

FC 3-260-06F  
1 June 2015

# **FACILITIES CRITERIA (FC)**

## **AIR FORCE DESIGN, CONSTRUCTION, MAINTENANCE, AND EVALUATION OF SNOW AND ICE AIRFIELDS IN ANTARCTICA**



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**FACILITIES CRITERIA (FC)****AIR FORCE**  
**DESIGN, CONSTRUCTION, MAINTENANCE, AND EVALUATION OF SNOW AND**  
**ICE AIRFIELDS IN ANTARCTICA**

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U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND

AIR FORCE CIVIL ENGINEER CENTER (Preparing Activity)

Record of Changes (changes are indicated by \1\ ... /1/)

<b>Change No.</b>	<b>Date</b>	<b>Location</b>

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**This FC supersedes ETL 02-16, *Design, Construction, Maintenance, and Evaluation of the Pegasus Glacial Ice Runway for Heavy Wheeled Aircraft Operations*, dated Oct 2002; and ETL 07-12, *Design, Construction, Maintenance, and Evaluation of the McMurdo Sound (Antarctica) Sea Ice Runway*, dated Sep 2007.**

## FOREWORD

Facilities Criteria (FC) provide functional requirements (i.e., defined by users and operational needs of a particular facility type) for specific DoD Component(s), and are intended for use with unified technical requirements published in DoD Unified Facilities Criteria (UFC). FC are applicable only to the DoD Component(s) indicated in the title, and do not represent unified DoD requirements. Differences in functional requirements between DoD Components may exist due to differences in policies and operational needs.

All construction outside of the United States is also governed by Status of Forces Agreements (SOFA), Host Nation Funded Construction Agreements (HNFA), and in some instances, Bilateral Infrastructure Agreements (BIA.) Therefore, the acquisition team must ensure compliance with the most stringent of the UFC (replace w/ FC), the SOFA, the HNFA, and the BIA, as applicable.

Because FC are coordinated with unified DoD technical requirements, they form an element of the DoD UFC system applicable to specific facility types. The UFC system is prescribed by MIL-STD 3007 and provides planning, design, construction, sustainment, restoration, and modernization criteria, and applicable to the Military Departments, Defense Agencies, and the DoD Field Activities. The UFC System also includes technical requirements and functional requirements for specific facility types, both published as UFC documents and FC documents.

FC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and the Air Force Civil Engineer Center (AFCEC) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content is the responsibility of the cognizant DoD working group. Recommended changes with supporting rationale should be sent to the respective service proponent office by the following electronic form: [Criteria Change Request](#). The form is also accessible from the Internet site listed below.

FC are effective upon issuance and are distributed only in electronic media from the following source:

- Whole Building Design Guide web site <http://dod.wbdg.org/>.

Refer to UFC 1-200-01, *General Building Requirements*, for implementation of new issuances on projects.

### AUTHORIZED BY:



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JOE SCIABICA, SES

Director

Air Force Civil Engineer Center

**FC 3-260-06F**

**1 June 2015**

## **FACILITIES CRITERIA (FC) NEW SUMMARY SHEET**

**Document:** FC 3-260-06F, *Design, Construction, Maintenance, and Evaluation of Snow and Ice Airfields in Antarctica*

### **Superseding:**

- ETL 02-16, *Design, Construction, Maintenance, and Evaluation of the Pegasus Glacial Ice Runway for Heavy Wheeled Aircraft Operations*, and ETL 07-12, *Design, Construction, Maintenance, and Evaluation of the McMurdo Sound (Antarctica) Sea Ice Runway*

### **Description:**

- Provides design, construction, and maintenance details, dimensional criteria, and structural evaluation criteria for compacted snow, glacial ice and ice runways used by wheeled or ski-equipped aircraft.

### **Reasons for Document:**

- The criteria presented herein unify and standardize current airfield practices for Antarctica previously found in multiple documents. These criteria update guidance on thickness of snow topping on glacial ice runways and clarifies marking and lighting requirements.

### **Impact:**

- Issuance of this document should not significantly impact future design costs, initial costs, energy savings, or life cycle cost as compared to current practices.

### **Unification Issues**

- Not Applicable



## TABLE OF CONTENTS

<b>CHAPTER 1 INTRODUCTION .....</b>	<b>1</b>
<b>1-1 PURPOSE.....</b>	<b>1</b>
1-1.1 Facilities Criteria .....	1
1-1.2 U.S. Antarctic Program. ....	1
<b>1-2 APPLICATION. ....</b>	<b>2</b>
1-2.1 McMurdo Station Operations. ....	2
<b>1-3 POINTS OF CONTACT.....</b>	<b>3</b>
<b>CHAPTER 2 CRITERIA.....</b>	<b>5</b>
<b>2-1 DIMENSIONAL CRITERIA.....</b>	<b>5</b>
2-1.1 Runways.....	5
2-1.2 Runway Shoulders.....	5
2-1.3 Runway Graded Area. ....	5
2-1.4 Overruns.....	11
2-1.5 Clear Areas.....	11
2-1.6 Taxiways.....	12
2-1.7 Aprons. ....	14
2-1.8 Typical Sections.....	17
<b>2-2 SNOW/ICE SURFACE CONSTRUCTION, MAINTENANCE, AND STRUCTURAL EVALUATION CRITERIA.....</b>	<b>18</b>
2-2.1 New Runway Construction.....	18
2-2.2 Preparation for Initial Seasonal Use. ....	18
2-2.3 Maintenance During Use. ....	18
2-2.4 Runway Strength Evaluation.....	19
2-2.5 Warm Weather Operations at Pegasus White Ice Runway.....	20
<b>2-3 AIRFIELD MARKINGS.....</b>	<b>20</b>
2-3.1 Airfield Marking Approach.....	20
2-3.2 Specific Requirements .....	20
2-3.3 Marking Criteria .....	21
2-3.4 Temporary Markings .....	21
2-3.5 Marker Flags.....	21
2-3.6 Frangibility .....	22
2-3.7 Low Visibility Markers. ....	22
<b>2-4 AIRFIELD LIGHTING.....</b>	<b>26</b>

2-4.1	Lighting Approach.....	26
2-4.2	Desirable Lighting Components.....	26
2-4.3	Light Installation.....	29
2-4.4	Lighting Details.....	31
2-4.5	Taxiway and Apron Lighting.....	31
<b>2-5</b>	<b>ELECTRONIC NAVIGATIONAL AID SYSTEMS (NAVAIDS).....</b>	<b>33</b>
2-5.1	NAVAIDS - General.....	33
2-5.2	NAVAIDS Siting Criteria.....	34
2-5.3	Positioning NAVAIDS.....	34
2-5.4	NAVAIDS Implementation.....	34
<b>2-6</b>	<b>AIRFIELD CERTIFICATION PROCESS.....</b>	<b>36</b>
2-6.1	Annual Certification.....	36
2-6.2	Periodic Air Force Team Certification.....	36
2-6.3	Operational Waivers to Criteria.....	37
<b>APPENDIX A REFERENCES.....</b>		<b>39</b>
<b>APPENDIX B BEST PRACTICES.....</b>		<b>41</b>
<b>B-1</b>	<b>DCP AND RSP OPERATING INSTRUCTIONS.....</b>	<b>41</b>
B-1.1	Device Configuration.....	41
B-1.2	Test Method.....	41
B-1.3	Errors.....	42
B-1.4	Soft Snow.....	42
B-1.5	Strength Index.....	42
<b>B-2</b>	<b>GLACIAL ICE AND WHITE ICE RUNWAY PATCHING PROCEDURE.....</b>	<b>43</b>
B-2.1	Introduction.....	43
B-2.2	Tools.....	43
B-2.3	Patching Procedure.....	43
<b>B-3</b>	<b>SEA ICE RUNWAY PATCHING PROCEDURE.....</b>	<b>47</b>
B-3.1	Introduction.....	47
B-3.2	Tools.....	47
B-3.3	Patching Procedure.....	47
<b>B-4</b>	<b>GLACIAL ICE STRUCTURAL EVALUATION PROCEDURE.....</b>	<b>51</b>
B-4.1	Glacial Ice Runway Surface Evaluation—Deformation Failure.....	51
B-4.2	Glacial Ice Runway Surface Evaluation—Creep Failure.....	52

B-4.3	Glacial Ice Runway Surface Evaluation—Flexural Failure.....	52
<b>B-5</b>	<b>WHITE ICE STRUCTURAL EVALUATION PROCEDURE.....</b>	<b>53</b>
B-5.1	White Ice Pavement Thickness.....	53
B-5.2	White Ice Runway Surface—Deformation Failure.....	53
B-5.3	White Ice Runway Surface—Snow Pavement Strength Determination. .....	53
B-5.4	White Ice Runway Surface—Allowable Aircraft Loads/Contact Pressures.....	57
<b>B-6</b>	<b>SEA ICE STRUCTURAL EVALUATION PROCEDURE .....</b>	<b>59</b>
B-6.1	Introduction .....	59
B-6.2	Sea Ice Operating Surface.....	59
<b>B-7</b>	<b>EXAMPLE CALCULATIONS TO ESTABLISH THE STATISTICAL SEA ICE THICKNESS VALUE.....</b>	<b>67</b>
B-7.1	Example Data .....	67
B-7.2	Data Manipulation.....	67
B-7.3	Data Plotting .....	67
B-7.4	Data Application.....	67
B-7.5	Data Validation .....	67
<b>B-8</b>	<b>EXAMPLE CALCULATIONS USING LANDING AND TAKE-OFF AND PARKING NOMOGRAPHS .....</b>	<b>69</b>
B-8.1	Example 1.....	69
B-8.2	Example 2.....	69
B-8.3	Example 3.....	70
B-8.4	Example 4.....	70
<b>B-9</b>	<b>TABULATED RESULTS FROM APPLICATION OF LANDING/TAKE- OFF AND PARKING NOMOGRAPHS TO C-17 AND BOEING 767- 300ER AIRCRAFT AT MCMURDO SOUND SEA ICE RUNWAY .....</b>	<b>77</b>
B-9.1	Nomographs - General .....	77
B-9.2	C-17 Nomographs .....	77
B-9.3	B767 Nomographs.....	77
<b>B-10</b>	<b>TEST PLAN FOR SEA ICE RUNWAY WHEELED AIRCRAFT OPERATIONS CERTIFICATION .....</b>	<b>129</b>
B-10.1	Introduction.....	129
B-10.2	Certification Process.....	129
<b>B-11</b>	<b>TEST PLAN FOR PEGASUS RUNWAY WHEELED AIRCRAFT OPERATIONS CERTIFICATION .....</b>	<b>133</b>

B-11.1	Introduction .....	133
B-11.2	Certification Process .....	133
<b>B-12</b>	<b>TYPICAL AIRFIELD LAYOUT FOR PEGASUS GLACIAL ICE RUNWAY, ROSS ICE SHELF, ANTARCTICA .....</b>	<b>139</b>
<b>B-13</b>	<b>TYPICAL AIRFIELD LAYOUT FOR SEA ICE AIRFIELD, MCMURDO SOUND, ANTARCTICA .....</b>	<b>143</b>
<b>B-14</b>	<b>CONVERSION FACTORS .....</b>	<b>147</b>
<b>APPENDIX C</b>	<b>GLOSSARY .....</b>	<b>149</b>
<b>C-1</b>	<b>ACRONYMS .....</b>	<b>149</b>
<b>C-2</b>	<b>DEFINITION OF TERMS .....</b>	<b>153</b>

## FIGURES

Figure 2-1	Typical Runway Layout for Bi-Directional Operations (Not to Scale) .....	9
Figure 2-2	Typical Runway Layout for Uni-Directional Operations (Not to Scale) .....	10
Figure 2-3	Typical Layout Arrangements for Taxiways and Aprons (Not to Scale) .....	16
Figure 2-4	Typical Cross-Section Dimensions for Runway, Taxiway, and Apron (Not to Scale) .....	17
Figure 2-5	Marker Layout for Ice Runways (Not to Scale) .....	23
Figure 2-6	Marker Details for Snow/Ice Runways .....	24
Figure 2-7	Low Visibility Cone Layout for Ice Runway .....	25
Figure 2-8	Lighting Layout for Snow/Ice Runways .....	30
Figure 2-9	Typical SSALR Elevated 6.1-m (20-ft) Light Barrette .....	31
Figure 2-10	Typical Threshold Light Installation for Snow/Ice Airfields .....	32
Figure 2-11	Lighting Details for Snow/Ice Airfields .....	33
Figure 2-12	Snow/Ice Runway NAVAIDS Layout with Dimensions .....	35
Figure B-1	Correlation Between RSP and DCP .....	54
Figure B-2	Correlation Between DCP Index and CBR .....	54
Figure B-3	Correlation Between RSP Index and CBR .....	55
Figure B-4	Strength Criteria for White Ice Pavement .....	56
Figure B-5	Landing and Take-off Nomograph for the McMurdo Sound Sea Ice Runway .....	63
Figure B-6	Allowable Parking Times for the McMurdo Sound Sea Ice Runway .....	65
Figure B-7	Tabular and Graphical Examples of Statistical Analysis of Sea Ice Thickness Data to Determine a Representative Value .....	68
Figure B-8	Example 1 .....	72
Figure B-9	Example 2 .....	73
Figure B-10	Example 3 .....	74
Figure B-11	Example 4 .....	75
Figure B-12	Tabular Representation of Landing/Take-Off Nomograph for C-17 .....	78
Figure B-13	Tabular Representation of Landing/Take-Off Nomograph for B767-300ER .....	79
Figure B-14	Tabular Representation of Parking Nomograph for C-17 on -4 °F (-20 °C) Sea Ice .....	80

Figure B-15 Tabular Representation of Parking Nomograph for C-17 on -2 °F (-19 °C)	
Sea Ice.....	81
Figure B-16 Tabular Representation of Parking Nomograph for C-17 on 0 °F (-17.5 °C)	
Sea Ice.....	82
Figure B-17 Tabular Representation of Parking Nomograph for C-17 on 2 °F (-16.5 °C)	
Sea Ice.....	83
Figure B-18 Tabular Representation of Parking Nomograph for C-17 on 4 °F (-15.5 °C)	
Sea Ice.....	84
Figure B-19 Tabular Representation of Parking Nomograph for C-17 on 6 °F (-14 °C)	
Sea Ice.....	85
Figure B-20 Tabular Representation of Parking Nomograph for C-17 on 8 °F (-13 °C)	
Sea Ice.....	86
Figure B-21 Tabular Representation of Parking Nomograph for C-17 on 10 °F (-12 °C)	
Sea Ice.....	87
Figure B-22 Tabular Representation of Parking Nomograph for C-17 on 12 °F (-11 °C)	
Sea Ice.....	88
Figure B-23 Tabular Representation of Parking Nomograph for C-17 on 14 °F (-10 °C)	
Sea Ice.....	89
Figure B-24 Tabular Representation of Parking Nomograph for C-17 on 15 °F (-9.5 °C)	
Sea Ice.....	90
Figure B-25 Tabular Representation of Parking Nomograph for C-17 on 16 °F (-9 °C)	
Sea Ice.....	91
Figure B-26 Tabular Representation of Parking Nomograph for C-17 on 17 °F (-8 °C)	
Sea Ice.....	92
Figure B-27 Tabular Representation of Parking Nomograph for C-17 on 18 °F (-7.5 °C)	
Sea Ice.....	93
Figure B-28 Tabular Representation of Parking Nomograph for C-17 on 19 °F (-7 °C)	
Sea Ice.....	94
Figure B-29 Tabular Representation of Parking Nomograph for C-17 on 20 °F (-6.5 °C)	
Sea Ice.....	95
Figure B-30 Tabular Representation of Parking Nomograph for C-17 on 21 °F (-6 °C)	
Sea Ice.....	96
Figure B-31 Tabular Representation of Parking Nomograph for C-17 on 22 °F (-5.5 °C)	
Sea Ice.....	97
Figure B-32 Tabular Representation of Parking Nomograph for C-17 on 23 °F (-5 °C)	
Sea Ice.....	98
Figure B-33 Tabular Representation of Parking Nomograph for C-17 on 24 °F (-4.5 °C)	
Sea Ice.....	99
Figure B-34 Tabular Representation of Parking Nomograph for C-17 on 25 °F (-4 °C)	
Sea Ice.....	100
Figure B-35 Tabular Representation of Parking Nomograph for C-17 on 26 °F (-3.5 °C)	
Sea Ice.....	101
Figure B-36 Tabular Representation of Parking Nomograph for C-17 on 27 °F (-2.5 °C)	
Sea Ice.....	102
Figure B-37 Tabular Representation of Parking Nomograph for C-17 on 28 °F (-2 °C)	
Sea Ice.....	103
Figure B-38 Tabular Representation of Parking Nomograph for B767-300ER on -4 °F (-20 °C) Sea Ice.....	104

