

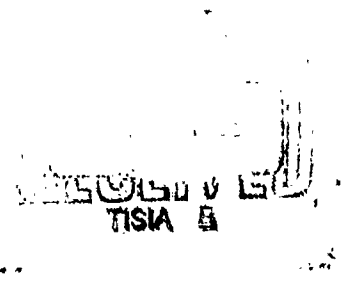
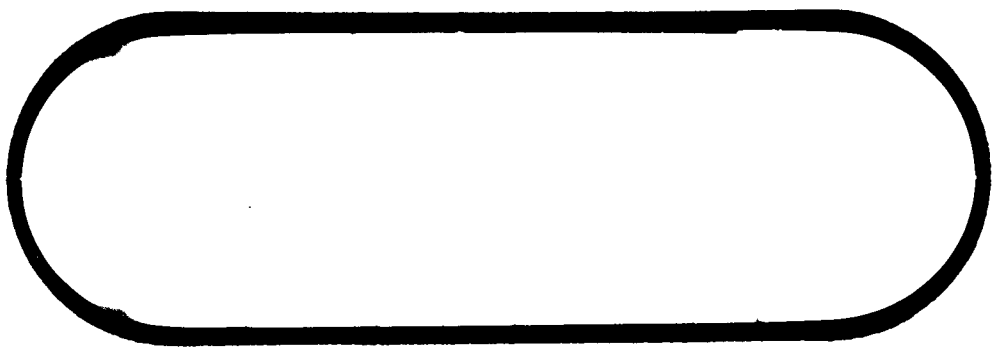
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CODE IDENT NO. 81205

NUMBER D2-15132

TITLE ANALYSIS - EFFECT OF DEPTH INCREASE, LAUNCH TUBE,
WING V

MODEL NO. WS-133A CONTRACT NO. AFOL(648)-289

ISSUE NO. 10 ISSUED TO ASTIA

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LIST OF REFERENCES

- D2-4979 Volume I, "Sile Launch Verification - Gas Dynamic Stability Characteristics - WS-133A - Minuteman", to be revised 15 July 1963
- D2-4979 Volume II, "Sile Launch Verification - Missile Clearance - WS-133A Minuteman" to be revised 1 September 1963
- D2-14136 Volume III, "Wing VI Launch Pressure Environment"
- D2-14137 Volume IV, "Wing VI Launch Thermal Environment"
- D2-14730 "Dynamic Analysis of Wing II Minuteman Missile Launcher Mount - Figure A 1322" (Revision A)

1.0

PURPOSE AND SCOPE

This document presents the results of evaluation of Weapon System compatibility with the 10 foot deeper launch tube at Wing V. Included are data reflecting missile launch performance, launcher configuration, maintenance requirements, and human factor considerations. Wing V launchers are designed; therefore, this document covers only those studies and mandatory hardware changes necessary to accommodate the 10 foot increase in depth of the launch tube.

It should be noted that this document merely summarizes the effects of the deeper launcher. In many instances, substantiating data will be found in the established Wing V documentation. In particular, reference must be made to missile performance and dynamic study documents (noted in paragraphs 3.0 and 5.0 and listed in the list of references) and, in Paragraph 2.2.2, to the Engineering Change Proposals for complete substantiating data.

2.0

STUDY PARAMETERS AND SUMMARY

2.1

BACKGROUND

2.1.1

This study has been conducted in accordance with SEL Document 6660.42-31 dated 3 January 1963. The study evaluates the Weapon System for compatibility with the Wing V Launch tube which is 10 feet deeper than those in Wing I to IV. Authorization for this study was given by CCP 815, CCN 816 (BSD-63-MSN-6004).

2.1.2

The vertical location of the missile in the deeper tube will be identical to that of the Wing I through IV configuration. Refer to Figure 4.1 and 4.2 (Page 13 and 14).

2.1.3

The missile will be the Wing II configuration.

2.1.4

Only the Weapon System changes made mandatory by the deeper launch tube are considered in this study. No other proposed Wing V changes were considered.

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This document presents the results of evaluation of Weapon System compatibility with the 10 foot deeper launch tube at Wing V. Included are data reflecting missile launch performance, launcher configuration, maintenance requirements, and human factor considerations. Wing V launchers are designed; therefore, this document covers only those studies and mandatory hardware changes necessary to accommodate the 10 foot increase in depth of the launch tube.

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2.1.3 The missile will be the Wing II configuration.

2.1.4 Only the Weapon System changes made mandatory by the deeper launch tube are considered in this study. No other proposed Wing V changes were considered.

2.1.5 Three areas of Weapon System effects were evaluated: Effect on missile performance, effect on system hardware and mandatory changes, and man - machine relationships.

2.2 STUDY RESULTS SUMMARY

2.2.1 It is predicted that Missile performance, including dynamics and fly-out trajectories, is not adversely affected by the Wing V site.

2.2.2 The following hardware changes are required:

<u>FIGURE A</u>	<u>NOMENCLATURE</u>	<u>CHANGE</u>
1248	Cable Set, Launcher	ECP 518
1322	Missile Suspension System	ECP 559
1403	Elevator Work Cage	ECP 539 RI
AOO 215	Hole Locating Fixture	ECP 559
AOO 216	Loading Fixture	ECP 559

2.2.3 No human-factors problems are evident.

2.2.4 System verification testing is required at VAFB.



3.0 MISSILE PERFORMANCE

3.1 GAS DYNAMIC STABILITY CHARACTERISTICS

3.1.1 Cold flow testing was not conducted. Existing cold flow data from Wing II and Wing VI tests will be analyzed so that Wing V gas dynamic stability characteristics may be defined.

3.1.2 The data will be published by July 15, 1963 and will appear as a revision to D2-4979, Volume I "Sile Launch Verification - Gas Dynamic Stability Characteristics - WS-133A - Minuteman".

3.2 FLY-OUT TRAJECTORY AND CLEARANCE

3.2.1 The missile fly-out trajectory and the nozzle/mount relative motion will be studied using the gas dynamic characteristics developed as noted in paragraph 3.1 (above).

3.2.2 Design clearance envelopes will be defined.

3.2.3 The data will be published by September 1, 1963 and will appear as a revision to D2-4979, Volume II "Sile Launch Verification - Missile Clearance - WS-133A - Minuteman".

3.2.4 No fly-out clearance problems are expected. This conclusion is based on analyses conducted to date on the Wing I and Wing II missile launches. The deeper launcher should reduce the magnitude of gas dynamic forces and moments acting on the missile. This should make the skirt/silo clearance greater than the Wing I or Wing II launches. Definition of the actual Wing V launch trajectory will be provided, however, to verify that there is no clearance problem.

3.3 THERMAL AND PRESSURE ENVIRONMENT

Review of the in-silo pressure and thermal environment showed that deepening the launcher reduced both blast wave overpressure and missile heating rates.. No pressure or thermal environmental problems will result from a 10 foot deeper launch tube with the missile remaining at the same level relative to the top of the launch tube.

These conclusions are based on studies made of Wing VI missile retrofit into Wing II launchers. D2-14137 Volume IV, "Wing VI Thermal Environment" and D2-14138 Volume III, "Wing VI Pressure Environment" show a more severe environment exists with a Wing VI missile in a Wing II launcher than in a Wing VI launcher (which is the same depth as Wing V launcher). Refer to Figure 4.1.

4.0 LF (RPIE) EFFECTS

4.1 Wing V RPIE and LF Facilities were investigated for functional compatibility with the Weapon System. It should be emphasized that Wing I - IV RPIE is not required to be used at Wing V but rather Wing V RPIE requirements are set forth as a separate entity to satisfy a new facility configuration.

4.2 Launch Tube requirements are defined by the "Facilities Design Criteria".

4.2.1 RPIE, Material, and Construction Specifications and details are defined by the BSD/AE plans and specifications.

4.2.2 Boeing had reviewed the A/E drawings for hardware and interface compatibility prior to construction contract award. Wing V facilities design was concurred with and recommendations given.

4.3 Specific areas of concern in regard to the affects of the 10 foot deeper launcher are as follows:

4.3.1 Environmental Control System (ECS)

- (a) Launch Tube heating requirements are a function of ground temperature and tube area. Ground temperature varies with depth and season, but is essentially equal to well water temperature in the site area and stabilizes at about 30 feet. Malmstrom AFB ground temperature is about 42° to 43° F. Warren AFB ground temperature is about 47° F. (from ASHRE Guide, 1952). Thus, although Wing V launchers have approximately 380 square feet more heat transfer area than Wing I launchers, the total heat loss of the two launchers is comparable.
- (b) The 4.5 KW launch tube heater will be as adequate at Wing V as at previous Wings. The ten foot additional length of the air duct would have less than a 1% reduction affect on air flow and net heat input.
- (c) Although the deeper launcher does not materially affect the heat and power loads associated with the LF ECS, the proposed ECS (Figure A 1211.3) for Wing V appears deficient in certain other aspects. These deficiencies are presently being



investigated. They are not analyzed here because the same problems are as applicable to Wings III and IV as they are to Wing V.

4.3.2 Sump Pump

- (a) The static head due to the increased depth on sump pump (SP-102) is 10 feet greater at Wing V compared to Wing IV. The friction head due to flow through the 10 foot longer discharge line is one half foot greater. Therefore, the total discharge head on the pump at the same flow is increased 10.5 feet.
- (b) Parsons drawings P-1 for both Wing IV and Wing V call for a pump capable of discharging 20 gpm against a total discharge head of 105 feet. The requirement cannot be the same at both wings.
- (c) The Corps contractor's shop drawings show the same pump at both wings in accordance with the Parsons requirements.
- (d) Calculations by Boeing estimate the total discharge head requirement at Wing V to be 104.5 feet and at Wing IV 93.0 feet.
- (e) Conclusion: The specified sump pump is satisfactory at Wing V. It is noted that the pump delivery at Wing IV will be approximately 35 gpm.

4.3.3 Missile Suspension System Interface

- (a) Provisions have been provided in Wing V LF for proper attachment of the suspension system.



(b) Refer to paragraph 5.1.4 for OGE analysis.

4.3.4

Security Motion Transducer

- (a) The vibration sensor Junction Boxes are located in the same relative position as required in Wings I through IV. This places them 10 feet higher relative to the bottom of the silo. Reference: A & E drawings and ICD 25-35211.
- (b) This location appears to be satisfactory. Penetration into the launch tube at the lowest 10 feet is unlikely. Also, the sensors are extremely sensitive (enough to preclude unauthorized entry at this depth).

4.3.5

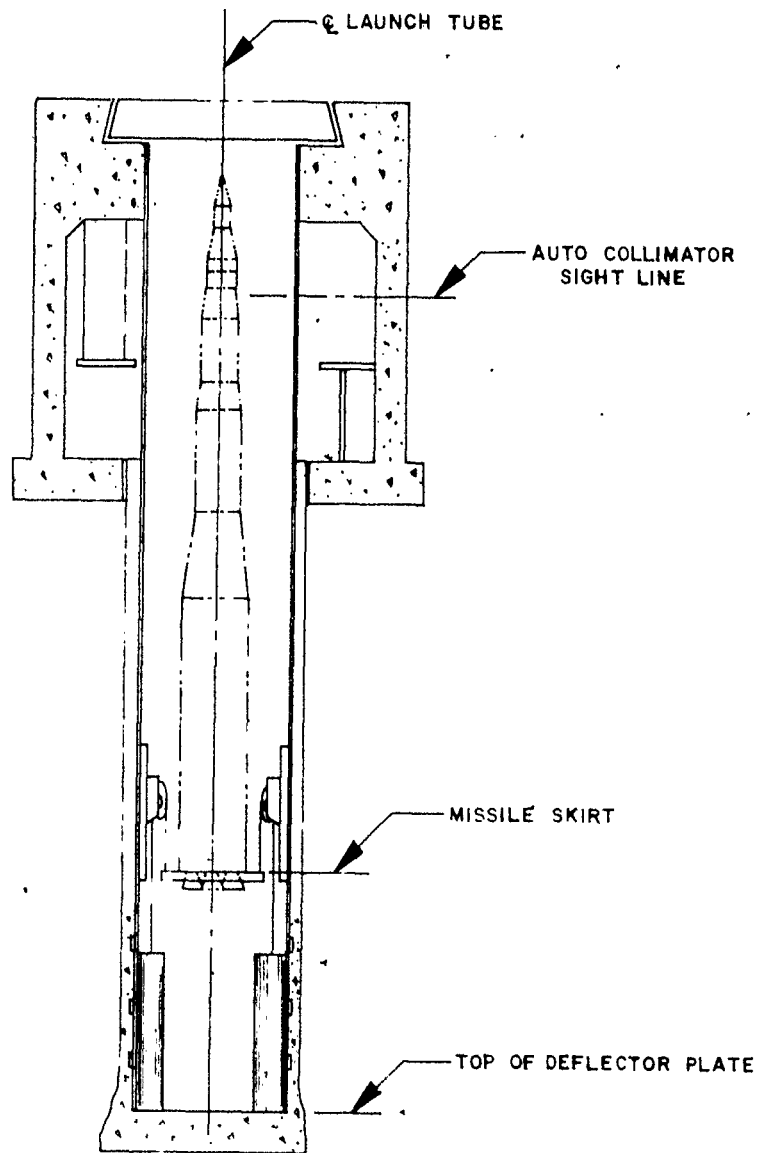
Missile Base Ground Tie Box

This box is correctly located relative to the missile mounting ring.

