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**DESCRIPTION, PLACEMENT, MAINTENANCE AND
RECOVERY INSTRUCTIONS FOR XW18 MEMBRANE**

Sidney G. Tucker, et al

**Army Engineer Waterways Experiment Station
Vicksburg, Mississippi**

June 1970

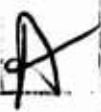
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INSTRUCTION REPORT S-70-4

**DESCRIPTION, PLACEMENT, MAINTENANCE
AND RECOVERY INSTRUCTIONS FOR
XW18 MEMBRANE**

by

S. G. Tucker, R. H. Grau



June 1970

Sponsored by U. S. Army Materiel Command

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Conducted by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi

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<p><i>Details of Illustrations in this document may be better studied on microfiche</i></p> <p>This manual was prepared to provide guidance for engineer construction troops and any troops of the field Army that emplace, maintain, and recover the XW18 membrane and accessories in support of aircraft landing facilities--specifically, runways in theaters of operations, which are essential for support of military airlift operations. This manual provides information describing the XW18 membrane and accessories. The techniques and construction procedures that should be followed during placement, maintenance, and recovery of the membrane surfacing and repair and maintenance of the soil subgrade are explained in detail. The number of personnel and the amount and type of equipment required to complete the various tasks concerning placement, maintenance, and recovery of the membrane surfacing are discussed. This manual does not include detailed information concerning landing zone criteria for cargo-type aircraft, as Tactical Air Command (TAC) Manuals 86-1 and 86-5 establish these criteria.</p>		U. S. Army Materiel Command Washington, D. C.

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FOREWORD

This instruction report was prepared to provide detailed procedures and techniques for emplacement, construction, repair, and recovery of XW18 membrane surfacing. This report has also been arranged in accordance with the format described in paragraph 3.4 Type 12 of Military Specification MIL-M-63009A (TM) for use by engineer construction troops and any troops of the field Army during integrated engineering/operational service tests (ET/OST).

This report is part of the Department of the Army Project 1G644717D556, "Prefabricated Airfield Surfacing and Dust Control," Task 02, "Prefabricated Membrane Development," sponsored by the U. S. Army Materiel Command, Ground Mobility Division, for the development of flexible prefabricated airfield and road surfacing membrane for dustproofing and waterproofing soil subgrades. This task supports military operations in Southeast Asia.

Engineers of the U. S. Army Engineer Waterways Experiment Station (WES) Soils Division who were actively engaged in planning, analyzing, and reviewing this report were Messrs. R. G. Ahlvin, W. L. McInnis, and S. G. Tucker under the general supervision of Mr. J. P. Sale, Chief of the Soils Division. This report was prepared by Messrs. Tucker and R. H. Grau.

The Director of the WES during preparation, review, and publication of this report was COL Levi A. Brown, CE. The Technical Director was Mr. F. R. Brown.

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SAFETY PRECAUTIONS

Care should be exercised when applying adhesives and nonskid compounds to membrane surfacing. Personnel who apply adhesives and nonskid compounds should be positioned upwind from the working area to prevent them from inhaling the fumes. Personnel should also wear gloves so their hands will not come in contact with adhesive and/or nonskid compounds.

Adhesives and nonskids can be removed from the skin with gasoline, methyl ethyl ketone, toluol, and/or waterless soaps.

Personnel who handle membrane surfacing should wear gloves to prevent injury to hands, especially during summer months when the temperature of the surfacing may rise to as high as 130 F.

Care should be exercised when the sections of membrane surfacing are recovered and accordion-folded onto wood pallets to prevent damage to personnel's feet by the skids of the pallets and/or tires of the forklift trucks.

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	2.54	centimeters
feet	0.3048	meters
square feet	0.092903	square meters
liquid pints (U. S.)	0.473179	cubic decimeters
gallons (U. S.)	3.78543	cubic decimeters
pounds	0.45359237	kilograms
tons (2000 lb)	907.185	kilograms
pounds per square foot	4.88243	kilograms per square meter
Fahrenheit degrees	5/9	Celsius or Kelvin degrees*

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

SECTION I

INTRODUCTION

I-01. The purpose of this report is to provide guidance for engineer construction troops and any troops of the field Army that emplace, maintain, and recover the XW18 membrane and accessories in support of aircraft landing facilities such as runways in theaters of operations, which are essential for support of military airlift operations. Army engineer units or groups of indigenous personnel under Army engineer supervision will use the surfacing to improve existing assault-type airfields or to construct new airfields in all areas of the world where field commanders require expedient surfacing or support of air mobile operations.

I-02. This report provides information concerning the techniques and construction procedures used successfully during engineer and service tests of membrane surfacings and also those methods used to assemble membrane surfacing in Southeast Asia where tactical consideration dictated that construction be accomplished as rapidly as possible. This report does not include detailed information concerning landing zone criteria for cargo-type aircraft, as Tactical Air Command (TAC) Manuals 86-1 and 86-5 establish these criteria. Subgrade strength requirements for membrane surfacing are not discussed in this report, as these criteria are provided in Department of the Army Technical Manual 5-366.

I-03. Results of engineer and service tests of membrane surfacings and information received from field commanders in Vietnam indicated that T17 membrane surfacing (FSN 5680-921-8730) was adequate for operations of light fixed-wing aircraft such as the OV-1 Mohawk, U-1A Otter, CV-2 Caribou, and the CV-7 Buffalo, but it was a marginal material for operations of C-130 aircraft. Precisely, the T17 membrane was not capable of withstanding C-130 aircraft assault landings that produced maximum wheel braking and reverse thrust procedures, or

maximum engine run-ups prior to takeoff that produced maximum wheel braking. The XW18 membrane surfacing was designed to withstand the braking action of C-130 aircraft and to be used in conjunction with the T17 membrane surfacing. The XW18 membrane surfacing will be used to surface the initial 500 ft* at each end of membrane-surfaced assault runways, while the remaining areas of the runways may be surfaced with T17 membrane. The XW18 membrane surfacing was also designed as an interim heavy-duty membrane that will withstand C-5 aircraft operations. When used for C-5 aircraft operations, the XW18 membrane will be used to surface the entire length of runway and the connecting taxiways.

* A table of factors for converting British units of measurement to metric units is presented on page ix.

SECTION II

DESCRIPTION OF XW18 MEMBRANE AND ACCESSORIES

II-01. Membrane. The XW18 membrane is a neoprene-coated, four-ply nylon fabric woven from continuous-filament nylon yarns. The finished membrane is supplied normally to the factory in rolls. The membrane placed on rolls varies in width from 54 to 56 in. and in length from 150 to 300 ft. The membrane is $5/64$ in. thick and weighs a minimum of 0.48 lb per sq ft and a maximum of 0.54 lb per sq ft. The 54- to 56-in.-wide runs of membrane are joined together in the factory by a series of 6- to $6-1/2$ -in.-wide, single-lap adhesive joints to provide the 66-ft-wide by 53-ft-long prefabricated surfacing. Typical construction of membrane surfacing that was treated with nonskid compound in the factory is shown in Figure II-1. To provide adequate braking action during inclement weather, nonskid compound has been applied to the surfacing used in the middle 32 ft of the runway, that is, 16 ft on each side of the runway center line. The nonskid compound has been applied to the membrane in a polka dot pattern (Figure II-1). White stripes, 12 in. wide, have also been painted on the surfacing to outline the nonskid-treated area, provide alignment of the surfacing during placement, and serve as runway markings for aircraft operations.

II-02. Accessories. Accessories required for the construction, emplacement, securing, maintenance, and repair of the XW18 membrane surfacing are as follows:

- a. Anchors. Disc-type steel anchors are used to expedite placement of the membrane surfacing by securing the

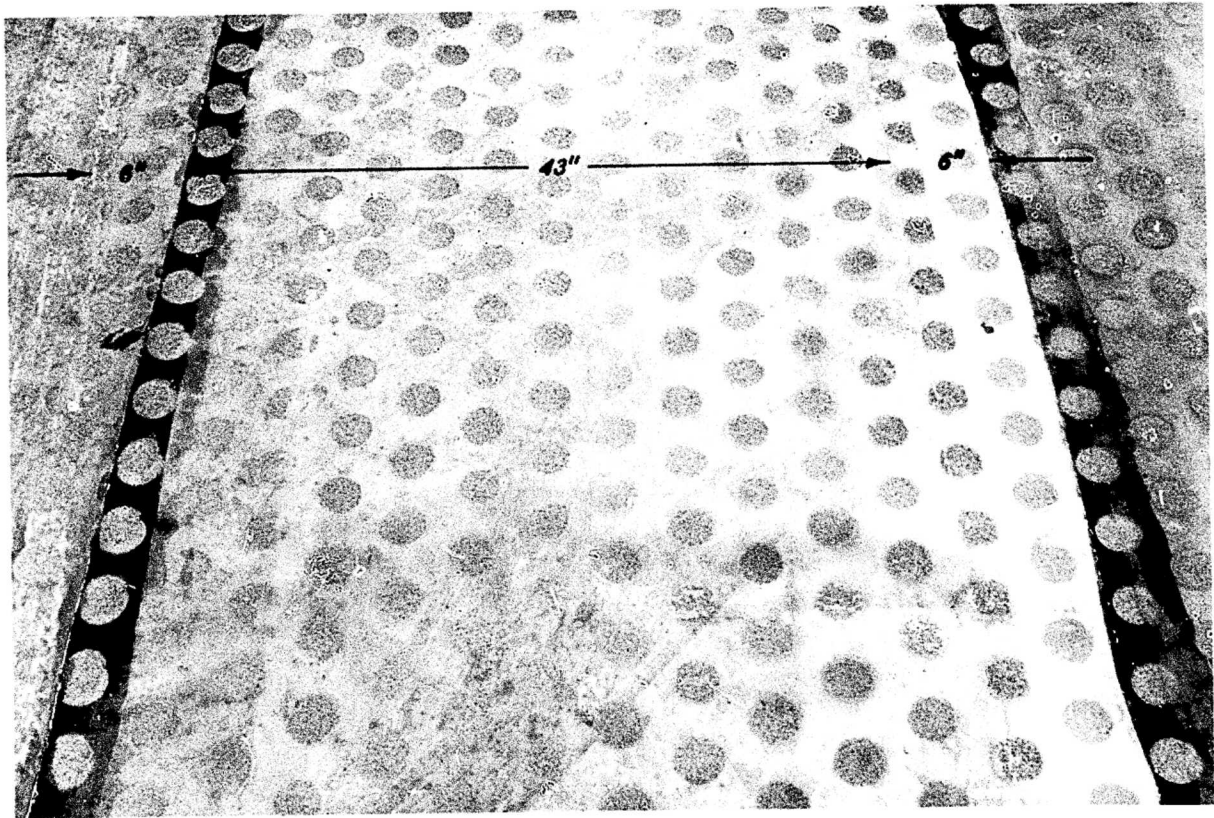


Figure II-1. Nonskid-treated 55-in.-wide run of membrane joined with 6-in.-wide single-lap adhesive joints.

surfacing in place. Each anchor consists of a 3/4-in.-diam steel reinforcing rod approximately 12 in. long arc-welded to a 1/8-in.-thick shaped steel plate 8 in. in diameter, and weighs approximately 3.0 lb (Figure II-2).