Figure B-39 Tabular Representation of Parking Nomograph for B767-300ER on -2 °F (-19 °C) Sea Ice.....	105
Figure B-40 Tabular Representation of Parking Nomograph for B767-300ER on 0 °F (-17.5 °C) Sea Ice.....	106
Figure B-41 Tabular Representation of Parking Nomograph for B767-300ER on 2 °F (-16.5 °C) Sea Ice.....	107
Figure B-42 Tabular Representation of Parking Nomograph for B767-300ER on 4 °F (-15.5 °C) Sea Ice.....	108
Figure B-43 Tabular Representation of Parking Nomograph for B767-300ER on 6 °F (-14 °C) Sea Ice.....	109
Figure B-44 Tabular Representation of Parking Nomograph for B767-300ER on 8 °F (-13 °C) Sea Ice.....	110
Figure B-45 Tabular Representation of Parking Nomograph for B767-300ER on 10 °F (-12 °C) Sea Ice.....	111
Figure B-46 Tabular Representation of Parking Nomograph for B767-300ER on 12 °F (-11 °C) Sea Ice.....	112
Figure B-47 Tabular Representation of Parking Nomograph for B767-300ER on 14 °F (-10 °C) Sea Ice.....	113
Figure B-48 Tabular Representation of Parking Nomograph for B767-300ER on 15 °F (-9.5 °C) Sea Ice.....	114
Figure B-49 Tabular Representation of Parking Nomograph for B767-300ER on 16 °F (-9 °C) Sea Ice.....	115
Figure B-50 Tabular Representation of Parking Nomograph for B767-300ER on 17 °F (-8 °C) Sea Ice.....	116
Figure B-51 Tabular Representation of Parking Nomograph for B767-300ER on 18 °F (-7.5 °C) Sea Ice.....	117
Figure B-52 Tabular Representation of Parking Nomograph for B767-300ER on 19 °F (-7 °C) Sea Ice.....	118
Figure B-53 Tabular Representation of Parking Nomograph for B767-300ER on 20 °F (-6.5 °C) Sea Ice.....	119
Figure B-54 Tabular Representation of Parking Nomograph for B767-300ER on 21 °F (-6 °C) Sea Ice.....	120
Figure B-55 Tabular Representation of Parking Nomograph for B767-300ER on 22 °F (-5.5 °C) Sea Ice.....	121
Figure B-56 Tabular Representation of Parking Nomograph for B767-300ER on 23 °F (-5 °C) Sea Ice.....	122
Figure B-57 Tabular Representation of Parking Nomograph for B767-300ER on 24 °F (-4.5 °C) Sea Ice.....	123
Figure B-58 Tabular Representation of Parking Nomograph for B767-300ER on 25 °F (-4 °C) Sea Ice.....	124
Figure B-59 Tabular Representation of Parking Nomograph for B767-300ER on 26 °F (-3.5 °C) Sea Ice.....	125
Figure B-60 Tabular Representation of Parking Nomograph for B767-300ER on 27 °F (-2.5 °C) Sea Ice.....	126
Figure B-61 Tabular Representation of Parking Nomograph for B767-300ER on 28 °F (-2 °C) Sea Ice.....	127
Figure B-62 Locations for Surface Properties Measurements.....	137
Figure B-63 Sample Field Data Sheet (Configured for DCP Measurements).....	138

Figure B-64 Pegasus Site Plan .....	139
Figure B-65 Pegasus Apron Layout .....	140
Figure B-66 Pegasus Town Complex.....	141
Figure B-67 McMurdo Sound Site Plan .....	143
Figure B-68 McMurdo Sound Apron Layout .....	144
Figure B-69 McMurdo Sound Town Layout.....	145
Figure B-70 McMurdo Sound C-17 Deflection Monitoring Plan.....	146
Figure C-1 Dynamic Cone Penetrometer (DCP) .....	154
Figure C-2 Russian Snow Penetrometer (RSP) .....	156

## **TABLES**

Table 2-1 Runway Dimensional Requirements for C-130, LC-130 and C-17 Operations	6
Table 2-2 Runway Overrun and End Clear Area Requirements for C-130, LC-130, and C-17 Operations.....	11
Table 2-3. Taxiway Dimensional Requirements for C-130, LC-130, and C-17 Operations .....	12
Table 2-4. Apron Requirements for LC-130, C-130 and C-17 Operations.....	14
Table 2-5 NAVAIDS .....	34
Table B-1 Minimum Snow Strength Required for White Ice Pavement .....	56

**FC 3-260-06F**  
**1 June 2015**

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## **CHAPTER 1 INTRODUCTION**

### **1-1 PURPOSE.**

#### **1-1.1 Facilities Criteria**

This Facilities Criteria (FC) provides design, construction, and maintenance details, dimensional criteria, and structural evaluation criteria for compacted snow and/or ice runways used by wheeled aircraft. Three potential surface conditions are considered:

- Wheeled aircraft operations on glacial ice
- Wheeled aircraft operations on white ice (glacial ice capped with processed snow)
- Wheeled aircraft operations on sea ice

The dimensional criteria are the same for all surfaces. Although these criteria were developed from operational experience on the airfields at McMurdo Station, Antarctica, the concepts are generally applicable to any runway composed of glacial ice, white ice, or sea ice. Appendices B-12 and B-13 provide drawings of the layout of an operational glacial ice airfield which includes a skiway and sea ice airfield located on the Ross Ice Shelf and McMurdo Sound, Antarctica.

**Note:** The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this FC does not imply endorsement by the U.S. Air Force.

#### **1-1.2 U.S. Antarctic Program.**

The airfields in Antarctica are operated by the U.S. Antarctic Program (USAP) and primarily support Air Force aircraft. Three airfields have been used at McMurdo Station and one skiway has been maintained at the South Pole Station.

##### **1-1.2.1 Williams Field Skiway.**

Williams Field is located in an area that receives heavy annual snowfall and is built in an area with a deep snow layer overlying the Ross Ice Shelf. The Williams Field skiway is comprised of a compacted snow surface. This FC does not apply to Williams Field skiway or other skiways. See AFI 13-217 for skiway criteria.

##### **1-1.2.2 Pegasus Glacial Ice Runway.**

Starting in 1993, the Pegasus airfield supported C-130 Hercules and C-141 Starlifter aircraft from an exposed glacial ice surface. In 2002 a compacted snow surface ("white ice") was placed over the glacial ice and C-130, C-141, and C-17 Globemaster III aircraft have since performed routine operations from this white ice surface.

**1-1.2.3 Sea Ice Runway.**

The sea ice runway on McMurdo Sound has previously supported C-130, C-141, C-5, and C-17 aircraft. For many years C-130 and C-17 aircraft have completed routine operations from an exposed graded sea ice surface. Since 2002, they have occasionally operated on a sea ice surface overlain by either a moderately processed thin snow cap or a thin layer of fresh, loose snow.

**1-1.2.4 South Pole Skiway.**

The skiway at South Pole Station is a high-altitude skiway constructed on compacted snow. It is served only by LC-130 and other ski-equipped aircraft. See AFI 13-217 for skiway criteria.

**1-2 APPLICATION.**

This FC applies to all Department of Defense (DOD) organizations responsible for design, construction, maintenance, and evaluation of snow and/or ice airfields.

**1-2.1 McMurdo Station Operations.****1-2.1.1**

It is anticipated that all of the field measurements and data collection prescribed in this FC can and will be accomplished by knowledgeable personnel within the USAP and deployed to Antarctica as part of their occupational performance. This does not preclude Air Force certification teams traveling to McMurdo Station to complete an evaluation; however, due to the logistics, coordination, cost, and uncertain nature of travel to and work in Antarctica, it is more likely that the USAP McMurdo Area airfield manager will be responsible for following all FC requirements for data collection.

**1-2.1.2**

Only Headquarters Air Mobility Command (HQ AMC) can determine the suitability of the airfield for operations of HQ AMC aircraft. It will be the USAP McMurdo Area airfield manager's responsibility to deliver all data and measurements, in the format prescribed in this FC, to the HQ AMC/A7OI contact (see paragraph 1-3) or designee. HQ AMC/A7OI will review the submittal and communicate its findings and decisions back to the airfield manager, who will be responsible for any remedial actions, waiver requests, and communicating the airfield status (e.g., open, closed, open with restrictions) to all impacted operational elements. When HQ AMC/A7OI determines that the airfield meets the criteria specified in this FC, HQ AMC/A3AS will be notified, and, in turn, will ensure HQ AMC/A3 provides approval for aircraft operations.

**FC 3-260-06F**  
**1 June 2015**

**1-3 POINTS OF CONTACT.**

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**FC 3-260-06F**  
**1 June 2015**

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## **CHAPTER 2 CRITERIA**

### **2-1 DIMENSIONAL CRITERIA.**

Details for establishing airfields for the support of routine operations of Air Force aircraft can be found in UFC 3-260-01. Snow and ice runways in the Antarctic region are unique in a number of ways (e.g., seasonal operation only; low volume of air traffic; extremely remote location; sited on a level, “featureless” ice shelf; limited resources available for construction and maintenance). The criteria are based for the most part on Class B runway requirements; however, some terminology used in this FC differs from that used in UFC 3-260-01. Figures 2-1 and 2-2 show the typical layout, including shoulders, lateral clear area, and end clear area.

#### **2-1.1 Runways.**

Table 2-1 provides dimensional criteria for the layout and design of snow and ice runways. Minimum runway length shall be 3050 meters (10,000 feet) for fully loaded C-17 aircraft operations and 2440 meters (8000 feet) for fully-loaded C-130 aircraft unless otherwise directed by the major command (MAJCOM) Director of Operations (A3).

#### **2-1.2 Runway Shoulders.**

Shoulders are required along each outside edge of the runway. They must be prepared to the same strength as the runway surface (and be of the same surface material: glacial ice, white ice, compacted snow, or sea ice) and be free of obstacles. Shoulder geometric requirements are presented in Table 2-1. Because the shoulders are constructed to the same strength as the runway surface, C-130s and LC-130s can use the shoulders for turnarounds. However, to prevent the need for very sharp turns and potential damage to the runway surface, C-17s will not use shoulders for turns and instead turn around at widened runway ends, as shown in Figure 2-3.

#### **2-1.3 Runway Graded Area.**

A graded area is required adjacent to the runway shoulder. It is not considered a full-strength area for supporting aircraft; however, it is sloped approximately the same as the shoulder, as described in Table 2-11. Marker flags are installed within the graded area.

**Table 2-1 Runway Dimensional Requirements for C-130, LC-130 and C-17 Operations**

Item No.	Description	Requirement	Remarks
1	Length (minimum)	See Remarks	Minimum runway length will be determined by the MAJCOM/A3 for the most critical aircraft in support of the mission.
2	Width	46 m (150 ft)	Since snow and ice runways are devoid of traditional painted surface markings, the runway will appear to be 64 m (210 ft) wide – the distance between the inner marker flags.
3	Width of shoulders (minimum)	7.6 m (25 ft)	Remove all snow berms and snow drifts in shoulder areas. All glacial ice, white ice, compacted snow and sea ice in shoulders shall be prepared to required runway strength standards.
4	Longitudinal grade	2% maximum (up or down)	The maximum grade of any tangent, as well as the total elevation change from one threshold of the runway to the other, shall not exceed 2%.
5	Longitudinal grade change	No grade change greater than 0.5% is to occur within 300 m (1000 ft) from the runway end	Hold to minimum practicable. Grades may be both positive and negative but must not exceed the limit specified. Applies to runway and shoulders.

Item No.	Description	Requirement	Remarks
6	Rate of longitudinal grade change	Maximum 0.167% per 30.5 m (100 ft)	<p>Grade changes will be held to a minimum and will be gradual. Application of this criterion will produce a vertical curve having a 182.9 m (600 ft) length for each percent of algebraic difference between the two grades. Minimum distance between grade changes is 61 m (200 ft). Grade changes cannot exceed 1.5% measured at 61-m (200-ft) intervals. Applies to runway and shoulders.</p> <p><b>Note:</b> In addition to these grade requirements, the runway shall be checked for high-frequency, low-amplitude undulations that degrade rideability and may decrease aircraft stopping performance. Any dips, rises or "chatter" shall be noted and corrected by fine-grading and re-compacting the surface.</p>
7	Transverse slope of runway	1.5% maximum	Transverse slopes can be flat and uniform, or crowned at the centerline. A crowned centerline is preferred. Sea ice runway is flat.
8	Transverse slope of shoulders	2% max. down 1% max. up	For a glacial ice surface, shoulders shall slope down from the runway edge. A white ice surface may slope down at 2% maximum or up at 1% maximum. Sea ice shoulders are flat.
9	Width of graded area	Minimum 12.2 m (40 ft)	The graded area is measured from the outside edge of the shoulder. Graded area will routinely have no more than 25 mm (1 in) of loose snow cover. (During clean-up following a drifting event, snow up to 300 mm [12 in] may exist immediately adjacent to runway markers while the runway proper and the shoulders are being maintained to the 25 mm (1 in) standard in order to resume critical flight operations. As soon as practicable, any drift snow in the graded area must be removed to maintain the overall runway standard.)

<b>Item No.</b>	<b>Description</b>	<b>Requirement</b>	<b>Remarks</b>
10	Transverse slope of graded area	2% maximum (up or down)	Ideally, graded area slope (up or down) will match that of runway shoulders.
11	Width of lateral clear area	79.5 m (260 ft)	The lateral clear area is measured outward from the outside edge of the graded area.
12	Transverse slope of lateral clear area	12% maximum (up)	Requirement is applied to imaginary plane extending from the outer edge of the graded area outward a distance of 79.5 m (260 ft). No object or surface feature may penetrate this imaginary plane.
13	Width of primary surface	244 m (800 ft)	Centered on the runway centerline and incorporates the runway, shoulder, graded area, and lateral clear area. No fixed or mobile objects may be located in this area unless the item is fixed by function and therefore a permissible deviation.
14	Distance between centerlines of parallel runways	305 m (1,000 ft)	Visual flight rules (VFR) without intervening parallel taxiway between the parallel runways. One of the parallel runways must be a VFR-only runway.
		633 m (2,075 ft)	VFR with intervening parallel taxiway.
		762 m (2,500 ft)	Instrument flight rules (IFR) using simultaneous operation (depart-depart) (depart-arrival).
		1311 m (4,300 ft)	IFR using simultaneous approaches.
15	Width of USAF mandatory zone of frangibility	152.5 m (500 ft)	Centered on the runway centerline. All items sited within this area must be frangible.
16	Length of USAF mandatory zone of frangibility	1829 m (6,000 ft)	Centered on the runway. All items sited within this area to the ends of the end clear zone must be frangible.



