	8	
<p>20. <u>Assumed responsibility to perform a task ordinarily done by someone else and was successful in doing so.</u></p> <p>He acted quickly to perform a task ordinarily done by someone else when he recognized that a situation would get out of control without immediate action.</p>	2	2		
<p>21. <u>Acted without delay in correcting a potentially dangerous condition.</u></p> <p>Upon recognition of a condition or situation that was potentially dangerous, he quickly took the required action(s) to prevent or remove the potential danger.</p>	2		2	
<p>22. <u>Took steps to insure effective training for an IND.</u></p> <p>He insured effective training for an IND by designating an appropriate instructor; by selecting assignments appropriate to his experience level; and by monitoring the IND's progress effectively.</p>	1			1
Totals for Effective Job Performance of WDs	61	7	17	37

Ineffective Job Performance of Intercept
Directors as Related to the WD Position Frequency

1. Did not follow instructions or ignored advice offered to him in the performance of his job.

He failed to follow instructions or ignored competent advice offered to him by the WD which resulted in an inadequate performance of the task assigned and the creation of additional problems.

4

2. Did not pass on important information required by the WD in the performance of his job.

He failed to provide the WD with information regarding the outcome of an intercept assignment; regarding situation that would affect the operational plan; or regarding uncommitted aircraft in the area.

3

3. Operated switches and/or equipment incorrectly or failed to use them properly while operating at his console position.

He took improper console switch actions or used the wrong equipment because he lacked knowledge of standard operating procedures and/or regulations related to the operation of the console because he lacked knowledge of the capabilities and limitations of his equipment.

4

4. Passed on incomplete or incorrect information without making subsequent effort to complete or correct the information.

He passed on incomplete or incorrect information because he lacked sufficient knowledge of the requirements; did not know to whom he should direct the information and did not understand the original information given to him.

1

Ineffective Job Performance of Intercept
Directors as Related to the WD Position

Frequency

5. Interfered with the functions of the Weapons Director by excessive and inappropriate use of the tactical line.

Because he lacked knowledge of standard operating procedures, regulations, etc., related to the performance of his task, he would call at inopportune times to request information which he should have known.

5

6. Did not position his aircraft properly during an intercept mission.

He failed to exercise adequate control in positioning his aircraft for an intercept because of poor judgment or because he did not use the proper display information necessary to effect a good position.

5

Total for Ineffective Job
Performance of INDs

22

Effective Job Performance of Intercept
Directors as Related to the WD Position

Frequency

7. Displayed initiative by maneuvering aircraft under his control into advantageous positions for commitment

When he recognized a flight of threatening aircraft or targets of opportunity, he acted on his own initiative to maneuver his interceptors into favorable positions for effective commitment against the targets.

4

Effective Job Performance of Intercept
Directors as Related to the WD Position

Frequency

8. Assisted the WD by making own commitments (pairings) on target aircraft.

He recognized that the WD was being hampered by a saturated display condition and made his own pairings to prevent the delay of timely and effective commitments.

4

9. Demonstrated resourcefulness by completing intercept although handicapped by computer malfunction or program limitations.

He demonstrated resourcefulness by using "manual vectoring" techniques to complete an intercept when he was hindered by computer failure or program limitations.

2

10. Demonstrated alertness by recognizing a condition or situation which could become dangerous and informing the responsible WD for action.

He demonstrated alertness by detecting a potentially dangerous condition or situation and by acting without delay to inform the responsible WD for action.

3

11. Acted effectively in handling an emergency situation.

When an emergency situation occurred, he took the necessary actions to render immediate aid to the distressed aircraft and to facilitate search and rescue operations.

2

<u>Effective Job Performance of Intercept Directors as Related to the WD Position</u>	<u>Frequency</u>
12. <u>Assumed responsibility to perform a task ordinarily done by someone else and was successful in doing so.</u>	
He acted quickly to perform a task ordinarily done by someone else when he recognized that a situation or condition would become further aggravated without immediate action.	1
Total for Effective Job Performance of IND	16

