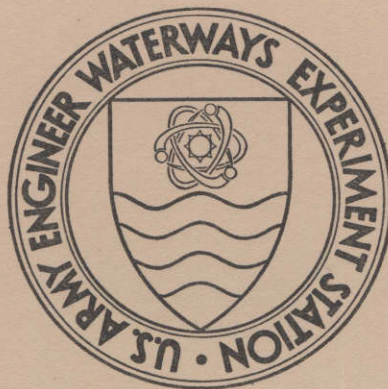


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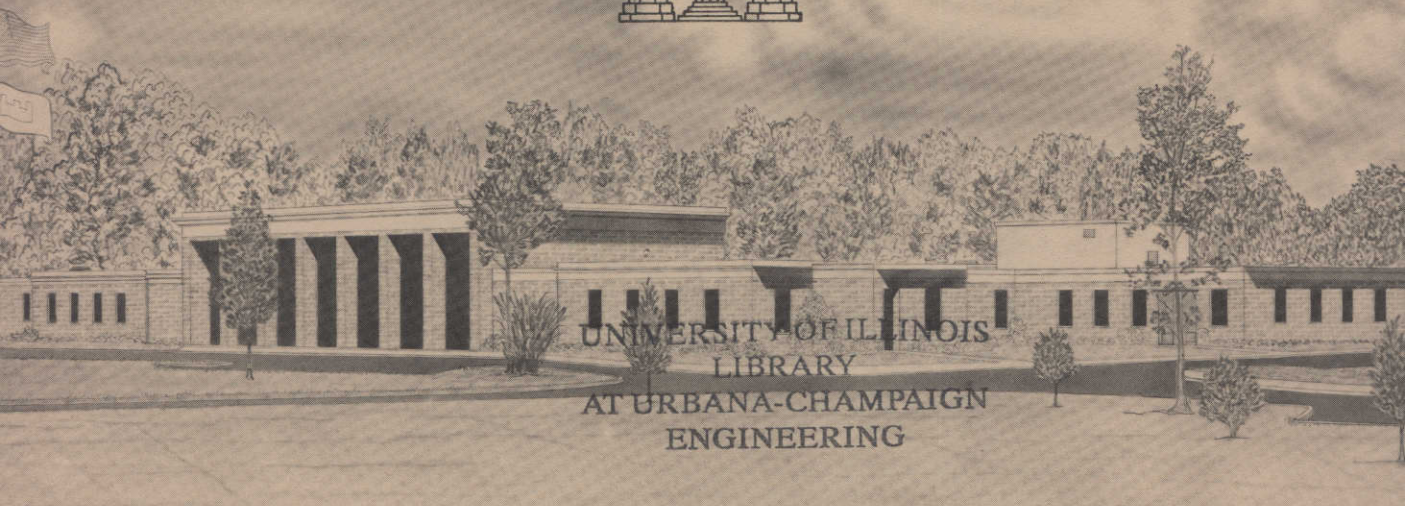
MISCELLANEOUS PAPER S-73-42

# CONDITION SURVEY, GRAND FORKS AIR FORCE BASE, NORTH DAKOTA

by

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

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Civil Engineering Department  
B106 C. E. Building  
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June 1973

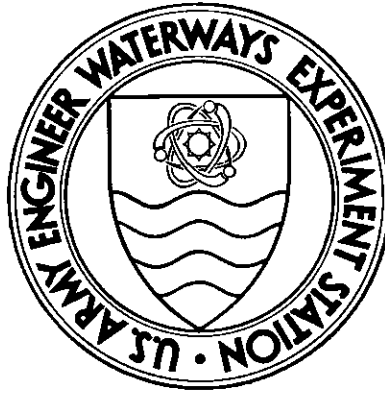
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Conducted by U. S. Army Engineer Waterways Experiment Station  
Soils and Pavements Laboratory  
Vicksburg, Mississippi

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ARMY-MRC VICKSBURG, MISS

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## 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.



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### Conversion Factors, British to Metric Units of Measurement

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

| <u>Multiply</u>                   | <u>By</u>  | <u>To Obtain</u>                 |
|-----------------------------------|------------|----------------------------------|
| inches                            | 2.54       | centimeters                      |
| feet                              | 0.3048     | meters                           |
| 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<br>square inch | 0.6894757  | newtons per square<br>centimeter |
| pounds per cubic inch             | 27.67984   | grams per cubic centimeter       |
| Fahrenheit degrees                | *          | Celsius or Kelvin degrees        |

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\* 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 Agassiz, 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.

---

\* 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<br>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

---

\* 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

---

\* 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.

| <u>Freezing<br/>Season</u> | <u>Freezing<br/>Index<br/>degree-days</u> | <u>Freezing<br/>Season</u> | <u>Freezing<br/>Index<br/>degree-days</u> |
|----------------------------|---|----------------------------|---|
| 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 AllB), 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       |        | Construction Period | Design Loading lb |
|---|----------------|--------|---------------------|-------------------|
|   | Thickness in.  | Type   |                     |                   |
| 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 APB FACILITY April 1972  |              |             | OVERLAY PAVEMENT |             |                     | PAVEMENT      |                             |                     | BASE            |  |                                    | SUBGRADE                              |                | GENERAL<br>CONDITION<br>OF AREA<br>CONSIDERED |
|--|--------------|-------------|------------------|-------------|---------------------|---------------|-----------------------------|---------------------|-----------------|--|------------------------------------|---------------------------------------|----------------|---|
| FACILITY NUMBER AND IDENTIFICATION   | LENGTH<br>FT | WIDTH<br>FT | THICK.<br>IN.    | DESCRIPTION | FLEX.<br>STR<br>PSI | THICK.<br>IN. | DESCRIPTION                 | FLEX.<br>STR<br>PSI | THICK.<br>IN.   | CLASSIFICATION   | CBR<br>OR<br>K                     | CLASSIFICATION                        | CBR<br>OR<br>K |   |
| N-S runway, 1st 500 ft, S end<br><br>R1A   | 500          | Variable    |                  |             |                     | 23            | Portland cement<br>concrete | 750                 | 19<br>4<br>26   | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2                 | 270<br><br>K <sub>f</sub> -<br>180 | Sand (SP) F2                          |                | Excellent                                     |
| N-S runway, 2nd 500 ft, S end<br><br>R2B   | Variable     | Variable    |                  |             |                     | 21            | Portland cement<br>concrete | 750                 | 17<br>4<br>30   | Gravel (GW)<br>Granular filter course<br>Select material sand<br>(SP) clay (CL) F3       | 270<br><br>K <sub>f</sub> -<br>120 | Sand (SP) F2                          |                | Excellent                                     |
| N-S runway interior<br>Sta 1+50 to 75+00, center 200 ft<br><br>R3C                                 | 7350         | 200         |                  |             |                     | 19            | Portland cement<br>concrete | 700                 | 15<br>4<br>34   | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2                 | 270<br><br>K <sub>f</sub> -<br>150 | Sand (SP) F2                          |                | Very good                                     |
| N-S runway interior<br>East edge, sta 1+50 to 10+00<br>West edge, sta 1+50 to 75+00<br><br>R7D     | 850<br>7350  | 50<br>50    |                  |             |                     | 16            | Portland cement<br>concrete | 700                 | 15±<br>4<br>37± | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2                 | 270<br><br>K <sub>f</sub> -<br>150 | Sand (SP) F2                          |                | Very good                                     |
| N-S runway interior<br>East edge, sta 10+00 to 75+00<br><br>R8D                                    | 5500         | 50          |                  |             |                     | 15            | Portland cement<br>concrete | 700                 | 16±<br>4<br>37± | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2                 | 270<br><br>K <sub>f</sub> -<br>120 | Sand (SP)<br><br>Frost group F2       |                | Very good                                     |
| N-S runway interior<br>East edge, sta 75+00 to 105+00<br>West edge, sta 75+00 to 105+00<br><br>R9D | 3000<br>3000 | 50<br>50    |                  |             |                     | 16            | Portland cement<br>concrete | 750                 | 15±<br>4<br>37± | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL) F3                 | 180<br><br>K <sub>f</sub> -<br>110 | Clay (CL)(CH)<br>(CL-OL)<br>F3 and F4 |                | Very good                                     |
| N-S runway interior<br>Sta 75+00 to 105+00, center<br>200 ft<br><br>R4C                            | 3000         | 200         |                  |             |                     | 19            | Portland cement<br>concrete | 750                 | 15<br>4<br>34   | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL) F3                 | 180<br><br>K <sub>f</sub> -<br>110 | Clay (CL)(CH)<br>(CL-OL)<br>F3 and F4 |                | Very good                                     |
| N-S runway, 2nd 500 ft, N end<br><br>R5B   | Variable     | Variable    |                  |             |                     | 21            | Portland cement<br>concrete | 750                 | 17<br>4<br>34   | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL) F3                 | 180<br><br>K <sub>f</sub> -<br>120 | Clay (CL)(CH)<br>(CL-OL)<br>F3 and F4 |                | Very good                                     |
| N-S runway, 1st 500 ft N end<br><br>R6A  | Variable     | Variable    |                  |             |                     | 24            | Portland cement<br>concrete | 750                 | 19<br>4<br>25   | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SM-SP)<br>clay (CL) F3 | 180<br><br>K <sub>f</sub> -<br>140 | Clay (CL)(CH)<br>(CL-OL)<br>F3 and F4 |                | Excellent                                     |
|  |              |             |                  |             |                     |               |                             |                     |                 |  |                                    |                                       |                |   |