Figure 2-1 Typical Runway Layout for Bi-Directional Operations (Not to Scale)

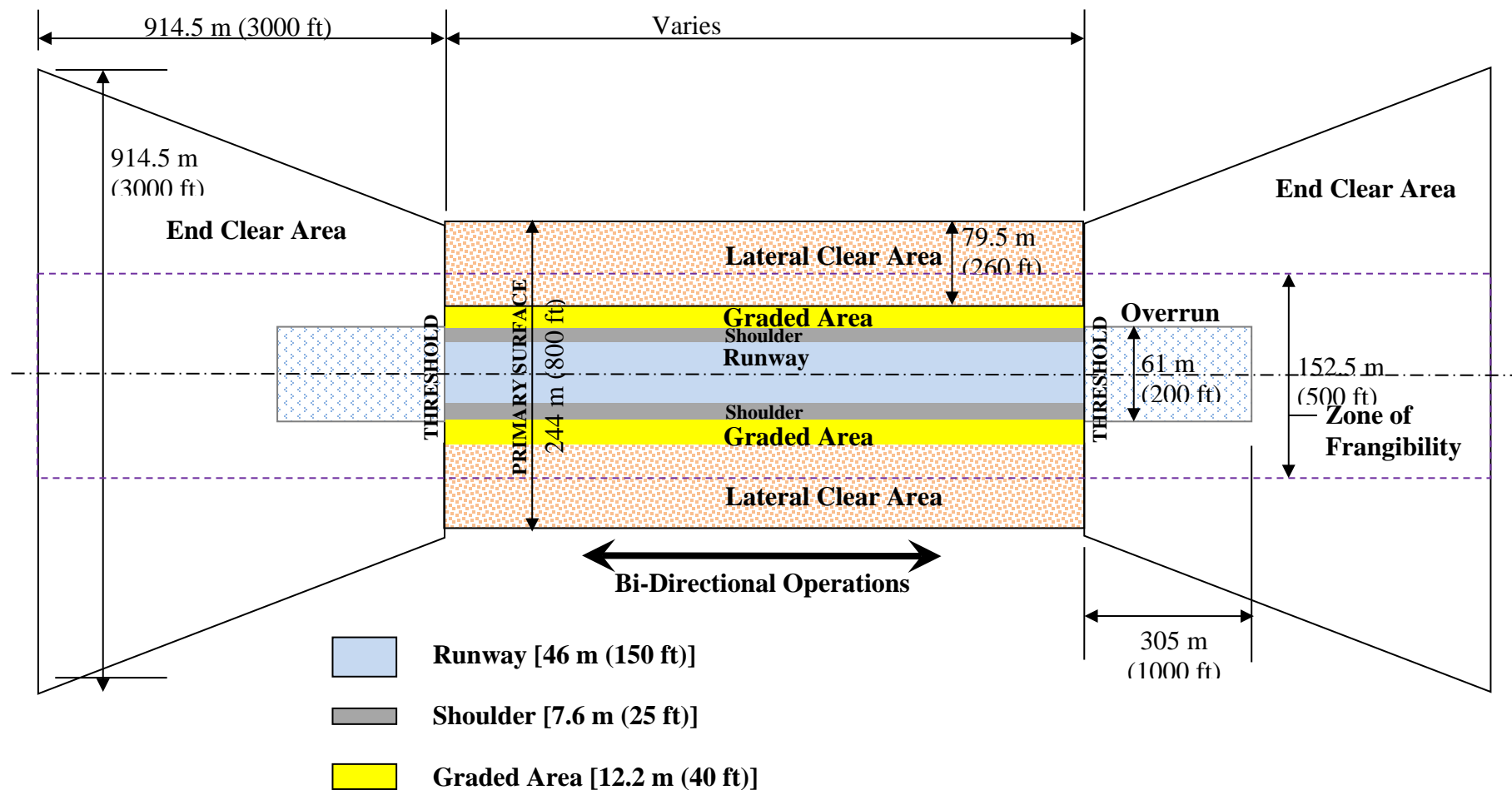
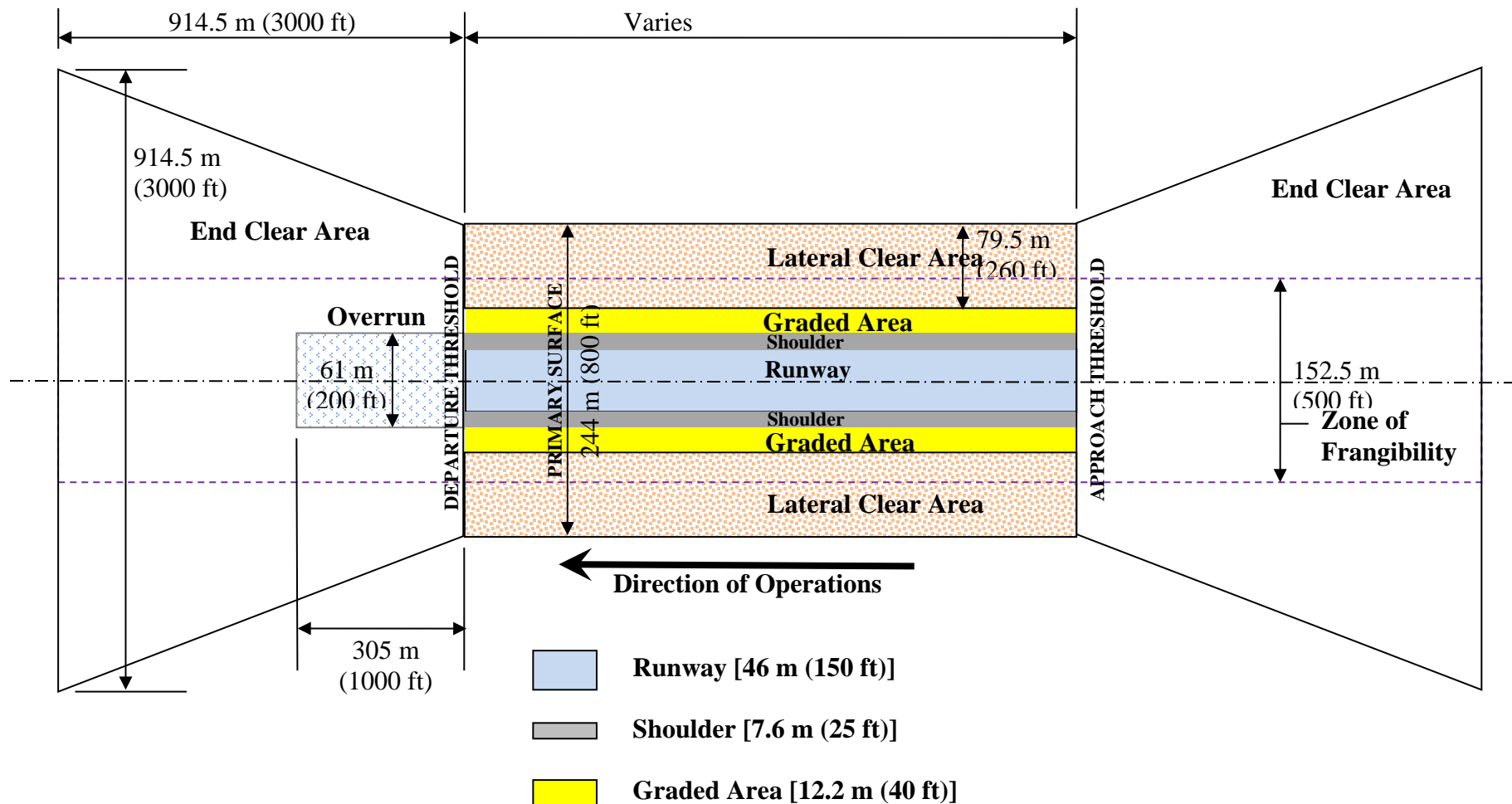


Figure 2-2 Typical Runway Layout for Uni-Directional Operations (Not to Scale)



**2-1.4 Overruns.**

Overrun geometric requirements are presented in Table 2-2. The overrun must be constructed to the same structural standards as the runway surface. For bi-directional operations, an overrun must be provided at both ends. For uni-directional operations, an overrun is only required at the departure end of the runway.

**2-1.5 Clear Areas.**

Runway end clear areas are required and their dimensions are given in Table 2-2. The layout is shown in Figures 2-3 and 2-4. Clear areas must be free of fixed or mobile objects that are not specifically identified and positioned as described in this FC.

**Table 2-2 Runway Overrun and End Clear Area Requirements for C-130, LC-130, and C-17 Operations**

Item No.	Description	Requirement	Remarks
1	End clear area length	914.5 m (3000 ft)	Measured along the extended runway centerline. Begins at the runway threshold.
2	End clear area width at inner edge	244 m (800 ft)	Centered about runway centerline at the threshold.
3	End clear area width at outer edge	914.5 m (3000 ft)	Centered about runway centerline at 914.5 m (3000 ft) from centerline.
4	Overrun length	305 m (1000 ft)	The runway overrun area falls within the runway end clear area. The maximum longitudinal grade (up or down) in the overrun area is 2%.
5	Overrun width	61 m (200 ft) (Runway surface + shoulders)	The overrun area will have a transverse section matching the runway (i.e., include shoulder, graded area, and lateral clear area). See Table 2-1 for transverse dimensional criteria. The longitudinal grade of the first 91.5 m (300 ft) of the overrun shall match the grade of the last 914.5 m (3000 ft) of the runway.
6	Overrun longitudinal grade	Max. 2%	Up or down.

Item No.	Description	Requirement	Remarks
7	Approach-departure clearance surface	50:1	Approach-departure clearance surface begins at the runway thresholds at the same elevation as the centerline elevation and extends away from the runway 7620 m (25,000 ft). During flight operations, no mobile or fixed object may penetrate this imaginary plane.

**2-1.6 Taxiways.**

Dimensional criteria for taxiways are given in Table 2-3. Taxiways (including shoulders) will have surface strength properties matching those of the runway.

**Table 2-3. Taxiway Dimensional Requirements for C-130, LC-130, and C-17 Operations**

Item No.	Description	Requirement	Remarks
1	Width	23 m (75 ft) minimum	Since the taxiway is devoid of traditional surface markings, it will appear to be 38.5 m (125 ft) wide (the combined width of the taxiway and the shoulders).
2	Centerline radius of turns (C-130, C-17)	30.5 m (100 ft) minimum	Curves in taxiway must be no tighter than the listed minimum turning radii, measured along the taxiway centerline. Edge of taxiway fillets at runway/taxiway/apron turns and/or intersections must be 46 m (150 ft) minimum radii.
3	Width of shoulder	7.6 m (25 ft)	Remove all snow berms and snow drifts in shoulder areas. Glacial ice, white ice, and sea ice in shoulders will be prepared to the same strength as the taxiway.

Item No.	Description	Requirement	Remarks
4	Longitudinal grade	3% maximum	Hold to minimum practicable. Grades may be either positive or negative. Applies to taxiway and shoulders.
5	Rate of longitudinal grade change	1% maximum over 30.5 m (100 ft)	Grade changes will be held to a minimum and will be gradual. Minimum distance between grade changes is 152.5 m (500 ft). Grade changes cannot exceed 1% measured at 30.5-m (100-ft) intervals. Applies to taxiway and shoulders.
6	Transverse slope of taxiway	3% maximum	Transverse slopes can be flat, uniform, or crowned at the centerline (crowned centerline is preferred).
7	Transverse slope of shoulders	3% maximum	An exposed glacial ice surface shall slope down from the taxiway edge. A white ice surface may slope upward to a maximum extent of 1%. A sea ice surface will be flat.
8	Runway-taxiway separation	93 m (305 ft)	Measured from the runway centerline to the parallel taxiway centerline.
9	Hold position	76.5 m (250 ft)	Measured from the runway centerline.
10	Infield area		All areas located between the runway and taxiways must be cleared of obstructions not fixed by function.
11	Clearance to fixed or mobile obstacles	61 m (200 ft)	Measured from the taxiway centerline.
12	Width of lateral clear area	42 m (137.5 ft)	Lateral clear area is measured outward from the outer edge of the shoulder. No object or surface feature may penetrate this imaginary plane.

Item No.	Description	Requirement	Remarks
13	Transverse slope of lateral clear area	12% maximum (up)	Requirement is applied to imaginary plane extending from the outer edge of the shoulder outward a distance of 79.5 m (260 ft). No object or surface feature may penetrate this imaginary plane.

### 2-1.7 Aprons.

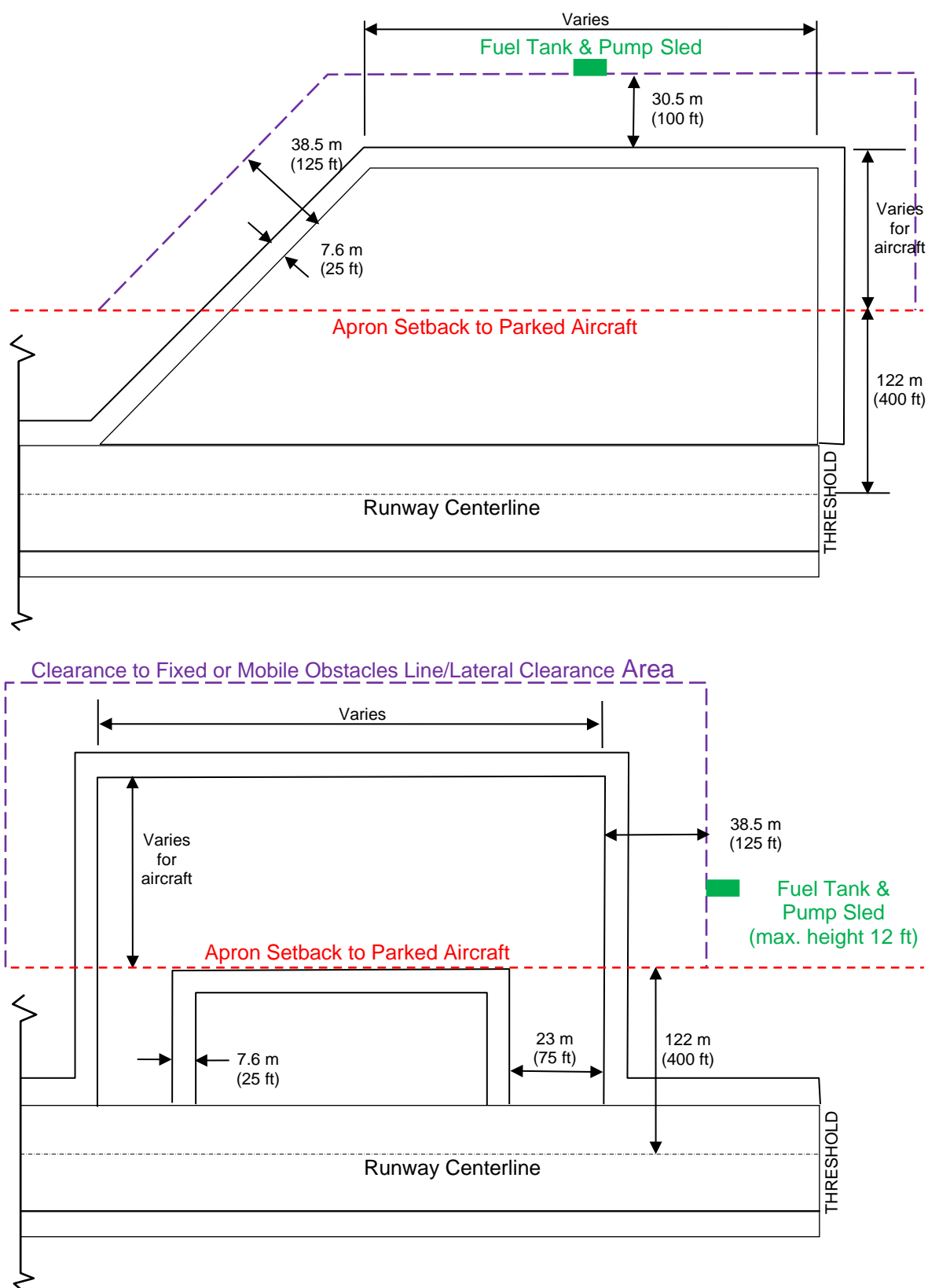
Dimensional criteria for aprons are given in Table 2-4 and plan views of suggested apron configurations are provided in Figure 2-3. Aprons will have surface strength properties matching those of the runway. An apron, parking area, or parallel taxiway is **required** if maximum on ground (MOG) will be greater than one aircraft.

