Project NY 012 021
Technical Memorandum M-094

SNOW-REMOVAL OPERATIONS WINTER 1953-54

15 October 1954

U. S.
naval
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and
evaluation
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port hueneme,
california

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B. P. Haskell, LT, CEC, USNR
W. H. Brookshire, BULC, USNR

SUMMARY

The objective of the task reported herein was to evaluate, under operational conditions, certain units comprising a revised functional advance-base snow removal component. Additional phases of the work included (1) determination of the adequacy of snow removal techniques outlined in an existing NavDocks manual, and (2) tests of a torque converter carrier and "roll-over"-type blade plow.

The work was conducted at the Brunswick Naval Air Station and tests were made on reversible-type blade plows, rotary snow plows, torque converter units, one-way blade-type plows with wings, sand spreaders, and a payloader.

Under the existing weather and traffic conditions, the group of equipment tested was considered adequate for the area. The number of units required for an average installation, using the Brunswick operation as a guide, was determined. Certain minor revisions were recommended for the Snow Removal Manual, equipment performance was discussed, and suggestions were made with reference to future tests to be conducted during the winter 1954-55.

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INTRODUCTION

This report evaluates the adequacy of a revised Functional Advance-Base Snow Removal Component under operating conditions, and determines the utility of techniques set forth in a Snow Removal Manual, technical publication NavDocks TP-PW-29, dated October 1953. As a secondary objective, tests with two recent innovations, namely a torque converter carrier and a "roll-over"-type blade plow were conducted and are reported on.

The authority for this investigation is contained in a letter from BUDOCKS* directing that this investigation be conducted under Evaluation SH-11 funds. After initiation of the test operation, the Bureau of Yards and Docks was assigned the task of preparing a snow-removal training film. Motion-picture coverage for this film was effected by the snow removal team in conjunction with the tests. This film is being prepared by the Navy Photographic Center at Washington, D. C.

During the winters 1951-52 and 1952-53, the U. S. Naval Civil Engineering Research and Evaluation Laboratory established the Sierra Test Site at June Lake, California. A major function of this cold-weather test site was to test and evaluate various types of commercial snow removal units and concurrently to investigate the techniques for snow removal in effect at various air installations. Augmenting this test facility with reference to snow removal equipment, a team of observers (four to five Chief Petty Officers during the two winters) was sent to the various air installations

*Bureau of Yards and Docks (F. F. Kravath) ltr P-311 G/mj NP/Pt Hueneme/N8 of 22 October 1953 to Officer in Charge, U. S. Naval Civil Engineering Research and Evaluation Laboratory.

within the snowfall area to observe and report on all types of snow removal equipment being used. Based on the results of these investigations, the aforementioned manual "Snow Removal" was published. Also published was a final NAVCERELAB Technical Memorandum M-047, dated 25 August 1953, which further crystallized the results of these investigations and set forth recommended revisions to an existing Advance Base Functional Snow Removal Component. The Brunswick snow-removal operations were undertaken to culminate these previous investigations.

An enlisted personnel group, consisting mainly of 25 construction drivers and mechanics, was extracted from MCB No. 1 upon its return from an overseas operation which was designated operation "George." This group was led by W. H. Brookshire, BULC, USNR. Five additional enlisted men, who had had previous experience in operating snow removal equipment at the USN Sierra Test Site, were detached on TAD from the U. S. Naval Construction Battalion Center, Port Hueneme, to orient the driver group in the complexities of snow-removal-equipment operation in the early stages of the operations. The technical and over-all field supervision of the operation was provided by B. Paul Haskell, LT, CEC, USNR, who was assigned on a TAD basis from NAVCERELAB. The Brunswick Naval Air Station provided shop facilities quarters and messing facilities as well as photographic support to the operation.

INVESTIGATIONS

Description of Equipment

MODEL AU AIRPORT SNOW REMOVAL UNIT. This unit consists of a 5-ton FWD chassis equipped with a two-way fully reversible Wausau plow with an involute spiral moldboard. The unit weighs approximately 19,000 lb, has a 150-in. wheelbase, is powered by a Waukesha Model 140 GZ 6-cyl, 4-cycle engine developing 188 bhp at 2600 rpm, and has a single-reduction full floating bevel-gear-type axle effecting 5 speeds forward and 1 in reverse. The maximum governed speed is 42 mph. Four of these units were included in the assemblage of equipment (see Figures 1 and 2).

SICARD ROTARY SNOW PLOW. This unit consists of a Sicard Model BLS-10 rotary snow plow, powered by a Hall Scott, Model 1091G, 6-cyl gasoline auxiliary engine mounted on an Oshkosh, Model 700-15R, 4-wheel drive, 4-wheel steer chassis; powered by a Hercules, Model RxLDH, 6-cyl gasoline engine developing 190 hp at 2600 rpm. The BLS-10 Sicard rotary plow is of the 2-auger-type, has an over-all cutting width of 8-1/2 ft, and was equipped with a Sicard vertical conveyor or auxiliary rake attachment for use in snow depths of from 4 to 8 ft. Four of these units were included in the assemblage of equipment (see Figures 3 and 4).

HARRIS "POWER HORSE" TRACTOR. The Harris "Power Horse" tractor is a rubber-tired unit combining planetary steering principles and a geared 4-speed-forward and reverse speed transmission; powered by a Chrysler Industrial 8-A 6-cyl, 4-cycle gasoline engine. In operation, the unit weighs 5200 lb with 13x24 6-ply tires, less attachments; shipping weight complete is approximately 8000 lb. This unit was equipped with a hydraulic-controlled Jarp 8 reversible dozer-type reversible plow (see Figure 5).

FRINK "ROLL-OVER" BLADE PLOW. The Frink "Roll-Over" plow is the latest commercial innovation in a reversible snow plow. This plow ostensibly combines the usefulness of the reversible blade plow with the taper characteristics of the one-way plow by reversing through a rolling-over action. This complete unit as furnished on loan by the Frink snow plow manufacturer, consisted of an R08 "roll-over" plow mounted on an Oshkosh 712 carrier. The plow had a 10-ft-long cutting edge, ranging in height from 1 ft 6 in. at the front of the moldboard to 5 ft 4 in. at the rear of the moldboard and weighed 2650 lb. The reversing mechanism is controlled from the cab and is actuated by two 3-1/2-in. double acting rams in conjunction with planetary gearing (see Figure 6).

ROSS ONE-WAY BLADE-TYPE PLOW. This unit, a Ross Model R-24 one-way rigid-type plow, was 15 ft long (over-all) with a 11-ft 9-in. cutting edge 40 in. high in the rear, weighed approximately 2100 lb, and was equipped with a Ross heavy-duty hydraulic lift hitch.

This plow unit was mounted on an Oshkosh W2201 carrier in conjunction with an R4-12 Ross heavy-duty wing weighing approximately 2540 lb. These units were equipped with dump bodies for miscellaneous hauling assignments (see Figures 7 and 8).

WOOLERY WEED BURNER. The Woolery weed burner consisted of 3 burners, each with a separate nozzle; each burner had a capacity of 30 gph. The accompanying blower was powered by an 18-hp air-cooled engine. The unit is mounted on a 2-wheel trailer-type chassis suitable for towing by jeep or rubber-tired tractor. Net weight of the unit is 1600 lb; it is 85 in. long and 60 in. wide (see Figure 9).

WALTERS V-PLOW. This unit consisted of a Walters Model AWUS truck chassis equipped with a Frink V-plow and wing.

The truck unit weighed approximately 20,000 lb, had an over-all length of 270 in., an over-all width of 96 in., a total height of 110 in., and was powered by a heavy-duty 6-cyl 250-hp at 1800 rpm Waukesha gasoline engine. The transmission was of a patented tractor, 6-speed-forward, 2-speed-reverse-type and had a patented double-reduction-type drive. The V-plow mounted thereon had an over-all cutting edge width of 12-1/2 ft, a height ranging from 5 ft at the nose to 8-1/2 ft at the rear, weighed 3000 lb, and was equipped with renewable cutting edges and shoes. The attached wing was 14 ft long, 4 ft high, weighed approximately 1000 lb, and was likewise equipped with renewable cutting edges and shoes (see Figures 10 and 11).

WALTERS MODEL ASUL TRUCK** WITH ONE-WAY AND RIGHT- AND LEFT-HAND WINGS. This unit, a newly developed "torque converter," was 300 in. long, 96 in. wide, 120 in. high, weighed approximately 22,000 lb, and was powered by a 300-hp gasoline engine. The unit was equipped with a tractor-type transmission having 3 forward speeds and 1 in reverse, and a Schneider 17-in.-diam torque converter drive. Mounted on this unit were a conventional one-way blade plow and right- and left-hand wings (see Figures 12 and 13).

HOUGH PAYLOADER. This unit, the HM model, was 18 ft 10 in. long, 8 ft wide, 8 ft 6 in. high, weighed approximately 1700 lb, was equipped with a 1-1/2-yd snow bucket, and was powered by a gasoline engine (see Figure 14).

**Furnished on loan by the Walters Truck Company.

FLINK-TYPE SAND SPREADER. This unit is a rotary-type spreader. It is mounted on the rear of a dump truck in such a way that the weight of the sander unit on the rubber wheels combined with the forward motion of the truck provides the traction for the wheels to turn and consequently to rotate the sand spreader mechanisms. Sand is supplied from the dump truck body which is tilted, the degree of tilt controlling the amount of sand entering the hopper of the spreader (see Figure 15). A highway-type unit was owned by the Brunswick Naval Air Station and by virtue of its successful employment by the station was considered on a comparative basis with the Flink-type sander as furnished.

Test Site and Memorandum of Procedure

The operations were conducted during the period 5 January 1954 to 11 March 1954 at the Brunswick Naval Air Station, which is located approximately 120 miles north of Boston, Massachusetts. Its accessibility by rail and air, available auxiliary airstrip, supporting facilities as well as its history for consistent snowfall was the basis for its selection. Two 8000-ft runways and one 1600-ft runway as well as numerous taxiways, parking areas, and access roads afforded excellent test facilities. The Memorandum of Procedure outlining a description of the tests is included as Appendix A.

Test Conditions

This investigation was conducted in temperatures ranging from -20 F to +40 F with periodic single snowfalls of a maximum depth of 8 in. and a cumulative total of approximately 60 in. During snowfall periods operations were underway on a 2-shift, 24-hr basis.

Test Procedure and Instrumentation

The tests consisted of cleaning at various times the three runway areas, taxiways, crossovers, parking areas, and access roads. To accomplish this it was necessary to windrow the snow with blade-type plows, cast aside the windrowed snow with rotary-

type plows, load certain portions of the snow into trucks with either the rotary units or the payloader, and in certain instances to apply flame to any resultant icy surfaces. Data concerning snow types, weight, amount moved, etc., coincident with fuel, horsepower, and unit considerations as well as weather conditions were recorded. The latest approved Mil Spec lubricants were used on all equipment throughout the tests.

Instruments used in recording such data consisted merely of a sampling can of known volume for determination of snow densities, tapes for recording distances, and stop watches for timing of various phases of the operation.

TEST RESULTS

Individual Units

REVERSIBLE-TYPE BLADE PLOWS. The five reversible units included in the assemblage of equipment were four FWD AU-type units and one Frink "Roll-Over"-type.

The four FWD AU units were utilized during the operation for a total of approximately 2000 miles with (as reflected in "Description of Repairs," Table 1) a minimum of repairs. Average unit fuel consumption was 12 gph.

In snow depths up to 6 in. of new fallen snow on the runway, and while averaging about 28 mph, the units were able to take a 9-ft cut and to clean the full width of the cut except for the usual 1/4- to 3/8-in. depth that remains. The high moldboard characteristics of this unit distributed the snow evenly over the unplowed surface, that is, they did not build up a windrow on the high-speed phase of the operation. The visibility when plowing in a light, new fallen snow was poor because the contour of the plow was responsible for a "whirlpool" effect at the upper edges of the moldboard. This was especially objectionable when the snow was being cast to the right.

The operators of the units were complimentary with reference to the ease-of-handling features of the units. In circumstances where rain had fallen on the snow and increased its weight to as much as 30 lb per cu ft, it was necessary to shorten the width of the cut to maintain a desirable speed. In this type plowing the building up of a windrow was effected, and in this particular situation the high moldboard characteristics of the plow were a definite asset. The more conventional one-way units in conjunction with the Frink "Roll-Over" plow could not handle this higher windrow. The single-reduction transmission of the FWD carrier offered no disadvantages for any type operation experienced, its gear range being considered adequate for this type unit.

The Frink "Roll-Over" unit mounted on the lightweight Oshkosh carrier was used continuously throughout the operation and proved to be the most versatile of the plow units. The roll-over reversing feature which combines the taper characteristics of the one-way blade and complete reversibility, was used for all types of blade work including the high-speed runway removal, parking area clearance, and road work. As noted in Figure 16, the unit gave excellent performance. In snow depths up to 6 in. of new fallen snow, and while averaging about 28 mph, the unit was able to take an 8-ft cut and to clean the full width of the cut except for the usual 1/4 to 3/8 in. that remains. In low-speed plowing in parking areas, etc., the ability of the unit to windrow the snow neatly, was outstanding. The only limiting features appeared to be its inability to bulldoze the snow, and its lower moldboard characteristic as compared with the FWD unit. Average fuel consumption of the unit was 12 gph.

