ASD TECHNICAL REPORT 61-739

PERSONNEL EQUIPMENT DATA: CONCEPT AND CONTENT

SIDNEY GAEL
LAWRENCE E. REED

BEHAVIORAL SCIENCES LABORATORY

DECEMBER 1961

AEROSPACE MEDICAL RESEARCH LABORATORIES
AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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Aeronautical Systems Division, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio

PERSONNEL EQUIPMENT DATA: CONCEPT AND CONTENT, by S. Gael and L. E. Reed. December 1961, 80p. incl. illus., 3 refs. (Proj. 1710; Task 171005) Unclassified report

Consideration of the degree of uncertainty surrounding Personnel-Equipment Data (PED), one of the Personnel Subsystem Elements (PSS), led to the present attempt to empirically define the content of PED, and to identify requirements contained in Military Specifications and related documents which can and often do, generate unnecessary duplicative

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DECEMBER 1961

PROJECT No. 1710
TASK No. 171005

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AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

The work reported was accomplished by the Personnel and Training Requirements Section, Training Research Branch, Behavioral Sciences Laboratory, Aerospace Medical Research Laboratories, under Project 1710, "Training, Personnel, and Psychological Aspects of Bio-astronautics", Task 171005, "Technical Guides for Designers of the Personnel Subsystem for New Weapon Systems." The study was completed in September 1961. Draft copies of the report were concurrently distributed to interested Air Force agencies in November 1961.

The present report, a companion to ASD TR 61-447, "A Data Organization Model for the Personnel Subsystem," was prepared to support both the Air Force and contractor applied Personnel Subsystem (PSS) efforts. Methods and techniques for implementing the relatively new PSS concept are constantly being developed, revised, and improved; changes which occurred subsequent to August 1961, have not been incorporated in the report – e.g., Personnel Subsystem will be abbreviated PS, the PSS elements or milestones will number twelve rather than the currently familiar nine, and MIL-R-26674 has been superceded by MIL-R-27542, (although the official date of MIL-R-27542 is 28 June 61, copies were not available prior to the completion of the study). In view of the dynamic nature of the Air Force specification structure, it was necessary to establish a cut-off point for updating the written material or the publication of the results would have been endlessly delayed. We felt that sufficient groundwork for specifying PED had been laid, and it will be the responsibility of weapon system development personnel to keep abreast of the current state of PSS development, and to judiciously supplement the information contained in this report.

Especial thanks are due Mr. Melvin T. Snyder, Chief, Personnel and Training Requirements Section, for his interest in this work and for his helpful guidance throughout the course of the study. The authors are also very grateful to personnel at Douglas Aircraft, Culver City, California, Lockheed Aircraft, Burbank, California, North American Aviation, Columbus, Ohio and Los Angeles, California, who contributed to the authors' understanding of data flow and Personnel-Equipment Data implementation problems within their organization.

ABSTRACT

Consideration of the degree of uncertainty surrounding Personnel-Equipment Data (PED), one of the Personnel Subsystem Elements (PSS), led to the present attempt to empirically define the content of PED, and to identify requirements contained in Military Specifications and related documents which can and often do, generate unnecessary duplicative effort. Eighteen documents deemed relevant to the study were scrutinized, and requirements calling for the submittal of data were extracted. A list of these requirements and their locations is presented. The amount of duplication tending to bring about redundant work effort was less than anticipated, but sufficient to provoke a good deal of concern. A few sources of unnecessary duplication of effort are discussed, and suggestions which can help eliminate duplication are presented.

PUBLICATION REVIEW

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PERSONNEL EQUIPMENT DATA: CONCEPT AND CONTENT

INTRODUCTION

Fifty years ago it was possible for a few people to completely design and fabricate a weapon system. World War II weapons were very complex compared to their predecessors, but it was still feasible for an airframe contractor to integrate subsystems developed by other manufacturers into a weapon system. Components and accompanying skills were easily interchanged between systems.

Present system requirements for increased range, speed and altitude, a higher degree of accuracy, etc., accompanied by tremendous advances in the electronics, propulsion, armament, and other scientific fields, paved the way for the Weapon System Concept. The basic tenet of this concept is to promote the design, production and management of the weapon system as an integrated effort instead of a series of individual efforts. As examples of increased system complexity, one has only to note that it took approximately 48 years from the time of the Wright Brothers to reach Mach 1, an additional 8 years to reach Mach 2, and increased speed has been attained in an even shorter time period. Engineering manhours expended have increased from approximately 7000 per month for the B-17 to over 100,000 per month for the B-70. Systems are being designed to perform specialized missions with a resulting decrease of interchangeability of parts and personnel between systems. Not only have the weapons become more complex, but so have the ground support equipment (now aerospace ground equipment), training techniques and training equipment and the operational organizations. Equipment and personnel lead times have increased while development times have diminished, necessitating greater management control over the development of the modern weapon system.

Several systems developed prior to the formulation of the Weapon System Concept (e.g., the F-86) conclusively indicated the need for management techniques that would insure the availability of all system components by the scheduled dates. No longer would a delay in the operational status of a system be tolerated because trained maintenance and operational personnel were not available. Personnel must be considered an integral part of the total system, and appropriate measures should be taken during the very early system planning phase to determine the kinds and number of personnel required for the system. To do otherwise would place the schedules and the ultimate success of the system in jeopardy.

The Personnel Subsystem (PSS) concept was predicated on the need for the development of personnel support of a weapon system concurrently and integrally with the system hardware: "The Personnel Subsystem of a weapon system is a composite of the trained military personnel and employment techniques required to operate, control, and maintain the integrated hardware subsystem of the weapon system."[1] The major elements required in the development of the PSS are:

1. Personnel Equipment Data (PED)
2. Human Engineering
3. Quantitative and Qualitative Personnel Requirements Information (QQPRI)
4. Training Concept
5. Training Plans
6. Training Equipment Planning Information (TEPI)
7. Training Equipment Development (TED)
8. Technical Orders and Technical Manuals (TOTM)
9. Personnel Subsystem Test and Evaluation (PSTE)

Personnel Equipment Data (PED), the primary concern in this report, is defined in the PSS Management document as "A centrally maintained body of analytical data, in the form of task and equipment information, that defines the interrelationship of functions performed by system people and system hardware."[2] PED should be a complete, accurate, and up-to-date pool of basic data which supports the preparation and/or the development of the entire PSS. It is the contractor's responsibility throughout system development to prepare and maintain PED as accurately as possible and to insure that data will be readily available to those agencies responsible for PSS development.

One may readily note vagueness, problems, and perhaps inconsistencies inherent in the above definition and discussion of PED. The statement that PED will be composed of task and equipment information lacks explicit detail concerning the data actually required and the source data needed to derive the PSS elements. The dynamic quality of system development represents an interesting challenge to the utility of the basic data pool. The data pool must be capable of expanding and adjusting as new data are generated to insure that the necessary storage, retrieval, and updating can be accomplished in an accurate and timely fashion. The support of TOTM, a PSS element, necessitates that PED be much broader in scope than initially conceived; thought must be given to the data pool as encompassing practically all system data.

The magnitude of modern weapon system development requires Air Force wide participation with assistance from industry. Documents, such as military specifications, bulletins, exhibits, and handbooks, are the means by which the Air Force provides the multiplicity of contractors with the quidance necessary to fulfill weapon system requirements. The data requested in those documents, which now will contribute to PED, originated in various Air Force agencies and were intended to serve different purposes. Some of the data requested in various Military Specifications and related documents tends to be quite similar, and in some instances are exact replicas. In the vast contractor and subcontractor organizations, if a combination of a degree of unawareness concerning the specifications and a lack of communication between working groups exists unnecessary duplication of data may be promoted (e.g., very similar task analysis data could be generated by a group primarily concerned with the maintainability aspects of a system, and also by a group working in the personnel requirements area). Some integration of the now sufficiently well established requirements for obtaining the trained Air Force capability to operate and maintain present systems is possible and should result in savings of funds, time, and technical manpower.