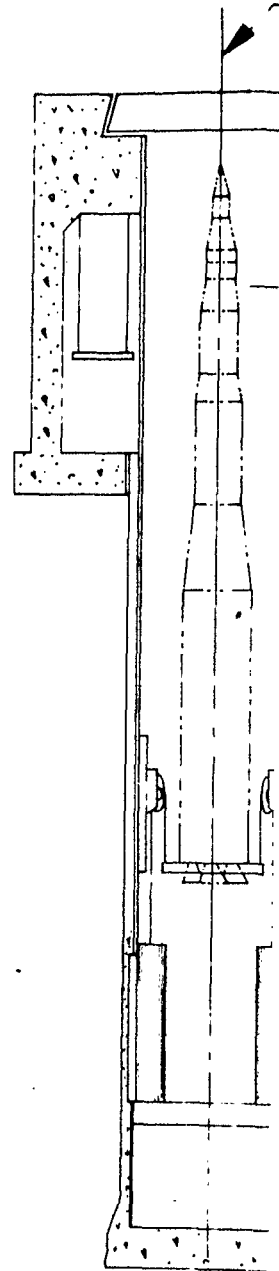
4.4

See Figure 4.1 and 4.2 for a pictorial comparison of VAFB and operational launchers.



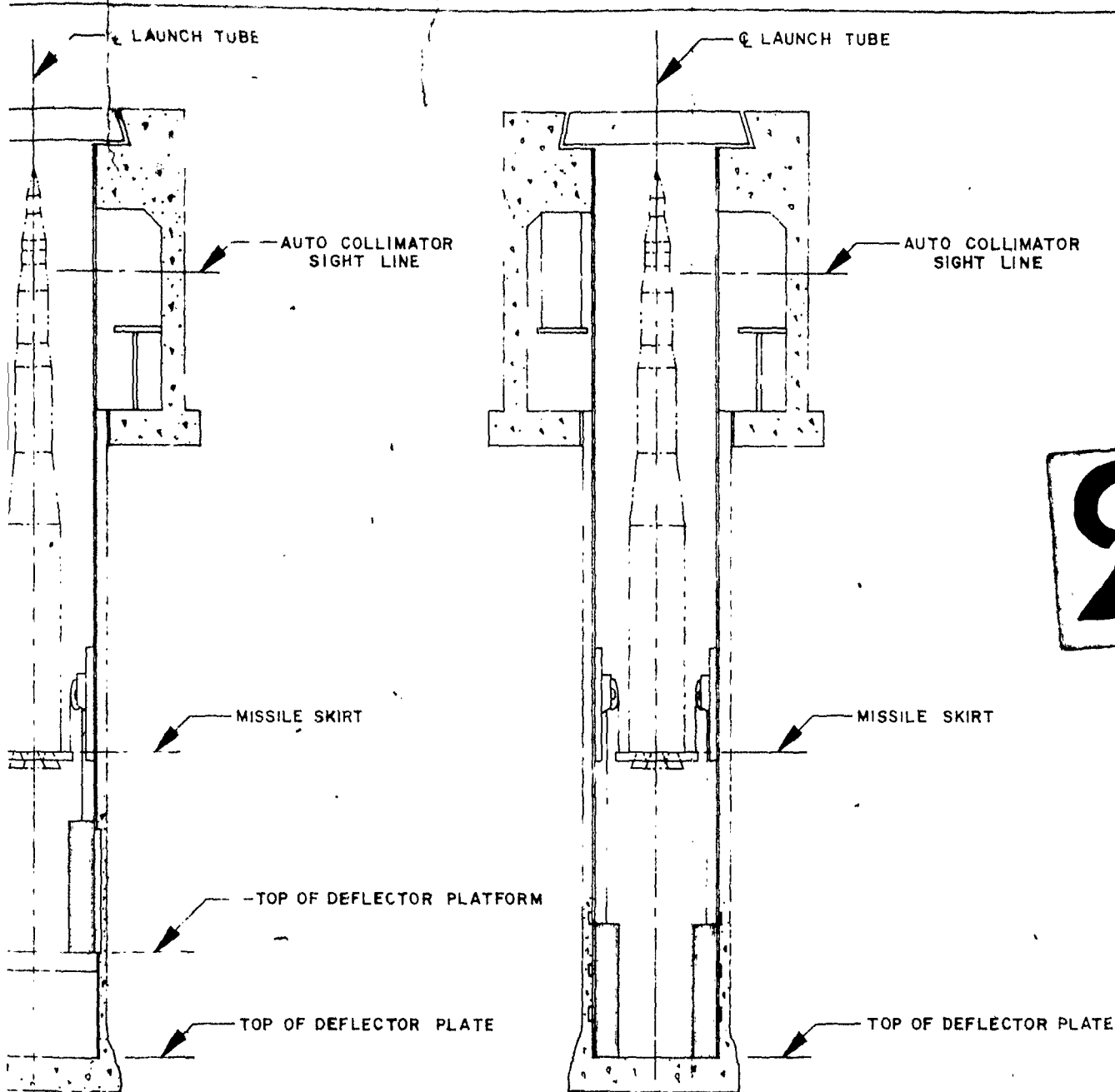


VAFB LF #6
WINGS II THRU IV CONFIGURATION



VAFB LF #
WING III CONFIGURATION

1



B LF #7
CONFIGURATION

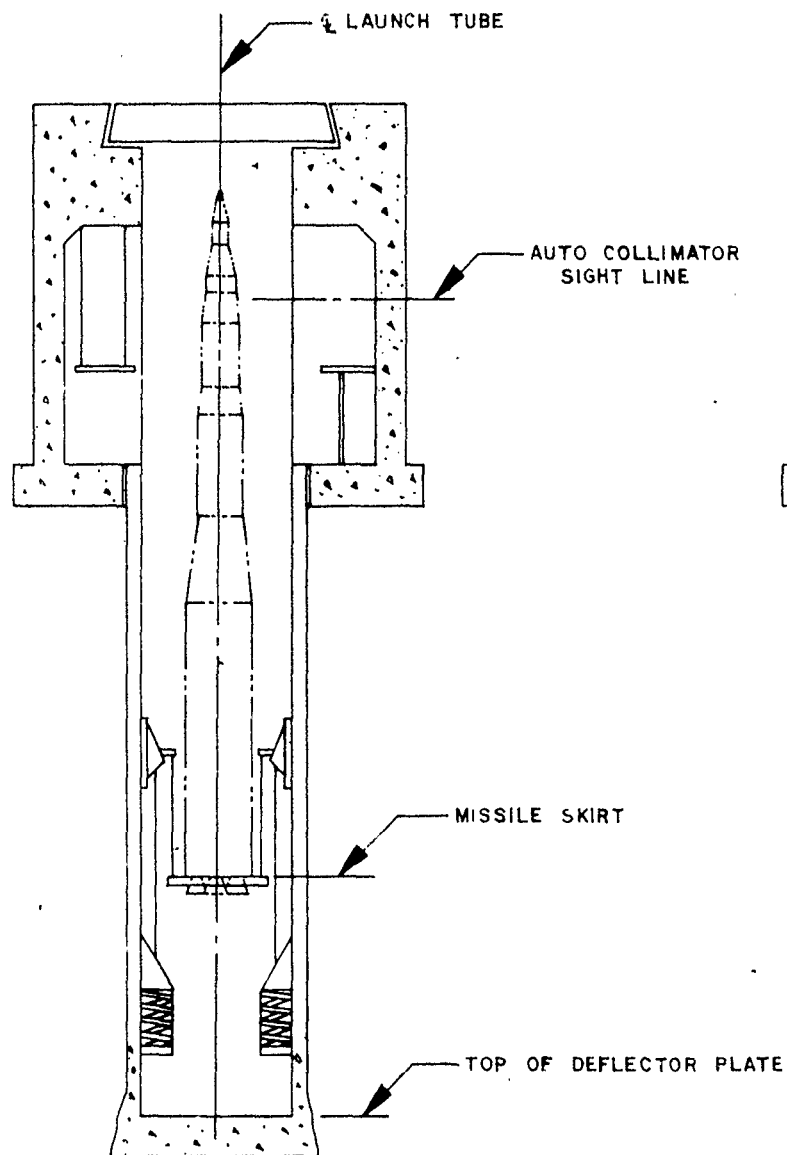
VAFB LF #8 (PROPOSED)
WING V CONFIGURATION
(SIMILAR TO WING VI SLO)

FIG 4.1 - VAFB LAUNCHER
PICTORIAL COMPARISON

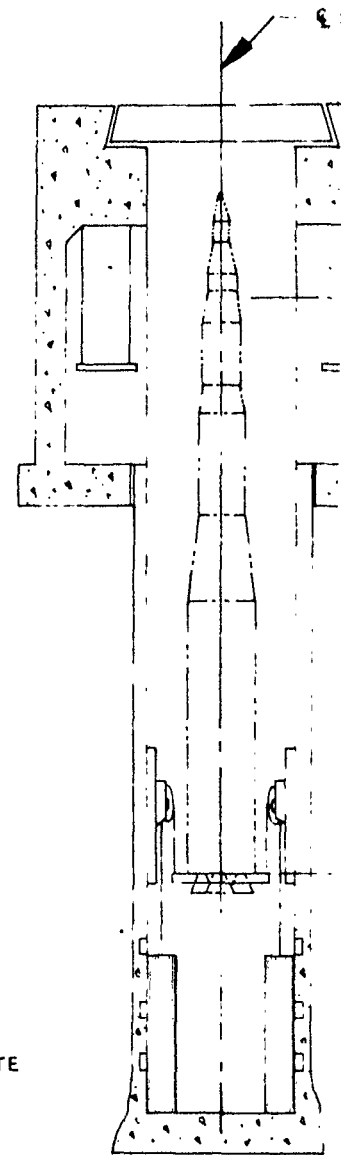
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WING I



WINGS II THRU

1

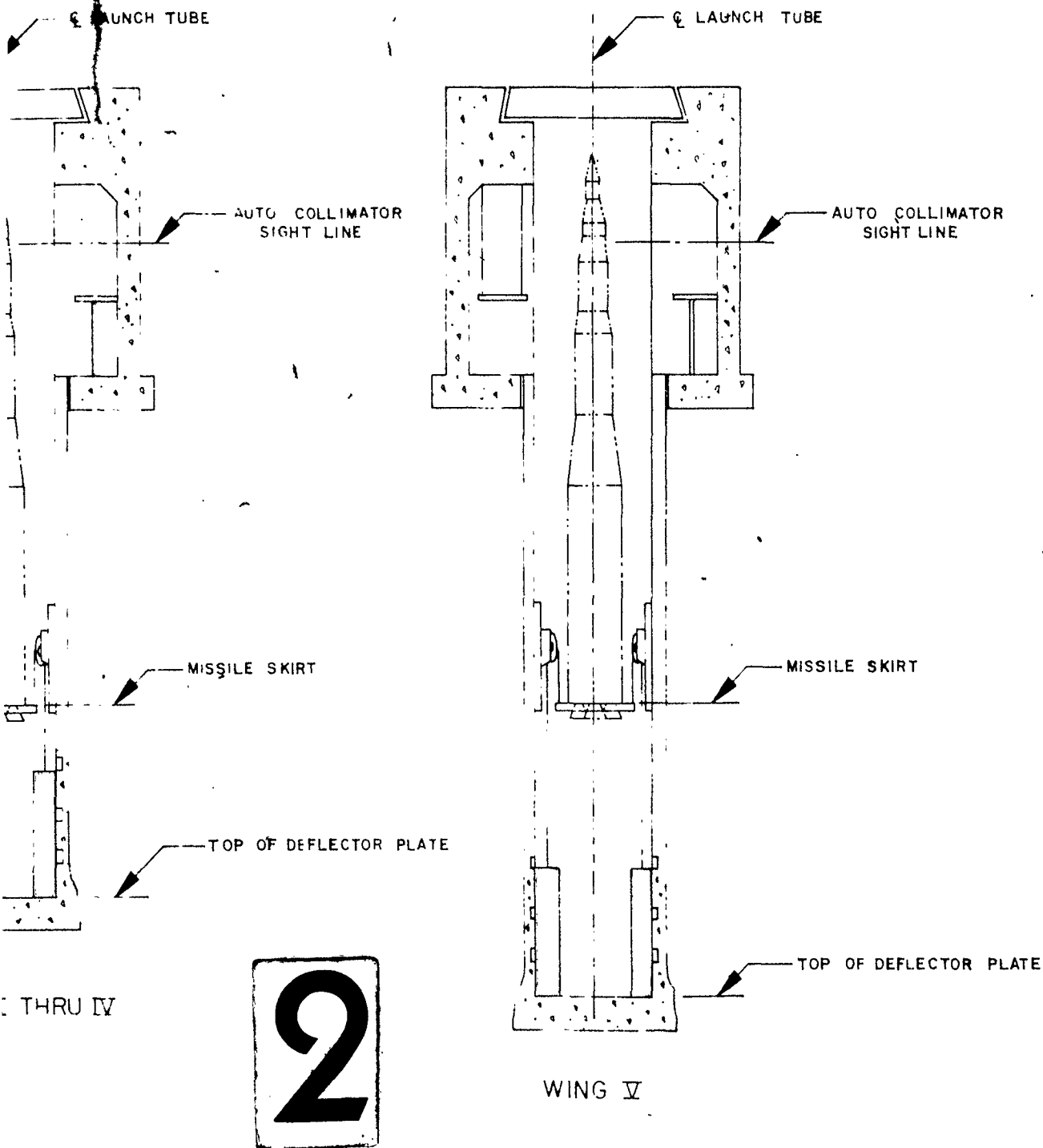


FIG 4.2 - OPERATIONAL
LAUNCHER PICTORIAL
COMPARISON
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- 5.0 OGE EFFECTS
- 5.1 FIGURE A 1322 - MISSILE SUSPENSION SYSTEM
- 5.1.1 Length of tether cables and suspension cables must be increased by 10 feet to allow for 10 foot deeper launcher.
- 5.1.2 Effect on vertical spring rate, and tether spring rate (due to cable length change) is negligible. No changes are required to the tether springs, suspension springs, nor the torsion bars. The tether and suspension cable diameters will not be changed.
- 5.1.3 The dynamic analysis for the missile suspension system may be found in D2-14730 "Dynamic Analysis of Wing II Minuteman Missile Launcher Mount - Figure A 1322" (Secret). It will be seen from this analysis that there are no problems with the redesigned system in the Wing V launcher.
- 5.1.4 ECP 559 has been established to procure hardware to the new Figure A (1322.5) for Wing V.
- 5.2 FIGURE A 1248 - CABLE SET, LAUNCHER
- 5.2.1 Only one cable, W720, is affected by the deeper launch tube. W720 is a telephone communication cable running between Unit No. 428 and Unit No. 426.
- 5.2.2 The cable will be revised under ECP 518, "Redesign of intrasite cable system for facility difference at Wing V".
- 5.3 No other item of OGE is affected by the 10 foot increase in launcher depth.

