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CONDITION SURVEY, GRAND FORKS AIR FORCE BASE, NORTH DAKOTA.(U)
JUN 73 P J VEDROS, H T THORNTON

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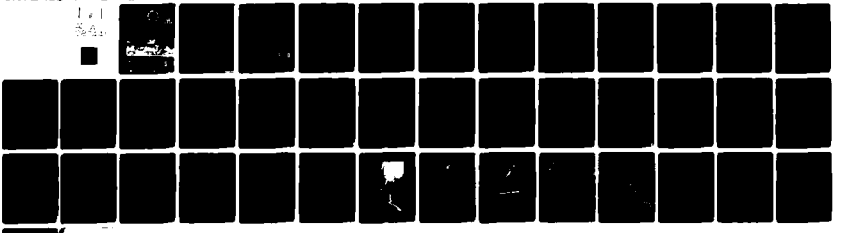

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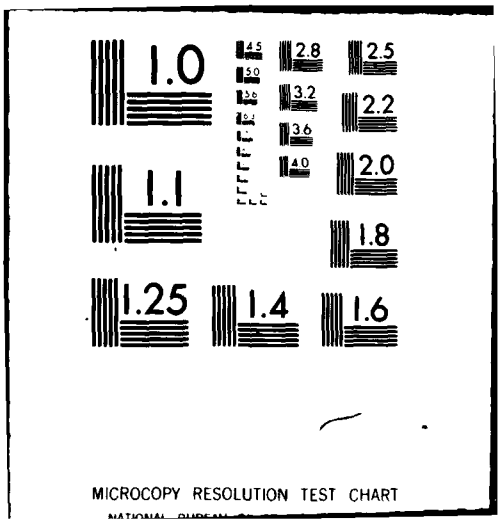
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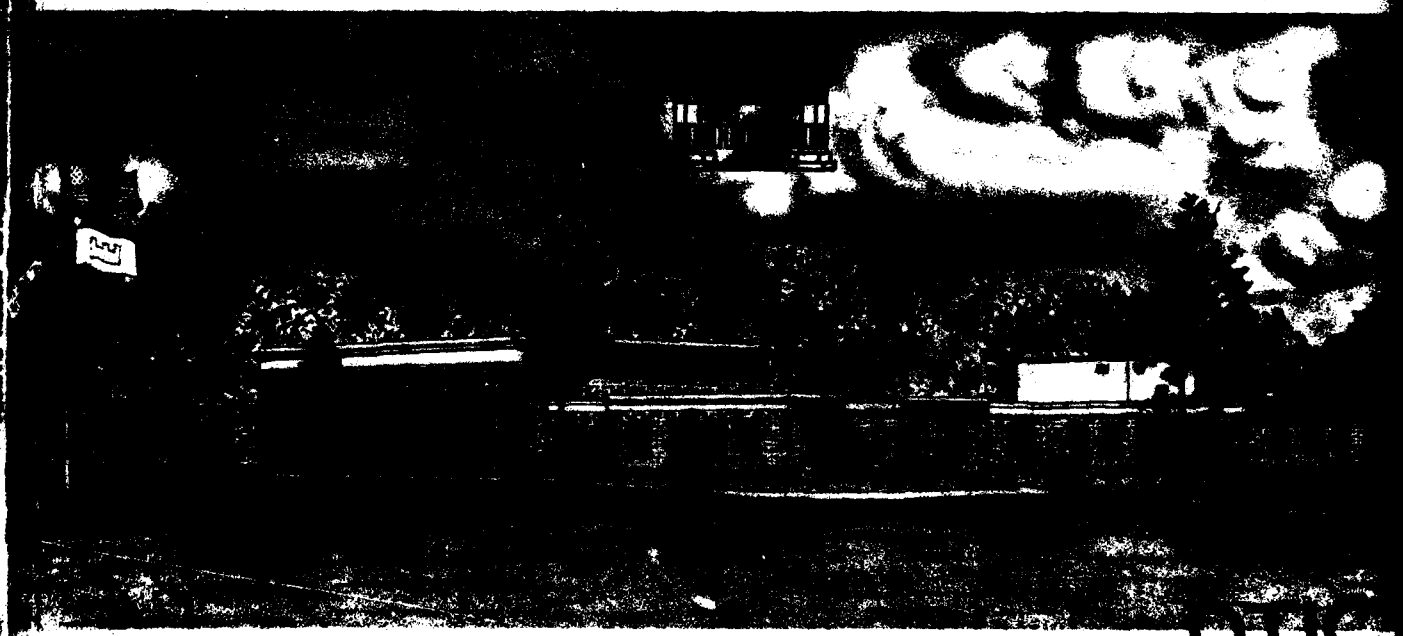
LEVEL II

MISCELLANEOUS PAPER S-73-42

CONDITION SURVEY, GRAND FORKS AIR FORCE BASE, NORTH DAKOTA

by

P. J. Vedros, H. T. Thornton, Jr.



June 1973

Sponsored by Office, Chief of Engineers, U. S. Army

Conducted by U. S. Army Engineer Waterways Experiment Station
Soils and Pavements Laboratory
Vicksburg, Mississippi

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(9) MISCELLANEOUS PAPER S-73-42

(6) CONDITION SURVEY, GRAND FORKS AIR FORCE BASE, NORTH DAKOTA.

by

(10) P. J. Vedros, H. T. Thornton, Jr.

(14) WES-MP-S-73-42

(11) Jun 73 (12) 42

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Conducted by U. S. Army Engineer Waterways Experiment Station
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ARMY-MRC VICKSBURG, MISS

Foreword

The study reported herein was conducted under the general supervision of the Engineering Design Criteria Branch, Soils and Pavements Laboratory, of the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi. Personnel involved in the condition survey were Messrs. H. T. Thornton, Jr., S. J. Alford, and R. N. Gordon, Sr., of the WES; LT Robert Eaton of the U. S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire; and Mr. George Schanz of the U. S. Army Construction Engineering Research Laboratory, Champaign, Illinois. The main portion of this report was prepared by Messrs. P. J. Vedros and Thornton under the general supervision of Messrs. J. P. Sale, R. G. Ahlvin, and R. L. Hutchinson of the Soils and Pavements Laboratory. Appendix A was obtained from the Air Force. The section of this report concerning frost action was prepared by LT Eaton and Mr. G. D. Gilman of CRREL.

COL Ernest D. Peixotto, CE, was Director of the WES during the conduct of the study and preparation of the report. Mr. F. R. Brown was Technical Director.

Contents

Conversion Factors, British to Metric Units of Measurement

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

Multiply	By	To Obtain
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
square inches	6.4516	square centimeters
square yards	0.8361274	square meters
miles per hour	1.609344	kilometers per hour
pounds (mass)	0.45359237	kilograms
pounds (force) per square inch	0.6894757	newtons per square centimeter
pounds per cubic inch	27.67984	grams per cubic centimeter
Fahrenheit degrees	*	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: $K = (5/9)(F - 32) + 273.15$.

CONDITION SURVEY, GRAND FORKS AIR FORCE BASE
NORTH DAKOTA

Authority

1. Authority for conducting condition surveys at selected airfields is contained in amendment to FY 1972 RDTE Funding Authorization (MFS-MC-5, 16 February 1972), subject: "Air Force Airfield Pavement Research Program," from the Office, Chief of Engineers, U. S. Army, Directorate of Military Construction, dated 18 February 1972.

Purpose and Scope

2. The purpose of this report is to present the results of a condition survey performed at Grand Forks Air Force Base (GFAFB), North Dakota, during 18-22 April 1972. The following three major areas of interest were considered in this condition survey:

a. The structural condition of the primary airfield pavements.

b. The condition of pavement repairs and the types of maintenance materials that have been used at this airfield.

c. Any detrimental effects of frost action to the pavement facilities.

3. This report is limited to a presentation of visual observations of the pavement conditions, discussion of these observations, and pertinent remarks with regard to the performance of the pavements. No physical tests of the pavements, foundations, or patching materials were performed during this survey.

Pertinent Background Data

General description of airfield

4. GFAFB is located in Grand Forks County, North Dakota, approximately 17 miles* west of the city of Grand Forks. A vicinity map is

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

shown in plate 1. The general topography of the site is of a comparatively flat to gently rolling nature. The airfield elevation is 911 ft above mean sea level. The airfield site is located on the edge of ancient Lake Aggassiz, which was formed as a retreating glacier blocked the flow of melting ice to the north. The foundation materials are heterogeneous, consisting of clays of CL-CH classification,* with some areas of silts and sands. The normal subgrade modulus K varies from about 100 to 175 pci.

5. In April 1972, the airfield facilities consisted of a N-S (17-35) runway, a parallel taxiway, a SAC operational apron with a hangar access apron and taxiway, an ADC alert apron and taxiway, an ADC operational apron and taxiways, a SAC alert apron and taxiway, a warm-up apron, connecting taxiways to the runway and aprons, a power check pad, and a missile loading ramp. The runway was 300 ft wide and 12,350 ft long; the taxiways were 75 ft wide with 50-ft shoulders on each side; the SAC operational apron was approximately 2,400 ft long and 675 ft wide; and the ADC apron was approximately 500 ft wide and 1,442 ft long. All airfield pavements were constructed of portland cement concrete (PCC). Blast pad shoulder pavements and overrun areas were of bituminous construction. A layout of the airfield and a pavement plan indicating the type of pavement on each facility are shown in plate 1.

Previous reports

6. Previous reports concerning the airfield facilities are listed below. Pertinent data were extracted from them for use in this condition survey report.

a. Condition survey reports:

(1) U. S. Army Engineer Division, Missouri River, CE, "Rigid Pavement Condition Survey of Grand Forks Air Force Base, North Dakota," May 1958, Omaha, Nebraska.

(2) _____, "Rigid Pavement Condition Survey of Grand Forks Air Force Base, North Dakota," June 1959, Omaha, Nebraska.

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* U. S. Department of Defense, "Unified Soil Classification System for Roads, Airfields, Embankments, and Foundations," Military Standard MIL-STD-619B, June 1968, U. S. Government Printing Office, Washington, D. C.

(3) U. S. Army Engineer Division, Missouri River, CE, "Rigid Pavement Condition Survey of Grand Forks Air Force Base, North Dakota," June 1960, Omaha, Nebraska.

