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THE **BOEING** COMPANY

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CODE IDENT NO. 81205

NUMBER D2-30085

TITLE HUMAN ENGINEERING PLAN - WS-133B (U)

MODEL NO. WS-133B CONTRACT NO. AFO4(694)-266

ISSUE NO. 11 ISSUED TO Astia

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TITLE HUMAN ENGINEERING PLAN - WS-133B (U)

MODEL NO. WS-133B CONTRACT NO. AF04(694)-266

ISSUE NO. 11 ISSUED TO ASST/ASST/ASST
OS-259072

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2-5-63*

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REV SYM A.P.H. 3/13/63
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REVISED 3-13-63

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REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED
135	This revision represents changes necessary for compliance with specific comments received in TWX BS AP-18-2-92/C Humphrey/8021, dated 2/18/63; subject, Human Engineering Plan WS-133B.	3/13/63	<i>[Signature]</i>

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REV SYM 3/13/63

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3.0 SYSTEM REQUIREMENTS ANALYSIS (Task 2)

Human Engineering will be included in Systems Requirements Analyses as required by para. 3.3, AFBSD Exhibit 61-99. Functional Flow charts and Form B analyses will be reviewed as they are developed in the Systems Engineering organization. Form B technical requirements and personnel tasks will generally be the same as for WS-133A. Re-design or new design Figure A requirements that emerge in WS-133B system analysis will be reviewed to insure that functions are appropriately allocated to personnel and that these functions can be accomplished efficiently, reliably, and safely.

Functional Flow and Form B reviews will result in classification of WS-133B Figure A items, designated in Exhibit G of the referenced Statement of Work, into one of the three following categories:

- (a) Equipment unchanged from WS-133A, with no change in human performance requirements.
- (b) New or modified equipment which must undergo development, during which human engineering principles shall be applied to detail design.
- (c) New or modified equipment requiring "significant critical human performance" (as defined by para. 6.3.5, AFBSD Exhibit 61-99) which shall be task analyzed in detail to identify performance requirements and relate requirements to human capabilities and limitations.

Where necessary during system analysis, trade-off studies may be required to insure that functions are properly allocated to men or to man-machine combinations. Such trade studies will be accomplished



per para. 3.3.1, AFBSD Exhibit 61-99, by comparing projected personnel requirements to known human capabilities and limitations, particularly in the areas of sensory ability, performance efficiency and reliability, anthropometric reach and space, ergometric force, and physiological functioning. Trade studies conclusions will be communicated to Systems Engineering as data to support, or to recommend changes to Functional Flow and Form B man-function allocations. Figure 5 presents a typical trade off summary.

For equipment identified under (c), above, as requiring "significant critical human performance," all related tasks will be analyzed in detail to insure that the tasks are reliably within human capabilities, and that personnel will not be subjected to unsafe or impossible physical demands or conditions. Task analysis data will be recorded on data sheets similar to that shown in Figure 6. Results of the analyses will be communicated to Systems Engineering and to responsible design groups. These along with Human Engineering and Life Support criteria will establish the constraints upon detail design of the equipment concerned.

Human engineers will coordinate this effort with Personnel Requirements and Maintainability groups in the Service Engineering organization and will supply information to these organizations during the development of task analyses, maintenance analyses and personnel requirements. As part of this effort Human Engineering personnel will prepare and maintain human engineering sections of the Design Discipline Documents.



4.0 DETAIL DESIGN-EQUIPMENT AND FACILITIES (Tasks 3, 4 and 8)

Human Engineering will work with design engineers during Preliminary Design (Task 3) and Design and Development (Task 4) to assure implementation of appropriate human engineering principles in detail design of equipment and facilities (Task 8).

Individual human engineers will be assigned responsibility for specific Figure A end-items or subsystems. They will maintain continual direct personal contact with responsible design engineers throughout the design phases. They will provide technical human engineering data to design engineers to permit compliance with human engineering and life support requirements identified during system analysis and modified during design development.

Particular and continuing attention will be concentrated on those Figure A items identified during systems analysis as requiring "significant critical human performance," as defined in Para 6.3.5 of AFBSD Exhibit 61-99, to insure that human engineering criteria and constraints are incorporated into detail equipment design. WS-133B equipments initially classified into this category include:

Figure A 5151 - Shelter, Environmental, Entrance Hatch

Figure A 4024 - Semi-Trailer, R/V-G&C

Figure A 1334 - Seat, Operator's

Figure A 1335 - Seat, Operator's (Second Operator)

As design progresses to a more explicit definition of technical requirements and solutions, other items may be added to the above list.