Table 2 (Continued)  
SUMMARY OF PHYSICAL PROPERTY DATA

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

Table 2 (Continued)  
SUMMARY OF PHYSICAL PROPERTY DATA

| Grand Forks AFB FACILITY April 1972                    |                      |                      | OVERLAY PAVEMENT |             |                     | PAVEMENT      |                             |                     | BASE          |   |                           | SUBGRADE        |                | GENERAL<br>CONDITION<br>OF AREA<br>CONSIDERED |
|--|----------------------|----------------------|------------------|-------------|---------------------|---------------|-----------------------------|---------------------|---------------|---|---------------------------|-----------------|----------------|---|
| FACILITY NUMBER AND IDENTIFICATION                     | LENGTH<br>FT         | WIDTH<br>FT          | THICK.<br>IN.    | DESCRIPTION | FLEX.<br>STR<br>PSI | THICK.<br>IN. | DESCRIPTION                 | FLEX.<br>STR<br>PSI | THICK.<br>IN. | CLASSIFICATION  | CBR<br>OR<br>K            | CLASSIFICATION  | CBR<br>OR<br>K |   |
| Warm-up apron<br><br>A1B                               | 750<br>Vari-<br>able | 300<br>Vari-<br>able |                  |             |                     | 21            | Portland cement<br>concrete | 750                 | 17<br>4<br>30 | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL-CH) F3 | 180<br><br>$K_f$ -<br>120 | Clay (CL-CH) F3 |                | Excellent                                     |
| SAC operational apron (north end)<br><br>A2B           | 2000                 | 600                  |                  |             |                     | 19            | Portland cement<br>concrete | 750                 | 15<br>4<br>34 | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL-CH) F3 | 210<br><br>$K_f$ -<br>110 | Clay (CL) F3    |                | Very good                                     |
| SAC operational apron (south end)<br><br>A3B           | 400                  | 600                  |                  |             |                     | 19            | Portland cement<br>concrete | 750                 | 15<br>4<br>34 | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL-CH) F3 | 270<br><br>$K_f$ -<br>110 | Sand (SP) F2    |                | Very good                                     |
| SAC hangar access apron and<br>taxiway<br><br>A4B      | Vari-<br>able        | Vari-<br>able        |                  |             |                     | 16            | Portland cement<br>concrete | 750                 | 12<br>4<br>40 | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL-CH) F3 | 270<br><br>$K_f$ -<br>90  | Sand (SP) F2    |                |   |
| SAC hangar access apron extension<br><br>A5B           | 325+                 | Vari-<br>able        |                  |             |                     | 13            | Portland cement<br>concrete | 750                 | 12<br>43<br>4 | Gravel (GW)<br>Select material<br>subbase F2<br>Granular filter course      | 350<br><br>$K_f$ -<br>300 | Clay (CL) F3    |                |   |
| ADC operational apron<br><br>A6B                       | 1200                 | 415                  |                  |             |                     | 16            | Portland cement<br>concrete | 750                 | 14<br>4<br>38 | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2    | 300<br><br>$K_f$ -<br>125 | Sand (SP) F2    |                | Excellent                                     |
| ADC hangar access aprons and<br>taxiways 3,<br><br>A7B | 150+                 | Vari-<br>able        |                  |             |                     | 14            | Portland cement<br>concrete | 750                 | 10<br>4<br>44 | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2    | 300<br><br>$K_f$ -<br>120 | Sand (SP) F2    |                |   |
| ADC alert taxiway and apron<br><br>A9B<br>T11B         | 2140+                | 75+                  |                  |             |                     | 11            | Portland cement<br>concrete | 750                 | 7<br>4<br>50  | Gravel (GW)<br>Granular filter course<br>Select material<br>sand (SP) F2    | 270<br><br>$K_f$ -85      | Sand (SP) F2    |                | Good  |
| SAC alert taxiway and apron<br><br>A10B<br>T10B        | Vari-<br>able        | Vari-<br>able        |                  |             |                     | 21            | Portland cement<br>concrete | 750                 | 17<br>4<br>30 | Gravel (GW)<br>Granular filter course<br>Select material<br>clay (CL) F3    | 180<br><br>$K_f$ -<br>120 | Clay (CL) F3    |                | Very good                                     |
|  |                      |                      |                  |             |                     |               |                             |                     |               |   |                           |                 |                |   |

