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ENVIRONMENTAL TESTS ON WS133B TECHNICAL FACILITIES PERSONNEL ACCESS HATCH

Frank T. Krek

TECHNICAL REPORT NO. AFSWC-TR-65-3

AIR FORCE SPECIAL WEAPONS CENTER
Air Force Systems Command
Kirtland Air Force Base
New Mexico

January 1966

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FOREWORD

This research was prepared under Program Element 1.10.15.01.4, Project 133A1. Inclusive dates of research were February 1965 through April 1965. The report was submitted 19 November by the AFSWC Project Officer, Frank T. Krek (SWTT).

This technical report has been reviewed and is approved.

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ABSTRACT

Testing of the WS133B, Minuteman, Personnel Access Hatch was performed by AFSWC at the request of BSD. The purpose of this test program was to measure the operating characteristics and to evaluate the performance of one Minuteman Wing VI personnel access hatch when exposed to extreme environmental conditions. The environmental tests were performed in accordance with MIL-E-4970A, as modified to comply with BSD requirements and included high temperature, low temperature, ice, rain, and exposure to sand and dust. Test results, notations of observations made during testing, and other pertinent test data are presented.

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SECTION I

INTRODUCTION

1. Purpose

The purpose of this test program was to measure the operating characteristics and to evaluate the performance of one Minuteman Wing VI personnel access hatch when exposed to the environmental conditions specified in the Test Plan (Ref. 1). Testing was conducted at AFSWC, Kirtland Air Force Base, New Mexico, from 23 February 1965 to 2 April 1965. Environmental tests were performed in accordance with MIL-E-4970A (Ref. 2) as modified to comply with BSD Exhibit 62-51 (Ref. 3). The Ralph M. Parsons Company represented BSD as the Test Director (Ref. 4).

2. Scope

The scope of this test program included procurement of a Minuteman Wing VI access hatch and security pit, construction of a test fixture to support the test item in the operational configuration, validation in accordance with the Wing VI validation procedure, and environmental testing as follows:

a. High temperature (150 degrees F).

b. Low temperature (minus 40 degrees F).

c. Ice (1/2 inch thick at 0 degrees F).

d. Rain (2 hours at ' inches per hour).

e. Sand and dust.

SECTION II

TEST SPECIMEN

The test speciman was obtained from the contractor at Minuteman Wing VI through Site Activation Task Force. The specimen consisted of one Launch Facility Personnel Access Hatch Assembly complete with security pit, mechanical locking device and access hatch actuator. Finned O-rings and electromagnetic (EM) shield gaskets, used with the main hatch cover, were obtained directly from the manufacturers of these items. A test fixture was constructed for the hatch assembly such that the concrete surface surrounding the access hatch and security pit contoured in accordance with the field installation. The test fixture assembly, before pouring concrete, is shown in figure 1. The completed fixture is shown in figure 2.

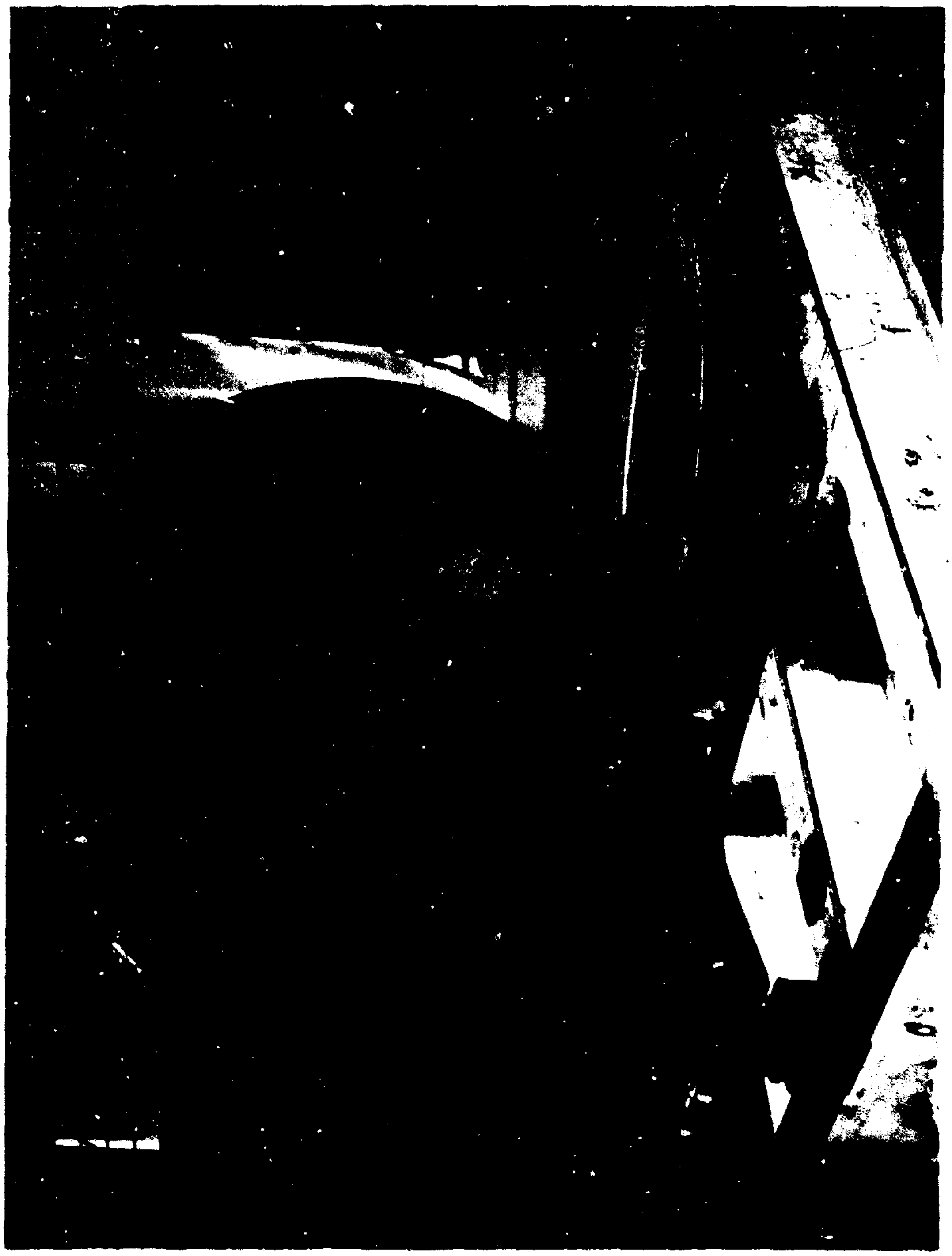


Figure 1. Test Fixture Without Concrete

Figure 2. Test Fixture

SECTION III

ENVIRONMENTAL TEST PROCEDURE

1. High-Temperature Tests

The following procedures were performed to conduct the high temperature tests:

a. Environmental Chamber. A 16-foot by 16-foot by 16-foot environmental chamber was provided to enclose the hatch assembly. The chamber was constructed of 8-foot by 16-foot insulating panels which were 4 inches thick.

b. Temperature Control Unit. A Conrad Mobile Unit, Conrad Model No. WD-25600-50-25T was provided for producing environmental temperature and humidity conditions. The unit is capable of producing specimen or chamber conditions ranging from +160°F to -80°F with a maximum relative humidity of 95 percent within the chamber. Temperatures at eleven points on the specimen as well as the wet-bulb and dry-bulb thermocouple temperatures were monitored and recorded on a Minneapolis-Honeywell Brown multipoint recorder for both the high-temperature, low-temperature and ice tests.

c. The test item was placed in the environmental chamber and eleven specimen thermocouples, a dry-bulb thermocouple, and a wet-bulb thermocouple were installed as shown in figure 3.

d. The Conrad Mobile Temperature Unit was connected to the chamber and the chamber was heated so that the rate of temperature rise of the test specimen would not exceed a rate of 15°F per hour. The dry- and wet-bulb temperatures were closely monitored in order to maintain the maximum permissible relative humidity of 15 percent.

e. After reaching the desired temperature of 150°F, the test specimen was maintained at this temperature for a period of 8 hours.

f. With the test specimen at 150°F, the operating torque of the locking device pin was measured using a calibrated spring scale, on a 3 1/2-inch lever arm attached to the operating handle as shown in figure 4.

g. With the test temperature maintained at 150°F, the operating torque required to open and close the main access hatch was measured with a calibrated 0 to 600 inch pound capacity torque wrench applied to the input shaft of the actuator as shown in figure 5.