ROTARY SNOW PLOW. The performance of the Sicard rotary snow plows, of which there were four that were mounted on Oshkosh 700-15-R carriers, was excellent throughout the operation. This truck-plow combination has shown its superiority in previous tests. Its ability to cast aside effectively or load windrowed snow of various densities is considered unsurpassable by any other presently available combination. Repairs with the exception of generator and voltage-regulator difficulties, which were caused by faulty connection of the terminals prior to delivery, were negligible. This "reverse polarization" of the circuits was such that there was no reflection on the merits of the units. These four units were

operated approximately 500 hr for a total distance of about 900 miles. Average fuel consumption was 25 gph.

WALTERS ASUL TORQUE CONVERTER UNIT. This unit, equipped with a conventional one-way plow and right- and left-hand wings performed creditably with but one exception. This exception was the difficulty experienced with the initial starting of the unit during periods of extreme temperatures. The more conventional drive units could be started and plowing operations initiated, whereas with this type of torque converter unit it was necessary to idle the engine for lengthy periods to allow the fluid system to heat sufficiently for forward movement. It was not ascertained whether this can be expected of all torque converter units. It is significant to note that the manufacturer's representative was present and was not able to correct this deficiency.

In comparing the unit, in actual snow operations, with both the Oshkosh 712 and W2201 carriers as well as the FWD AU unit no advantages could be visualized for this larger-type carrier. The units with approximately 180-hp engines and equipped with similar plows, did, in most circumstances, outperform this larger unit. While plowing on the main runway, the Walters unit was able to maintain speed with the Oshkosh W2201 equipped with one-way and wing, but was not able to maintain the forward speed of the FWD AU-type unit or with the Oshkosh 712 equipped with the Frink "Roll-Over" plow. For operations in smaller areas, the larger size of the unit represented a distinct handicap to the operator.

Average fuel consumption of the Walters unit was 22 gph.

ROSS ONE-WAY BLADE-TYPE PLOW WITH HEAVY-DUTY WINGS. This plow combination, mounted on an Oshkosh W2201 chassis, likewise gave excellent service during approximately 1600 miles of operation. This truck unit was noticeably harder to start in extreme temperatures than the Oshkosh W-700-15R unit. This difficulty is attributed to the 12-volt ignition system as compared with the 24-volt system. Those units equipped with a 24-volt system were much easier to start. The one-way and wing-type blade units performed well; the one deficiency observed was the hitch for the one-way unit. The fragile nature of this hitch was evident; any jarring experienced while in a raised position tended to bend the support. This was corrected with the help of the Ross factory representative. Average fuel consumption of the unit was 12 gph.

The Frink V-plow with wings mounted on the Walters AWUS, was used in a limited way as existing snow conditions did not warrant extensive use of a V-type plow. For its limited service, the unit performed well and no difficulties were experienced. Extensive repairs necessitated by freezing of the engine en route to Brunswick were necessary concurrently with a clutch replacement prior to the initiation of the operations; however, these repairs did not reflect unfavorably on the merits of the unit. The average fuel consumption of the unit was 17 gph.

The larger-type carrier (250 hp) is considered necessary for the successful utilization of the V-plow.

SAND SPREADERS. The two Flink sand spreaders as furnished on the operation, were used in a limited manner. As will be noted in Figure 15, the spreaders were installed on an Oshkosh carrier equipped with temporary chutes in the dump body, to facilitate discharge. The highway-type sand spreader (Figures 17 and 18), which was owned by the station and loaned for the test operations proved itself appreciably superior. When the spreader was being loaded, it was found that one man could operate the truck-sander combination with little difficulty. For the Flink-type, however, it was necessary to install the chutes and then to proceed with two men assisting the driver of the unit to feed the sander. Difficulties experienced included a loss of traction by the wheels of the spreader and subsequent loss of action by the spreader mechanism. Considering all factors, as compared with the highway-type spreader, the Flink-type represents a complicated and inefficient mode of sand spreading.

HOUGH PAYLOADER. Little data can be added to results previously obtained with this unit. It was used throughout the operation for such assignments as loading the sander trucks, cleaning small areas inaccessible by other means, and various and sundry snow loading details where the use of rotaries was not practicable. The unit being versatile, rugged, and easy for relatively inexperienced personnel to operate, is considered an indispensable item for any assemblage of snow removal equipment.

Group Evaluations

The teams of equipment consisting of four truck-mounted reversible units, two truck-mounted one-way units equipped with wings, four truck-mounted Sicard rotary snow plows, one Hough payloader, one Harris tractor, two Woolery weed burners, and miscellaneous brooms and sanders were used during various stages of the operation for the complete clearance of runways, taxiways, and associated areas. Under the prevailing weather and traffic conditions, this group of equipment was considered more than adequate for the Brunswick Air Station areas. All of the units originally furnished, with the exception of the sanding units, were considered adequate insofar as size and type were concerned. The reversible-type blade plow, by virtue of its obvious versatility, is considered indispensable to any successful assemblage of air installation snow-removal equipment. Of the two types of reversible plows representing distinctly different commercial innovations, each has distinct advantages and are discussed briefly in "Reversible-Type Blade Plows," under "Test Results." However, either type reversible unit cannot be replaced successfully by the more conventional one-way unit. This contention is believed to be substantiated both by a theoretical observation of the obvious advantages of a reversible-type unit for the runways, taxiways, and miscellaneous parking areas over the one-way plow because of the "deadheading" that is always necessary in at least a portion of every clearance operation when the one-way plows are used, and by the results of the Brunswick operation.

The two-flight auger-type rotary snow plow of which four were utilized on this operation, again supported the evidence of previous NAVCERELAB reports that this type represents the best of the commercial field. Evidence showed that they required a minimum amount of repairs and successfully removed or loaded all windrowed and otherwise deposited snow. As to the number of units required for an average installation, certain assumptions must be made using the Brunswick operation as a guide. These assumptions will be made and further discussed under "Discussion."

The two one-way units with wings as furnished gave excellent performance. However, for an air installation, when time is of paramount importance, the one-way unit has certain inherent disadvantages when compared with the reversible units. When the

one-way unit is considered in conjunction with the FWD AU reversible, the ratio of four reversible units to two one-way units with wings, is good. With the FWD AU-type of reversible unit the inherent characteristics of the design preclude the incorporation of wings so that the retention of the one-way units with wings is necessary. However, the incorporation of wings on the "roll-over"-type unit is entirely feasible and according to the manufacturer, presents no problem. If this type reversible is adopted, then the conventional one-ways could be eliminated from any component as this type reversible unit can do everything the one-way can and has added versatility.

Table 2 represents an over-all picture of the team results of the operation. It must be understood that the capacities given for the equipment are what can be expected of the various types of equipment under actual on-the-job conditions.

Techniques

A review of the Snow Removal Technical Publication NAVDOCKS TP-PW-29, dated 1 October 1953, in the light of additional data offered by the Brunswick operation, indicates that the manual is essentially sound but requires minor revisions. Such necessary revisions include deletions and substitutions of certain photographs which tend to give the wrong impression of the types of equipment that will be available in the field, and the provision of more explanatory addendum to the various capacities set forth therein. Certain recommended revisions will be initiated in a subsequent letter.

DISCUSSION

General

To ascertain the correct number of units to be included in any component, the requirements must be established. In the case of snow removal equipment, the first question with reference to requirements is "How much snowfall will there be?" Another question following in natural sequence is "Will the snowfall be constant, or will it be sporadic?" Because any selected component

must be adequate for all conditions within a snowfall area, it is essential that prior to determining the number of items required, certain assumptions must be made. In tentatively designing the snow removal component, assumptions were made as to size of runway, frequency of landings, take-offs, etc. However, the operational evaluations of this group of equipment offer additional information for refinements. With reference to the incorporation of these refinements, the following specific assumptions are made for a cold-weather component:

1. The airstrip considered for the single component will be 8000 ft long, 200 ft wide, and will have the number of taxiways and parking areas consistent with this size runway.
2. Snowfall will be continuous.
3. Climate will be sub-zero.
4. The interval of landing and/or take-offs will be interrupted by actual runway snow removal.
5. In general, the most extreme conditions will exist.

Functional components P20A and P20B (Appendixes B and C), are set up as separate allowance lists. The thoughts on this differentiation are understood to have been essentially for an anticipated snowfall variation. In the interest of simplicity, it is believed advisable to consolidate these allowance lists into one component suitable for both arctic and northern snowfall areas, with variations for larger size installations and extreme conditions provided through the supplying of additional components. In the review of existing P20A and P20B components, it is difficult to understand the reason for including four tractors, two graders, and two scrapers in the arctic component; and one crawler tractor, one scraper, and two graders in the northern component. The P20A and P20B components are visualized as auxiliary components to basic components and the inclusion of such items as crawler-type tractors, graders, and scrapers, are basic units of the initial component. Moreover, with the exception of the grader, which is useful for cleaning around landing lights, the only use anticipated for crawler-type tractors and scrapers would be as an emergency measure when suitable snow removal equipment was not available. The elimination of such items is believed advisable at this time.

Operational Characteristics

The team of equipment, as furnished where considered as a group, was relatively easy to operate. The group of enlisted men denoted as detachment "George," had previously never operated snow removal equipment, and the five men furnished from NAVCERELAB had only limited experience. After a few basic instructions, the men were able to operate the equipment satisfactorily and after several duty operations they were considered reasonably proficient. The blade-type plows including the one-ways with wings, and the high-speed reversibles were the easiest to operate and in several circumstances men with no prior instructions or experience were able to do a creditable job under actual duty conditions. The rotary type units, by virtue of their comparative complexities, were more difficult to operate and required more extensive instructions. Auxiliary units such as the payloader, Harris tractor, and flame throwers, required no particular training for qualified drivers.

Mechanical Adequacy

As evidenced by the tabulation of repairs in Table 1, the necessary repairs were not considered extensive, especially when many of the repairs listed therein can, by their nature, be discounted. Examples of these are the major engine repairs on the Walters AWUS, which were necessitated by "freezing up" en route to the operation; and the generator voltage-regulator repairs on the Oshkosh-Sicard unit, which have been previously discussed. With the exception of the Flink-type sand spreaders, all of the units were considered mechanically adequate.

Functional Components

With consideration to the aforementioned assumptions, the following major items of equipment are believed to be necessary for a snow removal component:

4 - High-speed truck-mounted reversible blade plows.
*2 - Truck-mounted one-way blade plows equipped with right-hand wings.

(*Note: One of these units to be equipped with a highway-type sander body augmenting the dump body as furnished with other truck units.)

4 - Truck-mounted auger-type rotary plows.
1 - Truck-mounted V-plow.
1 - Hough Payloader equipped with bucket.
1 - Harris-type tractor with dozer blade.
1 - Woolery weed-burner-type flame thrower.

or:

2 - High-speed truck-mounted reversibles similar to the FWD AU unit.
*4 - Truck-mounted "roll-over"-type reversibles (2 of which to be equipped with wings).

(*Note: One of these units to be equipped with a highway-type sander body as an auxiliary item to the dump body as furnished with the other truck units.)

4 - Truck-mounted auger-type rotary plows.
1 - Truck-mounted V-plow.
1 - Hough Payloader equipped with bucket.
1 - Harris-type tractor with dozer-type blade.
1 - Woolery weed burner.

Either of the foregoing basic snow removal lists is considered adequate.

Techniques

As discussed in "Test Results," the techniques as set forth in TP-PW-29, are sound and do not require changes. This does not mean that minor variations will not be dictated by conditions peculiar to any one operation.

Additional Work

With the incorporation of recommended changes to the existing component, the need for reflecting these changes in the Snow Removal Manual will exist. Also, an evaluation of the Frink "Roll-Over" plow, in conjunction with a wing plow, is considered advisable. Other than that, it is thought that the snow removal allowance list can be stabilized pending further innovations that may occur.

CONCLUSIONS

It is concluded that:

1. Existing functional components P20A and P20B are inadequate.
2. Assemblage of equipment as originally assigned to the Brunswick operation as a tentative component is, with minor modifications, adequate insofar as major units are concerned.
3. Functional components P20A and P20B should be consolidated.
4. Flink-type sand spreaders are inadequate.
5. Woolery weed burners have limited use in a snow removal component.
6. Any revisions to publication TP-PW-29 should be held in abeyance pending adoption of revisions to existing component.
7. "Torque Converter" units of the type furnished by Walters Company are not worthy of incorporation at this time.
8. Frink "Roll-Over" plow has exceptional merit.
9. Reversible-blade plows are indispensable to a successful snow removal component.
10. Suggested P20 (Revision A) Component as set forth in Appendix B, represents suitable equipment for such a component.
11. Upon successful test of "roll-over" plow with wing-plow attached, Functional Component P20 (Revision B) as set forth in Appendix C, will represent the most suitable equipment for a snow removal component.

RECOMMENDATIONS

It is recommended that:

1. Suggested components (Revision A) be tentatively adopted pending evaluation of Frink "Roll-Over" plow with wings.
2. Service test of Frink "Roll-Over" plow equipped with wing plows be undertaken in winter 1954-55.
3. If upon evaluation with wings, Frink "Roll-Over" plow is successful, that suggested component (Revision B) be adopted.
4. Other tests during winter 1954-55 be limited to studies of particular units and material which show evidence of being superior to those included in the suggested component.