(4) Ohio River Division Laboratories, CE, "Condition Survey Report, Grand Forks Air Force Base, North Dakota," May 1965, Cincinnati, Ohio.

b. Pavement evaluation reports:

(1) U. S. Army Engineer Division, Missouri River, CE, "Airfield Evaluation Report, Grand Forks Air Force Base, North Dakota," June 1959, Omaha, Nebraska.

(2) _____, "Airfield Evaluation Report, Grand Forks Air Force Base, North Dakota," March 1960, Omaha, Nebraska.

History of Airfield Pavements

Design and construction history

7. Details of the design and construction history of the airfield pavements (extracted from the reports referenced in paragraph 6) are presented in table 1. As is stated in the 1965 condition survey report (see subparagraph 6a(4)), taxiway G was under construction at the time of the survey. This taxiway was completed in late 1964. A 242- by 490-ft extension to the ADC parking apron and an 875- by 75-ft missile loading ramp were constructed in 1965. All pavements were of PCC construction; design loadings were not available. Pavement thicknesses, descriptions, and other details are presented in table 2.

Traffic history

8. A detailed record of traffic that has used the pavements was available for the year 1961 and for the period 1963-71. A tabulation of the cycles* of operation per type of aircraft is presented on the following page.

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* A cycle of operation is one landing and one takeoff.

Year	Cycles of Operation per Type of Aircraft					
	Medium Bomber	Heavy Bomber	Tanker	Medium Cargo	Heavy Cargo	All Others
1961	306	0	863	226	0	3,569
1963	78	415	1,062	113	0	4,476
1964	78	990	1,064	98	2	8,634
1965	3	937	797	60	27	4,456
1966	0	844	785	92	41	4,517
1967	0	908	669	54	23	4,851
1968	0	821	574	74	54	4,493
1969	0	662	582	37	60	4,310
1970	0	590	642	10	46	4,048
1971	0	900	936	19	72	6,302
Total	465	7,067	7,974	783	325	49,656
Average takeoff weight, lb	150,000	390,000	250,000	175,000	275,000	25,000 to 70,000

The records also indicate that since 1964 there have been approximately 625 alert exercises involving B-52 aircraft and 500 involving KC-135 aircraft. Under alert conditions, the B-52 aircraft weigh approximately 492,000 lb, and the KC-135 aircraft weigh approximately 300,000 lb.

9. It was reported that the south (35) end of the runway is used for approximately 65 percent of the takeoffs. This fact would indicate that, of the total number of coverages by B-52 aircraft (approximately 4,200), approximately 2,750 coverages have been applied to the pavements at the south end of the runway. This amount does not, however, include the coverages applied during alert exercises.

Conditions of Pavement Surfaces

Pavement inspection procedure

10. The following procedure was used in conducting the inspection of the rigid pavements. Representative features were selected for

detailed inspection. The features were then inspected slab* by slab, and the defects were recorded. The locations of the individual pavement features, the inspection starting points, and the directions in which the pavements were inspected (shown by arrows) are indicated in plate 1. The results of the rigid pavement survey for those features that were inspected in detail are presented in table 3. This table shows a quantitative breakdown of the various types of defects and a condition rating for each pavement feature inspected in detail. The procedures used for determining the condition rating of a pavement are given in Appendix III of Department of the Army Technical Manual TM 5-827-3, "Rigid Airfield Pavement Evaluation," dated September 1965.

11. It was reported in trip and letter reports in 1958 by the U. S. Army Engineer District, Omaha, and the Ohio River Division Laboratories that pavements constructed at GFAFB during 1957 were observed in April 1958 to contain numerous cracks. Crack surveys of the pavements were conducted during April 1958, June 1958, September 1958, March 1959, and April 1959. Results of these surveys were published in a report prepared by the Omaha District, entitled "Crack Investigation, Volume I, Grand Forks Air Force Base, North Dakota," dated June 1959, and in the report referenced in subparagraph 6a(2).

12. The greatest amount of cracking was occurring in the runway extension (4000-ft extension to the north (17) end of runway) between sta 75+00 and 98+00. It was concluded from the crack surveys in 1959 that the uncontrolled cracking was caused by nonuniform frost heave and subsidence of undisturbed soils.

Runway

13. During the 1972 survey, the pavement surface on the runway was in very good to excellent structural condition. The first 500 ft of the south end (feature R1A) was in excellent condition, with only about 7 percent of the slabs containing major defects. In the second 500-ft section of the south end (feature R2B), only about 2 percent of the slabs

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* A slab is the smallest unit, containing no joints, of a given pavement feature.

contained major defects. This end of the runway is used for approximately 65 percent of the takeoffs. The 200-ft-wide interior of the runway (features R3C and R4C) was in very good condition, with about 11 percent of the slabs containing major defects (table 3). As is stated in paragraph 12, a considerable amount of cracking was observed in the interior portion of the runway in 1959 between sta 75+00 and 98+00. It was found during the 1972 survey that the cracking in this area (photo 1) had increased approximately 75 percent above the amount found during the survey conducted by the Omaha District in 1959. To illustrate this fact more clearly, plate 2 compares the results of the 1959 and 1972 surveys with respect to the number and location of major structural defects. As is shown in plate 2, about 68 percent of all major defects observed in the runway occurred between sta 75+00 and 100+00. Of the total defects in this 2500-ft area, about 70 percent occurred outside the middle four lanes (lanes 5-8), which are considered the areas where traffic is applied (photo 2). This concentration of defects tends to substantiate the conclusion of the 1959 survey that the cracking was from some cause other than traffic and probably resulted from nonuniform heave. The first 500 ft of the north end of the runway (feature R6A) was in excellent condition, with no defects observed. The second 500 ft (feature R5B) was in very good condition, with approximately 3 percent of the slabs containing major defects. Pop-outs were numerous in most slabs of the runway (photo 3).

14. Structurally, the pavements seem to be performing satisfactorily under the B-52 aircraft now using the pavements. Fifteen B-52 pilots and 18 KC-135 pilots were asked to rate the riding quality of the runway pavement. Fifty-two percent rated it as smooth; 40 percent, fair; and 8 percent, rough. Most of the complaints were that the runway was rough when landing on the north end, which is the area containing the large amount of surface cracking.

Taxiways

15. All primary heavy-load taxiways surveyed were in excellent condition except for the taxiway to the north end of the SAC operational apron (feature T6A), which was in only good condition. Approximately

21 percent of the slabs in this feature contained major defects. Most of these defects were in the two east lanes of this three-lane taxiway. Pop-outs were observed in all taxiways (photo 4) except taxiway G. This taxiway was constructed in 1964 by the Air Force using a crushed granite aggregate in the concrete. Some transverse spalls on taxiway G had been patched with epoxy and were performing satisfactorily (photo 5).

SAC operational apron

16. Fourteen lanes on the east and west sides of the SAC operational apron (features A2B and A3B) could not be surveyed because of parked alert aircraft. The area that was surveyed was in very good condition, with approximately 18 percent of the slabs containing major defects. In the area where the aircraft were parked, considerable structural cracking had developed under the main gears. Mud jacking had been performed in the apron area in 1966 and 1970 in areas where slabs had settled. It was reported that poor drainage exists in the apron area, particularly on the east side.

SAC alert facility

17. The SAC alert facility consists of a taxiway (feature T10B) and nine parking stubs (features A10B and A11B). The four stubs constructed in 1959 (feature A11B) contained no major defects, and the pop-out problem was not as prevalent as in other portions of the alert system. The other five stubs (feature A10B) and the alert taxiway (feature T10B) were in very good condition, with approximately 4 to 5 percent of the slabs containing major defects (table 3).

ADC facility

18. This facility consists of an operational apron (feature A6B), an apron extension (feature A14B), an apron taxiway (feature T14B), taxiway H (feature T12B), taxiway B (feature T13B), an alert apron (feature A9B), and an alert taxiway (feature T11B). It was not possible to survey all of the slabs of features T14B, T11B, A9B, and A6B because of parked alert aircraft. The thicknesses of the pavements ranged from 11 to 18 in. for the alert facility, and the slabs investigated were in conditions ranging from good to excellent. Seventeen to 25 percent of the slabs of taxiways B and H (both 18 in. thick) contained

major defects. Of the slabs of the alert apron and taxiway (11-in.-thick pavement) surveyed, approximately 30 percent contained major defects. The operational apron and taxiway were in excellent condition. All of these facilities except the apron extension (which used a crushed granite aggregate in the concrete mix) contained numerous pop-outs.

Connecting taxiways A and D

19. Taxiway D (feature T8C) and taxiway A (feature T9C), which are 18-in.-thick pavement, were in excellent condition, with only 4 to 7 percent of the slabs containing major defects.

Warm-up apron and missile loading ramp

20. The warm-up apron (feature A1B) was in excellent condition, with only one transverse crack observed. The missile loading ramp (feature A15B) was in excellent condition, with only about 5 percent of the slabs containing major defects. Some slabs at the entrance to the loading ramp contained longitudinal cracks (photo 6).

Frost Action

Objectives of inspection

21. One member of the team inspected the pavement facilities for evidence of detrimental frost effects. The objectives of the inspection were to determine:

a. Any adverse effects of frost heave to the pavements during the winter months.

b. Any adverse effects of low-temperature contraction cracking to the flexible pavements.

c. Any traffic-induced failures that might be related to thaw weakening of the subgrades or base courses.

Frost heave

22. The airfield pavements were inspected for surface irregularities indicative of differential frost heaving. The inspection, which was conducted during the period 18-22 April, very closely followed the period of thawing of frozen base courses and subgrades; therefore, the effects of any detrimental nonuniform heave should have been apparent.

As is noted in paragraph 14, only 8 percent of the B-52 and KC-135 pilots who were asked to rate the riding quality of the runway regarded it as rough. The consensus of the condition survey team was that the runway did not exhibit roughness detectable in an automobile at speeds of up to 60 mph.

