

The Joint Winter Runway Friction Measurement Program - NASA Perspective

By

**Thomas J. Yager
Senior Research Engineer
NASA Langley Research Center**

For

**1st International Meeting on Aircraft Performance on
Contaminated Runways (IMAPCR '96)
October 22-23, 1996
Holiday Inn Hotel Montreal, Quebec**

The Joint Winter Runway Friction Measurement Program - NASA Perspective

by

Thomas J. Yager
Senior Research Engineer
NASA Langley Research Center

SUMMARY

Some background information is given together with the scope and objectives of the 5-year, Joint National Aeronautics & Space Administration (NASA)/Transport Canada (TC)/Federal Aviation Administration (FAA) Winter Runway Friction Measurement Program. The range of the test equipment, the selected test sites and a tentative test program schedule are described. NASA considers the success of this program critical in terms of insuring adequate ground handling performance capability in adverse weather conditions for future aircraft being designed and developed as well as improving the safety of current aircraft ground operations.

INTRODUCTION

In late December 1995, a joint international agreement was signed between NASA and Transport Canada to conduct instrumented aircraft and ground vehicle tests designed to fulfill several objectives related to winter runway operational safety. The wording and terms of this 5-year agreement starting January 1, 1996 were such that any member of the aviation community would be encouraged to participate. Many of the recommendations from the Canadian Dryden Commission's report and those described in a January 25, 1995 government/industry working group White Paper entitled: "An Evaluation of Winter Operational Runway Friction Measurement, Equipment, Procedures and Research" were incorporated into the objectives of this joint program.

The testing commenced at North Bay, Ontario in mid January 1996 with an instrumented National Research Council (NRC) Falcon-20 aircraft and four ground friction measuring devices. In early March 1996, the NASA B-737 aircraft and the NRC Falcon-20 aircraft shown in figure 1 participated in additional testing at North Bay with seven different friction measuring vehicles. In early August 1996, some wet and flooded runway tests were performed at NASA Wallops Flight Facility with the NASA B-737 aircraft and the Diagonal-Braked Vehicle. Most of the results from these different periods of testing will be presented and discussed in later conference presentations.

The current participants in this joint program are listed in figure 2 with NASA, Transport Canada with NRC, and the FAA identified as the major players on the basis of personnel and funding support. Other participants who will be contributing greatly to the overall success of this program in terms of objectives achieved and support in funding, personnel and equipment include the Norwegian Civil Aviation Authority, the U. S. Air Force, the Joint Aviation Authority, the Canadian Department of National Defense, the International Civil Aviation Organization, other aviation organizations/industries and equipment manufacturers. Additional participants are expected to join in the support of this program before its completion in June 2001.

OBJECTIVES/SCOPE

A listing of the major objectives of this joint program are given in figure 3 and when considered collectively, the robust scope of this ambitious endeavor is better appreciated. As the individual objectives imply, the overall thrust of this joint program is to improve the safety of aircraft ground operations in adverse weather conditions.

The primary instrumented test aircraft and ground friction measuring equipment are listed in figure 4. In addition to the NASA B-737 and NRC Falcon-20 aircraft, at least five other instrumented test aircraft are desired to participate in this program. A range of aircraft tire/brake systems, landing gear geometry and ground

operational speeds are necessary to confidently establish the relationship between aircraft braking performance and ground vehicle friction measurements. The ground friction measuring equipment selected cover the full range of test tire types, sizes, inflation pressures, tread designs, and braking slip ratios. For tests with a particular instrumented aircraft only some, and not all, of these ground vehicles are needed to collect comparable data.

The different sites currently selected for conducting these aircraft and ground vehicle tests are shown in figures 5 through 9. The three runway layout at North Bay Airfield, Ontario is shown in figure 5 with runway 8/26 the primary aircraft test site. Figure 6 shows an aerial view of the two parallel runways at Brunswick Naval Air Station, Maine. The outboard runway 19R/1L will be the primary aircraft and ground vehicle test site with the inboard runway 1R/19L kept bare and dry for Naval aircraft operations. Features and specifications of the Aircraft Landing Dynamics Facility (ALDF) at NASA Langley Research Center are shown in figure 7. This unique NASA facility will be used for aircraft tire/brake parametric studies in support of several joint program objectives. Figure 8 shows an aerial view of NASA Wallops Flight Facility with several of the major features identified including the Landing Research Runway 4/22. A schematic of NASA Wallop's runway 4/22 test surfaces is given in figure 9 together with information on several taxiway test surfaces. Wet and flooded runway tests are planned to be conducted with each of the different instrumented test aircraft on surfaces A and B (ungrooved and grooved concrete) shown in figure 9.