- b. Adhesive. Adhesive is used to form membrane construction joints and to repair membrane in the field. The adhesive consists of a synthetic rubber resin dispersed in solvent that evaporates rapidly after exposure to air, thus developing the bond strength of the resin. The adhesive used during dry weather is supplied in 5-gal tight-head pails with pouring spouts. Each 5-gal pail of adhesive weighs approximately 40 lb (Figure II-3). Adhesive used for wet weather repairs and replacement of surfacing is furnished in 1-gal pails with accelerator. This adhesive must be mixed in the field (basic cement and accelerator) prior to use. It has a short pot life and no more of the adhesive should be mixed than that planned for use during a period of 2 hours. The adhesive and accelerator are packaged in cases. Each case contains four 1-gal pails of adhesive and four 1-pint cans of accelerator (Figure II-4).
- c. Nonskid compound. Nonskid compound consisting of catalyzed epoxy binder with abrasive particles supplied in compartmented 5-1/4-gal pails is used to provide an adequate braking surface during inclement weather. Each pail of compound weighs approximately 65 lb (Figure II-5). Factory and field application of nonskid compound will be as described hereinafter.
- d. Paint rollers, handles, and covers. Paint rollers 9 in. wide with 48-in.-long wooden handles are used to apply

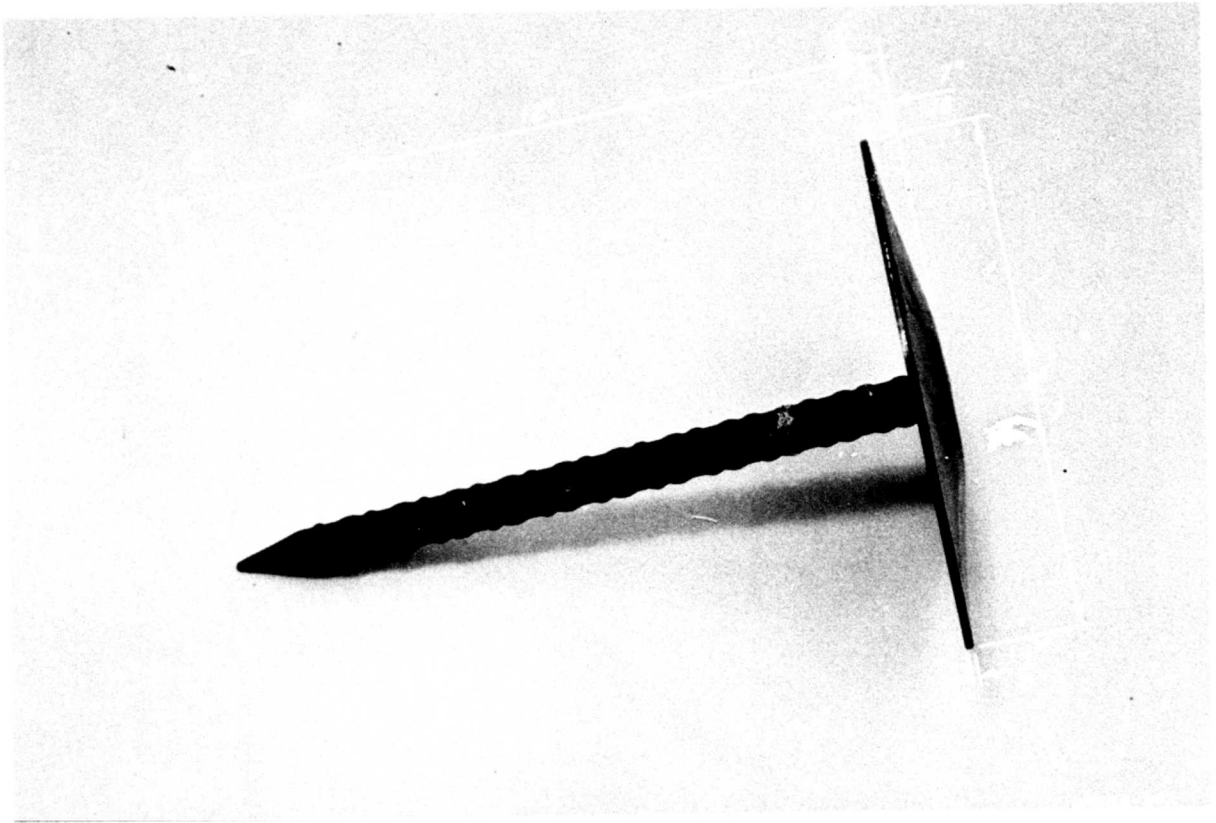


Figure II-2. Steel anchor consisting of 8-in.-diam shaped steel plate welded to 3/4-in.-diam reinforcing rod.



Figure II-3. 5-gal pail containing adhesive.



Figure II-4. 1-gal pail of adhesive and 1-pt pail of accelerator.

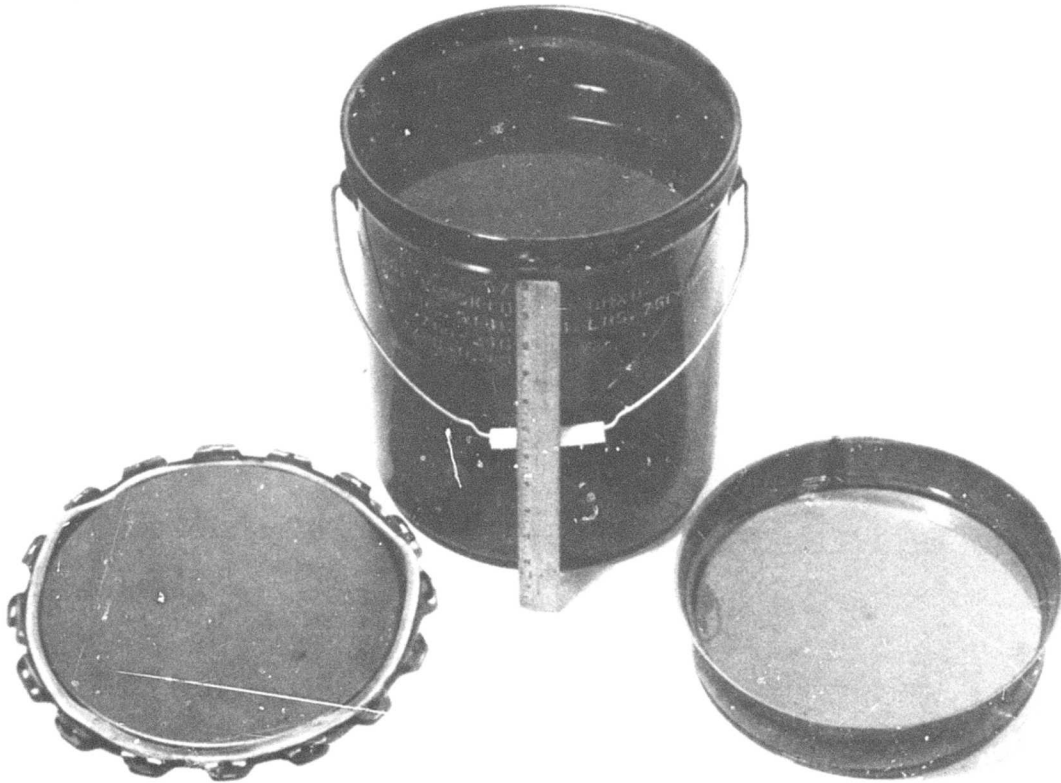


Figure II-5. Compartmented 5-1/4-gal pail that contains epoxy binder with abrasive particles and steel compartment that contains catalyst at right.

adhesive and nonskid compound (Figure II-6). Lamb's wool or synthetic fabric disposable roller covers are provided so that after use the covers can be removed from the rollers and new covers placed on the rollers before reuse.

- e. Joint sealer, caulking gun, and putty knife. A one-part sealant, which cures upon exposure to air and/or moisture, is supplied in a cartridge for application with a one-half barrel-type caulking gun. The sealer is used to seal the edges of the 36-in.-wide reinforcing strip used on adhesive construction joints and for rapid repairs to seams and joints during all weather conditions. To remove excess sealant from areas, a 1-1/4-in.-wide putty knife is used to strike and draw the sealant from the surfacing (Figure II-7).
- f. Roll of membrane, 3 by 66 ft. The XW18 membrane described previously in paragraph II-01 is furnished in a roll that is 36 in. long and has a 10-in. diameter (Figure II-8). One roll of membrane is supplied per set. The roll of membrane is used to reinforce adhesive construction joints and to provide a single-layer cushion of membrane over the heads of disk-type anchors used in each adhesive construction joint.

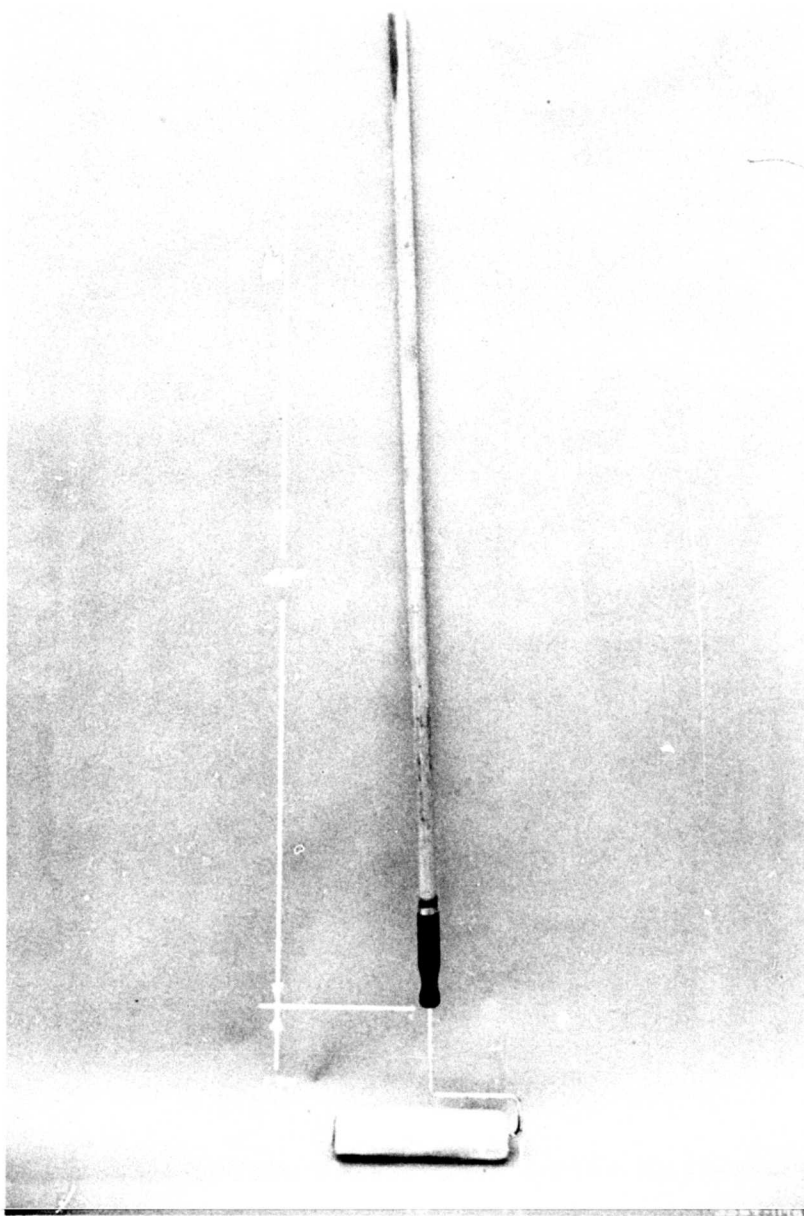


Figure II-6. Paint roller with wooden handle.