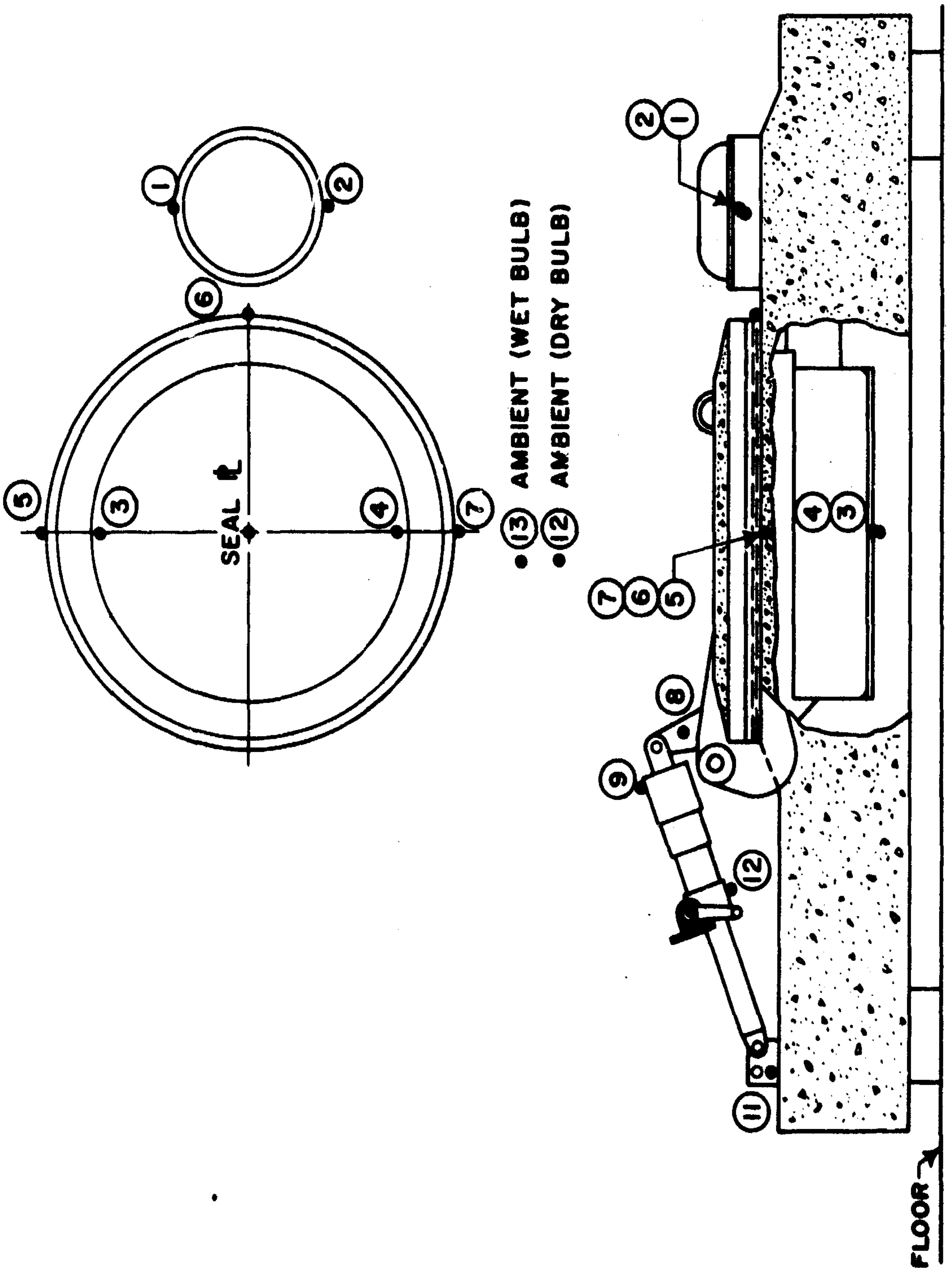


Figure 3. Personnel Access Hatch Thermocouple Locations

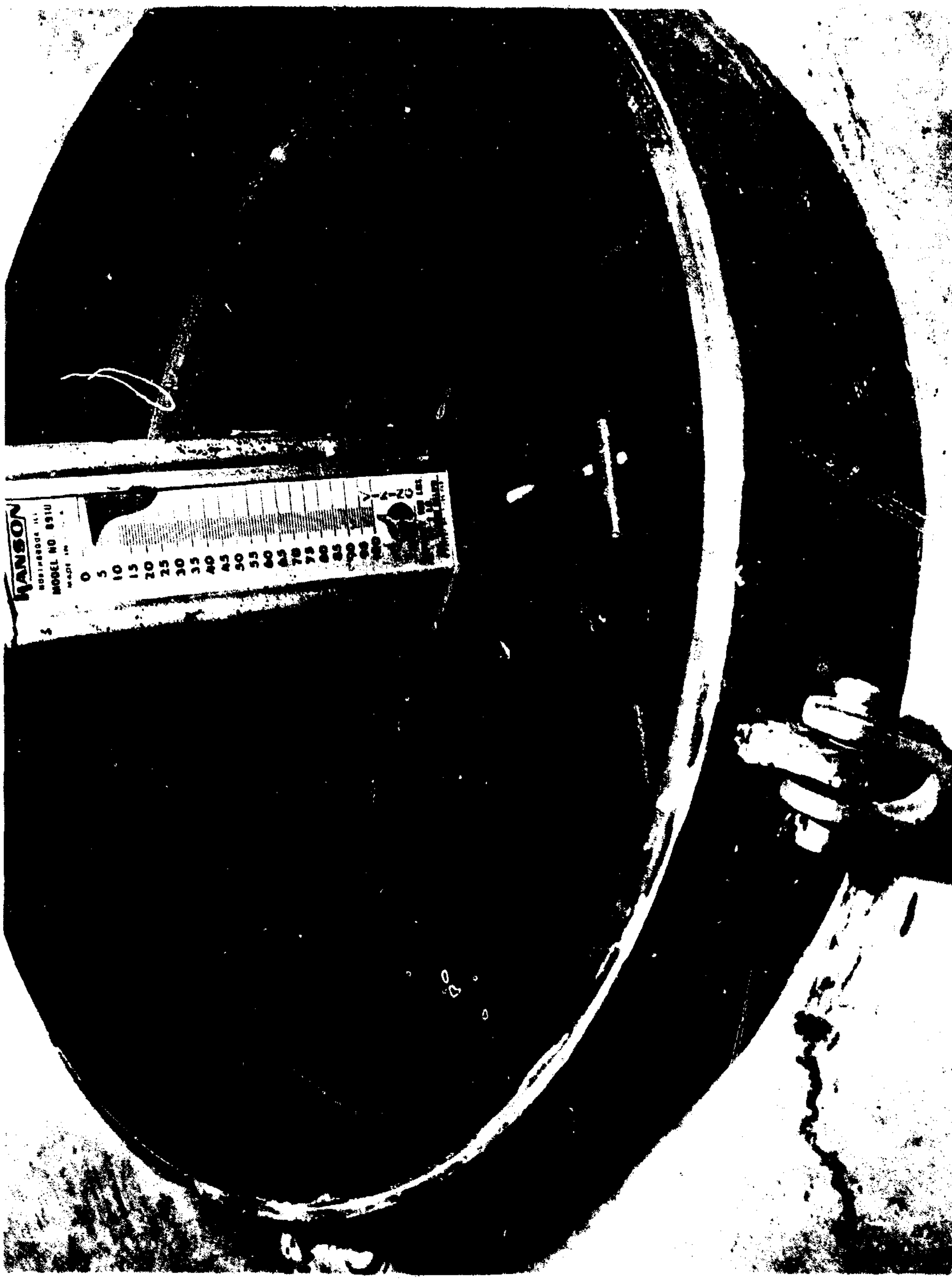


Figure 4. Locking Device with Calibrated Spring Scale Attached

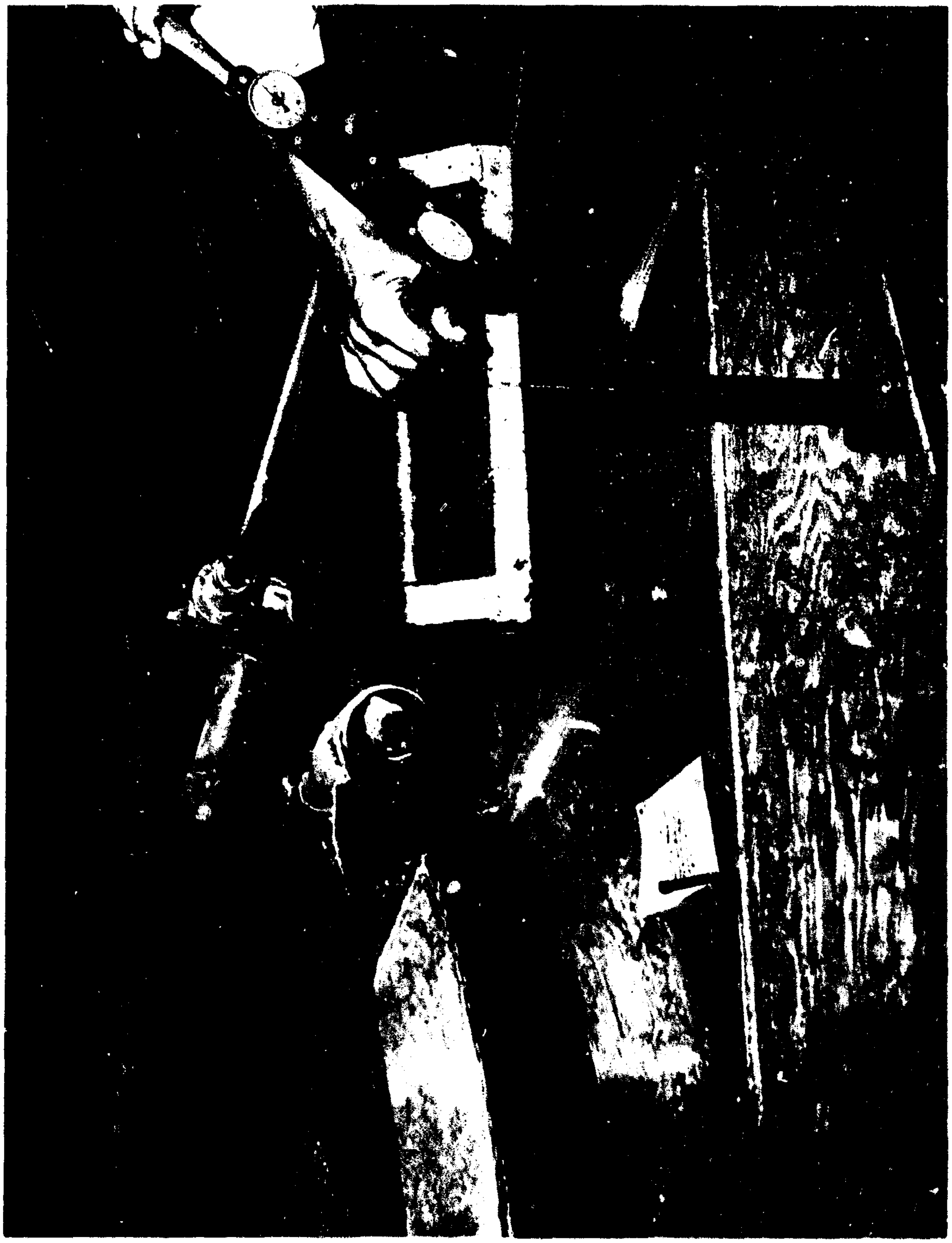


Figure 5. Typical Access Hatch Torque Measurement

h. During the course of the test, a visual inspection was made of both hatch interiors, the locking pin, actuator, hatch seals and seal surfaces for proper functioning. Any unusual condition was noted and recorded.

i. After the completion of the test, the temperature of the test specimen was allowed to return to ambient. The operating cycle (unlock, open, close, and lock) was performed with the operating torques being measured and recorded.