6.0 MGE EFFECTS

6.1 FIGURE A 4043 - ELEVATOR WORK CAGE

6.1.1 Use of the Elevator-Work-Cage in the ten foot deeper launcher of Wing V is limited by the length of the two cables: (1) The Power and Communication Cable and (2) the Hoist Cable

6.1.1.1 Figure 6.1 and 6.2 show the limiting factors to be as follows:

Power and Communication Cable

- (a) With the present routing of the Power and Communication Cable, the Work Cage would be one foot $11\frac{1}{2}$ inches short of reaching the nominal launcher depth (see Figure 6.1).

NOTE: Nominal dimensions of the launcher from A & E drawings as shown in Figure 6.2.

- (b) By rerouting the cable inside the Work Cage, the cage could descend a maximum of one-half inch beyond the nominal launcher depth.

Hoist Cable

- (a) The hoist cable allows the bottom of the Work Cage to reach 11 inches beyond the nominal launcher depth (see Figure 6.2)
- (b) Fully extended, the bearing point of the hoist hook will reach 5 feet $5\frac{1}{2}$ inches short of the nominal bottom of the launcher.

6.1.1.2 From meager available data, Liaison has provided field measurements showing the following:

Whiteman launch tube depth 1.58 inches greater than nominal.

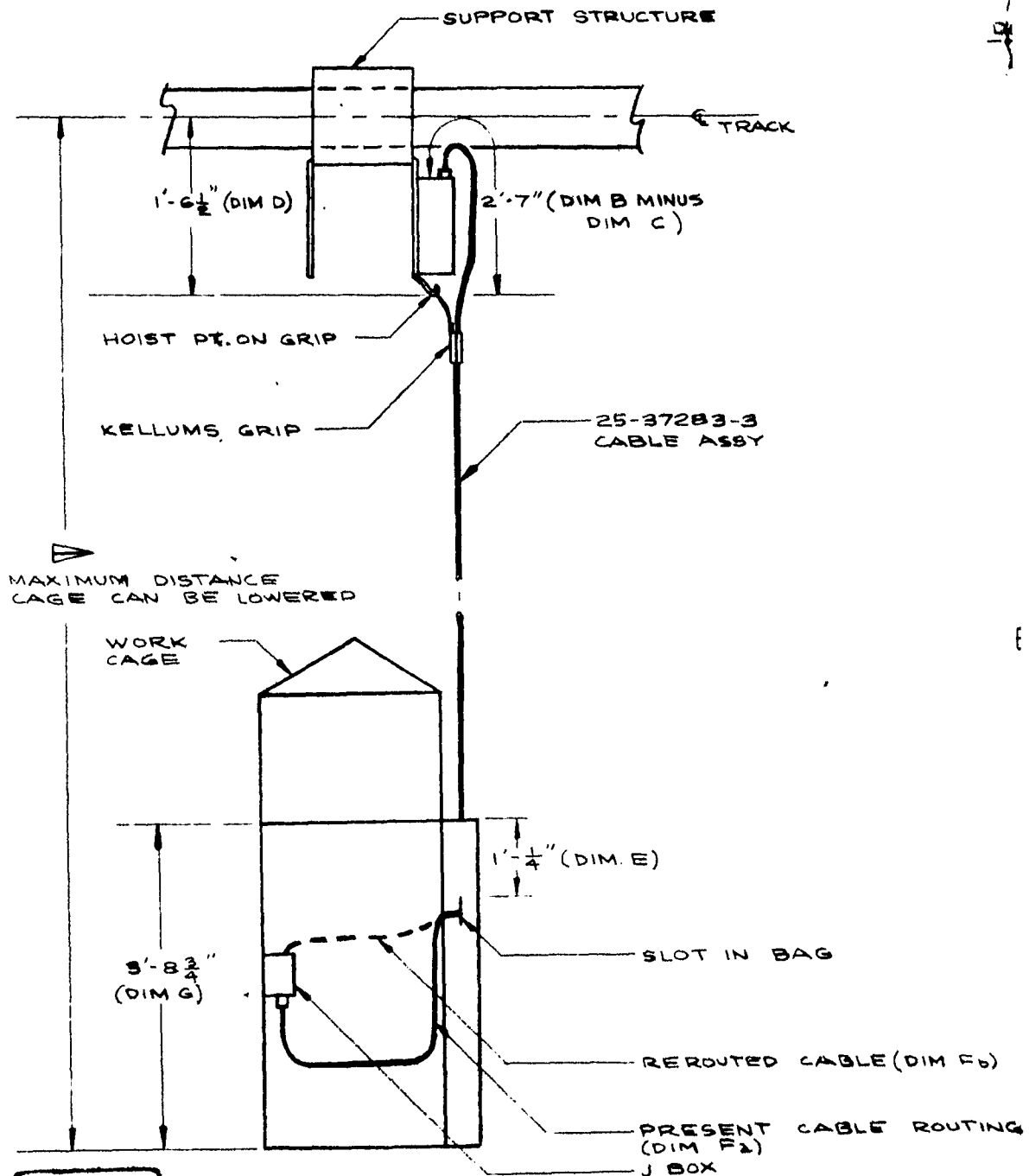
Ellsworth launch tube depth in excess of 1.25 inches greater than nominal.

This information indicates that the launchers may not be more than an inch or two deeper than nominal.



- 6.1.2 The Power and Communication Cable must be rerouted to allow the Elevator-Work Cage to reach nominal bottom in the ten foot deeper launch tube. Since there is only about one-half inch to spare and extra length should be supplied for cut-off when connector ends are repaired, it is recommended that the cable length be increased by adding approximately seven foot extension to be permanently installed in the Work Cage.
- 6.1.3 In addition to hoisting workmen and tools, the Elevator Work Cage is used as a hoist during maintenance of the sump pump located in the bottom of the launcher. This is in accordance with procedures set up by Form "C" No. 1209 (D2-6951 Volume IV G).
- 6.1.3.1 A one-half inch hemp rope is to be used to secure the hoisted part to the Elevator Work Cage. This provides flexibility in reaching the sump pump from the hook on the work cage hoist line, which is five to six feet above the bottom of the launcher.
- 6.1.3.2 Replacement of the present Elevator Work Cage hoist cable for these stated uses is not recommended as being required for use in the Wing V launcher.
- 6.1.4 It should be noted ECP 539R-1 is being submitted and ten feet additional cable is being proposed in accordance with Air Force request. If ECP 539R-1 is incorporated, there will be no requirement to extend the capabilities of the Elevator-Work Cage under CCP 815.
- 6.2 NO OTHER ITEMS OF MGE ARE AFFECTED.





1

WORK CAGE / POWER & CONTROL CABLE

DIMENSION TABLE

DIM	DESCRIPTION	VALUE
A	MIN LENGTH OF CABLE 25-37283-3 PER ADCLN G TO 25-37283	83'-0"
B	FROM END OF CONNECTOR TO BOTTOM END OF KELLUMS GRIP (P/N SD-9)	3'-8"
C	BOTTOM END TO HAIST PT ON SD-9 GRIP (FROM KELLUMS GRIP CATALOG)	1'-1"
D	FROM TRACK TO BEARING POINT OF HOOK SUPPORTING GRIP (PER G34030 SHT2)	1'-6 1/2"
E	TOP OF BAG TO TOP OF SLOT IN BAG (PER ADCLN G TO 25-37263)	1'-1/4"
F	CABLE FROM SLOT IN BAG TO J BOX a - PRESENT (PER 10 ON 25-18099) b - REROUTED	6' 10" 4' 10"
G	TOP OF BAG TO BOTTOM OF CAGE (PER 25-18605)	3' 8 3/4"

➤ MAX. WORK CAGE LOWERING ALLOWED BY
POWER & CONTROL CABLE

1. PRESENT CABLE ROUTING:

$$= DIM A - [E + F_a + (B - C)] + D + G$$

$$= 77 \text{ FEET} - 10 \text{ INCHES}$$

2. POSSIBLE BY REROUTING CABLE WITHIN CAGE:

$$= DIM A - [E + F_b + (B - C)] + D + G$$

$$= 79 \text{ FEET} - 10 \text{ INCHES}$$

(REF: LAUNCHER NOMINAL DEPTH WING V 79 FEET - 9 1/2 INCHES

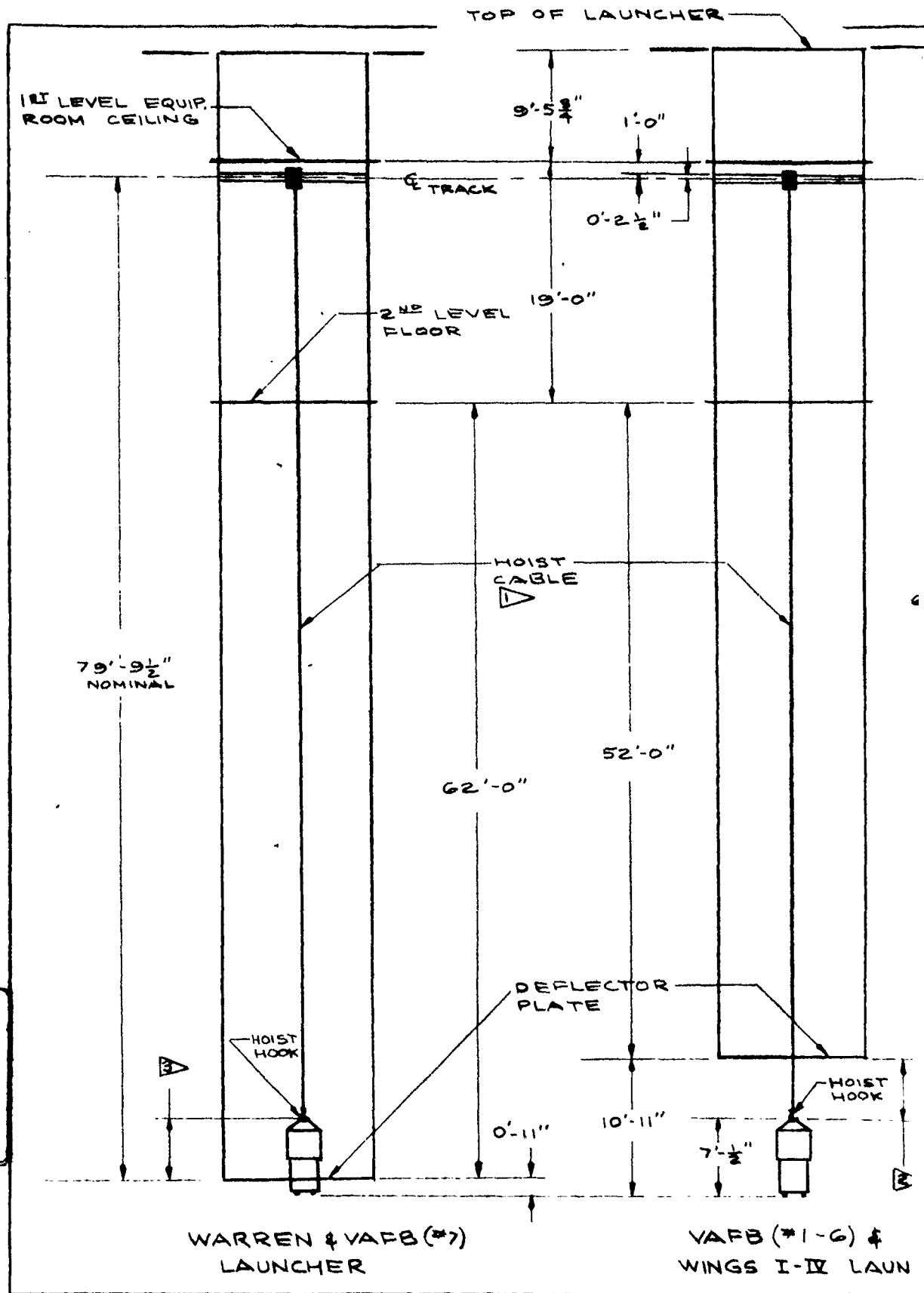
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ROUTING

CABLE LIMITATIONS

FIGURE G.1		02-
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NOTES

1. LAUNCHER DIMENSIONS FROM A&E DRAWINGS:
MALMSTROM - SHT 3-19 & 3-32 ; ELLSWORTH, MINOT,
& WHITEMAN - SHT 3-19 & 3-33 ; VAFB - SHT 3-20 & 3-34 ;
& WARREN - SHT 3-19 & 3-33.
2. ALL LF DIMENSIONS ARE NOMINAL. FIELD CHECK
SHOWS THAT 12TH LEVEL EQUIP ROOM CEILING
TO BOTTOM OF LAUNCHER WAS 1.58 INCHES
GREATER THAN NOMINAL AT WHITEMAN AND
1.25 INCHES GREATER THAN NOMINAL AT ELLSWORTH.
3. THE HOIST HOOK WILL REACH TO THE
BOTTOM OF THE LAUNCHER AT WINGS I-IV
AND MIGHT BE USED FOR LIFTING ITEMS
OTHER THAN THE WORK CAGE. THE HOOK
WILL BE 5'-5½" SHORT OF LAUNCHER
BOTTOM AT WING V

69'-9½"
NOMINAL

1. 73'-8" PER 10-20862 PARAGRAPH 3.1.6.6
2. BEARING POINT OF HOOK CAN EXTEND 3'-10½"
BEYOND NOMINAL DEPTH OF LAUNCHER
WHEN LOWER LIMIT SWITCH IS ACTUATED
3. BEARING POINT OF HOOK WILL BE 5'-5½"
FROM NOMINAL DEPTH OF LAUNCHER WHEN
LOWER LIMIT SWITCH IS ACTUATED

HOIST
HOOK

3

6) &
LAUNCHER

2

FIGURE G.2 - WORK
CAGE/HOIST LIMITATIONS

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7.0 HUMAN ENGINEERING

7.1 Detailed task analyses were performed on the following functions to determine if any human engineering problems were created by the 10-foot extension of the launch tube.