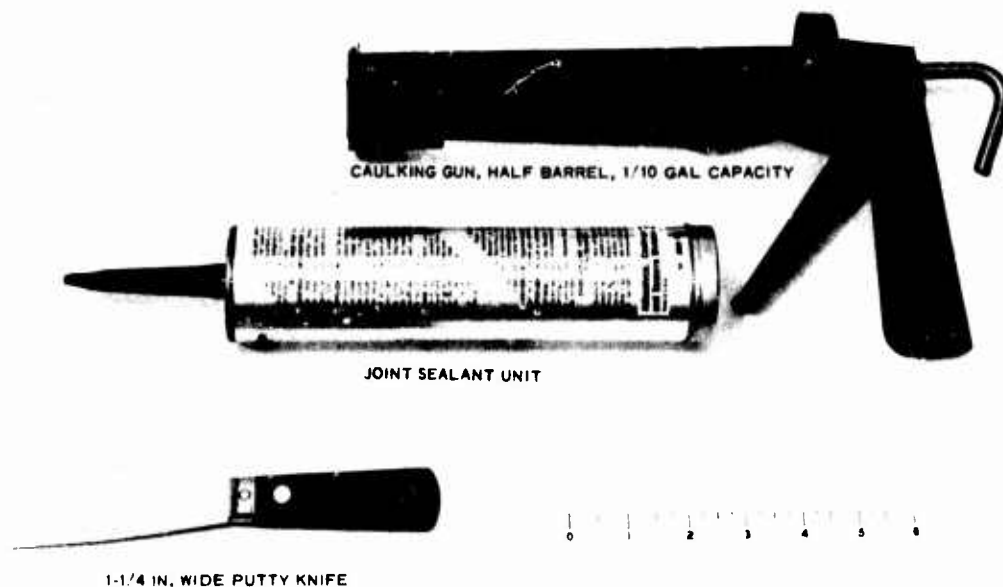


Figure II-7. 1-1/4-in.-wide putty knife, 1/10-gal cartridge of sealant, and 1/2-barrel-type caulking gun.



Figure II-8. Roll of membrane 3 ft wide and 66 ft long.

SECTION III

SELECTION AND PREPARATION OF SITE TO BE SURFACED

III-01. First, selection of the site should be made by the utilization of available topographical maps, aerial photographs, and geological and climatological data on the general area proposed for construction of the airfield. Maximum advantage should be made of local terrain to avoid unnecessary construction effort. When final site selection has been made, the average in-place bearing strength will be determined and its capability evaluated for anticipated aircraft traffic. Detailed landing zone criteria for C-130 aircraft are provided by TAC Manual 86-1 dated September 1968. When grading and sloping of the site are completed, L-shaped anchor ditches 2 ft deep will be constructed at the sides and ends of the area to be surfaced. All anchor ditches should not be constructed before placement of the surfacing. In fact, for a given area that consists essentially of two sides and two ends, only the anchor ditches at the sides and one end should be constructed prior to placement of the membrane. The remaining end anchor ditch should not be constructed until placement and joining of all membrane sections are complete. This will permit access to the area by vehicles and also will permit an exact determination of the location of the final anchor ditch. All soil removed in construction of anchor ditches will be windrowed outside the area to be surfaced. Grading and sloping of the area will be accomplished with motor graders. Construction of anchor ditches will be accomplished with motor graders and/or ditching machines (Figures III-1 and III-2). During periods of forecasted weather conditions that indicate probability of thunderstorms, rain showers, and severe weather, construction of anchor ditches should be held to a minimum so that emplacement of membrane and backfilling of anchor ditches can be completed before such weather conditions occur.



Figure III-1. Motor grader constructing L-shaped, 2-ft-deep anchor ditch.



Figure III-2. Ditching machine constructing 2-ft-deep anchor ditch.

SECTION IV
PLACEMENT OF SURFACING AND USE OF ACCESSORIES

IV-01. Placement of surfacing. Engineer construction troops should be used, if available, to place membrane surfacing; however, if engineer troops are not available, all troops of the field Army with minimum instruction and on-the-job training can place and maintain the surfacing. The membrane is supplied for field use in wood crates (see Section IX) and is folded and secured by steel straps to a wooden skid platform therein. After crates of the surfacing have been stockpiled at the selected site, vehicles should be selected with beds large enough to transport the crates and also provide adequate working space at the sides and rear of the crates. Vehicles such as the M35, M36, M41, M54, M135, M614, and M621 should be used. While in the stockpile area, the tops and sides of the crates should be removed just prior to lifting the skid platform with banded surfacing onto the placement vehicle. To lift, swing, and position the surfacing on vehicles, M62 and/or M543 medium wreckers should be used. The steel straps which secure the surfacing onto the skid platform should not be cut until after the vehicle is positioned on the area to be surfaced. The skid platform will be placed on the vehicle so that its length parallels the length of the vehicle. The end of the skid platform that contains the folded surfacing should be positioned on the bed so that it is near the open side or rear of the vehicle. The vehicle will be positioned on the area to be surfaced so that one edge of the folded membrane can be placed along the center line of the area to be surfaced; then the steel straps that secure the surfacing to the wood platform shall be cut and removed.

IV-02. Placement of the first section of membrane will be initiated by removing approximately 3 ft of the folded surfacing from the skid and placing it in the anchor ditch that has been constructed transverse

to the area to be surfaced (Figure IV-1). The words "top" and "bottom" that are stenciled on the uppermost surface of the accordion-folded section of surfacing will be disregarded during this stage of placement. Next, the placing vehicle will move slowly along the center line of the graded area while the membrane surfacing is unfolded from the rear of the vehicle and placed on the ground. Care will be taken by the driver of the vehicle to ensure that alignment of the membrane with the center line of the area is maintained. Care will also be exercised by the placing crew to ensure the following: one edge of the surfacing is aligned with the center line, the surfacing is placed flat on the ground, and all slack is removed from the surfacing (Figure IV-2). When the membrane is first placed on the ground, it will consist of an accordion-folded surfacing that is approximately 48 in. wide and 53 ft long. After the surfacing is unloaded from the vehicle, troops will be stationed at equal intervals along the 53-ft length of the surfacing and will unfold the surfacing to one side of the area and place the edge of the surfacing in a side anchor ditch. Then the remaining half of the surfacing will be unfolded to the other side of the area and placed in the side anchor ditch (Figure IV-3). The section of membrane will be unfolded so the side marked "top" will face upward and the side marked "bottom" will face downward to contact the soil subgrade. Should the section be unfolded incorrectly, the smooth side of the section will face upward, and it will be necessary to turn the section over so that the nonskid-treated area faces upward and the section repositioned so that alignment of edge and center-line striping is maintained. Every effort will be made to align, position, and remove slack from the surfacing before steel anchors are placed in the surfacing and the ditches backfilled. The anchors will be driven through the membrane in the factory single-lap construction joints where the membrane thickness is doubled. Once the surfacing is positioned on the area and most of the slack removed, steel anchors

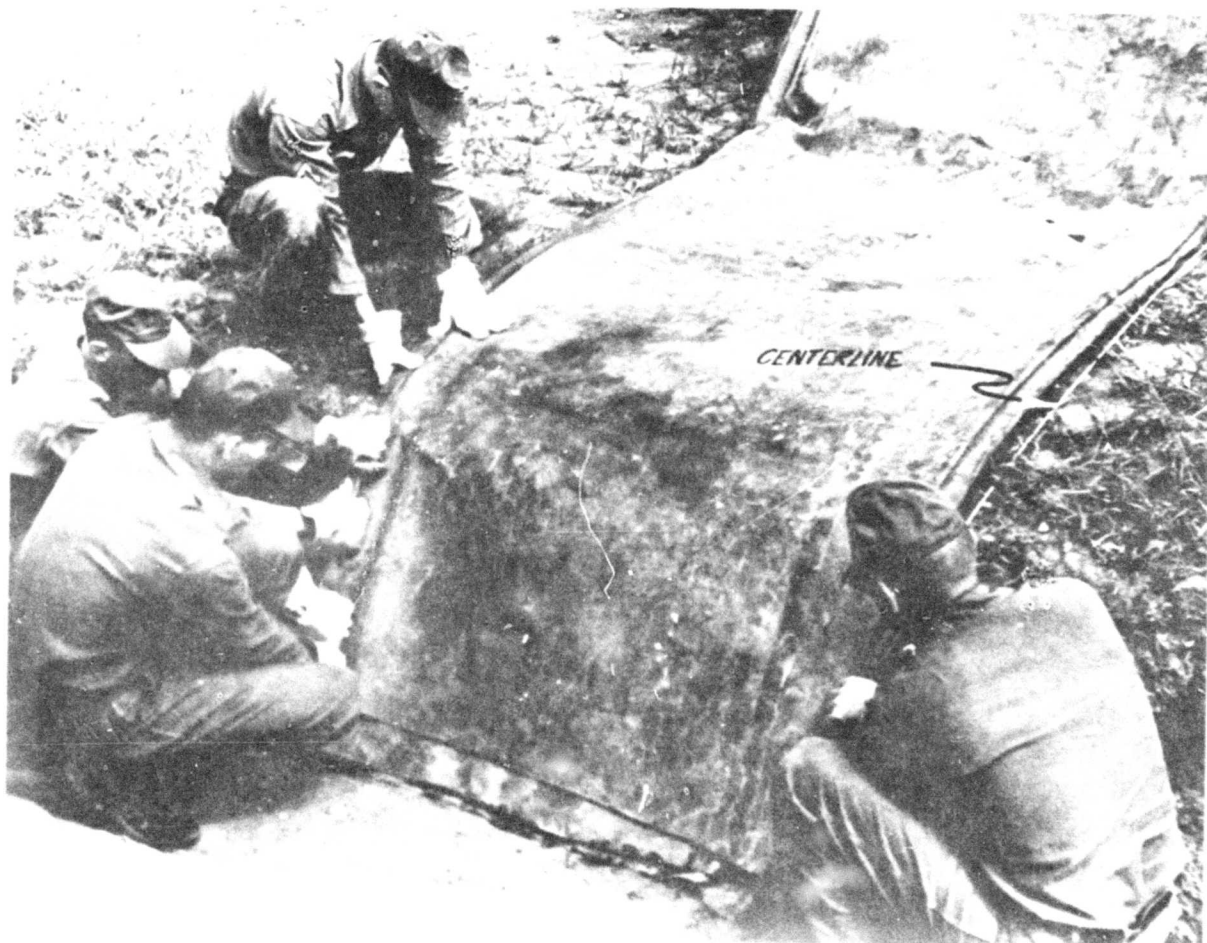


Figure IV-1. Placing membrane in anchor ditch at end of area to be surfaced.



Figure IV-2. Unfolding membrane from truck onto ground along center line of area to be surfaced.



Figure IV-3. Troops stationed along edge of surfacing unfolding it into side anchor ditch.

will be driven through the surfacing in the end anchor ditch approximately 6 in. from the edge of the surfacing (Figure IV-4). Eight steel anchors will be used to secure the membrane surfacing in the end anchor ditch. Anchors will be driven in three alternate factory single-lap construction joints located immediately on each side of the center line of the section of membrane and in each corner of the section that is placed in the end anchor ditch. The end anchor ditch will then be backfilled and compacted with a motor grader. Additional slack will be removed from the surfacing by troops pulling on the free end of the surfacing that has not been placed in anchor ditches (Figure IV-5). As slack is removed, steel anchors will be driven through alternate single-lap adhesive construction joints on approximately 9-ft centers and 1 ft from the outer edge of the free end of the surfacing (see step 1 of Figure IV-6). White lines 1/8 in. wide located 1 ft from each end of the section of membrane have been painted on the section to provide alignment of anchors driven through the membrane (Figure IV-7). Steel anchors will then be driven through the surfacing placed in the side anchor ditches on 17-ft centers and approximately 6 in. from the outer edge of the surfacing. After anchors are driven in the side ditches, backfill will be placed in the ditches in 6-in. lifts and compacted with a motor grader. Other wheeled vehicles, such as those used to transport the membrane surfacing, may be used to expedite compaction of the backfill in the ditches. The side ditches will not be backfilled completely to the free end of the section of surfacing, as room will be needed to construct the adhesive construction joint. Backfilling of the side ditches will stop approximately 6 ft from the free end of the surfacing.