<u>Ineffective Job Performance of Senior Weapons Directors as Related to the WD Position</u>	<u>Frequency</u>
1. <u>Interfered with the functions of the WD by excessive and inappropriate use of the tactical lines.</u>	
He would call to obtain information which could be more readily obtained from other sources (e.g., SIDs and DIDs); to inquire about information without allowing sufficient time for the information to be obtained; to inquire about matters unrelated to the immediate situation; and to ask questions which could be attributed to his own lack of knowledge.	14
2. <u>Took action without obtaining all the information necessary for the accomplishment of a task.</u>	
He acted before he had obtained all necessary information from personnel, display sources, etc., to accomplish the task.	1

Ineffective Job Performance of Senior
Weapons Directors as Related to the WD
Position

Frequency

- | | |
|---|----|
| 3. <u>Took action without informing the personnel who would be concerned with or affected by the action.</u> | 3 |
| He failed to inform relevant personnel before acting, causing the original condition or problem to become further aggravated and causing new problems to be created. | |
| 4. <u>Failed to formulate and/or execute an effective operational plan for the Weapons Section.</u> | 5 |
| He did not formulate a workable plan for the Weapons Section and did not provide appropriate instructions to the personnel concerned. He failed to carry out the operation according to prior plans and caused confusion and disruption to the operation. | |
| Total for Ineffective Job
Performance of SWDs | 23 |

Effective Job Performance of Senior
Weapons Directors as Related to the WD
Position

Frequency

- | | |
|---|---|
| 5. <u>Displayed alertness by recognizing a condition or situation which could become dangerous and notifying the appropriate Weapons Director for action.</u> | 3 |
| Upon recognition of a condition or situation which could become dangerous, he informed the responsible Weapons Director of the matter and provided him with directions and suggestions for corrective action. | |

Effective Job Performance of Senior
Weapons Directors as Related to the WD
Position

Frequency

6. Assisted the Weapons Director by assuming responsibility for coordination with the appropriate facilities, agencies, and personnel concerned with a particular situation.

When a situation arose in which the responsible Weapons Director was occupied by other important and immediate tasks concerned with the situation, he assisted the WD by assuming responsibility for coordinating with the appropriate facilities, agencies and personnel concerned.

3

7. Anticipated an event which would provide difficulties during a mission and took effective preparatory or preventive action.

While monitoring an operation, he anticipated certain events that would provide difficulties for the personnel involved in performing the task and took the required action to prevent or alleviate these difficulties when they occurred.

3

8. Formulated and executed an effective operational plan for the Weapons Section.

He formulated a workable plan for the conduct of the air battle by the Weapons Section and provided appropriate instructions to all personnel concerned. He executed the operation according to plan by effective scheduling, by effective monitoring of the operation, and by effective coordination with the personnel concerned.

2

Effective Job Performance of Senior
Weapons Directors as Related to the WD
Position

Position	Frequency
9. <u>Maintained effective discipline on the use of the tactical lines.</u>	
He helped maintain discipline on the use of the tactical lines by establishing "guidelines" on the types of calls to be made and the types of calls to be excluded.	1
Total for Effective Job Performance of SWDs	12

B. Statistical Data concerning the Incidents and the Respondent Population

An analysis was made of the type of mission in which the incidents occurred. Eighty-two incidents occurred during simulated missions and 76 occurred during live exercises. An examination of the recency of the occurrence of the incidents with respect to the time of report was made. The results are shown in Table II.

TABLE II

Recency of Incident Occurrence
with respect to Time of Report

<u>Time Interval</u>	<u>Frequency of Incidents</u>
≤ 1 month	77
≤ 2 months	35
≤ 3 months	19
≤ 4 months	7
≤ 5 months	7
≤ 6 months	5
7 to 12 months	3
1 year and over	5
	158

The respondent population was composed of the following: Senior Weapons Directors (N=7), Weapons Directors (N=22), Intercept Directors (N=40). Table III presents statistical data regarding some of the characteristics of the respondents in the study.

TABLE III

Some Characteristics of the Respondent Population

<u>Characteristic</u>	<u>SWD (N=7)</u>	<u>WD (N=22)</u>	<u>IND (N=40)</u>
Manual experience	M = 6.6 yrs.	M = 4.2 yrs.	M = 1.8 yrs.
SAGE experience	M = 1.1 yrs.	M = 1.6 yrs.	M = 1.3 yrs.
Total Air Defense Experience	M = 7.7 yrs.	M = 5.8 yrs.	M = 3.1 yrs.
Time since completion of formal manual training*	M = 4.1 yrs.	M = 5.8 yrs.	M = 3.2 yrs.
Time since completing SAGE training**	M = 1.1 yrs.	M = 1.7 yrs.	M = 1.3 yrs.
Combat Ratings***			
Training	0	1	2
Combat Ready	7	21	24
Skilled	---	----	12
Expert	---	----	2

* Means were calculated excluding those who did not undergo any formal manual training (e.g., Controller School at Tyndall AFB) and those who did not furnish the information.