TEST PROGRAM SCHEDULE

The tentative overall 5-year test program schedule is shown in figure 10. The earlier tests this year at North Bay, Ontario and NASA Wallops are denoted together with tentative plans to tests at Brunswick NAS, ME in early December 1996 with the NASA B-737. Additional aircraft and ground vehicle tests are scheduled for North Bay, Ontario for January 19-31, 1997 and February 23 to March 7, 1997. It is possible that the FAA B-727 and the Norwegian Dash 8

aircraft will be available for testing in 1997-98 timeframe. The NASA B-737 aircraft will be "retired" in April 1997 but the NASA B-757 aircraft will not be available for testing until the winter of 1998-99. Support from Airbus and Boeing in using their instrumented wide body aircraft later in this joint program is still being discussed. In any event, all participants will have an opportunity to get a T-shirt and/or hat with the joint program logo (see figure 11) emblazoned upon it.

CONCLUDING REMARKS

To achieve the scope and objectives of the Joint NASA/Transport Canada/FAA Winter Runway Friction Measurement Program, the support and encouragement of most of the aviation community is needed. Many useful, practical and efficient procedures/techniques are expected to be derived from these studies and with any degree of success, the aviation industry and the traveling public should gain a significant improvement in safety of aircraft ground operations. Although the initial testing has been successful, most of the test work, data collection and analysis, evaluation and conclusions lie ahead of us. Let's just do it!

JOINT WINTER RUNWAY FRICTION MEASUREMENT PROGRAM

A 5-year effort involving NASA, Transport Canada, Federal Aviation Administration with support from aviation industry.

Instrumented Aircraft Evaluated at North Bay, Ontario.



NASA B-737 AIRCRAFT



CANADIAN FALCON-20 AIRCRAFT

Figure 1

Joint Winter Runway Friction Measurement Program

PARTICIPANTS

**MAJOR: National Aeronautics & Space Administration (NASA)
Transport Canada with National Research Council(NRC)
Federal Aviation Administration (FAA)**

**OTHERS: Norwegian Civil Aviation Authority
U. S. Air Force
Canadian Department of National Defense
Joint Aviation Authority (JAA)
International Civil Aviation Organization (ICAO)
Aviation organizations/industries
Equipment manufacturers**

Joint Winter Runway Friction Measurement Program

OBJECTIVES/SCOPE

- Evaluate instrumented aircraft and ground vehicle friction harmonization
- Validate James Brake Index (JBI) tables for landing distances and possible expansion to accelerate-stop distances
- Measure contaminant drag effects on aircraft ground handling performance
- Assess effects of both aircraft and runway anti- and de-icing chemicals
- Conduct parametric studies at Langley's Aircraft Landing Dynamics Facility
- Implement many of the Jan. 1995 government/industry White Paper recommendations
- Configure test run matrices to optimize usefulness of results to pilots, airport operators, regulatory agencies, equipment manufacturers and airframe companies

Figure 3

Joint Winter Runway Friction Measurement Program

TEST EQUIPMENT

Instrumented Aircraft:

NASA B-737

NASA B-757

FAA B-727

Wide body, i.e. A320, B-777

NRC Falcon-20

Norwegian Dash 8

Military aircraft

Ground Test Equipment:

Vehicles

Diagonal-braked

Electronic recording decel.