APPENDIX A. Memorandum of Procedure

U. S. NAVAL CIVIL ENGINEERING
RESEARCH AND EVALUATION LABORATORY
CONSTRUCTION BATTALION CENTER
Port Hueneme, California

NT4-59/NY 012 021
715/BPH/jes
29 Dec 1953

MEMORANDUM OF PROCEDURE, PROJECT NO. NY 012 021 JOB ORDER NO. 70710

Subj: Snow Removal

1. GENERAL

Further investigations within the scope of work authorized by RDB card project NY 012 021, "Advanced Base Snow and Ice Removal" approved 22 March 1950.

2. PURPOSE

The purpose of the 1954 testing program is to:

a. Through operations under actual field conditions to ascertain the adequacy or inadequacy of a revised P20B Snow Removal Component (northern).

b. To determine what units if any should be added to or deleted from the Revised Component.

c. Test and evaluate other individual equipment items believed suitable for possible inclusion in the existing component.

d. Determine the adequacy of existing techniques set forth in a Snow Removal Manual, Technical Publication NAVDOCKS TP-PW-29 dated October 1953, for the removal of snow and ice from airstrip runways, access roads and facility areas.

3. DESCRIPTION OF TEST SITE

The Naval Air Station at Brunswick, Maine located approximately 175 miles northeast of Boston, Massachusetts. As indicated in Enclosure 1, a drainage map of the Naval Air Station, there are two 8,000 ft runways and one 6000 ft airstrip. Two of these runways are equipped with lighting systems and any tests conducted on these two strips will be in coordination with the operation of aircraft from the station. The third runway has no lighting system and is normally cleared only after all other operating areas are completed. This strip will be always available for test operations.

4. OPERATIONAL TEST PROCEDURES AND EQUIPMENT

The Snow Removal Operation will be concerned primarily with echelon movements of various assemblages of equipment contained in the latest revised component lists. The equipment to be used will consist of the following:

1 truck mounted V plow w/wings.
2 truck mounted blade type plows w/wings.
4 truck mounted rotary snow plows.
4 truck mounted reversible blade type snow plows.
1 payloader.
1 rubber tired planetary type steering tractor equipped with dozer blade.
1 sweeper.
1 sander.
1 flame for ice melting.
1 new type "Roll-over" reversible blade plow.

Various assemblages of this equipment will be used in the airstrip clearance operation, however the basic maneuver from which variations can be explored will be a maneuver identified as, Plan A (Drawing SR-67) Enclosure 2. This will be considered a basic maneuver and altered to fit climatic and other natural conditions. Drawing SR-67 does not pertain to the New Brunswick location and as procedures practiced at Brunswick must be patterned to fit flight operations, no specific plan will be formulated at this time - but will be formulated on the site consistent with airfield operations. The bulk of the testing will be carried out on the airstrip however attendant operations in access road clearance will be conducted in keeping with the base operations. Specific objectives of the Airfield removal will include:

a. Determine cleaning times for runway, windrows, lights, shoulders, intersections, and hardstands for various techniques and plow assemblages.

b. Determine the practicability of techniques set forth in Snow Removal Manual NAVDOCKS TP-PW-29 dated 1 October 1953.

c. To ascertain in detail quantities of snow moved relative to time, fuel and horsepower considerations.

5. INSTRUMENTATION

Instrumentation for this operation will consist of Simplified Classification of Natural Snow Types for Engineering Purposes as published by the Snow, Ice and Permafrost Research Establishment Corps of Engineers, U. S. Army, Wilmette, Illinois, for determining snow characteristics and stop watches and tapes for recording of time and distance factors.

6. PHOTOGRAPHIC COVERAGE

Suitable photographic coverage both still and movies will be effected.

7. REPORTS

Bi-weekly reports will be submitted to the Bureau covering the operation and a final report will be prepared by U. S. Naval Civil Engineering Research and Evaluation Laboratory.

B. P. HASKELL
Project Engineer

APPROVED

Director, Construction Division

Acting Head, Equipment Research Dept.

REFERENCE DRAWINGS

REVISION	DATE	DESCRIPTION	BY

DESIGNED

DRAWN [illegible] DATE 6-26-67

CHK'D Ed Durup

SUPERVISOR

APPROVED

DATE

OFFICER IN CHARGE

US NAVAL CONSTRUCTION BATTALION CENTER PORT HUENEME, CALIF.

US NAVAL CIVIL ENGINEERING
RESEARCH & EVALUATION LABORATORY

SNOW REMOVAL TECHNIQUE
PLAN '9'

SCALE

PROJECT PARTS OF

DRAWING NO SR-67

SHEET 1 OF 1

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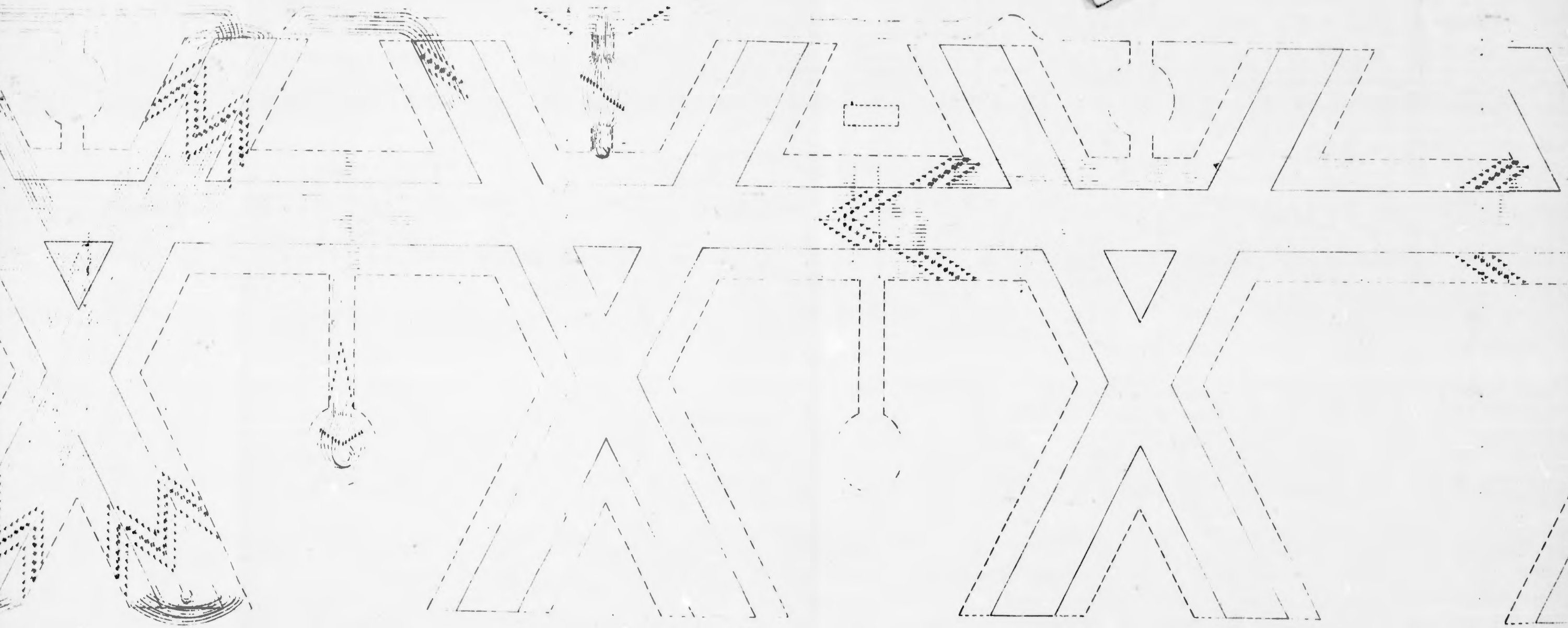
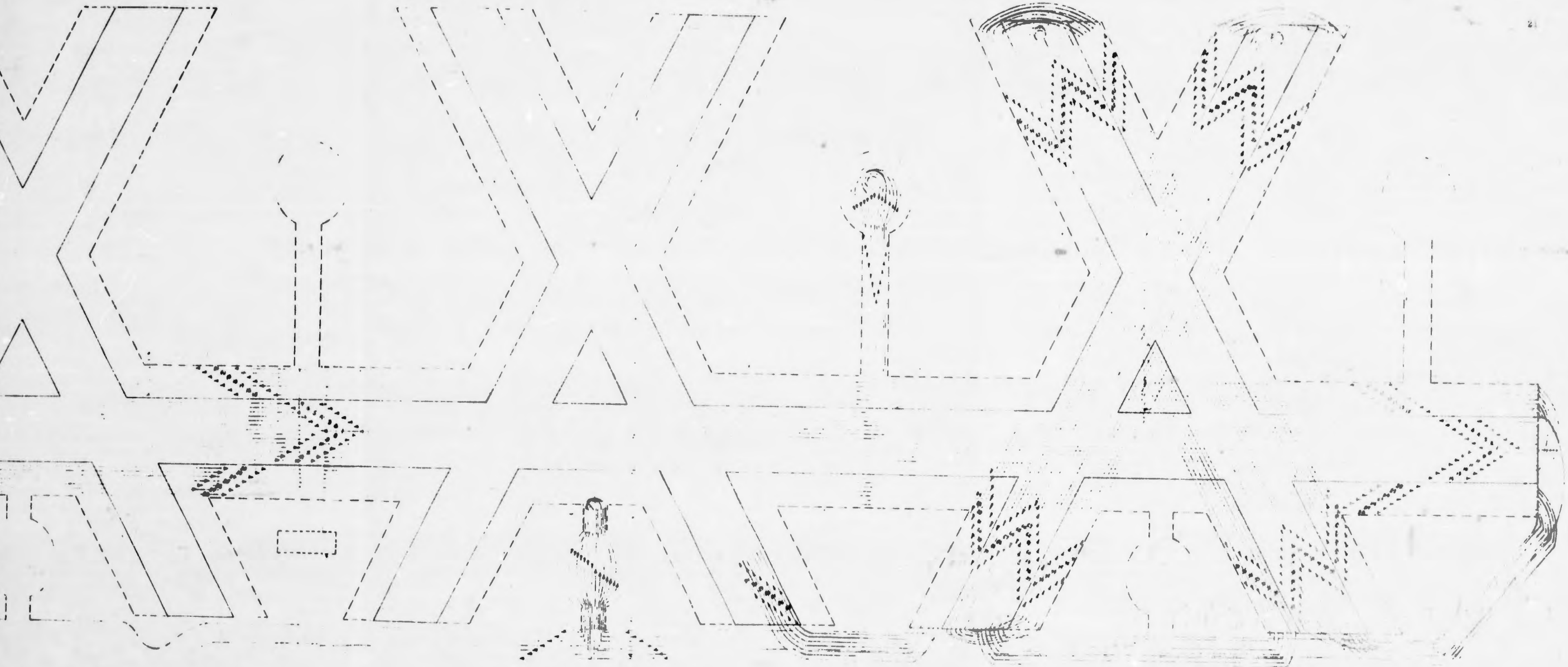