Table 2 (Continued)  
SUMMARY OF PHYSICAL PROPERTY DATA

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

Table 3

| DATE: April 1972  |                                   | SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY |                             |                        |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    | AIRFIELD:<br>Grand Forks AFB, N. Dak. |                                |                                      |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
|---|-----------------------------------|---|-----------------------------|------------------------|---|----|-----|---|---|---|----|---|---|---|----|---|---|---|----|---------------------------------------|--------------------------------|--------------------------------------|-----------|--------------------|---|-----------------|---|--------------|---|------------------|---|---------|---|---------------|---|----------------|---|---------------------------|---|---------|---|--------------|---|-----------------------------|---|--------------------------------|---|----------------|---|--------------|---|--------------|---|---------------------|---|------------|--|--|
| FEATURE   |                                   | SLAB<br>SIZE<br>FT                                | APPROX<br>NO. OF<br>SLABS   | PAVE.<br>THICK.<br>IN. | NO. OF SLABS CONTAINING INDICATED DEFECTS |    |     |   |   |   |    |   |   |   |    |   |   |   |    |                                       | % OF<br>SLABS<br>NO<br>DEFECTS | % OF<br>SLABS NO<br>MAJOR<br>DEFECTS | CONDITION |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| NO.   | DESIGNATION                       |   |                             |                        | I   | -  | \   | Δ | * | K | W  | S | J | ↓ | J  | ⬇ | M | P | O  | C                                     |                                |                                      |           | D                  |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| R1A<br>R2B  | N-S runway<br>1st 500 ft<br>S end | 25x25   | 240                         | 21 and<br>23           | 15  | 2  |     |   |   |   |    |   |   |   |    |   |   |   |    | 93                                    | 93                             | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| R2B   | N-S runway<br>2nd 500 ft<br>S end | 25x25   | 240                         | 21                     | 4   |    | 2   |   |   |   |    | 1 | 3 |   |    |   |   |   |    | 97                                    | 98                             | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| R3C<br>R4C<br>R7D<br>R8D<br>R9D   | N-S runway<br>interior            | 25x25   | 4968                        | 15, 16<br>and 19       | 419                                       | 74 | 109 | 3 | 6 |   | 68 | 2 | 5 | 7 | 85 |   |   | 1 | 49 | 85                                    | 89                             | Very<br>Good                         |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| R5B   | N-S runway<br>2nd 500 ft<br>N end | 25x25   | 240                         | 21                     | 1   | 5  |     | 2 |   | 1 |    |   | 2 |   |    |   |   |   |    | 96                                    | 97                             | Very<br>Good                         |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| R6A<br>R5B  | N-S runway<br>1st 500 ft<br>N end | 25x25   | 240                         | 21 and<br>24           |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    | 100                                   | 100                            | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| T1A   | Taxiway F                         | 25x25   | 165                         | 24                     |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    | 100                                   | 100                            | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| T2A   | Taxiway E                         | 25x25   | 492                         | 21-<br>24-<br>21       | 1   |    |     |   |   | 1 |    |   |   |   |    |   |   |   |    | 99                                    | 99                             | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| T3A   | Taxiway C*                        | 25x25   | 933                         | 16-<br>18-<br>16       | 42  | 1  | 8   |   |   | 6 | 4  | 1 |   | 1 |    |   |   |   |    | 94                                    | 95                             | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| T4A   | Taxiway G                         | 15x15   | 495                         | 19                     |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    | 100                                   | 100                            | Excel-<br>lent                       |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| REMARKS: * This facility did not contain pop-outs.  |                                   |   |                             |                        |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    |                                       |                                |                                      |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |
| LEGEND: <table border="0"> <tr> <td> </td><td>LONGITUDINAL CRACK</td> <td>W</td><td>SHRINKAGE CRACK</td> <td>M</td><td>MAP CRACKING</td> </tr> <tr> <td>-</td><td>TRANSVERSE CRACK</td> <td>S</td><td>SCALING</td> <td>P</td><td>PUMPING JOINT</td> </tr> <tr> <td>\</td><td>DIAGONAL CRACK</td> <td>J</td><td>SPALL ON TRANSVERSE JOINT</td> <td>O</td><td>POP-OUT</td> </tr> <tr> <td>Δ</td><td>CORNER BREAK</td> <td>↓</td><td>SPALL ON LONGITUDINAL JOINT</td> <td>C</td><td>UNCONTROLLED CONTRACTION CRACK</td> </tr> <tr> <td>*</td><td>SHATTERED SLAB</td> <td>J</td><td>CORNER SPALL</td> <td>D</td><td>"D" CRACKING</td> </tr> <tr> <td>K</td><td>KEYED JOINT FAILURE</td> <td>⬇</td><td>SETTLEMENT</td> <td></td><td></td> </tr> </table> |                                   |   |                             |                        |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    |                                       |                                |                                      |           | LONGITUDINAL CRACK | W | 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 |  |  |
|   | LONGITUDINAL CRACK                | W   | 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                  |                        |   |    |     |   |   |   |    |   |   |   |    |   |   |   |    |                                       |                                |                                      |           |                    |   |                 |   |              |   |                  |   |         |   |               |   |                |   |                           |   |         |   |              |   |                             |   |                                |   |                |   |              |   |              |   |                     |   |            |  |  |

Table 3 (Continued)

| DATE: April 1972   |   | SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY |                             |                        |   |    |    |   |   |   |    |   |   |   |    |   |   |   |   |   | AIRFIELD:<br>Grand Forks AFB, N. Dak. |                                      |           |                |
|--|---|---|-----------------------------|------------------------|---|----|----|---|---|---|----|---|---|---|----|---|---|---|---|---|---------------------------------------|--------------------------------------|-----------|----------------|
| FEATURE  |   | SLAB<br>SIZE<br>FT                                | APPROX<br>NO. OF<br>SLABS   | PAVE.<br>THICK.<br>IN. | NO. OF SLABS CONTAINING INDICATED DEFECTS |    |    |   |   |   |    |   |   |   |    |   |   |   |   |   | % OF<br>SLABS NO<br>DEFECTS           | % OF<br>SLABS NO<br>MAJOR<br>DEFECTS | CONDITION |                |
| NO.  | DESIGNATION                                 |   |                             |                        | I   | -  | \  | Δ | * | K | ~  | S | J | ↓ | J  | ⬇ | M | P | O | C |                                       |                                      |           | D              |
| T6A  | SAC operational<br>apron taxiway<br>(N end) | 25x25   | 240                         | 21-<br>24-<br>21       | 31  | 4  | 23 | 2 |   |   | 9  |   | 1 |   |    | 2 | 6 |   |   |   | 8                                     | 72                                   | 79        | Good           |
| T7A  | SAC operational<br>apron taxiway<br>(S end) | 25x25   | 157                         | 21-<br>23-<br>21       | 6   | 1  | 3  | 2 |   |   | 2  |   |   | 1 | 1  |   |   |   |   |   | 1                                     | 90                                   | 94        | Excel-<br>lent |
| T10B   | SAC alert taxiway                           | 25x25   | 313                         | 21                     | 15  |    |    |   |   |   |    |   |   | 7 |    |   |   |   |   | 4 |                                       | 92                                   | 96        | Very<br>good   |
| A2R<br>A3B   | SAC operational<br>apron                    | 25x25   | 1045**                      | 19                     | 129                                       | 19 | 50 | 1 | 4 |   | 24 |   |   | 2 | 7  | 7 |   |   |   |   | 12                                    | 78                                   | 82        | Very<br>good   |
| A10B   | SAC alert apron                             | 25x24   | 640                         | 21                     | 24  | 2  | 5  |   |   | 9 | 25 |   | 6 |   | 15 | 1 |   |   |   |   | 22                                    | 85                                   | 95        | Very<br>good   |
| A10B   | Alert stubs<br>1-5                          | 25x24   | 430                         | 21                     | 7   | 7  | 1  | 2 |   |   |    |   |   |   | 1  |   |   |   |   |   |                                       | 95                                   | 96        | Very<br>good   |
| A11B   | Alert stubs<br>6-9                          | 15x15   | 424                         | 18                     |   |    |    |   |   |   |    |   |   |   |    |   |   |   |   |   |                                       | 100                                  | 100       | Excel-<br>lent |
| A1B  | Warm-up apron                               | 25x25   | 218                         | 21                     |   | 1  |    |   |   |   | 2  |   | 1 |   | 1  |   |   |   |   |   |                                       | 98                                   | 99        | Excel-<br>lent |
| T13B   | Taxiway B                                   | 25x25   | 72                          | 16-<br>18-<br>16       | 13  |    |    |   |   |   |    |   |   |   |    |   |   |   |   |   |                                       | 83                                   | 83        | Very<br>good   |
| T12B   | Taxiway H                                   | 25x25   | 72                          | 16-<br>18-<br>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                  |                        |   |    |    |   |   |   |    |   |   |   |    |   |   |   |   |   |                                       |                                      |           |                |