2. <u>Low-Temperature Test</u>

The same procedure was used for the low-temperature test as was used for the high-temperature test, using -40°F for the test temperature.

3. <u>Ice Test</u>

The following procedures were performed to conduct the ice test in the Conrad Mobile Unit.

a. The thermocouples previously mentioned were used to monitor temperatures for the ice test.

b. With the specimen in the environmental chamber, the chamber temperature was controlled in such a way that the test specimen temperature decrease would not exceed a rate of 15°F per hour at any of the thermocouple locations.

c. The specimen was maintained at 0°F, and water at 34°F was sprayed over the entire top surface of the security pit, the access hatch, and the actuator until a minimum ice thickness of 1/2 inch had been formed. The spray unit, a standard garden-type (5 gallon) pressurized sprayer, was equipped with an adjustable nozzle which produced a mist (fog) spray.

d. After the coat of ice was formed, the temperature was maintained at 0°F and the operation cycle was performed, with the torque measurements being recorded.

e. At the completion of the ice test when the temperature of the test specimen had returned to ambient, the operating cycle was repeated.

4. <u>Rain Test</u>

The following procedures were performed to conduct the simulated rain tests:

a. Ten spray nozzles were installed above the specimen to simulate rainfall. The nozzles were regulated to permit a flow rate at the hatch cover (through all ten nozzles) of approximately 1/2 inch every 7 1/2 minutes (4" per hour rate). The nozzles were adjusted to spray water on the specimen from both sides at angles of 45°.

b. The test specimen was subjected to a two-hour simulated rain exposure at a rate of four inches per hour with the water temperature varying from 59 to 61°F.

c. After a short period for the water to drain from the test specimen, the operating cycle was performed and the torque measurements were recorded.

d. At the completion of the rain test and with the test specimen dry and at ambient temperature, the operating cycle was again repeated and the torque measurements recorded.

5. Sand and Dust Test

The following procedures were performed to conduct the sand and dust tests:

a. The test specimen was placed in the sand and dust chamber, and all auxiliary equipment which was used to move the hatch into the chamber was removed. A Barkelew High-Velocity Sand and Dust Chamber was provided to house the specimen during sand and dust tests. The chamber interior is 8 foot x 8 foot x 25 foot with an 8 foot x 8 foot door opening. It is designed to meet both specifications, MIL-E-5272 and MIL-E-4970A (MIL-C-9436) (Ref. 2).

b. The test specimen (hatch assembly) was exposed to a chamber environmental temperature of 77°F and to a sand and dust velocity of 2300 to 2800 fpm for a 6-hour period. Sand and dust density was maintained between 0.1 to 0.5 grams per cubic foot within the test chamber.

c. The chamber temperature was then increased to 150°F with the sand and dust density and velocity maintained for an additional six hours.

d. After the dust had settled, the test specimen was allowed to cool to ambient. It was then removed from the chamber to be inspected and submitted to operational tests. No sand or dust was intentionally removed from the test specimen.

e. The unlock, open, close and lock cycle was performed and torque measurements were recorded.

6. Torque Measurement

A 0-600 inch-pound torquewrench was provided to make the torque measurement for all of the main hatch tests (figure 5). It is manufactured by Snap-on Tools Corporation, Kenosha, Wisconsin and is identified as ACF #465-01-19. The torquewrench was last calibrated on 11 February 1965.

7. Calibrated Spring Scale

The scale used to measure the operating torque of the locking device was a Calibrated Spring Scale Model No 8910 manufactured by the Hanson Company, Northbrook, Illinois. It is graduated from 0 to 100 pounds and is provided with an adjusting screw for calibration.

SECTION IV

TEST RESULTS

1. Pretest Inspection

a. Inspection of the access hatch actuator revealed the following conditions:

(1) Prior to installation in the test fixture, the actuator leaked sufficient oil over a twelve hour period to leave a puddle several inches in diameter. No attempt was made to disassemble the actuator and determine the cause at this time.

(2) The exposed portion of the inside tube had an extremely irregular protective plating applied to its outside diameter. Inspection revealed many surface imperfections, including voids and weld spatters on its surface as shown in figure 6. This plated surface was smoothed with fine emery cloth prior to any cycling of the actuator, with the results shown in figure 7. The surface was smoothed to prevent the wiper seal surface at the end of the outside tube from being scored.

(3) The uninstalled centerline to centerline measurement of actuator mounting pin holes showed actuator closed position length to be 35 inches and extended position length to be 49-1/8 inches. When installed on the hatch, the closed length was 35-3/4 inches (hatch open), and the extended length was 47-1/2 inches (hatch closed). These dimensions verify that actuator "bottoming out" does not occur when the hatch cover is in the fully opened or closed positions.

b. Inspection of the access hatch revealed the following conditions:

(1) As shown in figure 8, the EM-shield retainer ring protruded above the hatch cover groove in two areas after installation. This was because the retainer ring bolt circle has a slightly larger diameter than the bolt circle tapped into the hatch cover. These protruding areas did not have any noticeable effect on the performance of the access hatch assembly in closing or sealing.

(2) The countersink were not concentric with the screw holes in the retainer ring, nor were they of sufficient depth. This caused the screw head

Figure 6. Access Hatch Actuator Inside Tube

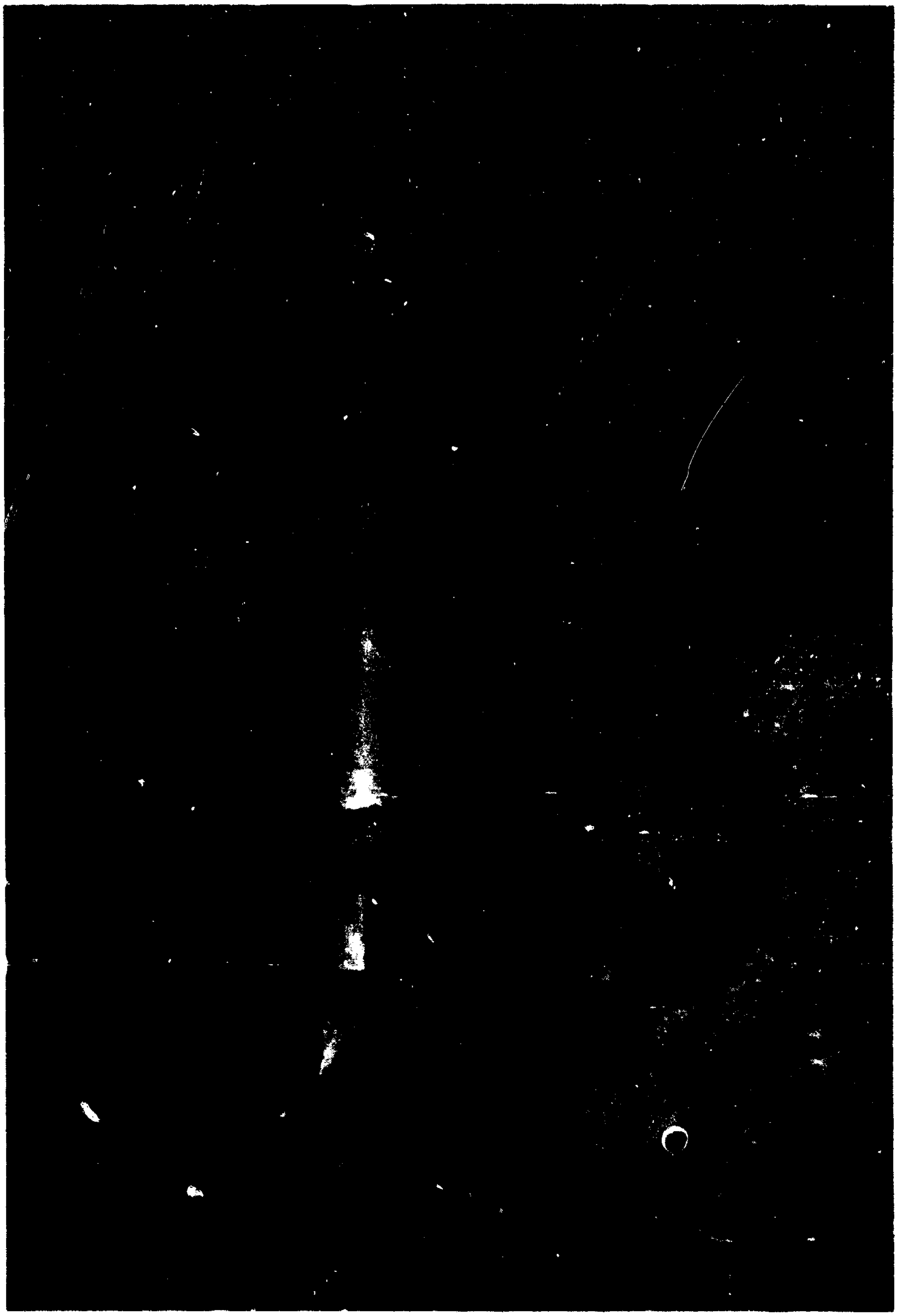


Figure 7. Access Hatch Actuator Inside Tube (After Emery Cloth Smoothing)

Figure 8. EM Shield Retainer Ring

to project above the EM-Shield groove after installation. The retainer ring holes were reworked to the proper depth and concentricity in the machine shop prior to validation and testing.