Runway Friction Tester

Surface Friction Tester

Instrumented Tire Tester

Trailers

GripTester

Runar & Oscar

E-274 Skid

IMAG

Mu-meter

Figure 4

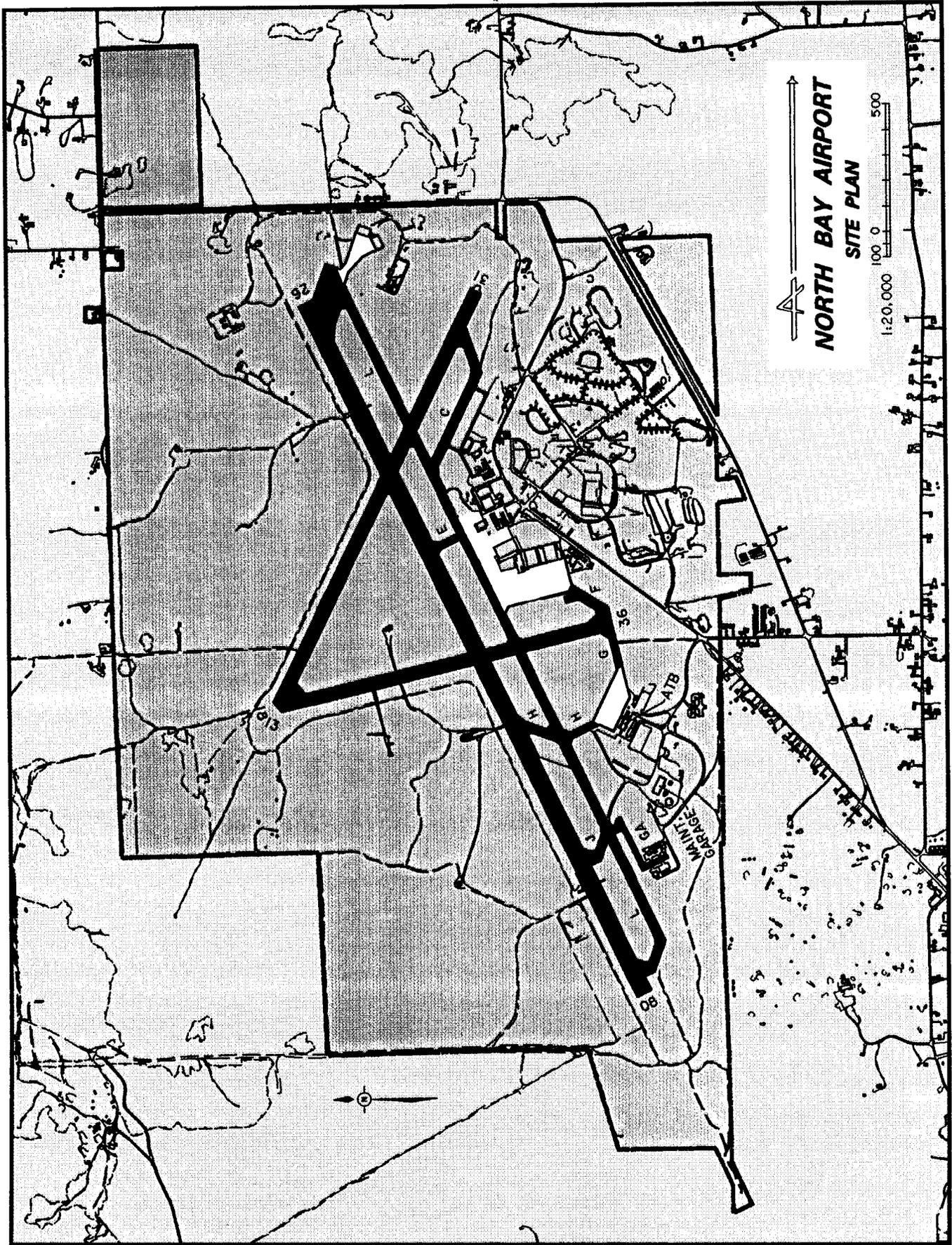


Figure 5

AERIAL VIEW OF BRUNSWICK NAVAL AIR STATION, BRUNSWICK MAINE