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[1] Personnel Subsystem Management. Joint ARDC-ATC Policy On Management Of Personnel Subsystem Development For Weapon /Supporting Systems, 1 February 1960, p. 1

[2] I bid; p. 3

The above discussion indicates the need for the present study. This study empirically defines the content of PED and identifies those requirements appearing in selected military specifications and related documents that may lead to unnecessary duplicative effort.

METHOD

The task at hand was to examine the military specifications and related documents that have PSS implications and to develop a technique for identifying, extracting, and recording the requirements contained therein.

Selection of Documents

The present study was confined to those military specifications, exhibits, and standards that would contribute to PED (and therefore PSS development). Many military specifications and related documents were reviewed and the following were selected as relevant to this study:

MIL-D-9310B Data for Aeronautical Weapon Systems and Support Systems

MIL-W-9411A Weapon Systems: Aeronautical, General Specification For

MIL-D-9412C Data For Ground Support of Weapon Systems, Support Systems, Subsystems, and Equipment

MIL-D-26239A Data, Qualitative and Quantitative Personnel Requirements Information (QQPRI)

MIL-M-26512A Maintainability Requirements For Weapon, Support, and Command and Control Systems, and Equipment

MIL-R-26674 Reliability Requirements For Weapon Systems

MIL-H-25946 Human Factors Data For Manned Aircraft Weapon Systems

MIL-H-26207 Human Factors Data For Guided Missile Weapon Systems

MIL-T-27382 Training Equipment, Subsystem, Technical Data, Preparation of

MIL-T-27474 Training Equipment, Ground, General Requirements For

MIL-T-9212A Trainer, Flight Simulator, General Specification For

MIL-T-25304A Trainers, Cockpit Procedure, General Specification For

MIL-T-6328F Trainers, Flight Equipment, Aircraft or Missile Components, Mobile, General Specification For

MIL-T-4860C Trainers, Operational Procedure, General Requirements For

MIL-T-8823 (ASG) Training Aids, Aircraft/Missile Systems, Animated Panel, General Specification For

MIL-STD-803 Human Engineering Criteria For Aircraft, Missile, and Space Systems, Ground Support Equipment

MIL-P-2596 Procedures for Development of a Cockpit Subsystem and the Accomplishment of Systems Integration

AFBMD EXHIBIT 60-1 Personnel Subsystem Testing For Ballistic Missile And Space Systems

The original intent was to limit the investigation to those specifications having Air Force wide distribution. However, an exception was made to include AFBMD Exhibit 60-1, because it was the only document found which provided PSTE requirements.

Extraction of Requirements

A set of rules was needed to determine exactly which requirements in the specifications should be extracted and submitted to further analysis. Since a primary interest of the study was to define the limits of PED, it seemed pertinent to record all the PSS related requirements for which the contractors must submit data. At times, data is submitted to indicate adherence to certain principles and criteria listed in the specifications, e.g., maintainability principles, even though they are not requirements in the strict sense, and do not necessarily request the submission of data.[3] Therefore, two basic guidelines were formulated for extracting requirements from the specifications listed above. These were:

1. Record all personnel related requirements for which the contractor must submit data.

2. Record all principles and criteria which could warrant data submittal.

As is often the case, some terms warrant further clarification. The expression "personnel related requirements" posed the problem of establishing a cut-off point on a personnel-equipment continuum that would help determine whether or not a particular requirement was within the range of this study. Although not presented as a continuum, figure 1 may help illustrate the complications involved in identifying pertinent requirements to be extracted from the specifications. Area E, in figure 1, pertains to those requirements related directly to equipment, and having no personnel linkages (e.g., metal stress testing). Requirements represented by Area P pertain only to personnel and are not related to hardware. Lastly, Area P-E represents those requirements indicating personnel and equipment interrelationships (e.g., color coding of electronic components for ease of maintenance). The limits of the areas depicted in figure 1 were set forth to permit greater facility for identifying and extracting relevant requirements from the specifications and were not intended to constitute a rigid definition of the areas.

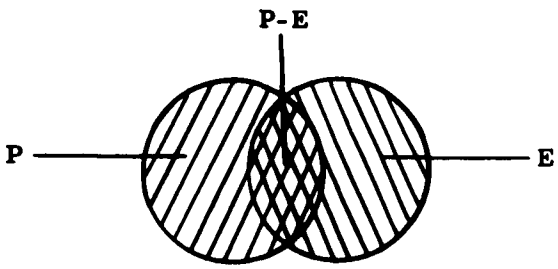

Figure 1. System Data

[3]Some feel that adherence to principles and criteria is implied if the weapon system has met the operational requirements, and therefore, data submittal is unnecessary.

The present study was concerned primarily with the personnel and the personnel-equipment requirements represented by Areas P and P-E respectively. Accordingly, the preliminary phase of the study was devoted to identifying and recording personnel and personnel-equipment requirements, while eliminating those requirements dealing solely with equipment (Area E). No attempt was made to differentiate between personnel (Area P) requirements and personnel-equipment (Area P-E) requirements at this point.

Several methods (e.g., McBee Cards, IBM, outlining, etc.) were considered for recording the requirements extracted from the specifications, but adequate flexibility for handling, filing, and analyzing the data was afforded simply by using blank 3 by 5 cards. Each document was scrutinized, and requirements deemed pertinent to the study were individually recorded on the cards, along with the specification number and the paragraph number within the specification in which the requirements appeared. The considerable accumulation and diverse nature of the requirements initially abstracted and recorded on the cards directed attention to the need for providing a logical framework for the recorded information. Previous attempts to classify requirements proved to be quite inadequate because the basis for the classification was subjective and slighted the documentation used in Air Force Weapon System development programs. Accordingly, it was deemed that the framework be empirically determined.

An unanticipated and interesting paradox came to light after the requirements had been extracted from the specifications and summarily recorded on the cards. Vigorous interest in relating requirements to each other and to PED subverted the fact that by extracting requirements from the source documents, relationships among the requirements as they originally appeared were sacrificed. On the one hand, an attempt was being made to establish interrelationships between requirements which would enhance the objectives of the present investigation, while on the other hand, existing relationships were being eliminated.

The following four approaches were considered for organizing the recorded information:

1. Alphabetical order
2. Order of importance
3. Weapon system development phase
4. Common factors

Although ordering the cards alphabetically would have provided the desired objectivity, this method was not adopted because relationships between requirements could not be indicated and because of the problem of selecting a representative word to alphabetize the requirement. The second method, order of importance, provided a logical framework for organizing the requirements, but was also discarded because establishing an order of importance among the requirements was too subjective, and in many other ways, impractical. The third approach, categorizing the requirements according to the weapon system development phase during which the data orginate, was eliminated from consideration because it proved to be extremely difficult to determine exactly when all the data are derived. Lastly, forming categories based on the requirements and placing requirements having common elements in the same category was the method adopted for the study, since it provided structure while remaining relatively objective.

Initially, the entire deck of cards was sorted into small groups having similar requirements, e.g., requirements pertaining to human performance under varied environmental conditions were all placed in the same group, those requirements dealing with maintainbility and/or maintenance data were placed in another group, etc. In this manner, each small grouping of cards came to represent a particular category composed of similar requirements. As the investigation continued, the initial categories resulting from the collection process were repeatedly refined until suitable categories were attained.

The next step was to select category titles that objectively described the requirements contained therein. A brief examination of the titles clearly indicated that two rather broad headings —— Personnel Requirements and Personnel-Equipment Requirements —— neatly subsumed practically all of the categories. The few remaining categories, which could not readily be

assigned to either the Personnel-Equipment Requirements or Personnel Requirements classifications, uniformly fit under a third major classification consisting of those categories whose requirements pertained to the total weapon system (e.g., system description, design, operations, etc).