- A. Missile Base Support Leveling
- B. Dead Band Leveling Missile Base Support
- C. Sump Pump Installation, Removal & Maintenance
- D. Work Cage Utilization
- E. Installation and Maintenance of the SIM Inter-Communications J-Box
- F. Installation and Maintenance of the Motion Sensing Transducers
- G. Missile Installation and Removal

7.2 The analyses (Fig. 7.1 through 7.7) indicate that no significant human engineering problems are created by the launch tube extension.

7.3 An increased utilization of the elevator work cage is predicated on the basis of using it to perform skirt umbilical remove and replace functions for which a step ladder is now employed. The additional 10 feet will make the use of a stepladder unrealistic.



FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Three members assemble work cage*		
2) Place vapor-proof flood lamps in work area on second level and secure to provide light in lower launch tube area.	Vision, hearing, touch. Illumination such that glare is reduced by lamp adjustment at 2nd level.	Number of light required, wattage, i.e., 75 to 300 watts available.
3) Enter elevator work cage and descend to missile base.		
4) Verify that first stage missile skirt grounding strap, located near skirt umbilical restraint bracket is connected to missile support ring adapter.	Vision, touch.	Whether proper connection is made.
5) Verify that ground cable is connected between ground strap located on outside of missile support ring adapter and one of the cable connector lugs in missile base ground point junction box.	Vision, touch. Are junction box connector lugs free of corrosion.	Is a proper earth ground established.
6) Using first stage skirt restraint clamp bolt holes, install missile base support level set on missile support ring adapter so that levels are oriented to one of three leveling jacks.	Vision, touch	Which leveling jack to orient to - jack 1, or 3.

1

*See detailed Task Analysis for work cage, page 33

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK . . FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, hearing, touch. Illumina- tion such that glare is reduced by lamp adjust- ment at 2nd level.	Number of lights required, what wattage, i.e., 75 to 300 watts available.	Attach lights by screwing and ad- justing clamp.	Voice communication between operators. No visual links in this location.	Safety lanyards attached when work- ing in silo on work cage and attaching lights.	Misjudging light ment for glare-free illumination at a bottom.
Vision, touch.	Whether proper connection is made.		Voice		Insecure ground attachment.
Vision, touch. Are junction box connector lugs free of corrosion.	Is a proper earth ground established.	Make earth ground attach- ment.	Voice		Insecure ground attachment.
Vision, touch	Which leveling jack to orient to - jack 1, 2 or 3.	Tighten thumb screws pro- vided with level set.	No specific com- munications re- quirement. One member operation.	Safety lanyard must be connected to ring of work cage.	None likely.

FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
7) Read both level sensors.	Vision, touch, sound.	Determine that each sensor bubble is centered in the sensor scale.
8) (Assuming non-level missile base support.) Use socket wrench to loosen spring retaining plate lock bolts, four places for each leveling jack.	Vision, touch	Spring retaining plate to be loose.
9) Slide spring retaining plates toward launch tube wall until they contact wall. Use socket wrench to retighten spring retaining plate lock bolts.	Vision, touch, sound.	Decide when plate touch wall. De- termine all bolts are tight.
10) Use a wrench to turn each leveling jack drive nut as required for level sensor bubble positions until bubbles are centered in both level sensors.	Vision, touch, Critical function or repetition necessary. Poor illumination could affect leveling.	Determine when both bubbles are centered.
11) Use an adjustable wrench to loosen spring retaining plate lock bolts (See attached fig. A-4) and slide spring retaining plates away from launch tube wall until plates are centered with respect to jacks.	Vision, touch. If bolts stick avoid excessive force.	Determination as to centering of plates in relatic to jack. Whether missile has been indexed to target azimuth.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch, sound.	Determine that each sensor bubble is centered in the sensor scale.	2nd operator turns jack screws.	Oral communication between operator in cage and operator at missile base 20 ft down.	Safety lanyard must be connected to ring of work cage.	Sensor bubbles not centered.
Vision, touch	Spring retaining plate to be loose.	Loosen bolts with socket wrench.	No critical communi- cation.	No critical requirement unless performed from work cage.	Bolts not suffi- ciently loosened.
Vision, touch, sound.	Decide when plates touch wall. De- termine all bolts are tight.	Slide spring re- taining plates - tighten plate bolts.	No critical communi- cation.	No critical requirement unless performed from work cage.	Plates are not against wall and bolts are not properly retight- ened.
Vision, touch, Critical function or repetition necessary. Poor illumination could affect leveling.	Determine when both bubbles are centered.	Use wrench.	Oral response between operators.	Measure jack travel stem with steel rule and do not allow any jack stem to extend more than nine inches.	Jack stop could fail and cause equi- ment damage that m- injure personnel.
Vision, touch. If bolts stick avoid excessive force.	Determination as to centering of plates in relation to jack. Whether missile has been indexed to target azimuth.	Torque required to loosen spring retaining plate lock bolts.	Voice communi- cation between operators and SIN telephone com- munication to LCC and equipment room.	Adjustable wrenches are prone to slip. Care should be taken in applying force to avoid skinned knuckles of bruised hands or arms.	Poorly centered pl.

2

DATA SHEET

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS DEEPER SILO WITH V
lanyard must be ed to ring of ge.	Sensor bubbles not centered.	adjustable wrench. 2nd operator		Distance between one operator and the other increased by 10 feet to approx. 20 feet.
ical requirement performed from ge.	Bolts not suffi- ciently loosened.	Socket wrench.		
ical requirement performed from ge.	Plates are not against wall and bolts are not properly retight- ened.	Socket wrench		
jack travel stem el rule and do w any jack stem d more than nine	Jack stop could fail and cause equip- ment damage that may injure personnel.	Wrench		
le wrenches are slip. Care e taken in force to avoid knuckles of hands or arms.	Poorly centered plates	Adjustable wrench		Same

3

REV. ED. DATE

FIGURE 7.1 CON'T.

THE **BOEING** COMPANY
SEATTLE 24, WASHINGTON

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FUNCTION: A MISSILE BASE SUPPORT LEVELING	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENT
12) Loosen thumbscrews and remove missile base support level set.	Vision, touch.	The decision th missile base su dead band level was or was not accomplished wa made.*
13) Place missile base support level set in storage case and secure storage case in work cage. Place tools in work cage and secure with tietlines.	Vision, touch.	None critical.

1

*See Function B for Missile Base Support Dead Band Leveling Task Analysis

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10 FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision, touch.	The decision that missile base support screw. dead band leveling was or was not to be accomplished was made.*	Manual thumb-	Oral communication to 2nd operator at silo base.	Safety lanyard attached to work cage ring.	None
Vision, touch.	None critical.	Manually secure	None critical.	All tools and equip- ment to be transported in work cage must be properly secured in work cage.	Damage to missile and equipment or injury to person may result from a falling object.

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS NIGHT SILO WITH V
------------------------	-----------------	-------------------	-------------	-------------------------

lanyard attached * cage ring.	None	Work Cage.		Increased communication distance between operators
----------------------------------	------	------------	--	---

ols and equip- o be transported k cage must be ly secured in age.	Damage to missile and equipment or injury to personnel may result from a falling object.	Tiedown straps.		Same.
---	--	-----------------	--	-------

3

REVISED	DATE	FIGURE 7.1 CONT. THE BOEING COMPANY SEATTLE 28 WASHINGTON	D2-15132 P23

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
As described in	As described in	As described in	As described in	As described in	As described in Func-	As described in
A. Function A.	Function A.	Function A.	Function A.	Function A.	tion A.	Function A.
Vision, touch.	Verify bubble	Visual and man-	Oral communication	Safety lanyard operator	Not detecting	
	motion.	ual.	between operators.	in work cage.	bubble motion.	

Vision, touch,
ability to write
legible numbers.

Interpretation of 70-ft. lb. of
minutes of arc in torque to wrench
relation to grad- in a close envi-
ient marks. Close ronment inter-
correlation in spersedwith oral
inter-operator un- communication and
derstanding of a decision making
wrench turns ver- requirement.
sus bubble readings.

Oral, between
operators.

Safety lanyard in
work cage.

Poor readings.
Improper corre-
lation between
what operators
understand and
subsequent
response.

▶ If the number of turns recorded in B-3 exceeds 14 turns, suspend post emplacement operations. The
missile support suspension and alignment system will require maintenance and possible missile removal.

umbilical cable connection procedures and procedures for connecting
ave been performed Before proceeding with dead band leveling missile

in both level sensors, select the level sensor bubble
st motion. Record bubble position.

DATA SHEET

2

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS DEEPER SILO WING V
As described in Func- tion A.	As described in . Function A.	As described in Func- tion A.		
y lanyard operator work cage.	Not detecting bubble motion.	Wrench.		Illumination may be decreased. Oral communication more diffi- cult depending on noise level from environmental supply duct now located above operators head at silo base.
y lanyard in cage.	Poor readings. Improper corre- lation between what operators understand and subsequent response.	Wrench, pencil, note- book. Skill in read- ing sensor bubble and communicating in- formation to another operator for action.		
ions. The missile removal.				

3

		REVISED	DATE	FIGURE 7.2 CONT. DEAD BAND LEVELING THE BOEING COMPANY SEATTLE 24 WASHINGTON	D2-15132 P24
Appr					
Appr					

Calc	DATE	REVISED							
Trac									
Ch									
Appr									
Appr									
THE BOEING COMPANY SEATTLE 28 WASHINGTON FIGURE 7.2 CONT P 25 02-15132									

calcu-	Pencil, log book	Same
calcu-	Wrench	Same
driver	Applicable screw-	Same
screw	driver	
not de-	Wrench, level set,	If illumination is not ad-
addings,	pencil, log book	equates at deeper level operator
lation		Fatigue may result sooner.
operators		
subse-		
tered.	Wrench	Same



FUNCTION: B DEAD BAND LEVELING MISSILE BASE SUPPORT	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
5) Divide the number of recorded turns by 2 and subtract 1.	Vision	Information required from log book.
6) Turn jack No. 1 jackscrew clockwise the number of turns calculated in Function B-5.	Vision, touch	Information required from log book.
7) Tighten No. 1 leveling jack drive nut set screw.	Vision, touch	Decision as to proper screw setting forces.
8) Repeat steps B-2 through B-7 for jack No. 2.	Vision, touch	Same as Function B-3 and B-4 plus information required from log book.
9) Repeat steps B-2 through B-7 for jack No. 3.		
10) Use wrench to loosen spring retaining plate lock bolts and slide spring retaining plates away from launch tube wall until plates are centered with respect to leveling jacks.	Touch, vision. Critical that plates be centered.	Stress condition brought on by fatigue from wringer operation in st base could affect decision that plates were centered with respect to leveling jacks.



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision	Information re- quired from log book.	Mathematical cal- culation.	No critical com- munications if notes are not in doubt.	Wear protective head gear at all times when working in silo. (Wear and attach safety lan- yard when in work cage).	Error in turn calc lation.
Vision, touch	Information re- quired from log book.	Mathematical cal- culation			Error in turn calc lation.
Vision, touch	Decision as to proper screw set- ting forces.	Tighten set screw			Improper screw dri head can cause scr head damage.
Vision, touch	Same as Function B-3 and B-4 plus information re- quired from log book.	Environmental con- ditions and fatigue will effect operator potential. Time re- quirements will ex- ceed preceeding operations due to operator fatigue.			Bubble action not tected, poor readi improper correlati between what operc understand and sul quent response.
Touch, vision. Critical that plates be cen- tered.	Stress conditions brought on by fa- tigue from wrench operation in silo base could affect decision that plates were cen- tered with respect to leveling jacks.	Same as Function B-8 & 9. (Time requirements needed but not available).			Plates not center

DIFFERENCES	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
Protective head all times when in silo. (Wear each safety lan- gen in work cage).	Error in turn calcu- lation.	Pencil, log book		Same	
	Error in turn calcu- lation.	Wrench		Same	
	Improper screw driver head can cause screw head damage.	Applicable screw- driver		Same	
	Bubble motion not de- tected, poor readings, improper correlation between what operators understand and subse- quent response.	Wrench, level set, pencil, log book			If illumination is not ad- equates at deeper level operator fatigue may result sooner.
	Plates not centered.	Wrench		Same	

3

Calc		REVISED	DATE	FIGURE 7.2 CONT THE BOEING COMPANY SEATTLE 24 WASHINGTON	02-15132 P 25
Tran					
Link					
APP					
APP					

FUNCTION B:	PERCEPTUAL	DECISION
DEAD BAND LEVELING MISSILE BASE SUPPORT	REQUIREMENTS	REQUIREMENTS

11) Use wrench to tighten spring re-	Vision, touch.	Do Determine prop
taining plate lock bolts.	not over tighten.	tightness.