(3) The inner top corner of the finned O-ring groove in the hatch cover had an extremely rough and jagged chrome-plated edge which could have damaged the O-ring during installation, causing subsequent leakage. Considerable work using emery cloth was required to smooth the surface.

(4) Weld spatter and paint globules were found on the plated surface of the hatch cover and were removed.

(5) During installation of the actuator on the access hatch, interference was found between the actuator clevis throat and the attaching arm on the hatch cover. The attaching arm was notched as shown in figures 9 and 10 to permit installation of the actuator.

(6) Weld cracks were noted in the area where the actuator attaching arm was welded to the hatch cover. No corrective action was taken.

2. Personnel Access Hatch Validation

Validation of the personnel access hatch was conducted in accordance with Validation Procedure No. 1 for the WS 133B Technical Facilities at Grank Forks Air Force Base, North Dakota. Exceptions and results are listed below:

a. Feeler-Gage Check

Design of the access hatch prevents the use of a feeler gage to check the clearance between the hatch cover and bearing ring with the hatch in the closed position. This section should be deleted from the validation procedure.

b. Lead-Wire Test

Clearance between the hatch cover and the bearing ring, as determined by the lead wire test at 20 equally spaced locations, varied from a maximum of 0.024 inch to a minimum of 0.009 inch. Allowable variation is 0.030 inch maximum and 0.010 inch minimum. A tabulation of the measured clearances appears in table I.

c. EM-Shield Gasket Measurement

The erratic nature of the projection of the wire mesh EM-shield gasket above its groove makes accurate and meaningful measurements of this projection difficult. Visual observation to ensure 360-degree contact of the EM-shield gasket would be a more practical requirement. No attempt was made to measure this projection.

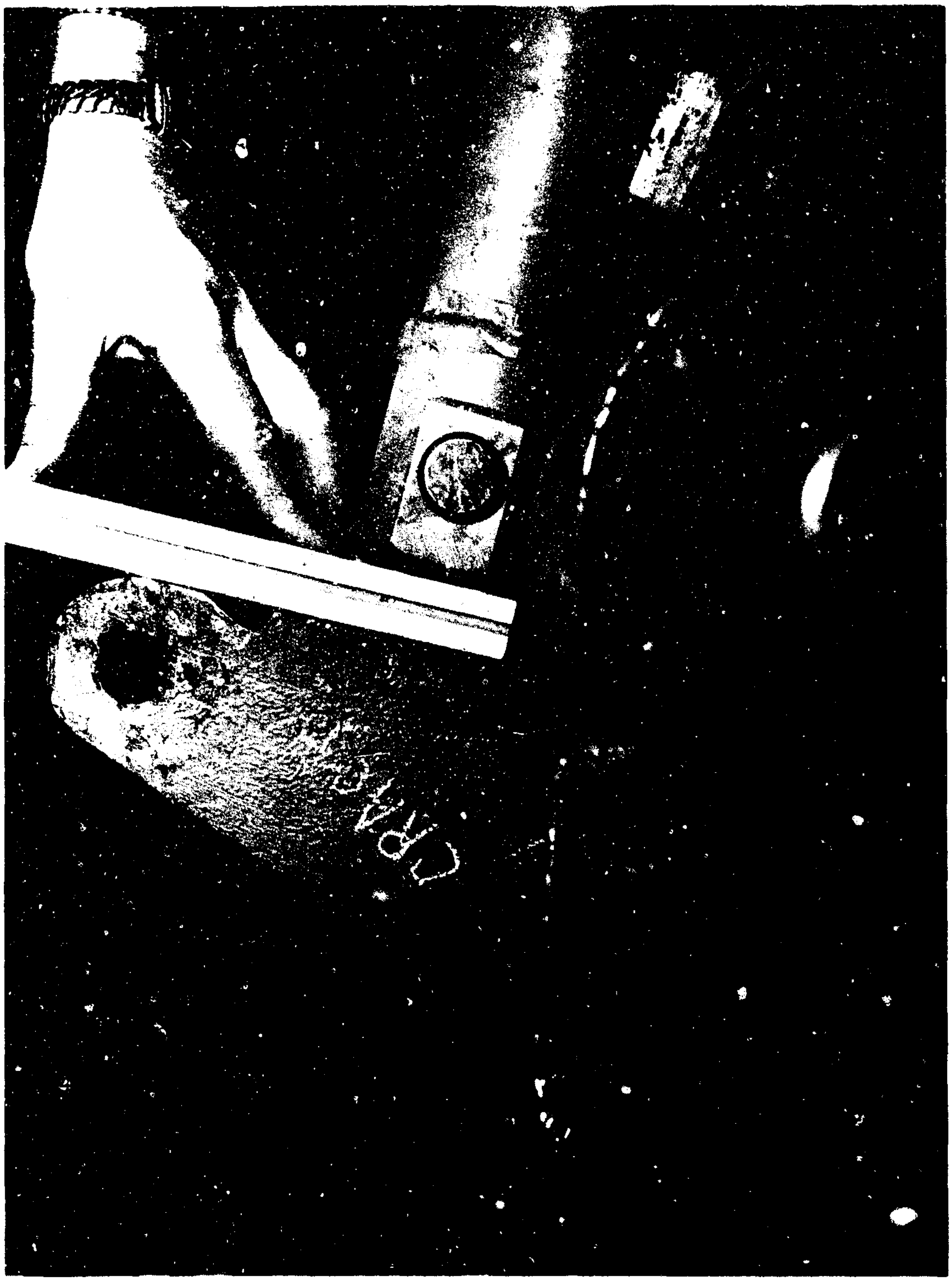


Figure 9. Hatch Arm Notching Measurements

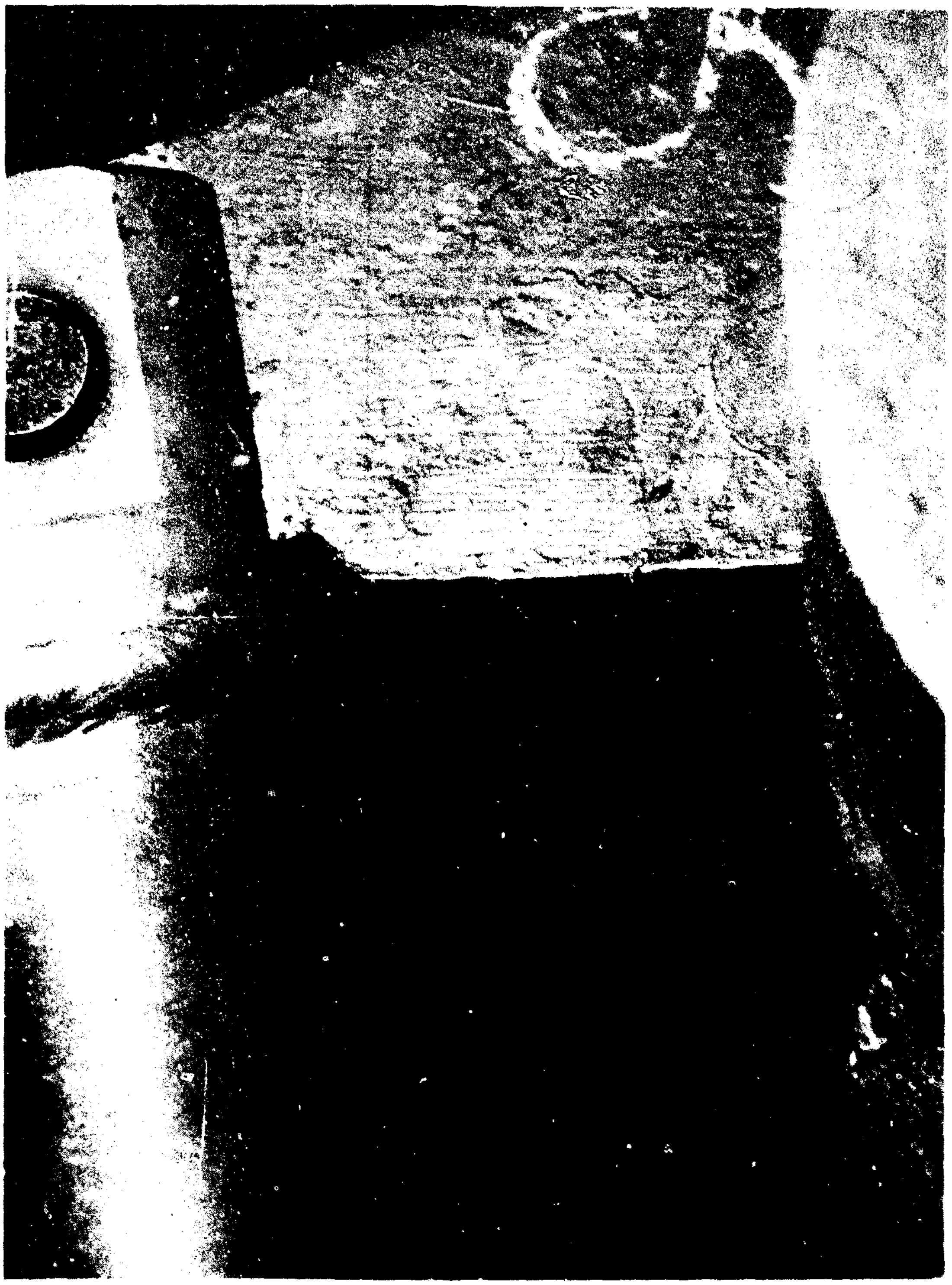
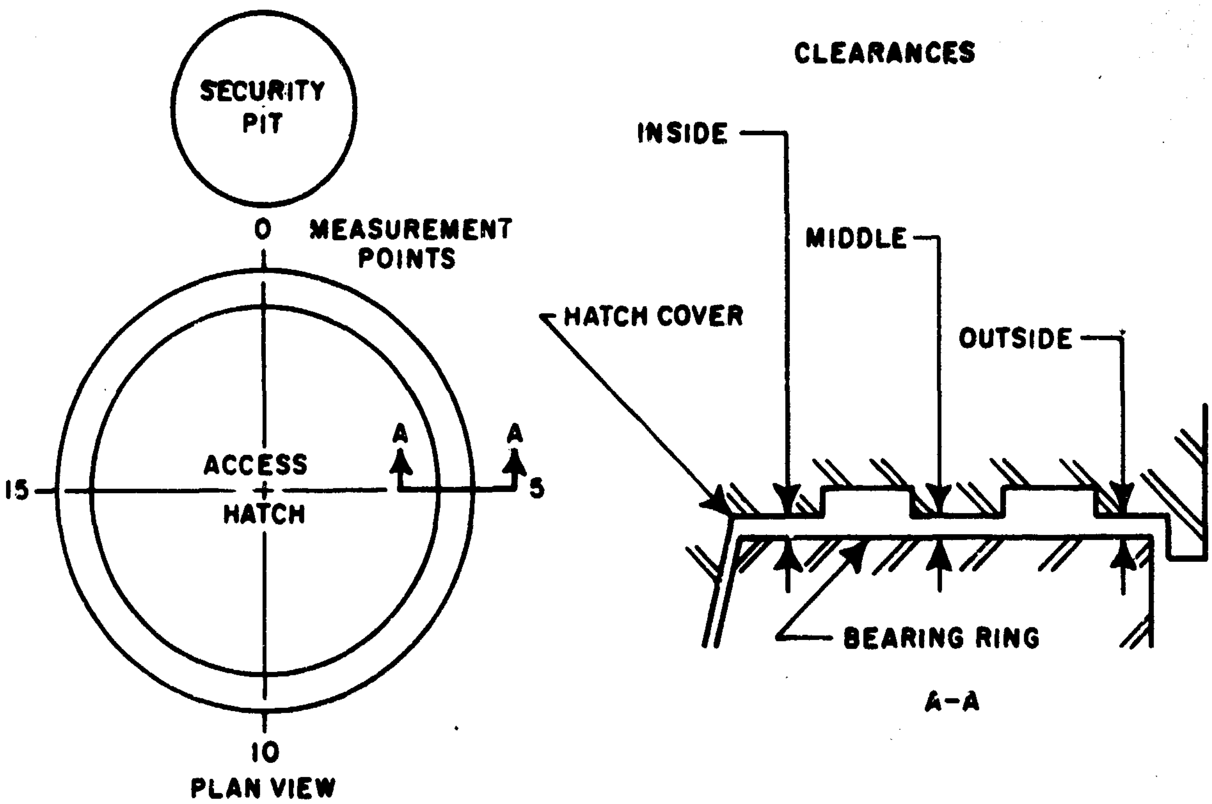