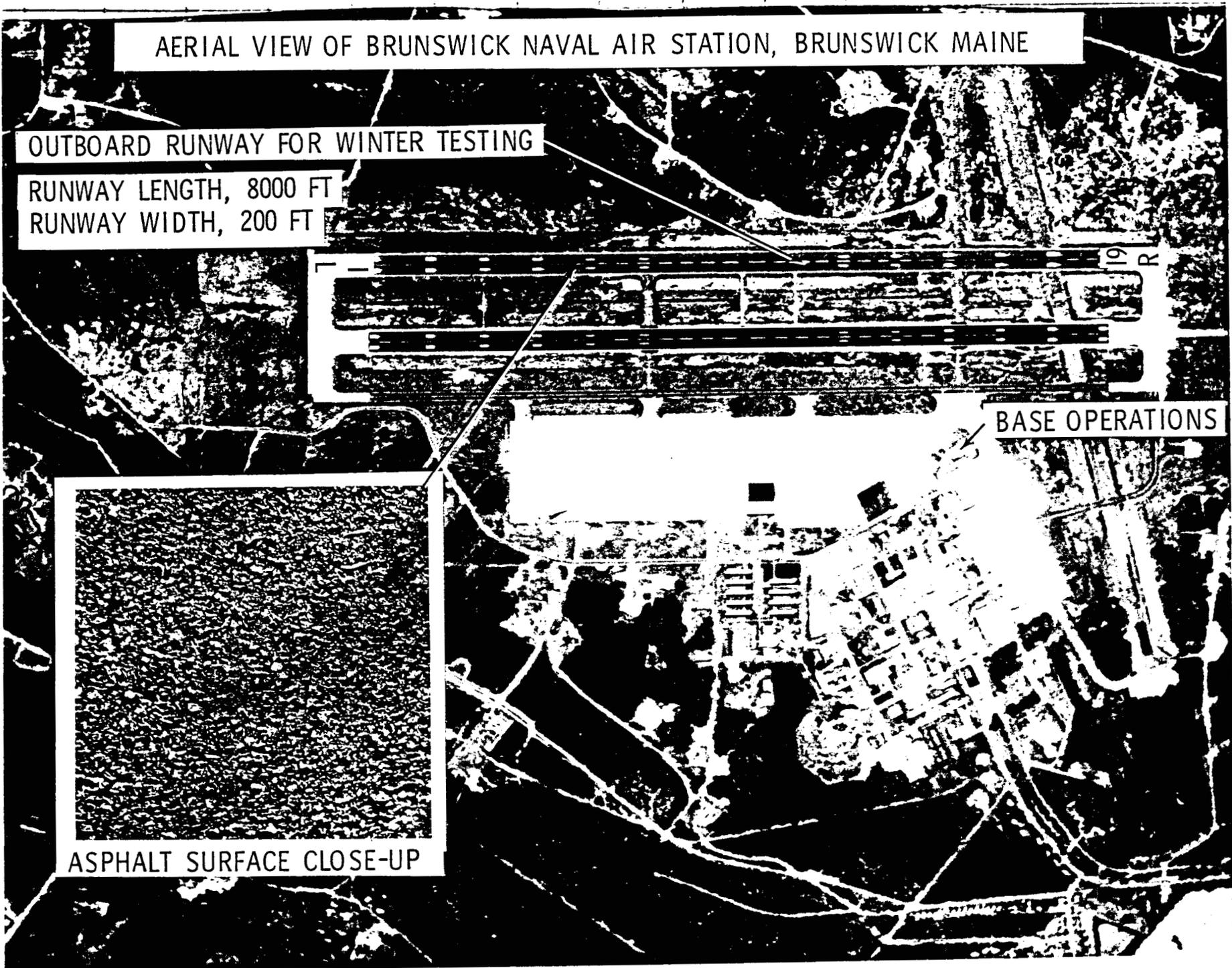
OUTBOARD RUNWAY FOR WINTER TESTING

RUNWAY LENGTH, 8000 FT
RUNWAY WIDTH, 200 FT

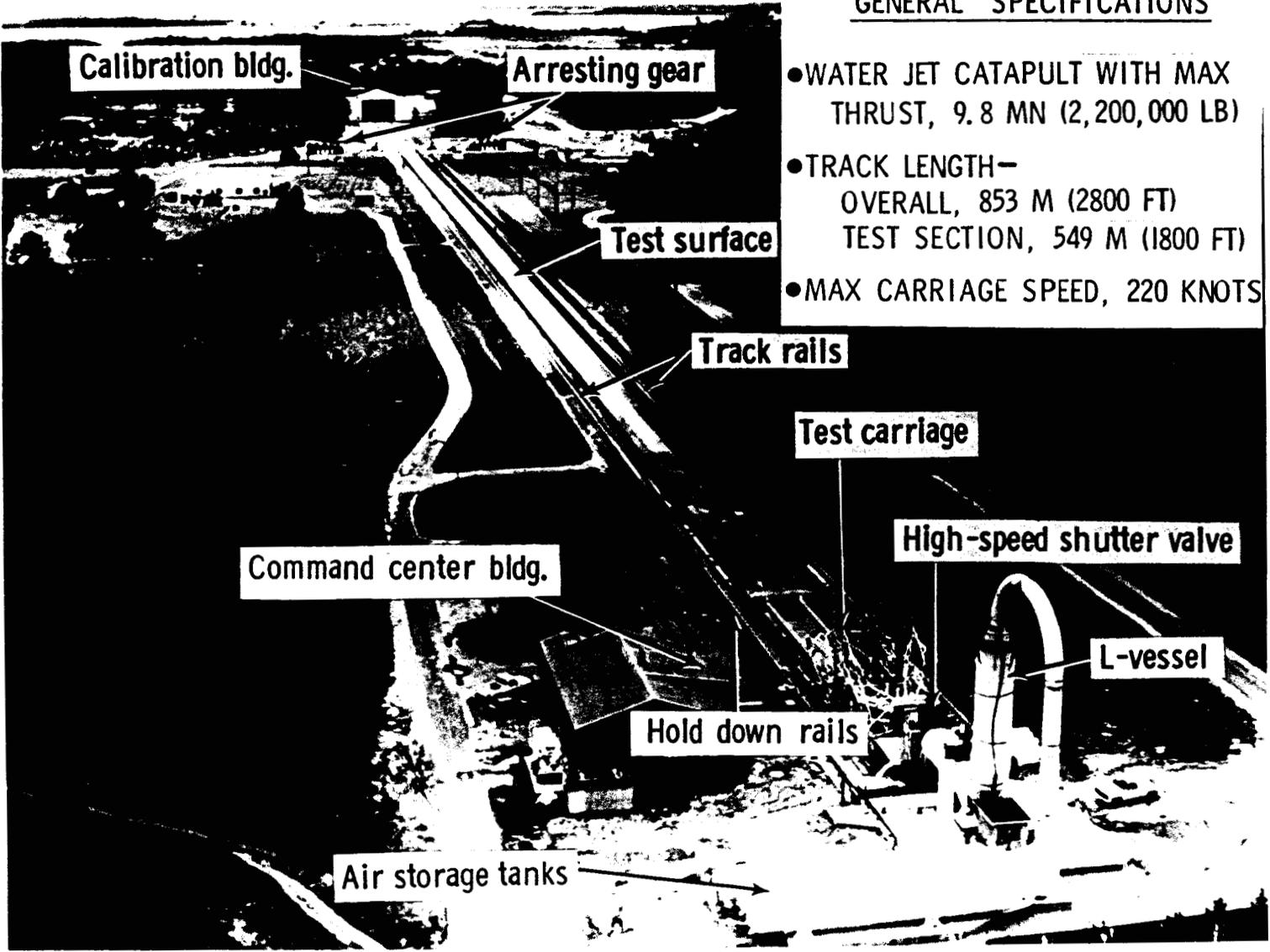
BASE OPERATIONS

ASPHALT SURFACE CLOSE-UP

Figure 6



AIRCRAFT LANDING DYNAMICS FACILITY



GENERAL SPECIFICATIONS

- WATER JET CATAPULT WITH MAX THRUST, 9.8 MN (2,200,000 LB)
- TRACK LENGTH—
OVERALL, 853 M (2800 FT)
TEST SECTION, 549 M (1800 FT)
- MAX CARRIAGE SPEED, 220 KNOTS