23. Runway. In April 1958, considerable cracking was observed on the 4000-ft runway extension (features R4C, R5B, R6A, and R9D) which had been constructed in 1957. To determine the cause of this cracking, surveys were conducted in 1958 and 1959 (see paragraphs 11 and 12). As is noted in paragraph 13, cracks in the interior portion in this area of the runway (feature R4C) increased by approximately 75 percent since the earlier surveys. Most of the cracking was outside of the lanes subject to the most traffic, and nonuniform heave is considered to be the most probable cause. Records indicate that the original design called for a 34-in. sand (F2*) subbase under a 19-in. pavement and 19-in. base course. However, due to depletion of the sand source, natural subgrade material (F3** and F4†) was used for the subbase with F4 material removed to a 72-in. depth. This construction resulted in a variable F3 or better subbase, and subgrade soils within the depth of frost penetration are indicated to be variable F3 with pockets of F4 materials.

24. Aprons and taxiways. A 1-in. differential heave between two slabs was observed during this survey on the southeastern part of the SAC operational apron (feature A3B). Crack surveys had also been conducted on this apron in 1958 and 1959; the investigational report ascribed the cracking to differential heaving, noting that a variable F3 subbase had been placed in the pavement structure. A record of the

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* F2 denotes gravelly soils in which 10-20 percent (by weight) of the particles are finer than 0.02 mm, or sands in which 3-15 percent of the particles are finer than 0.02 mm.

** F3 denotes gravelly soils in which more than 20 percent of the particles are finer than 0.02 mm, clays with plasticity indices greater than 12, and sands in which more than 15 percent of the particles are finer than 0.02 mm.

† F4 denotes all silts, very fine silty sands in which more than 15 percent of the particles are finer than 0.02 mm, and clays with plasticity indices less than 12.

progression of cracking in this area since 1959 is not available, since parked aircraft prevented a complete pavement inspection during the 1972 survey. No significant evidence of detrimental heaving was observed on the other aprons or taxiways.

25. Overruns. The south overrun area, which has a combined thickness of 63 in. of pavement, base, and subbase, was in good condition, with only minor evidence of frost heave. The north overrun, for which previous reports show the same cross section, was in poor condition, with cracking, rutting, and unevenness from differential frost heave. It is not known whether the base and subbase meet current gradation requirements for classification as nonfrost-susceptible materials. Standing water was observed beside the pavement, and it was obvious that the soil was saturated at the time of the survey.

26. Shoulders. The shoulder pavements have performed adequately with respect to load-bearing capacity, and frost heaving has been minor. There were a few PCC light inserts that had heaved somewhat and had been damaged slightly by snow plows, but they were not interfering with snow removal operations. On the SAC alert taxiway (feature T10B), a 1/2- to 1-in. differential existed between the PCC pavement and AC shoulder, the former being higher, and three areas had noticeably settled over the underdrains. The shoulder pavements on the stubs of the SAC alert apron, which are sloped away from the stubs, had numerous cracks with water seeping from all shoulders of stubs on the west and southeast sides. There was a standing pool of water in the southeast corner of the alert area at the time of this survey.

Freezing indices

27. A design freezing index of 3253 degree-days (based on temperature data from the Grand Forks Federal Aviation Administration Weather Station) has been determined for GFAFB. This value reflects the average of the three coldest winters in the past 30 years (1949-50, 1968-69, and 1950-51). The value considers average monthly temperatures for months entirely within the freezing seasons and average daily temperatures for the two transition months.

28. Since data are not now available to permit the determination

of seasonal indices for GFAFB for other than the years cited above, the values tabulated below are from the records of the U. S. Weather Bureau Station at Williston, North Dakota, which is approximately 300 miles west of GFAFB. Although these values do not reflect the indices actually experienced at GFAFB, and, being entirely determined from average monthly temperatures, are somewhat lower than indices which consider average daily temperatures for the two transition months, they do indicate the relative severity of winters since the completion of the first pavements designed for heavy-load aircraft. Several substantially colder-than-normal winters are indicated to have occurred during this period.

Freezing Season	Freezing Index degree-days	Freezing Season	Freezing Index degree-days
1957-58	1215	1965-66	2206
1958-59	2159	1966-67	2250
1959-60	1961	1967-68	1850
1960-61	1154	1968-69	2818
1961-62	2427	1969-70	2041
1962-63	1606	1970-71	2410
1963-64	1658	1971-72	2544
1964-65	2521		
	Mean (1931-60) 2125*		

* Based on daily data

29. The combined thickness of pavement and base required for prevention of subgrade freezing in the design index year ranges from approximately 145 to 150 in., and for limited subgrade frost penetration, from about 95 to 110 in. Accordingly, substantial subgrade freezing may be expected during most winters under pavements with a combined protective thickness of 72 in., which is the maximum provided by any of the GFAFB pavement facilities. This is the minimum nonfrost-susceptible thickness that is permitted under current criteria to be used solely for frost-condition design purposes without specific approval of the Chief of Engineers. However, at GFAFB, the subbases in most cases are frost

susceptible (F2 and F3). Also, although the groundwater table at GFAFB is indicated to be in excess of 10 ft below the surface, the clay subgrade is relatively impervious, and the presence of a perched water table was evident in many areas. However, detrimental differential heaving has been observed under traffic pavements only in locations where variable subbase soils are known to exist.

Low-temperature contraction cracking

30. Annual temperatures at GFAFB vary over a range of at least 150 F, and all of the bituminous pavements have low-temperature contraction cracks, longitudinal as well as transverse and diagonal. These cracks are not induced by traffic or frost heaving but result from a stiffness characteristic of AC at low temperatures and its inability to withstand or adjust to thermal contraction stresses. The AC taxiway shoulders and apron shoulders and the bituminous surface treatment in the overrun areas had about equally severe incidences of cracks. Longitudinal cracks were most pronounced in the overrun pavements. In most areas on the taxiway shoulders, the transverse cracks were fairly regular, spaced at 6- to 10-ft intervals, with a longitudinal crack running approximately down the middle.

Thaw weakening

31. The extent of thaw weakening of underlying soils was not readily determined by inspection of the pavement surfaces, since it is often impossible to establish by this means whether structural defects are the result of thaw weakening or of deficiencies in strength or thickness of the pavement components with respect to "normal" period subsoil and traffic conditions. The depletion of the fatigue resistance of a pavement system is progressive under repeated loadings and in seasonal frost areas is related to thaw weakening in that the rate of depletion is greater during and directly following the frost-melting period. Thus, while the evidence of fatigue or failure that might become apparent in the spring is directly related to thaw weakening, similar evidence that might appear at other times of the year can also be related to previous thaw periods. At GFAFB, the generally very good to excellent condition of pavements that have withstood considerable

amounts of aircraft traffic (paragraph 8) indicates that there is no significant acceleration of fatigue due to thaw weakening. Some limited perception of frost action at GFAFB can be gained by comparing the performance of certain pavement features with what might be expected in the light of current frost-condition design criteria.

32. The primary runway, taxiways E, F, and G, the SAC operational apron, and the SAC alert facility were designed for heavy-load aircraft. Except for the SAC alert apron extension (feature A11B), which has 72 in. of nonfrost-susceptible protection over the subgrade (limited subgrade frost penetration design), these pavements were designed under the criteria for reduced subgrade strength design in the frost-melting period. Since the subbase is frost susceptible (F2 and F3), the criteria were applied by determining the K_f* value of the subbase rather than that of the less critical underlying subgrade. This design approach accordingly requires a nonfrost-susceptible base that is at least equal to the slab thickness, a requirement which the primary pavements at GFAFB generally meet. The frost-capacity evaluations for B-52 type gear, nevertheless, are somewhat lower for some pavement features than the current gear load of 492,000 lb used during alert operations. Such alert operations, if conducted during the period of subgrade weakening would significantly overload the SAC operational apron (features A2B and A3B) and slightly overload the SAC alert facility and runway feature R5B. A portion of taxiway C between the south end of the SAC operational apron and taxiway G was designed for medium-load aircraft. It would be slightly overloaded by alert operations in the normal period and grossly overloaded during the frost-melting period.

33. It should be noted that reduced subgrade strength design is not recommended when variable frost-susceptible materials are present within the seasonal frost active zone. The principal detrimental frost effects at GFAFB seem to have occurred in some of the locations where this criterion was not followed.

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* K_f is the modulus of subgrade, subbase, or base course reaction in pounds per cubic inch for the frost-melting period.

Maintenance

34. Maintenance at GFAFB has consisted of crack sealing, joint resealing, patching joint spalls, and mud jacking. Mud jacking was necessary for settled slabs of the SAC operational apron and the extension to the north end of the runway. The base annual pavement maintenance plan, which was obtained from the Air Force, is included in this report as Appendix A. This maintenance plan indicates the type and amount of maintenance and repair that have been performed through 1971.

35. Pop-outs are occurring in all pavements at this airfield except the missile loading ramp, the ADC operational apron extension, and taxiway G. The majority of the pop-outs are 1 in. or less in diameter and about 1/2 in. deep. The pavements are kept clean of loose aggregate on the surface by daily sweeping. It has not been necessary to patch the pop-outs.

36. Patching of spalls in the SAC operational apron pavements in 1971 was necessary; however, this project is not included in the maintenance plan presented in Appendix A.

Evaluation

37. The latest evaluation report for this airfield was prepared in 1960 (see subparagraph 6b(2)). Because some changes in gear configurations and methods of evaluation have been made since that time, a new evaluation table (table 4) has been prepared. The physical properties of the materials as determined in previous evaluations were used for this evaluation, with engineering judgement applied to specific pavement areas where performance has indicated that the load-carrying capacity should be modified from that obtained in using the strength properties assigned in the physical property data.

Conclusions

38. The following remarks summarize the findings of the 1972 inspection:

a. The pavement surface on the runway was generally in very good to excellent structural condition, except in the area between sta 75+00 and 98+00 where cracking had increased and the pavement was reported to be rough to landing aircraft. The cause of cracking is attributed to nonuniform heave and not to overloading.

b. The area of the SAC operational apron on which B-52 aircraft are parked contained structural cracking under the main gears of these aircraft. Mud jacking had been performed in some areas of this apron.

c. Detrimental heaving was observed under traffic pavements only in locations where variable subbase soils were known to exist.

d. Pop-outs were occurring in most of the pavements of the airfield; however, it has not been necessary to patch these pop-outs. Sweeping keeps the surface clean of any loose aggregate.