** The original query was in regard to formal SAGE training (e.g., courses at Keesler AFB or Richards-Gebaur AFB). Since a large proportion of respondents did not undergo any formal training, the means reflect completion of training of formal and on-site (OJT) courses. The means were calculated excluding those who did not furnish the information.

*** Combat ratings are concerned with Intercept Direction capability. Senior Weapons Directors and Weapons Directors are classified in either combat ready or training status since they normally are not engaged in intercept direction.

C. Incidents obtained from the Weapons Director Operational Procedures and Equipment Questionnaires

A total of 64 incidents related to problems concerning equipment, computer program and standard operating procedures were obtained from these questionnaires.

These incidents provided a listing of 20 different problems and related suggestions for improvement (Ref. 5). Six of the problems had been corrected or were in the process of being corrected by appropriate equipment or program changes. Seven problems were considered appropriate for the recommendation of corrective action. The remaining problems and related suggestions were rejected for the following reasons:

1. Implementation of the suggested change was not considered feasible.
2. The recommended change and desired results were incompatible.
3. The problem was concerned with a program error peculiar to a location.

V. DISCUSSION

The critical incident technique was used to obtain reports of the following types: 1) incidents concerning the performance requirements of the Weapons Director's position, 2) incidents in which a Senior Weapons Director's action had provided an aid or hindrance to the effective functioning of the Weapons Director, 3) incidents in which an Intercept Director's action had provided an aid or hindrance to the effective functioning of the Weapons Director, 4) incidents in which constraints or limitation of the equipment, computer program or standard operating procedures had provided a hindrance to the WD function. The behaviors abstracted from the incidents described in items 1, 2, and 3 above, were formed into categories and listed under the appropriate aspects of the Weapons Director's function, e.g., WD performance requirements; WD's interactions with SWDs and INDs. The incidents concerned with the equipment, SOPs, etc., provided a list of problems and suggestions for change associated with that aspect of the function. An examination of the content of the incidents and consideration of the frequency of incidents occurring within a category provided a means for identifying and describing some of the problem areas associated with the position. The frequencies of behaviors within a category provided some indication of the relative importance of the item. It should be understood that frequency does not solely determine whether a given category of behavior is important. However, if the frequency is large, it is difficult to assume that the item

is of no importance. For example, if a large proportion of personnel indicated a particular behavior as being ineffective or a particular piece of equipment as being defective, it would be difficult not to consider these items as relevant to some problems associated with the position.

A description of some of the problem areas which were identified are presented below:

a. Area assignment for INDS

Assigning INDS to interceptors in widely separated areas causes a large number of difficulties for the INDS in monitoring and conducting intercepts. When the intercepts progress badly or are missed as a result of difficulties in control, the WD obtains a large amount of additional work in contending with the situation (e.g., making reassignments, new assignments, etc.). In some of the reports the probability of assignments being made in widely separated areas was enhanced by assigning the WD to air bases at opposite ends of the sector.

b. Commitment of Interceptors to targets

In some of the cases, the WD made commitments of interceptors to targets that were immediately displayed as impossible according to program calculations. Again, the WD made additional work for himself in making new commitments and "straightening out" the confusion created for the INDS. Emphasis should be placed on the use of appropriate information displays in preventing such types of commitments and reducing the frequency of recommit actions.

c. Distributing assignments and maintaining even loads on INDS

Ineffective utilization of the Intercept Direction capacity and the ensuing related problems can be attributed to poor distribution of assignments and uneven loads on INDS. This is not meant to imply that all INDS should get the same number of aircraft to control, since aircraft control capabilities vary among different INDS. However, each director should receive a load commensurate with his capacity so maximum utilization of the weapons team capability is achieved.

d. Formulation of adequate "pre-mission plans"

In the incidents described by the category "Lost control over a situation for which he was responsible," a major causal factor was the lack of definitive and specific pre-mission "work plans" (within the context of the major battle plan) for the weapons team.