Since one of the main objectives of the study was to identify those requirements that might tend to generate duplicative effort, a need existed to organize the information recorded on the cards in a manner that would facilitate comparing requirements. The need was met by constructing a chart in which the columns represented the documents and the rows represented the requirements, thus forming a matrix of paragraph numbers (figure 2).

	Specifications		
Requirements	9310B	26239A	26512A
------1-------	3.4.8.2.g		3.3.1
------2-------		App I. 4/4-1 2.2	
------3-------		3.1.1	3.3.1

Figure 2. An Illustration of the Working Charts

Note that the first requirement listed in figure 2 can be found in paragraph 3.4.8.2.g of MIL-D-9310B as well as in paragraph 3.3.1 of MIL-M-26512A. Similarly, the third requirement can be found in two of the three specifications included in figure 2.

Duplicate requirements appearing in the selected documents were identified concurrently with the transfer of information from the cards to the chart. It was necessary to refer repeatedly to the source documents to ascertain the degree of similarity between seemingly duplicative requirements, because when taken out of context and summarized on the cards, many requirements appearing to be duplicative were actually requesting different data (see page 9-Context). When requirements were sufficiently similar to be considered duplicative, the paragraph numbers in which they appeared were recorded along the same row in the appropriate columns of the chart. However, if we judged that the requirements were not duplicative, the paragraph numbers were recorded in the appropriate columns but in different rows (figure 2).

Requirements extracted from AFBMD Exhibit 60-1, Personnel Subsystem Testing For Ballistic Missile and Space Systems were listed separately because they do not have Air Force wide acceptance.

Since the method for assigning requirements to categories was not entirely objective, the reader may think that some of the requirements were inappropriately p'geon-holed. Categorizing was not intended to be completely rigid, but was rather a tool to provide organization to an otherwise unstructured, confusing list of requirements. However, an objection of this kind cannot be totally discounted, since, in some cases, a requirement could have been classified in more than one category. For instance, paragraph 3.12.d in MIL-M-26512A, the maintainability specification, refers to reliability factors in the maintainability program. This requirement could have been subsumed under either the maintainability category, because it refers to the maintainability and is found in the maintainability specification, or it may have been appropriately classified in the reliability category. In such cases it was necessary to determine the category that best described the requirement. In the above instance, the requirement was included in the reliability category, because the primary emphasis was on reliability rather than on maintainability.

RESULTS AND DISCUSSION

The results of the study, a list of requirements and their locations in the selected documents, are presented in Appendix I and Appendix II. Although a more extensive list of requirements could have been formulated and presented in Appendix I, the present study focused only upon those documents that appeared to contribute most to the basic pool of analytical data —PED —thus limiting the length of the requirements list. For instance, only two requirements dealing with handbooks and manuals and very few requirements pertaining to mock-ups, quality control, packaging and other areas were included in the list. Each of these areas could have received much greater emphasis had it been deemed necessary to review and extract requirements from those specifications that deal individually with handbooks and manuals (e.g., MIL-M-005474C, MIL-H-6757A), mock-ups (e.g., MIL-S-26634), etc.

Space limitations played a great part in presenting a modified version of the working charts previously described. The modification has in no way changed the meaning and content of the requirements transferred from the working charts, and provides a simple format for locating desired information. The extracted requirements are documented on the left side of the list and their locations, a combination of a code letter representing a particular document, and a number specifying the paragraph within the document in which the requirements can be found, follow on the right side (e.g., A-3.2 represents MIL-D-9310B, Data For Aeronautical Weapon Systems and Support Systems, paragraph 3.2). If the same or a similar requirement appears more than once, either between or within documents, the source of each is recorded. The document code list is presented in Appendix I.

The requirements extracted from the selected documents were categorized according to factors that groups of requirements had in common. A list of the empirically determined categories is presented below to provide the reader with a brief overview of the possible confines of PED.

I. SYSTEM REQUIREMENTS

- A. Operations
- B. Design

II. PERSONNEL REQUIREMENTS

- A. General
- B. Positions
- C. Manning
- D. Performance
  - Personnel interaction
  - Time
  - Tasks
  - Environment
- E. Skills and knowledges
- F. Proficiency
- G. Training
- H. Illustrations

III. PERSONNEL-EQUIPMENT REQUIREMENTS

- A. General
- B. Facilities
- C. Work areas
- D. Logistics
- E. Trade-offs
- F. Safety
- G. Test
- H. Performance
  - Environment
  - Time
- I. Maintenance and maintainability
- J. Reliability
- K. Quality control
- L. Failure
- M. Support equipment
- N. Tools and test equipment
- O. Training equipment
- P. Mock-up
- Q. Displays
- R. Controls
- S. Coding
- T. Illustrations
- U. Handbooks

Since the requirements in Appendix I have been abstracted from source documents and are out of context, the reader may have some difficulty interpreting or clearly understanding the requirements as they are listed. Additional information and clarification concerning any of the requirements can be obtained simply by referring directly to the appropriate source document.

Perhaps the phrase "out of context," as it appears in the preceding paragraph, warrants additional attention. Once the requirements are extracted from the specifications they seem to be reduced to discrete, vague, bits of information scarcely alluding to weapon system development time phasing and do not have a semblance of the sequential order in which they originally appeared in the specifications. However, weapon system time phasing information has been provided throughout the requirements list whenever possible. For instance, information has been included in the list to differentiate between requirements for design selection or developmental data. Furthermore, a PSS development time phasing chart, which illustrates sequential relationship

between PSS development and the weapon system major milestones, is presented in figure 3 (ref. 2). Since the primary intent of this study was to define the limits of PED, it was not deemed appropriate to present a lengthy discussion of time phasing and sequencing of requirements at this time. If the reader is particularly interested in obtaining additional information concerning these topics, he should refer directly to the specifications and to several PSS related Technical Reports (ref. 1, 2, 3).

The identification of duplicate requirements proved to be a rather complex task. The original intent was to emphasize those requirements which tended to generate duplicate effort, but several problems arose which tended to complicate accurate identification of the requirements. Since these problems have a bearing upon the interpretation of the requirements list and are somewhat distinct, they will be discussed individually.

1. Apparent versus real duplication

   a. Real duplication exists when more than one military specification or related document used in the same weapon system development program contains the same or very similar requirements. Unless these requirements are identified early in the program, usually at the managerial level, they will tend to generate redundant effort.

   b. Apparent duplication is found when several documents ordinarily not used in the same weapon system development program contain the same or similar requirements. For example, MIL-H-26207 and MIL-H-25946 are essentially identical documents, except that the former pertains to human factors data in guided missile weapon systems, whereas the latter is concerned with human factors data for manned aircraft weapon systems. Therefore, the requirements appearing in these specifications do not amount to duplication in the sense that they would generate redundant effort. However, requirements of this nature have been included in the list to reveal that they can be found in more than one document.

2. General weapon system specifications and duplicative requirements

   General weapon system military specifications such as MIL-D-9310B and MIL-W-9411A refer to other military specifications for specific information. For example, paragraph 3.4.8.2.c in MIL-D-9310B requests a "List of squadron manning by Air Force Specialty Code (AFSC). This information to be derived from the Qualitative Personnel Requirements Information prepared in accordance with Specification MIL-D-26239." The actual requirement is found in Appendix 1.3 of MIL-D-26239, the QPRI specification. Although a statement of this requirement is found in both MIL-D-9310B and MIL-D-26239, real duplication as defined above does not exist in this case. Nevertheless, for the purpose of the present study, whenever one document requests data in accordance with the information appearing in other documents all the locations should be listed together. Although real and apparent duplication may seem to be confounded in the list of requirements, one may note the documents in which the requirement appeared; i.e., if one of the requirements appeared in a general Military Specification the duplication is probably apparent rather than real. The incorporation in the list of all the locations of a requirement has the distinct advantage of directing the reader to the source documents.