Table 1

Airfield Construction History

Pavement Facility	Pavement Thickness in.	Pavement Type	Construction Period	Design Loading lb
N-S (17-35) runway, first 1000 ft each end	24, 23, and 21	PCC	Apr 1957-Nov 1958	240,000*
N-S (17-35) runway interior, 200-ft-wide center section	19	PCC	Jan 1956-Nov 1958	240,000*
N-S (17-35) runway interior, 50-ft-wide edges	15 and 16	PCC	Jan 1956-Nov 1958	100,000**
Taxiways A, B, C, D, H, and ADC apron taxiway	18	PCC	Jan 1956-Nov 1957	100,000**
Taxiways E, F, and SAC operational apron taxiway	24	PCC	Apr 1957-Nov 1958	240,000*
ADC operational apron	16	PCC	Jan 1956-Nov 1957	100,000**
ADC operational apron extension.	16	PCC	Jan 1956-Nov 1957	100,000**
SAC operational apron	19	PCC	Apr 1957-Nov 1958	240,000*
Warm-up apron	21	PCC	Apr 1957-Nov 1958	240,000*
ADC hangar access taxiways	14	PCC	Jan 1956-Nov 1957	80,000**
SAC hangar access apron	16	PCC	Apr 1957-Nov 1958	160,000*
ADC washrack	10	PCC	Jul 1958-Dec 1958	20,000†
ADC alert facility	11	PCC	Jan 1956-Nov 1957	25,000†
SAC alert facility	21	PCC	Apr 1957-Nov 1958	240,000*
Blast pads and shoulder pavements	2	AC	Jan 1956-Nov 1958	--
Overrun pavements	--	DBST††	Apr 1957-Nov 1958	--
SAC alert apron extension	18	PCC	Apr 1959-Nov 1959	--
SAC hangar access apron extension	13	PCC	1962	--
Power check pad	10	PCC	1963‡	--
Service area	9	PCC	1962	--
Taxiway G	19	PCC	1964‡	--
ADC operational apron extension	14	PCC	1965	--
Missile loading ramp	14	PCC	1965	--

* Twin-twin gear assembly.
** Dual gear assembly.
† Single-wheel assembly.
†† Double bituminous surface treatment.
‡ Constructed by U. S. Air Force.

Table 2

SUMMARY OF PHYSICAL PROPERTY DATA

Grand Forks AFB FACILITY	April 1972		OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
N-S runway, 1st 500 ft, S end R1A	500	Variable				23	Portland cement concrete	750	19 4 26	Gravel (GW) Granular filter course Select material sand (SP) F2	270 K_f-180	Sand (SP) F2		Excellent
N-S runway, 2nd 500 ft, S end R2B	Variable	Variable				21	Portland cement concrete	750	17 4 30	Gravel (GW) Granular filter course Select material sand (SP) clay (CL) F3	270 K_f-120	Sand (SP) F2		Excellent
N-S runway interior Sta 1+50 to 75+00, center 200 ft R3C	7350	200				19	Portland cement concrete	700	15 4 34	Gravel (GW) Granular filter course Select material sand (SP) F2	270 K_f-150	Sand (SP) F2		Very good
N-S runway interior East edge, sta 1+50 to 10+00 West edge, sta 1+50 to 75+00 R7D	850 7350	50 50				16	Portland cement concrete	700	15± 4 37±	Gravel (GW) Granular filter course Select material sand (SP) F2	270 K_f-150	Sand (SP) F2		Very good
N-S runway interior East edge, sta 10+00 to 75+00 R8D	6500	50				15	Portland cement concrete	700	16± 4 37±	Gravel (GW) Granular filter course Select material sand (SP) F2	270 K_f-120	Sand (SP) Frost group F2		Very good
N-S runway interior East edge, sta 75+00 to 105+00 West edge, sta 75+00 to 105+00 R9D	3000 3000	50 50				16	Portland cement concrete	750	15± 4 37±	Gravel (GW) Granular filter course Select material clay (CL) F3	180 K_f-110	Clay (CL)(CH) (CL-OL), F3 and F4		Very good
N-S runway interior Sta 75+00 to 105+00, center 200 ft R4C	3000	200				19	Portland cement concrete	750	15 4 34	Gravel (GW) Granular filter course Select material clay (CL) F3	180 K_f-110	Clay (CL)(CH) (CL-OL), F3 and F4		Very good
N-S runway, 2nd 500 ft, N end R5B	Variable	Variable				21	Portland cement concrete	750	17 4 45	Gravel (GW) Granular filter course Select material clay (CL) F3	180 K_f-120	Clay (CL)(CH) (CL-OL) and F4		Very good
N-S runway, 1st 500 ft N end R6A	Variable	Variable				24	Portland cement concrete	750	19 4 25	Gravel (GW) Granular filter course Select material sand (SM-SP) clay (CL) F3	180 K_f-140	Clay (CL)(CH) (CL-OL) F3 and F4		Excellent

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(1 of 4 sheets)

Table 2 (Continued)

SUMMARY OF PHYSICAL PROPERTY DATA

Grand Forks AFB FACILITY	April 1972		OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
Taxiway F T1A	1184	75				24	Portland cement concrete	750	20 4 24	Gravel (GW) Granular filter course Select material clay (CL-CH) F3	180 K_f-140	Clay (CL) F3		Excellent
Taxiway E T2A	3637±	75				21-24-21	Portland cement concrete	750	19 4 25	Gravel (GW) Granular filter course Select material (SP) F2	180 K_f-180	Clay (CL) F3		Excellent
Taxiway C	8389±	75				16-18-16	Portland cement concrete	750	14	Gravel (GW)	300	Sand (SP) F2		Excellent
Taxiway A	1000	75							4	Granular filter course				Excellent
Taxiway H	535	75							36	Select material sand (SP) F2	K_f-140			Good
Taxiway I	535	75												Very good
ADC apron taxiway T3A T9C T12B T13B T14B	1200	75												Excellent
Taxiway G T4A	1200±	75				19	Portland cement concrete	750	12 37 4	Gravel (GW) Select material subbase F2 Granular filter course	350 K_f-300	Clay (CL) F3		Excellent
SAC operational apron access taxiway T5A	975±	75				24	Portland cement concrete	750	20 4 24	Gravel (GW) Granular filter course Select material clay (CL) F3	210 K_f-140	Silty sand (SP-SM) F3		Excellent
SAC operational apron taxiway (north end) T6A	2000±	75				21-24-21	Portland cement concrete	750	20 4 24	Gravel (GW) Granular filter course Select material clay (CL) F3	210 K_f-140	Silty sand (SP-SM) F3		Good
SAC operational apron taxiway (south end) T7A	875	75				21-23-21	Portland cement concrete	750	19 4 25	Gravel (GW) Granular filter course Select material clay (CL) F3	270 K_f-135	Sand (SP) F3		Excellent
Taxiway D T8C	1000	75				16-18-16	Portland cement concrete	750	14 4 36	Gravel (GW) Granular filter course Select material sand (SP) F2	300 K_f-140	Sand (SP) F2		Excellent

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(2 of 4 sheets)

Table 2 (Continued)

SUMMARY OF PHYSICAL PROPERTY DATA

Grand Forks AFB FACILITY April 1977			OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
Warmup apron A1B	750 Variable	300 Variable				21	Portland cement concrete	750	17 4 30	Gravel (GW) Granular filter course Select material clay (CL-CH) F3	180 K_f-120	Clay (CL-CH) F3		Excellent
[illegible] operational apron north end) A2B	1000	300				19	Portland cement concrete	750	15 4 34	Gravel (GW) Granular filter course Select material clay (CL-CH) F3	210 K_f-110	Clay (CL) F3		Very good
(A7 operational apron south end) A3B	400	400				19	Portland cement concrete	750	15 4 34	Gravel (GW) Granular filter course Select material clay (CL-CH) F3	270 K_f-110	Sand (SP) F2		Very good
[illegible] hangar access apron and taxiway) A4B	Variable	Variable				16	Portland cement concrete	750	12 4 40	Gravel (GW) Granular filter course Select material clay (CL-CH) F3	270 K_f-90	Sand (SP) F2		
[illegible] hangar access apron extension A5B	325±	Variable				13	Portland cement concrete	750	12 43 4	Gravel (GW) Select material subbase F2 Granular filter course	350 K_f-300	Clay (CL) F3		
[illegible] operational apron A6	1200	400				10	Portland cement concrete	750	14 4 38	Gravel (GW) Granular filter course Select material sand (SP) F2	300 K_f-125	Sand (SP) F2		Excellent
[illegible] taxiway and apron A7B	1200±	Variable				14	Portland cement concrete	750	10 4 44	Gravel (GW) Granular filter course Select material sand (SP) F2	300 K_f-170	Sand (SP) F2		
[illegible] alert taxiway and apron A8B [illegible]	2140±	75±				11	Portland cement concrete	750	7 4 50	Gravel (GW) Granular filter course Select material sand (SP) F2	270 K_f-85	Sand (SP) F2		Good
[illegible] alert taxiway and apron A10B T10B	Variable	Variable				21	Portland cement concrete	750	17 4 30	Gravel (GW) Granular filter course Select material clay (CL) F3	180 K_f-[illegible]	Clay (CL) F3		Very good

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MAR 1958

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Table 2 (Continued)

SUMMARY OF PHYSICAL PROPERTY DATA

Grand Forks AFB FACILITY	April 1972		OVERLAY PAVEMENT			PAVEMENT			BASE			SUBGRADE		GENERAL CONDITION OF AREA CONSIDERED
FACILITY NUMBER AND IDENTIFICATION	LENGTH FT	WIDTH FT	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	DESCRIPTION	FLEX. STR PSI	THICK. IN.	CLASSIFICATION	CBR OR K	CLASSIFICATION	CBR OR K	
SAC alert apron extension (stubs 6-9) A11B	Variable	Variable				18	Portland cement concrete	735	50 4	Gravel (GW) Granular filter course	350 K_f-315	Clay (CL) F3		Excellent
Power check pad A12C						10	Portland cement concrete	750	15 4 43	Gravel (GW) Granular filter course Select material F2	180 K_f-140	Clay (CL) F3		
ADC operational apron extension A14B	242	490				14	Portland cement concrete	740	12 4 40	Gravel (GW) Granular filter course Select material F2	350 K_f-160	Clay (CL) F3		Excellent
Missile loading ramp A15B	875	75				14	Portland cement concrete	625	10 4 44	Gravel (GW) Granular filter course Select material F2	300 K_f-120	Sand (SP) F2		Excellent

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MAR 1958

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Table 3

DATE: Apr. 1[illegible]

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

AIRFIELD: Grand Forks AFB, N. Dak.