Table 3 (Continued)

| DATE: <u>April 1972</u> |                                      | SUMMARY OF DATA - RIGID PAVEMENT CONDITION SURVEY |                           |                        |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | AIRFIELD:<br><u>Grand Forks AFB, N. Dak.</u> |     |                             |                                      |           |
|-------------------------|--------------------------------------|---|---------------------------|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|-----|-----------------------------|--------------------------------------|-----------|
| FEATURE                 |                                      | SLAB<br>SIZE<br>FT                                | APPROX<br>NO. OF<br>SLABS | PAVE.<br>THICK.<br>IN. | NO. OF SLABS CONTAINING INDICATED DEFECTS |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |     | % OF<br>SLABS NO<br>DEFECTS | % OF<br>SLABS NO<br>MAJOR<br>DEFECTS | CONDITION |
| NO.                     | DESIGNATION                          |   |                           |                        |   | - | \ | 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<br>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 |   |   |   |   |   |   | 89   | 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:

|   |                     |   |                             |   |                                |
|---|---------------------|---|-----------------------------|---|--------------------------------|
|   | 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                  |   |                                |

Table 4  
SUMMARY OF PAVEMENT EVALUATION

| NAME OF AIRFIELD: Grand Forks AFB<br>DATE OF EVALUATION<br>MONTH: April YR: 1972   |  |                                | LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS |                                      |                                      |  |   |  |  |   |                               |   | REMARKS |
|--|--|--------------------------------|--|--------------------------------------|--------------------------------------|--|---|--|--|---|-------------------------------|---|---------|
| FEATURE  |  | PAVEMENT<br>OPERATIONAL<br>USE | TRICYCLE ARRANGEMENT   |                                      |                                      |  |   |  |  |   |                               | BICYCLE   |         |
| NO.  | DESIGNATION  |                                | SINGLE<br>100-PSI<br>TIRE PRESSURE   | SINGLE<br>100-SQ-IN.<br>CONTACT AREA | SINGLE<br>241-SQ-IN.<br>CONTACT AREA | TW 28-IN. C-C<br>226-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | SINGLE TANDEM<br>60-IN. SPACING<br>400-SQ-IN.<br>CONTACT AREA | TW 37-IN. C-C<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TW 44-IN. C-C<br>630-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TWIN TANDEM<br>33 IN. x 48 IN.<br>208-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | C-5A<br>GEAR<br>CONFIGURATION | TWIN TWIN<br>SPCG 37-62-37<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE |         |
|  |  |                                | 1  | 2                                    | 3                                    | 4  | 5   | 6  | 7  | 8   | 9                             | 10  |         |
| R1A  | N-S runway<br>1st 500 ft<br>S end                                      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>600,000+  |         |
| R2B  | N-S runway<br>2nd 500 ft<br>S end                                      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000<br>480,000  |         |
| R3C  | N-S runway<br>interior<br>Sta 1+50 to<br>75+00 Center<br>Center 200 ft | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>530,000   |         |
| R4C  | N-S runway<br>interior<br>Sta 75+00 to<br>105+00<br>Center 200 ft      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000<br>550,000  |         |
| R5B  | N-S runway<br>2nd 500 ft<br>N end                                      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 520,000<br>480,000  |         |
| R6A  | N-S runway<br>1st 500 ft<br>N end                                      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 590,000<br>590,000  |         |
| T1A  | Taxiway F  | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 590,000<br>590,000  |         |
| T2A  | Taxiway E  | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 590,000<br>590,000  |         |
| T3A  | Taxiway C  | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 320,000<br>300,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 480,000<br>400,000  |         |
| T4A  | Taxiway G  | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 550,000<br>550,000  |         |
| Note: + sign denotes allowable gross loading greater than maximum gross weight of any existing aircraft having indicated gear configuration.<br>(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<br>DATE OF EVALUATION<br>MONTH: April YR: 1972 |   |                                | LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS |                                      |                                      |  |   |  |  |   |                               |   | REMARKS |
|--|---|--------------------------------|--|--------------------------------------|--------------------------------------|--|---|--|--|---|-------------------------------|---|---------|
|  |   |                                | TRICYCLE ARRANGEMENT   |                                      |                                      |  |   |  |  |   |                               |   |         |
| FEATURE  |   | PAVEMENT<br>OPERATIONAL<br>USE | SINGLE<br>100-PSI<br>TIRE PRESSURE   | SINGLE<br>100-SQ-IN.<br>CONTACT AREA | SINGLE<br>241-SQ-IN.<br>CONTACT AREA | TW 28-IN. C-C<br>226-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | SINGLE TANDEM<br>60-IN. SPACING<br>400-SQ-IN.<br>CONTACT AREA | TW 37-IN. C-C<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TW 44-IN. C-C<br>630-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TWIN TANDEM<br>33 IN. x 48 IN.<br>208-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | C-5A<br>GEAR<br>CONFIGURATION | TWIN TWIN<br>SPCG 37-62-37<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE |         |
| NO.  | DESIGNATION                                     |                                | 1  | 2                                    | 3                                    | 4  | 5   | 6  | 7  | 8   | 9                             | 10  |         |
| T5A  | SAC operational<br>apron access<br>taxiway      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>590,000   |         |
| T6A  | SAC operational<br>apron taxiway<br>(north end) | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>590,000   |         |
| T7A  | SAC operational<br>apron taxiway<br>(south end) | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>550,000   |         |
| T12B   | Taxiway H                                       | Capacity                       | 155,000+   | 85,000+                              | 155,000+                             | 220,000+   | 200,000+  | 330,000+   | 230,000+   | 380,000+  | 800,000+                      | 510,000   |         |
| T13B   | Taxiway B                                       | Frost capacity                 | 155,000+   | 85,000+                              | 155,000+                             | 220,000+   | 200,000+  | 300,000  | 230,000+   | 380,000+  | 800,000+                      | 400,000   |         |
| T14B   | ADC apron<br>taxiway                            |                                |  |                                      |                                      |  |   |  |  |   |                               |   |         |
| T8C  | Taxiway D                                       | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>530,000   |         |
| T9C  | Taxiway A                                       | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 600,000+<br>530,000   |         |
| A1B  | Warm-up apron                                   | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 520,000<br>480,000  |         |
| A2B  | SAC operational<br>apron<br>(north end)         | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 470,000<br>410,000  |         |
| A3B  | SAC operational<br>apron<br>(south end)         | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>320,000                                      | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 520,000<br>410,000  |         |
| A4B  | SAC hangar<br>access apron<br>and taxiway       | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>210,000                                      | 200,000+<br>200,000+  | 300,000<br>230,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 410,000<br>300,000  |         |
| A5B  | SAC hangar<br>access apron<br>extension         | Capacity<br>Frost capacity     | 150,000<br>140,000   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000<br>205,000                                       | 200,000+<br>200,000+  | 255,000<br>230,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 360,000<br>330,000  |         |