The Human Engineering responsibility during design will be to insure that man-equipment interfaces are engineered to enable required system performance, i.e., that human operator and maintenance requirements are within the capabilities and limitations of Air Force personnel. Within this overall design support function, human engineers will work directly with personnel in other Minuteman organizations to provide design engineering with acceptable solutions to problems involving more than one area of interest.

Reliability. (Task 11) During design and development tests, human engineers shall identify human-induced error and recommend corrective modifications. This effort shall continue through Category I and II testing and into the operational phase of the system, and will satisfy the requirements of paragraphs 3.1 (f), 3.5.3, 3.6.4 (o), and 4.3 (a) of MIL-R-27542, "Reliability Program Requirements for Aerospace Systems, Subsystems and Equipment."

Safety. (Task 14) Design features of equipment will be studied within the context of its intended usage and juxtaposition to other equipment to eliminate threats to personnel safety.

Maintainability. (Task 10) Equipment end-items will be examined in subsystem and system context to preclude problems of access and manipulation which adversely affect maintenance functions. This effort be directed at fulfillment of paragraphs C.1.3, C.1.4 and D.1.4 of AFBSD Exhibit 62-53, "WS-133B Maintainability Design Criteria."

Interface Control. Under the provisions of AFBSD Exhibit 62-46, "Minuteman Interface and Space Control Program," equipment and



facilities designs of subcontractors and other associate contractors will be reviewed to insure that operator and maintenance personnel will not encounter impractical requirements at contractor interfaces. Human engineers will assist in resolution of interface problems through negotiations with the contractor involved, or, where appropriate, through BSD/STL.

Life Support. Human Engineering will review equipment and facilities designs to insure that personnel protection and life support provisions comply with system operational and survivability requirements, as defined in AFBSD Exhibit 62-79, "Life Support Criteria for WS-133B."

Design features which require critical operator or maintenance performance or which require performance approaching the limits of human capacity will be mock-up and dynamic simulation studies will be performed where necessary to provide realistic design information (Task 5.0). These mock-ups will not duplicate others required by PDR, CRD, or configuration control. Such mock-ups or simulations will be employed only to study problems or work-space, functional reach and vision, and force and work capabilities required to support minor studies as described in para. 6.0 of this plan. The studies will be confined to those necessary to solve specific design problems identified during the detail design phase of equipment development. They will employ prototype hardware, or hardware associated with the engineering development laboratory effort wherever possible. When such equipment or components are not available they will be fabricated from the most inexpensive material consistent with the needs of the study.

Human Engineering personnel will maintain liaison with the Service Engineering organization to assist in development of personnel requirements information (Task 13) consistent with total system requirements for personnel performance, tasks, and functions. These requirements will be identified initially in systems analysis and modified as design development progresses. Service Engineering Publications organization will be consulted to insure that personnel requirements and procedures are adequately incorporated into relevant documents and technical publications.

Human engineers will assist in preparation for and participate in Preliminary and Critical Design Reviews. Human engineering deviation reports will be submitted to BSD/S^TL during these reviews.

Inputs for the Performance and Design Specifications and for Acceptance and Qualification Test requirements shall be furnished during the design phase (see para. 5.0, below).

Human Engineering inputs to design groups will be reported to Systems Engineering for coordination within the weapon system, to prevent perturbations in total system planning and design.

Approval of detailed equipment drawings, packaging drawings, panel layout drawings, and interface control drawings by the responsible design or systems engineers shall verify that the designs comply with applicable human engineering principles, standards and criteria.



6.0 STUDY EFFORT (Task 15)

The Human Engineering organization shall examine the studies required by Task 15 of the Statement of Work to determine if human engineering or life support requirements should be included as part of the study.

Human engineering and/or life support studies shall be undertaken when design development requires data for specific weapon system design objectives. Requirements for major study efforts required primarily to establish human engineering or life support design requirements will be defined later at the appropriate stage of development, and submitted to BSD/STL for approval subject to contract negotiation. Minor studies to resolve specific and immediate design problems will be conducted in existing Bioastronautics Section human engineering and physiological laboratories under the direction of the Human Engineering organization. It is expected, subject to detail design developments, that minor studies may be required on the following Figure A items:

Figure A 4063 - Truck, Electronic Maintenance (Placement, Weight, Handling and Accessibility of Stowed MGE)

Figure A 4031 - Truck, Mechanical Maintenance (Placement, Weight, Handling and Accessibility of Stowed MGE)

Figure A 1432 - Control System, Blast Valves, LCEB (accessibility for maintenance, operability of controls, legibility of displays)

Figure A 5001 - Control System, Blast Valves, LEB (accessibility for maintenance, operability of controls, legibility of displays)



Figure A 5002 - AC-DC Converter (placement and labeling of terminals, and connectors for safety and maintenance accessibility)

Figure A 5000 - Valves, blast, LEB (size, weight and configuration for remove and replace, and for maintenance access to component parts)

Figure A 5151 - Shelter, Environmental, Entrance Hatch (work space, reach, and force requirements for handling equipment in shelter between maintenance vans and access hatch)

Figure A 4024 - Semi-Trailer, R/V-G&C (placement, weight, handling and accessibility of stowed MGE and AVE; workspace for performing required receipt-through-launch functions inside restricted van space.