FEATURE NO.	FEATURE DESIGNATION	SLAB SIZE FT	APPROX NO. OF SLABS	PAVT. THICK. IN.	NO. OF SLABS CONTAINING INDICATED DEFECTS																	% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION
					I	—	\	Δ	*	K	~	S	J	↓	J	◆	M	P	O	C	D			
R1A R2E	N-S runway 1st 500 ft S end	25x25	240	21 and 23	15	2																93	93	Excellent
R2E	N-S runway 2nd 500 ft S end	25x25	240	21	4		2								1	3						97	98	Excellent
R2C R4C R7D R8D R9D	N-S runway interior	25x25	4068	15, 17 and 19	419	74	109	3	6		68	2	5	7	85					1	49	85	89	Very Good
R5E	N-S runway 2nd 500 ft N end	25x25	240	21	1	5			2		1				2							96	97	Very Good
R6A R5E	N-S runway 1st 500 ft N end	25x25	240	21 and 24																		100	100	Excellent
T1A	Taxiway F	25x25	165	24																		100	100	Excellent
T2A	Taxiway E	25x25	492	21-24-21	1						1											99	99	Excellent
T3A	Taxiway C*	25x25	933	16-18-16	42	1	8				6	4	1		1							94	95	Excellent
T4A	Taxiway G	15x15	495	19																		100	100	Excellent

REMARKS: * This facility did not contain pop-outs.

LEGEND:

I	LONGITUDINAL CRACK	~	SHRINKAGE CRACK	M	MAP CRACKING
—	TRANSVERSE CRACK	S	SCALING	P	PUMPING JOINT
\	DIAGONAL CRACK	J	SPALL ON TRANSVERSE JOINT	O	POP-OUT
Δ	CORNER BREAK	↓	SPALL ON LONGITUDINAL JOINT	C	UNCONTROLLED CONTRACTION CRACK
*	SHATTERED SLAB	J	CORNER SPALL	D	"D" CRACKING
K	KEYED JOINT FAILURE	◆	SETTLEMENT		

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JUN 1972

(1 of 3 sheets)

Table 5 (Continued)

DATE: April 1972

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

AIRFIELD: Grand Forks AFB, N. Dak.

FEATURE NO.	FEATURE DESIGNATION	SLAB SIZE FT	APPROX NO. OF SLABS	PAVE. THICK. IN.	NO. OF SLABS CONTAINING INDICATED DEFECTS																	% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION
					I	—	\	Δ	*	K	~	S	J	↓	J	◆	M	P	O	C	D			
T6A	SAC operational apron taxiway (N end)	25x25	240	21-24-21	31	4	23	2			9		1			2	6				8	72	79	Good
T7A	SAC operational apron taxiway (S end)	25x25	157	21-23-21	6	1	3	2			2			1	1						1	90	94	Excellent
T10B	SAC alert taxiway	25x25	313	21	15										7					4		92	96	Very good
A2P A3P	SAC operational apron	25x25	1045**	19	129	19	50	1	4		24			2	7	7					12	78	82	Very good
A10B	SAC alert apron	25x24	640	21	24	2	5			9	25		6		15		1				22	85	95	Very good
A10B	Alert stubs 1-5	25x24	440	21	7	7	1	2							1							95	96	Very good
A11B	Alert stubs 6-9	15x15	424	18																		100	100	Excellent
A1B	Warm-up apron	25x25	218	21		1					2		1		1							98	99	Excellent
T13B	Taxiway B	25x25	72	16-18-16	13																	83	83	Very good
T12B	Taxiway H	25x25	72	16-18-16	15	1	2						1									75	75	Good

REMARKS: ** Total number of slabs surveyed (alert aircraft were parked on slabs not surveyed).

LEGEND:

I	LONGITUDINAL CRACK	~	SHRINKAGE CRACK	M	MAP CRACKING
—	TRANSVERSE CRACK	S	SCALING	P	PUMPING JOINT
\	DIAGONAL CRACK	J	SPALL ON TRANSVERSE JOINT	O	POP-OUT
Δ	CORNER BREAK	↓	SPALL ON LONGITUDINAL JOINT	C	UNCONTROLLED CONTRACTION CRACK
*	SHATTERED SLAB	J	CORNER SPALL	D	"D" CRACKING
K	KEYED JOINT FAILURE	◆	SETTLEMENT		

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JUN 1972

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Table 3 (Continued)

DATE: April 1972

SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY

AIRFIELD: Grand Forks AFB, N. Dak.

FEATURE		SLAB SIZE FT	APPROX NO. OF SLABS	PAVE. THICK. IN.	NO. OF SLABS CONTAINING INDICATED DEFECTS																% OF SLABS NO DEFECTS	% OF SLABS NO MAJOR DEFECTS	CONDITION
NO.	DESIGNATION				I	—	\	Δ	*	K	~	S	J	↓	J	◆	M	P	O	C	D			
T14B	ADC operational apron taxiway	25x25	51*	16-18-16										1								100	100	Excellent
T11B A9B	ADC alert taxiway and apron	25x25	204*	11	57	5	1							1	2					1		70	70	Good
A6B	ADC operational apron	25x25	289*	16	16	1	1							2						3	1	90	94	Excellent
A14B	ADC operational apron extension**	14x14	595	14																		100	100	Excellent
A15B	Missile loading ramp**	25x25	133	14	3	1	1															95	95	Excellent
T9C	Taxiway A	25x25	172	16-18-16	8	1	3	2			2			1								93	93	Excellent
T8C	Taxiway D	25x25	135	16-18-16	6						5	1			3							99	96	Excellent
T5A	SAC operational apron access taxiway	25x25	160	24	1	4									6					3		94	97	Excellent

REMARKS: * Total number of slabs surveyed (alert aircraft were parked on slabs not surveyed).
** This facility did not contain pop-outs.

LEGEND:

I	LONGITUDINAL CRACK	~	SHRINKAGE CRACK	M	MAP CRACKING
—	TRANSVERSE CRACK	S	SCALING	P	PUMPING JOINT
\	DIAGONAL CRACK	J	SPALL ON TRANSVERSE JOINT	O	POP-OUT
Δ	CORNER BREAK	↓	SPALL ON LONGITUDINAL JOINT	C	UNCONTROLLED CONTRACTION CRACK
*	SHATTERED SLAB	J	CORNER SPALL	D	"D" CRACKING
K	KEYED JOINT FAILURE	◆	SETTLEMENT		

WES FORM NO. 2004
JUN 1972

(3 of 3 sheets)

Table 1

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Grand Forks AFB DATE OF EVALUATION MONTH: April YR: 1972			LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										
			TRICYCLE ARRANGEMENT									BICYCLE	
FEATURE		PAVEMENT OPERATIONAL USE	SINGLE 100-PSI TIRE PRESSURE	SINGLE 100-SQ-IN. CONTACT AREA	SINGLE 241-SQ-IN. CONTACT AREA	TW 28-IN. C-C 226-SQ-IN. CONTACT AREA EACH TIRE	SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA	TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE	TW 44-IN. C-C 630-SQ-IN. CONTACT AREA EACH TIRE	TWIN TANDEM 33 IN. * 48 IN. 208-SQ-IN. CONTACT AREA EACH TIRE	C-5A GEAR CONFIGURATION	TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE	REMARKS
NO.	DESIGNATION		1	2	3	4	5	6	7	8	9	10	
R1A	N-S runway 1st 500 ft S end	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
R2B	N-S runway 2nd 500 ft S end	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	480,000	
R3C	N-S runway interior Sta 1+50 to 75+00 Center Center 200 ft	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	530,000	
R4C	N-S runway interior Sta 75+00 to 105+00 Center 200 ft	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	550,000	
R5B	N-S runway 2nd 500 ft N end	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	520,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	480,000	
R6A	N-S runway 1st 500 ft N end	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
T1A	Taxiway F	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
T2A	Taxiway F	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
T3A	Taxiway C	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	320,000	230,000+	380,000+	800,000+	480,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	300,000	230,000+	380,000+	800,000+	400,000	
T4A	Taxiway G	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	550,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	550,000	

Note: + sign denotes allowable gross loading greater than maximum gross weight of any existing aircraft having indicated gear configuration.
(a) denotes allowable gross loading less than minimum gross weight of any existing aircraft having indicated gear configuration.

Table 4 (Continued)

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Grand Forks AFB DATE OF EVALUATION MONTH: April YR: 1972			LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										
			TRICYCLE ARRANGEMENT									BICYCLE	
FEATURE		PAVEMENT OPERATIONAL USE	SINGLE 100-PSI TIRE PRESSURE	SINGLE 100-SQ-IN. CONTACT AREA	SINGLE 241-SQ-IN. CONTACT AREA	TW 28-IN. C-C 228-SQ-IN. CONTACT AREA EACH TIRE	SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA	TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE	TW 44-IN. C-C 530-SQ-IN. CONTACT AREA EACH TIRE	TWIN TANDEM 33 IN. × 46 IN. 208-SQ-IN. CONTACT AREA EACH TIRE	C-5A GEAR CONFIGURATION	TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE	REMARKS
NO.	DESIGNATION		1	2	3	4	5	6	7	8	9	10	
T5A	SAC operational apron access taxiway	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
T6A	SAC operational apron taxiway (north end)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	590,000	
T7A	SAC operational apron taxiway (south end)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	550,000	
T12B T13B T14B	Taxiway H Taxiway B ADC apron taxiway	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	510,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	300,000	230,000+	380,000+	800,000+	400,000	
T8C	Taxiway D	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	530,000	
T9C	Taxiway A	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	600,000+	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	530,000	
A1B	Warm-up apron	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	520,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	480,000	
A2B	SAC operational apron (north end)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	470,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	410,000	
A3B	SAC operational apron (south end)	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	520,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	320,000	230,000+	380,000+	800,000+	410,000	
A4B	SAC hangar access apron and taxiway	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	300,000	230,000+	380,000+	800,000+	410,000	
		Frost capacity	155,000+	85,000+	155,000+	210,000	200,000+	230,000	230,000+	380,000+	800,000+	300,000	
A5B	SAC hangar access apron extension	Capacity	150,000	85,000+	155,000+	220,000	200,000+	255,000	230,000+	380,000+	800,000+	360,000	
		Frost capacity	140,000	85,000+	155,000+	205,000	200,000+	230,000	230,000+	380,000+	800,000+	330,000	