**Table 2-4. Apron Requirements for LC-130, C-130 and C-17 Operations**

Item No.	Description	Requirement	Remarks
1	Apron size	Varies	Sized to accommodate number of aircraft on ground. Maximum visibility and minimum wingtip clearance must be maintained at all times. As a minimum, the pilot must be able to clearly see all parked aircraft when taxiing.
2	Apron grade	3% maximum	Ideally, uniform grade will exist over entire apron area.
3	Width of shoulder	7.6 m (25 ft)	Remove all snow berms and snow drifts in shoulder areas. Snow in shoulders will be prepared to the same strength as the apron.
4	Transverse slope of shoulders	3% maximum (down) 1% maximum (up)	An exposed glacial ice surface shall slope down from the apron edge. A white ice or compacted snow surface may slope upward to a maximum extent of 1%. Sea ice shoulders are flat.
5	Apron setback	122 m (400 ft)	Measured from the runway centerline to the near edge of the parking apron.

<b>Item No.</b>	<b>Description</b>	<b>Requirement</b>	<b>Remarks</b>
6	Clearance to fixed or mobile obstacles	38.5 m (125 ft)	Measured from the outer edge of the apron.
7	Width of lateral clear area	30.5 m (100 ft)	Lateral clear area is measured outward from the outer edge of the shoulder. No object or surface feature may penetrate this imaginary plane.
8	Transverse slope of lateral clear area	12% maximum (up)	Requirement is applied to imaginary plane extending from the outer edge of the shoulder outward a distance of 79.5 m (260 ft). No object or surface feature may penetrate this imaginary plane.
9	Wingtip clearance	15.2 m (50 ft)	Parked and taxiing aircraft must maintain 15.2 m (50 ft) wingtip clearance from obstructions at all times. Applies to parked aircraft as well as peripheral and internal taxilanes.
10	Centerline radius of turns	46 m (150 ft)	Lay out apron parking positions and taxi lanes to provide ample distance for aircraft to align properly in the parking position. Larger radii are needed on aprons because there are very few visual cues on the snow/ice surface for pilots to steer. In addition, sharp turns on loaded LC-130 skis are very difficult to execute.

Figure 2-3 Typical Layout Arrangements for Taxiways and Aprons (Not to Scale)

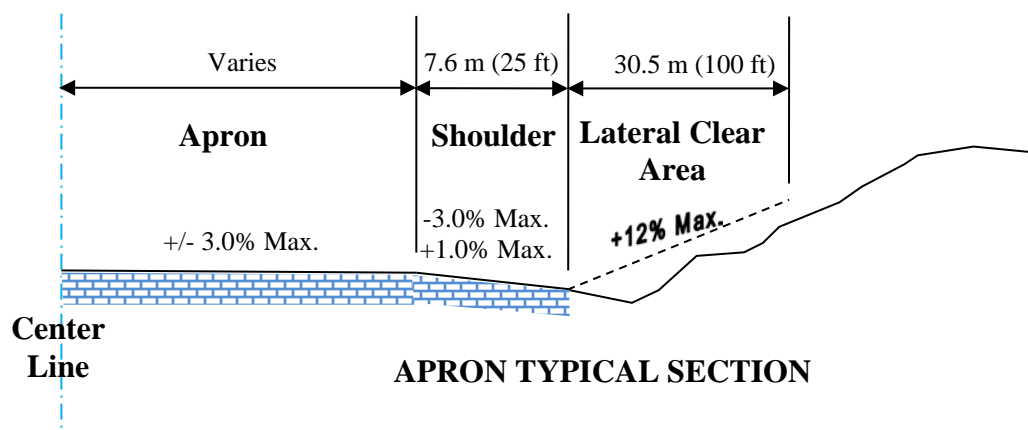
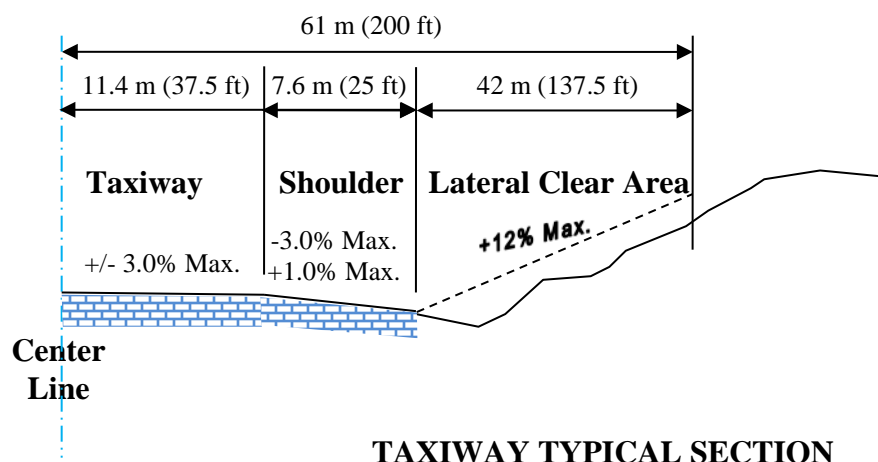
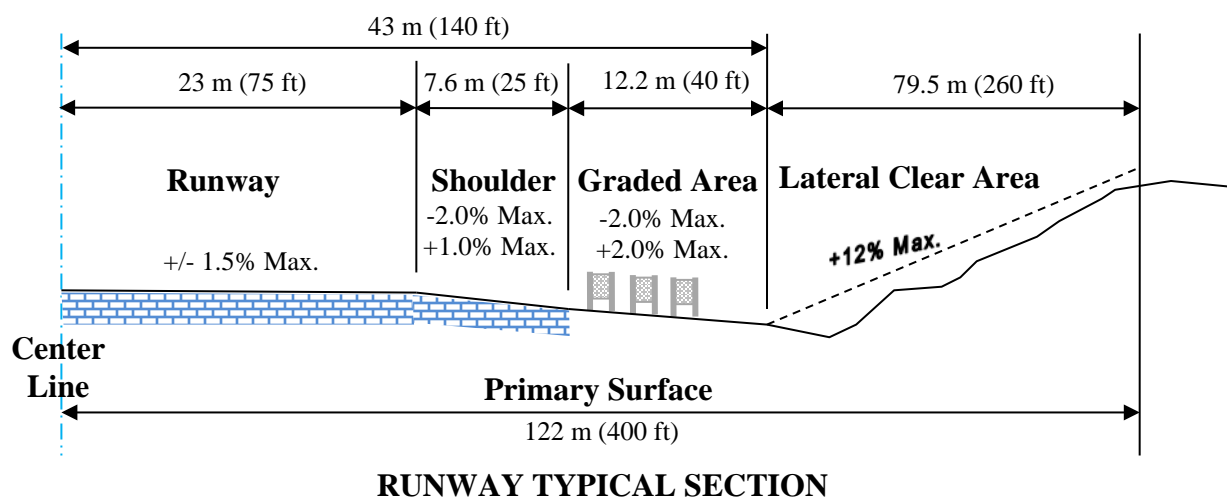




**2-1.8 Typical Sections.**

Cross-section views of the runway, taxiway, and apron, showing the dimensions from Tables 2-1, 2-2, and 2-3, are shown in Figure 2-4.

**Figure 2-4 Typical Cross-Section Dimensions for Runway, Taxiway, and Apron (Not to Scale)**



## **2-2 SNOW/ICE SURFACE CONSTRUCTION, MAINTENANCE, AND STRUCTURAL EVALUATION CRITERIA.**

### **2-2.1 New Runway Construction.**

Construction of a new glacial ice runway is described in CRREL Monograph 98-1. For additional criteria on new construction, contact the individuals listed in paragraph 1-3.

### **2-2.2 Preparation for Initial Seasonal Use.**

#### **2-2.2.1 White Ice Runway Surface.**

##### **2-2.2.1.1 WinFly.**

Prior to WinFly, the white ice runway surface will be graded smooth to remove drifts and snow accumulated during the austral winter. After grading and rolling, marker flags or cones will be installed as needed to support the WinFly flights.

##### **2-2.2.1.2 Mainbody Flying.**

Prior to Mainbody flying, the runway surface will be surveyed longitudinally and with transverse cross-sections to identify areas that do not meet the grading criteria stipulated in Tables 2-1 and 2-2. Bulldozers, snow blowers, and graders will be used to cut down slopes and place new snow on the runway surface where the snow cap is too thin. Some grading and dragging between roller passes may be required to make the surface smooth. After compaction is complete and strength testing has passed requirements, all marker flags will be installed per the requirements in paragraph 2-3.5.

#### **2-2.2.2 Sea Ice Runway Surface.**

Prior to initial use, clear the sea ice runway of loose snow to expose the sea ice. Check the surface for unacceptable roughness or undulations and serrate the surface with a grader blade, as needed, to smooth out the surface. In addition, fresh water may be added to the surface and allowed to freeze to fill in rough areas. Survey transverse cross-sections to verify snow moved off the runway surface does not conflict with the lateral clear area slope requirements. See the patching procedure in Appendix B-3 for additional repair criteria.

### **2-2.3 Maintenance During Use.**

Ice irregularities, often hidden by snow cover, can do significant damage to wheels when struck at any speed. Surface preparation must include a thorough visual inspection of the landing area to look for ice irregularities and study snow depths and characteristics. Any unacceptable irregularities must be removed. Snow irregularities may be large enough to require the entire surface to be dragged or graded to fill low areas and remove high areas. All undulating surfaces must be graded to minimize the slope and prevent wheel damage.

**2-2.3.1 White Ice Runway Surface.**

The runway surface must be inspected following every wheeled aircraft operation. Any areas with rubber or soot deposits must be scarified and contaminated snow/ice removed to eliminate any dark material that can absorb sunlight and result in melting the surface. Between C-17 operations and after any snowfall deposits the entire surface shall be rolled with the proof load cart to keep the compacted white ice cap well compacted. When needed, thin lifts of snow may be cut from the berms on either lateral clear area and dragged onto the white ice runway surface then compacted with the proof load cart.

**2-2.3.1.1**

Maintaining the compacted snow surface will require periodic dragging to remove surface irregularities created by wind action (sastrugi) and to promote ice crystal deformation to harden the loose surface snow. Various types of drag devices have been successfully used. The compacted snow surface will be dragged immediately after fresh snow accumulation, windstorms, or when landings/takeoffs or cargo loading operations have disturbed the surface. Regular inspections by the airfield manager or a designated representative and pilot reports will determine if dragging or other maintenance action is required.

**2-2.3.1.2**

Aprons shall be groomed to harden the surface prior to supporting cargo loading operations.

**2-2.3.2 Sea Ice Runway Surface.**

New snow accumulation on the sea ice runway shall be either removed or compacted, depending on the depth. Thin lifts of snow can be compacted (25 millimeters [1 inch] or less compacted thickness) onto the runway surface with the proof load cart. This improves the friction and braking action on the runway.

**2-2.4 Runway Strength Evaluation.**

Annually, before commencing aircraft operations, the airfield surfaces will be evaluated following the structural evaluation criteria outlined in Appendices B-4 through B-11. In addition, the airfield manager is responsible for interim evaluations as conditions change and as repairs are made. All structural data and recommendations for weight-bearing capacity shall be transmitted to HQ AMC/A7OI for analysis and concurrence. See paragraph 2-6 for airfield certification procedures.

**2-2.4.1 Glacial Ice Operating Surface.**

The glacial ice surface must be evaluated for three failure modes: deformation, creep, and flexural. Methods for evaluating each mode are described in Appendix B-4.

#### **2-2.4.2 White Ice Operating Surface.**

The white ice surface must be evaluated for thickness and strength to avoid deformation failure. Methods for evaluating the white ice surface are described in Appendix B-5.

#### **2-2.4.3 Sea Ice Operating Surface.**

##### **2-2.4.3.1**

Sea ice is often categorized as first-year or multi-year ice. This characterization of the ice indicates much about its nature, with multi-year ice having significantly greater complexity. However, for the purposes of a sea ice runway for heavy wheeled aircraft, this FC treats both types the same, using overall ice thickness and ice temperature as governors for ice strength, which ultimately determines its ability to support a given aircraft operation.

##### **2-2.4.3.2**

The sea ice surface must be evaluated for three failure modes: deformation, flexural (landing and takeoff), and creep (parking). Methods for evaluating each mode are described in Appendix B-6.

#### **2-2.5 Warm Weather Operations at Pegasus White Ice Runway.**

Warm weather, typically occurring during the months of December and January, could restrict airlift operations on Pegasus white ice runway, requiring all aircraft to arrive and depart during restricted hours. The USAP will develop procedures for conducting airfield operations in warm weather to include monitoring, testing, and reporting requirements. The airfield manager is responsible for implementing the procedures.

### **2-3 AIRFIELD MARKINGS.**

#### **2-3.1 Airfield Marking Approach**

Many snow/ice runways are VFR-only facilities and operated solely during daylight. However, due to their unconventional appearance (white surface, white surroundings), for compatibility with standard pilot experience, and for periods where landings are required but weather conditions are less than ideal, a minimum level of markings are required. The use of markings has evolved over the years and is expected to continue into the future. This FC does not address markings needed for night operations or skiways. See AFI 13-217 for skiway marking requirements.

#### **2-3.2 Specific Requirements**

Adopting the full extent and type of markings found at a conventional airfield is impractical for a snow/ice runway. Painted markings will degrade the snow/ice and quickly be covered by blowing snow or new snowfall. Conventional airfield directional signs will be quickly buried by snow. Sometimes other visual aids (lights) and electronic signals (navigational aid systems [NAVAIDS]) are available to assist with acquiring and

lining up on the runway; therefore, a system of flags is used to indicate the limits of the runway. Required and optional markers are listed below.

Threshold markers	Required
Distance remaining and edge markers	Required
Approach line markers	Optional
Taxiway and apron flagging	Optional

### **2-3.3 Marking Criteria**

Minimizing the number and surface area of markings is desirable for the purpose of reducing runway maintenance and increasing runway availability and longevity. Figure 2-5 shows the layout of a typical snow/ice runway, including the positions of threshold, distance remaining, and approach line markers. All markers will be made of durable, lightweight materials. Support posts must be frangible and present a tiny cross-section to the wind to minimize snow drifting, which will be accomplished by a minimum number of posts; bamboo canes are currently used with good results. The markers are ideally of a mesh material to minimize the impedance of the wind, both to limit wind loading on the support posts and, more importantly, to reduce snow drifting. Ideally, the base of a marker shall be more than 0.3 meter (1 foot) above the snow surface to avoid snow drifting. This height must be balanced against the need for adequate clearance between the base of an aircraft wing, engine, or propeller and the top of the marker. Currently, black or red fabric is used for marker flags. White numbers on the black fabric are used for distance-remaining markers. Flags without numbers are punched with up to five 50-millimeter (2-inch) -diameter holes to reduce wind resistance and bending force in the support posts. Note that all marker flags are well above the runway surface and that no surface markings are present to depict the runway centerline, shoulder edges, landing zone, or thresholds.