IV-03. While the side ditches are being backfilled on the first section of surfacing, the next section of surfacing will be unloaded on the area in the manner described previously for the first section of surfacing. Before the second section of surfacing is unloaded on the ground, the vehicle will be positioned and a sufficient amount of

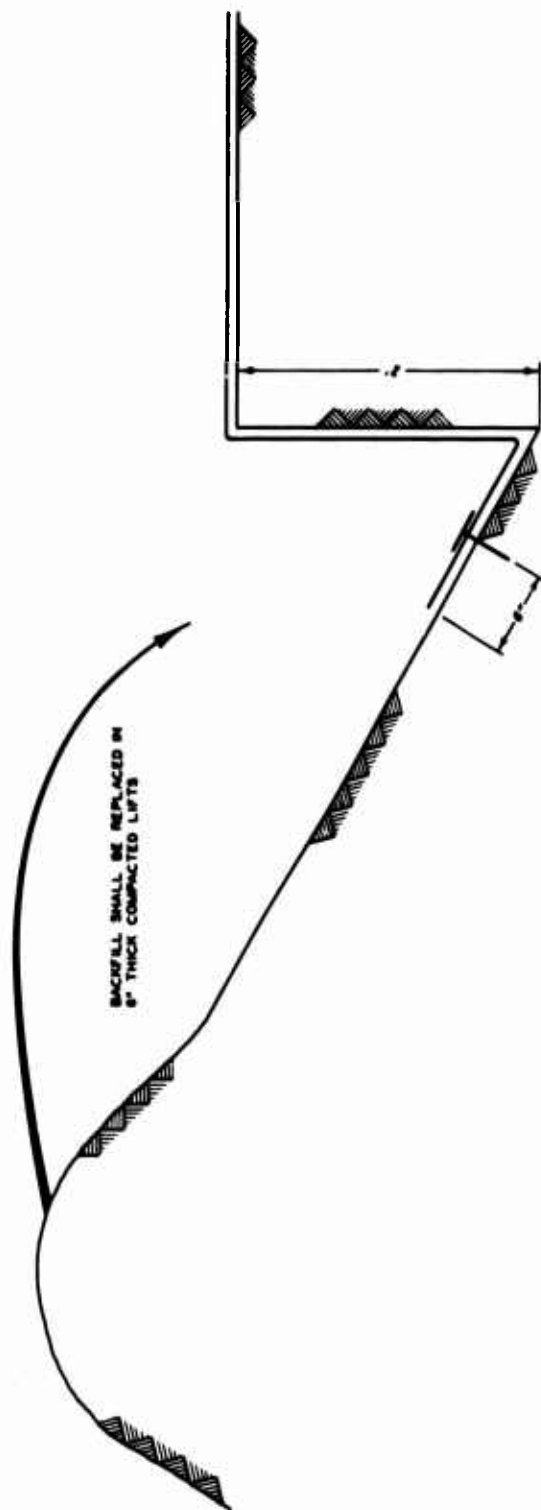


Figure IV-4. Procedure for anchoring membrane in anchor ditch.



Figure IV-5. Troops removing slack from section of surfacing by pulling on free end of surfacing.

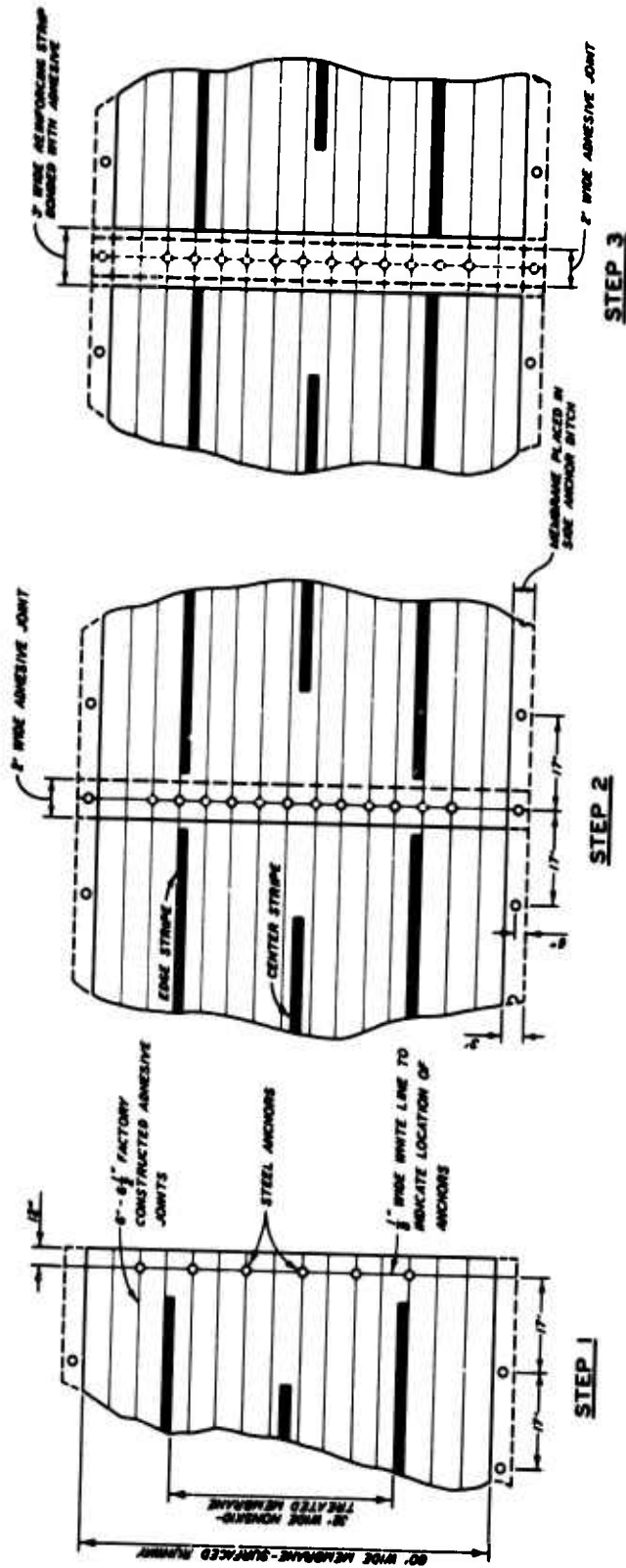


Figure IV-6. Procedure for construction of membrane field joint.

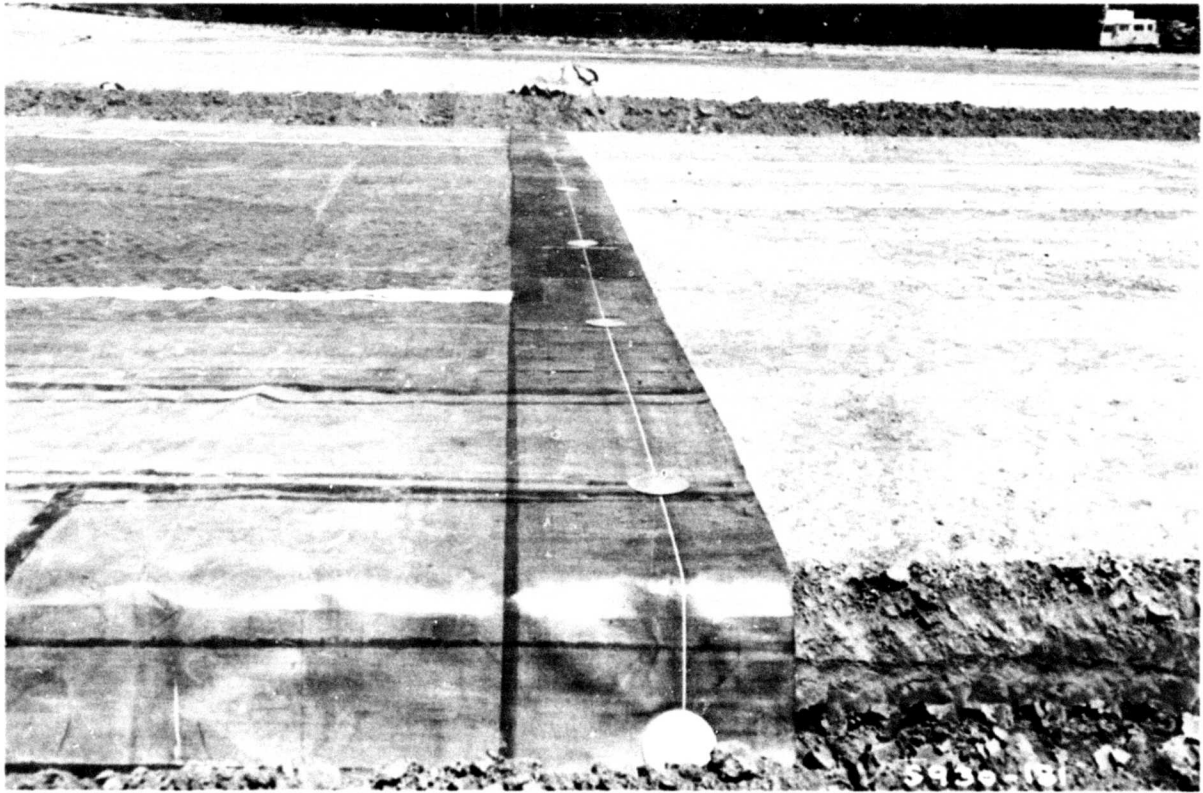


Figure IV-7. Alignment of anchors on 1/8-in.-wide white line.

surfacing unfolded from the vehicle so that the end of the second section overlaps the first approximately 24 in. (Figure IV-8). After the second section has been unfolded and placed in anchor ditches, as was the first section, the protective paper shall be removed from the overlapping ends of the first and second sections. The paper will not be removed from both ends of the second section until completion of the adhesive construction joint and removal of slack from the section. This sequence for removing the protective paper will be followed until placement of all sections is completed. When the protective paper has been removed, the overlapping end of the second section will be positioned over the end of the first section so the 1/8-in.-wide white line on the second section will be placed directly over the white line on the end of the first section. The second section will be positioned so the 12-in.-wide white center line will be aligned with the center line of the first section. Before any effort is made to remove slack from the second section of surfacing, steel anchors will be driven through the overlapping ends of both membrane sections and into the subgrade to a depth of approximately 6 in. (Figure IV-9). These anchors will be located between the anchors driven previously through the first section of surfacing (Figure IV-6). All anchors will be driven through the overlapping sections and positioned on the 1/8-in.-wide white line located 1 ft from the edge of the surfacing. After the anchors are driven through the surfacing, initial slack will be removed from the second section of surfacing, and then anchors will be driven through the factory-constructed single-lap joints located in the free end of the surfacing. The 1/8-in.-wide white line on the free end of the second section indicates where anchors will be driven. The anchor spacing will be the same as that used previously on the first section of membrane surfacing. Anchors placed on 17-ft centers will be driven through the surfacing placed in the side anchor ditches. Construction of the adhesive construction joint between



Figure IV-8. Second section of surfacing overlapping first section approximately 24 in.