The lack of adequate pre-mission planning causes the weapons team to function in a disorganized manner and requires the WD to spend too much time during the air battle dispensing instructions and information to the INDs which could have been disseminated earlier. When a disproportionate amount of time is spent in this activity, the WD often cannot attend to and deal quickly with potentially dangerous conditions when they arise. When these conditions are not effectively contained, loss of control results. Incidents of effective behavior regarding this activity were reflected in the category "Formulated and executed an effective work plan for his weapons team."

e. Interfering with the functions of the WD by excessive and inappropriate use of the tactical lines

A large number of cases involving the SWD pertain to this area. In many of the incidents the SWD did not serve effectively as a "buffer" in reducing the number of calls. Queries initiated by the Battle Staff were submitted to the WD by the SWD without consideration of the activity in which the WD was engaged. The relevance of the query in regard to the present situation or the immediate task was frequently ignored. Other calls generated by the SWD are revealing of the fact that plans for the weapons teams in conducting the air battle were inadequate or had not been provided. Interfering calls from the INDs were indicative of situations in which the IND was unsure of himself or did not have the required knowledge to operate his position.

A plan to effect and maintain telephone discipline may help in alleviating a large number of problems related to this area.

f. Heavy overprinting of symbology and difficulties in read-through

The need for a X8 expansion for the WD console is indicated by the large number of reports related to the symbology overprinting problem. Among the reports collected by the WD Operational Procedures and Equipment Questionnaire, 16 incidents were related to this problem and all recommendations called for the provision of X8 as a solution.

Heavy overprinting causes many problems for the WD in reading track symbology and results in considerable delay in taking appropriate console actions. One of the effective behaviors of the WD was described by the category "Assisted another Weapons Director (WD) by effectively monitoring the 'gross' air picture." If use of the X8 display produces a tendency among the WDs to confine their monitoring activities to small areas of the scope,

the benefits which result from the behavior described above will be negated. It would appear that discriminate use of the X8 display should be beneficial in obtaining rapid read-through.

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Appendix A

CRITICAL INCIDENT FORM (WD-E)

- I. Think about the live and simulated (STP) missions in which you participated, or in which you had a chance to observe a Weapons Director working during the past six months. Try to recall a situation or occasion in which a Weapons Director did something, or in which something occurred that made you feel the Weapons Director was very effective. The Weapons Director need not have performed 100% effectively in all phases of the mission. What is important is that the behavior you observed in that particular situation was superior to the behavior displayed by other Weapons Directors when similar situations occurred. The Director may have been yourself or another Weapons Director you were observing. In either case, you should be quite knowledgeable of the circumstances and what the Weapons Director did.

On the next page describe the most recent situation you observed in which you felt a Weapons Director was very effective.

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CRITICAL INCIDENT FORM (WD-E)

In writing your report, please provide as much detail as possible.

A. Exactly what was the situation or the surrounding circumstances?

B. What did the Weapons Director do?

C. Why would you consider this behavior as being very effective?

(After completing the description be sure to answer the questions on the next page.)

Since we would like to get information from different Weapons Directors with different experiences, we would like the following information:

- (a) Approximately how long ago did the incident occur? _____
- (b) In what type of mission did the incident occur? SIM _____ LIVE _____
- (c) What was the experience level of the Weapons Director?
Training status _____ Combat Ready _____
- (d) How long has it been since you completed Weapons Controller training?
Manual _____ Where _____
SAGE _____ Where _____
- (e) What is your current status?
Training _____ Combat Ready _____
- (f) How many years have you worked in SAGE? _____ Manual _____

CRITICAL INCIDENT FORM (WD-I)

- II. Now consider the opposite type of behavior. Try to recall a situation or occasion in which a Weapons Director did something or in which something occurred that made you feel the Weapons Director was very ineffective during the course of the mission. The Weapons Director need not have performed 100% ineffectively in all phases of the mission. What is important is that the behavior you observed in that particular situation was inferior to the behavior displayed by other Weapons Directors when similar situations occurred. The Director may have been yourself or another Director you were observing. In either case you should be quite knowledgeable of the circumstances and what the Weapons Director did.

On the next page describe the most recent situation you observed in which you felt a Weapons Director was ineffective.

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CRITICAL INCIDENT FORM (WD-I)

In writing your report, please provide as much detail as possible.