TABLE 2. OPERATING PERFORMANCE CHART OF SNOW REMOVAL EQUIPMENT

Date	Weather	Snow Condition	Equipment Component Used	Snow Windrowed		Snow Moved by Rotaries		Snow Moved by Other Means		Fuel Consumed			Operating Time			Remarks
				Wt (tons)	Vol (cu ft)	Wt (tons)	Vol (cu ft)	Wt (tons)	Vol (cu ft)	Blades (gal)	Rotaries (gal)	Other (gal)	Blades	Rotaries	Other	
13 Jan 1964	Clear and cold temp +5 to +15 F	6" snow-dry 10 lb per cu ft	4 Oshkosh Truck w/Ross One-way 1 Sicard Rotary on Oshkosh W700-15-R 1 Bros Rotary on Reo Truck	4000	800,000	4000	800,000	None	None	67.7	155.4	None	4-1/4 hr (4-units)	10-1/4 hr (2-units)	None	Testing program was initiated with limited amount of equipment - 2 Oshkosh trucks w/one-way plow, 1 Sicard Rotary Snow Plow augmented by two one-way plows furnished by NAS Public Works.
13 Jan	Clear and cold temp +5 to +15 F	6" snow-dry	1 Hough Payloader 2 Oshkosh Trucks	None	None	19.37	1937	19.37	1937	None	None	22	None	None	3 hr (3-units)	Haul distance for this loading operation was approximately 1/2 mile.
18 Jan	Clear temp -10 to +12 F	No snow	2 Oshkosh Trucks 1 Hough Payloader	None	None	No record	No record	No record	No record	None	None	22	No record	No record	No record	Station assist. checked out 2 flame throwers.
25 Jan	Clear temp +20 to +35 F	No snow	1 Oshkosh Truck 1 FWD AU Unit 4 Sicard Rotary on Oshkosh W700-15-R 1 Harris Tractor	Practice run	Practice run	Practice run	Practice run	Practice run	Practice run	32.9	52.6	4.8	3-3/4 hr (2-units)	5 hr (4-units)	1-1/4 hr (1-unit)	This was a "dummy" run to further orient drivers in echelon operations.
25 Jan	Overcast temp +20 to +35 F	6 to 8" snow	1 Sicard Rotary on Oshkosh W700-15-R 3 GMC Dump Trucks	None	None	109.35	12,150	109.35	12,150	None	55	No record	None	3 hr (1-unit)	1-3/4 hr (2-units)	This was a loading operation.
28 Jan	Clear and windy temp +10 to +15 F	6 to 8" snow-dry	2 Sicard Rotary on Oshkosh W700-15-R	None	None	No record	No record	No record	No record	None	55	No record	No record	No record	No record	
29 Jan	Clear and windy temp +10 to +28 F	6" snow-wet-soft	1 FWD AU Unit 1 Frink "Roll-over" on Oshkosh W712 2 Ross One-way on Oshkosh W2201 4 Sicard Rotary on Oshkosh W700-15-R 1 Harris Tractor w/Jarp Rever Plow	7200	800,000	7200	800,000	None	None	57.3	455	None	5-1/2 hr (5-units)	35 hr (4-units)	None	
29 Jan	Clear and windy temp +10 to +28 F	Old-moist	1 Hough Payloader 2 GMC Dump Trucks 1 Frink "Roll-over" on Oshkosh W712	13.5	3402	None	None	13.5	3402	17.4	None	34.8	1 hr (1-unit)	None	4-1/2 hr (3-units)	
30 Jan	Overcast temp +7 to +20 F	8" snow	1 FWD AU Unit 2 GMC Dump Trucks 4 Sicard Rotary on Oshkosh W700-15-R 1 Oshkosh w/Frink Reversible 4 Oshkosh Trucks w/Ross One-way	14,760	1,640,000	14,560	1,640,000	No record	No record	365.5	384.4	54	56 hr (6-units)	32 hr (4-units)	4 hr (2-units)	Difference in tonnage between snow windrowed and snow removed by rotaries due to previous accumulation of snow.
14 Feb	Overcast temp +10 to +20 F	3" snow-dry	4 FWD AU Unit 1 Frink "Roll-over" on Oshkosh W712 3 Sicard Rotary on Oshkosh W700-15-R	9225	1,025,000	9225	1,025,000	None	None	132.9	110.4	None	9 hr (5-units)	7-1/2 hr (3-units)	None	
15 Feb	Clear and windy temp +20 to +40 F	3" snow-soft-moist	4 FWD AU Unit 1 Frink "Roll-over" on Oshkosh W712 3 Sicard Rotary on Oshkosh W700-15-R 2 Walters Trucks 1 Ross One-way on Oshkosh W2201	2700	300,000	4700	300,000	No record	No record	157.2	86.9	None	10-3/4 hr (8-units)	6 hr (3-units)	None	Detailed time data on this operation would not reflect true operational picture.
16 Feb	Overcast temp +35 to +45 F	3" snow-wet	4 FWD AU Units 1 Harris Tractor 4 Sicard Rotary on Oshkosh W700-15-R 1 Frink " Roll-over" on Oshkosh A712	4000	400,000	4000	400,000	No record	No record	40.4	32.6	6.6	3 hr (5-units)	3 hr (4-unit)	1 hr (1-unit)	
17 Feb	Rain, sleet, and snow temp +30 to +35 F	3" snow-wet	4 FWD AU Units 1 Walters Truck 1 Frink "Roll-over" on Oshkosh A712 4 Sicard Rotary on Oshkosh W700-15-R 2 Ross One-way on Oshkosh W2201	22,140	1,640,000	22,140	1,640,000	None	None	284.3	267	None	19 hr (8-units)	11 hr (4-units)	None	
17 Feb	Rain, snow, sleet temp +30 F temp +30 to +35 F	6" snow-wet	4 FWD AU Units 1 Frink "Roll-over" Oshkosh A712 1 Frink One-way on Walters AWU1 2 Ross One-way on Oshkosh W2201 4 Sicard Rotaries on Oshkosh W700-15-R	30,240	2,240,000	30,240	2,240,000	None	None	453.9	599.2	None	48 hr (8-units)	32 hr (4-units)	None	
18 Feb	Clear temp +32 to +50 F	6" snow-wet	6 FWD AU Units 2 Oshkosh W2201 Trucks 2 Sicard Rotaries on Oshkosh W700-15-R Trucks 1 Hough Payloader	2160	160,000	2160	160,000	2160	160,000	109.6	108	61.5	24 hr (4-units)	12 hr (2-units)	13 hr (3-units)	
19 Feb	Clear temp +30 to +45 F	4" snow-crusted	4 FWD AU Units 1 Frink One-way on Walters AWU1 Truck 1 Frink "V" Plow on Walters AWU1 Truck 1 Frink "Roll-over" on Oshkosh A712 Truck 2 Sicard Rotaries on Oshkosh W700-15-R Trucks	9000	600,000	9000	600,000	None	None	159.9	158.3	None	24-1/4 hr (7-units)	10 hr (3-units)	None	

STATISTICAL DATA: Approx 1000 tons snow moved per hr per blade plow
Approx 400 tons per hr per rotary unit



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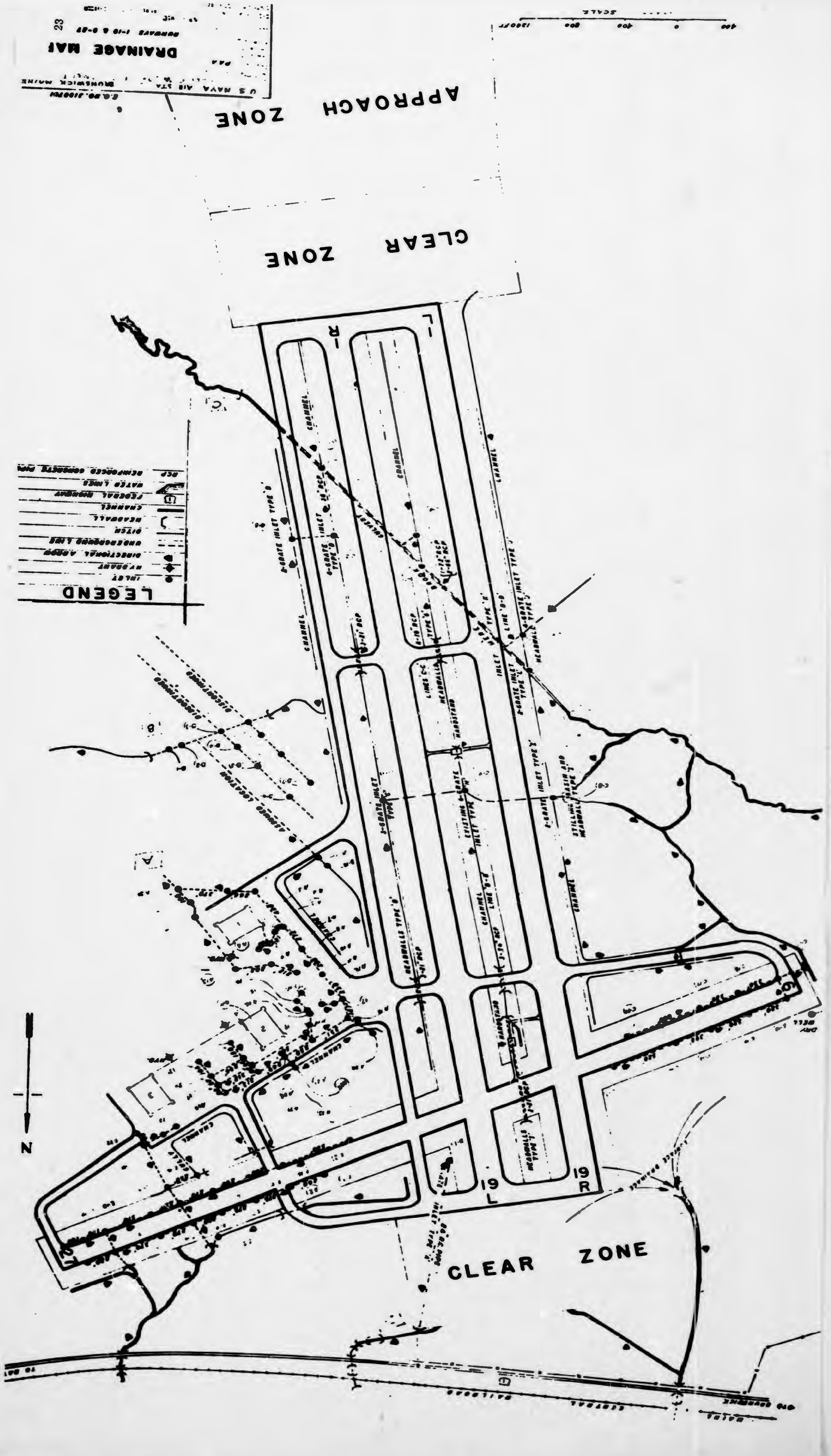


DRAINAGE MAP
U S NAVAL AIR STA BRUNSWICK MAINE
23
APPROACH ZONE
CLEAR ZONE
LEGEND
INLET
HYDRANT
DIRECTIONAL ARROW
UNDERGROUND LINES
DITCH
HEADWALL
CHANNEL
FEDERAL HIGHWAY
WATER LINES
RCP REINFORCED CONCRETE PIPE
1 R
1 L
A
B
C
N
19 L
19 R
CLEAR ZONE

APPENDIX B

FUNCTIONAL COMPONENT P20 (REVISION A)

SNOW-REMOVAL EQUIPMENT

Bureau of Naval Personnel
No Personnel

Reference No.	Description	Unit	Quantity	Weight (lb)	Cube (cu ft)
	Section 7 - Construction Equipment				
C 76 P	Plow - snow, 2-way fully reversible, controllable from cab, 9-ft working width w/5-ft moldboard, mounted on 5- to 8-ton 4x4 truck (dump)	ea	4	80,000	8,000
C 76 P	Plow - snow, 1-way, 9-ft working width w/40-in. moldboard, mounted on 7- to 8-ton 4x4 dump truck equipped with rt-hand wing	ea	2	44,000	2,000
C 76 S	Sweeper - gang-type, towed	ea	2	4,000	400
C 76 S	Sander - body-type, equipped with grizzly-type body for mounting on 4x4 truck	ea	1	2,000	400
C 76 P	Plow - snow, rotary auger-type, 45 tons per min, with loading attachment	ea	4	160,000	8,000
C 76 P	Plow - snow rake attachment for 9-ft drift clearance, suitable for mounting on above rotary unit	ea	2	2,000	400
C 76 P	Plow - snow, V-type w/wing, 9-ft cutting width, mounted on 250-hp carrier	ea	1	23,000	2,000
C 76 T	Tractor - rubber-tired, planetary steering, equipped with fully reversible dozer blade controllable from cab	ea	1	8,000	300
C 76 T	End Loader - equipped w/1-1/2-yd bucket, full hydraulic control	ea	1	17,000	400
C 76 T	Flame Thrower - weed-burner type	ea	1	3,000	300
	Section 8 - Shop Equipment and Hand Tools				
G 41 S	Shovel - scoop, general purpose	ea	24	360	16
G 41 P	Pusher - snow, hand	ea	12	180	10
	Section 9 - Construction Consumables				
G 42 F	Fence - snow	ft	8,000	40,000	4,000
G 22 W	Wire - soft black, 12 ga	lb	500	500	10
C 48 P	Post - steel, for snow fence	ea	800	5,000	100
G 51 W	Wax	lb	50	75	5

NOTE: Weight and cube figures are estimates only

APPENDIX C

FUNCTIONAL COMPONENT P20 (REVISION B)