Minor studies will, where possible, employ existing mockups or engineering models. Necessary additional mockups or simulations will be constructed, where practical, to the level of the problem component(s) only, such as valves, cranks, levers, switches, and tools. Where reach or handling problems arise, plywood workspace models may be necked up, and inexpensive containers simulating weight and dimensions of equipment requiring maintenance handling may be constructed. These will be evaluated in existing anthropometric-ergometric laboratories in Boeing Bioastronautics. Studies will be initiated as problems are identified in the development cycle, and will be completed and results reported to responsible design groups not less than 15 days prior to release of detail and assembly drawings. These schedules are reflected in Figure 7.



7.0 VALUE ENGINEERING

Human engineers participating in detail design development will insure that good value engineering principles are applied to equipment designed or selected for human use. This equipment will include, but not be limited to, switch handles, control knobs and dials, indicators, valve and pump handles and carrying handles or straps

8.0 PROGRAM CONTROL EFFORT

Human engineering activity will be integrated into total system R & D. Program Control displays such as Event Networks, will, reflect only those human engineering activities which become pacing items during Category I and II testing (see para. 9.0), or which will cause a delay in a design effort due to lack of human engineering technical data.

9.0 TIME-PHASE SCHEDULING

Human engineering activities will be integrated into total system R & D. Schedules will be determined by the master schedule for the system. Only during Category I and II testing will human engineering activities become milestones in the schedule, when specific personnel subsystem test objectives will require unencumbered access to test systems for data collection (see para. 5.3). Figure 7 presents a summary of these milestones.



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Figure 5

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(TYPICAL) TRADE-STUDY SUMMARY			
Function: (Number and Identification from Functional Flow)	Within Capability of Programmed AF Personnel	If NO, can machine accomplish and/or what aids are required for man to accomplish?	REMARKS
			Cost Est. Manned Automatic
Requirements: List from Form B, to include Sensory -detection -discrimination -identification -time allotted Motor -work force -gross, fine, or precision -time allotted Data Processing or Decision -precision -criticality -time allotted			
SUPPORT REQUIREMENTS List from Form B, Interface data, and system criteria, to include: Environment -temperature -humidity -shock -vibration -lighting -atmosphere -etc. Safety Considerations Work Space Requirements	IF MANNED	IF MACHINE	
		Total Costs	Allocation (circle one) man machine



TYPICAL TASK ANALYSIS FORMAT

FUNCTION (From Form 3) STEP	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION (Including Work or Force Requirements)	COMMUNICATIONS REQUIREMENTS	SAFETY
detailed sequential state- ment of tasks to be per- formed.	1. Sense modality to be used, i.e. vision, hearing, etc.	1. Nature of decision to be made	1. Type of action re- quired, i.e. turn switch, torque bolt, report failure.	Voice or visual links required.	Ida- base whic caps
	2. Specific information required, i.e. GNC status complete in silo.	2. Criticality of decision.	2. Environmental con- ditions which may affect action poten- tial, i.e. tempera- ture or wind condi- tions, restricted work space, etc.		need yard arou tube
	3. Environmental con- ditions which may affect perception such as noise, illu- mination, etc.	3. Information needed from other sources such as memory, log book, etc.			
	4. Time requirements for perception	4. Stress conditions which may affect operator's decision process.	3. Time requirements for action.		
	5. Displays required to support operator	5. Time requirements.			