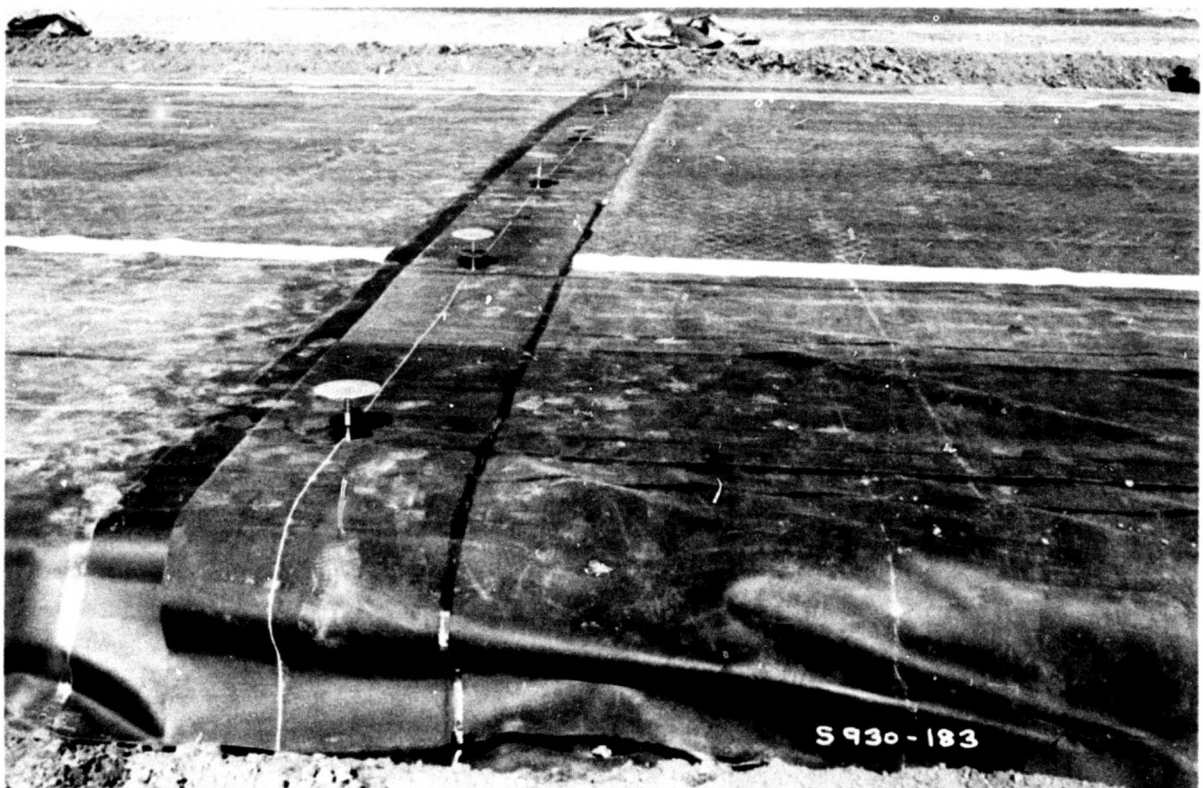


Figure IV-9. Anchors driven through the overlapping ends of two sections of membrane to a depth of approximately 6 in.

the first and second sections will be undertaken after the anchors have been driven through the overlapping end of the second section of membrane. To construct the joint, the 2-ft-wide overlapping end of the second section will be raised with 48-in.-long paint roller handles (Figure IV-10) so adhesive can be poured onto the underlying surfacing. The joint will be constructed in increments approximately 9 ft long located between anchors driven through the surfacing. Uniform spreading of the adhesive onto the surfacing will be accomplished with the long-handled rollers so that the adhesive covers an area that extends approximately 1 ft beyond the anchor heads. Ample time (usually 2 to 5 minutes) will be allowed for the adhesive to become tacky to the touch; however, additional or less time may be required, depending on weather conditions. When the adhesive becomes tacky, the overlapping ends of the sections will be placed in contact and the anchors driven flush with the surfacing. Care should be exercised to avoid overdriving the anchors. When a snug fit is obtained between the surfacing and anchor head, driving should be stopped. To reinforce the adhesive construction joint, a 36-in.-wide strip of membrane will be placed over the joint and bonded to the surfacing with adhesive (Figure IV-11). In placing the strip over the joint, the roll of membrane will be aligned so that it straddles the 1/8-in.-wide white line located on the overlapping section. Care will be exercised when placing the reinforcing strip to ensure that the edges of the strip do not extend onto the nonskid-treated area of the surfacing. Adhesive will be spread at intervals of 10 to 15 ft along the joint in a width of approximately 38 in. After the adhesive becomes tacky, the roll of membrane will be rolled across the adhesive-covered area; care will be exercised to maintain alignment of the strip and to remove all slack and wrinkles from the membrane. This procedure of applying adhesive and then rolling the membrane across the adhesive-covered area will be continued for the full length of the joint. After the strip has been allowed to set for approximately



Figure IV-10. Overlapped end of second section raised with 48-in.-long paint roller handles.



Figure IV-11. Reinforcing adhesive construction joint with a 36-in.-wide strip of membrane.

15 minutes, the strip may be rolled with a rubber-tired vehicle (jeep) (Figure IV-12). Rolling of the reinforcing strip with a jeep is optional. If a visual inspection of the strip reveals that air pockets exist beneath the strip, then the joint should be rolled to remove these pockets. If no such pockets are found, then rolling the joint is not required. The edges of the 3-ft-wide reinforcing strip will be sealed with sealant. The edges may be sealed with sealant after each reinforcing strip has been allowed to set for approximately 15 minutes and/or been rolled with a jeep. Sealing of the strips may also be delayed until near the end of the working day. Because of the cure time required for the sealant, no traffic of any kind will be allowed on the sealed strips for a minimum period of 48 hours. Any foreign material that may have accumulated adjacent to the edges of the reinforcing strips will be removed before the sealant is applied to the surfacing. A 1/4-in.-wide continuous bead of sealant will be applied to each edge of the reinforcing strip with a caulking gun as shown in Figure IV-13. The bead of sealant will be beveled with a putty knife (Figure IV-14) so the sealant will be flush with the upper surface of the reinforcing strip. Placement of additional sections of surfacing will be accomplished in the same manner as that described previously in this section. Caution. Loaded dump trucks should be used to compact soil backfill placed in 6-in. lifts in all anchor ditches. If motor graders are used to compact the backfill placed in 6-in. lifts, care will be taken to prevent the grader blade from snagging or cutting the surfacing (Figure IV-15). Adhesive construction joints will not be constructed during inclement weather, as the adhesive will ball up and will not adhere to wet membrane surfacing.

IV-04. Personnel and equipment. The number of personnel and the equipment required to accomplish placement of the membrane surfacing will be determined by the size of the areas to be surfaced. The minimum number of crews, personnel, and equipment required to emplace sections of heavy-duty membrane on airfield runways are as follows:



Figure IV-12. Rolling adhesive construction joint with jeep.

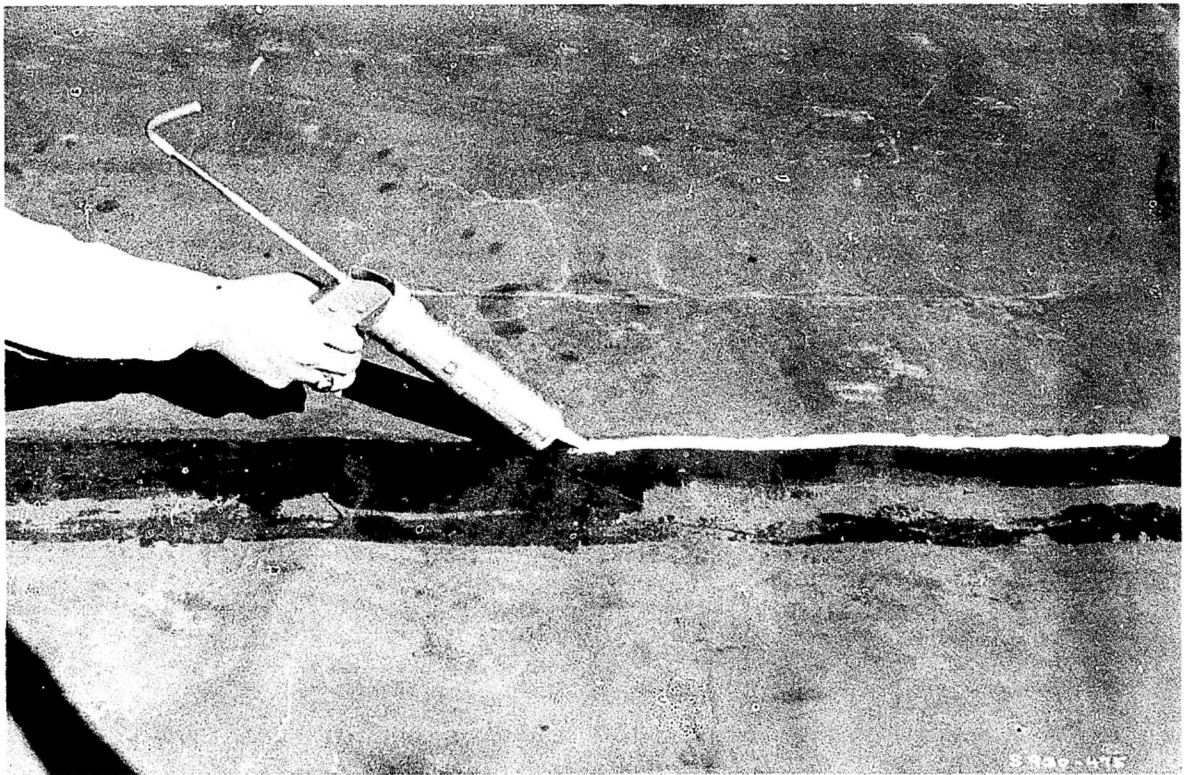


Figure IV-13. Applying a continuous bead of sealant to the edge of the reinforcing strip.



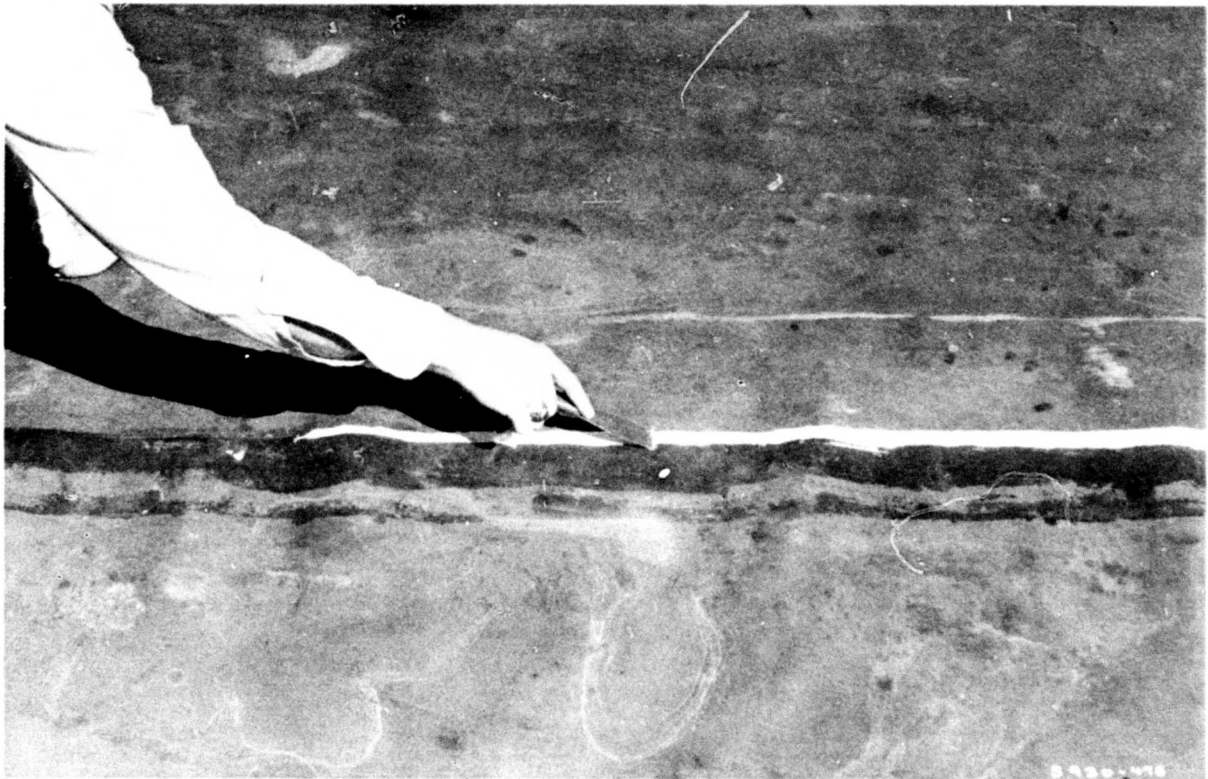


Figure IV-14. Beveling bead of sealant with putty knife.