Figure 10. Hatch Arm Notching Detail

Table I

HATCH COVER - BEARING RING CLEARANCE



MEASUREMENT POINT	WIRE DIAMETER	CLEARANCE (INCHES) INSIDE	MIDDLE	OUTSIDE
0	.040	.015	.014	.015
1	.040	.020	.021	.024
2	.040	.021	.021	.021
3	.040	.022	.022	.020
4	.041	.021	.021	.020
5	.040	.022	.021	.020
6	.040	.019	.017	.019
7	.040	.018	.016	.014
8	.041	.016	.014	.013
9	.040	.017	.013	.012
10	.041	.016	.014	.009
11	.041	.014	.015	.014
12	.041	.017	.016	.016
13	.041	.021	.018	.018
14	.039	.019	.019	.019
15	.041	.018	.018	.017
16	.037	.016	.015	.014
17	.041	.018	.016	.016
18	.040	.018	.017	.016
19	.041	.017	.016	.014

Projection of the finned O-ring above its groove varied from 0.118 inch maximum to 0.082 inch minimum when measured at 18 equally space locations. At two locations the projection was a few thousandths less than the acceptable minimum projection of 3/32 inch specified in the validation procedure. However, the projection was sufficient to provide a leak-tight seal. A tabulation of the measured O-ring projection appears in table II.

d. Flood Test

There was no leakage into the hatch from the flooding test conducted in accordance with the validation procedure. This test is shown in figure 11.

e. 3-Cycle Time Test

Total elapsed time for one man to unlock, open, close, and lock the hatch through three cycles was 45 minutes (60 minutes was allowed in the validation procedure). It should be noted that this operating time does not include the time required to open and close the security pit lock since it was not furnished with the test specimen. Incremental times required for the first cycle operation are listed below:

		ELAPSED TIME (min : sec)
(1)	Disengage swing bolts, open security pit weather cover, and retract access hatch locking pin.	1:05
(2)	Operate access hatch cover actuator to the full open hatch postion.	1:43
(3)	Operate actuator to the full closed hatch position.	1:00
(4)	Extend locking pin, close security pit weather cover, and secure swing bolts.	1:30
	TOTAL ELAPSED TIME (1ST CYCLE)	5:18

f. Open Hatch Position

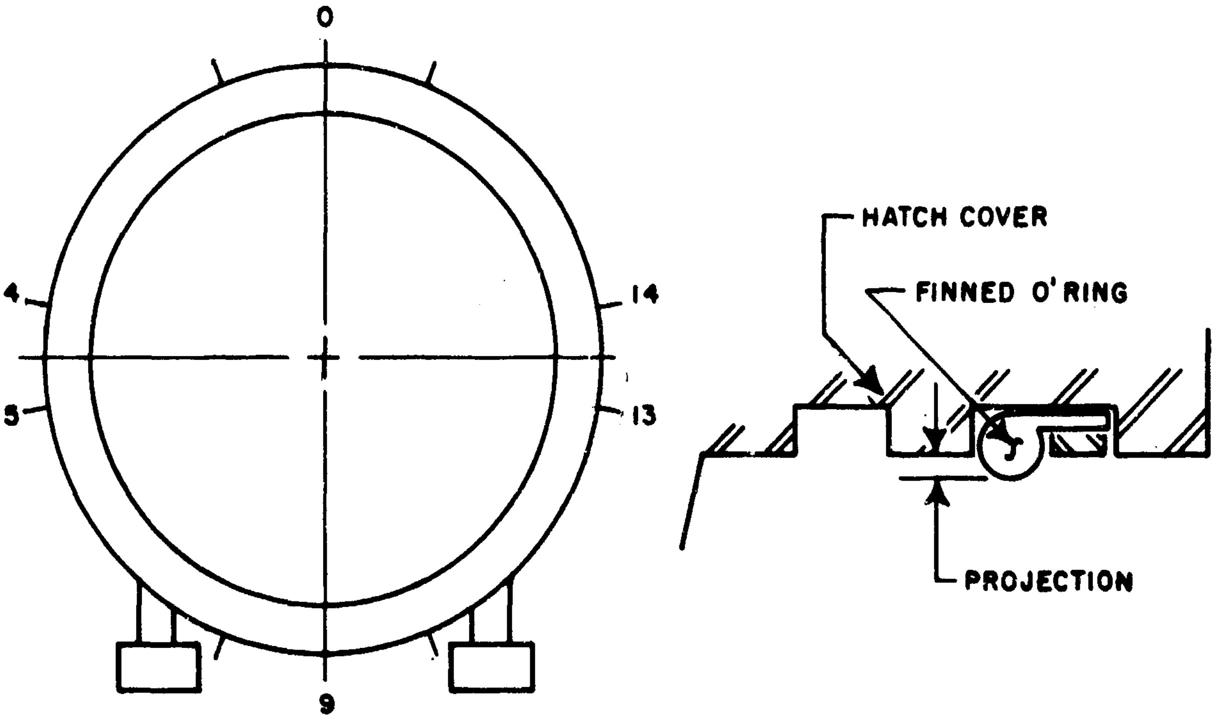
The open position of the hatch was measured at an average of 102 degrees and 30 minutes as compared with an opening of [illegible]ees required by the validation procedure.

g. Seal Damage

No damage was noted in the seals and gaskets following validation.

Table II

FINNED O-RING PROJECTION



LOCATION	PROJECTION (INCHES) AT VALIDATION	AFTER TESTING	COMPRESSION SET (INCHES)
0	.087	.072	.015
1	.105	.085	.020
2	.100	.069	.031
3	.109	.070	.039
4	.093	.075	.018
5	.105	.087	.018
6	.097	.076	.021
7	.100	.066	.034
8	.095	.064	.031
9	.099	.053	.041
10	.110	.068	.042
11	.104	.053	.051
12	.109	.046	.063
13	.092	.048	.042
14	.118	.047	.071
15	.091	.065	.026
16	.115	.070	.045
17	.082	.067	.015

Figure 11. Flood Test

h. Chromate Film Removal

The use of levigated alumina to remove the chromate film from the cadmium plated surface of the bearing ring does not produce an adequate result. For the purposes of this test the following method was used to remove the chromate film:

(1) The bearing ring was cleaned with fine steel wool and water.

(2) The ring was then cleaned with fine steel wool and detergent and with SOS scouring pads.

(3) The surface of the ring was then cleaned with a wet rag and wiped dry.