### **2-3.4 Temporary Markings**

On glacial ice, white ice, and compacted snow parking aprons, temporary markings are sometimes applied to guide aircraft to parking positions. Reflective orange or red paint can be sprayed on the apron surface just prior to arrival to indicate the nose gear centerline path and stop point. When the marking is no longer needed, it shall be quickly scarified to avoid absorbing sunlight radiation that can lead to melting of the surface.

### **2-3.5 Marker Flags**

Figure 2-6 shows details of the marker flags. Note that all markings are only present at the site during the flight periods. At all other times markers are removed from the site to discourage progressive snow accumulation.

## **2-3.6 Frangibility**

All structures placed or constructed within the airfield environment are required to be frangible (to the maximum extent practicable). This applies for any aboveground construction within 76.5 meters (250 feet) of the runway centerline and an extension of that dimension for 914.5 meters (3000 feet) beyond the ends of the runway thresholds and within 61 meters (200 feet) of the taxiway centerline (except required NAVAIDS). Frangibility implies that an object will collapse or fall over after being struck by a moving aircraft with minimal damage to the aircraft.

## **2-3.7 Low Visibility Markers.**

For operations during low-light or no-light periods, special high-intensity, retro-reflective and radar-detectable cones may be deployed at the locations shown in Figure 2-7. One type of suitable cone is manufactured by Reginald Bennett (RBI) International, Model Number 336.

### **2-3.7.1 Cone Dimensions and Characteristics.**

Cones will be shaped like a square-base pyramid. Cones will be minimum 790 millimeters (31 inches) tall and 610 millimeters (24 inches) wide at the base. Cones used for marking the landing zone boxes will have red and green sides. Cones used for marking the runway edge will be silver on all sides.

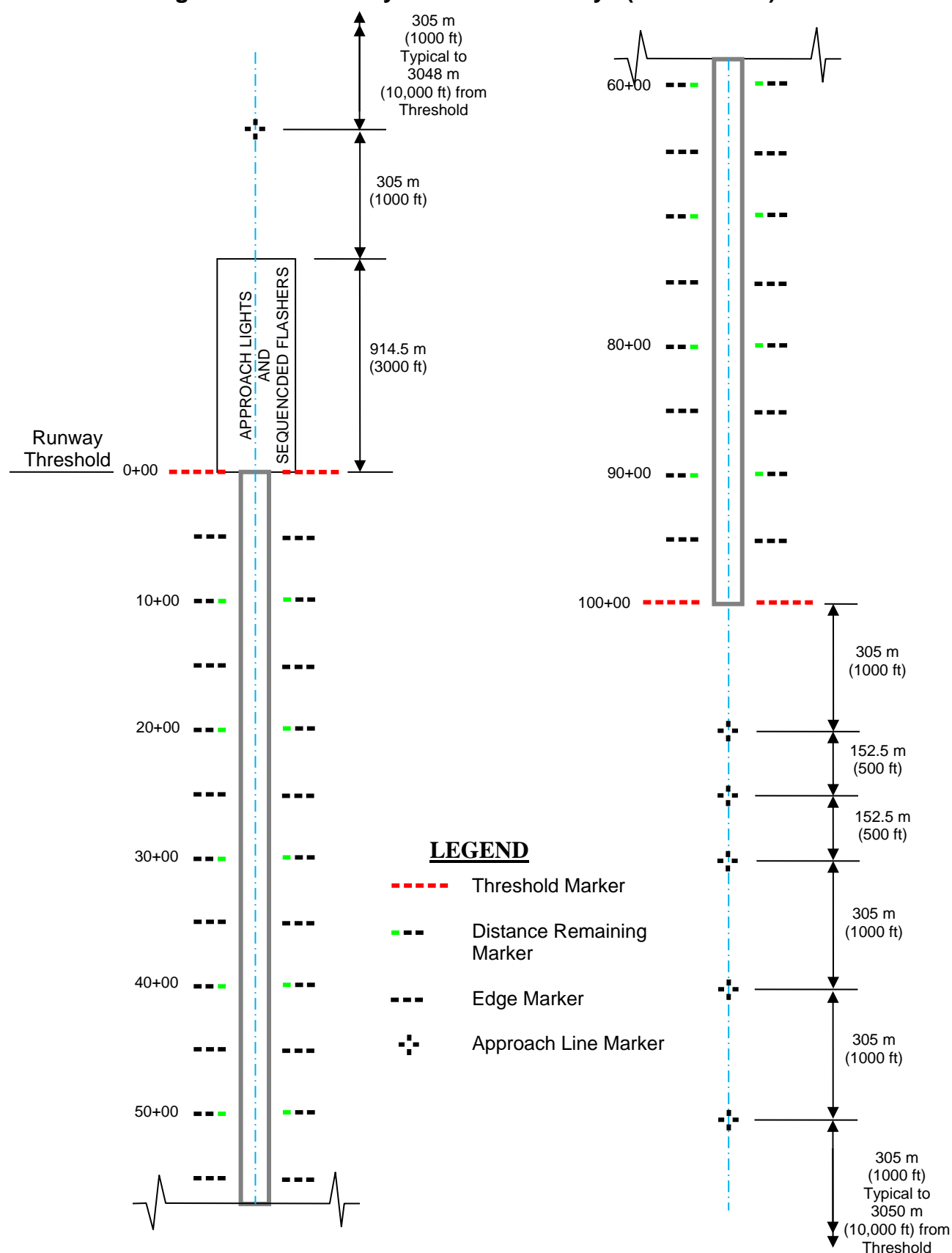
### **2-3.7.2 Cone Layout.**

Cones will be placed every 152.5 meters (500 feet) on each side of the runway next to the normal daytime flag markers (approximately 30.5 meters [100 feet] from centerline). The first 305 meters (1000 feet) of each approach end will have cones spaced 305 meters (1000 feet) apart with double cones to create a landing zone “box.” The cones shall be spaced laterally at a minimum of 1.8 meters (6 feet) apart to allow visual acquisition of two separate cones—any closer and they merge into one cone reflection. Two cones will be placed symmetrically about the centerline, spaced 1.8 meters (6 feet) apart at the departure end of the overrun.

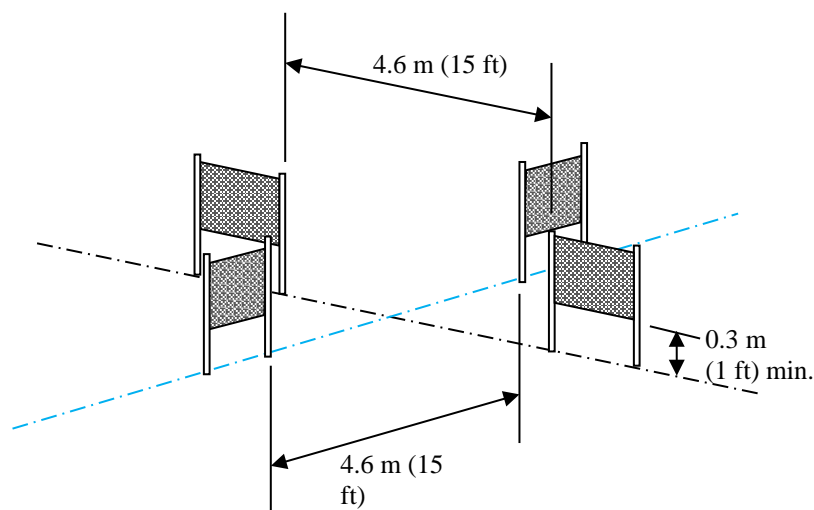
### **2-3.7.3 Cone Installation.**

Cones are secured to the ice runway using four lag screws, each 275 millimeters (11 inches) long and 9 millimeters (0.375 inch) in diameter, with 38-millimeter (1.5-inch) fender washers. Holes are pre-drilled in the ice, 6 millimeters (0.25 inch) in diameter and 300 millimeters (12 inches) deep.

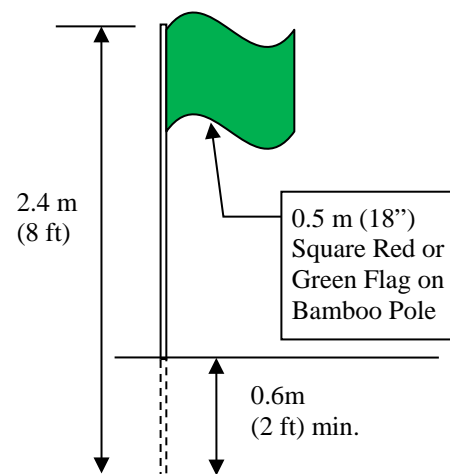
Figure 2-5 Marker Layout for Ice Runways (Not to Scale)



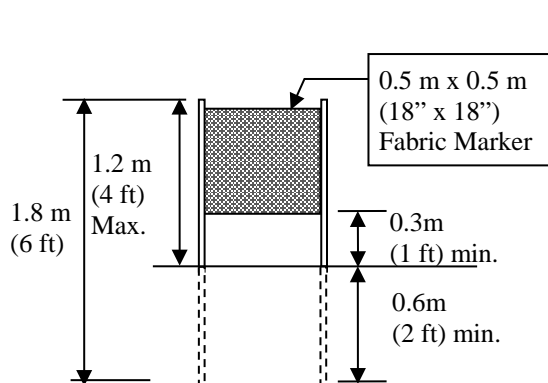
**Figure 2-6 Marker Details for Snow/Ice Runways**



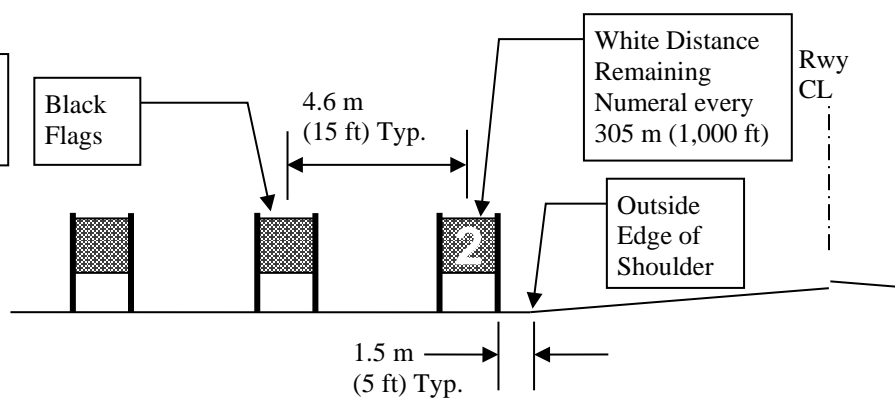
**Detail 1: Four Marker Configuration for Approach Lines**



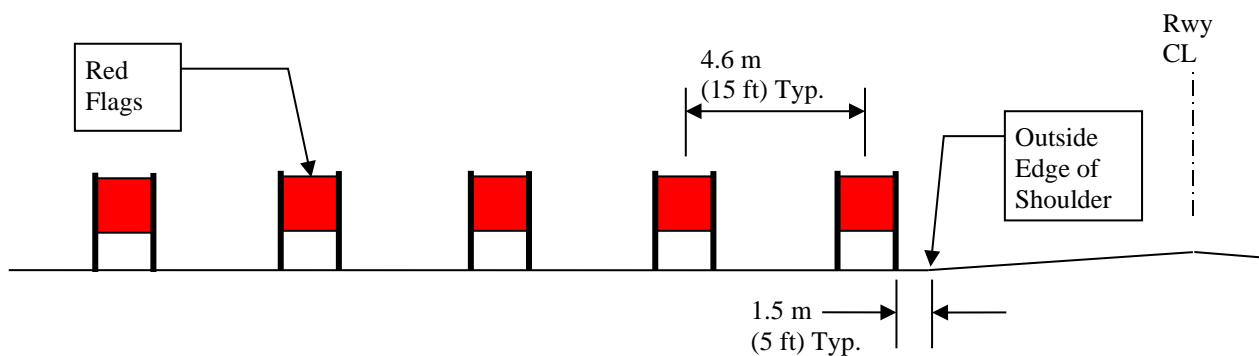
**Detail 2: Taxiway and Apron Marking Flags**



**Detail 3: Runway Marker Flags**



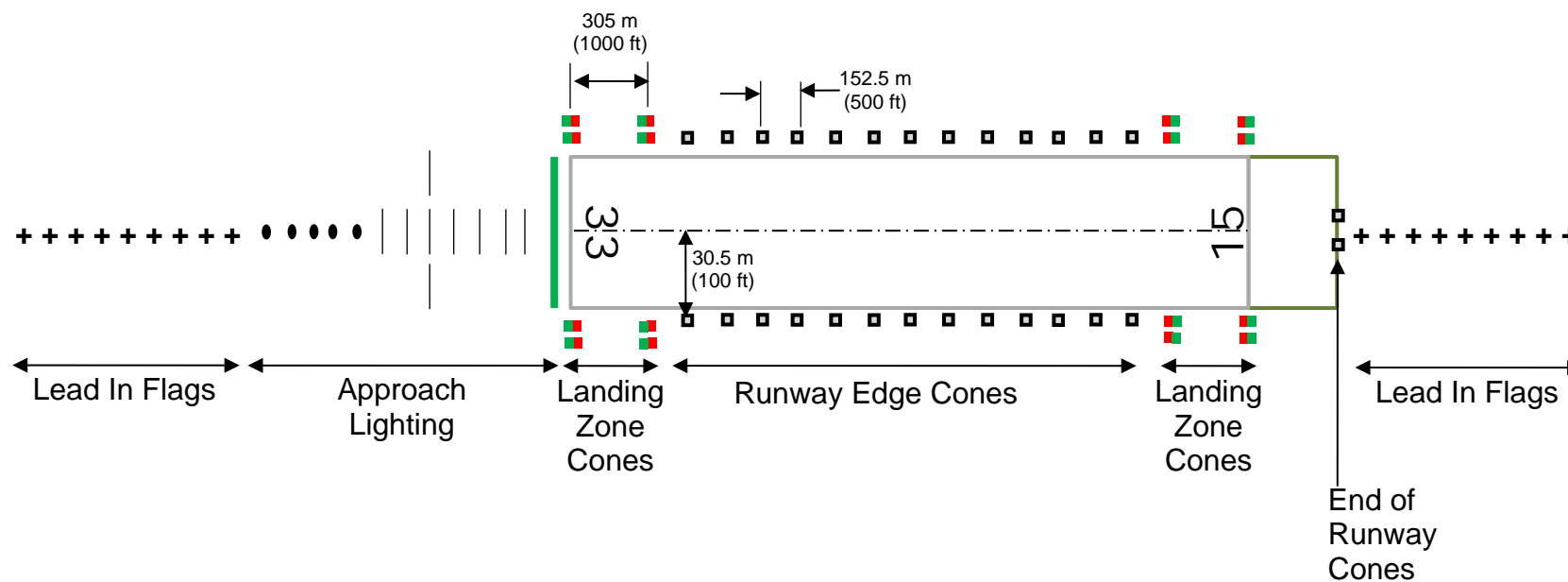
**Detail 4: Runway Edge Markers**



**Detail 5: Runway Threshold Markers**



Figure 2-7 Low Visibility Cone Layout for Ice Runway



- Red/Green NVG Cone
- Silver NVG Cone
- | Approach Light Barrette
- Sequenced Flashing Strobe Light
- +++ Lead-in Flags

**2-4 AIRFIELD LIGHTING.****2-4.1 Lighting Approach**

A limited number of lights are helpful for runway alignment acquisition, particularly during less-than-perfect weather conditions. The use of airfield lighting on snow/ice runways has evolved over the years and is expected to continue into the future.