3. Context

   An example may best illustrate the contextual problem encountered. Several documents refer to requirements dealing with noise. If summary statements of these requirements are considered out of context, an impression may be obtained that only the human element is involved, and thus would be identified as duplicative and categorized under Personnel. However, a more detailed examination revealed that the requirements relating to noise are distinctly different: first, noise as a variable to

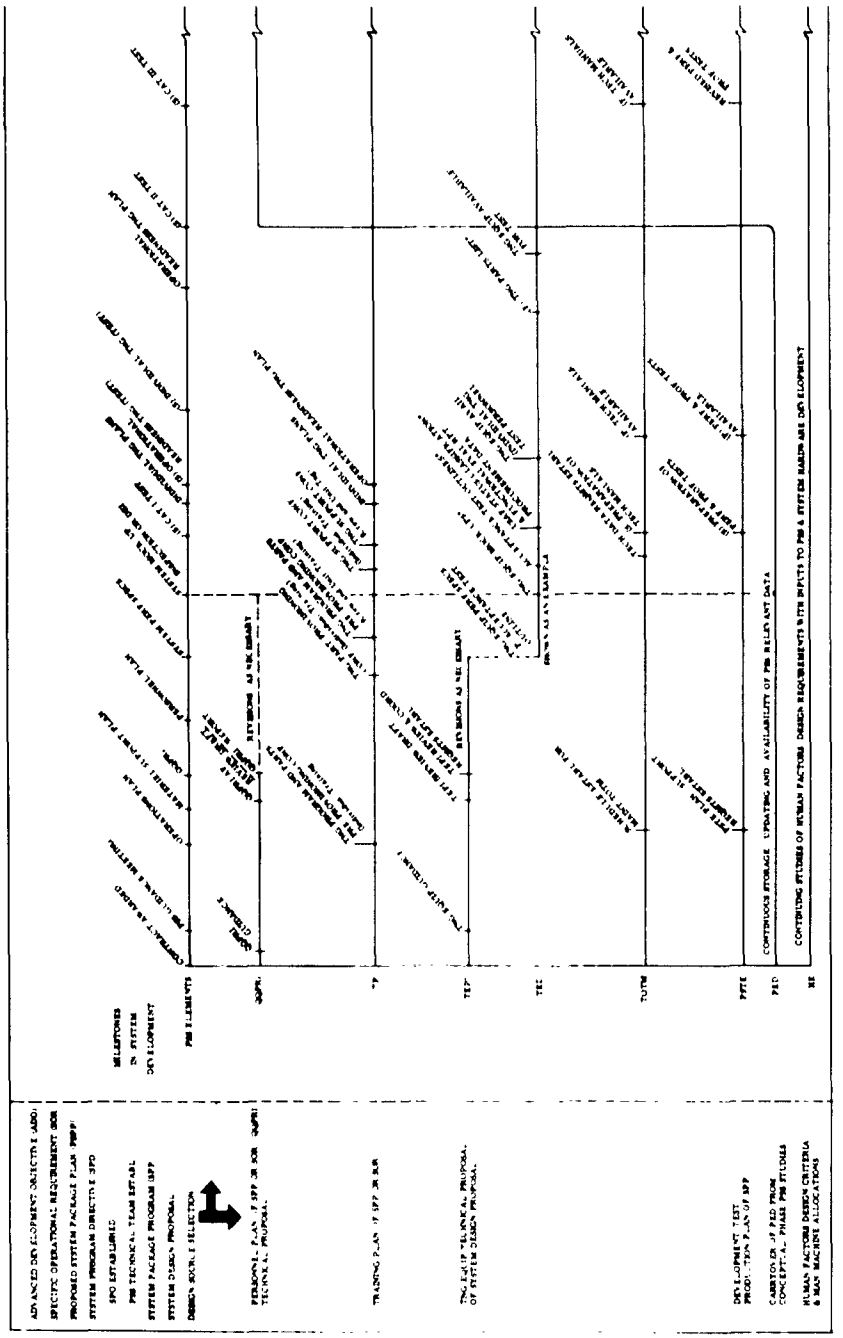

Figure 3. Time Phasing of PSS Development During the Acquisition Phase of System Development

be considered in the design of equipment (e.g., MIL-W-9411A, paragraph 3.2.10) and secondly, as an environmental condition affecting human performance capability (e.g., MIL-H-26207, paragraph 3.2.3.7.d). Although somewhat related, these two requirements would not generate duplicative effort. Accordingly, the former requirement emphasized the human element and was therefore placed in the Personnel category.

4. Principles and criteria

As previously stated, there are times when data is submitted to indicate adherence to specific principles and criteria found in the specifications regardless of the fact that they are not requirements in the strict sense and do not necessarily require the submission of data. For example, paragraph 3.3.3.g of MIL-M-26512A states that "the system be designed for maximum safety for both equipment and personnel involved in the performance of maintenance." On the other hand, paragraph 3.1.3.2 in MIL-T-27382 states that a description of safety features for the system be included in the TEPI report. If we assume that data is submitted in the former case, then the two requirements cited above may be considered to be duplicative. Since data is occasionally submitted to indicate adherence to the principles and criteria, we thought that this information should be included in the list of requirements. In an effort to avoid confusion and value judgments, all principles and criteria have been identified in the list of requirements presented in Appendix I.

The general results of the study have shown clearly that the amount of real duplication between and within the documents examined was not as extensive as anticipated. In fact, if the list had been restricted exclusively to those requirements that would tend to generate redundant effort, the amount of duplication recorded would have been reduced considerably. Yet, the amount of real duplication identified was sufficient to provoke a good deal of concern. Although it may not seem very important if a few, seemingly trivial requirements appear in more than one specification and perhaps result in unnecessary duplication of effort, some very terse requirements can cause the expenditure of thousands of manhours of work; e.g., identification of maintenance tasks (E-3.3 and J-3.1.3).[4] Although requirements are not identical, as was the case in the previous example, the data derived to satisfy one requirement (E-3.3), frequently can be used in part to fulfill another requirement (J-3.1.3).

What types of conditions lead to duplicate effort? Generally speaking they are:

1. The data needed is not readily available
2. A group needing data is not aware that the data already exists
3. Poor management control

In accordance with the example in the above paragraph, the group concerned with the maintenance aspects of the system may describe the maintenance tasks (E-3.3). By the same token, the group responsible for the preparation of TEPI uses task descriptions as a basis for their report, and under the conditions listed above, may replicate part of the work done by the maintainability engineers (J-3.1.3) in order to complete their contribution to the system development program.

[4] Refer to page 16 for the code list

The situation is further complicated in that increased system complexity tends to create a concomitant increase in the demand for highly specialized skills with the resultant formation of new working groups. At times, these new working groups possess overlapping capabilities and responsibilities, and without proper management control the amount of duplication would increase directly with the additional increase of working groups. Fortunately, however, management usually exercises its authority and delegates definite responsibility for the development of certain data to specific groups to avoid potential duplication of effort.

Generally, we found that Air Force contractors are aware that some work duplication occasionally occurs within their organizations, but have been unable to cope with the problem even though they have exercised a modicum of control over the distribution of work. Since the problem is partly due to the duplication of requirements in various military specifications, many contractors have taken it upon themselves to closely review the specifications relevant to the development of a new weapon system, identify duplicate requirements, and deal with them at a management level prior to negotiating with the Air Force. However, many of the contractors' attempts to control duplication of effort are abrogated by the assignment of overlapping responsibilities to several working groups.