**SAFETY
INSTRUMENTS**

PROBABLE ERRORS

JOB AIDS OR TOOLS

NORMAL SILO

VS

DEEPER SILO WING V

Intensive head

Loose bolts.

Wrench

Same

3

CHK	REVISED	DATE	FIGURE 7.2 CONT. THE BOEING COMPANY SEATTLE 24 WASHINGTON	D2-15132 P 26
TRK				
CHK				
APP				
ALL				

FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION AND MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Three members assemble work cage.*		
2) Place vapor proof flood lamps in work area on second level and se- cure to provide light in lower launch tube area.**		
3) Enter elevator work cage and de- scend to missile base.*		
4) Remove sump cover plate by re- moving hold down nuts, attaching 5/8 inch eyebolt, positioning work cage over sump, attach rope to cage and eyebolt, and move work cage with cover to one side, lower to floor and detach rope.	Vision, touch; if bolts stick, avoid sump cover plat excessive force.	Where to move t where to attach rope to work ca
5) Remove water from sump by using hand pump to transfer water from sump to containers	Vision	Whether it is r quired to pump any excess of where to transf the water.
6) Remove pumping unit by unbolt- ing and removing cover support beam from sump, disconnect pump discharge piping, disconnect pump power cable at J-Box, and remove pump base hold down nuts	Vision, touch; if bolts stick, avoid sump pump is m excessive force.	To determine ti functioning.

* See detailed task analysis for work cage, page 33

** See detailed task analysis for flood lamps, item 2, page 21



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision, touch; if bolts stick, avoid excessive force.	Where to move the sump cover plate, where to attach rope to work cage.	Torque required to loosen bolts and attach eye-bolt.	Voice communication between operators; and SIN telephone communication to LCC equipment room for emergency only.	Very easy to drop the sump cover if not properly tied to work cage - cover weight 125 lbs. Electrical power removed from pump.	Electrical pump left on - cover stick to sump and cage may result to elevator work cage while pulling it
Vision	Whether it is required to pump out any excess of water where to transfer the water.	Pumping of hand pump.	Voice communication between operators; and SIN telephone communication to LCC equipment room for emergency only.	Slipping on wet sile floor. Electrical power removed from pump.	
Vision, touch; if bolts stick, avoid excessive force.	To determine that pump is malfunctioning.	Torque required to loosen bolts and nuts.	Voice communication between operators; and SIN telephone communication to LCC equipment room for emergency only.		

**SAFETY
REQUIREMENTS**

PROBABLE ERRORS

JOB AIDS OR TOOLS

NORMAL SILO

V8

DEEPER SILO WING V

sy. to drop the
ver if not pro-
ied to work cage-
sight 125 lbs.
cal power re-
nom pump.

Electrical pump cover
left on - cover may
stick to sump and dam-
age may result to
elevator work cage
while pulling it loose.

541X0 and/or 564X0
wrench or crows foot
rope, 5/8 inch eye
bolt, work cage

Same

g on wet silo
Electrical power
from pump.

541X0 and 564X0 hand
pump, containers for
water (30 gal. drum
or like item).

Same

541X0 or 564X0
wrench or crowsfoot

3

Cal		REVISED	DATE	FIGURE 7.3 SUMP PUMP HANDLING & MAINT THE BOEING COMPANY SEATTLE 24, WASHINGTON	D2-15132 P 27
Tra					
Chr					
Appr					
Ass					

FUNCTION: C SEMP PUMP REMOVAL, INSTALLATION AND MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
7) Lift sump pump from sump by attaching a rope to the lifting lugs on the motor and to the elevator work cage; lift and lower to floor and detach rope; remove holddown nuts at motor base and detach motor from pump; place motor and pump on work cage platform and raise to equipment room level; hand carry motor and pump to access shaft and reassemble to facilitate handling; raise pumping unit to surface using truck hoist; lower replacement pump and motor to equipment room level; detach motor from pump and hand carry pump and motor to work cage; lower to sump floor and reassemble pumping unit; then attach rope to motor lift lugs and to work cage and lower pumping unit into sump using work cage as hoist.*	Vision, touch; if bolts stick avoid excessive force.	Where to move pump to prior lifting into work cage and vice versa.
8) The rest of the procedure for installation of the pump is just the reverse of steps 6, 5, and 4 (Function C).		

1

*See attached illustration of sump pump removal operation.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
- Vision, touch; if bolts stick avoid excessive force.	Where to move the pump to prior to lifting into work cage and vice versa.	Torque required to loosen bolts, lifting force to move motor and pump to and from the work cage and to hoist in access shaft.	Voice communication between operators; SIN telephone communication to LCC equipment room for emergency only.	Very easy to drop the pump if not properly tied to work cage. Pump weighs 117 lbs., motor above weighs 85 lbs.	Pump may stick to s and damage may result to elevator work assembly in pulling base.

p removal operation.

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
easy to drop the	Pump may stick to sump	541X0 and/or 564X0			Same
if not properly	and damage may result	wrench, mechanical			
to work cage.	to elevator work cage	maintenance truck,			
weighs 117 lbs.,	assembly in pulling it	rope, work cage.			
above weighs	base.				

3

REVISED	DATE	FIGURE 7.3 CONT THE BOEING COMPANY SEATTLE 21 WASHINGTON	D2-15132 P 28

FUNCTION: C SUMP PUMP REMOVAL, INSTALLATION & MAINTENANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
9) Checkout the pump by returning the water from temporary storage to the sump; activate START-STOP switch if quantity of water is not sufficient to actuate float switch; observe that pump removes water from sump and place control switch in AUTO position.	Vision: to see that enough water is available and is check that water is removed from sump.	To determine water quantity is sufficient to actuate float switch.
10) If it is determined that the malfunction is in the check valve, then steps 4 through 9 (Function C) may be eliminated; turn HAND-OFF-AUTO switch for pump to OFF position and remove check valve using common hand tools.	Vision, touch: the check valve may be stuck by corrosion to its connecting pipes.	To determine function is the check valve
11) Install a new valve immediately using common hand tools, set HAND-OFF-AUTO to AUTO position.	Vision, touch: the check valve should not be over torqued.	
12) If it is determined that the liquid level float switch is malfunctioning then steps 4 through 11 (Function C) may be eliminated; place circuit breaker for pump to OFF position, disconnect electrical wire to switch, remove hardware holding switch in place and remove switch.	Vision	To determine malfunction: float switch



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERFORMANCE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
ump by returning the rary storage to the START-STOP switch water is not suffi- e float switch; ob- removes water from control switch in	Vision: to see that enough water is available and is check that water is removed from sump.	To determine if water quantity is sufficient to actuate float switch.		Voice communication between operators; SIN telephone com- munication to LCC equipment room for emergency only.	Avoid spilling water on floor of silo.
mined that the mal- the check valve, rough 9 (Function inated; turn HAND- n for pump to OFF remove check valve and tools.	Vision, touch: the check valve may be stuck by corrosion to its connecting pipes.	To determine mal- function is in the check valve.	Torque required to loosen check valve from ad- jacent fittings.		
valve immediately and tools, set to AUTO position.	Vision, touch: the check valve should not be over torqued.		Torque required to tighten valve in place.		
mined that the float switch is mal- en steps 4 through) may be eliminated; breaker for pump to disconnect electri- itch, remove hard- switch in place and	Vision	To determine if malfunction is in float switch.			Insure circuit breaker is in OFF position.

SAFETY REQUIREMENTS	PROBABLE ERROR	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
---------------------	----------------	-------------------	-------------	----	--------------------

filling water		51X0 and/or 564X0		Same	
of silo.					

HAND-OFF-AUTO switch
may not be turned to
OFF position.

Same

Same

circuit breaker OFF position.	Circuit breaker left in AUTO position.			Same	
----------------------------------	---	--	--	------	--

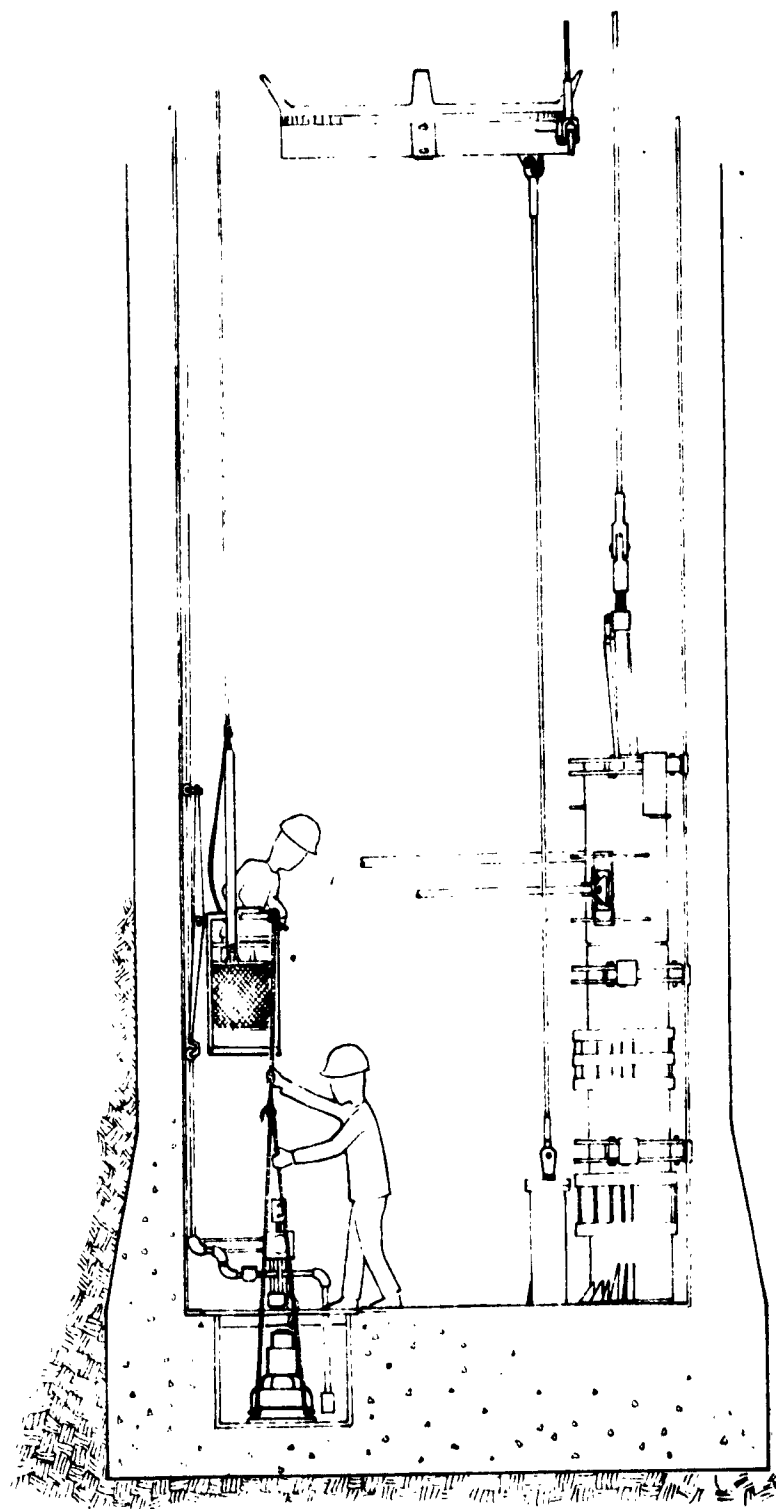
Same

3

CHK	REVISED	DATE	FIGURE 7.3 CONT
CHK			
ADD			
ADD			

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SEATTLE 21 WASHINGTON

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P 29



CALC			REVISED	DATE	FIGURE 7.3 CONT. SUMP PUMP REMOVAL OR INSTALLATION PART OF STEP 7	GER
CHECK						02-15132
APR					THE BOEING COMPANY	PAGE
APR						30

FUNCTION: C
SUMP PUMP REMOVAL,
INSTALLATION & MAINTENANCE

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

- | | | |
|--|--------------------------------------|---|
| <p>13) Position and attach a new float switch immediately after the removal of the defective switch; connect electrical wire to switch. return HAND-OFF-AUTO switch to AUTO position.</p> | <p>Vision</p> | |
| <p>14) Check out float switch by hand operation to determine if pump starts at high level and stops at low level.</p> | <p>Vision</p> | |
| <p>15) Prior to removal and replacement of various sump pump components fault isolation must taken place for a flooded sump condition by using START-STOP switch to determine that pump operates; check for electrical continuity across START-STOP switch; check for malfunction in motor starter; determine that water in sump is discharged when pump operates; see that check valves are open; check flexible hose on discharge line for leaks; check for electrical continuity across HAND-OFF-AUTO control switch; check for malfunction in high level relay switch.</p> | <p>Vision, inspection for leaks.</p> | <p>Determination of fault by isolation of components.</p> |

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

ACTION
WORK FORCE

COMMUNICATIONS
REQUIREMENTS

SAFETY
REQUIREMENTS

PROBABLE ERRORS

Vision

Voice communication
between operators;
SIM telephone com-
munication to LCC
equipment room for
emergency only.

Vision

Vision, inspec- Determination of
tion for leaks. fault by isola-
tion of compon-
ents.

Avoid standing in damp
areas of missile floor
while making electrical
tests.