**2-4.2 Desirable Lighting Components**

Adopting the full extent and type of lighting found at a conventional airport is not practical for a snow/ice runway. Runway edge lights would interfere with maintenance of the snow or ice surface and providing power with above-ground cables is not practical. Snow/ice runways can be used without airfield lights as long as the field is properly marked and the airspace is controlled. However, airfield lights are highly desirable and can significantly improve the safety of flying operations, especially at locations such as Williams Field that have nearby topographical features that require circling approaches to land. The lighting components listed below are optional but desirable and listed in the order of importance. Airfield lighting systems that are operational shall be noted in the airfield manager's certification report to HQ AMC/A3AS (see paragraph 2-6).

Threshold lights	Optional
Approach lights (modified MALSR)	Optional
Precision approach path indicators (PAPI)	Optional
Runway end identifier lights (REIL)	Optional

**2-4.2.1 Threshold Lights.**

Install threshold lights in a line perpendicular to the extended runway centerline prior to the threshold a distance of not more than 3 meters (10 feet). The line of lights is symmetrical about the runway centerline and extends 5 meters (15 feet) outboard of the lines of the innermost runway edge marker flags (total of 36.5 meters [120 feet] from centerline). The threshold lights consist of elevated lights with green lenses. Lights are symmetric about the runway centerline and spaced 1.5 meters  $\pm$  50 millimeters (5 feet  $\pm$  2 inches) apart (total of 48 lights). Even when threshold lights are installed, threshold marker flags must still be installed as described in paragraph 2-3.5.

**2-4.2.2 Approach Lights.**

Approach lights are placed in a modified SSALR (simplified short approach lighting with runway alignment indicator lights [RAILs]) configuration and consist of two different types of lights: steady burn and sequenced flashing strobes. Steady-burn elevated white lights in groups of five are placed within the 427 meters (1400 feet) prior to the approach threshold at 61 meters (200 feet) spacing. An additional two groups of five lights are placed either side of the center barrette at 305 meters (1000 feet) from the threshold. Elevated sequenced flashing strobe lights (SFL) are installed on centerline and between 488 meters (1600 feet) and 914.5 meters (3000 feet) from the approach

threshold at 61 meters (200 feet) spacing. Three to eight flashing strobes can be installed, depending on equipment availability. The SFL must flash in sequence from the outer end toward the runway threshold at a steady rate between 60 and 120 times per minute. The interval between flashes of adjacent lights must nominally be 1/30 second. See UFC 3-535-01, paragraph 3.5, for specific color, intensity, and aiming criteria.

### **2-4.2.3 Precision Approach Path Indicators (PAPI).**

The PAPI is an unattended system that provides visual glide path criteria for landing an aircraft. Sighting and configuration requirements are listed below. See UFC 3-535-01 for additional details.

#### **2-4.2.3.1 Configuration.**

The standard PAPI system consists of a light bar with four light units (FAA L-880, per FAA AC 150/5345-28G) placed on the left side of the runway in the vicinity of the touchdown point. See Figure 3-12 in UFC 3-535-01 for an illustration of the configuration.

**Note:** At McMurdo Station airfields, a two-bar PAPI system is commonly used. This configuration is less desirable, but acceptable, and shall be noted in the airfield suitability report (see paragraph 2-6.1).

##### **2-4.2.3.1.1**

Each light unit must be frangible mounted. It must contain two lamps minimum (three lamps preferred) and an optical system that produces a horizontally split, two-color (white over red) light beam.

##### **2-4.2.3.1.2**

Beginning at the outboard-most units, each unit in a bar is aimed into the approach at a successively higher angle above the horizontal. When on a proper approach path, the pilot sees the two inboard lights in both bars as red and the two outboard lights as white. As the approaching aircraft settles below the proper path, the pilot sees an increasing number of red lights in each outboard light bar. As the aircraft rises above the path, the pilot sees an increasing number of white lights in each inboard light bar.

##### **2-4.2.3.1.3**

The edge of the innermost unit in each bar must be no closer than 15.2 meters (50 feet) from the runway edge and the units in a bar must be 9 meters (30 feet) apart. The beam centers of all light units must be within  $\pm 0.025$  meter (1 inch) of a horizontal plane. This horizontal plane must be within  $\pm 0.30$  meters (1 foot) of the elevation of the runway centerline at the intercept point of the visual glide path with the runway. The units in a bar must all be within 0.025 meter (1 inch) of a line drawn perpendicular to the runway centerline. The distance from threshold to the PAPI shall be the shortest distance that will accommodate the criteria in paragraph 2-4.2.3.2.

**2-4.2.3.1.4**

Two-Bar PAPI System. In a two-bar system, the units are aimed such that when on a proper approach path the pilot sees the inboard light bar as red and the outboard light bar as white. As the approaching aircraft settles below the proper path, the pilot sees an increasing number of red lights in the outboard light bar. As the aircraft rises above the path, the pilot sees an increasing number of white lights in the inboard light bar.

**2-4.2.3.2 Photometric Requirements.**

See UFC 3-535-01, paragraph 3-7.3, for PAPI photometric criteria.

**2-4.2.3.3 Siting Considerations.**

Siting a PAPI must consider, as a minimum, the following: existing or planned instrument landing system (ILS) glide slope; the established glide path (aiming angle, typically 3 degrees); the threshold crossing height (TCH) for the selected aircraft height group; and the runway gradient (longitudinal slope) from the threshold to the PAPI location. See UFC 3-535-01, paragraph 3-7.4, for criteria regarding additional siting considerations.

**2-4.2.4 Runway End Identifier Lights (REIL).**

The REIL provides the pilot with rapid and positive identification of the runway threshold during approach for landing. The REIL assists the pilot to make landings in VFR conditions and in non-precision instrument approaches in IFR conditions.

**2-4.2.4.1 Configuration/Location/Aiming.**

A REIL system consists of synchronized flashing lights placed symmetrically about the runway centerline in the vicinity of the runway threshold. The optimum location is 12.2 meters (40 feet) from the runway edge and in line with the threshold lights. The lights may be located laterally up to 23 meters (75 feet) from the runway edge and longitudinally up to 12.2 meters (40 feet) downwind (away from the runway) from the threshold lights to 27.5 meters (90 feet) upwind. Adjust the location of both lights as equally as possible to maintain the symmetry of the installation. The difference in locations must not be more than 3 meters (10 feet) laterally or longitudinally. The elevation of both lights must be within 3 meters (10 feet) of the runway centerline at the threshold. See UFC 3-535-01, paragraph 3-6, for additional information.

**2-4.2.4.2 Photometric Requirements.**

The color and intensity requirements for sequenced flashing lights apply to REIL.

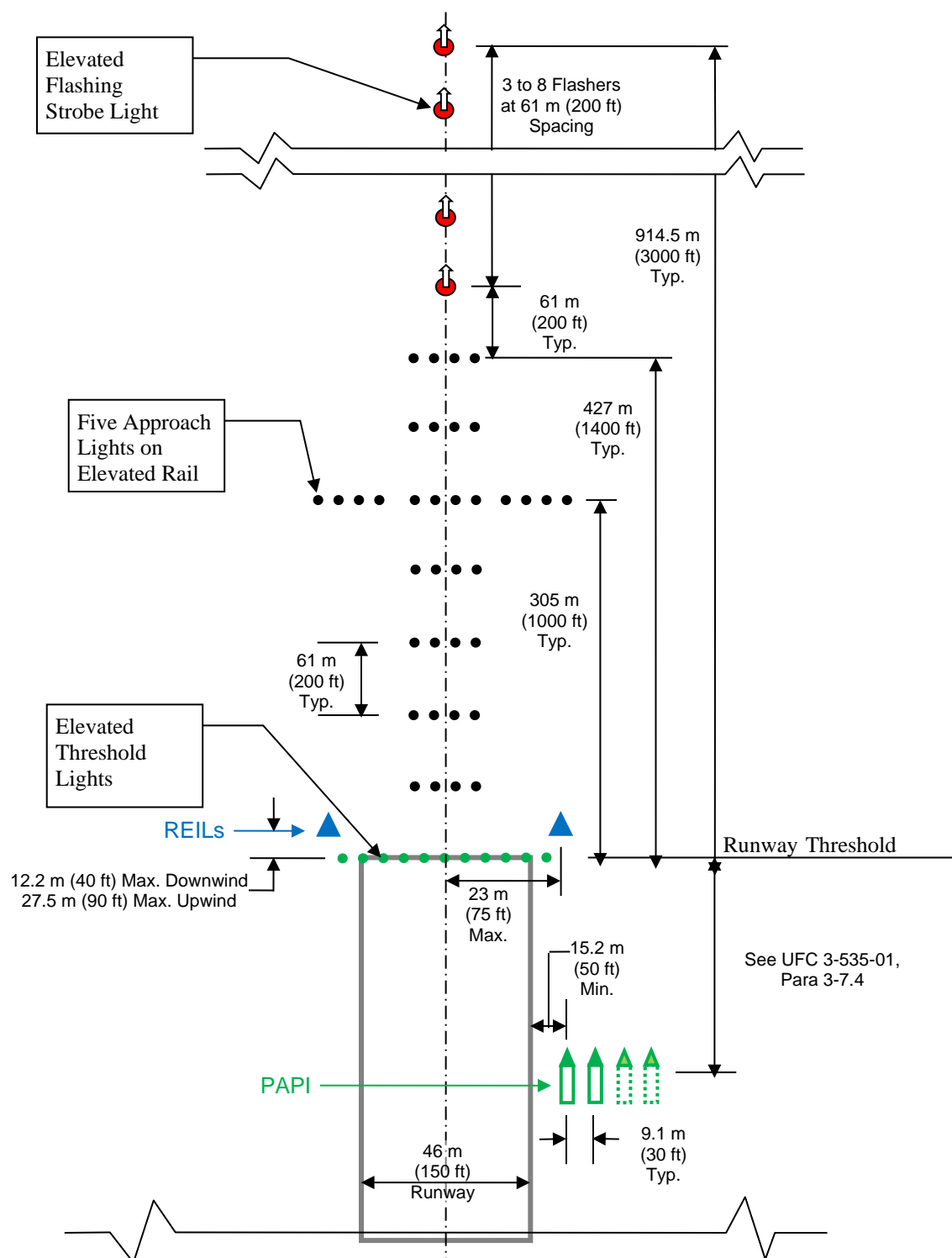
**2-4.2.4.3 Power Requirements.**

The system may be powered by solar cells, separately by generator, or by a power adapter unit connected to the threshold runway light circuit. There is no requirement for standby power.

### **2-4.3 Light Installation**

Figure 2-8 shows the layout of lights on a typical snow/ice runway, including the positions of approach lights and threshold lights. Lights may be powered by solar cells or generators. All lights must be installed on frangible supports. Generators must be positioned outside the runway lateral clear area and the runway end clear area. All installations are above the surface; however, power cables may be trenched into glacial ice, white ice, and compacted snow airfields to allow the use of central and displaced power generation. **Trenches must never be cut into a sea ice airfield.**

Figure 2-8 Lighting Layout for Snow/Ice Runways



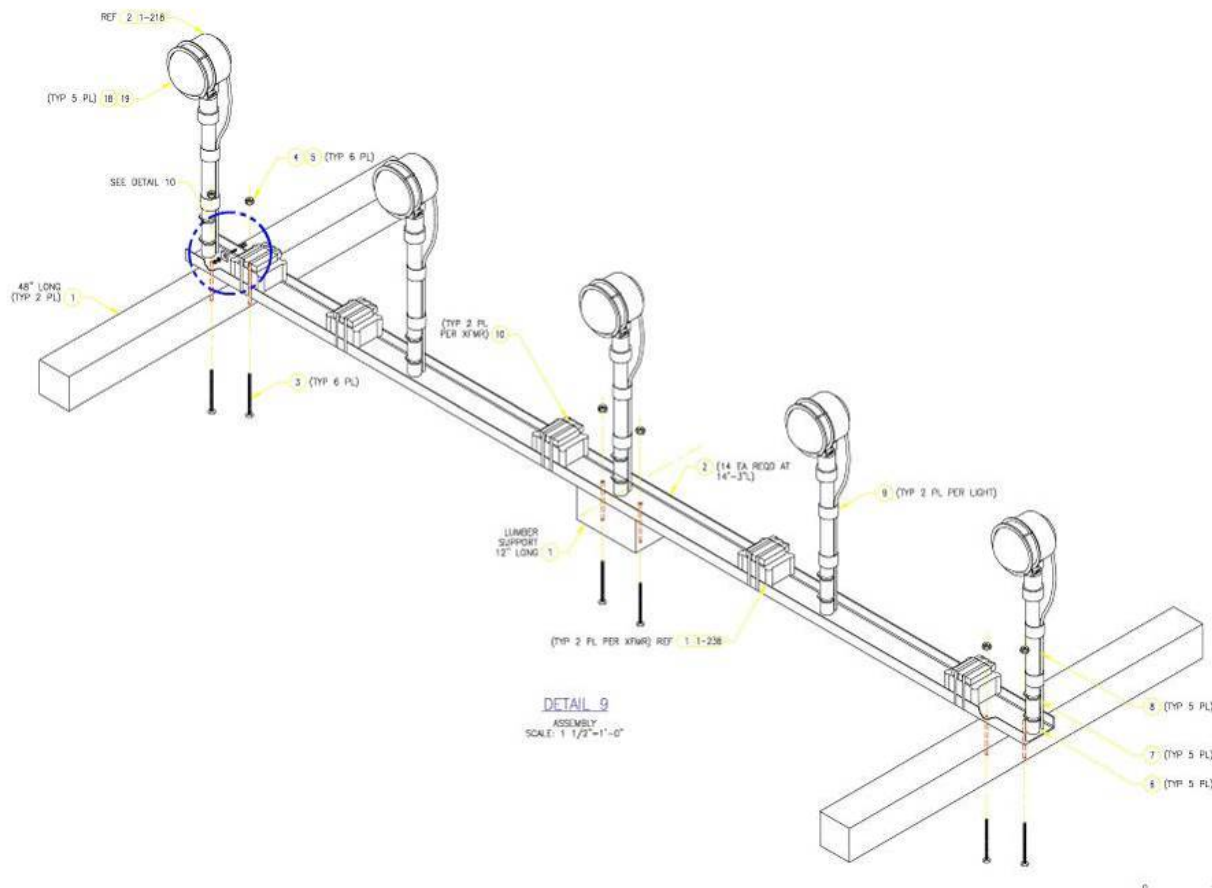
## 2-4.4 Lighting Details

Figures 2-9, 2-10 and 12-11 show details of the lights that may be installed on snow/ice runways. Note that lights are typically only present at the site during normal flying periods. At all other times, all equipment (except electrical cable set in trenches) is removed from the site to discourage drifting snow accumulation.

## 2-4.5 Taxiway and Apron Lighting

Lights are not typically installed for snow/ice airfield taxiways or aprons because operations on these features are almost exclusively during daylight. If operating during darkness, the airfield manager is responsible for using follow-me vehicles, temporary lighting, or other suitable systems to guide the aircraft.