A. Exactly what was the situation or the surrounding circumstances?

B. What did the Director do?

C. How do you think the situation might have been handled, or what might the Director have done instead?

(After completing the description be sure to answer the questions on the next page.)

Since we would like to get information from different Intercept Directors with different experiences, we would like the following information:

- (a) Approximately how long ago did the incident occur? _____
- (b) In what type of mission did the incident occur? SIM _____ Live _____
- (c) What was the experience level of the Weapons Director?
Training status _____ Combat Ready _____
- (d) How long has it been since you completed Weapons Controller training?
Manual _____ Where _____
SAGE _____ Where _____
- (e) What is your current status?
Training _____ Combat Ready _____
- (f) How many years have you worked in SAGE? _____ Manual _____

Appendix B

WEAPONS DIRECTOR OPERATIONAL PROCEDURES
AND EQUIPMENT QUESTIONNAIRE

The effective performance of a job is affected by certain conditions which operate within the SAGE environment other than the people. There have probably been situations which have arisen in the past in which you felt your performance could have been better had certain conditions been improved or modified. Specially, we are concerned with those conditions brought about by the following factors:

1. Console equipment
2. Computer program
3. Communications equipment
4. Standard operating procedures

Try to recall a particular situation in which you felt that one of the factors mentioned above caused a condition which hindered you in performing your job.

On the following pages describe the situations in detail telling what happened, what factors were involved, how the conditions(s) might be improved so that more efficient performance can take place.

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WEAPONS DIRECTOR OPERATIONAL PROCEDURES
AND EQUIPMENT QUESTIONNAIRE

Please write only one incident on this page.

1. What factor was involved?

2. What happened, or what condition or situation occurred that hindered you in performing your job? (Describe in detail.)

3. How might the condition be improved to allow you to perform more efficiently?

Appendix C

A Description and Guide for the Administration
of the Critical Incident QuestionnairesIntroduction

As a part of the Weapons Director workload project, a modification of the Critical Incident Technique* is being employed as one of the data gathering methods. Data collected by this method should help to uncover problem areas of the Weapons Director's position in two respects: 1) in terms of the WD's function and his interactions with the Senior Weapons Director and the Intercept Directors, and 2) in terms of the console equipment, communications equipment, computer programs and standard operating procedures.

The critical incident technique, in general terms, consists of the collection of reports of observed behavior in specific situations which are considered extremely effective or ineffective in the performance of a job. A brief explanation of the questionnaire forms utilized in this project might serve to indicate the adaptation and use of the basic technique which has been made for the present study.

The Questionnaire Forms

Six types of critical incident questionnaires have been adapted for the project. Three of the questionnaires are designed to obtain reports from Senior Weapons Directors, Weapons Directors, and Intercept Directors, concerning effective and/or ineffective behaviors they observed of WD performance.

Two questionnaire forms are utilized to obtain data concerning the WD and his interactions with the SWD and the INDs. On one of the forms, the Weapons Director is asked to report a specific situation in which an SWD's action had either aided or provided a detriment to his effective functioning. On the other form the Weapons Director is asked the same question in regard to an IND's behavior.

* Psychological Bulletin, Vol. 51, No. 4, July 1954, p. 327-358.

The Questionnaire Forms (Cont'd)

The sixth form, which is administered to Weapons Directors, is used to obtain data that would help to uncover any problems associated with console equipment, communications equipment, computer programs, and standard operating procedures. The Weapons Director is asked to report on a specific situation in which a deleterious condition arose as a result of shortcomings attributable to any of the factors mentioned above.

A table of questionnaire forms to be used and their purposes will be presented in Table 1 as an aid for the proper disposition of them.

Table 1

Form #	Form Name	Respondent (Person to whom form is administered)	Purpose
AR-4477/000/00	WD equipment and operational procedures questionnaire	WD only	For reports of incidents concerning console, communications equipment, programs, SOPs, etc.
AR-4477/001/00	Critical Incident Form (WD-IND-E) (WD-IND-I)	WD	Reports of incidents concerning interactions with IND.
AR-4477/002/00	Critical Incident Form (WD-SWD-E) (WD-SWD-I)	WD	Reports of incidents concerning interactions with the SWD.
AR-4477/003/00	Critical Incident Form (WD-E) (WD-I)	WD	Reports of incidents concerning Weapons Director performance
AR-4477/004/00	Critical Incident Form (IND-WD-E) (IND-WD-I)	IND	Reports of incidents concerning WD performance.
AR-4477/005/00	Critical Incident Form (SWD-WD-E) (SWD-WD-I)	SWD	Reports of incidents concerning WD performance.