Which methods and techniques must be considered by the Air Force and the contractors to eliminate unnecessary redundant effort? The results of the present study suggest that a joint Air Force —contractor study be initiated to analyze and integrate wherever possible the PSS related specifications. Second, maximum communication should be promoted among the working groups in the contractors' organizations. Consideration must also be given to consolidating various groups having common responsibilities (e.g., Personnel Requirements, Maintenance Engineering, etc). Each working group must be informed of the other weapon system technical groups' products and when these data become available.

Finally, redundant work effort may be reduced through the implementation of PED. Should the integration of the various working groups within an organization, as suggested above, present too many problems or be generally impractical, communication between groups can still be facilitated through PED. PED can provide rapid retrieval of data generated by the various groups involved in a weapon system development program. The existence of a data pool or PED might limit, but should not necessarily preclude, the many advantages attainable through personal contact among weapon system technical team members.

SUMMARY

The Personnel Subsystem (PSS) concept was predicated on the need for the development of personnel support of a weapon concurrently with the other aspects of the system. Personnel-Equipment Data (PED), one of the PSS elements, has not been adequately defined and is probably the least understood of the elements. Consideration of the degree of uncertainty surrounding the PED concept has indicated the need for the present study. This study is an attempt to empirically define the content of PED and to identify those requirements appearing in selected military specifications and related documents that could possibly generate unnecessary duplicative effort.

The task at hand was to examine the military specifications and related documents that have PSS implications, and to develop a technique for identifying, extracting and recording the requirements contained therein. Many military specifications, exhibits, bulletins, and standards were reviewed and 18 were selected as relevant to the study.

All requirements calling for the submittal of data were recorded on 3 by 5 cards with the specification number and the paragraph number within the specification in which the requirement appeared. The entire deck of cards was sorted and similar requirements were placed in the same group. Each group of cards formed a category and each category was titled. A working chart was

constructed so that the information collected could be scanned rapidly. The columns in the chart represented the documents and the rows represented the requirements. If a requirement appeared in more than one document, entries were made along the same row, but in different columns. The working charts were modified for presentation in the report.

The results of the study, a list of requirements and their locations in the selected documents, are presented in the appendices. The extracted requirements are documented on the left side of the list and their locations follow on the right side. The location of each requirement is represented by a combination of a code letter, representing a particular document, and a number specifying the paragraph within the document in which the requirement can be found.

The results of this study have shown clearly that the amount of duplication that would tend to bring about redundant effort was less than anticipated, but sufficient to provoke a good deal of concern. We also found that duplication can result either through unavailability of needed data, unawareness that data already exists, or poor managerial control. Contractors are aware that duplication of effort does occur; they have tried, but have been unable to cope with the problem. Elimination of duplication may possibly be achieved through a joint Air Force—contractor study of specifications; promotion of maximum communication among working groups in the contractor's organization; consolidating various groups in the contractor' s organization having common responsibilities; and finally, implementing PED.

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3. Marks, M. R., A Data Organization Model for the Personnel Subsystem, ASD Technical Report 61-447, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, September 1961.

APPENDIX I

SPECIFICATION CODE LIST

Code	Specification
A	MIL-D-9310B
B	MIL-M-9411A
C	MIL-D-9412C
D	MIL-D-26239A
E	MIL-M-26512A
F	MIL-R-26674
G	MIL-H-25946
H	MIL-H-26207
J	MIL-T-27382
K	MIL-T-27474
L	MIL-T-9212A
M	MIL-T-25304A
N	MIL-T-6328F
P	MIL-T-4860C
Q	MIL-T-8823 (ASG)
R	MIL-STD-803
S	MIL-P-25996

LIST OF ABBREVIATIONS*

AGE	Aerospace Ground Equipment
GSE	Ground Support Equipment
QPRI	Qualitative Personnel Requirements Information
QQPRI	Qualitative & Quantitative Personnel Requirements Information
TEPI	Training Equipment Planning Information
SPO	System Program Office

*The terms GSE and QPRI have been superseded by the terms AGE and QQPRI respectively. The terms which are now out of date have been used in order to remain consistent with older specifications which are still in effect. The latest terms, as they appear in recently written or revised specifications, also are included in Appendix I.

I. SYSTEM REQUIREMENTS

A. OPERATIONS

General System description	A-3.1.1.3 A-3.4.8.2.a D-App I.2 G-3.2.a H-3.1.a
Operational analysis	S-3.1
Define the general intended mission and tactics	S-3.1.1
Predict the detailed operational conditions and tactics	S-3.1.2
Flight characteristics	S-3.1.2.b
Target characteristics	S-3.1.2.c
Flight Profiles	S-3.1.2.d
Probable enemy profiles	S-3.1.2.e
Operational concept (D-3.1.5 as a basis for QQPRI; J-3.1.3 as a basis for TEPI)	A-3.4.8 D-3.1.5 J-3.1.3
System maintenance concept (D-3.1.5 as a basis for QQPRI; J-3.1.3 as a basis for TEPI)	D-3.1.5 J-3.1.3
Systems functions initially derived from the overall system analysis required by Specification MIL-W-9411 (shall be used as a basis for QQPRI)	D-3.1.5
A concise functional description of the Military purpose and operational characteristics	D-App I.2/2-1
Probable modes of operation	D-App I.2/2-2

System operational requirements (E- 3.3.1 as an element of maintainability, and E-3.8.4.a as a design parameter affecting the application of maintainability principles)	E-3.3.1 E-3.8.4.a E-3.12.a
Organization and operational data	A-3.4.8
System analysis reports will periodically show the results of continuous analysis of the operational system.	A-3.4.8.1
System operational and maintenance report supplementing the system analysis report defines step by step activity of the operational squadron utilizing the system	A-3.4.8.2
System success parameters shall be related to overall system effectiveness	F-3.2.1 F-3.2.1.2
Mission segments-time based	D-App I.3

B. DESIGN

System requirements studies data	A-3.2 G-3.1
System design analysis data (as required by MIL-#-9411)	A-3.2.1 B-3.2.1 E-3.2 F-3.2.1
(same as A-3.2.1 above but more detailed)	A-3.3.7
Subsystems or technical areas study data identified as being critical or for which the procuring activity has specified that data be submitted	A-3.2.3
System specifications for design selection or developmental data	A-3.3.1 A-3.4.1 B-3.3.7 B-3.3.7.1

Air vehicle detail specification submitted for design selection (in accordance with MIL-S-8169, MIL-S-6252, and MIL-I-9430)	A-3.3.2
Air vehicle detail specification (a refinement of A-3.3.2 for developmental data)	A-3.4.2
Design coordination data for engineering evaluation of the design prior to completion of detailed design for manufacturer	A-3.4.15 F-3.2.5
System development criteria	B-3.1.1
General performance requirements and characteristics shall be determined prior to initiation of design or development	B-3.2
New weapon system proposal should include performance and quantitative reliability objectives (during the design selection phase)	F-3.2.1.2
Design factors	B-3.2.1.1
Accuracy	B-3.2.1.1.b
Lethality	B-3.2.1.1.c
Producibility and procurability	B-3.2.1.1.h
Vulnerability	B-3.2.1.1.i
Growth potential	B-3.2.1.1.j
Versatility	B-3.2.1.1.k
System integration (into Air Force mission)	B-3.2.1.1.l
Maneuverability of the vehicle	S-3.1.4.m

Vulnerability (as a system requirement)	B-3.2.6
Operational planning documents (to be used for design criteria for GSE)	C-3.3.1.2.3
Human factors requirements	K-3.4.2 P-3.4.2.1
Human factors data for the purpose of selecting a preliminary system design (in accordance with MIL-H-26207 or MIL-H-25946)	A-3.3.9
Human factors data (same as above but submitted during the developmental phase of the system)	A-3.4.13
Human factors (as a factor affecting operational requirements that may be pertinent to design trade-offs)	E-3.8.4.h
Systems elements-description and analysis (alternatives for using humans to meet system requirements)	G-3.1.a
Design selection data (human factors)	G-3.2 H-3.1
Methods and criteria for optimum utilization of the human component in the system	G-3.2 H-3.1
Summary of the human factors effort expended during the system study phase	G-3.2.b H-3.1.b
Plans for incorporating human engineering principles into the design of the developmental model	B-3.2.4 G-3.2.c H-3.1.c
Description of any research to resolve human factors engineering problems	G-3.2.d H-3.1.d