**Figure 2-9 Typical SSALR Elevated 6.1-m (20-ft) Light Barrette**

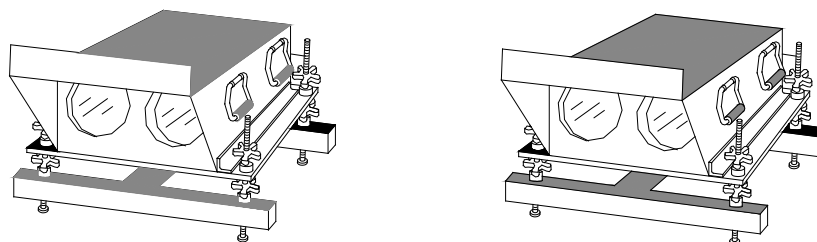


FC 3-260-06F  
1 June 2015

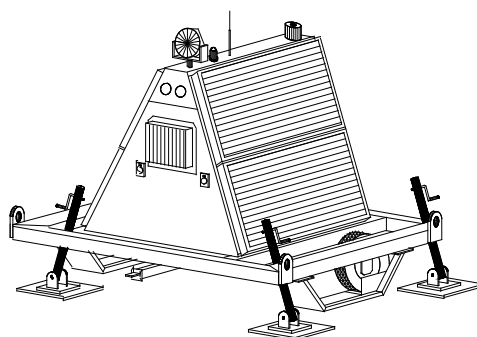
**Figure 2-10 Typical Threshold Light Installation for Snow/Ice Airfields**





**Figure 2-11 Lighting Details for Snow/Ice Airfields**

2 PRECISION APPROACH PATH INDICATOR (PAPI)  
C-02 SCALE: NONE



2 RUNWAY END IDENTIFIER LIGHTING SYSTEM (REILS)  
C-02 SCALE: NONE

## **2-5 ELECTRONIC NAVIGATIONAL AID SYSTEMS (NAVAIDS).**

### **2-5.1 NAVAIDS - General**

Although some snow/ice runways are VFR-only facilities and operated solely during daylight (such as field science camps), it is still desirable to have a limited number of electronic NAVAIDS to help guide the aircraft to the airfield. In some locations such as Williams Field, NAVAIDS are required to fly the runway approaches defined by terminal instrument procedures (TERPS) due to significant terrain obstacles in close relation to the airfield. Whenever NAVAIDS are installed, they greatly increase aircraft operational safety, particularly when weather conditions are less than ideal.

## 2-5.2 NAVAIDS Siting Criteria

Adopting the full extent and type of NAVAIDS generally found at a conventional airport (e.g., ILS localizer and glideslope antennas) would be difficult to acquire and maintain in a snow/ice environment. Generally, it is not necessary for a snow/ice runway to have the full complement of available NAVAIDS, but in some cases terrain may dictate the need for NAVAIDS. Some snow/ice runways can be used without NAVAIDS as long as the field is properly marked and the airspace is controlled (such as field science camps). However, NAVAIDS are highly desirable and can significantly improve the safety of flying operations. The NAVAIDS listed below are optional (unless dictated by TERPS) but desirable and listed in the order of importance.

**Table 2-5 NAVAIDS**

System	Required?	Siting Criteria
Microwave landing system (MLS)	Optional	AFI 11-230, para. 6.11
Tactical air navigation (TACAN)	Optional	UFC 3-260-01, Appendix B, Section 13
Airport weather observation station (AWOS)	Optional	FAA Order 6560.20
Mobile air traffic control tower (MATCT)	Optional	UFC 3-260-01, Appendix B, Section 17 UFC 3-260-01, para. B13-2.12
Wind indicators (cones)	Optional	UFC 3-535-01, para. 10-2 FAA AC 150/5345-27E, Type L-806 (Frangible)

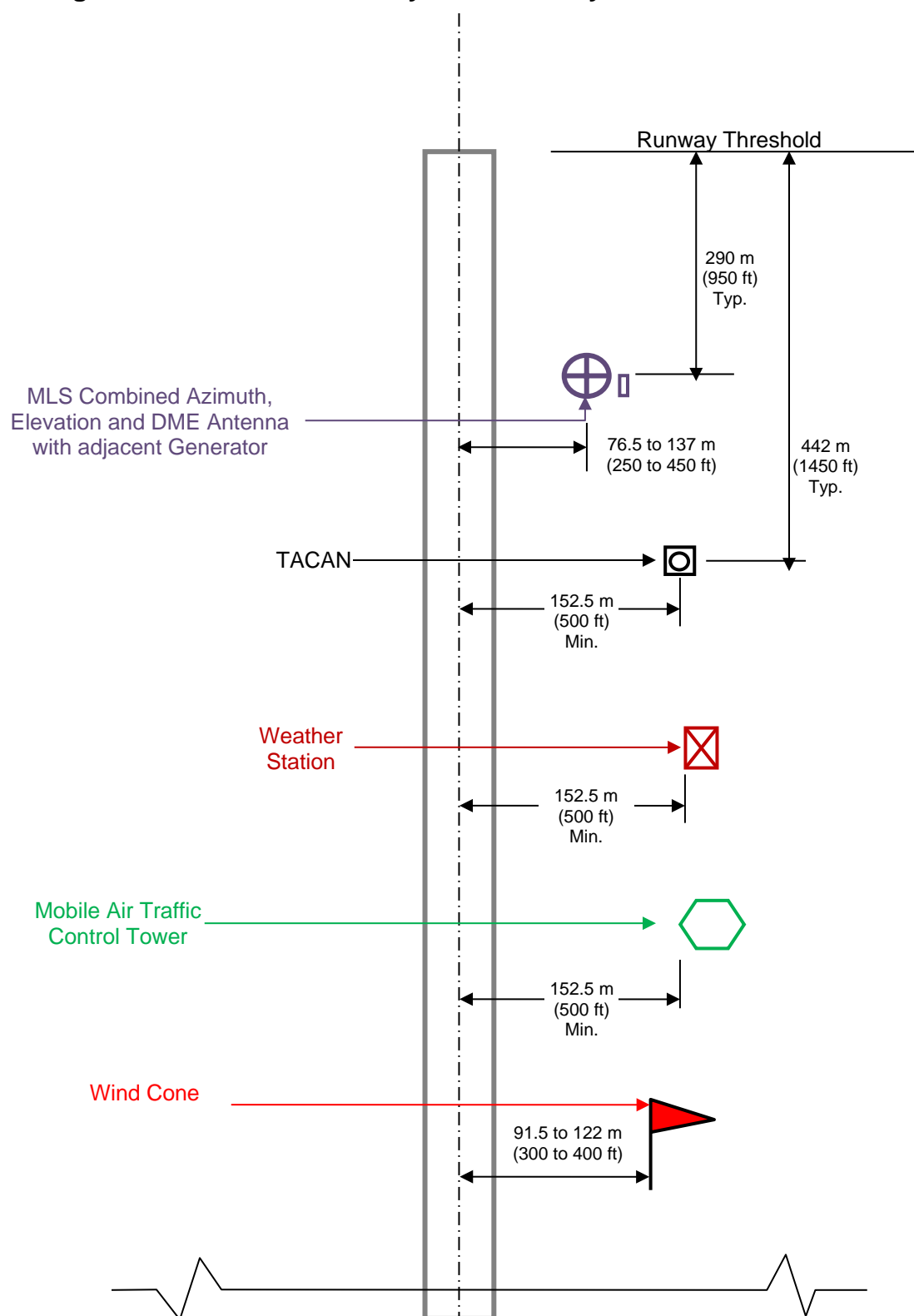
## 2-5.3 Positioning NAVAIDS

Figure 2-12 shows the positions for installing NAVAIDS (MLS, TACAN, AWOS, MATCT, and wind cone). These are strictly above-surface installations; however, subsurface wiring may be used for the NAVAIDS to allow central and displaced power generation.

## 2-5.4 NAVAIDS Implementation

Note that all NAVAIDS are generally only present at the site during the flying seasons. At most other times, all surface structures, including buildings and other support structures, are removed from the site to discourage progressive snow accumulation.

Figure 2-12 Snow/Ice Runway NAVAIDS Layout with Dimensions



**2-6 AIRFIELD CERTIFICATION PROCESS.****2-6.1 Annual Certification.****2-6.1.1**

The sea ice runway and white ice runway will be annually certified for operations by HQ AMC/A3. The airfield manager at McMurdo Station will initiate the request for certification by transmitting necessary information (dimensions, strength, cross-section, electronic NAVAIDS, lighting, markings) to HQ AMC/A7OI and HQ AMC/A3AS for review, comment, and to ensure all criteria are met. HQ AMC/A7OI provides the recommendation for certification for aircraft operations prior to the initial seasonal mission execution. The runway certification statement will be entered in the HQ AMC airfield suitability assessment maintained in the Global Decision Support System (GDSS) airfield database (AFD) in accordance with the Airfield Suitability and Restrictions Report (ASRR) and AMCI 11-211.

**2-6.1.2**

Due to the dynamic nature of the McMurdo airfields, environmental conditions change during a flying season or certification period, most often due to seasonal temperature fluctuations. The following changes to airfield conditions require notification to HQ AMC/A3AS for update to the GDSS AFD and, if applicable, waiver processing. Other changes to conditions (e.g., inoperable lighting system, missing edge marker flag) shall be issued as a Notice to Airmen (NOTAM) or airfield advisory by the airfield manager.

- Reductions in runway, shoulder, overrun, lateral clear area, or end clear area dimensions
- Reductions in allowable weight-bearing capacity (Sea Ice Monitoring Report)

**2-6.2 Periodic Air Force Team Certification.**

Although the primary responsibility for airfield data collection to verify design criteria falls with the on-site USAP airfield manager and staff, periodic evaluations by Air Force engineering personnel are needed for the reasons listed below. Evaluation of the Pegasus white ice runway by Air Force personnel will occur every third year.

**2-6.2.1**

Air Force engineers need to maintain an understanding of the extreme snow/ice runway environment and the challenges associated with building and maintaining a snow/ice airfield for use by Air Force aircraft.

**2-6.2.2**

HQ AMC/A7 is tasked to verify the interpretation of snow/ice runway airfield data and make a recommendation to certify the snow/ice runways for opening to aircraft traffic. The quality of the interpretation is substantially enhanced when the engineer has the on-site experience to understand how the data is collected and what it means.

**2-6.2.3**

The criteria established in this FC are currently only applied at McMurdo Station; therefore, updates to the FC are routinely needed to incorporate changes in equipment and airfield configurations.

**2-6.3 Operational Waivers to Criteria.**

The criteria in this FC are the minimum permissible for DOD aircraft (C-130, C-17, and C-5 operations). When deviations exist or occur, an operational waiver must be obtained before flight operations begin. The airfield manager or a designated representative will initiate a written waiver request through 13 AEG/CC and HQ PACAF/A3 to the Air Force component with operational control (OPCON) for Antarctic missions. The waiver must outline all criteria that do not meet the requirements of this FC. The appropriate airfield manager or airfield survey team will verify existing prepared landing zone (PLZ) dimensions and grades. HQ AMC/A7O and /A3V will assess the waiver request for viability and risk and make a recommendation to the Air Force component commander with OPCON for Antarctic missions. For Transportation Command (TRANSCOM)/AMC operational missions under OPCON of 18th Air Force, 18 AF/CC is the waiver authority in accordance with AFI 11-202V3.

**Note:** In addition to sending data and requests for deviations to HQ AMC/A3, data monitoring results shall be courtesy-copied to HQ PACAF/A7 and HQ AMC/A7.

**FC 3-260-06F**  
**1 June 2015**

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## APPENDIX A REFERENCES

### AIR FORCE

AFI 11-202, Vol. 3, *General Flight Rules*, <http://www.e-publishing.af.mil>

AFI 11-230, *Instrument Procedures*, <http://www.e-publishing.af.mil>

AFI 13-217, *Drop Zone and Landing Zone Operations*, <http://www.e-publishing.af.mil>

AMCI 11-211, *Destination Airfield Suitability Analysis*, <http://www.e-publishing.af.mil>

### ARMY

CRREL Monograph 98-1, *Construction, Maintenance, and Operation of a Glacial Runway, McMurdo Station, Antarctica*,  
[http://www.crrel.usace.army.mil/library/monographs/M98\\_01.pdf](http://www.crrel.usace.army.mil/library/monographs/M98_01.pdf)

CRREL Technical Report 153, *Study of the Rammsonde for Use in Hard Snow*

Waterways Experiment Station Instructional Report GL-92-3, *Description and Application of Dual Mass Dynamic Cone Penetrometer*,  
<http://www.dtic.mil/dtic/tr/fulltext/u2/a251960.pdf>

### NAVY

Naval Civil Engineering Laboratory Report, *Nomographs for Operating Wheeled Aircraft on Sea-Ice Runways: McMurdo Station, Antarctica*, presented at the Third International Conference on Ice Technology, Cambridge, MA

Naval Facilities Engineering Service Center, *Landing and Parking Curves for the C-17 Globemaster on Sea Ice: McMurdo Station, Antarctica*, available in Proceedings of the Seventh (1997) International Offshore and Polar Engineering Conference

Vaudrey, K. 1977, *Ice Engineering – Study of Related Properties of Floating Sea-Ice Sheets and Summary of Elastic and Viscoelastic Analyses*, U.S. Naval Construction Battalion Center, Port Hueneme, CA, Civil Engineering Laboratory, Technical Report R-860

### JOINT SERVICE

UFC 3-260-01, *Airfield and Heliport Planning and Design*,  
[http://www.wbdg.org/ccb/browse\\_cat.php?o=29&c=4](http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

UFC 3-535-01, *Visual Air Navigation Facilities*,  
[http://www.wbdg.org/ccb/browse\\_cat.php?o=29&c=4](http://www.wbdg.org/ccb/browse_cat.php?o=29&c=4)

## **AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)**

ASTM D1883, *Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils*

ASTM D6951, *Standard Test Method for Use of the Dynamic Cone Penetrometer in Shallow Pavement Applications*

## **AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)**

Barthelemy, J., 1992, Nomographs for Operating Wheeled Aircraft on Sea-Ice Runways: McMurdo Station, Antarctica, 11th International Conference on Offshore Mechanics and Arctic Engineering, Calgary, Alberta, June 7–12, 2002, Proceedings, Vol. 4. Edited by Ayorinde, Sinha, Sodhi, and Nixon, p. 27-33, published by the American Society of Mechanical Engineers, New York.

## **FEDERAL AVIATION ADMINISTRATION (FAA)**

FAA Order 6560.20B, *Siting Criteria for Automated Weather Observing Systems (AWOS)*,  
[http://www.faa.gov/regulations\\_policies/orders\\_notices/index.cfm/go/document.information/documentID/9380](http://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/9380)

FAA Advisory Circular (AC) 150/5345-27E, *Specification for Wind Cone Assemblies*,  
[http://www.faa.gov/documentlibrary/media/advisory\\_circular/150\\_5345\\_27e.pdf](http://www.faa.gov/documentlibrary/media/advisory_circular/150_5345_27e.pdf)

FAA AC 150/5345-28G, *Precision Approach Path Indicator (PAPI) Systems*,  
[http://www.faa.gov/airports/resources/advisory\\_circulars/index.cfm/go/document.current/documentNumber/150\\_5345-28](http://www.faa.gov/airports/resources/advisory_circulars/index.cfm/go/document.current/documentNumber/150_5345-28)



## APPENDIX B BEST PRACTICES

### B-1 DCP AND RSP OPERATING INSTRUCTIONS

#### B-1.1 Device Configuration.

For application on snow and ice airfields, the dynamic cone penetrometer (DCP) device shall be operated with a fixed 60°, 20-millimeter (0.8-inch) diameter cone, and an 8-kilogram (17.6-pound) drop hammer. The Russian snow penetrometer (RSP) shall be operated with the standard 30°, 11-millimeter (0.4-inch) diameter cone, and a 0.8-kilogram (1.75-pound) drop hammer.

#### B-1.2 Test Method.

Penetrometer measurements can be taken at any time of day, at any air temperature, and in any weather conditions (but environmental conditions at the time of testing must be documented). Take snow strength measurements at the locations noted in the field data sheet (see Figure B-63). **Note:** Ideally, two persons will work together to take measurements and record penetrometer data.

##### B-1.2.1

Verify that a measuring mechanism is available to accurately note every 25 millimeters (1 inch) of penetration of the penetrometer shaft (e.g., distance marks on the penetrometer shaft or an adjacent measuring rod). The “zero” penetration mark is located at the top of the cone’s pointed end (i.e., at the lowest point on the penetration tip where the maximum penetrometer width occurs).