SNOW-REMOVAL EQUIPMENT

Bureau of Naval Personnel
No Personnel

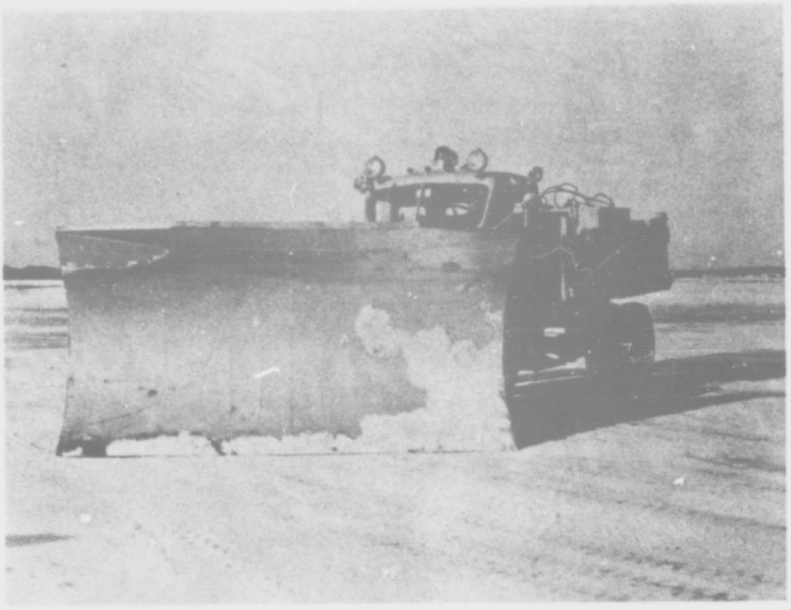
Reference No.	Description	Unit	Quantity	Weight (lb)	Cube (cu ft)
	Section 7 - Construction Equipment				
C 76 P	Plow - snow, 2-way fully reversible controllable from cab, 9-ft working width w/5-ft moldboard mounted on 5- to 8-ton 4x4 truck (dump)	ea	2	40,000	4,000
C 76 P	Plow - snow, 11 ft 3-in. cutting edge, 2-way reversible w/"roll-over" action thus retaining spiral configuration of conventional 1-way plow, mounted on 5- to 8-ton 4x4 dump truck	ea	4	80,000	8,000
C 76 P	Plow - snow, wing-type, suitable for mounting on rt-hand side of above unit	ea	2	4,000	400
C 76 S	Sweeper - gang-type, towed	ea	2	4,000	400
C 76 S	Sander - body-type, equipped with grizzly-type body for mounting on 4x4 truck	ea	1	2,000	400
C 76 P	Plow - snow, rotary auger-type, 45 tons per min, with loading attachment	ea	4	160,000	8,000
C 76 P	Plow - snow rake attachment for 9-ft drift clearance, suitable for mounting on above rotary unit	ea	2	2,000	400
C 76 P	Plow - snow, V-type w/wing, 9-ft cutting width, mounted on 250-hp carrier	ea	1	23,000	2,000
C 76 T	Tractor - rubber-tired, planetary steering, equipped with fully reversible dozer blade controllable from cab	ea	1	8,000	300
C 76 T	End Loader - equipped w/1-1/2-yd bucket, full hydraulic control	ea	1	17,000	400
C 76 T	Flame Thrower - weed-burner type	ea	1	3,000	300
	Section 8 - Shop Equipment and Hand Tools				
G 41 S	Shovel - scoop, general purpose	ea	24	360	16
G 41 P	Pusher - snow, hand	ea	12	180	10
	Section 9 - Construction Consumables				
C 42 F	Fence - snow	ft	8,000	40,000	4,000
G 22 W	Wire - soft black, 12 ga	lb	500	500	10
C 48 P	Post - steel, for snow fence	ea	800	5,000	100
G 51 W	Wax	lb	50	75	5

NOTE: Weight and cube figures are estimates only

TABLE 1. DESCRIPTION OF REPAIRS

Equipment Unit	Description	Description of Repairs	Manhours Expended
FWD AU USN 57-01236	FWD AU high-speed reversible unit	Renewed bolts in exhaust pipe, repaired windshield wipers.	1.0
		Total	1.0
Walters AWUS (No number assigned)	Walters carrier w/V-plow	Removed both cylinder heads, checked for cracked heads or blown gaskets.	42.5
		Renewed pressure plate, throwout bearing, springs in pressure plate, and friction plate.	50.0
		Renewed 5th and 6th sleeves and all rings; assembled engine and accessories.	56.0
		Total	148.5
FWD AU USN 57-01238	FWD AU high-speed reversible unit	Installed one new tire and tube.	5.0
		Renewed hose on manifold.	2.0
		Total	7.0
Harris Tractor USN 48-09078	"Power Horse"	Repaired tire.	3.0
		Fixed flats.	6.0
		Mounted blade on tractor.	16.0
		Mounted spotlight, changed over blade trip.	4.0
		Removed, repaired, and replaced heater; fixed flat.	14.0
		Total	43.0
Hough Payloader (No number assigned)	Payloader with bucket	Charged batteries.	1.0
		Repaired brake line.	2.0
		Renewed coil.	1.0
		Installed new generator, points, plugs, and regulator.	3.0
		Total	7.0
Oshkosh USN 57-00640	Oshkosh carrier w/Sicard rotary	Renewed starter complete, ring gear, and oil pipe line to gage; replaced rubber, air compressor gasket.	6.0
		Tightened chain in gear box, filled gear box with oil, checked safety switch, renewed and connected bulb in tachometer.	5.0
		Total	11.0
Oshkosh USN 57-00638	Oshkosh carrier w/Sicard rotary	Replaced regulator.	1.0
		Charged batteries with acid, made up battery cables, greased, and changed oil.	21.0
		Replaced air compressor.	2.0
		Total	24.0
Oshkosh USN 57-00637	Oshkosh carrier w/Sicard rotary	Tightened drive chain for auxiliary motor.	2.0
		Replaced generator and regulator.	2.0
		Charged all batteries with acid, made up battery cables, greased, and changed oil.	15.0
		Total	19.0
Oshkosh USN 57-00754	Oshkosh carrier w/Ross one-way	Renewed cutting edges on snow plow, changed oil.	2.0
		Renewed and strengthened hydraulic lift assembly.	10.0
		Replaced lube-oil-line from block to pressure gage, with copper tubing; made new angle-iron clips, layout holes; and drilled for subframe.	3.0
		Total	15.0
Oshkosh USN 57-00755	Oshkosh carrier w/Ross one-way	Renewed cutting edge on snow plow, changed oil.	2.0
		Renewed and strengthened hydraulic lift assembly.	6.0
		Removed air-lock in gas line.	2.0
		Adjusted clutch, changed crankcase oil.	3.0
		Total	13.0
Oshkosh USN 57-86039	Oshkosh carrier w/Ross one-way	Renewed bolt in plow hanger.	0.5
		Straightened plow, checked windshield wiper.	1.0
		Total	1.5

NOTE: 1. Oshkosh unit equipped w/Frink "Roll-Over" not included.
2. Walters "Torque Converter" unit equipped w/one-way and wings, not included.
3. Only two FWD AU units included - other two units required no repairs.



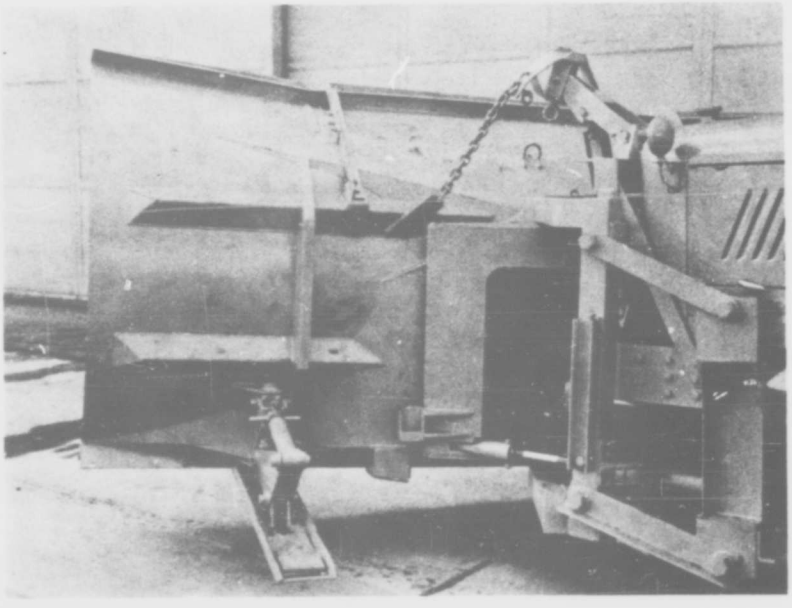


Figure 1. (Top) FWD AU reversible unit mounted on FWD truck.
(Bottom) Close-up of reversing mechanism.

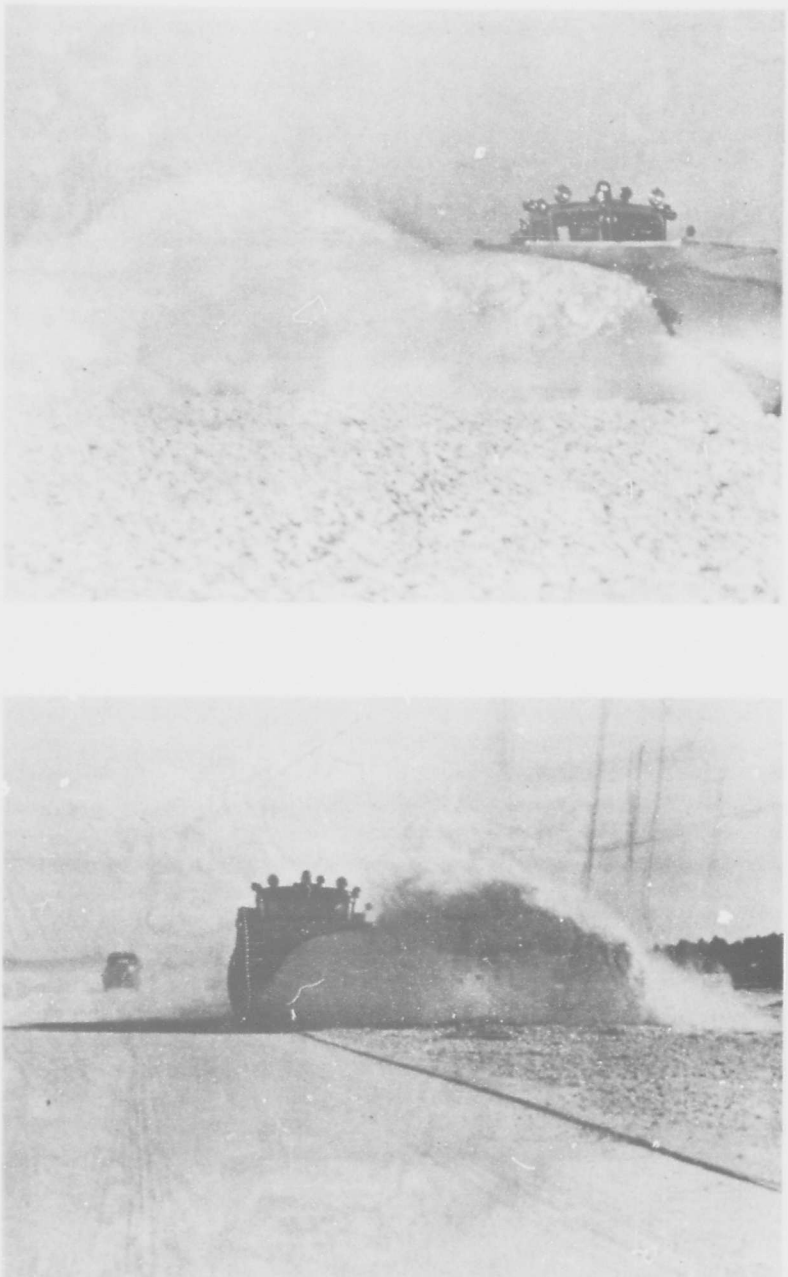


Figure 2. (Top) FWD AU reversible unit operating at high speed on runway (plowing to right).
(Bottom) FWD AU reversible unit operating at high speed on runway (plowing to left).

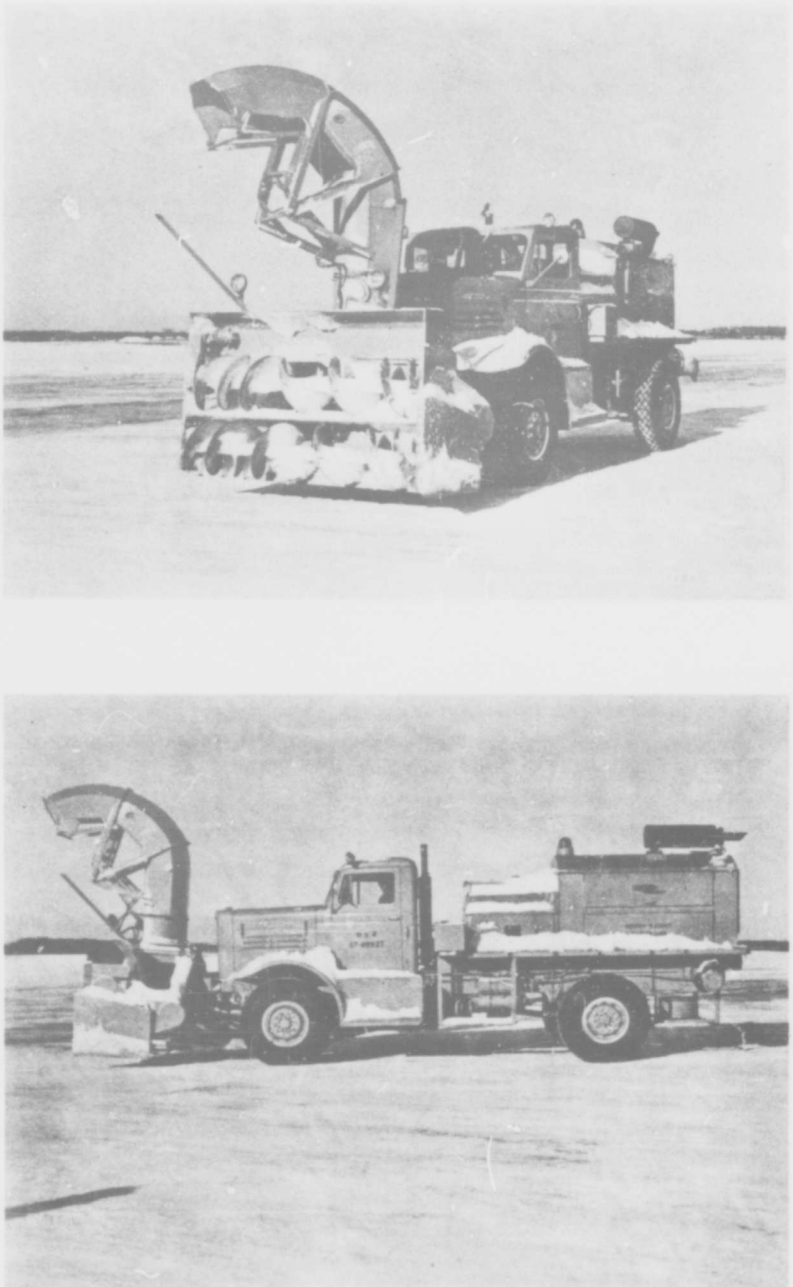


Figure 3. (Top) Three-quarter view of Sicard rotary snow plow mounted on Oshkosh truck.
(Bottom) Side view.