Insuring that all
valves are open, n
seeing leaky condi

**PERY
REMARKS**

PROBABLE ERRORS

JOB AIDS OR TOOLS

NORMAL SILO

VS

DEEPER SILO WING V

541X0, electric lan-
tern

Same

541X0, electric lan-
tern

Same

ading in damp
missile floor
ing electrical

Insuring that all check
valves are open, not
seeing leaky condition.

542X0 or 541X0,
liquid level in-
dicator, multi-
meter, electric
lantern.

Same

3

REVISED	DATE	FIGURE 7.3 CONT THE BOEING COMPANY SEATTLE 24 WASHINGTON 02-15132 P 31

FUNCTION: C
 SUMP PUMP REMOVAL
 INSTALLATION & MAINTENANCE

PERCEPTUAL
 REQUIREMENTS

DECISION
 REQUIREMENTS

- | FUNCTION: C
SUMP PUMP REMOVAL
INSTALLATION & MAINTENANCE | PERCEPTUAL
REQUIREMENTS | DECISION
REQUIREMENTS |
|--|----------------------------|--|
| 16) Component fault isolation for a low water level condition in the sump should be accomplished by manually actuating the float switch, and testing the high level probe for a short circuit resulting in false high level indication | Vision | Determination of fault by isolation of components. |
| 17) As a result of fault isolation the various items such as the sump pump discharge hose, high level alarm probe, START-STOP switch, motor starter relay, HAND-OFF-AUTO control switch, and the high level alarm relay must be removed, repaired and/or replaced (as well as the previously mentioned pump, check valve, and float switch). | Vision, touch | |
| 18) Following repair check out must be accomplished on all items repaired (with the exception of the flexible hoses) by seeing that no high level alarm signal is generated unless water in sump is at high level; checking that START-STOP switch operates pump; checking that motor starts when HAND-OFF-AUTO switch operates properly; simulating high level in sump by applying jumper across terminals of high level probe to see that pump should start and high level alarm should come on. | Vision | |



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK { FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision	Determination of fault by isola- tion of compon- ents.		Voice communication between operators; SIN telephone com- munication to LCC equipment room for emergency only.	Avoid standing in damp areas of missile floor while making electrical tests.	
Vision, touch		Torquing required to remove and in- stall various com- ponents	Voice communication between operators; SIN telephone com- munication to LCC equipment room for emergency only.		Electrical power must be off during replacement of elec- trical components.
Vision			Voice communication between operators; SIN telephone com- munication to LCC equipment room for emergency only.		
r starts					
s					
n					
r-					
eval					

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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standing in damp		542X0 or 543X0		Same	
------------------	--	----------------	--	------	--

missile floor		multimeter			
---------------	--	------------	--	--	--

king electrical					
-----------------	--	--	--	--	--

Electrical power

must be off during

replacement of elec-

trical components.

Same

Same

3

REVISED	DATE	FIGURE 7.3 CONT.
THE BOEING COMPANY	SEATTLE 24, WASHINGTON	02-15132 P 32

FUNCTION: D
WORK CAGE UTILIZATION AT SILO BASE
(LAUNCH TUBE BASE)

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

This procedure requires three (3)
personnel - one in equipment room,
two in work cage.

1) Identical to those of step (1) of
Function "A".

2) Identical to those of step (2) of
Function "A".

3) Place tool kit in work cage. Elevator work cage * will be lowered and positioned adjacent to, e.g., azimuth drive motor and first stage gear reduction. ** Utilize work cage control pendant (P/N 25-18099-1 or P/N 25-18099-2):

Visual, tactual

Estimates required for vertical and traverse distance

a) Depress DOWN-RIGHT switch. Set cage on silo floor.

b) Depress TRAVERSE and DOWN-RIGHT switches.

4) *** Wings I through V require two personnel in work cage. Man #1 leaves work cage for floor of silo. Man #2 remains in work cage.

Visual, tactual

Equipment room personnel: estimate required of adequacy of sling application; accuracy of sling to hoist attachment; speed of lowering.

1

* Procedures for entering work cage, precautions to be observed, detailed in It is anticipated that no maintenance will be required on this unit up to 4 If maintenance should be required beyond the motor and first stage reduction including base support ring will require removal. (This would necessitate The weight of this combined unit (Azimuth drive motor, first and downstage base support ring) is 7000 pounds, and would require a crane 1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK, FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Visual, tactual	Estimates required for vertical and traverse distances.	Digital pressure; minimal	Communication may be required with personnel in equipment room (voice), or via telephone with maintenance support vehicle, SM80A, SM80B.		Over/under estimate of vertical/traverse distance; press wrong button. Failure to utilize safety lanyard. Failure to take tool kit.
Visual, tactual	Equipment room personnel: estimate required of adequacy of sling application; accuracy of sling to hoist attachment; speed of lowering.	Attachment of sling to ladder; attachment of package to hoist operation of hoist.	With equipment room (voice)	Accuracy in attachment of package to sling and hoist. Safety belt for use on ladder.	Slipping or falling off ladder through error in attachment of sling or hoist. Failure to utilize safety belt.

Precautions to be observed, detailed in T.O. SM80A-2-10 will be required on this unit up to a period of three years. Beyond the motor and first stage reduction gear, the complete unit, wire removal. (This would necessitate removal of the missile) smooth drive motor, first and downstage gear reduction, 200 pounds, and would require a crane for removal.

***Step 4 and 5A apply to Wings I through V, regular silo; step 5B applies to Wing V deeper silo only.

REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
--------------	-----------------	-------------------	-------------	----	--------------------

Over/under estimate of vertical/traverse distance; press wrong button. Failure to utilize safety lanyard. Failure to take tool kit.

Standard tool kit for work cage. Torque wrench may be required; information not available.

Ability to estimate spatial relationships.

Provide 10 feet more cable on drum according to RCP 539R1. Power and communications cables must have same requirement for additional length.

Key in attachment of package to hoist and hoist. Key belt for use on ladder.

Slipping or falling off ladder through error in attachment of sling or hoist. Failure to utilize safety belt.

Hoist, sling, tagging, safety belt.

Consistent observance of task requirements.

3

Wings I through 5B applies to y.

REVISED	DATE	FIGURE 7.4 WORK CAGE AT SILO BASE THE BOEING COMPANY SEATTLE 21 WASHINGTON	02-15132 P 33

FUNCTION: D
WORK CAGE UTILIZATION AT SILO BASE
(LAUNCH TUBE BASE)

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

5A) Where azimuth drive motor requires removal, procedure would require two men as follows: Man #1 - position 12-foot ladder under motor. Wear safety belt on mounting ladder. Man #2 - depress UP-LEFT switch and ascend approximately 30 feet. Depress TRAVERSE and DOWN-RIGHT buttons for vertical alignment of work cage with motor. Man #3 - use sling to fasten hoist lugs on motor to hoist ring on elevator work cage.	Visual, tactual	Placement of ladder for maximum efficiency during operation. Determine alignment of sling fasten-
5B) a. Equipment room personnel will disconnect all power to work cage at instigation of personnel at silo base.	Visual, tactual	Silo base personnel will determine if cage is resting on silo floor.
b. Personnel at base of silo will communicate with equipment room personnel to assure power has been disconnected.	Auditory	
c. Personnel (silo base) will attach a tagline to hoist on work cage.	Tactual	Determine adequacy of tagline attachment and point of attachment.
d. Personnel (silo base) will then disconnect hoist cable and power and communication cable	tactual, kinesthetic	Minimal

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Visual, tactual	Placement of ladder for maximum efficiency during operation. Determine alignment. Determine adequacy of sling fastening.	Placement of ladder; attachment of hoist. Depress controls.	Voice communication between two personnel at base of silo. Possible requirement for voice communication with personnel in equipment room.	Adequate caution in use of ladder and care in attachment of hoist and sling.	Careless use of inadequate caution in attachment of all and safety belt. to wear safety belt work cage or on
Visual, tactual	Silo base personnel will determine work cage is resting on silo floor.	Pull circuit breakers.	Receive message (voice) that work cage is resting on silo floor.	None	No circuit breakers pulled; wrong circuit breakers pulled.
Auditory		Communicate with personnel in equipment room; receive confirmation of power disconnect.	Send and receive (See Action column).	None	Garbled communications.
Tactual	Determine adequacy of tagline attachment and point of attachment.	Attach tagline to hoist cable.	None	None	Inadequate attachment; cable length would be insufficient for manipulation.
tactual, kinesthetic	Minimal	Hoist: remove hook. Power & communications; wrist rotation, abduction.	None	Must have received incontrovertible evidence of power disconnect.	Bend or break connector pins on disconnect.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

W AT SILO BASE (BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
ive motor requires re would require ws: Man #1 - position nder motor. Wear ounting ladder. UP-LEFT switch and tely 30 feet. De- nd DOWN-RIGHT buttons gment of work cage #3 - use sling to s on motor to hoist work cage.	Visual, tactual	Placement of lad- der for maximum efficiency during operation. De- termine alignment. Determine adequacy of sling fastening.	Placement of ladder; attachment of hoist. Depress controls.	Voice communication between two personnel at base of silo. Possible requirement for voice communica- tion with personnel in equipment room.	Adequate caution in use of ladder and care in attachment of hoist and sling.
m personnel will l power to work gation of per- o base. base of silo will ith equipment l to assure power onnected.	Visual, tactual	Silo base personnel will determine work cage is resting on silo floor.	Pull circuit breakers.	Receive message (voice) that work cage is resting on silo floor.	None
lo base) will ine to hoist on	Auditory		Communicate with personnel in equip- ment room; receive confirmation of power disconnect.	Send and receive (See Action col- umn).	None
lo base) will ct hoist cable ommunication	Tactual	Determine adequacy of tagline attach- ment and point of attachment.	Attach tagline to hoist cable.	None	None
	tactual, kinesthetic	Minimal	Hoist: remove hook. Power & communications; wrist rotation, abduction.	None	Must have received incontrovertible evi- dence of power dis- connect.

FUNCTION D
WORK CAGE UTILIZATION AT SILO BASE
(LAUNCH TUBE BASE)

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

5B) Continued

e. Personnel will remove tool kit and items of excessive weight from work cage, and manually maneuver cage into position immediately below azimuth drive motor. Replace tool kit, etc.	Visual, tactual, kinesthetic	Approximate alignment of cage with motor.
f. Equipment room personnel will attach line to traversing motor, and utilize this line to pull work cage traverse motor until it is in vertical alignment with work cage, immediately above azimuth drive motor.	Visual, tactual	Approximate alignment of traversing motor with work cage.
g. Personnel at silo base will reconnect hoist and power and communications cables.	Visual, tactual	Evaluation of connect operation
h. Inform equipment room personnel of connection. Equipment room personnel reconnect power.	Equipment room personnel: auditory, tactual	
i. Enter work cage and attach safety belt, depress UP-LEFT switch and hold until maximum ascent is achieved. Fasten sling to hoist lugs on motor and to hoist ring on work cage.	Visual, tactual	Maximal height



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK : FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Visual, tactual, kinesthetic	Approximate alignment of cage with motor.	Remove excess items from work cage. Move cage manually.			Drop items being moved from cage. alignment of cage motor.
Visual, tactual	Approximate alignment of traverse motor with work cage.	Attach line; pull motor to desired position.	Possible check with personnel below.		Line not adequately attached; misalign
Visual, tactual	Evaluation of connect operation.	Hoist: insert hook; power and communication: push connector parts together; rotate knurled nut to complete connection.			Bend or break connector pins; fail connect hook.
Equipment room personnel: auditory, tactual		Connect power.	Receive		Garbled communication; failure to connect power.
Visual, tactual	Maximal height.	Depress button.		Requirement for wearing safety belt.	Press wrong button Failure to wear safety belts.

SAFETY ELEMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
	Drop items being removed from cage. Misalignment of cage with motor.		Not applicable		Spatial relationships (alignment)
	Line not adequately attached; misalignment.	Tagline	Not applicable		Spatial relationships (alignment)
	Bend or break connector pins; fail to connect hook.	Torque wrench	Not applicable		Care in connection of electrical connector.
	Garbled communication; failure to connect power.		Not applicable		None
Failure for wearing belt.	Press wrong button. Failure to wear safety belts.	Safety belt (standard for work cage).	Not applicable		Spatial relationships

3

CHK	REVISED	DATE	FIGURE 7.4 CONT.
CHK			
CHK			
APD			
ALL			
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TASK ANALYSES OF OPERATIONS

FUNCTION: D WORK CAGE UTILIZATION AT SILO BASE (LAUNCH TUBE BASE)	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
6) Loosen and remove bolts fastening azimuth drive motor and first stage gear reduction to base support ring. Base motor into suspended position. Stow all nuts, bolts, etc., in pouch.	Visual, tactual, kinesthetic.	Point of operation at which motor requires support.
7A) Ladder is hoisted. Procedure is reverse of step number 4 (Function D). Two men ascend in work cage.		
7B) Personnel in work cage will depress DOWN-RIGHT switch and bring work cage to rest on silo floor. Steps detailed under 5B (Function D) will be performed in reverse order.		
8) Lowering of azimuth drive motor will be the reverse of raising.		
9) Replacing of azimuth drive motor will be reverse of removal.		
10) Check azimuth drive motor by performing steps 1 through 3, inclusive, of para. 5, page 11, D2-14702.	Visual, tactual	Evaluate mechanical response; follow sequence; Time estimate (minimal)

* Step 7A applies to Wings I through V, regular silo; step 7B applies to Wing V deeper silo.



SAFETY ELEMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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ladder while motor. Safety	Lack of care in dis- mounting motor. Fail- ure to wear safety belt.	Hoist, sling, ta- line, ladder, wrench, safety belt.			
-------------------------------	---	--	--	--	--

Activate wrong control.	Possible torque
Inadequate adapter ring	wrench; information
look down, incomplete	not available.
connection of cables.	
Failure to close circuit	
breaker.	