Figure IV-15. Compacting backfilled anchor ditch with motor grader.

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Equipment operators	5 (2 motor grader operators, 3 truck drivers)	Two motor graders, three 2-1/2-ton trucks with flat beds
Unfolding, stretching, and anchoring membrane	18* (2 on truck, cut straps, and unfold onto ground; 8 on ground, align, walk surfacing flat; and 8 drive anchors in anchor ditches and construction joints)	Four 12-lb sledgehammers
Adhesive construction joint	5 (2 to pour adhesive, 2 to spread adhesive on joint, and 1 jeep driver to roll joint)	One 2-1/2-ton truck with A frame, or medium M62, M543 wrecker 1 jeep

* The full crew of 18 personnel will be used to unfold the membrane surfacing into the side anchor ditches.

SECTION V
MAINTENANCE, REPAIR, AND
REPLACEMENT OF MEMBRANE SURFACING

V-01. Maintenance and repair of membrane. Service tests have indicated that repair and maintenance of membrane surfacing for operation of current U. S. Army aircraft will be minor. However, more repairs and maintenance can be expected for traffic with maximum-loaded C-130 aircraft. Most, if not all, repairs will be needed in the first 300 ft of surfacing at each end of the runway. The size of the repair and maintenance crew will be determined by the size of the area surface. For airfield complexes, a crew of six men is adequate. The surfacing should be inspected thoroughly just before initiation of sustained aircraft operations to determine the condition of the surfacing and to perform essential maintenance. When aircraft operations begin, the surfacing must be inspected by the crew with binoculars to permit uninterrupted use of the surfacing. Should a failure occur in the surfacing during aircraft operations, the failure will be repaired as soon as aircraft operations permit; otherwise, ballooning of the surfacing may occur. Usually, ballooning occurs only when the surfacing has been punctured or torn and air is forced through these openings in the surfacing by the prop wash of aircraft engines. The air forced through the opening and subsequently trapped beneath the surfacing causes the surfacing to balloon, arise from the surface of the ground, and become airborne. Service tests on the surfacing have shown that small surface failures may be trafficked by aircraft for a limited period without severe damage or ballooning of the surfacing; nevertheless, the best practice is to repair all failed areas as soon as possible. Less time and effort will be required to repair a small area immediately after failure than to risk the small area developing into a major repair problem.

V-02. Since the nonskid compound will cover the upper surface of the membrane in the traffic area, failures in this area will be repaired by slitting the failed surfacing in the form of a cross and folding the four flaps back. An area approximately 2 ft wide surrounding the failure on all sides will be cleaned to remove dirt or dust that may have accumulated on the underneath side of the surfacing. After the surfacing has been cleaned, the area will be allowed to dry before the adhesive is applied. Then adequate membrane surfacing will be removed from a roll of membrane and placed beneath the nonskid-treated membrane surfacing so that it extends beyond the failed area of surfacing approximately 2 ft on all sides. Adhesive will then be applied to the top of the membrane removed from the membrane roll and to the bottom of the surfacing coated with nonskid compound. Adhesive will be spread over the membrane with the long-handled rollers. After the adhesive becomes tacky (2 to 15 minutes), the flaps that were folded back previously will be placed in their original positions, and the adhesive allowed to set for approximately 15 minutes before rolling the patched areas with a jeep. This manner of patching may also be used for areas of surfacing that are not coated with nonskid compound, but it is recommended that these areas be patched on the top side. However, should considerable traffic occur on the area that must be repaired, the patch should be applied to the bottom side of the membrane. Should free water be found on the soil subgrade beneath the membrane, patching can be expedited by applying the patch to the top surface of the membrane. When a failure is patched from the top, an area approximately 2 ft wide surrounding the failure will be cleaned to remove all dirt and foreign material. Then adhesive will be applied to the cleaned area and to the swatch of membrane removed from the roll. After the adhesive becomes tacky, the adhesive-coated swatch of membrane and the adhesive-coated surfacing will be placed in contact and allowed to set for approximately 15 minutes before the patched area is rolled with a jeep. If the failure is large or irregular, it may be necessary

to use some of the anchors furnished with the maintenance kit to anchor and reinforce the repaired surfacing. When anchors are used to repair the surfacing, care will be exercised to ensure that adequate patching material is used to completely cover the heads of all anchors and extend 2 ft beyond the failed area of surfacing.

V-03. Procedures described in paragraph V-02 for repairs during dry weather are also applicable for membrane repairs during inclement weather with the exception that the surfacing does not have to be dry, but it must be free of mud. The wet-weather adhesive (adhesive furnished in 1-gal pails) will adhere to wet membrane surfacing, and it can be applied to the surfacing during rains. The bond strength of the wet adhesive usually decreases after a period of two to three weeks; therefore, it will be necessary to replace the wet-weather patch with a dry-weather patch as soon as the weather permits.

V-04. The thickness and stiffness of the heavy-duty membrane surfacing are such that it is necessary to always exercise care in the construction of adhesive joints to prevent wrinkled joints. If wrinkles extend the full width of a joint, water will pass through the wrinkles and wet the underlying soil subgrade. Cartridges of sealant are furnished in the maintenance kits which will be used to seal these wrinkles. The sealant will be applied with a caulking gun to the wrinkled joint area as shown in Figure IV-13. The bead of sealant will be beveled with a putty knife (Figure IV-14) so it will be flush with the upper surface of the membrane.

V-05. The minimum crew and equipment required to perform routine maintenance to membrane-surfaced airfields are as follows:

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Inspect and repair membrane	7 (1 NCOIC, 2 truck drivers, and 4 to make repairs)	Two 3/4-ton trucks

V-06. Maintenance and repair of nonskid compound. When 25 percent or more of the original factory-applied nonskid compound has been removed from the membrane surfacing, it will be necessary to apply nonskid compound to the surfacing. The nonskid compound will be applied to the surfacing with paint rollers at a rate of 80 to 100 sq ft per gal. The compound consists of two components: namely, the accelerator, which is contained in a steel compartment located in the top of the 5-1/4-gal pail, and the basic compound located in the lower part of the pail. The nonskid compound will be mixed by pouring the accelerator into the pail with the basic compound and thoroughly mixing these components for a minimum period of 15 minutes. One of the 1- by 4-in. braces on the maintenance kit can be used to mix the nonskid compound. When the components are mixed adequately, the compound will be allowed to set for a period of 45 minutes before it is applied to the membrane surfacing. Paint rollers with 48-in.-long handles will be used to apply the nonskid compound to the surfacing. It will be applied to provide complete coverage of the surfacing in the traffic area. A minimum cure time of 24 hours will be allowed for the nonskid compound before traffic is resumed on the surfacing.

V-07. The minimum crew and equipment required to apply nonskid compound to membrane surfacing are as follows:

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Inspect and apply nonskid compound	7 (1 NCOIC, 1 truck driver*, 1 to mix nonskid compound, 2 to pour compound on surfacing, and 3 to apply nonskid compound*)	One 3/4-ton truck

V-08. Replacement of membrane surfacing. Replacement kits are provided so that one or more sections of membrane surfacing can be replaced.

* Same individual, dual tasks.

These kits will be used only when it is not feasible to perform expedient repairs to an installed section of surfacing. A failed section of membrane surfacing will be removed by first cutting it at the sides parallel to and approximately 6 ft from the side anchor ditches. These cuts will extend to the 3-ft-wide reinforcing strips located at each end of the section. The surfacing will also be cut free at each end where the edge of the reinforcing strips joins the section of membrane. The failed section of membrane surfacing will be removed after it has been cut free on all four sides. The reinforcing strip at each end of the removed section will also be cut approximately 6 ft from the side anchor ditches. Although the full width of the strips will be cut, extreme care will be exercised so that only the reinforcing strip is cut and not the underlying surfacing. After the strips are cut, they may be removed by peeling one end loose by hand for a length of 4 to 5 ft and then attaching the loose end to the bumper of a vehicle. The vehicle will be moved slowly so that the remaining length of the strip is peeled loose. The steel anchors will be exposed when the strips are peeled loose. These anchors will be pried out of the ground with picks and/or shovels. The piece of membrane surfacing approximately 2 ft wide that was trimmed from the failed section will also be removed from one of the adhesive construction joints.

V-09. The replacement section of the membrane surfacing will be unfolded and positioned on the runway in the same manner as that described for membrane placement in Section IV. Care will be exercised to ensure that the center line of the replacement section is aligned with the center lines of the adjacent sections of membrane. Transverse adhesive construction joints located at each end of the section will be constructed in the same manner as described in Section IV. The sides of the replacement section will be bonded with 2-ft-wide adhesive single-lap joints to the in-place sides of the failed section. Reinforcing strips will not be required for these adhesive joints at the sides.

Adhesives supplied in the replacement kits may be used during both dry and wet weather.

V-10. The minimum number of personnel and equipment required to replace one or more sections of membrane surfacing are as follows:

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Load crate into 2-1/2-ton flat-bed truck and transport to site	4 (2 truck drivers, and 2 to sling load crates)	One 2-1/2-ton truck with A frame, one 2-1/2-ton truck with flat bed
Unfolding, stretching, and anchoring membrane	18	Four 12-lb sledgehammers
Adhesive construction joints	5 (2 to pour adhesive, 2 to spread adhesive, and 1 jeep driver to roll joint)	1 jeep

SECTION VI
RECOVERY OF MEMBRANE SURFACING

VI-01. Removal of membrane. When aircraft operations are completed on a membrane-surfaced airfield, the surfacing may be removed from the airfield and installed at new locations. In order to recover 90 percent of the surfacing, the soil backfill will be removed from the end and side anchor ditches with a motor grader (Figure VI-1). Approximately 2 to 3 in. of soil should be left in contact with the surfacing to prevent cutting the surfacing with the blade of the motor grader (Figure VI-2). This soil backfill will be removed from the anchor ditches with hand shovels. The 3-ft-wide strips of membrane that reinforce each adhesive construction joint will be removed first by peeling one end loose for a distance of approximately 5 ft, and then attaching the loose end to the bumper of a vehicle. The vehicle will then be used to pull the 3-ft-wide strip loose from the surfacing. When all backfill is removed from the ditches, anchors that have been exposed in each adhesive construction joint and in anchor ditches will be removed first by prying them loose from the subgrade with picks and shovels. After anchors are removed, one corner of the uppermost section of membrane will be peeled loose by hand for approximately 5 ft (Figure VI-3); then, the loose corner will be wrapped around the bumper of a truck, and the truck moved slowly across the runway (Figure VI-4) until the sections are separated. After sections are peeled apart and all anchors removed, they will be turned over so that dirt and mud that have accumulated on the bottom side of the surfacing can be removed with shovels and brooms. Failures that are found when the underneath side is cleaned will be repaired. The repairs will be made with materials from the maintenance kits. When the supply of membrane material in the maintenance kits is depleted, the 3-ft-wide reinforcing strips that were peeled from the adhesive construction joints will be used to repair additional failures. After the sections are swept clean and repaired, troops



Figure VI-1. Motor grader removing soil backfill from end anchor ditch.