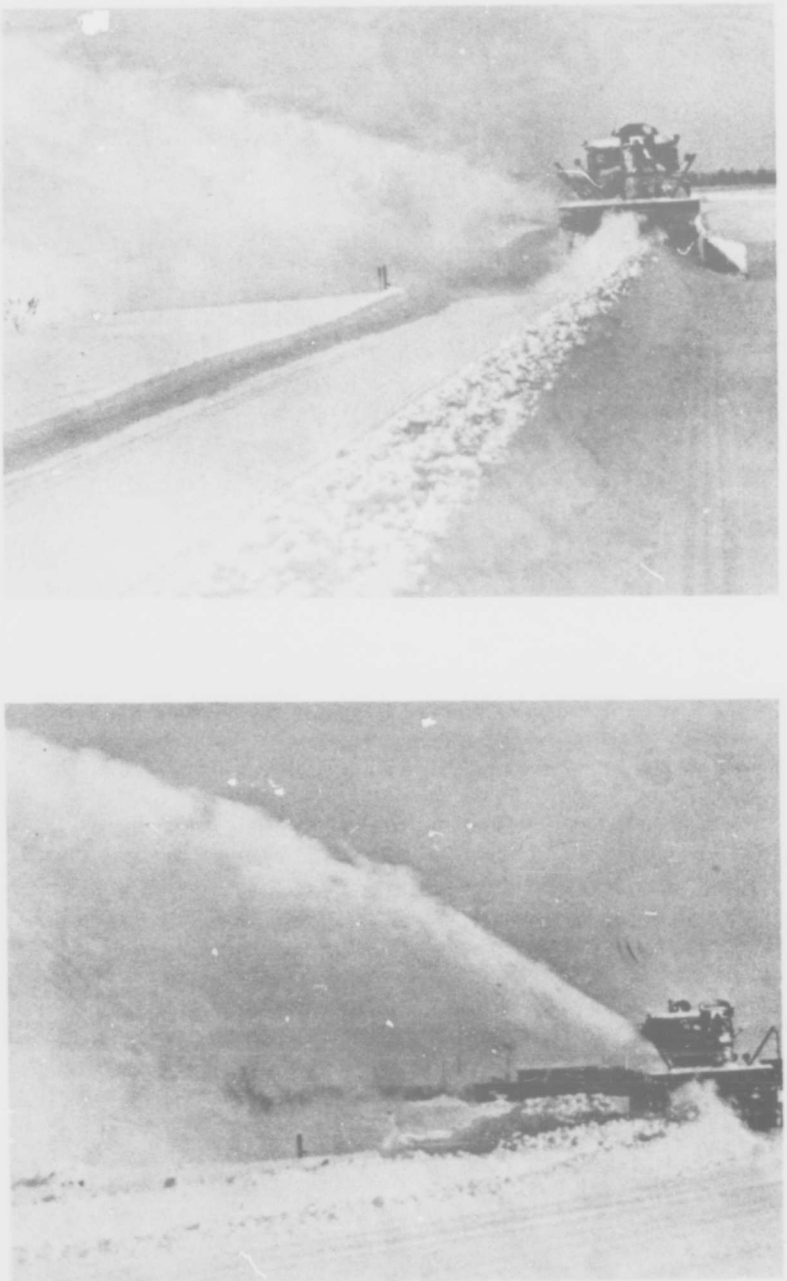


Figure 4. (Top) Sicard rotary plow casting windrowed snow beyond landing lights.
(Bottom) Sicard rotary plow cleaning up intersection area.

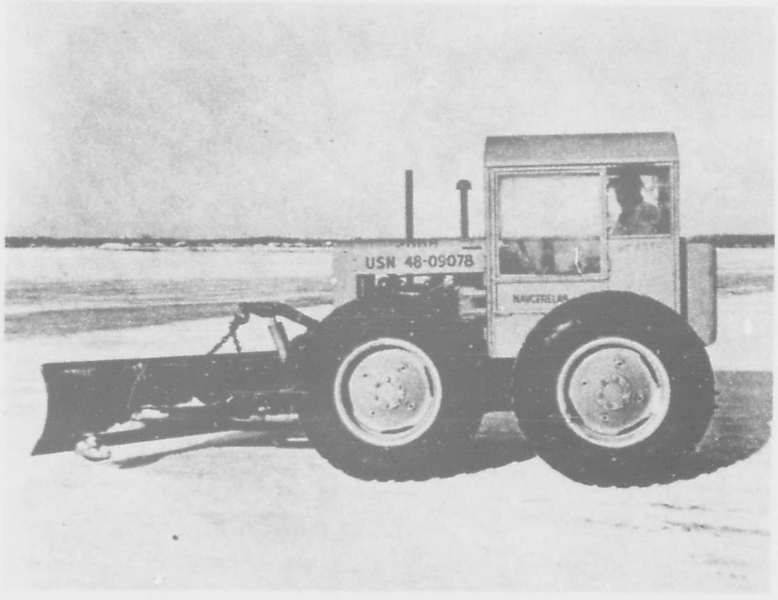


Figure 5. Harris "Power Horse" tractor equipped with Jarp reversible snow plow.

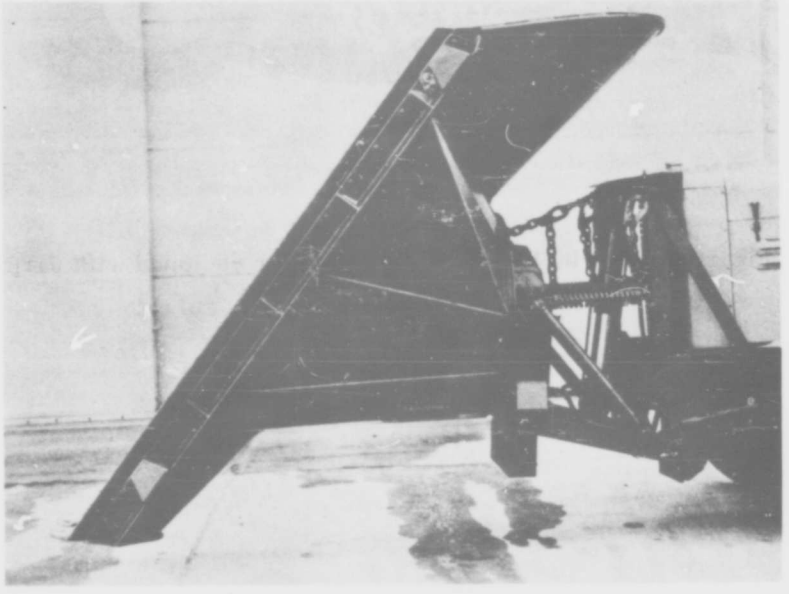
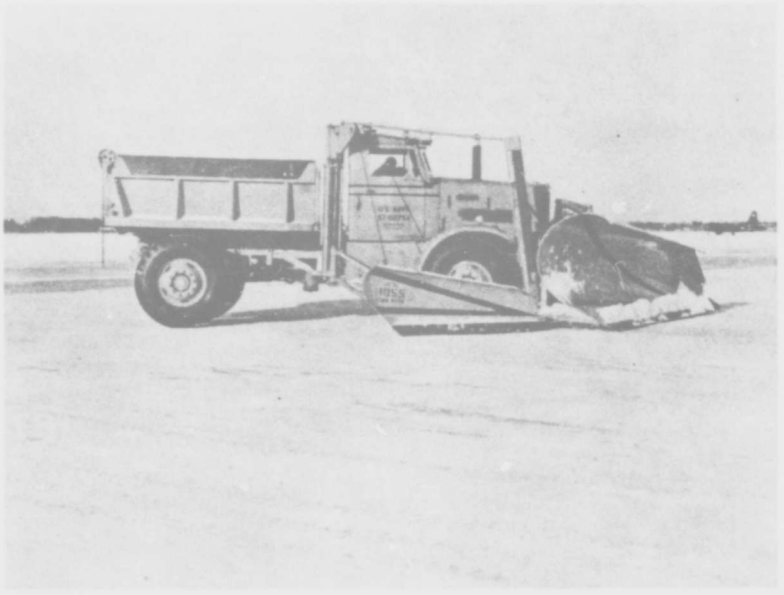


Figure 6. (Top) Three-quarter view Frink "Roll-Over" plow mounted on Oshkosh truck.
(Bottom) Close-up view of "Roll-Over" feature.



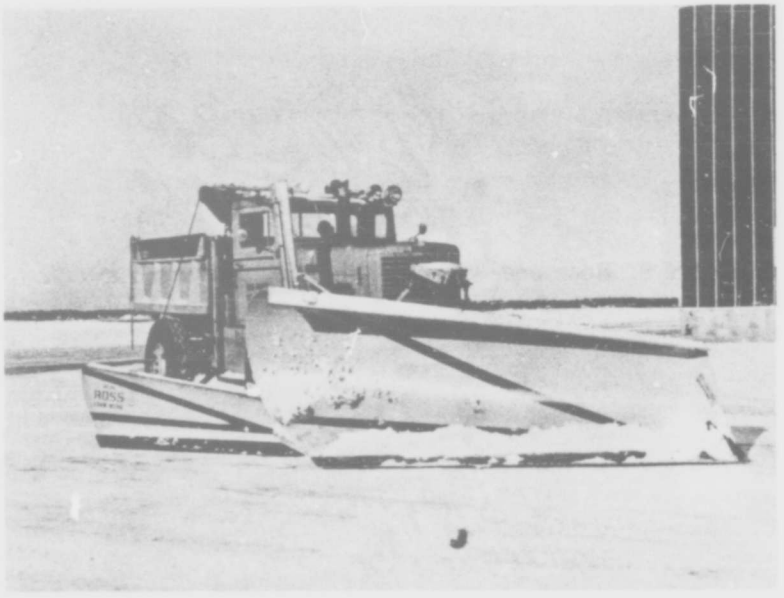


Figure 7. (Top) Side view Ross one-way plow and Ross wing mounted on Oshkosh truck.
(Bottom) Front view of Ross plow units.

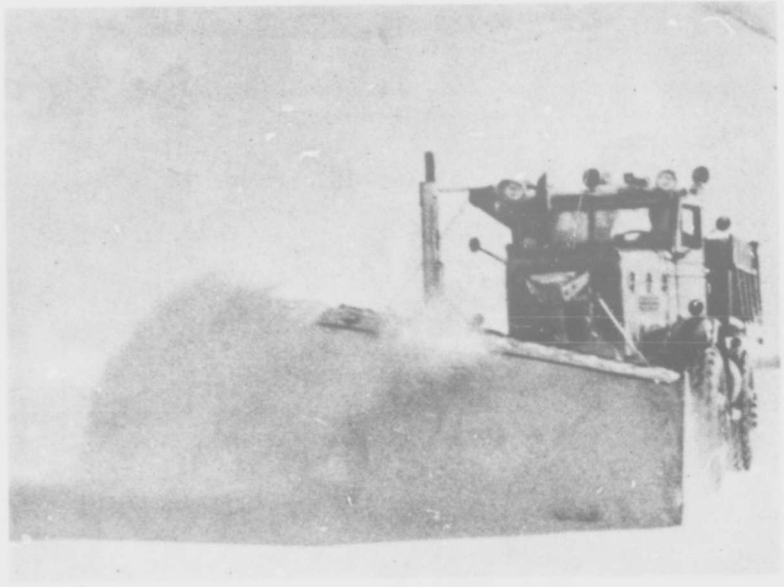


Figure 8. Ross one-way plow clearing snow on runway.