Human factors program report will include schedule and methods for the collection, analysis and application of human engineering data	G-3.3.2 H-3.2.2
Results of human factors engineering research will be submitted	G-3.3.3.4 H-3.2.3.4

II. PERSONNEL REQUIREMENTS

A. GENERAL

Personnel information design proposal data (QPRI for the system shall be prepared and submitted in accordance with MIL-D-26239)	A-3.3.6
Personnel information-same as above but more detailed for developmental data	A-3.4.7
Personnel planning documents	C-3.3.1.2.6
Technical proposal for QPRI to be submitted as part of and concurrent with the overall system design proposal	D-3.1.1
Personnel problems-an outline of all unique or special personnel problems the system is expected to create by virtue of its design, mission or operational and maintenance concepts	D-3.1.1.b
The QQPRI shall be verified and tested throughout system development	D-3.1.4

B. POSITIONS

Personnel positions anticipated to operate, maintain and control the system shall be considered in the technical proposal for QQPRI	D-3.1.1
QQPRI shall recommend descriptive positions required for depot level support	D-3.1.3

Supervisory positions shall be generally described when a supervisory function is needed to complete the personnel requirements picture	D-3.1.3
Division of responsibilities between crew members	S-3.1.4
Overall workload on the person	S-3.1.4.a
Relative priority of the various functions	S-3.1.4.f
Summary of job operations	D-App I.3/3-1
AFS title	D-App I.4/4-1.
Positions title	D-App I.4/4-1.1
General features of each position	D-App I.4/4-1.2
Position summary	D-App I.4/4-1.2.1
Position description	D-App I.4/4-1.2.1
Position description-depot level only	D-App II.2
Relation of defined positions to existing Air Force specialities-indicate similarities and differences	D-App I.4/4-1.2.3
AFS modification when the existing AFS does not fit the defined position	D-App I.4/4-1.2.3.c
Recommendations for new career ladder	D-App I.4/4-1.2.3.d
Recommendation for shredouts	D-App I.4/4-1.2.3.e

C. MANNING

Type of Military organization, military unit, and location for which the personnel requirements information is required	D-App I.1/1-3
Identification of operator, maintenance and control personnel by AFSC, or proposed AFSC and quantity required	A-3.4.8.2.c D-3.1.3 D-App I.3/3-2
Unit manning (as a design parameter affecting the degree of application of maintainability principles)	E-3.8.4.c
The manning concept for the system shall include the number of shifts required for each of the work areas	D-App I.5/5-1.1
Basis for manning estimates	D-App I.5/5-1.1
Estimate of the number of personnel required to perform the duties of each type of position per standard working shift under typical working conditions	D-App I.5/5-2
Number of crew members	E-3.1.4.j
Manning estimates for depot and area support only	D-App II.2
Total number of facility occupants	A-3.4.9.b
Estimated number of male and female occupants	A-3.4.9.b
Minimum maintenance personnel-(a maintainability principle in the Complete System Maintainability Evaluation Plan)	E-3.11.i

D. PERFORMANCE

PERSONNEL INTERACTION

Team performance-indicate team composition and distinguish between the requirements for a skilled mechanic and just a pair of hands	D-App I.3/3-1
A brief description of team interaction and associated workers	D-App I.4/4-1.2.1

TIME

Maintenance manhours-for the evaluation of maintainability	E-3.3.7.1.g.1
Mean time for repair (as an element of maintainability)	E-3.3.1
Mean time for scheduled maintenance (E-3.3.1 as an element of maintainability)	A-3.4.8.2.g E-3.3.1
Equipment designed so that scheduled and unscheduled maintenance time is sufficiently low so as to assure operational availability of the system to satisfy the Air Force requirements (as a maintainability principle)	E-3.8.3.j
Minimum time for identification, isolation and correction of malfunctions (a maintainability principle in the Complete System Maintainability Evaluation Plan)	E-3.11.b
Scheduled maintenance tasks shall be completed in the times allocated for these tasks	E-3.12.a
Time available for task vs. time required	S-3.1.4.i

Unscheduled maintenance tasks resulting from critical equipment malfunction must be capable of completion in the specified or planned time span	E-3.12.b
Estimate of the total time, in hours and and decimal fractions of an hour, required to perform or accomplish each operation, duty and/or task	D-App I.3/3-4 D-App I.4/4-1.2.1 D-App I.4/4-1.5

TASK

A description of the nature of the work performed	D-App I.4/4-1.2.1
Nature of procedures (whether fixed or variable, system data flow analysis or circuit analysis, etc.)	D-App I.4/4-1.2.1
Time sharing between tasks	S-3.1.4.c
List of duties and tasks by job operation for each position	D-App I.4/4-1.3
Operator and maintenance tasks and duties as a basis for TEPI	J-3.1.3
List of functions, on a time base, required for air crew awareness and control	S-3.1.3
Analysis of both normal and emergency inflight operations	G-3.3.3.1.a H-3.2.3.1.a
Analysis of critical maintenance and ground support activities and of both normal and emergency operation of ground support equipment	G-3.3.3.1.b H-3.2.3.1.b
Identification of maintenance tasks	E-3.3

Minimum number and complexity of maintenance tasks by maximum use of simple design (a maintainability principle)	E-3.8.3.a
Estimate of and method for recording the frequency of task performance	D-App I.4/4-1.5 D-App I.4/4-1.5.b

ENVIRONMENT

Working environment data	D-App I.4/4-1.2.2 G-3.3.3.3 H-3.2.3.3
Crew environment	S-3.1.4.e
Effective temperature (temperature, humidity, airflow)	D-App I.4/4-1.2.2 G-3.3.3.3.a H-3.2.3.3.a
Toxicity (gaseous or liquid)	G-3.3.3.3.b H-3.2.3.3.b
Vibration	G-3.3.3.3.c H-3.2.3.3.c
Noise (acoustic)	D-App I.4/4-1.2.2 G-3.3.3.3.d H-3.2.3.3.d
Irradiation	D-3.1.1.d G-3.3.3.3.e H-3.2.3.3.e
Isolation	G-3.3.3.3.f H-3.2.3.3.f
"G" forces	G-3.3.3.3.g H-3.2.3.3.g

Pressure	G-3.3.3.3.h H-3.2.3.3.h
Restrictive personnel equipment (e.g., arctic clothing, pressure suits, etc.)	D-App I.4/4-1.2.2 G-3.3.3.3.i H-3.2.3.3.i
Environmental Hazards	D-App I.4/4-1.2.2
Human Environmental limitations	S-3.1.4.t
Space limitations	D-App I.4/4-1.2.2
Special personnel problem areas (emphasis placed on hazards)	D-3.1.1.d D-App I.6
Personnel duty location in isolated regions	D-3.1.1.d

E. SKILLS AND KNOWLEDGES

Skills and knowledges required of personnel who operate and maintain proposed weapon system (E-3.3.1 as an element of maintainability)	D-3.1.1 E-3.3.1 E-3.12.c J-3.1.1
Unusual skills generated by the proposed design of the system	D-3.1.1.c
Up-dating of skills and knowledges	D-3.1.4
Special skills for interpreting the meaning and significance of feedback indications	D-App I.4/4-1.4
Special transporting and handling skills	D-App I.4/4-1.4
Skills for manipulating controls	D-App I.4/4-1.4