Table 4 (Continued)

SUMMARY OF PAVEMENT EVALUATION

NAME OF AIRFIELD: Grand Forks AFB DATE OF EVALUATION MONTH: April YR: 1972			LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS										
			TRICYCLE ARRANGEMENT									BICYCLE	
FEATURE		PAVEMENT OPERATIONAL USE	SINGLE 100-PSI TIRE PRESSURE	SINGLE 100-SQ-IN. CONTACT AREA	SINGLE 241-SQ-IN. CONTACT AREA	TW 28-IN. C-C 226-SQ-IN. CONTACT AREA EACH TIRE	SINGLE TANDEM 60-IN. SPACING 400-SQ-IN. CONTACT AREA	TW 37-IN. C-C 267-SQ-IN. CONTACT AREA EACH TIRE	TW 44-IN. C-C 630-SQ-IN. CONTACT AREA EACH TIRE	TWIN TANDEM 33 IN. × 48 IN. 208-SQ-IN. CONTACT AREA EACH TIRE	C-5A GEAR CONFIGURATION	TWIN TWIN SPCG 37-62-37 267-SQ-IN. CONTACT AREA EACH TIRE	REMARKS
NO.	DESIGNATION		1	2	3	4	5	6	7	8	9	10	
A6B	ADC operational apron	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	320,000	230,000+	380,000+	800,000+	430,000	
		Frost capacity	155,000	85,000+	155,000+	220,000+	200,000+	250,000	230,000+	380,000+	800,000+	330,000	
A7B	ADC hanger access aprons and taxiways	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	265,000	230,000+	380,000+	800,000+	370,000	
		Frost capacity	125,000	85,000+	155,000+	175,000	200,000+	200,000	230,000+	340,000	800,000+	270,000	
A9B T11B	ADC alert apron and taxiway	Capacity	100,000	80,000	145,000	150,000	200,000+	170,000	230,000	330,000	800,000+	240,000	
		Frost capacity	80,000	65,000	110,000	115,000	175,000	130,000	165,000	235,000	690,000	(a)	
T10B A10B	SAC alert taxiway and apron	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	520,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	480,000	
A11B	SAC alert apron extension	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	540,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	330,000+	230,000+	380,000+	800,000+	510,000	
A12B	Power check pad	Capacity	105,000	80,000	150,000	155,000	200,000+	175,000	230,000+	340,000	800,000+	250,000	
		Frost capacity	100,000	80,000	140,000	145,000	200,000+	165,000	220,000	310,000	800,000+	230,000	
A14B	ADC apron extension	Capacity	155,000+	85,000+	155,000+	220,000+	200,000+	275,000	230,000+	380,000+	800,000+	390,000	
		Frost capacity	155,000+	85,000+	155,000+	220,000+	200,000+	255,000	230,000+	380,000+	800,000+	360,000	
A15B	Missile loading ramp	Capacity	130,000	85,000+	155,000+	190,000	200,000+	215,000	230,000+	380,000+	800,000+	310,000	
		Frost capacity	95,000	75,000	125,000	135,000	200,000	150,000	190,000	260,000	770,000	(a)	

Photo 1. Longitudinal cracks in slabs in interior of runway (typical of area from sta 75+00 to 100+00)

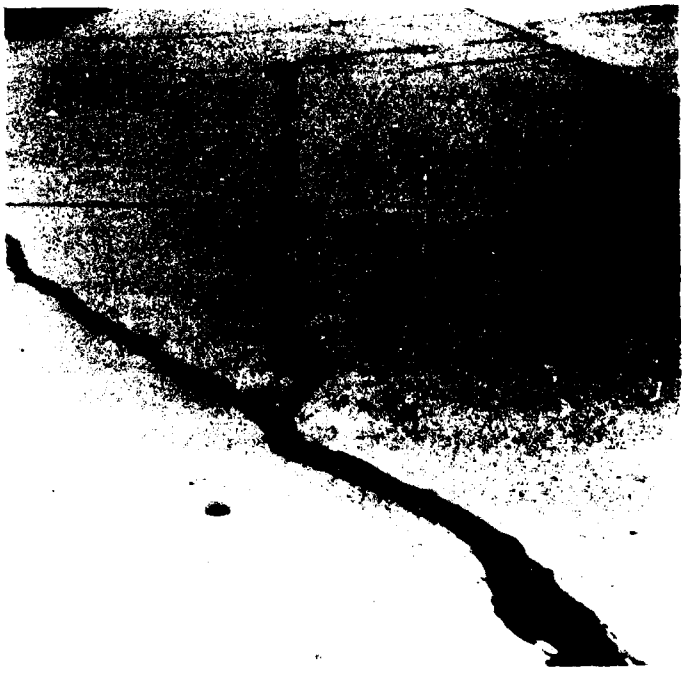


Photo 2. Cracking in outside lane of runway

Photo 3. Typical pop-out condition on south end of runway. One-ft-square grid pattern marked to indicate concentration of pop-outs per square foot

Photo 4. Pop-out condition on north end of taxiway C

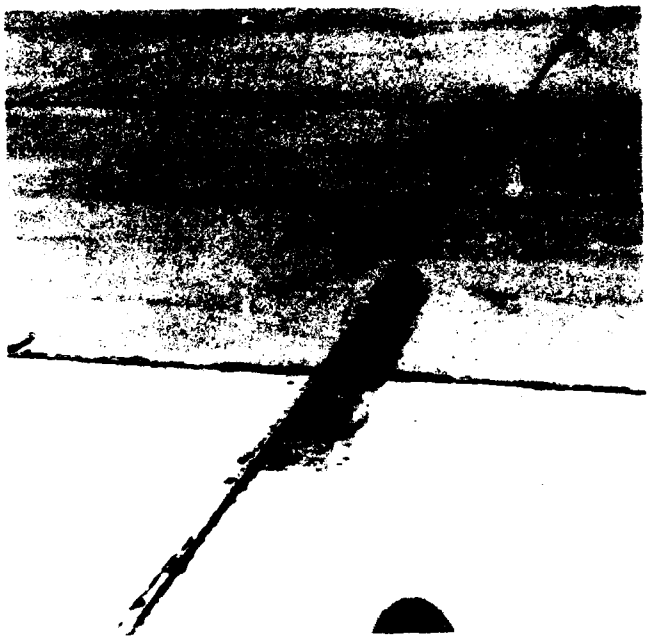


Photo 5. Transverse spalls on taxiway G patched with epoxy. Note absence of pop-outs

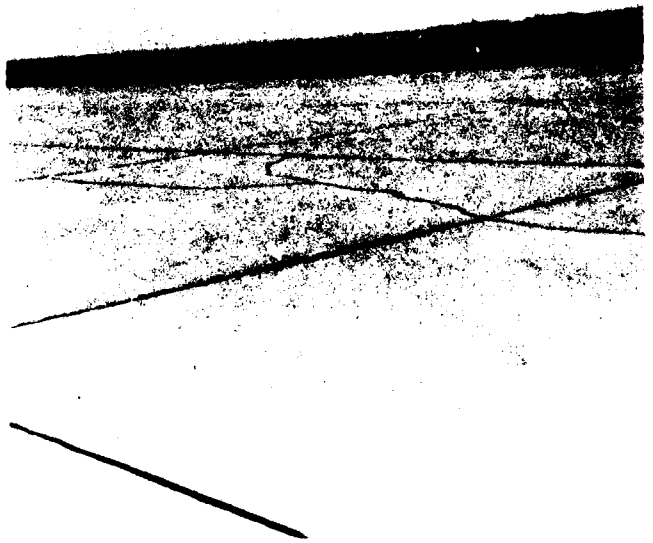
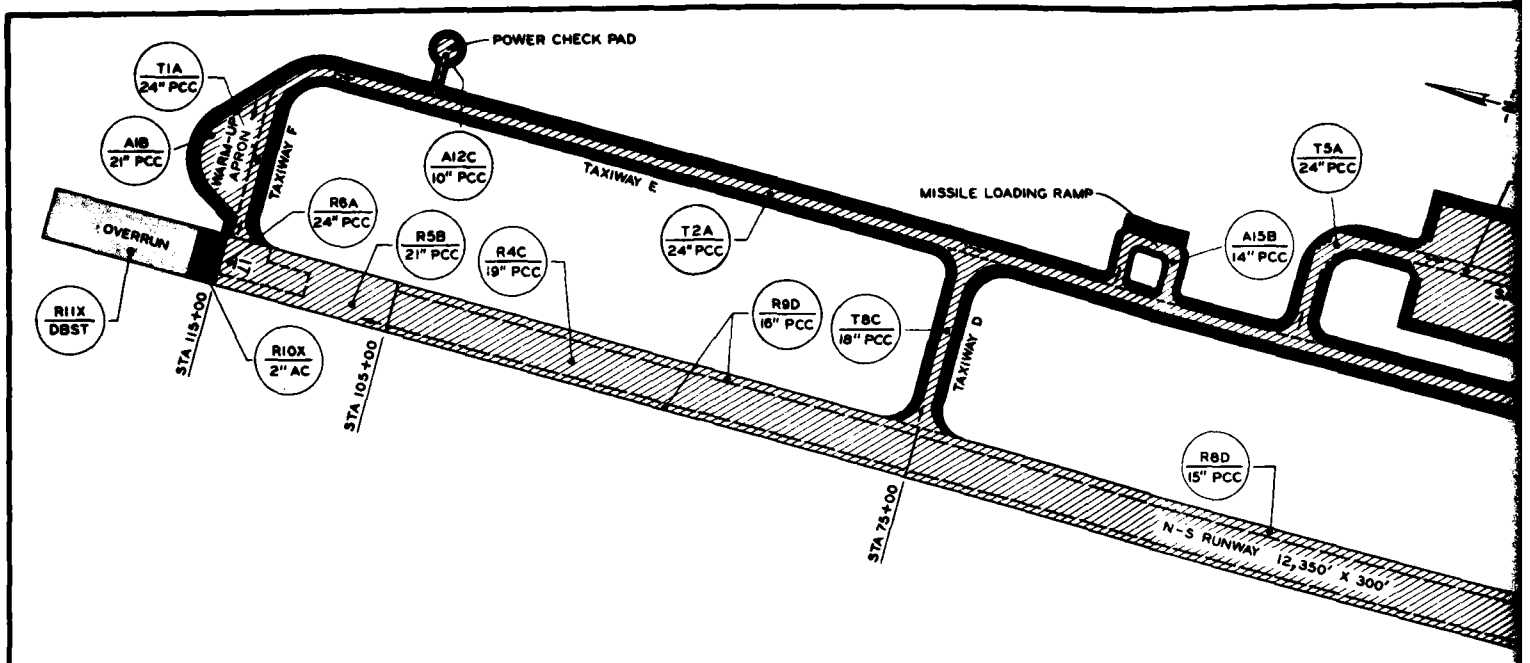