Figure 7

NASA Wallops Flight Facility Airfield Layout

CHINCOTEAGUE

CONTROL TOWER

RUNWAY 10/28

RUNWAY 17/35

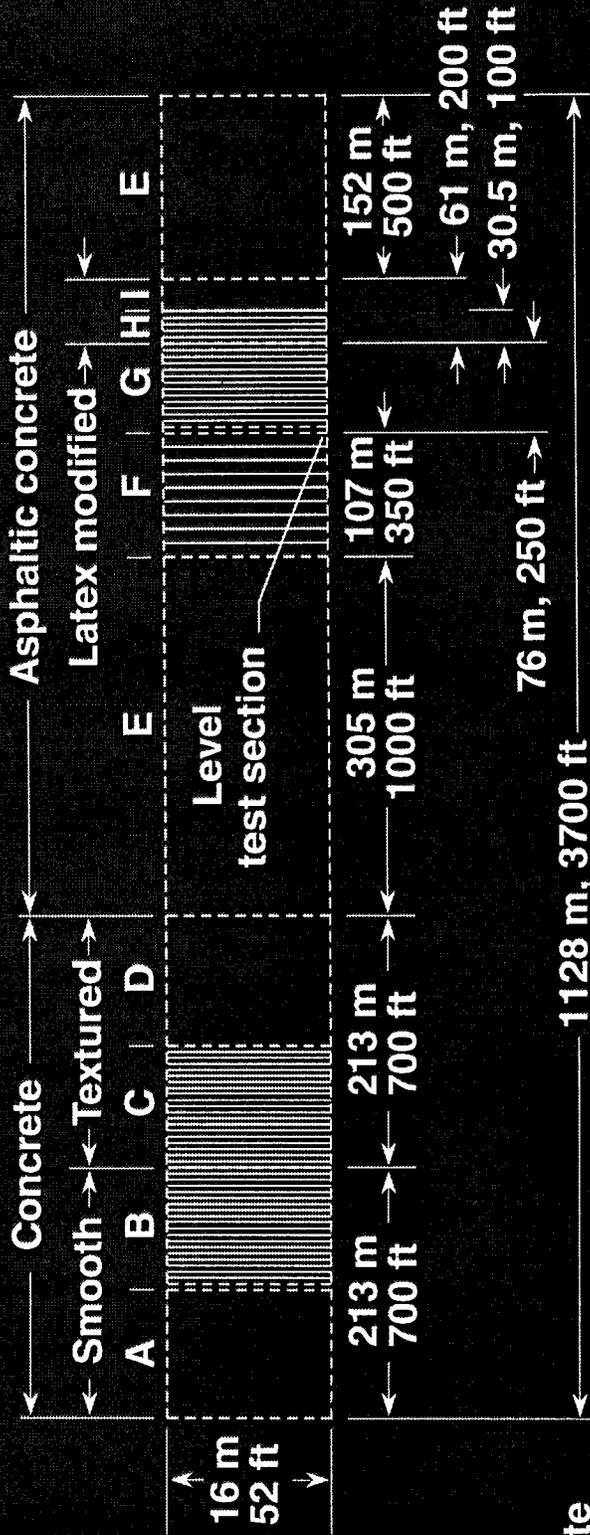
LANDING RESEARCH
RUNWAY 4/22

HANGER N159

MAIN GATE

Figure 8

SCHEMATIC OF NASA WALLOPS RUNWAY 4/22 TEST SURFACES



Note:
Taxiway test surfaces include small aggregate asphalt, aluminum panels, special reference surface panels and micro-surfacing treatments

Surfaces B, C, G and H transversely grooved 0.25 x 0.25 x 1.0 in.

Surface F transversely grooved 0.25 x 0.25 x 2.0 in.

----- Slots cut in pavement to hold rubber belt dam material

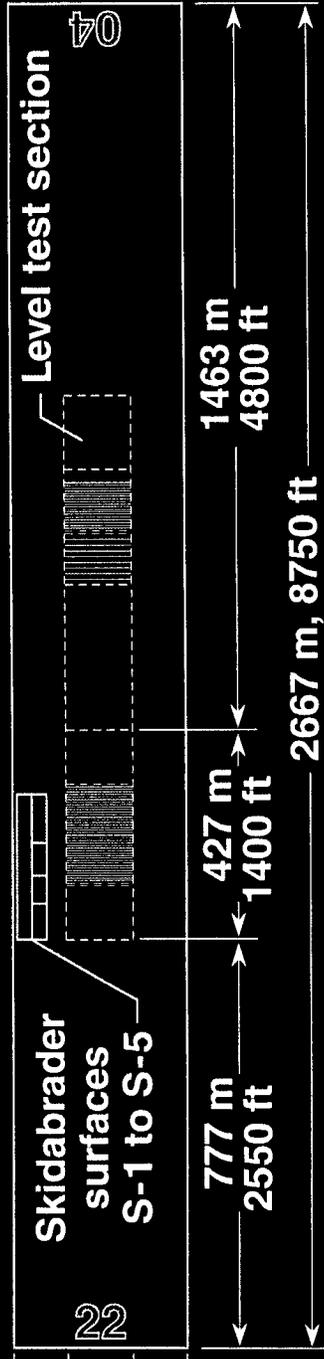
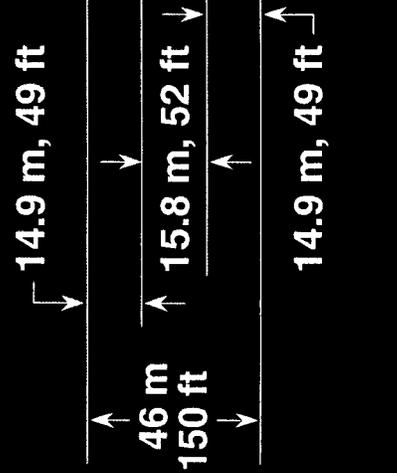