Minimum personnel skills (E-3.8.3.d as a maintainability principle and E-3.11.e as a maintainability principle in the Complete System Maintainability Evaluation Plan)	E-3.8.3.d E-3.11.e
Analysis of the communication skills required, for pre-flight operation and for maintenance	H-3.2.3.1.c
Useful and reliable measures of skills	K-3.4.2.1
Methods of determining the effect of operator skill on weapon system performance	A-3.4.17
Amount of diversification of attention allowable while still maintaining adequate awareness and control of any one item	S-3.1.4.b
Degree of concentration or attention required for each item	S-3.1.4.d
Degree of capacity reserved for tactics or overall situation considerations as opposed to instant by instant detailed control during a phase of the mission	S-3.1.4.e
Need for judgement and decision	S-3.1.4.g
Degree of degradation considered acceptable or to be tolerated in man	S-3.1.4.q
Human capabilities and limitations and related problems requiring research	G-3.1.b

F. PROFICIENCY

Trainee proficiency measurement	F-3.4.2.1.5
Task proficiency level-to be furnished by SPO's personnel subsystem team prior to RFPRI publication	D-App I.4/4-1.6
Measures of proficiency-method of evaluating the extent to which the student is learning	K-3.4.2.1.4
Derivation of student proficiency measures-based on comparison to some standard	K-3.4.2.1.4.2
Maintenance of proficiency training-as a basis for TEPI	J-3.1.3

G. TRAINING

Training concept and plans	A-3.4.8
Knowledges, skills and attitudes to be learned-based on a documented analysis of the tasks to be performed by personnel during operation	P-3.4.2.1.1
Initial ability of the trainee should be considered during the selection of the detailed tasks to be trained	P-3.4.2.1.1
Effective training and transfer of those tasks to be trained	P-3.4.2.1.1
Special training problems the system is expected to create by virtue of its design, mission or operational concept	J-3.1.1.1
Training concept-as a basis for TEPI	J-3.1.3
Plans for individual training-as a basis for TEPI	J-3.1.3

Crew and unit training-as a basis for TEPI	J-3.1.3
Shredout recommendations shall be supported by estimates of the number of weeks of additional training	D-App I.4/4-1.2.3.e
Minimum training (as a maintainability principle in the Complete System Maintainability Evaluation Plan)	E-3.11.e

H. ILLUSTRATIONS

Mission profiles and flow diagrams of anticipated method of operation and support	D-App I.2/2-2
Photographs, drawings, etc, to illustrate job operations, locations, position interaction and sequential work flow	D-App I.3
Manning data format to illustrate probable position types, quantities per standard shift, recommended AFSC's	D-App I.5/5-2
Organizational diagrams to illustrate overall functional organization including composition of major organizational units, crews, teams	D-App I.5/5-3
Functional flow chart of the relationship of activities within a facility	A-3.4.9
Format of the Maintenance Analysis Specification Plan	C-3.3.2

III. PERSONNEL-EQUIPMENT REQUIREMENTS

A. GENERAL

Standard and commercial parts shall be maximally used commensurate with design requirements (variety shall be held to a minimum)	B-3.2.19.2
Government furnished equipment shall be integrated into the weapon system	B-3.2.19.1
Government furnished equipment lists	A-3.4.9.d N-6.2.e
Surveillance item data (performance parameters and functions and reliability requirements)	A-3.3.8
Equipment weight, shape and size limits (E-3.8.5.d as a factor affecting operational requirements)	E-3.8.5.d R-10.4.3
General description of end items requiring support by operational ground support equipment with a general indication of the types of operational support functions required	C-3.3.1.3.2.1.1
List of system equipment operated by operator and maintenance positions	D-App I.4/4-1.4
Equipment maintained or operated for position summary	D-App I.4/4-1.2.1
Equipment identified as new to the Air Force (in accordance with MIL-D-9412)	D-App I.4/4-1.4

Difference between new equipment and similar equipment in other systems	D-App I.4/4-1.2.3.e
Equipment status	D-App I.1/1-5
Operability (as a design factor in design analysis)	B-3.2.11
Stability (flight equilibrium)	B-3.2.2 S-3.1.4.n
Automation	R-3.3 S-3.1.4.o
Expendable components	D-App I.2/2-2
Replaceable Assemblies	D-App I.2/2-2
Mobility requirements (as a GSE design requirement)	C-3.4.1.4.b.3
Equipment evaluation to determine degree of application of maintainability principles	E-3.8.5 E-3.8.7
Basis for assigning equipment characteristics	B-3.3.7.2.4
Classification of equipment characteristics	B-3.3.7.2
Critical major and minor characteristics (definition)	B-3.3.7.2.2
Classification of test points	R-10.6

B. FACILITIES

Facility requirements including space and floor plan of buildings and the identification of functions which must be performed under controlled conditions - e.g., environmentally controlled rooms.	C-3.3.1.3.1.4
Anticipated requirements for unique facilities	

Anticipated requirements for unique facilities (buildings, power, etc.) generated by the proposed design of the training equipment	J-3.1.1.1
Facilities planning document	C-3.3.1.2.8
Installation facilities data - sets forth design criteria for all installation facilities required for integrating the system into the operational inventory	A-3.4.9
A description of the primary supporting functions of the facility including a plot plan and showing location and road set	A-3.4.9.a
Minimum facilities to meet operational requirements (as a maintainability principle in the Complete System Maintainability Evaluation Plan)	E-3.11.j
Available facilities (a design parameter affecting the degree of application of maintainability principles)	E-3.8.4.e
Facilities (as an element of maintainability)	E-3.3.1
Growth potential of the facility	A-3.4.9.e
C. WORK AREAS	
Work area facilities to accomplish maintenance tasks	E-3.12.c
Description of work areas	D-App I.4/4-1.2.1
Location or place where each duty and task is performed	D-App I.4/4-1.2.1 D-App I.4/4-1.5
Probable equipment availability	S-3.1.4.r

Work space characteristics	R-12
Anthropometry	R-12.1
Standing operation	R-12.1.2
Seated operation	R-12.1.3
Work surface description	R-12.1.4
Work seating	R-12.1.5

D. LOGISTICS

Logistics concept and plans	A-3.4.8
Logistics planning documents	C-3.3.1.2.7
Training equipment logistics	K-3.7
Transportation requirements (C-3.4.1.4.b.6 as a GSE design requirement)	B-3.2.14.1 C-3.4.1.4.b.6
System elements which are stored until ready for operational use shall be designed for a maximum storage life without reconditioning before operational use or return to storage	B-3.2.11
Storage requirements	B-3.2.21.1
Storage space	K-3.4.11
Design, test and evaluation of packaging materials to prevent degradation of reliability during handling by contractor	F-3.1.6
Packaging data (to be submitted in accordance with MIL-P-9024)	A-3.4.14

Preservation, packing and packaging shall be coordinated with any applicable aircraft, shipboard and land based handling and transportation facilities	B-3.2.21

E. TRADE-OFFS

Trade-offs (in maintainability design) to achieve maximum operational capability including economic limitations	E-3.8.5
Design trade-off determination (for evaluation of maintainability)	E-3.8.7.1.c
Trade-off parameters (a reliability design principle)	F-3.2.3.e
Trade-offs (in servicing and testing) between the need for high level technical skills and total cost of more complicated hardware that may require lower skills	B-3.3.4.1
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Operational GSE System Specification (Plan) Part I	C-3.3.1
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Summary of the technical, logistic, personnel, facility and operational criteria and requirements affecting the support system	C-3.3.1.3.2.1.2
A detailed summary of the OGSE system	C-3.3.1.3.2.1.3
Support requirements shall be identified with respect to functions and characteristics of the end items and its major subsystem and the design of operating criteria of the GSE system	C-3.3.1.3.2.2.1
Requirements for ground support shall be identified and will consist of a listing of the specific functional requirements which generate a need for support procedures or equipment	C-3.3.1.3.2.2.2
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Spare parts to accomplish maintenance tasks	E-3.12.c