Photo 6. Cracking in slabs of taxiway C at entrance to missile loading ramp



LEGEND

PORTLAND CEMENT CONCRETE (PCC)

DOUBLE BITUMINOUS SURFACE TREATMENT (DBST)

BLAST PAVEMENT (AC-NON TRAFFIC)

R1A / 23" PCC — FEATURE DESIGNATION (SEE NOTE 1)
SURFACE PAVEMENT THICKNESS AND TYPE

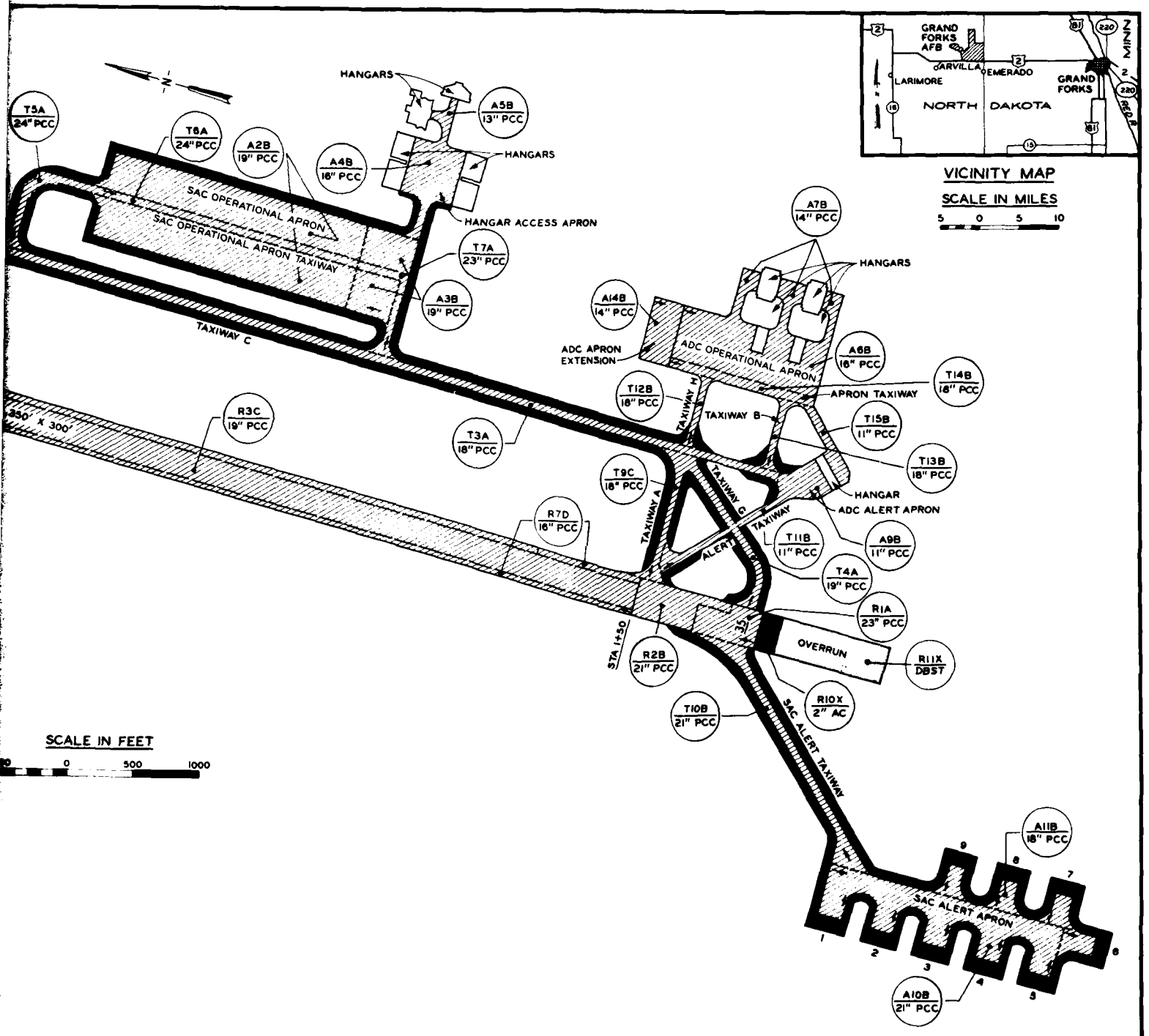
TYPE OF FEATURE
- R - RUNWAY
- T - TAXIWAY
- A - APRON

TYPE TRAFFIC AREA (SEE NOTE 2)
- A - A TYPE TRAFFIC
- B - B TYPE TRAFFIC
- C - C TYPE TRAFFIC
- D - D TYPE TRAFFIC
- X - NO TRAFFIC TYPE ASSIGNED

DIRECTION OF SURVEY

SCALE IN FEET
500 0 500

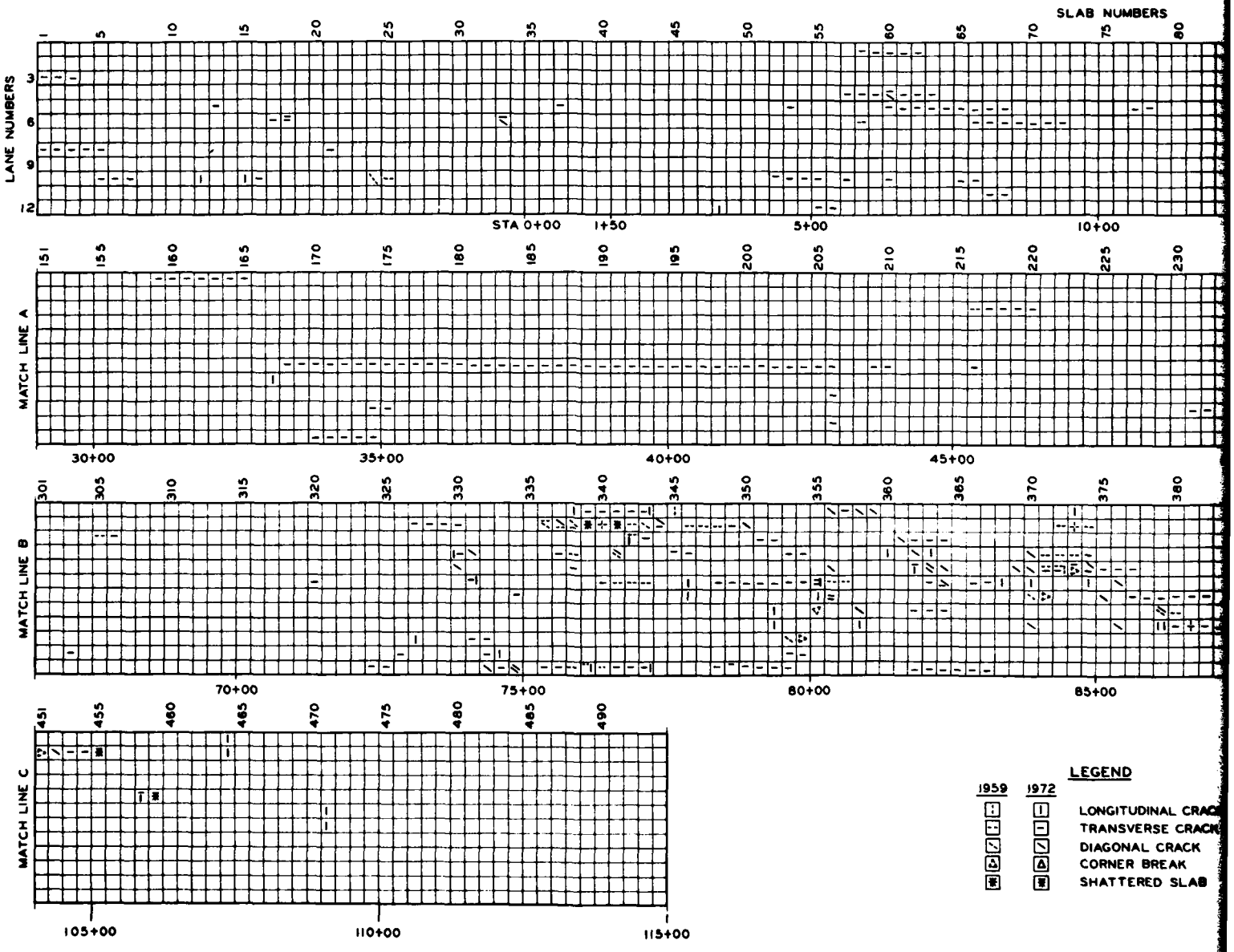
NOTES: 1. FEATURE DESIGNATION DENOTES TYPE OF FEATURE, NUMBER OF FEATURE FOR GIVEN TYPE, AND TYPE OF TRAFFIC AREA.
2. TRAFFIC AREA DESIGNATIONS ARE BASED ON HEAVY-LOAD CRITERIA.