Figure VI-2. Backfill left adjacent to membrane surfacing after the motor grader had removed the soil from the side anchor ditch.



Figure VI-3. Troops peeling corner of adhesive construction joint loose.



Figure VI-4. Truck pulling membrane section loose from adhesive construction joint.

stationed at equal intervals along the 53-ft lengths of the sections (Figure VI-5) will accordion-fold each section of membrane into a bundle approximately 48 in. wide and 53 ft long (Figure VI-6). Each folded section will then be accordion-folded onto wood pallets. The end of the folded section will be placed on a pallet and held in place by troops while three 10-ft-long pipes are positioned at equal intervals beneath the membrane surfacing for a distance of 12 to 15 ft. As shown in Figure VI-7, troops will hold the surfacing with the pipes high enough to clear the pallet while a forklift truck moves the pallet beneath the surfacing. As the forklift truck moves forward, the surfacing will be lifted with the pipes and accordion-folded onto the pallet. Figure VI-8 shows a section of membrane that has been accordion-folded onto the pallet. Steel straps* will be used to secure each section of membrane to the wood pallet.

VI-02. Personnel and equipment. The number of personnel and equipment required to remove the membrane surfacing will be determined by the size of the area that is surfaced. The minimum number of personnel and equipment required to handle sections of membrane and perform tasks are as follows:

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Equipment operators	4 (2 motor grader operators, and 2 to direct motor grader operators)	2 motor graders
Adhesive construction joint	6 (5 to peel reinforcing strip and membrane section loose, and 1 truck driver)	One 2-1/2-ton truck
Remove anchors	4	

* Not furnished with membrane kits. Prior to recovery, adequate banding equipment and steel strapping and nails must be obtained from depot stocks.

(cont'd)

<u>Crew</u>	<u>No. of Personnel</u>	<u>Equipment</u>
Accordion-fold membrane sections	18 (17 to fold membrane, and 1 forklift operator)	1 forklift, 3 pipes* 2 to 3 in. in diameter and 10 ft long
Band membrane to wood pallets	2	Steel banding equipment* (FSN 3540-565-6244 and 3540-278-1251)

* Not furnished with membrane kits. Must be obtained from depot stocks.



Figure VI-5. Troops accordion-folding membrane section.

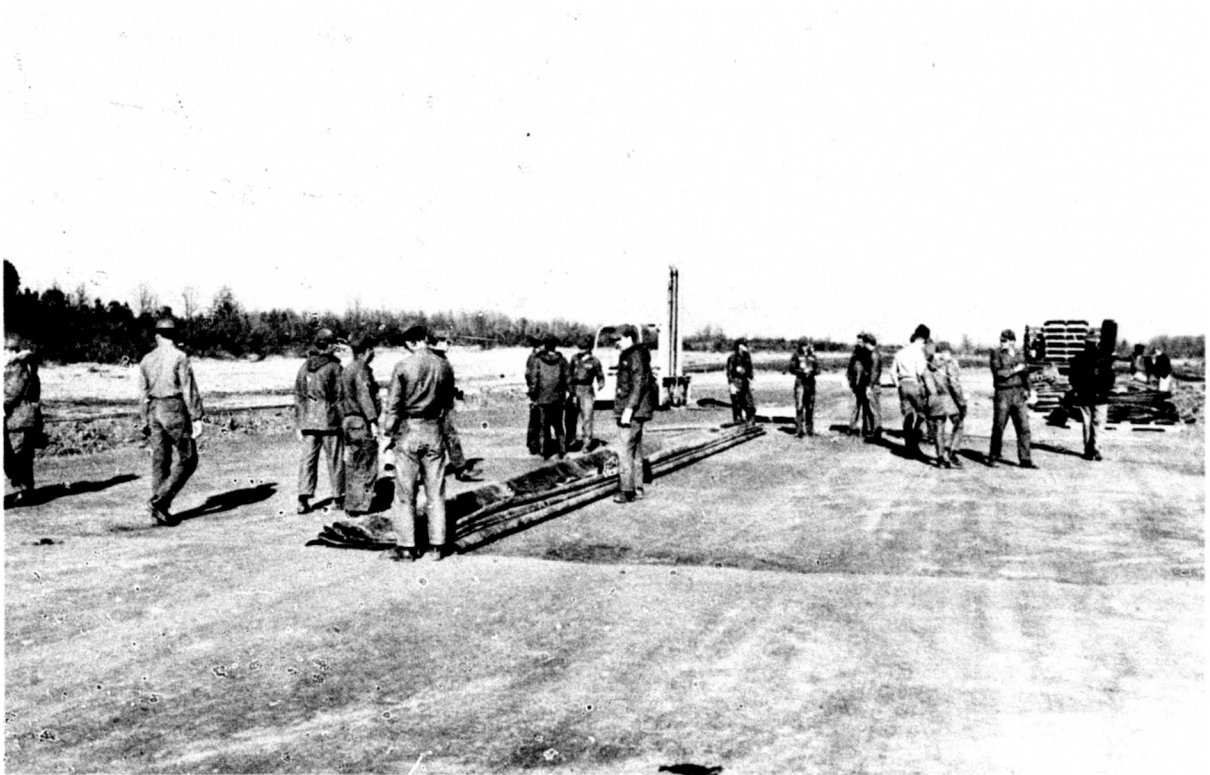


Figure VI-6. Accordion-folded membrane section approximately 48 in. wide and 53 ft long.

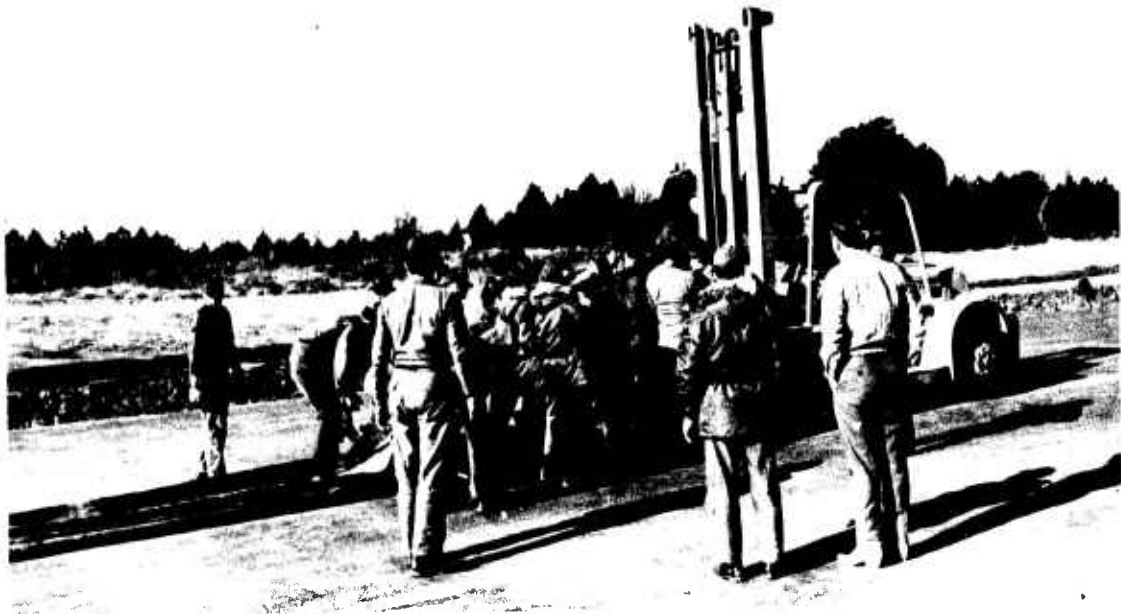


Figure VI-7. Troops accordion-folding membrane surfacing onto a wood pallet.



Figure VI-8. Wood pallet containing an accordion-folded section of membrane surfacing.

SECTION VII

REPAIR AND MAINTENANCE OF SOIL SUBGRADE

VII-01. When the soil subgrade beneath the membrane surfacing becomes rutted by aircraft traffic to the extent that the ruts constitute a hazard to aircraft operation, then the subgrade will be repaired. If possible, the subgrade will be repaired by leaving the membrane surfacing in place and cross-rolling the rutted area to smooth out the ruts and compact the area. Rolling can be accomplished with a steel-wheel roller (Figure VII-1), a 13-wheel, rubber-tired roller, a 4-wheel, 50-ton rubber-tired roller, or a loaded M51, 5-ton, 6 by 6 dump truck. If any of the above-mentioned equipment causes the subgrade to pump, it will be necessary to slit the membrane surfacing and fold the surfacing back to provide working room for construction equipment. In some cases, the subgrade can be dried by scarifying the soil and allowing it to air dry; in other cases, the wet soil will have to be excavated and replaced with dry backfill material. Figure VII-2 shows a motor grader spreading dry backfill material on an area that is being repaired. The dry soil will be compacted with one of the pieces of construction equipment listed previously. Operations of construction equipment, especially steel-tracked bulldozers, should be in a direction parallel to the width of the surfacing; this will allow the equipment to enter and leave the area without traversing the membrane surfacing. Once the area has been repaired, the membrane surfacing will be returned to its original position and patched as discussed previously in Section V.



Figure VII-1. Rolling out ruts in soil subgrade beneath membrane surfacing with steel-wheel roller.



Figure VII-2. Motor grader spreading backfill material in rutted area.

SECTION VIII
STORAGE OF MEMBRANE SURFACING

VIII-01. The crated sections of membrane surfacing and accessories, maintenance kits, and replacement kits can be stored in open or closed depot storage. The crates are constructed so they can be stacked in tiers three high. The materials used to construct the crates will last indefinitely in closed storage and approximately ten years in open storage. The items contained in the wood crates will last indefinitely in open or closed storage. If the crated sections of membrane are stored in the open, they will be placed on an area that has adequate drainage so rainwater will not puddle under the wood crates, for this will shorten the life of the crates.

SECTION IX
ILLUSTRATED PARTS BREAKDOWN

Description	Quantity
MEMBRANE SET, RUNWAY SURFACING, XW18 (Figure IX-1)	
Section of XW18 membrane, 66 ft wide and 53 ft long	1
Roll of XW18 membrane, 3 ft wide and 66 ft long	1
Adhesive, 5-gal pail (use during dry weather)	2
Disc-type anchor	18
Paint roller with cover	2
Roller handle	2
Caulking gun	2
Sealant, 1/10-gal cartridge	2
Putty knife	2
MAINTENANCE KIT, XW18 MEMBRANE (Figure IX-2)	
Roll of XW18 membrane, 3 ft wide and 66 ft long	2
Disc-type anchor	18
Adhesive, 5-gal pail (use during dry weather)	2
Paint roller with cover	6
Roller handle	6
Roller cover	12
Nonskid compound, 5-1/4-gal pail	6
Sealant, 1/10-gal cartridge	12
Caulking gun	2
Putty knife	2
Adhesive, 1-gal pail with accelerator (use during wet weather)	12



Figure IX-1. Runway set, XW18 membrane surfacing.