Figure 9

OVERALL JOINT NASA/TC/FAA WINTER RUNWAY FRICTION PROGRAM SCHEDULE

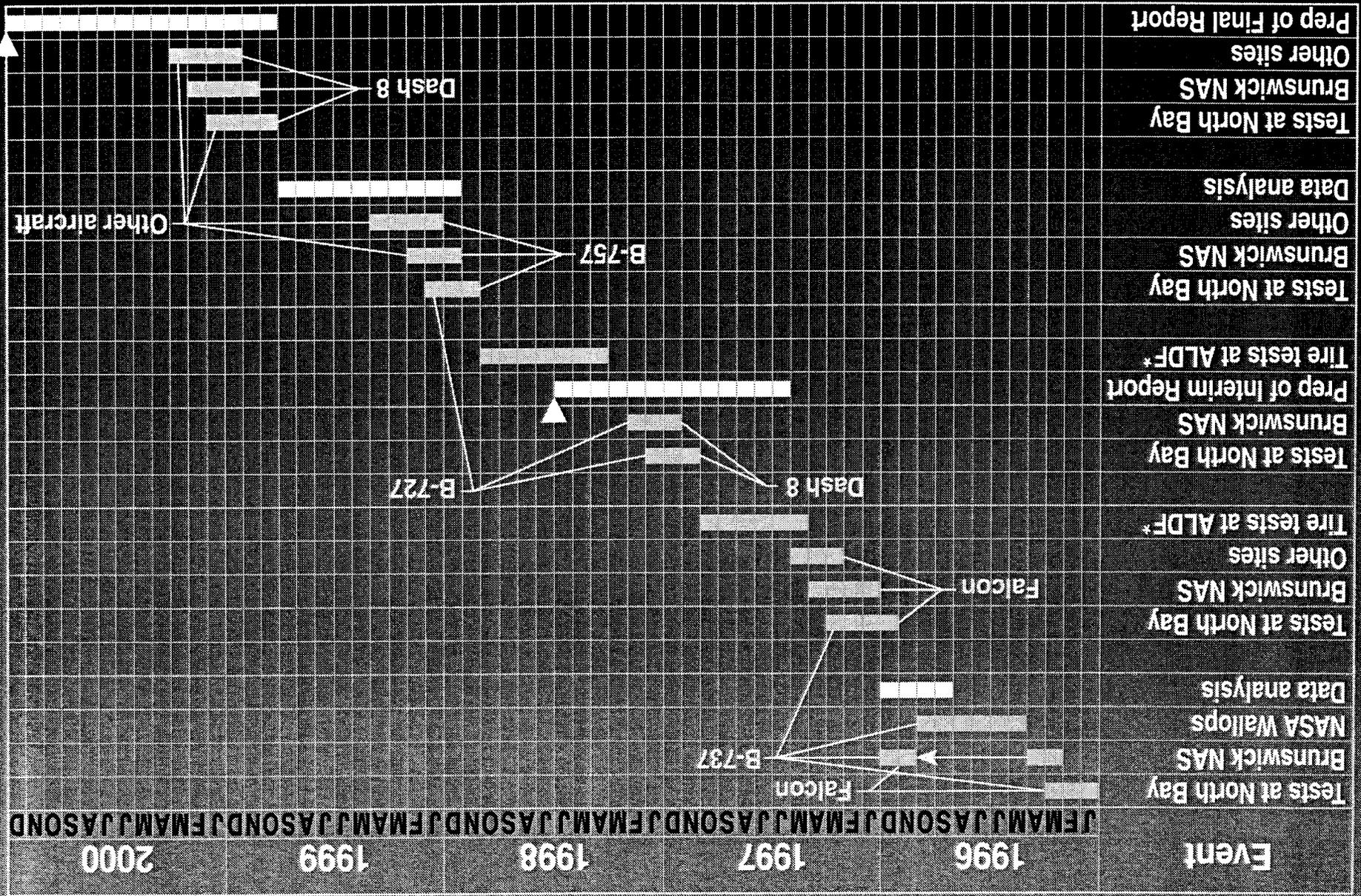


Figure 10

* ALDF - Aircraft Landing Dynamics Facility



Figure 11