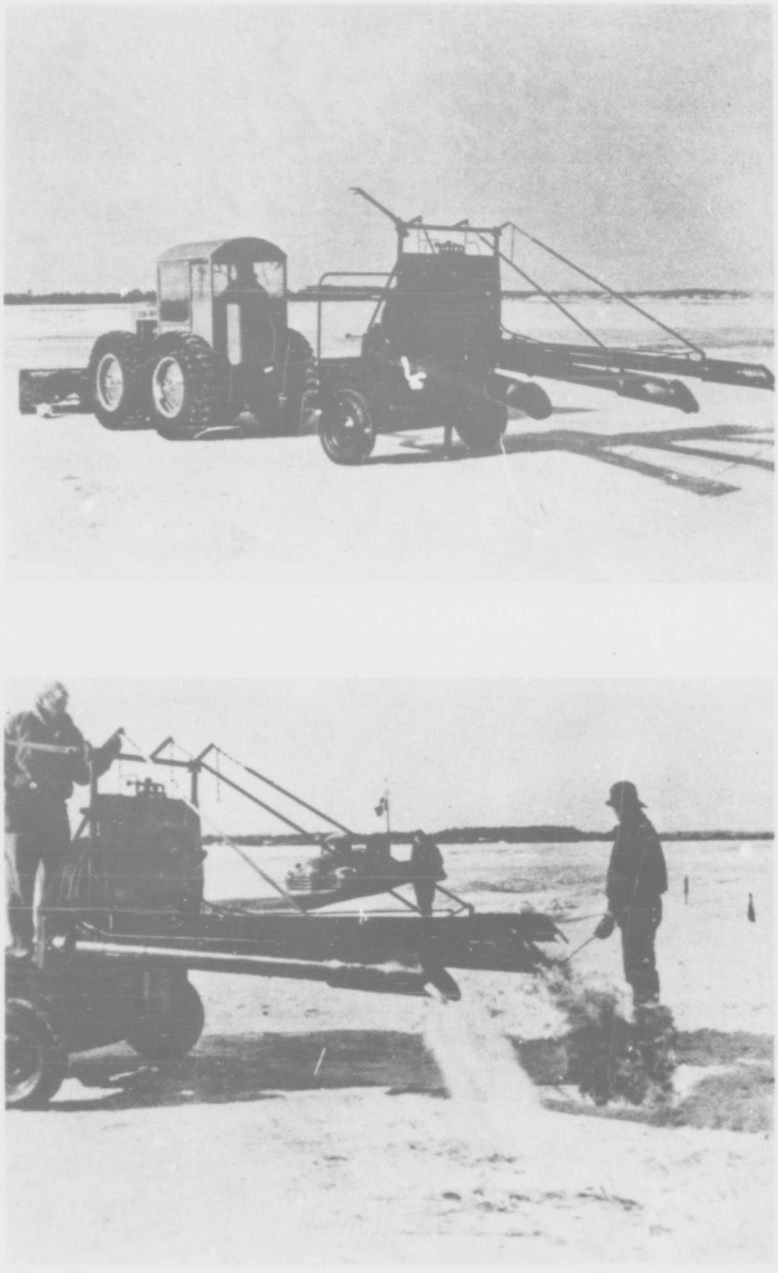


Figure 9. (Top) Woolery weed burner being towed by Harris tractor.
(Bottom) Melting of icy surface with Woolery weed burner.

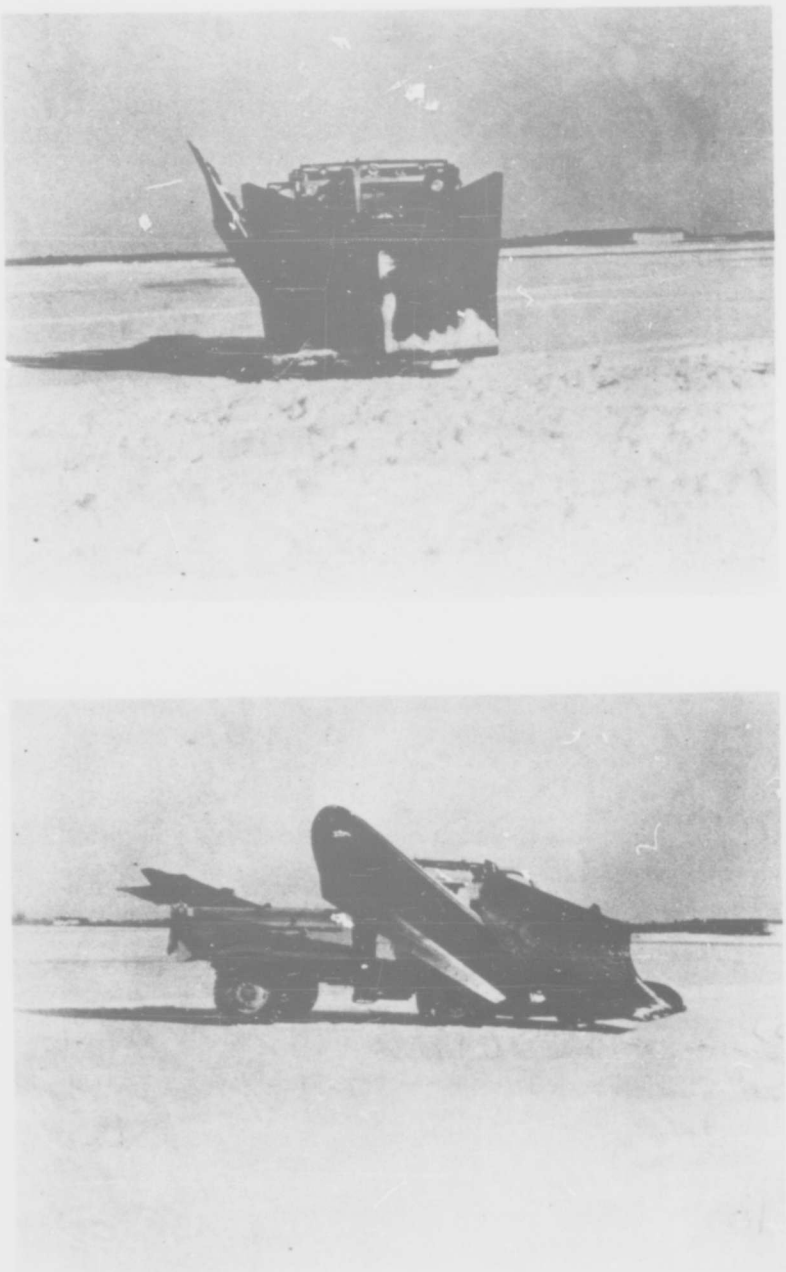


Figure 10. (Top) Front view Walters AWUS unit equipped with V-plow and right-hand wing.
(Bottom) Side view showing wing in raised position.

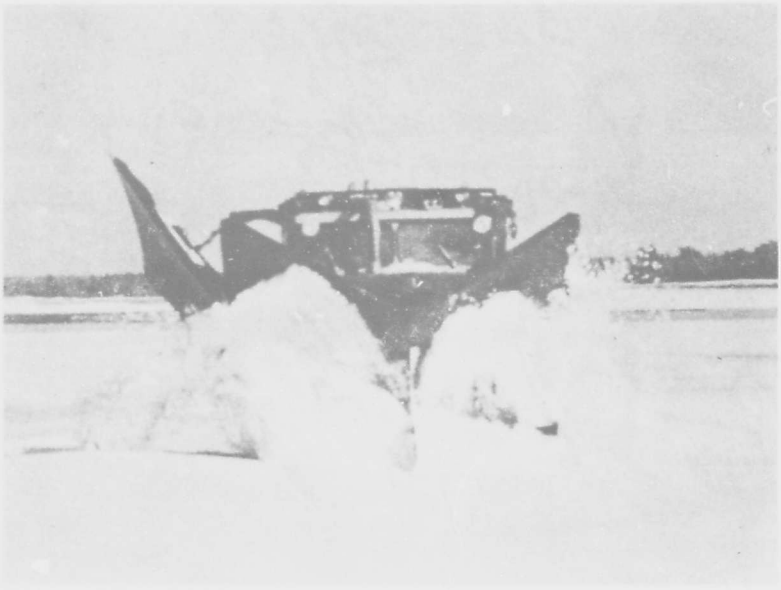


Figure 11. Walters AWUS w/V-plow and wing making initial center cut.

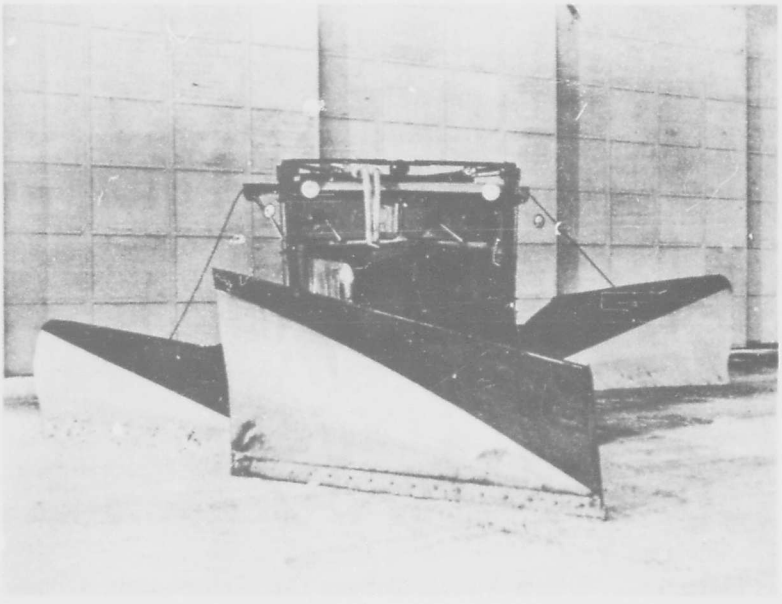


Figure 12. Walters ASUL "Torque Converter" Truck Unit equipped with one-way blade and right- and left-hand wings.

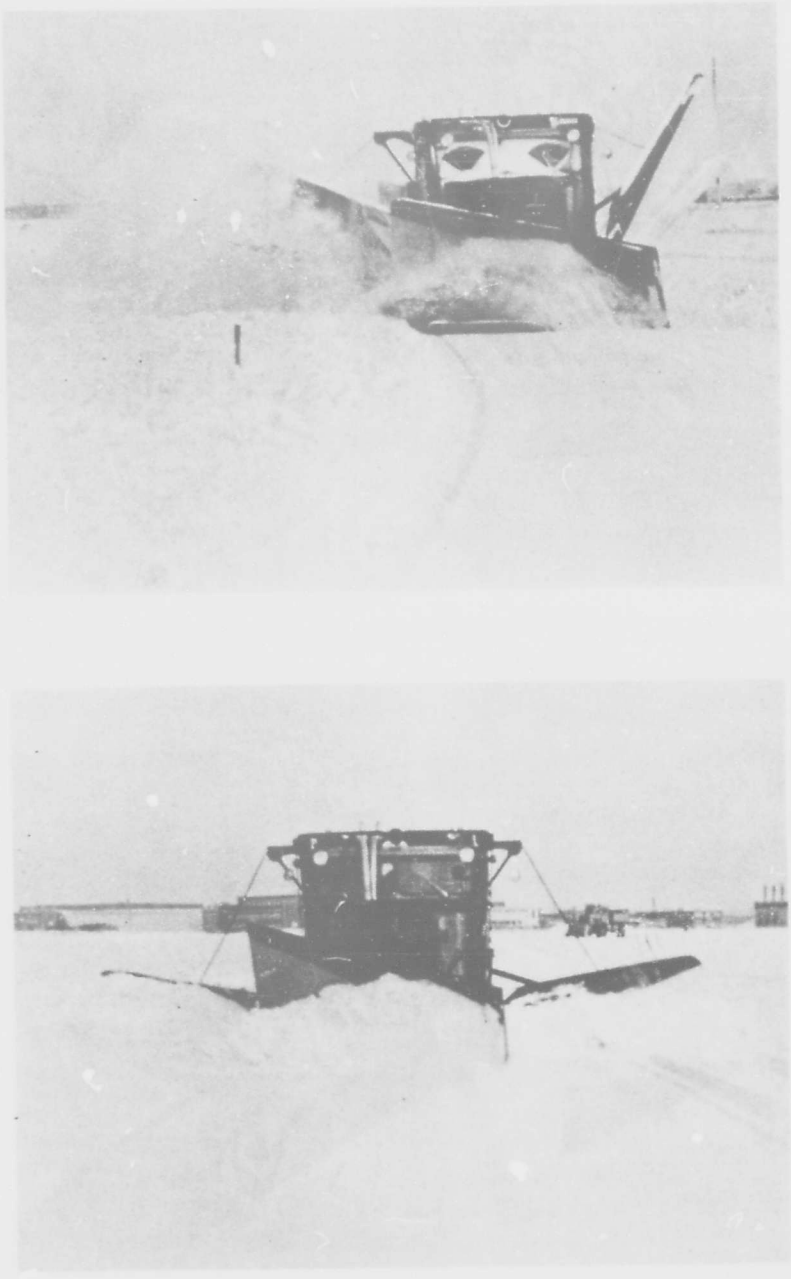


Figure 13. Walters ASUL "Torque Converter" Unit w/one-way and wings operating in 6-in. snowfall on runway (two views).