(4) A fine brass wheel attached to a 1/4-inch drill motor was used on the bearing ring, and the ring was wiped clean.

(5) The ring was cleaned with a light steel wire wheel attached to a 1/4-inch drill motor, using light pressure. Then the ring was wiped clean.

For normal field requirements, it is recommended that steps (3) and (5) above be used to remove chromate. It is believed that these steps alone will remove enough of the chromate for normal purposes.

3. Operating Measurements

a. During the course of validation, the following measurements were obtained (refer to Table III).

(1) Torque required to open the hatch varied from 320 inch-pounds running torque in the down position to 115 inch-pounds at the 90 degree open position. Torque required to close the hatch was 80 inch-pounds to break away from the fully open position and a relatively constant 10 inch-pounds thereafter. There was little measurable difference between starting and running torques.

(2) Approximately 148 turns of the actuator are required between the fully open and fully closed positions of the hatch.

(3) Torque required to actuate the locking device varied from 17 to 21 inch-pounds.

(4) Approximately 21-1/2 turns of the locking device operator are required for full travel of the locking pin with the hatch closed.

(5) The ac tor was self-locking at all positions of the hatch.

OPENING TESTS							CLOSING TESTS						
NO. OF TURNS	HATCH LIFTING MECHANISM OPERATING TORQUE IN-LBS						NO. OF TURNS	HATCH LIFTING MECHANISM OPERATING TORQUE IN-LBS					
	Validation	High Temp	Low Temp	Ice	Rain	Sand & Dust		Validation	High Temp	Low Temp	Ice	Rain	Sand & Dust
0 - 3	320	300	500 350	330 320	300 290	320 310	0 - 2	80	100	100 80	80 75	95 90	95 90
15	300	280	370 360	300 295	285 280	300 290	15	10	10	30 20	10 5	10 5	10 5
30	270	250	290 280	260 260	250 245	250 245	30	10	10	15 10	10 5	10 5	10 5
45	235	230	270 250	240 230	250 245	245 240	45	10	10	15 10	10 5	10 5	10 5
60	230	210	250 240	235 230	220 215	230 225	60	10	10	15 10	10 5	10 5	10 5
75	215	205	270 250	225 220	215 210	225 220	75	10	10	15 10	10 5	10 5	10 5
90	190	185	230 220	215 210	190 185	200 190	90	10	10	15 10	10 5	10 5	10 5
105	185	170	210 200	195 190	175 170	190 185	105	10	10	15 10	10 5	10 5	10 5
120	165	155	190 180	165 160	160 155	160 155	120	10	10	15 10	10 5	10 5	10 5
135	160	120	160 150	135 130	135 130	115 110	135	10	10	15 10	10 5	10 5	10 5
141 (Lid Vert)	115	90	130 120	95 90	100 95	105 100	147-1/2 (Lid Closed)	-	-	-	-	-	-
148-1/2 (Fully Open)	-	-	-	-	-	-							

Table III PERSONNEL ACCESS HATCH OPENING AND CLOSING TESTS

4. Environmental Test Results

a. High-Temperature Test

Following exposure to a 150° F environment for a period of eight hours, the following test results were observed:

(1) The torque required to open the hatch at the test temperature varied from 300 inch-pounds running torque in the down position to 90 inch-pounds at the 90 degree open position. Torque required to close the hatch was 100 inch-pounds to break away from the fully open position and a relatively constant 10 inch-pounds thereafter. Starting torque was approximately 5 inch-pounds greater than running torque at all positions of the hatch. A tabulation of the measurements recorded appears in table III.

(2) The torque required to actuate the locking device was a uniform 17-1/2 inch-pounds throughout the travel of the locking pin.

(3) The locking device screw operation was normal.

(4) The seals and seal-surface were normal.

(5) The locking pin lubricant had softened and was dripping.

(6) The access hatch actuator developed a slight noise during the closing cycle.

(7) The rubber seal, where the input shaft entered the Curtis-Wright safety lock on the actuator, was being forced from its housing during the closing cycle.

b. Low-Temperature Test

Following exposure to a minus 40 degrees F. environment for a period of eight hours, the following test results were observed:

(1) The torque required to open the hatch at the test temperature varied from 500 inch-pounds break-away and 350 inch-pounds running torque in the down position to 130 inch-pounds break-away and 120 inch-pounds running torque at the 90 degree open position. Torque required to close the hatch was 100 inch-pounds break-away and 80 inch-pounds running at the fully open position and 15 inch-pounds break-away and 10 inch-pounds thereafter. A complete tabulation of the measurements recorded appears in table III.

(2) Two men pulling on the end of a three foot length of pipe (cheater) were required to retract the locking pin a minus 40 degrees F. This force was constant throughout retraction and was also required to extend the pin.

(3) A slight sticking of the seal on the seal surface was noted when opening the security pit weather cover.

After the access hatch returned to ambient temperature, it was again operated with the following results:

(4) The maximum torque required to open the hatch was approximately 290 inch-pounds (normal).

(5) The torque required to actuate the locking device was 56 inch-pounds on the first turn, 49 inch-pounds on the second turn, and 17 inch-pounds (normal) from the fifth turn on.

(6) The finned O-ring seal had some visible permanent set but was in good condition, retaining its elastic property.

(7) The actuator gear box or the Curtis-Wright safety lock developed some noise when closing the hatch.

(8) The seal where the input shaft entered the Curtis-Wright safety lock on the actuator again continued to pop out during the closing operation.

c. Ice Test

After application of 1/2 inch of ice to the hatch and actuator at 0° F. as shown in figure 12 and 13, the following test results were observed:

(1) The torque required to open the hatch at the test temperature varied from 330 inch-pounds break-away and 320 inch-pounds running torque in the down position to 95 inch-pounds break-away and 90 inch-pounds running torque at the 90 degree open position. It was not necessary to break ice away from the hatch or actuator in order to open the hatch. Torque required to close the hatch was 80 inch-pounds break-away and 75 inch-pounds running at the fully open position and 5 inch-pounds running torque thereafter. A complete tabulation of the measurements recorded appears in table III.

(2) The torque required to retract the locking device was 175 to 210 inch-pounds to start; then it started binding, requiring in excess of 350 inch-pounds for the first two turns. It then loosened up to the normal operating force thereafter.

(3) The security pit cover was iced closed but required little effort to break loose. A lifting force of 52 pounds was required to open the cover with 1/2 inch of ice cover.

(4) The seal and seal-surface was normal. Some compression set was noted in the finned O-ring, but the material was still elastic.

After the access hatch returned to ambient temperature, it was again operated with the following results:

(5) The maximum torque required to open the hatch was 280 inch-pounds.