Table 4 (Continued)  
SUMMARY OF PAVEMENT EVALUATION

| NAME OF AIRFIELD: Grand Forks AFB<br>DATE OF EVALUATION<br>MONTH: April YR: 1972 |   |                                | LOAD-CARRYING CAPACITY IN LB OF GROSS PLANE LOAD FOR INDICATED LANDING GEAR TYPES AND CONFIGURATIONS |                                      |                                      |  |   |  |  |   |                               |   | REMARKS |
|--|---|--------------------------------|--|--------------------------------------|--------------------------------------|--|---|--|--|---|-------------------------------|---|---------|
| FEATURE  |   | PAVEMENT<br>OPERATIONAL<br>USE | TRICYCLE ARRANGEMENT   |                                      |                                      |  |   |  |  |   |                               | BICYCLE   |         |
| NO.  | DESIGNATION                                 |                                | SINGLE<br>100-PSI<br>TIRE PRESSURE   | SINGLE<br>100-SQ-IN.<br>CONTACT AREA | SINGLE<br>241-SQ-IN.<br>CONTACT AREA | TW 28-IN. C-C<br>226-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | SINGLE TANDEM<br>60-IN. SPACING<br>400-SQ-IN.<br>CONTACT AREA | TW 37-IN. C-C<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TW 44-IN. C-C<br>630-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | TWIN TANDEM<br>33 IN. x 48 IN.<br>208-SQ-IN.<br>CONTACT AREA<br>EACH TIRE | C-SA<br>GEAR<br>CONFIGURATION | TWIN TWIN<br>SPCG 37-62-37<br>267-SQ-IN.<br>CONTACT AREA<br>EACH TIRE |         |
|  |   |                                | 1  | 2                                    | 3                                    | 4  | 5   | 6  | 7  | 8   | 9                             | 10  |         |
| A6B  | ADC operational<br>apron                    | Capacity<br>Frost capacity     | 155,000+<br>155,000  | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 320,000<br>250,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 430,000<br>330,000  |         |
| A7B  | ADC hanger<br>access aprons<br>and taxiways | Capacity<br>Frost capacity     | 155,000+<br>125,000  | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>175,000                                      | 200,000+<br>200,000+  | 265,000<br>200,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>340,000   | 800,000+<br>800,000+          | 370,000<br>270,000  |         |
| A9B<br>T11B  | ADC alert<br>apron and<br>taxiway           | Capacity<br>Frost capacity     | 100,000<br>80,000  | 80,000<br>65,000                     | 145,000<br>110,000                   | 150,000<br>115,000                                       | 200,000+<br>175,000   | 170,000<br>130,000                                       | 230,000<br>165,000                                       | 330,000<br>235,000  | 800,000+<br>690,000           | 240,000<br>(a)  |         |
| T10B<br>A10B   | SAC alert<br>taxiway and<br>apron           | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 520,000<br>480,000  |         |
| A11B   | SAC alert<br>apron<br>extension             | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 330,000+<br>330,000+                                     | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 540,000<br>510,000  |         |
| A12C   | Power check pad                             | Capacity<br>Frost capacity     | 105,000<br>100,000   | 80,000<br>80,000                     | 150,000<br>140,000                   | 155,000<br>145,000                                       | 200,000+<br>200,000+  | 175,000<br>165,000                                       | 230,000+<br>220,000                                      | 340,000<br>310,000  | 800,000+<br>800,000+          | 250,000<br>230,000  |         |
| A14B   | ADC apron<br>extension                      | Capacity<br>Frost capacity     | 155,000+<br>155,000+   | 85,000+<br>85,000+                   | 155,000+<br>155,000+                 | 220,000+<br>220,000+                                     | 200,000+<br>200,000+  | 275,000<br>255,000                                       | 230,000+<br>230,000+                                     | 380,000+<br>380,000+  | 800,000+<br>800,000+          | 390,000<br>360,000  |         |
| A15B   | Missile loading<br>ramp                     | Capacity<br>Frost capacity     | 130,000<br>95,000  | 85,000+<br>75,000                    | 155,000+<br>125,000                  | 190,000<br>135,000                                       | 200,000+<br>200,000   | 215,000<br>150,000                                       | 230,000+<br>190,000                                      | 380,000+<br>260,000   | 800,000+<br>770,000           | 310,000<br>(a)  |         |
|  |   |                                |  |                                      |                                      |  |   |  |  |   |                               |   |         |



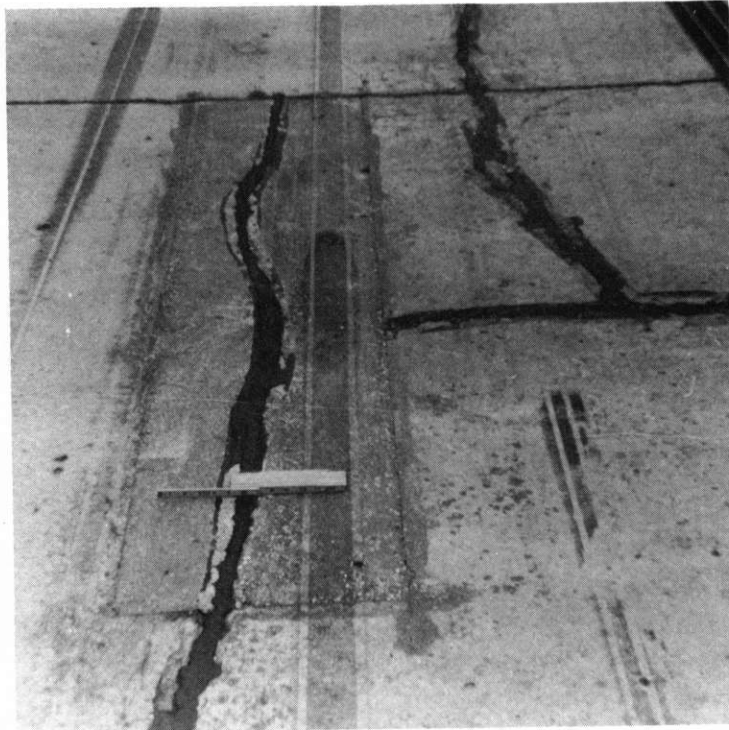


Photo 1. Longitudinal cracks in slabs in interior of runway (typical of area from sta 75+00 to 100+00)