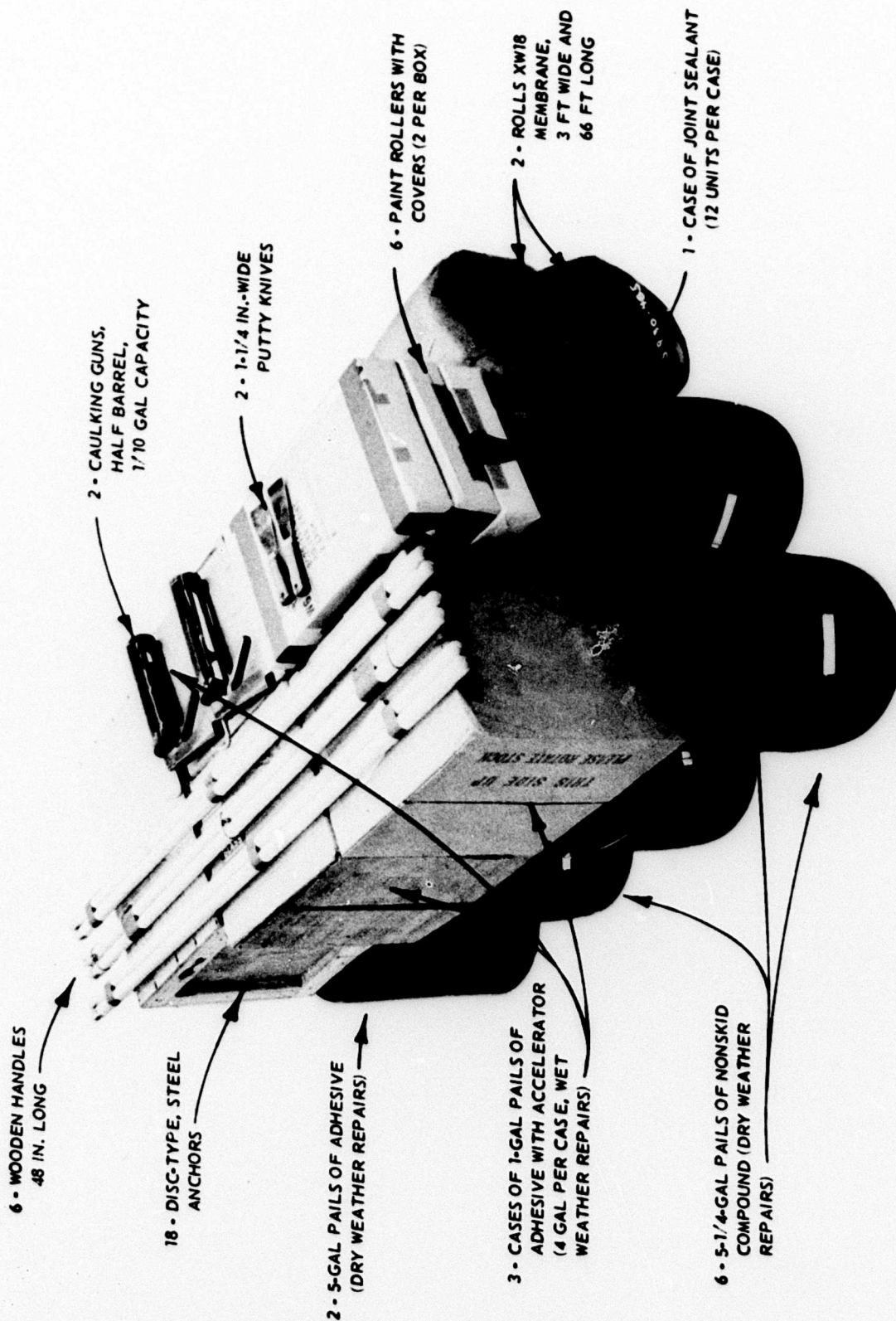


Figure IX-2. Maintenance kit, XW18 membrane surfacing.

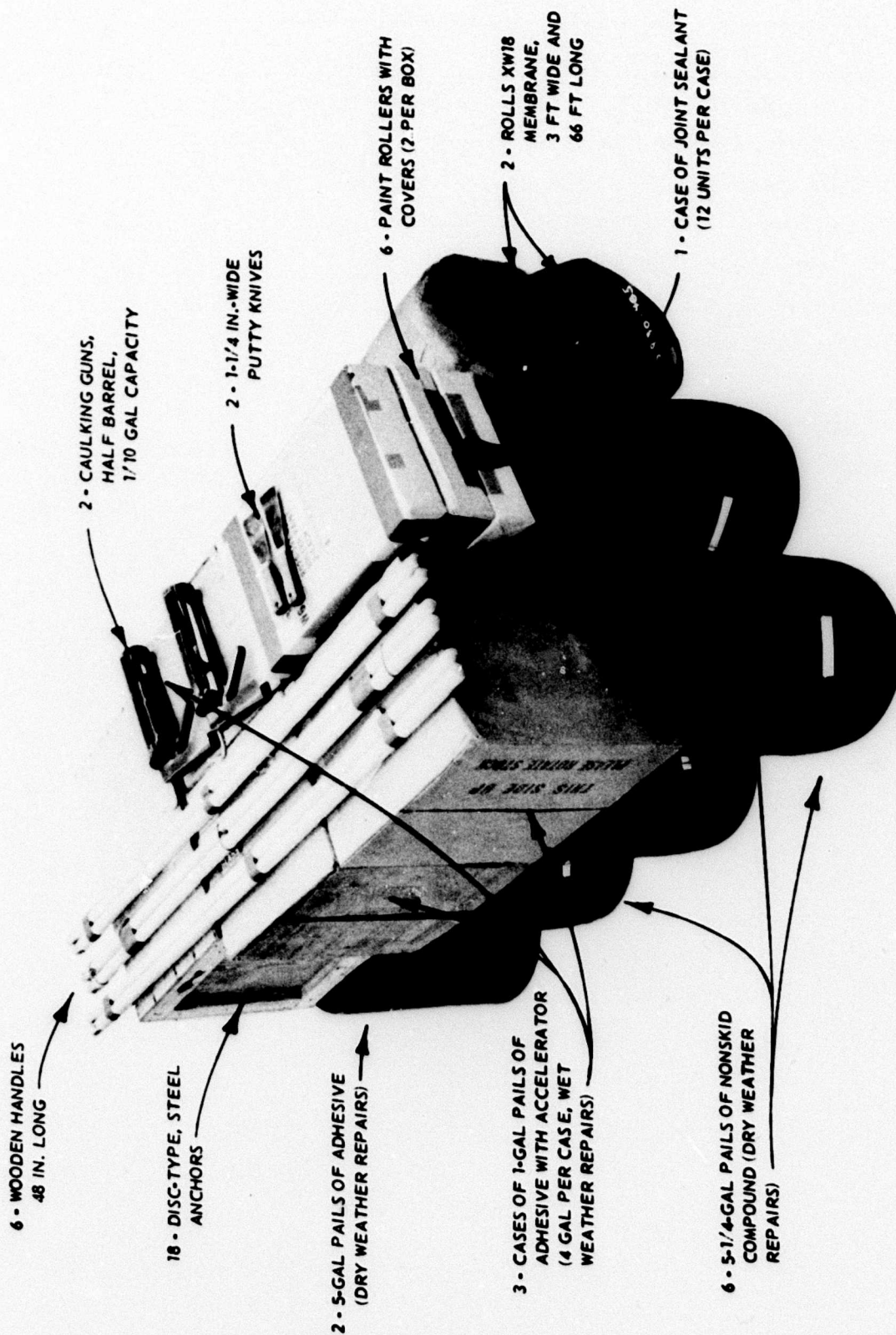


Figure IX-2. Maintenance kit, XW18 membrane surfacing.

Description	Quantity
REPLACEMENT KIT, XW18 MEMBRANE (Figure IX-3)	
Section of XW18 membrane, 54 ft wide and 53 ft long	1
Roll of XW18 membrane, 3 ft wide and 66 ft long	2
Disc-type anchor	36
Adhesive, 5-gal pail (use drying dry weather)	4
Adhesive, 1-gal pail with accelerator (use during wet weather)	20
Paint roller with cover	4
Roller handle	4
Caulking gun	4
Putty knife	4
Sealant, 1/10-gal cartridge	12

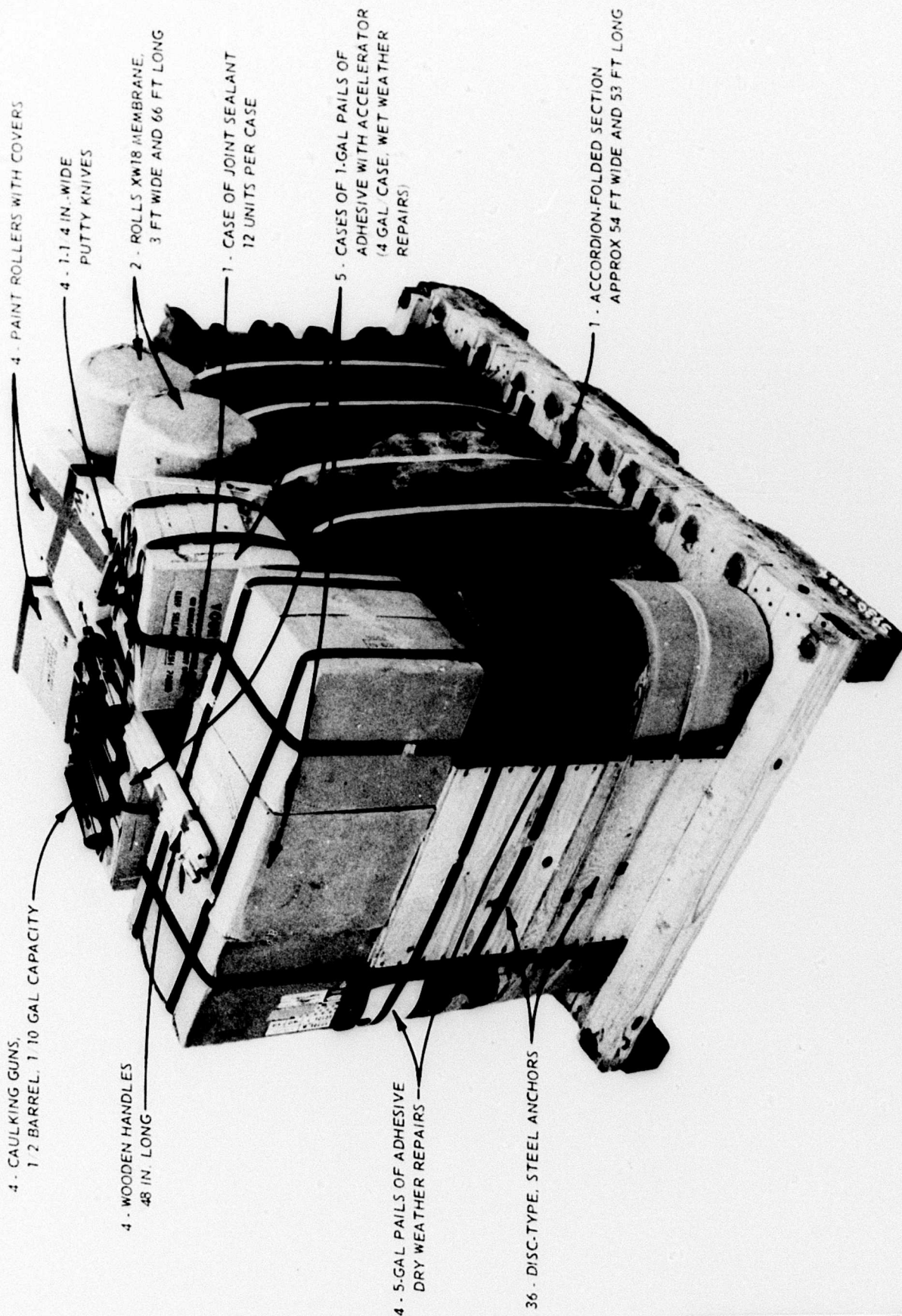


Figure IX-3. Replacement kit, XW18 membrane surfacing.