3

Ca			REVISED	DATE	FIGURE 7.4 CONT	
Des						
CHK						
App						
Auth						
THE BOEING COMPANY SEATTLE 24 WASHINGTON						02-15132 P 36

FUNCTION: E
INSTALLATION & MAINTENANCE OF SIM
INTER-COMMUNICATIONS JACK BOX

PERCEPTUAL REQUIREMENTS

DECISION REQUIREMENTS

- 1) Operator utilizes work cage to Vision and touch Must maintain hc
install extension cable to SIM alignment to sui
inter-communication Jack Box. clamp holes.

- 2) Install SIM inter-communication Vision and touch J-Box to silo wall using four phillips head screws.

- 3) Remove cover and wire box (4 Vision and touch Which wires go
slotted head screws required). where. Highly
critical opera-
tion. If not
correct, commun-
ication will not
exist.

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision and touch	Must maintain hole alignment to suit clamp holes.	Two holes must be drilled into concrete at approx. 14 inch intervals.	If SIM communication is considered necessary at the operational site.	Safety lanyard must be connected to ring.	Difficult to align holes when working from a moving platform.
Vision and touch					
Vision and touch	Which wires go where. Highly critical operation. If not correct, communication will not exist.	Maintenance is reversed of steps 2 and 3 (Function E)	Oral communication between operators.	Electrical power should be disconnected.	Color coding on wires.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK / FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
Vision, touch	Must maintain hole alignment to suit clamp holes.	Four holes must be drilled into concrete.	Oral communication between operators.	Safety lanyard must be connected, work cage yoke ring.	Difficult to maintain hole alignment when working from a moving platform.
Vision, touch	Which wires go where?	For maintenance remove faulty transducer and replace.	Oral communication		Color coding on wires

SAFETY PRESENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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Lanyard must be attached to work cage at all times. Color coding on wire.	Difficult to maintain hole alignment when working from a moving platform.	Star drill, hammer and screw driver. Wire strippers, open end wrench.			Transducer is 14 feet from silo floor rather than 6 feet.
---	--	---	--	--	--

3

FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
1) Descend in properly prepared work cage to a point opposite missile tie-point junction box on silo wall. Attach earth ground cable to grounding strap on outside of missile support ring adapter and to connector lugs in tie-point junction box.	Vision, touch	Has a proper ground contact been established? Do I know proper attach points?
2) Attach missile skirt grounding strap to grounding clip on inside of missile support ring.	Vision, touch	Has a proper ground contact been established? Do I know proper attach points?
3) Install hoist support hook on receive ring and missile base support ring.	Vision, touch	Is hoist support hook flush with receiver ring missile base support ring.
4) Hand torque adjustment nut to maximum possible torque to insure adequate preloading.	Vision, touch. A great variance may exist between hand torque ability of various air men. An adjustment nut torque study should be made to ascertain required torque and 5th to 95th percentile man adequacy.	Is this force sufficient to meet requirements of the T.O.?

* Function G is to be reversed for Missile Preparation for Emplacement

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
ie- d- up-	Vision, touch Has a proper earth ground contact been established? Do I know proper attach points?	Manual connection of earth ground cable.	Telephone with micro- phone headset.	Protective head gear worn. Safety lanyard attached to work cage ring. Safety shoes.	Poor ground attach- made.
	Vision, touch Has a proper earth ground contact been established? Do I know proper attach points?	Manual connection of earth ground cable.	Telephone with micro- phone headset.		Poor ground attach- made.
	Vision, touch Is hoist support hook flush with receiver ring and missile base sup- port ring.	Manual manipula- tion of hoist support hook.	Telephone with micro- phone headset.		If hoist support h is properly seated error possible.
	Vision, touch. A great variance may exist be- tween hand torque ability of vari- ous air men. An adjustment nut torque study should be made to ascertain required torque and 5th to 95th percentile man adequacy.	Is this force sufficient to meet requirements of the T.O.?	Hand torque ad- justment nut..	Telephone with micro- phone headset.	Loose adjustment n

Missile Preparation for Replacement

DATA SHEET

2

FUNCTION: 6
PREPARATION & REMOVAL OF MISSILE

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

- | | | |
|--|---------------|-----------------|
| 5) Attach hoist chain to hoist support hook. | Vision, touch | Is it attached? |
|--|---------------|-----------------|

CAUTION: Use extreme care when handling missile skirt umbilical cable head in steps 6 through 14. Cable head contains shear pins which may be sheared if cable head is bumped, pulled or otherwise mishandled.

- | | | |
|--|----------------------------------|------------------------------------|
| 6) Position lower cable grip around missile skirt umbilical cable with cable grip lanyards up. | Vision touch, good illumination. | Insure cable positioned correctly. |
|--|----------------------------------|------------------------------------|

- | | | |
|---|---------------|--|
| 7) With rawhide lace, lace from top down in a criss cross pattern through approximately every third loop and secure rawhide lace with a square knot. Distance between umbilical head lanyards and cable grip lanyard should be approximately four feet. | Vision, touch | Insure that distance is approximately four feet. |
|---|---------------|--|

- | | | |
|--|---------------|--|
| 8) Extend chain hoist and attach hook to lanyards. | Vision, touch | |
|--|---------------|--|

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
rt Vision, touch	Is it attached?	Manual connection	Telephone with micro- phone headset.	Protective head gear worn. Safety lanyard attached to work cage ring. Safety shoes.	No probable error
ag missile through 14. may be sheared herwise mis-					
h Vision touch, good illumina- tion.	Insure cable po- sitioned correct- ly.	Manual manipu- lation.			See Caution Note p ceding Step 6.
Vision, touch	Insure that dis- tance is approxi- mately four feet.	Manual manipu- lation.			See Caution Note p ceding Step 6.
ce-					
ok Vision, touch		Manual manipu- lation.			See Caution Note p ceding Step 6.

FUNCTION: 0

PREPARATION & REMOVAL OF MISSILE

PERCEPTUAL
REQUIREMENTSDECISION
REQUIREMENTS

- 9) Operate chain hoist until weight of umbilical is on hoist. Vision, touch Insure that weight is on hoist. good illumination bilical weight is on hoist.
- * 10) Loosen two bolts attaching umbilical clamp halves to clamp bracket and loosen clamp bracket bolts. Vision, touch Bolts are looser good illumination
- 11) Loosen bolt and swing clamp clear of missile skirt umbilical. Vision, touch Clamp is clear good illumination of umbilical
- 12) Remove bolts and remove umbilical head lanyards from bolts; reinstall bolts. Vision, touch Recheck to be sure bolts are good illumination sure bolts are reinstalled.
- 13) Remove umbilical head threaded receptacle from raceway cable connector with strap wrench. Vision, touch Are threads good illumination stripped?
- 14) Lower umbilical cable with chain hoist until protective cap can be installed. Install cap. Vision, touch good illumination
- 15) Lower umbilical cable until clear of missile base support and disconnect cable grip lanyards from chain hoist hook. Vision, touch good illumination

NOTE: Lower cable grip assembly/shall remain secured to skirt umbilical cable until skirt umbilical is reinstalled.

* When missile skirt umbilical cable requires maintenance, steps 10 through 13 should be included in umbilical cable Remove/Replace procedure.

1

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
f Vision, touch good illumination	Insure that umbilical weight is on hoist.		Telephone with micro- phone headset.	Protective head gear worn. Safety lanyard attached to work cage ring. Safety shoes.	See Caution Note pre- ceding Step 6
Vision, touch good illumination	Bolts are loosened	Manual and mechan- ical manipulation			
Vision, touch good illumination of umbilical	Clamp is clear	Manual and mechan- ical manipulation			
Vision, touch good illumination	Recheck to be sure bolts are reinstalled.	Manual manipulation			
Vision, touch good illumination	Are threads stripped?	Manual manipulation			
Vision, touch good illumination		Manual manipulation			Cap is loose
Vision, touch good illumination		Manual manipulation			

shall remain secured to
umbilical is reinstalled.

requires maintenance steps 10
umbilical cable Remove/Replace procedures.

DATA SHEET

2

REMARKS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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re head gear	See Caution Note pre-	Manual-visual coordi-		Same	
safety lanyard	ceding Step 6	nation			
to work cage					
safety shoes.					

Same

Same

Cap is loose

3

Ch		REVISED	DATE	FIGURE 7.7 CONT	D2-15132 12 41
Trn					
Chk					
App					
App					
THE BOEING COMPANY SEATTLE 24 WASHINGTON					

FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
16) Remove chain hoist from hoist support hook and remove hook from receiver ring and missile base support.	Vision, touch, good illumination	
17) Swing umbilical clamp-half into place and tighten clamp-half bolt. Tighten clamp bracket bdts.		
18) Operate power azimuth drive controller, visually positioning missile raceway halfway between support arms 1 and 2.		Try to get as close to center as possible.
19) Align center or receiver ring ear that is nearest arm 1 with centerline of arm 1 within $\pm$ one-half inch.		Is tolerance within $\pm \frac{1}{2}$ inch.
20) Return to base of missile and verify step 19. If ear is not centered, rotate missile as necessary.		Is tolerance within $\pm \frac{1}{2}$ inch.
21) Position adapter ring to missile skirt clamps set. Bolts attaching missile skirt to missile support ring adapter should be hand tightened.		Attachment has been made as bolts only tight.

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERRORS
up- Vision, touch, re- good illumination support.		Manual manipula- tion	Telephone with micro- phone headset.	Safety shoes, hat and lanyards.	
olt.		Manual manipula- tion.			
a- n	Try to get as close to center as possible.	Manual manipula- tion and visual judgment			Error in visual ment would require more time on step 19 and 20.
ear ter- f	Is tolerance within $\pm \frac{1}{2}$ in.	Fine manual mani- pulation			Won't be within ance necessary in Step 20.
	Is tolerance within $\pm \frac{1}{2}$ in.	Manual-visual manipulation			Judgment error
le hing art ght-	Attachment has been made and bolts only hand tight.	Manual manipula- tion			

SAFETY ELEMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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r shoes, hat yards.		High manual-visual			
		coordination, plus			
		Step 1 of this Function			

Error in visual judgment would require more time on steps 19 and 20.

Won't be within tolerance necessary in Step 20.

Judgment error

3

CHK	REVISED	DATE	FIGURE 7.7 CON'T.
CHK			
ADD			
ADD			
THE BOEING COMPANY SEATTLE 24 WASHINGTON			D2-15132 42

FUNCTION: G PREPARATION & REMOVAL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS
22) Torque 16 clamp set bolts to 1200 (+ 50) inch pounds	Vision, touch, good lighting	Torquing is co rect and torqu wrench is with calibration da
23) Adjust each positioning post to fixed position by removing adjust- ment nut lockpin and turning adjust- ment until positioning pin can be installed in positioning post. In- stall positioning pin.	Vision, touch, good lighting	Alignment is correct
24) Install adjustment nut lockpin and remove positioning pin from position- ing post.	Vision, touch, good lighting	Alignment is correct
25) Feed quick release pin and posi- tioning pin on positioning post down through mounting bracket on missile support ring adapter.	Vision, touch, good lighting	Alignment is correct
26) Continue feeding positioning post until quick release pin hole in positioning post aligns with hole on side of mounting bracket. In- stall quick release pin.	Vision, touch, good lighting	Alignment is correct

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT SLEEPER SILO - WING V

	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
00	Vision, touch, good lighting	Torquing is cor- rect and torque wrench is within calibration date.	Manual Manipula- tion	Telephone with micro- phone headset.	Safety hat	Torque error
st-	Vision, touch, good lighting	Alignment is correct	Manual manipula- tion	Telephone with micro- phone headset.	Safety hat	
Just-						
be						
In-						
and	Vision, touch, good lighting	Alignment is correct	Manual manipula- tion	Telephone with micro- phone headset	Safety hat	
ition-						
-	Vision, touch, good lighting	Alignment is correct	Manual manipula- tion	Telephone with micro- phone headset.	Safety hat	
n						
st	Vision, touch, good lighting	Alignment is correct	Manual manipula- tion	Telephone with micro- phone headset.	Safety hat	
le						
n-						

SAFETY REQUIREMENTS	PROBABLE ERRORS	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
hat	Torque error	Mechanical visual- manual			Same
hat					Same
hat					Same
hat					Same
hat					Same

3

Chg		REVISED	DATE	FIGURE 7.7 CONT THE BOEING COMPANY SEATTLE 21 WASHINGTON	D2-15132 P 43
Trk					
Chr					
Appr					
Appr					

FUNCTION: G
PREPARATION & REMOVAL OF MISSILE

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

- 27) After pre-removal operation at top of silo have been completed, an observer will be slotted in launcher-equipment room. Headset communications will be established between this observer and operator of hoist rods (at ground level) in order to inform operator of clearances at silo base.
- 28) Attach hoist sling rods to mating missile support ring adapter fittings as follows:
- a) Take missile grounding cable from T-E support truck and lower all but 5 feet into the launch tube.
 - b) After lowering work cage to missile base, attach end of grounding cable to missile support ring adapter.
 - c) Stow permanent cable in work cage.
 - d) Remove sling rod ends covers and stow in work cage.
 - e) Insure that hoist sling rods have been lowered sufficiently for proper alignment of bolt holes in mating fittings of sling rods and support ring adapter. If sling rods will not mate it will be necessary to open control panel and depress LOWER button until sling rod fittings can be connected to the support ring adapter fitting.
- Proper lighting, vision, touch, audio.
- Judgment of clearance
- Are sling rod ends in good condition before attachment?
- Is proper earth ground established at both upper area and missile support ring.
- To tie articles down in work cage. Are bolt holes clear of dirt and not damaged? Is alignment correct for connection?



TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Proper lighting, vision, touch, audio.	Judgment of clearance	Establish communi- cations	Telephone with micro- phone headset.	Protective head gear Safety lanyards while in work cage. Are hoist cables taut and free from all encumbrances? Have any objects fallen from T-E which must be retrieved?	Faulted hoisting gear Damaged hoist rod en Frayed hoist cables not noticed?
Proper lighting, vision, touch, audio	Are sling rod ends in good con- dition before attachment?	Attach rod ends.	Telephone with micro- phone headset.		
	Is proper earth ground established at both upper silo area and missile support ring.	Make earth ground attachment.			Not attached correc- ly.
	To tie articles down in work cage. Are bolt holes clear of dirt and not damaged? Is alignment correct for connection?				Trouble with con- nection.

DATA SHEET

2

SAFETY ELEMENTS

PROBABLE ERROR

JOB AIDS OR TOOLS

NORMAL SILO

VS

DEEPER SILO WING V

re head gear

Faulted hoisting gear. Tool kit, technical

Same

yards while in

Damaged hoist rod ends. manual, sling rod

Are hoist

Prayed hoist cables

and covers for en-

out and free

not noticed?

placement.

encumbrances?

objects fallen

which must be

1?

Not attached correctly.

Trouble with connection.

3

Chk		REVISED		DATE	
Trk					
CHK					
ALD					
ASD					

FIGURE 7.7 CONT.

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SEATTLE 24, WASHINGTON

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FUNCTION: C
PREPARATION & REMOVAL OF MISSILE

PERCEPTUAL
REQUIREMENTS

DECISION
REQUIREMENTS

28) Continued

f. Remove sling rod mounting bolts and position sling rod fittings in respective fittings on missile support ring adapter.

g. Install mounting bolts attaching sling rods to ring adapter.

h. Tighten mounting bolts and install cotter pins.

Are bolts tight

i. Disengage adapter ring lock downs by pulling handle out as far as possible and rotating 45 degrees from vertical in either direction. Handle must always be above gear teeth on receiver ring.

Is handle out as far as possible
Is handle above gear teeth?

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

AL OF MISSILE	PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK OF FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS
g rod mounting bolts	Vision, touch		Manual-mechani-	Telephone with micro-	Safety hat and shoes
on sling rod fittings			cal manipulation	phone headset.	
ve fittings on mis-					
t ring adapter.					
unting bolts attach-					
ods to ring adapter.					
unting bolts and in-		Are bolts tight			
or pins.					
adapter ring lock		Is handle out			
ulling handle out as		as far as possible?			
ible and rotating		Is handle above			
from vertical in		gear teeth?			
ection. Handle must					
bove gear teeth on					
ng.					

TASK ANALYSES OF OPERATIONS ASSOCIATED WITH A 10-FOOT DEEPER SILO - WING V

PERCEPTUAL REQUIREMENTS	DECISION REQUIREMENTS	ACTION WORK OF FORCE	COMMUNICATIONS REQUIREMENTS	SAFETY REQUIREMENTS	PROBABLE ERROR
Vision, touch		Manual-mechanical manipulation	Telephone with microphone headset.	Safety hat and shoes	
	Are bolts tight				
	Is handle out as far as possible?				
	Is handle above gear teeth?				

FEET REMENTS	PROBABLE ERROR	JOB AIDS OR TOOLS	NORMAL SILO	VS	DEEPER SILO WING V
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at and shoes		Mechanical visual- manual		Same	
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Rev		REVISED		DATE		FIGURE 7.7 CONT. THE BOEING COMPANY SEATTLE 21 WASHINGTON	102-15132 245
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8.0 ACO EFFECTS

8.1 ACO 216 FIXTURE, MISSILE SUSPENSION SYSTEM LOADING

8.1.1 Figure 8.1 depicts the new configuration required to make ACO 216 compatible with the deeper launch tube. The required revision consists of adding an additional rod and turnbuckle section to the existing linkage. Specific changes are:

- (a) Two new linkage rods (each approximately 5 feet in length)
- (b) Two additional ME 25-26222-213 turnbuckles
- (c) New pallet or box to hold rods and turnbuckles
- (d) Reworked shipping fixture to hold pallet or box. Fixture will employ brackets to assist the assembly of sections prior to installing tool in launcher.

8.1.2 Change will be accomplished under RCP 559. Wing V A & CO requirements document will include this change in the basis release. A new ACO number (ACO 216.5) is recommended.

8.2 ACO 215 FIXTURE - HOLE LOCATING, MISSILE SUSPENSION SYSTEM SPRING CAN

8.2.1 Figure 8.2 depicts the new configuration required for ACO 215 targets. An additional circle has been added to the target to measure tolerance.

8.2.2 The change is necessary because the deeper launcher caused an increase in the missile suspension pulley bracket out-of-tolerance requirement. This requirement is measured by dropping plumbobs from the pulley brackets to the targets on ACO 215.

8.2.3 Change will be accomplished under RCP 559. A new ACO number (ACO 215.5) is recommended.

8.3 NO OTHER ACO ITEMS ARE AFFECTED.

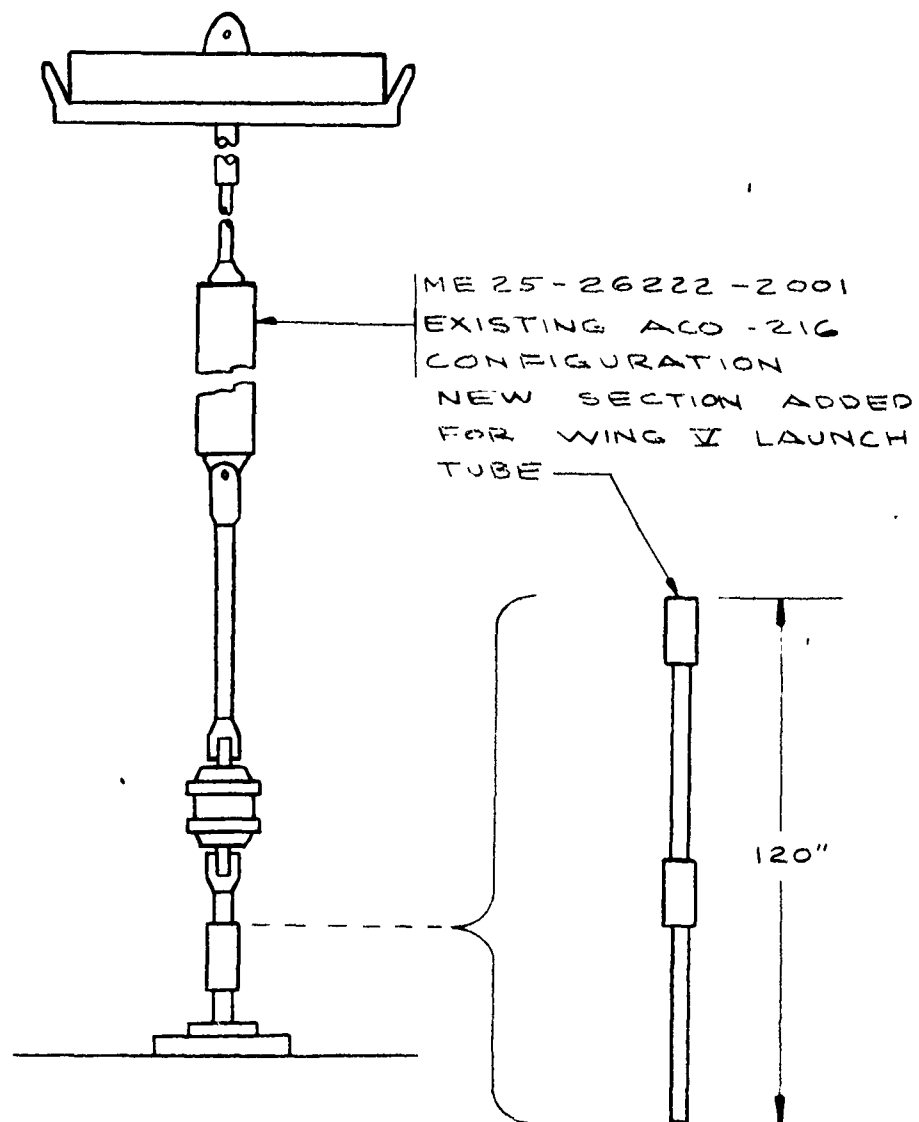


FIG 8.1 -ACO 216 REVISION



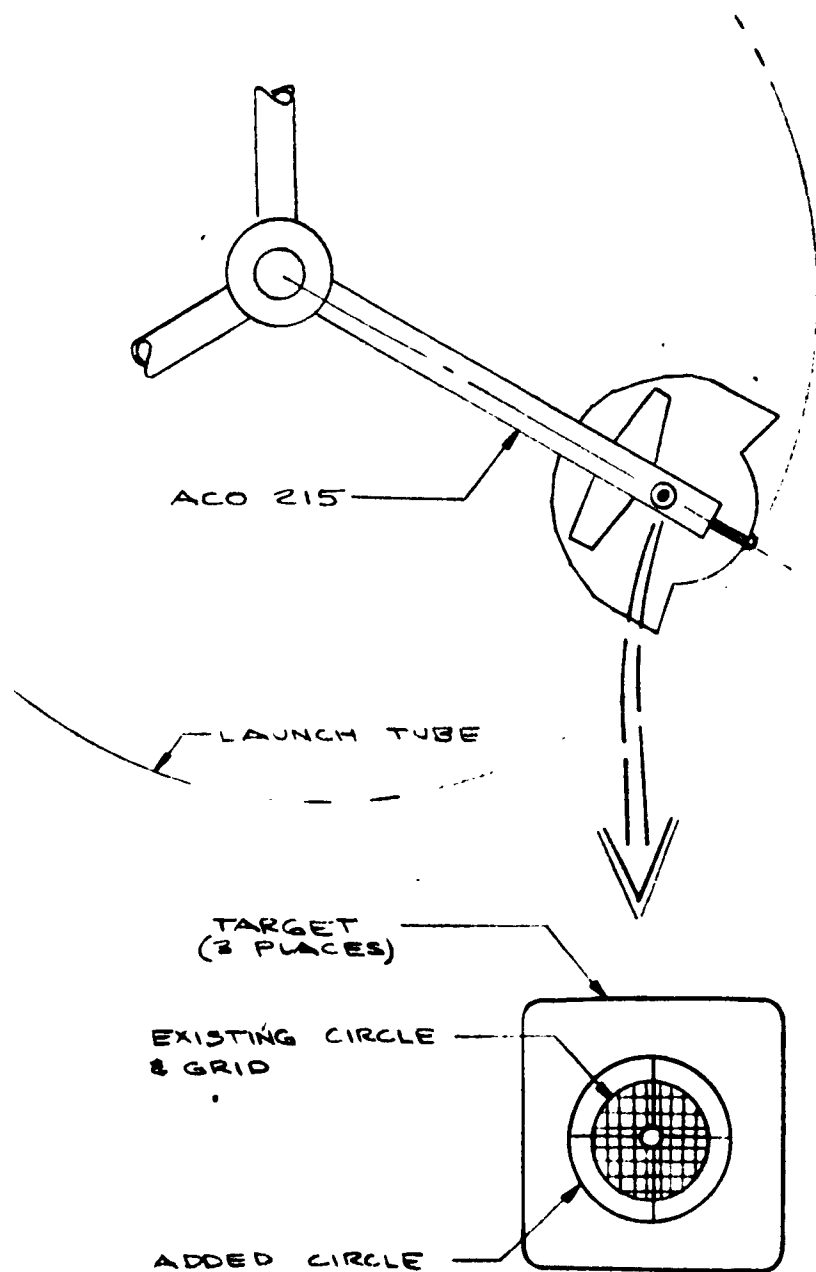


FIG 8.2 - ACO 215 REVISION



9.0 TEST PROGRAM

9.1 Wing V testing will be required. At least one missile launch from a 90 foot deep launcher is recommended. This is necessary to verify the revised missile mount as well as to verify missile fly-out. Preliminary coordination for a Wing V test program has been conducted. (Reference: Telecon Severide/BSD Col. Stuber, 5-21-63).

NOTE: No special testing is authorized at STP III, AMR or VAFB under the scope of this study document and STL Document 6660.42-31 dated 3 January 1963.

9.1.1 The results of this study indicate that no large scale R & D test program is necessary to obtain data on the Wing V changes. It is therefore not necessary to bring STP III or AMR to a "Wing V" configuration solely as a result of the deeper launcher.

9.1.2 Verification testing at VAFB is necessary to demonstrate the validity of the analyses. This test program should consist of one or more firings, with the following specific objectives:

- (a) Demonstrate the systems capability and adequacy of the Wing V ten-foot deeper launcher configuration, including facilities, equipment, and technical manuals.
- (b) Demonstrate by the successful launch of a missile, that the Wing V configuration launcher does not produce gas dynamic effects deleterious to the missile or mission.
- (c) Demonstrate by the successful launch of a missile, that the Wing V configuration of the Support, Missile Suspension, Figure A 1322.5, operates satisfactorily during launch.
- (d) Demonstrate that the personnel subsystem including QCPRI, training, technical data, and human engineering can provide the human performance required by the Wing V configuration.

9.2 Launch Facility #7 (0000008) at VAFB is constructed to the Wing V 90-foot depth, however, as shown in Figure 4.1, a steel platform is installed ten feet above the

bottom of the launcher to provide a Wing III configuration. The facility will have to be modified to the Wing V configuration to support testing of the Wing V system.

9.3

The proposed LF #8 at VAFB (See Figure 4.1) would not be available early enough to support Wing V testing. Firings should be scheduled as early in the program as possible to allow time for fixes of any problems that occur.