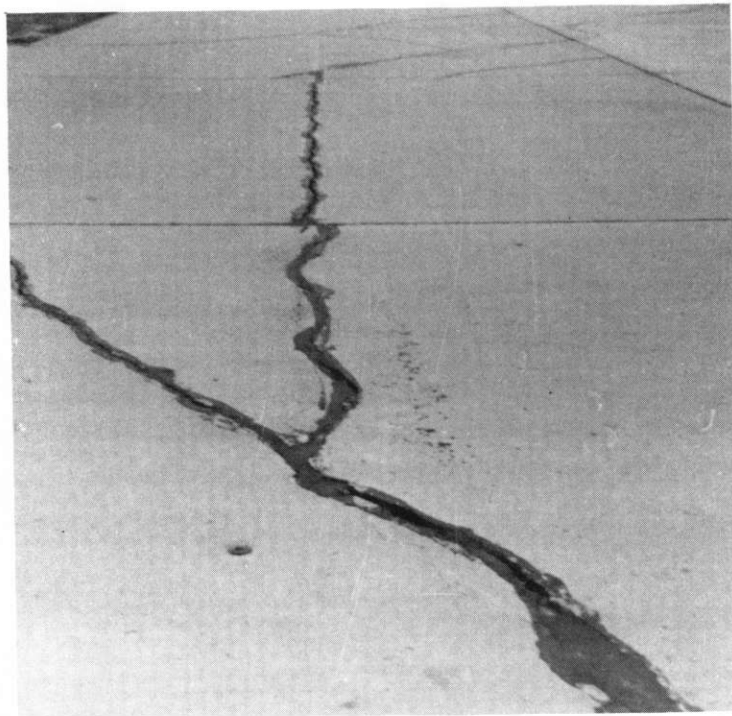


Photo 2. Cracking in outside lane of runway

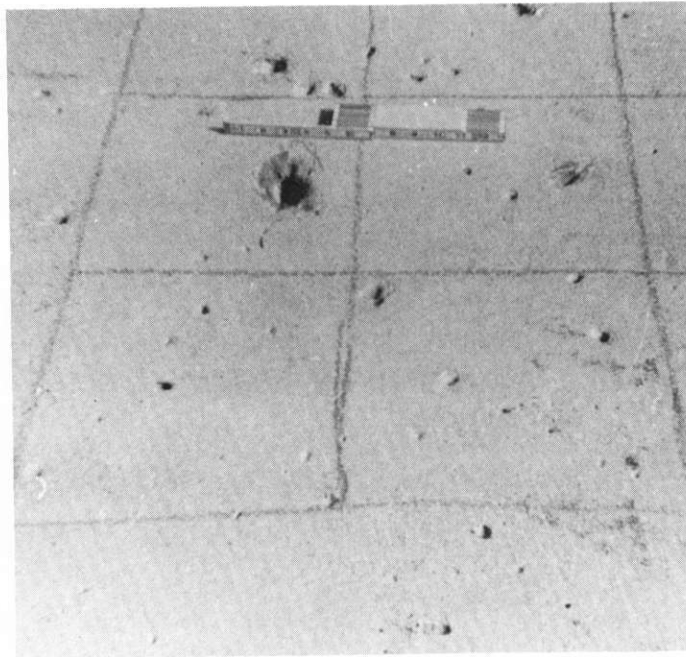


Photo 3. Typical pop-out condition on south end of runway.  
One-ft-square grid pattern marked to indicate concentration  
of pop-outs per square foot

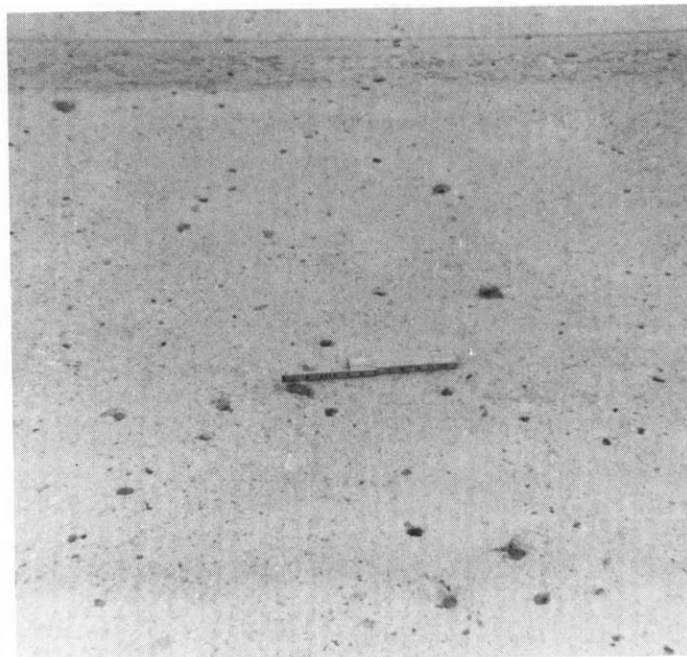


Photo 4. Pop-out condition on north end of taxiway C

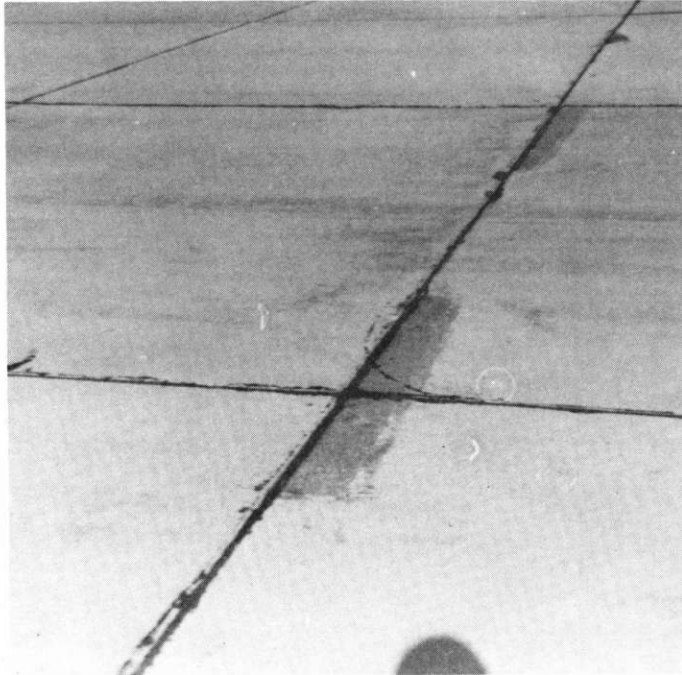


Photo 5. Transverse spalls on taxiway G patched with epoxy.  
Note absence of pop-outs