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DATA SHEET



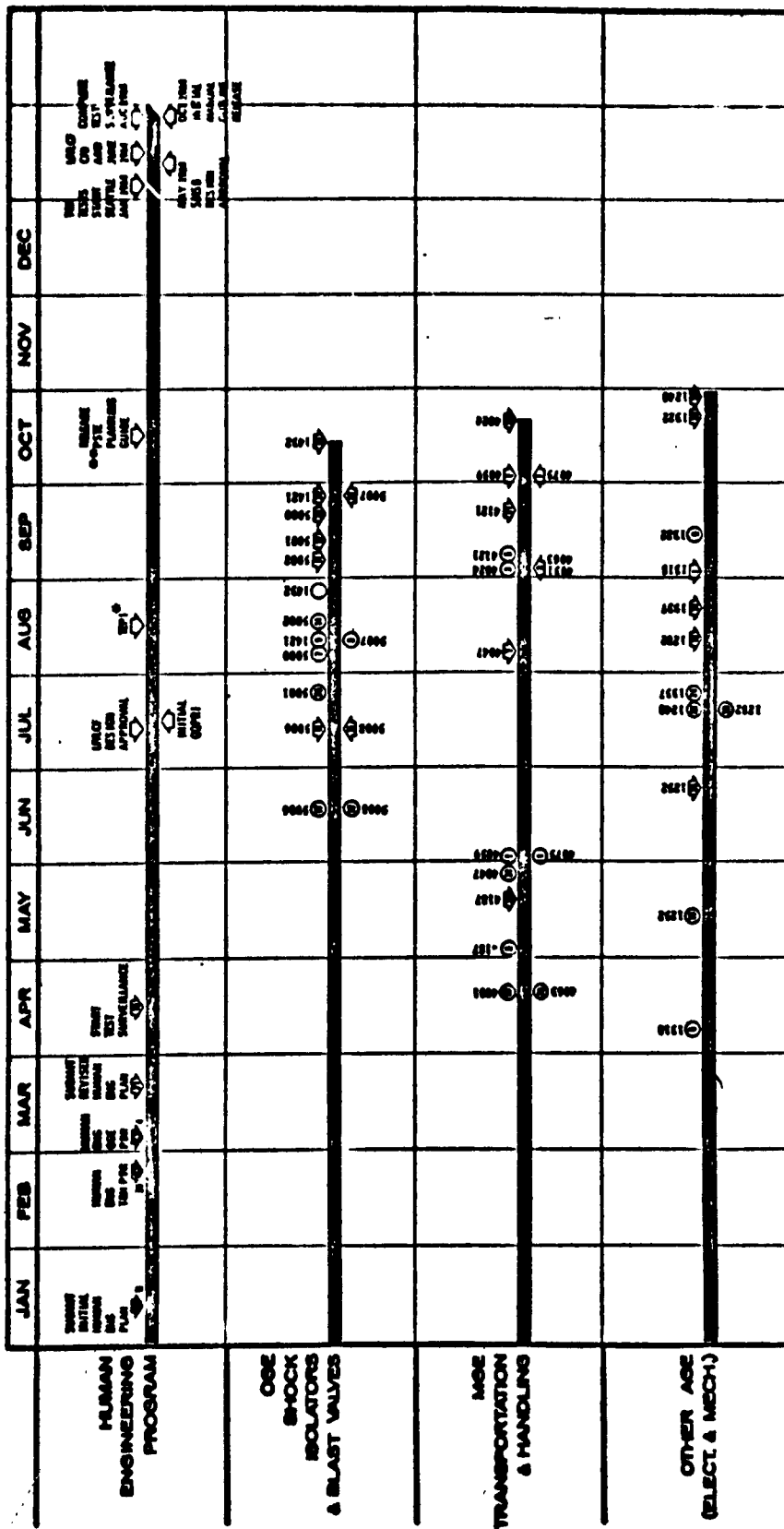
FUNCTION (Work or Force Requirements)	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR SOURCES	JOB AIDS OR TOOLS REQ'D	SKILL REQUIREMENTS	REMARKS
Function re- . i.e. turn . torque ball, failure.	Voice or visual links required.	List of potential hazards to operator which affect his work capabilities, i.e. need for safety lan- yard while working around open launch tube.	Type of possible operator error and con- sequence of errors on completion of function or upon operation of system or subsystem.	TO BE UTILIZED AS NECESSARY BY MAINTENANCE, OPER, TECH MANUALS OR TRAINING.		Additional informa- tion needed to clarify task
mental con- s which may action poten- i.e. tempera- r wind condi- restricted seas, etc.						
equipments tion.						

Cch:		REVISED	DATE	Figure 6	Page 17b
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CM:				THE BOEING COMPANY SEATTLE 4, WASHINGTON	
App:					
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HUMAN ENGINEERING PROGRAM - WING VI



LEGEND:

- PRELIMINARY HUMAN ENGINEERING STUDIES COMPLETE
- ◇ FINAL HUMAN ENGINEERING STUDIES COMPLETE
- MILESTONE ACCOMPLISHED
- ▶ MILESTONE ACCOMPLISHED

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