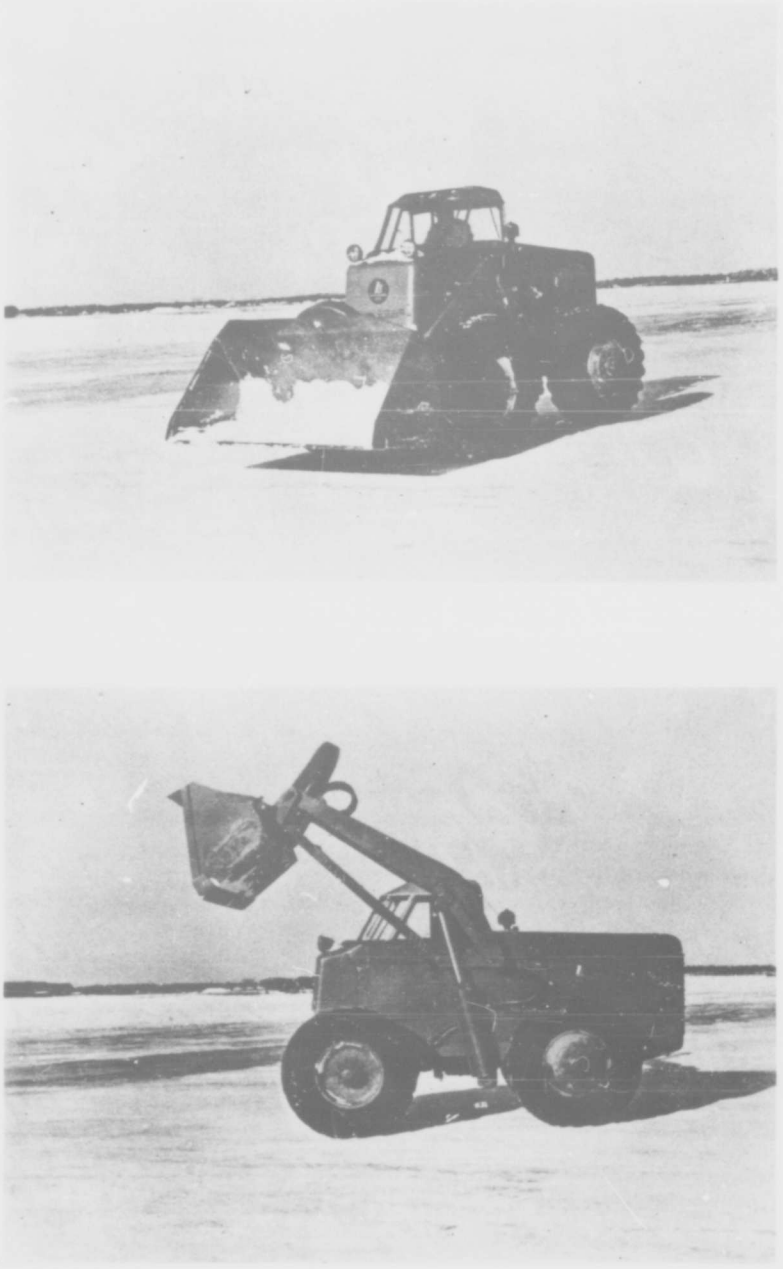
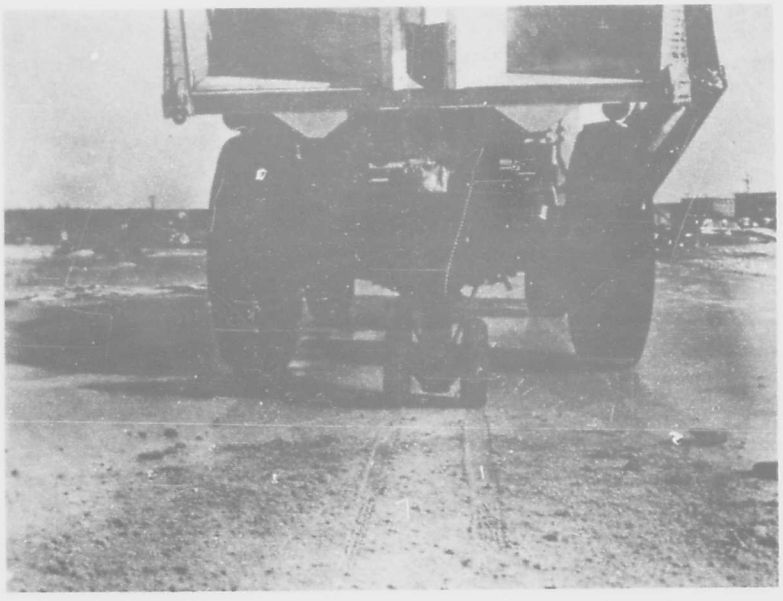


Figure 14. (Top) Three-quarter view Hough "Payloader" equipped with bucket.
(Bottom) Side view Hough "Payloader" with bucket raised.



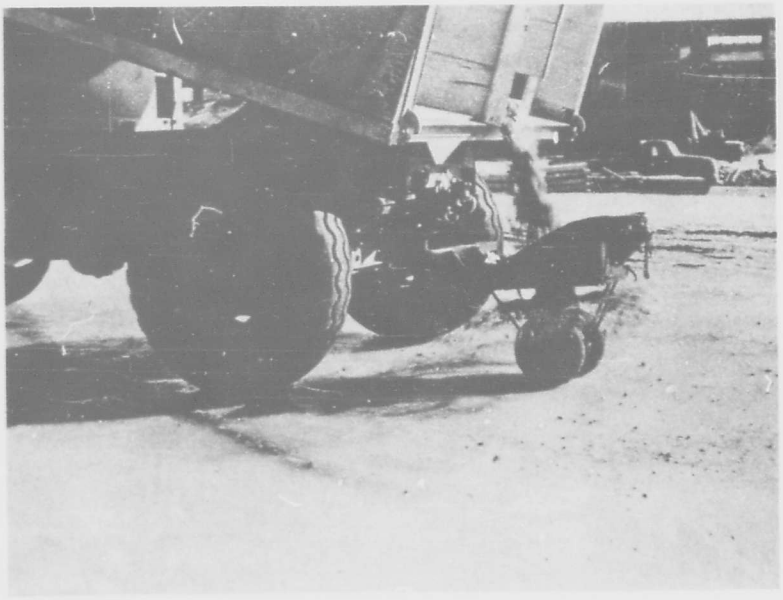


Figure 15. (Top) Flink Sand Spreader mounted on Oshkosh truck.
(Bottom) View showing dump body in raised position discharging sand into spreader.

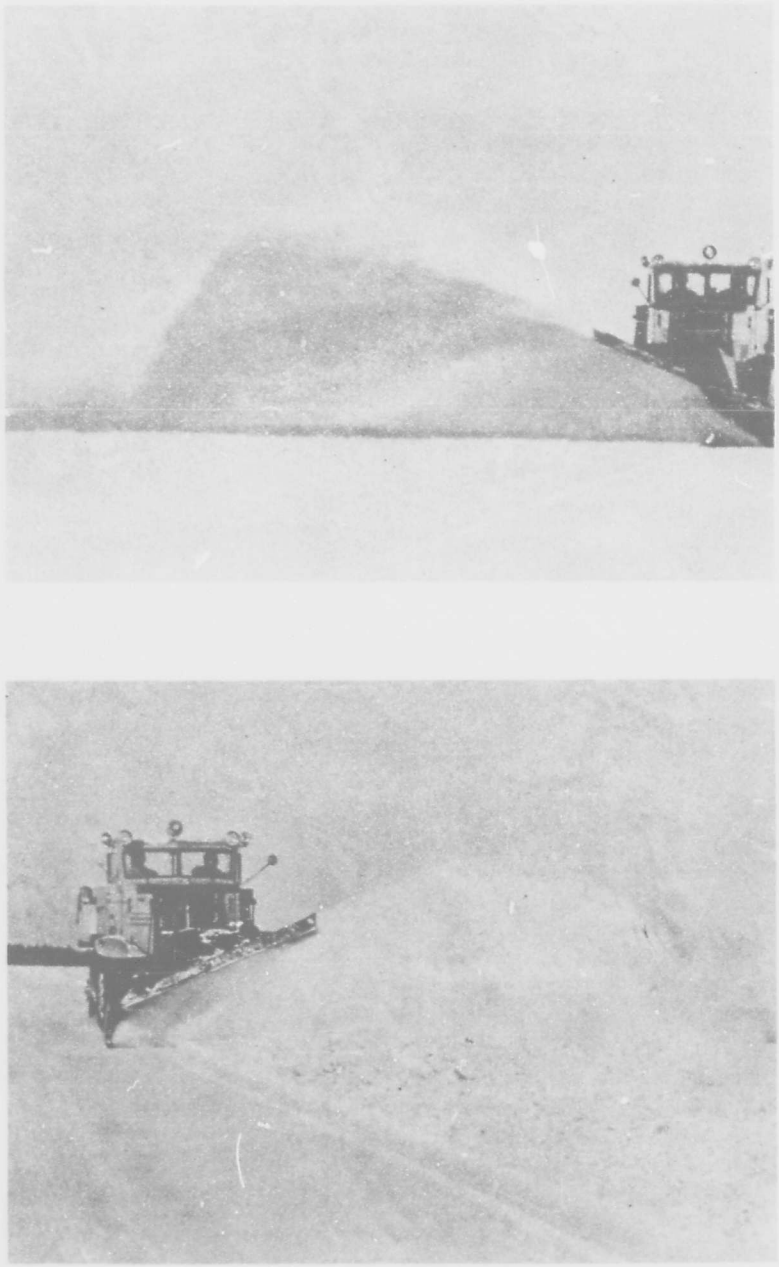


Figure 16. (Top) Frink "Roll-Over" plow operating at high speed on runway (plowing to right).
(Bottom) Frink "Roll-Over" plow operating at high speed on runway (plowing to left).

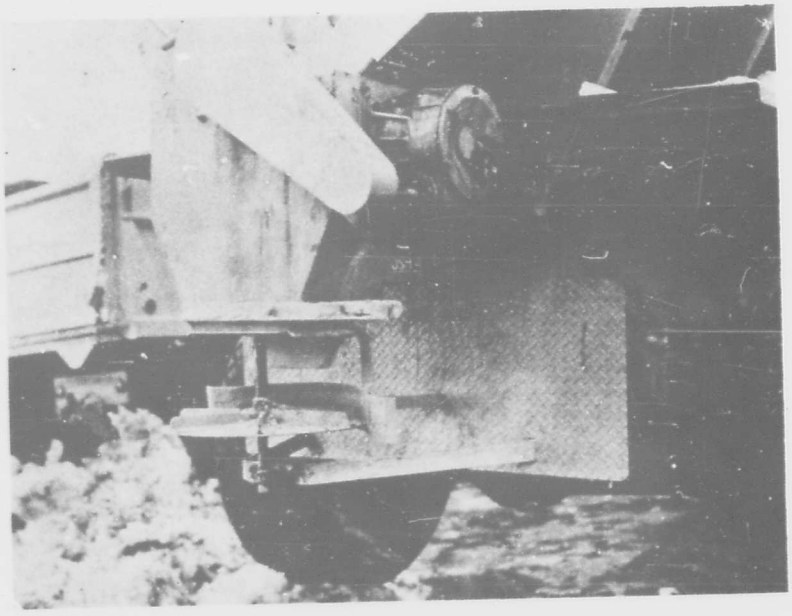


Figure 17. (Top) Oshkosh Truck Uńit equipped with Highway Model E Spreader.
(Bottom) Close-up of sand spreading mechanism.

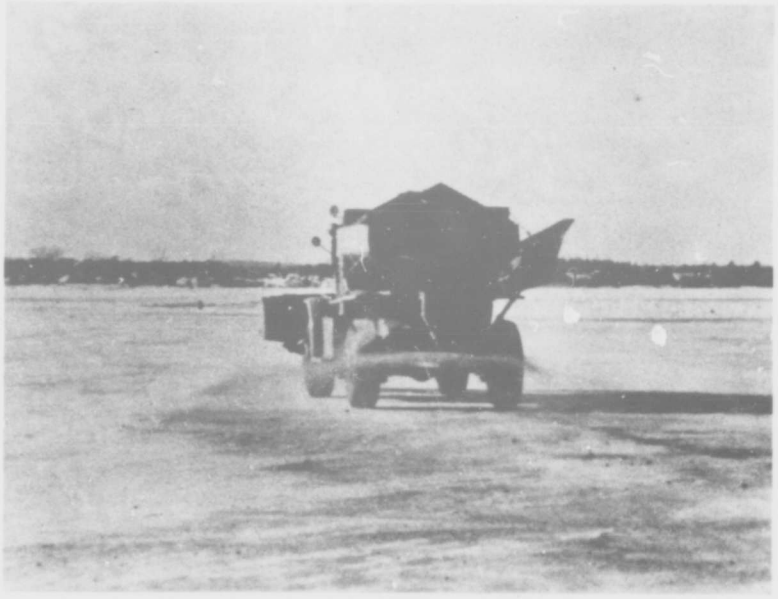


Figure 18. Highway-type sander w/sander body mounted on Oshkosh carrier sanding runway area.

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SNOW-REMOVAL OPERATIONS, WINTER 1953-54, by B. Paul Haskell, LT (CEC) USNR, and W. H. Brookshire, BULC, USNR.

UNCLASSIFIED

Evaluation tests were conducted, under operational conditions at Brunswick Naval Air Station, on reversible-type blade plows, rotary snow plows, torque converter units, one-way blade-type plows with wings, sand spreaders, a payloader, a torque converter carrier, and a "roll-over"-type blade plow. The adequacy of snow removal techniques outlined in NavDocks TP-P V-29, "Snow Removal," was determined, as well as the number of units of functional advance-base snow removal components required for an average installation. Certain minor revisions are recommended for the snow removal manual, equipment performance is discussed, and suggestions are made with reference to future tests to be conducted during the winter 1954-55.

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