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Special tools and test equipment (as factors affecting operational requirements that may be pertinent to design trade-offs)	E-3.8.5.e
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TEPI will be based on ~~FRI~~	J-3.1.3
Training equipment recommendations (A-3.4.6 and B-3.3.5 in accordance with MIL-T-27382)	A-3.4.6 B-3.3.5 J-3.1.3
TEPI report divided into its intended purpose and uses, basic assumptions and cut-off dates	J-3.1.3.1
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Flexibility in the trainer and in the level of problem difficulty so that all students will have some degree of success	K-3.4.2.1.2 P-3.4.2.1.3.d
Knowledge of results (feedback to the trainee such as scores)	K-3.4.2.1.2 P-3.4.2.1.3.e
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New display development must be clearly substantiated and recommendations for resolving inequities between needs and capabilities will be prepared	S-3.2
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Panel layouts	L-3.5.14.3 P-3.4.3.4 Q-3.7
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List of technical manuals by location	A-3.4.8.2.e

APPENDIX II

PERSONNEL SUBSYSTEM TEST AND EVALUATION

AFBMD EXHIBIT 60-1

Test objectives	3.1
Requirement for test	3.2
Test philosophy	3.3
Test program	3.4
Establishment of performance criteria for PSS test programs	3.4
Processes and products (e.g., technical manuals, training courses, training equipment, etc) shall be evaluated	3.4
Tests of the adequacy and reliability of performance required of personnel	3.4.1
Test of the PSS shall be integrated with the test of the system as a whole	3.4.2
PSS testing shall encompass all major equipment items, subsystem and weapon system activities	3.4.3
PSS test objectives shall be incorporated in system test directives	3.4.4
PSS test data shall be collected at system milestones	3.4.5

Failure, consumption data, hazards, accident, safety, etc. reports shall be utilized to collect data that have PSS implications	3.4.6
Procedures for monitoring PSS test progress shall be established	3.4.7
Action shall be taken to correct deficiencies and problem areas	3.4.9
Differences between the test situation and the operational situation and the relationships of these differences to personnel performance in the system shall be taken into account	3.5.1
Test results shall be qualified and evaluated by the limitations of the data collection situation	3.5.2
Personnel variability and interchangeability directly effect the operational capability and shall be taken into account when test data are evaluated	3.5.3
Products and processes	3.6
Human engineering	3.6.1
Technical adequacy and compliance with technical direction	3.6.1.1
Adequacy of trade-off points for automated versus manual operations	3.6.1.2
Effect of equipment arrangement on crew efficiency including such items as information flow	3.6.1.3
Communications efficiency	3.6.1.4

Adequacy of handling and transporting equipment and procedures	3.6.1.5
Identification of design features prejudicial to proper maintenance and operation	3.6.1.6
Identification of design features or procedures which constitute a hazard to safety of personnel or equipment	3.6.1.7
Identification of error inducing design features of the equipment	3.6.1.8
Sufficiency of human engineering direction for accomplishment of intended functions	3.6.1.9
QPRI	3.6.2
Technical adequacy and compliance with technical direction, requirements and specifications	3.6.2.1
Adequacy of types and number of specialists for manning	3.6.2.2
Analysis of task performance requirements for improvement of procedural efficiency	3.6.2.3
Adequacy of identification of tasks, sequencing of tasks and time-phasing of tasks	3.6.2.4
Adequacy of task description to reveal skill and knowledge requirements, environmental conditions, tools and equipment, frequency of task performance and time for performance	3.6.2.5
Adequacy of grouping of tasks by position to permit application of homogeneous qualification requirements for personnel selection and training	3.6.2.6

Effectiveness of organization and utilization of personnel	3.6.2.7
Sufficiency of QPRI data for accomplishing the function for which it was intended	3.6.2.8
Technical manuals	3.6.3
Technical adequacy and compliance with technical direction, requirements and specifications	3.6.3.1
Adequacy of manuals in setting forth job instructions for operation, maintenance and control of operational system hardware	3.6.3.2
Verification of technical manuals and related job aids	3.6.3.3
Ability of the technical manuals to accomplish their intended functions in support of human performance	3.6.3.4
Training and training equipment	3.6.4
Technical adequacy and compliance with technical direction, requirements, and specifications	3.6.4.1
Adequacy of training and training equipment coverage in relation to detailed task performance requirements	3.6.4.2
Sufficiency of training courses, devices, and equipments to accomplish the intended function in support of human performance	3.6.4.3
Unit proficiency system (UPS)	3.6.5
Technical adequacy and compliance with technical direction, requirements, and specifications	3.6.5.1
Adequacy of proficiency measurement and UPS coverage	3.6.5.2

Sufficiency of the UPS to accomplish its intended function in support of human performance	3.6.5.3
Test Plan	3.7
Human performances which have been selected for testing and the PSS processes and products to be tested shall be identified in a PSS test plan	3.7.1
Method, techniques and procedures for testing the PSS shall be devised, specified and developed to meet specific conditions for testing	3.7.2
Requirements for PSS test and data collections on military personnel shall be designated in the PSS test annex	3.7.3
The PSS test plan shall include, but shall not be limited to:	3.7.4
Identification of the specific human performance, product and process to be tested	3.7.4.a
Specification of test criteria, methods, and procedures for testing each performance, product and process to be tested	3.7.4.b
List of data to be collected and data collection technique for each performance, product and process to be tested	3.7.4.c
Statement of the type or kind of personnel required for the testing of each performance, product and process	3.7.4.d
Designation of test site or facility, location, and test conducting agency for each performance, product and process	3.7.4.e

Composition of PSS data collection team that shall implement the PSS testing at each designated test site or facility	3.7.4.f
Provisions for data analysis and utilization of test results	3.7.4.g
Separately definable PSS studies which may be conducted in such areas as acoustics, illumination, communications, climatic efforts, etc., shall be annotated in the test plan	3.7.5
Criteria (time-standards, performance specifications, etc.) and data collection forms, checklist, questionnaire, etc., shall be available prior to scheduled test implementation	3.8
Operational and technical requirements of the weapon system shall be used as criteria against which to assess the functioning of the PSS	3.8.2
Efforts shall be made to obtain data in a form that will indicate where and to what degree the aspect of human performance under evaluation deviates from the defined performance criterion or standard	3.8.5
Test plans and reports shall provide for comprehensive, systematic, and integrated coverage of the PSS test program encompassing all test facilities	3.9
Test plans shall provide for the complete testing of the PSS	3.9.1
PSS test reports shall be submitted in accordance with test reporting procedures in the Contractor Reports Exhibit (AFBM 58-1)	3.9.2

The final PSS test report shall include, but shall not be limited to: 3.9.3

- Identification of the objectives, performance tested, criteria, test facility, equipment configuration and characteristics of personnel tested 3.9.3.a
- Statement of test methods and procedures, the type of data collected, data collection techniques, and sample of each type of form, checklist, questionnaire, etc., used for data collection 3.9.3.b
- Summary of the findings, noted deficiencies, problem areas, and corrective action taken 3.9.3.c
- Implications of significant test findings for the weapon system and/or future weapon systems 3.9.3.d
- Limitation of test results and suggestions for further testing 3.9.3.e
- Specific recommendations 3.9.3.f

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Aeronautical Systems Division, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio
PERSONNEL EQUIPMENT DATA: CONCEPT AND CONTENT, by S. Gael and L. E. Reed. December 1961, 80p. incl illus., 3 refs. (Proj. 1710. Task 171005) Unclassified report

Consideration of the degree of uncertainty surrounding Personnel-Equipment Data (PED), one of the Personnel Subsystem Elements (PSS), led to the present attempt to empirically define the content of PED, and to identify requirements contained in Military Specifications and related documents which can and often do, generate unnecessary duplicative

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