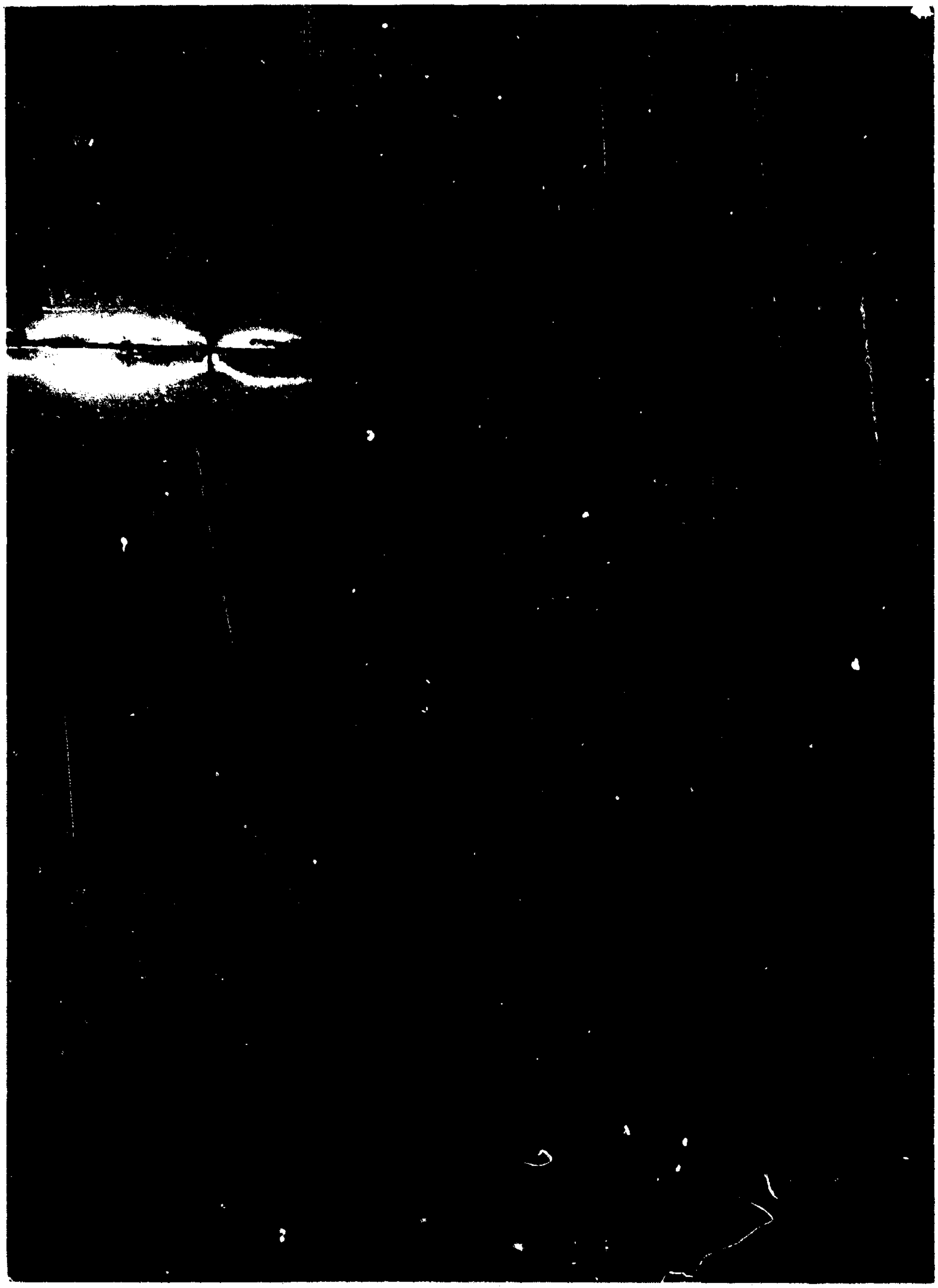


Figure 12. Access Hatch - Ice Test

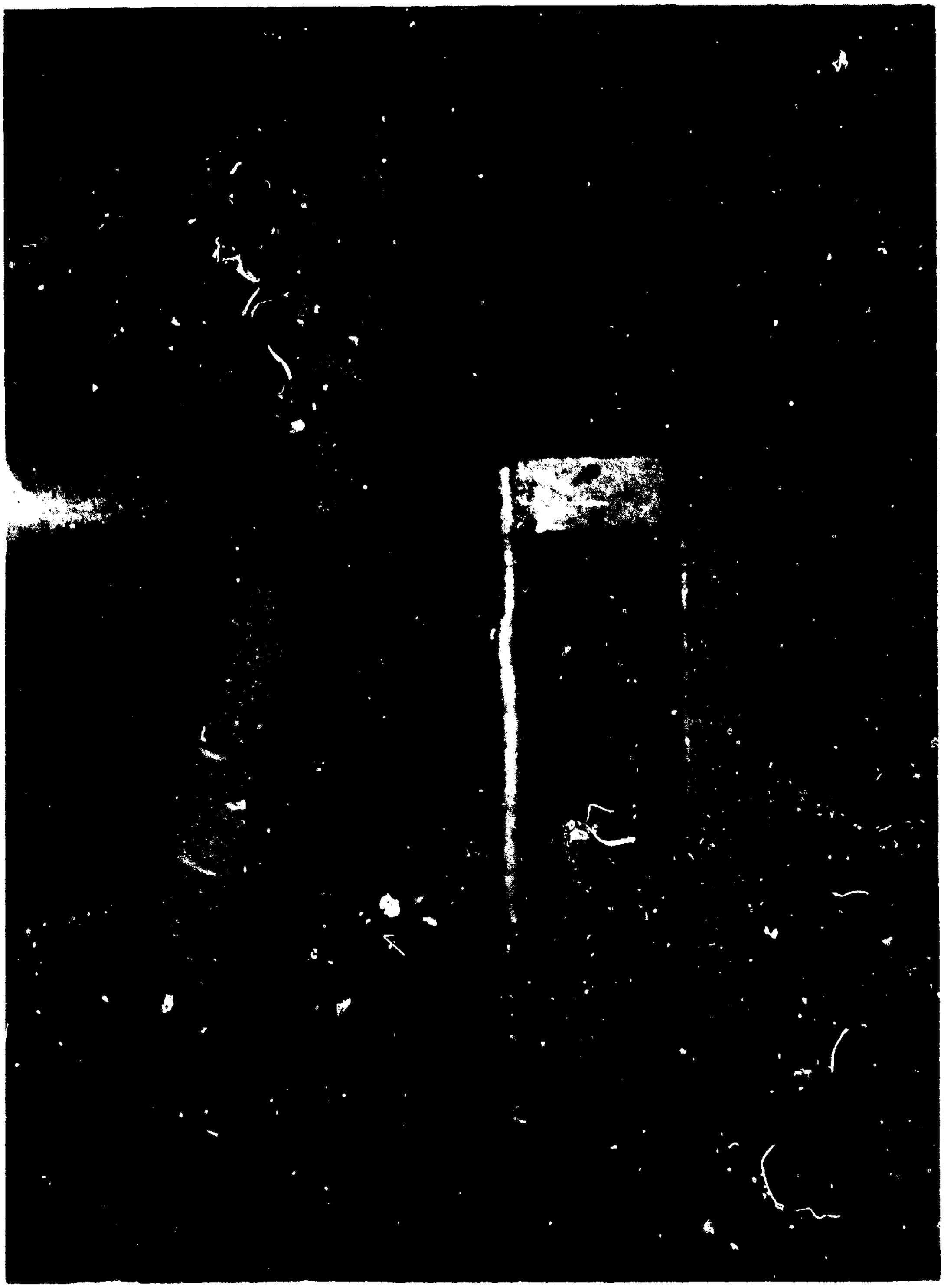


Figure 13. Actuator - Ice Test

(6) The torque required to operate the locking device varied from 24 to 28 inch-pounds.

d. Rain Test

Following exposure to simulated rain as shown in figures 14 and 15 for two hours at a ambient temperature and a rate of approximately 4 inches per hour, the following test results were observed:

(1) The torque required to open the hatch varied from 300 inch-pounds break-away and 290 inch-pounds running torque in the down position to 100 inch-pounds break-away and 95 inch-pounds running torque at the 90 degree open position. Torque required to close the hatch was 95 inch-pounds break-away and 80 inch-pounds running at the fully open position and 10 inch-pounds break-away and 5 inch-pounds running thereafter. A complete tabulation of the recorded measurements appears in table III.

(2) The torque required to actuate the locking device was a uniform 28 inch-pounds.

(3) The hatch interior was dry; no leakage existed.

(4) There was no noise from the actuator during the closing cycle as on previous tests.

After the access hatch dried, it was again operated with the following results:

(5) The maximum torque required to open the hatch was 295 inch-pounds.

(6) The torque required to operate the locking device was a uniform 21 inch-pounds.

(7) The seals and seal-surface were normal, and there was little observable permanent set in the finned O-ring.

(8) There was no noise from the gear box during the closing cycle.

e. Sand and Dust Test

After exposure to a sand and dust environment as described in the test procedure and as shown in figures 16, 17, and 18 the following results were observed:

(1) The overall hatch assembly was slightly dusty with small deposits of dust on all exterior surfaces.

(2) The interior of the security pit was clean with no observable dust penetration.

(3) The torque required to actuate the locking device was 17.5 inch-pounds to retract and 21 inch-pounds to extend the pin.

Figure 14. Access Hatch - Rain Test

Figure 15. Actuator - Rain Test

Figure 16. Access Hatch - Dust Test

Figure 17. Actuator - Dust Test

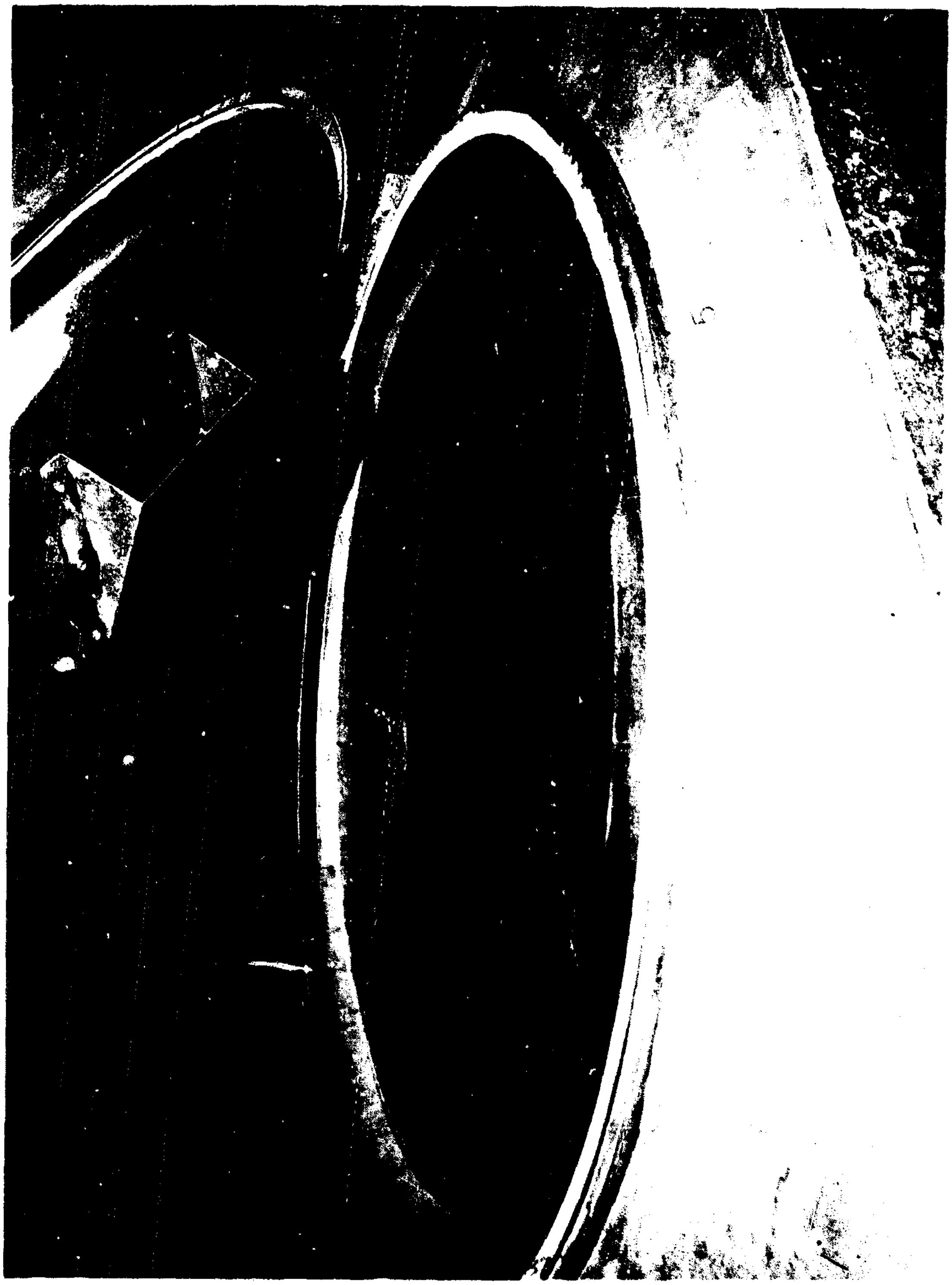


Figure 18. Access Hatch Opened After Dust Test

(4) The torque required to open the hatch varied from 320 inch-pounds break-away and 310 inch-pounds running in the down position to 105 inch-pounds break-away and 100 inch-pounds running at the 90 degree open position. Torque required to close the hatch was 95 inch-pounds break-away and 90 inch-pounds running at the fully open position and 10 inch-pounds break-away and 5 inch-pounds running thereafter. A complete tabulation of the recorded measurements appears in table III.