Guidelines for the Administration of Questionnaires

The guidelines listed below are provided to assist the reader in the administration of the questionnaires:

1. Brief group of respondents on the nature of the project and set up a schedule for the individual administration of the questionnaires.
2. Administer questionnaire to respondents individually. This procedure has been suggested as a result of a preliminary administration of the questionnaires at LAADS. Individual interviews enhanced respondents' motivation and were found to be much more effective for incident production.
3. Assure the respondents of the anonymity of the data. Names are not to be used in any portion of the report. The respondents are also not to include their names.
4. Check to insure that incidents are reported according to specifications. A complete description (e.g., what occurred, what the person did, why the respondent felt the behavior was effective or ineffective, how the situation might have been handled otherwise, etc.) is needed for a usable report. Also, be sure that the sample control data section following each incident description is filled out.
5. It is desirable to obtain at least two reports (one of effective and one of ineffective behavior) on each of the forms from each of the respondents. An exception being the WD equipment and operational procedure questionnaire where reports of incidents concerning inadequacies of console equipment, communication equipment, computer programs or SOPs are desired. If any respondent can provide more incidents, he should be encouraged to do so and should be supplied with additional forms.

Briefing for the Respondents

A briefing (see Appendix A and B) should be given to the respondents for the following purposes:

1. To explain the nature and purpose of the study.
2. To give instructions for filling out the questionnaires.

3. To give examples of well written and poorly written incident reports as an aid to the respondents for identifying and writing out critical incidents. By directing the respondents' attention to specific results following effective or ineffective behavior, it becomes possible for them to isolate and describe the relevant behavior or behaviors concerned. This should help to make clear the "meaning" of critical incidents as well as the requirements for writing the reports.

Appendix C

*Briefing for WDs

We (the System Development Corporation, with APASTO and ADC) are engaged in a study to uncover certain problem areas associated with the Weapons Director's function. To obtain information which might help in providing a focus upon the relevant problem areas associated with the WD function, we are asking many Weapons Directors, like yourselves, from different direction centers in different areas of the country to assist us by responding to several questionnaires. One of the ways in which we can obtain information on these problem areas is to study specific situations in which either very effective or ineffective behavior was demonstrated by a WD in performing his job. On one of the forms we would like you to describe at least two incidents in which you observed an effective and/or ineffective behavior concerning WD performance. Another aspect of the problem is to study situations which involve interactions between Weapons Directors and the SWD and INDs. Two forms are provided for these purposes. On one of these forms we would like you to describe two situations or incidents in which a SWD had either aided or provided a detriment to your functioning. On the other form we would like at least two reports of incidents involving the IND. On the fourth and final form we would like you to describe several situations in which inadequacies of either console equipment, communications equipment, computer programs, or SOPs caused a condition which hampered you in the performance of your job.

In writing your reports do not include any names in your descriptions. Please do not include your name on the report. The reports we get from you will be used only for the purposes of this research. You may have a few questions you would like to ask at this point. Before we get to answering them, perhaps a few examples of critical incident reports may help to answer some of your questions.

* It is not intended that this briefing be delivered verbatim, but is provided as an aid to the administrator of the questionnaires to insure that all pertinent points are covered.

1. A well written report of ineffective behavior

During a mission with a heavy load of traffic entering the sector, the WD became engrossed in the replacement of aircraft as they were becoming low on fuel. A situation developed when he assigned a flight of interceptors in the far northern part of the sector and another flight in the far southern part of the sector to the same IND for control against targets in those areas. This action necessitated the IND to continually switch his display to different parts of the sector and restricted his use of the X8 expanded mode. It also made it necessary for the IND to use two radio sites instead of one. Under these conditions the IND missed a number of intercepts. I think the WD should have taken a reassignment action or should have effected a transfer of fighters so that the IND could control fighters that were in one portion of the sector. The WD should try when possible to insure that all missions assigned to an IND are confined to one part of the sector.

Comment: This report is well written since you clearly understand what the situation was, what happened, what the WD did, and what the person thought the WD should have done instead.