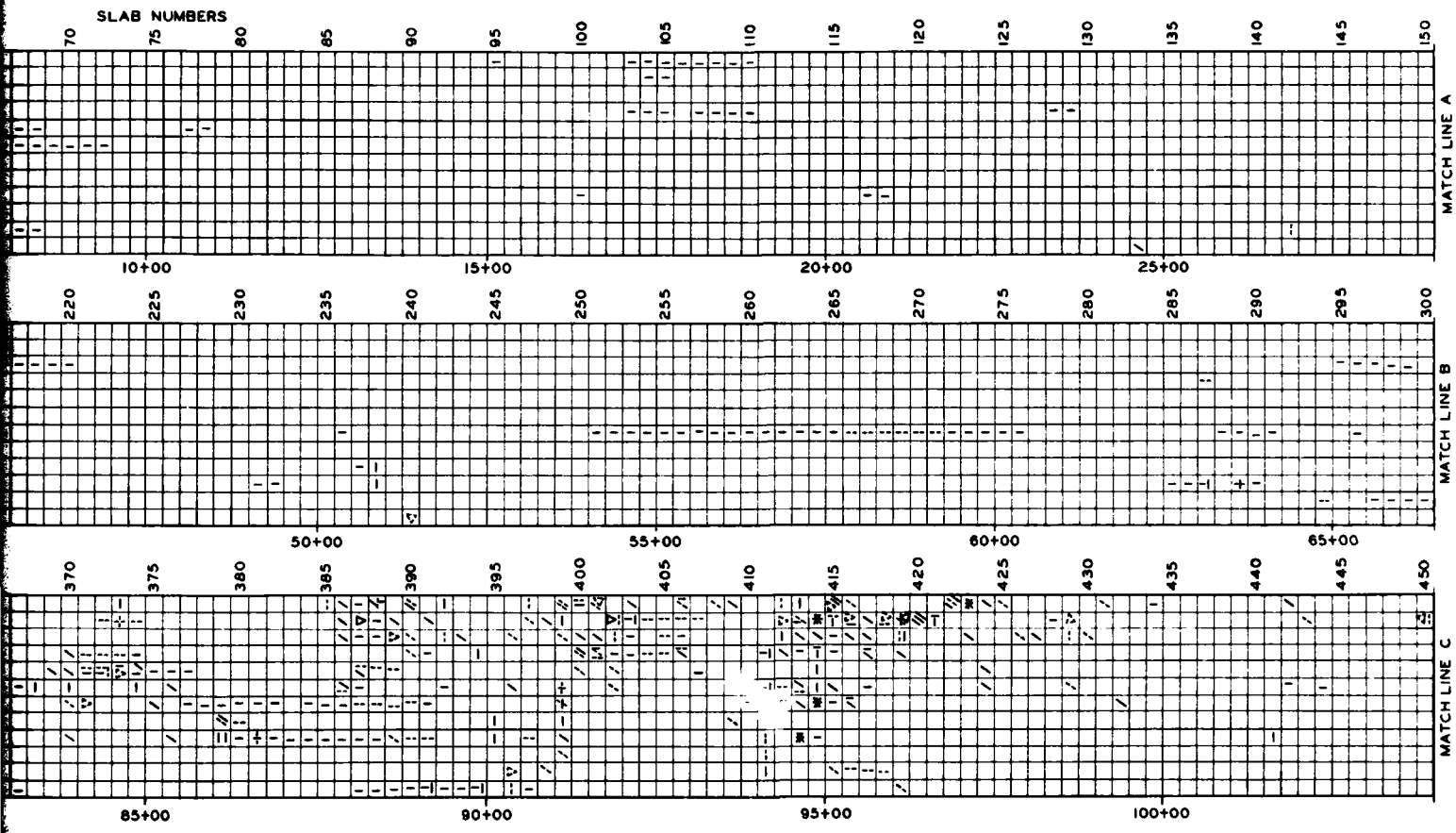


GRAND FORKS AFB

AIRFIELD LAYOUT AND PAVEMENT PLAN

PLATE 1


SLAB NUMBERS
LANE NUMBERS
STA 0+00
1+50
5+00
10+00
MATCH LINE A
30+00
35+00
40+00
45+00
MATCH LINE B
70+00
75+00
80+00
85+00
MATCH LINE C
105+00
110+00
115+00
LEGEND
1959
1972
LONGITUDINAL CRACK
TRANSVERSE CRACK
DIAGONAL CRACK
CORNER BREAK
SHATTERED SLAB



LEGEND

1959	1972	
⊡	⊡	LONGITUDINAL CRACK
⊡	⊡	TRANSVERSE CRACK
⊡	⊡	DIAGONAL CRACK
⊡	⊡	CORNER BREAK
⊡	⊡	SHATTERED SLAB

GRAND FORKS AFB, NORTH DAKOTA

PROGRESSION OF MAJOR DEFECTS ON NORTH-SOUTH RUNWAY

PLATE 2

Appendix A: GFAFB Annual Pavement Maintenance Plan

Area No.	Fac No.	Description	Pavement Type	Year Const	Existing Condition	Inspection requirements	Maint Priority	Maint and Repair History	Present or Proposed Maint and Repair
1	904	Primary Runway 12, 350' x 300' Original Runway ADC 7500' x 100'	Rigid Heavy	1956	Satis	Monthly F&G Semi-Annually EM & Planner	II	Resealed Joints Repaired Spalls-1966 & 1970	
		Runway Extension	Rigid Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner		Resealed Joints 1966 & 1970 Mudjacked - 1966 Repaired Spalls-1966	
2	946	Warm-up Pad 27,400 SY	Rigid Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	II	Repaired Bad Spalls - 1965 Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints Grd 15-2, Construction to start August 71
3	926	Warm-up Pad Shoulders - 15,540 SY	Flex Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	III	Patched & Seal Coated - 1966 & 1971	
4	905	Parallel Taxiway Original Taxiway (ADC) 8400' x 75'	Rigid Med	1956	Satis	Monthly F&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
		Taxiway Extension (SAC) 3637' x 75'	Rigid Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner		Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
5	926	Parallel Taxiway Shoulders (ADC) 75,000 SY	Flex Med	1956	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
		SAC 41,000 SY	Flex Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner		Repaired and Seal Coated-1966 & 1971	
6	943	Operational Apron	Rigid Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 & 1970 Mudjacked-1966 & 1970	
7	926	Operational Apron (SAC) Shoulders 33,900 SY	Flex Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired & Seal Coated - 1966 & 1971	
8	905	Operational Apron (SAC) Taxiways 1500' x 75'	Rigid Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
9	926	Operational Apron (SAC) Taxiway Shoulders 18,300 SY	Flex Heavy	1958	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
10	943	Apron Hanger Access (SAC) 450' x 425' 350' x 100' 150' x 100'	Rigid Heavy	1958 & 1961	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
11	926	Apron Hanger Access (SAC) Shoulders, 2200 SY	Flex Heavy	1961	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
12	943	Parking Apron (ADC) 1200' x 490' 1840' x 75' (varies) 330' x 50' 110' x 85' 630' x 50' 120' x 100' 242' x 490'	Rigid Med Light Light Med	1957 1959 1960 1965	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired Spalls-1966	Reseal Joints GRF 15-2, Construction to start August 1971
13	905	Taxiways to ADC Parking Apron 535' x 75' 535' x 75'	Rigid Med	1957	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
14	926	Taxiways to ADC Parking Apron Shoulders, 2200 SY	Flex Med	1957	Satis	Monthly F&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
15	905	Alert Apron & Taxiways (ADC) 2140' x 75' (varies)	Rigid Light	1957	Satis	Monthly F&G Semi-Annually EM & Planner	II	Repaired Spalls Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971

Area No.	Fac No.	Description	Pavement Type	Year Const	Existing Condition	Inspection Requirements	Maint Priority	Maint and Repair History	Present or Proposed Maint and Repair
16	926	Alert Apron & Taxiways (ADC) Shoulders, 6001 SY	Flex Light	1957	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
17	905	Cross Taxiways (Center & South) 2000' x 75'	Rigid Med	1957	Satis	Monthly P&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
18	926	Cross Taxiways Shoulders (Center & South) 18,800 SY	Flex Med	1957	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
19	943	Alert Apron (SAC) 1800' x 180' (varies)	Rigid Heavy	1958 & 1959	Satis	Monthly P&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
20	926	Alert Apron (SAC) Shoulders 10,000 SY	Flex Heavy	1958 & 1959	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	Repair Asph shoulder GRF 70-1
21	905	Alert Apron Taxiway (SAC) 1980' x 75'	Rigid Heavy	1958	Satis	Monthly P&G Semi-Annually EM & Planner	II	Repaired Spalls-1966 Resealed Joints-1966	Reseal Joints GRF 15-2, Construction to start August 1971
22	926	Alert Apron Taxiway (SAC) Shoulders, 34,500 SY	Flex Heavy	1958	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Coated-1966 & 1971	
23	926	North & South Over run 1000' x 300' 1000' x 300'	Flex	1958	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Seal Coated-1966 & 1970	
24	926	Power Check Pad Taxiway & Shoulders 120' x 30', 2200 SY	Flex Light	1961	Satis	Monthly P&G Semi-Annually EM & Planner	III	Repaired & Seal Seal Coated-1966 & 1971	
25	938	Power Check Pad 1056 SY	Rigid Light	1961	Satis	Monthly P&G Semi-Annually EM & Planner	III	Sealed Random Cracks-1966	Reseal Joints GRF 15-2, Construction to start August 1971
26	532	Helicopter Hardstand 384 SY	Rigid Light	1963	Satis	Quarterly P&G Annually EM & Planner	V	None	Reseal Joints GRF 15-2, Construction to start August 1971
27	905	Taxiway Runway Access (SAC) 75' x 1250'	Rigid Heavy	1964	Satis	Monthly P&G Semi-Annually	II	Repaired Spalls-1966	Reseal Joints GRF 15-2, Construction to start August 1971
28	926	Taxiway Runway Access (SAC) Shoulders, 14,200 SY	Flex Heavy	1964	Satis	Monthly P&G Semi-Annually	III	Repaired & Seal Coated-1966 & 1971	
29	943	Apron Loading (Missile) 875' x 75'	Rigid Med	1965	Satis	Monthly P&G Annually EM & Planner	IV	None	Reseal Joints GRF 15-2, Construction to start August 1971
30	926	Apron Loading (Missile) Shoulders 6370 SY	Flex Med	1965	Satis	Monthly P&G Annually EM & Planner	IV	Seal Coated-1971	