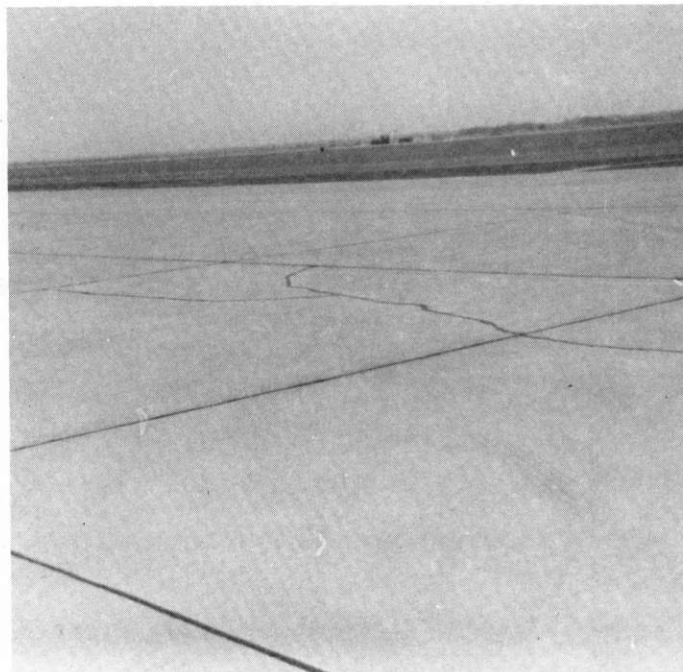
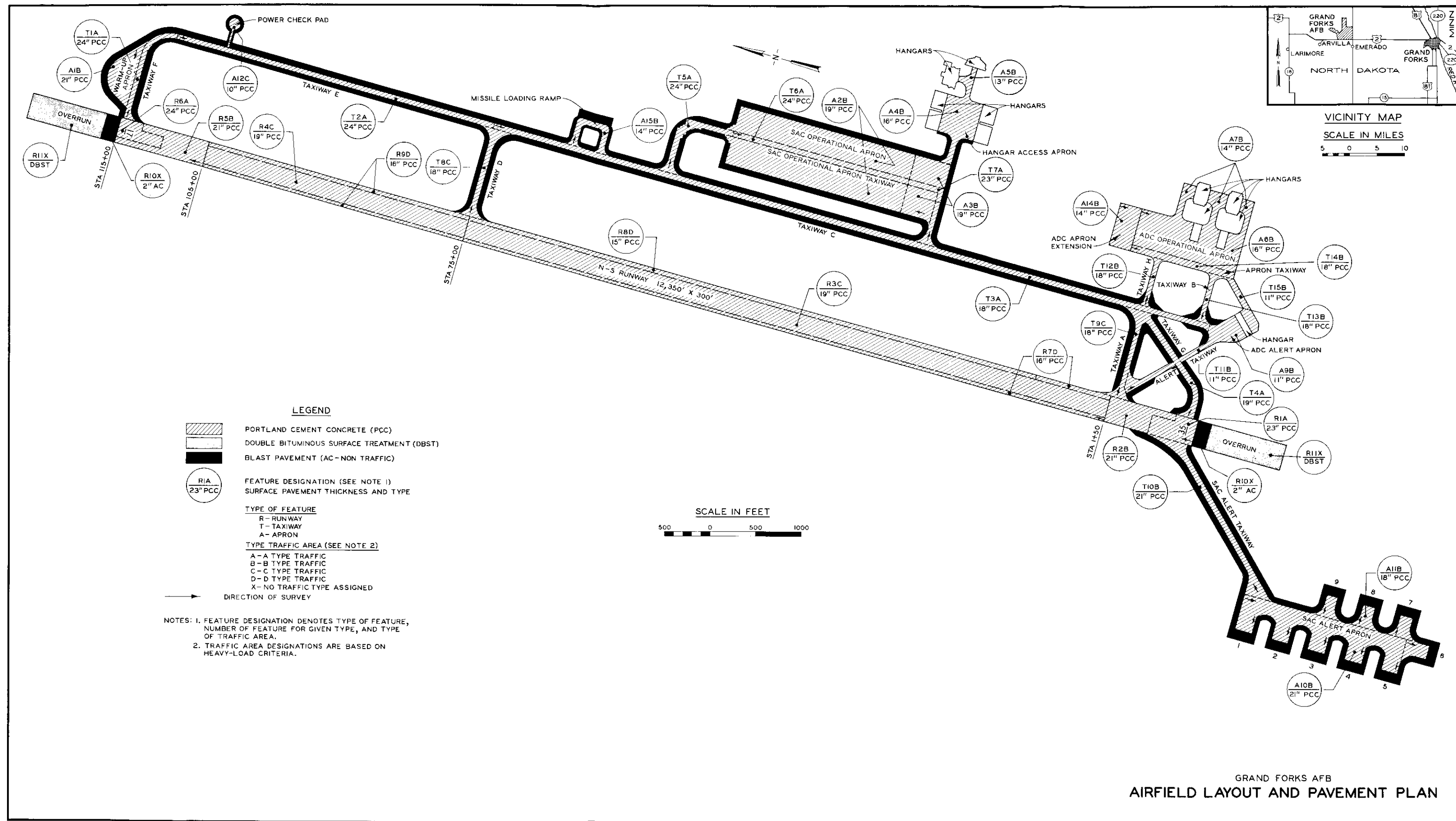
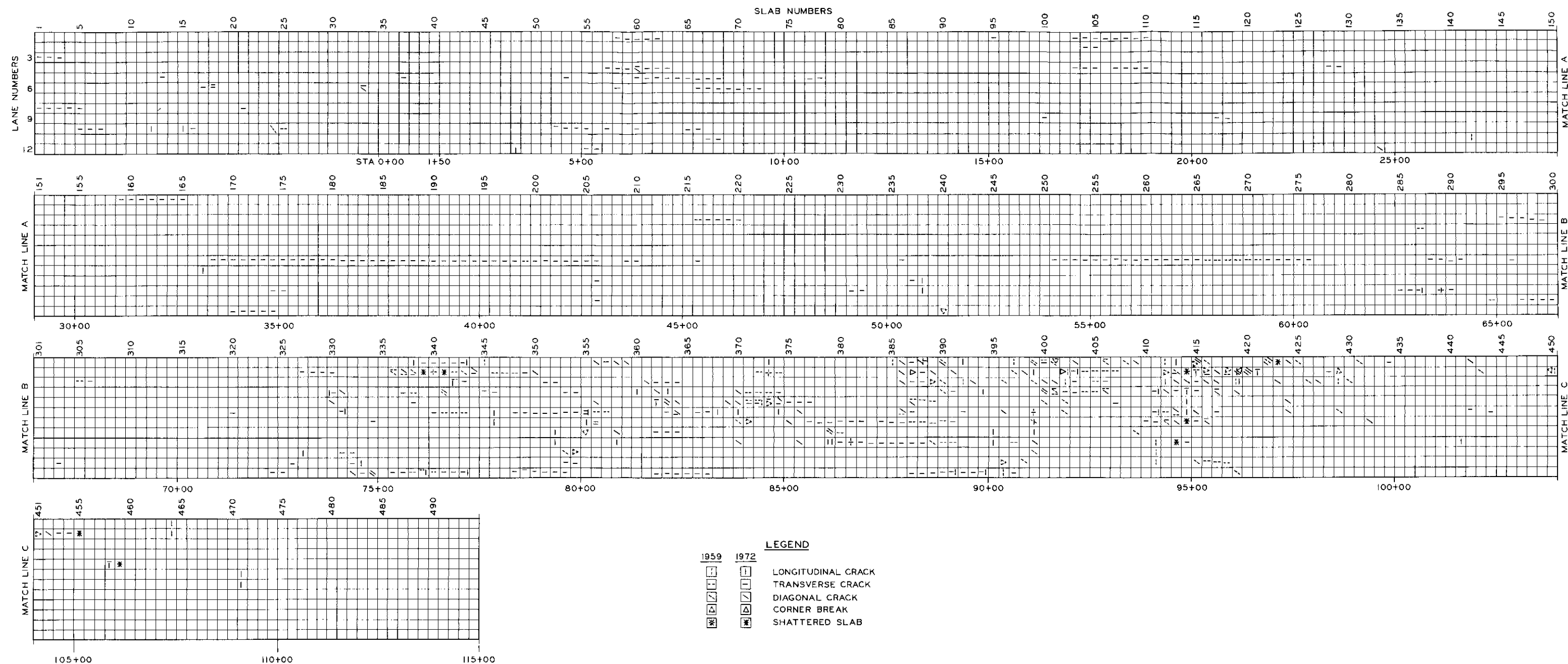