2. A well written report of effective behavior

The Weapons Director of Team 2 was working the northern part of the sector where the bulk of the traffic was coming in. The INDs on his team were nearly fully loaded with interceptors under control. The SWD had gone into the automatic assignment mode and WD-2 kept receiving more Fakers. At this point WD-3 called WD-2 and offered him interceptors which he (WD-3) had positioned earlier. This lessened the load on WD-2's position and averted an overload situation from developing. By effective monitoring of the air situation and by recognizing a load condition developing at WD-2's position, WD-3's quick action averted an extreme overload from developing which helped significantly towards the success of the mission.

Comment: Again, this report tells us what happened, what the WD did, and why the behavior was particularly effective.

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3. A poorly written report of effective behavior

The WD during the last mission seemed particularly effective. Throughout the mission he demonstrated a good knowledge of operational procedures. He maintained cool composure under difficult circumstances and displayed initiative in many instances throughout the mission.

Comment: This report is poorly written, primarily because it lacks anything specific. The terms "demonstrated good knowledge of operational procedures," "displayed initiative," tells us very little of exactly what occurred or what the Director did in being effective.

Are there any questions in regard to these questionnaires?

(Directions may now be given as to when each individual will be interviewed for the completion of the questionnaires, etc.).

Appendix C

*Briefing for SWDs and INDs

We (the System Development Corporation, with APASTO and ADC) are engaged in a study to uncover certain problem areas associated with the Weapons Director's function. By studying specific situations in which either very effective or ineffective behavior was demonstrated by a Weapons Director in performing the job, we can get information which may help in focusing on the problem areas associated with this function. During our study we are asking many persons, like yourselves, who interact to a great extent with Weapons Directors, to describe several recent situations in which either type of behavior occurred. Since you are involved in some way with the Weapons Director's function, we feel you are a very appropriate source for obtaining this information.

In your job as an IND or SWD you have probably observed or experienced a few situations about which you can report.

In writing your reports do not include any names in your descriptions. Please do not include your name on the report. The reports we get from you will be used only for the purposes of this research. You may have a few questions you would like to ask at this point. Before we get to answering them, perhaps a few examples of critical incident reports may help to answer some of your questions.

1. A well written report of ineffective behavior

During a mission with a heavy load of traffic entering the sector, the WD became engrossed in the replacement of aircraft as they were becoming low on fuel. A situation developed when he assigned a flight of interceptors in the far northern part of the sector and another flight in the far southern part of the sector to the same IND for control against targets in those areas. This action necessitated the IND to continually switch his display to different parts of the sector and restricted his use of the X8 expanded mode. It also made it necessary for the IND to use two radio sites instead of one. Under these conditions the IND missed a number of intercepts. I think the WD should have taken a reassignment action or should have effected a transfer of fighters so that the IND could control fighters

* It is not intended that this briefing be delivered verbatim, but is provided as an aid to the administrator of the questionnaires to insure that all pertinent points are covered.

that were in one portion of the sector. The WD should try when possible to insure that all missions assigned to an IND are confined to one part of the sector.

Comment: This report is well written since you clearly understand what the situation was, what happened, what the WD did, and what the person thought the WD should have done instead.

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Comment: Again, this report tells us what happened, what the WD did, and why the behavior was particularly effective.

3. A poorly written report of effective behavior

The WD during the last mission seemed particularly effective. Throughout the mission he demonstrated a good knowledge of operational procedures. He maintained cool composure under difficult circumstances and displayed initiative in many instances throughout the mission.

Comment: This report is poorly written, primarily because it lacks anything specific. The terms "demonstrated good knowledge of operational procedures," "displayed initiative," tells us very little of exactly what occurred or what the Director did in being effective.

Are there any questions in regard to these questionnaires?

(Directions may now be given as to when each individual will be interviewed for the completion of the questionnaires, etc.).

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System Development Corporation,
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IDENTIFICATION OF PROBLEM AREAS IN THE
WEAPONS DIRECTOR FUNCTION THROUGH
CRITICAL INCIDENTS.

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Examines three aspects of the
Weapons Director (WD): 1) the
performance requirement of the
position; 2) the Weapons Director's
interactions with the Senior Weapons
Director (SWD) and the Intercept
Directors (INDs); 3) the console
equipment communications equipment,
computer programs and standard
operating procedures with which the
WD is concerned.

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