(5) The actuator gear box was noisy during the closing cycle.

(6) The input shaft seal did not pop out during the closing cycle.

(7) There was no observable penetration of sand or dust beyond the finned O-ring seal.

(8) Some damage to the finned O-ring surface where it compresses against the rough chrome plated edge of the seal groove was noted.

After the access hatch returned to ambient temperature and the sand and dust were removed, it was again operated with the following results:

(9) The torque required to operate the locking device was 17.5 inch-pounds.

(10) The maximum torque required to open the hatch was 310 inch-pounds.

(11) The actuator gear box was noisy during the closing cycle.

5. Post-Test Inspection

a. The Duff-Norton access hatch actuator was disassembled under the supervision of Mr. R. J. Beck, Chief Engineer, Duff-Norton Company. The disassembled actuator is shown in figure 19. Inspection revealed the following conditions:

(1) Some moisture was found in the outside tube indicating the joint between the outside tube and the shell cap does not seal effectively.

(2) No sand or dust penetration into the assembly was observed.

(3) The inside tube and its plated surface were in good condition except as noted in the pretest inspection.

(4) The wiper-scraper seal at the end of the outside tube had several local discontinuities in the scraper. These discontinuities were probably caused by actuator operation at the manufacturer's plant prior to removal of weld spatter from the inside tube plated surface, as noted in the pretest inspection.

(5) All bearing and shaft seals were in good condition, showing no evidence of cracking or deterioration from the extreme environment.

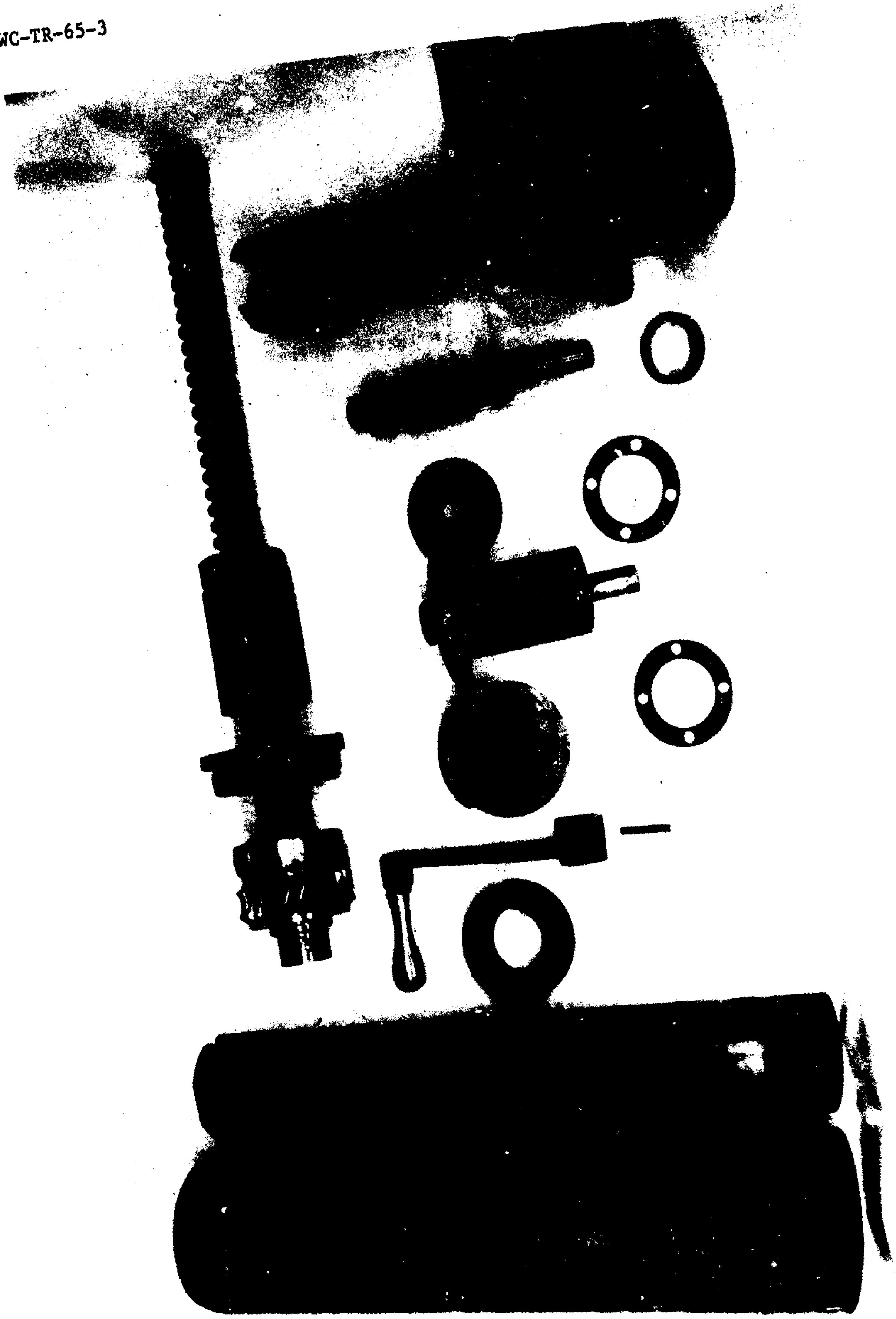


Figure 19. Disassembled Actuator

(6) The ball screw and nut were in good condition, well lubricated, and showed no signs of excessive wear.

(7) The worm and gear were in good condition with no sign of wear.

(8) All anti-friction bearings were in good condition and functioned freely and smoothly.

(9) The oil leakage noted in the pretest inspection was apparently caused by limited disassociation of the base oil from the Molykote in the in the molybdenum-disulfide grease used to lubricate the actuator. This base oil escaped through the unsealed joint between the outside tube and the shell cap when the actuator was not installed and was resting horizontally. No detrimental effect to the actuator or its operation could be attributed to either the disassociation or leakage.

(10) The Curtis-Wright safety lock is a factory sealed unit, and no attempt was made to disassemble this item.

(11) The groove pin used to assemble the crank handle to the input shaft dropped out during validation and was replaced by a cotter pin. Inspection showed the holes for the groove pin in both the crank handle and the input shaft has been enlarged due to bearing pressure resulting from normal operating torques.

b. Access hatch inspection revealed the following:

(1) The security pit seal was in good condition.

(2) The locking device was in good condition, and no change was noted in the normal operating torque over the period of testing.

(3) The access hatch hinge assembly was in good condition and operated freely without evidence of binding.

(4) The E-M shield was in good condition with no evidence of wear or fraying. This shield had not been replaced during validation or testing.

(5) The finned O-ring showed some surface defects and damage resulting from the sharp edges on its chrome-plated groove noted in the pretest inspection. Compression set of the O-ring over the period of testing is tabulated in table II.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

a. All test requirements were met and the operational and functional features of the hatch assembly were acceptable, with the exception of the Low-Temperature (-40°F) tests.

b. Although no failure of either the locking pin or the hatch drive mechanism occurred, it was felt that the load required to operate these components at the extreme low-temperature (-40°F) was excessive.

c. The hatch drive mechanism and method of actuation allowed much room for improvement. Corrective measures are now being initiated, by Ballistics Systems Division, to modify the hatch drive mechanism.

2. Recommendations

a. It is recommended that design of the security pit locking pin be reviewed. The retraction and extension difficulties encountered during the Low-Temperature Test may have been due to the differential expansion of the locking pin assembly and not primarily to a lubrication problem.

b. It is recommended that a load reduction design be adapted to the actuator.

c. It is recommended that a clutch arrangement be designed for the actuator drive mechanism to protect the ball screw drive during any maximum load input.

REFERENCES

1. The Ralph M. Parsons Company, Test Plan, WS133B Technical Facilities, Personnel Access Hatch, Environmental Tests, dated 15 November 1964.

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3. AFBM Exhibit 62-51, WS133B Environmental Design Criteria, Minuteman.

4. The Ralph M. Parsons Company, Test Report WS133B Technical Facilities Personnel Access Hatch Environmental Tests, No. RMP-TR-3497-2/2, dated April 1965.

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13. ABSTRACT

Testing of the WS133B, Minuteman, Personnel Access Hatch was performed by AFSWC at the request of BSD. The purpose of this test program was to measure the operating characteristics and to evaluate the performance of one Minuteman Wing VI personnel access hatch when exposed to extreme environmental conditions. The environmental tests were performed in accordance with MIL-E-4970A, as modified to comply with BSD requirements and included high temperature, low temperature, ice, rain, and exposure to sand and dust. Test results, notations of observations made during testing, and other pertinent test data are presented.

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
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Personnel access hatch						
Validation tests						
Environmental tests						
Test results						
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