Photo 6. Cracking in slabs of taxiway C at  
entrance to missile loading ramp









GRAND FORKS AFB, NORTH DAKOTA  
PROGRESSION OF MAJOR DEFECTS  
ON NORTH-SOUTH RUNWAY



Appendix A: GFAFB Annual Pavement Maintenance Plan

| Area No. | Fac No. | Description   | Pave-ment Type | Year Const     | Existing Condition | Inspection Requirements                      | Maint Priority | Maint and Repair History  | Present or Proposed Maint and Repair                            |
|----------|---------|---|----------------|----------------|--------------------|--|----------------|---|---|
| 1        | 904     | Primary Runway<br>12, 350' x 300'<br>Original Runway<br>ADC 7500' x 100'  | Rigid Heavy    | 1956           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Resealed Joints<br>Repaired Spalls-1966<br>& 1970                             |   |
|          |         | Runway Extension  | Rigid Heavy    | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner |                | Resealed Joints<br>1966 & 1970<br>Mudjacked - 1966<br>Repaired Spalls-1966    |   |
| 2        | 946     | Warm-up Pad<br>27,400 SY  | Rigid Heavy    | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Bad<br>Spalls - 1965<br>Repaired Spalls-1966<br>Resealed Joints-1966 | Reseal Joints GRF 15-2,<br>Construction to start<br>August 71   |
| 3        | 926     | Warm-up Pad<br>Shoulders -<br>15,540 SY                                   | Flex Heavy     | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Patched & Seal<br>Coated - 1966 & 1971  |   |
| 4        | 905     | Parallel Taxiway<br>Original Taxiway<br>(ADC) 8400' x 75'                 | Rigid Med      | 1956           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-1966<br>Resealed Joints-1966                                  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
|          |         | Taxiway Extension<br>(SAC) 3637' x 75'                                    | Rigid Heavy    | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner |                | Repaired Spalls-1966<br>Resealed Joints-1966                                  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
| 5        | 926     | Parallel Taxiway<br>Shoulders (ADC)<br>75,000 SY                          | Flex Med       | 1956           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal<br>Coated-1966 & 1971   |   |
|          |         | SAC 41,000 SY   | Flex Heavy     | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner |                | Repaired and Seal<br>Coated-1966 & 1971                                       |   |
| 6        | 943     | Operational Apron   | Rigid Heavy    | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-<br>1966 & 1970<br>Mudjacked-1966 & 1970                      |   |
| 7        | 926     | Operational<br>Apron (SAC)<br>Shoulders<br>23,900 SY                      | Flex Heavy     | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal<br>Coated - 1966 & 1971                                       |   |
| 8        | 905     | Operational<br>Apron (SAC)<br>Taxiways<br>1500' x 75'                     | Rigid Heavy    | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-1966<br>Resealed Joints-1966                                  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
| 9        | 926     | Operational<br>Apron (SAC)<br>Taxiway Shoulders<br>18,300 SY              | Flex Heavy     | 1958           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal<br>Coated-1966 & 1971   |   |
| 10       | 943     | Apron Hanger<br>Access (SAC)<br>450' x 425'<br>350' x 100'<br>150' x 100' | Rigid Heavy    | 1958 &<br>1961 | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired Spalls-1966<br>Resealed Joints-1966                                  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
| 11       | 926     | Apron Hanger<br>Access (SAC)<br>Shoulders, 2200 SY                        | Flex Heavy     | 1961           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal<br>Coated-1966 & 1971   |   |
| 12       | 943     | Parking Apron (ADC)<br>1200' x 490'                                       | Rigid Med      | 1957           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired Spalls-1966  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
|          |         | 1840' x 75' (varies)  |                |                |                    |  |                |   |   |
|          |         | 330' x 50'  | Light          | 1959           |                    |  |                |   |   |
|          |         | 110' x 85'  |                |                |                    |  |                |   |   |
| 13       | 905     | 630' x 50'  | Light          | 1960           |                    |  |                |   |   |
|          |         | 120' x 100'   |                |                |                    |  |                |   |   |
|          |         | 242' x 490'   | Med            | 1965           |                    |  |                |   |   |
|          |         |   |                |                |                    |  |                |   |   |
| 13       | 905     | Taxiways to ADC<br>Parking Apron<br>535' x 75'<br>535' x 75'              | Rigid Med      | 1957           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired Spalls-1966<br>Resealed Joints-1966                                  | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |
| 14       | 926     | Taxiways to ADC<br>Parking Apron<br>Shoulders, 2200 SY                    | Flex Med       | 1957           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal<br>Coated-1966 & 1971   |   |
| 15       | 905     | Alert Apron &<br>Taxiways (ADC)<br>2140' x 75' (varies)                   | Rigid Light    | 1957           | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls<br>Resealed Joints-1966                                       | Reseal Joints GRF 15-2,<br>Construction to start<br>August 1971 |


## Appendix A (Continued)

| Area No. | Fac No. | Description   | Pave-ment Type | Year Const  | Existing Condition | Inspection Requirements                      | Maint Priority | Maint and Repair History                     | Present or Proposed Maint and Repair                      |
|----------|---------|---|----------------|-------------|--------------------|--|----------------|--|---|
| 16       | 926     | Alert Apron & Taxiway (ADC) Shoulders, 6000 SY          | Flex Light     | 1957        | Satis              | Monthly P&G<br>EM & Planner<br>Semi-Annually | III            | Repaired & Seal Coated-1966 & 1971           |   |
| 17       | 905     | Cross Taxiways (Center & South) 2000' x 75'             | Rigid Med      | 1957        | Satis              | Monthly P&G<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-1966<br>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<br>Semi-Annually<br>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<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-1966<br>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<br>Semi-Annually<br>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<br>Semi-Annually<br>EM & Planner | II             | Repaired Spalls-1966<br>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<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal Coated-1966 & 1971           |   |
| 23       | 926     | North & South Over run 1000' x 300'<br>1000' x 300'     | Flex           | 1958        | Satis              | Monthly P&G<br>Semi-Annually<br>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<br>Semi-Annually<br>EM & Planner | III            | Repaired & Seal Seal Coated-1966 & 1971      |   |
| 25       | 938     | Power Check Pad 1056 SY                                 | Rigid Light    | 1961        | Satis              | Monthly P&G<br>Semi-Annually<br>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<br>Annually<br>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<br>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<br>Semi-Annually                 | III            | Repaired & Seal Coated-1966 & 1971           |   |
| 29       | 943     | Apron Loading (Missile) 875' x 75'                      | Rigid Med      | 1965        | Satis              | Monthly P&G<br>Annually<br>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<br>Annually<br>EM & Planner      | IV             | Seal Coated-1971                             |   |









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