##### B-1.2.2

Gently place the tip of the penetrometer onto the snow surface and keep the shaft in a vertical position.

##### B-1.2.3

Push the penetrometer vertically into the snow until the widest part of the tip cone is flush with the surface of the snow (i.e., at the “zero” depth mark).

##### B-1.2.4

Gently raise the hammer weight until light contact is made with the top handle. The hammer must not impact the handle when being raised.

##### B-1.2.5

Allow the hammer to freely fall down onto the anvil, thus forcing the cone into the snow/ice.

**B-1.2.6**

Record how many hammer blows (drops) are needed to drive the penetrometer cone 25 millimeters (1 inch) into the surface, as measured by the markings on the shaft or detached measuring device. This will complete Blow Set 1. Note: 25 millimeters (1 inch) is the penetration goal for each blow set, but if the snow properties suddenly change and the cone quickly penetrates further than 25 millimeters (1 inch), simply note the actual penetration depth and number of blows in that blow set.

**B-1.2.7**

In the penetrometer field data sheet for that location, write down the number of blows under Blow Set 1 and the penetration of the cone (in millimeters) for that blow set.

**B-1.2.8**

Without moving the penetrometer begin Blow Set 2, driving the penetrometer another 25 millimeters (1 inch) into the snow by dropping the hammer as many times as needed to achieve this penetration.

**B-1.2.9**

Record the Blow Set 2 data into the appropriate blocks on the field data sheet. Continue the penetration test, 25 millimeters (1 inch) at a time, until the penetrometer tip firmly contacts the supporting glacial ice surface and penetration effectively stops. In deep compacted snow the entire rod may advance until the anvil contacts the surface.

**B-1.3                    Errors.**

If the test data are suspicious or erroneous due to problems attributable to operator or equipment error, fix the problem, move the penetrometer 1 meter (3 feet) away from the original test location, and start the test again. Note the event in the "Comments or Observations" block of the field data sheet.

**B-1.4                    Soft Snow.**

If the penetrometer tests indicate an area of soft snow (only one or two blows gives 25 millimeters [1 inch] of penetration), note the area on the data sheet and mark the location with a pole or flag for further testing and repair. Move 1 meter (3 feet) down the runway and start the test over.

**B-1.5                    Strength Index.**

The strength index can be determined from the DCP and RSP tests using the formulas given in Appendix C-2. Alternatively, the Ice Runway Strength Survey Tool program, a software analysis routine, is available by contacting the National Science Foundation POC in paragraph 1-3. This software will ultimately be available in the Pavement Computer Assisted Structural Engineering (PCASE) package of applications.

## **B-2 GLACIAL ICE AND WHITE ICE RUNWAY PATCHING PROCEDURE**

### **B-2.1 Introduction.**

Infrequently, there may be damage to the runway surface from equipment gouging, solar-induced subsurface melt pool formation, or surface melting instigated by windborne or spilled contaminants. These areas will require clean-out, repair, and re-certification. The following patching procedure shall be followed. Repair these areas by removing the damaged snow and ice and replacing it with a crushed ice and water “patch” (in the glacial ice) and a new snow pavement (on the surface) that provides the required hardness/strength. The repair procedure is based on information in CRREL Monograph 98-1, page 57.

### **B-2.2 Tools.**

The following tools are needed:

- Long-handled chisel
- Welder’s slag hammer or rock hammer
- Coal shovel
- Source of cold, fresh water

### **B-2.3 Patching Procedure.**

Thoroughly remove all contaminants (including melted and/or refrozen snow and ice) at the site of the repair and dispose of in accordance with site regulations. Remove any loose (but clean) snow and ice from the damaged area and place it to the side for later use. Clear the faces and edges of the cavity to allow close inspection of the ice along the sides and bottom.

#### **B-2.3.1 Glacial Ice.**

##### **B-2.3.1.1**

Use the chisel to excavate the area surrounding the failure area to make certain that all of the weak ice has been dislodged. If a large area of the surrounding ice is weak, use one of the large-scale test methods (see CRREL Monograph 98-1, page 47) to break up the weak ice and identify its limits.

##### **B-2.3.1.2**

Glacial ice removed from the failed area shall be further broken up with a hammer into pieces roughly the size of a fist or smaller. The crushed ice shall be packed into the cavity to fill the hole slightly above its top (approximately 75 to 100 millimeters [3 to 4 inches] higher). Remove any excess ice from the runway.

**B-2.3.1.3**

Slowly fill the hole containing the crushed ice with cold water (ideally very near 0 °C [32 °F]) to approximately 75% full. Fill the hole by directing the water around the perimeter of the hole. Mix the ice-water slurry in the hole with the chisel and shovel by vigorous vertical probing to ensure that all pore spaces are filled with water and to encourage water to flow into any cracks radiating into the surrounding ice. After about an hour, proceed to add water to approximately 50 millimeters (2 inches) below the ice surface. Smooth the surface with the backside of a shovel. Allow it to cool for three to four hours, after which time the surface usually will be frozen over.

**B-2.3.1.4**

Using the chisel, break the top of the ice surface in a number of places (10% of total surface area). Slowly re-flood the patch area to fill the air gap under the ice surface with cold water.

**B-2.3.1.5**

Use a brightly colored flag (e.g., orange) to mark the location of the patch on the ice surface. A corner of the flag can be frozen into the surface using cold water. If the runway is not in use, a bamboo or plastic pole with a flag can be pushed into the ice-water slurry to mark the location.

**B-2.3.1.6**

Note the approximate location of the patched area using the runway markers as a guide for the long axis and the knowledge of the runway width for the other axis. If air operations are in effect, the airfield manager, the air traffic controller, and the flight crew coordinator shall be notified that a fresh patch is on the runway and that this area will be avoided for at least 48 hours.

**B-2.3.1.7**

Allow the area to freeze for at least 48 hours before allowing traffic to resume; the flag shall then be removed. If possible, the patched area shall be “dressed” with the chisel-tooth grader blade to blend its edges into the surrounding ice surface and to provide a uniform surface texture.

**B-2.3.1.8**

Following repair of the glacial ice, the site must be re-certified using the procedures given in paragraph B-4 if the repair area is greater than 0.4 square meter (4.3 square feet).

**B-2.3.2 White Ice.****B-2.3.2.1**

For a white ice surface requiring repair, whether or not the previous procedures (paragraph B-2.3.1 et seq.) were required to patch the underlying glacial ice, ensure that all weak, contaminated, or damaged pavement is stripped from the glacial ice surface.

**B-2.3.2.2**

Fill the area with clean, fresh (no more than one-year-old) snow using hand or mechanical equipment, depending on the volume of snow required.

**B-2.3.2.3**

Level the snow surface with a light drag or snow plane, or a wide-tire (1 meter), low-ground-pressure (tire inflation pressure of 100 kilopascals (kPa) [14.5 pounds per square inch (psi)] or less) wheeled vehicle.

**B-2.3.2.4**

Use a compaction roller (used to initially construct the white ice surface) to level the entire patched area using 85% of the final tire pressure and gross load used at initial construction. Allow the snow to “rest” for 24 hours and repeat compaction rolling at 95% of the final tire pressure and gross load. After another 24-hour rest, repeat compaction rolling at 100% of the final tire pressure and gross load used during initial construction. The patched area will be ready to accept routine aircraft traffic following another 24-hour rest period, but this must be verified with certification tests as given in Appendix B-5.

**FC 3-260-06F**  
**1 June 2015**

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**B-3 SEA ICE RUNWAY PATCHING PROCEDURE****B-3.1 Introduction.**

Infrequently, there may be damage to the runway surface from equipment gouging, solar-induced melt features, or surface melting caused by windborne or spilled contaminants. These areas will require clean-out, repair, and re-certification. The following patching procedure shall be followed. Repair these areas by removing the damaged snow and ice and replacing it with a crushed ice and water “patch” (in the sea ice) and a new snow pavement (on the surface) that provides the required hardness/strength. The repair procedure is based on information in CRREL Monograph 98-1, page 57. Note that this procedure is commonly used during runway construction, but when ice temperatures rise above about -6.5 °C (20 °F) this process is largely ineffective because of excessive freeze-up times.

**B-3.2 Tools.**

The following tools are needed:

- Long-handled chisel
- Welder’s slag hammer or rock hammer
- Coal shovel
- Source of cold, fresh water

**B-3.3 Patching Procedure.**

Thoroughly remove all contaminants (including melted and/or refrozen snow and ice) at the site of the repair and dispose of in accordance with site regulations. Remove any loose (but clean) snow and ice from the damaged area and place it to the side for later use. Clear the faces and edges of the cavity to allow close inspection of the ice along the sides and bottom.

**B-3.3.1 Sea Ice.****B-3.3.1.1**

Use the chisel to excavate the area surrounding the failure area to make certain that all of the weak ice has been dislodged. If a large area of the surrounding ice is weak, use one of the large-scale test methods (see CRREL Monograph 98-1, page 47) to break up the weak ice and identify its limits.

**B-3.3.1.2**

Dispose of sea ice removed from the failed area. Pieces of glacial ice (not sea ice) roughly the size of a human fist or smaller shall be packed into the cavity to fill the hole slightly above its top (approximately 75 to 100 millimeters [3 to 4 inches] higher).

Packed snow may be used in the absence of sufficient glacial ice. Any excess material shall be removed from the runway.

**B-3.3.1.3**

Slowly fill the hole containing the crushed ice (or packed snow) with cold, fresh water (ideally, very near 0 °C [32 °F]) to approximately 75% full. Fill the hole by directing the water around the perimeter of the hole. Mix the ice-water slurry in the hole with the chisel and shovel by vigorous vertical probing to ensure that all pore spaces are filled with water and to encourage water to flow into any cracks radiating into the surrounding ice. If using packed snow, gently push down on the patch with the backside of a shovel only; do not probe and stir with a tool. After about an hour, add water to approximately 50 millimeters (2 inches) below the surrounding sea ice surface. Smooth the surface with the backside of a shovel. Allow it to cool for three to four hours, after which time the surface usually will be frozen over.

**B-3.3.1.4**

Using the chisel, break the top of the ice surface in a number of places (10% of total surface area). Slowly re-flood the patch area to fill the air gap under the ice surface with cold, **fresh** water.

**B-3.3.1.5**

Use a brightly colored flag (e.g., orange) to mark the location of the patch on the ice surface. A corner of the flag can be frozen into the surface using cold water. If the runway is not in use, a bamboo or plastic pole with a flag can be pushed into the ice-water slurry to mark the location.

**B-3.3.1.6**

Note the approximate location of the patched area, using the runway markers as a guide for the long axis and the knowledge of the runway width for the other axis. If air operations are in effect, the airfield manager, the air traffic controller, and the flight crew coordinator shall be notified that a fresh patch is on the runway and that this area must be avoided for at least 48 hours.

**B-3.3.1.7**

Allow the area to freeze for at least 48 hours before allowing traffic to resume; the flag shall then be removed. If possible, the patched area shall be “dressed” with the chisel-tooth grader blade to blend its edges into the surrounding ice surface and to provide a uniform surface texture.

**B-3.3.1.8**

Following the sea ice repair, the site must be re-certified using the procedures given in Appendix B-6 if the repair area is greater than 0.4 square meter (4.3 square feet).



**B-3.3.2            Snow Cap.****B-3.3.2.1**

For a runway surface operated with a snow cap, it is required to replace the cap after patching the sea ice.

**B-3.3.2.2**

Fill the area with clean, fresh (not more than one year old) snow using hand tools or mechanical equipment, depending on the volume of snow required.

**B-3.3.2.3**

Level the snow surface with a light drag or snow plane, or a wide-tire (1 meter), low-ground-pressure (tire inflation pressure of 100 kPa [14.5 psi] or less) wheeled vehicle.

**B-3.3.2.4**

If the snow cap being replaced was processed, use the same procedure originally applied to bring the snow patch to an equivalent level of strength. Allow the snow to “rest” for 24 hours before allowing routine aircraft traffic.

**FC 3-260-06F**  
**1 June 2015**

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**B-4 GLACIAL ICE STRUCTURAL EVALUATION PROCEDURE****B-4.1 Glacial Ice Runway Surface Evaluation—Deformation Failure.**

The glacial ice surface must be shown to be capable of supporting C-130 and C-17 contact pressure levels for heavy wheeled aircraft without compressive or shear failure. These capacities will be demonstrated by one of the two following methods, depending on the circumstances: proof rolling to detect zones of weakness, or the experience of past operations.

**B-4.1.1 Proof Rolling.****B-4.1.1.1**

The primary source of ice weakness at the Pegasus site is caused by melt and re-freeze features. When they occur, they commonly show no surface expression and may give the runway a deceptive appearance of strength. Rigorous adherence to prescribed maintenance procedures can avoid such melt/re-freeze problems (see CRREL Monograph 98-1 for maintenance procedures). If there is any doubt, or if the conditions described in paragraph B4.1.1.2 apply, then the runway must be tested for structural strength.

**B-4.1.1.2**

Proof rolling tests are required if the surface temperature in the ice (measured at a depth of 10 millimeters [0.5 inch]) rises to or above  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ) (as confirmed by solar-shielded, continuously recording temperature probes buried in the ice). If ice temperatures reach or exceed  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ), the potential exists for subsurface melt-pool formation and the runway surface must be inspected for such potential melt-damaged areas by proof rolling. The testing will be performed with pneumatic tire(s) having a minimum inflation pressure of 7.7 kilograms per square centimeter (760 kPa or 110 psi). The vehicle shall have a minimum individual tire load of 16,000 kilograms (35,000 pounds). Coverage shall be at no greater than 1-meter (3-foot) lateral spacing over the entire width of the runway and shoulder surface. Successful proof rolling will generate no ice cracking resulting in a removable ice piece greater in size than 0.3 meter by 0.3 meter by 0.05 meter deep (12 inches by 12 inches by 2 inches deep). Any defective areas discovered will be removed, repaired, and retested according to the process outlined in Appendix B-2.

**B-4.1.2 Past Operations.**

Previous aircraft operations at the Pegasus runway have demonstrated that the existing ice surface has sufficient compressive strength to support aircraft with tire pressures up to 13.7 kilograms per square centimeter (1350 kPa or 195 psi). If aircraft operations were successfully supported by the Pegasus runway in the immediately previous flight period (as confirmed by close visual inspection of the runway for damage), and as long as the near-surface ice temperature has not risen to or exceeded  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ) since the last flight period (as confirmed by continuously recording temperature probes buried in the ice), the ice surface will be considered adequate for aircraft with tire pressures up

to the magnitude of the maximum operated during the prior flight period. If previous aircraft operations were not successfully supported, needed repairs and re-certification of the runway must be accomplished before further aircraft operations.

## **B-4.2                    Glacial Ice Runway Surface Evaluation—Creep Failure.**

Long-term parking at warm ice temperatures can lead to creep deformation of the glacial ice. At ice temperatures below  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ) creep deformation is relatively slow. Since the Pegasus PLZ is operated principally as a “turn-around” runway (i.e., arriving aircraft debark within a few hours, spending limited time onsite), it is expected that creep deformation will be negligible. However, if aircraft will be parked for extended time periods then they will have to be moved periodically to avoid any difficulty during the initial rollout. It is recommended that no more than 25 millimeters (1 inch) of deformation occur below a parked aircraft tire. In general, this limit will be reached in one hour at an ice temperature of  $-2.5^{\circ}\text{C}$  ( $27.5^{\circ}\text{F}$ ), two hours at  $-5^{\circ}\text{C}$  ( $23^{\circ}\text{F}$ ), and three hours at  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ ).

## **B-4.3                    Glacial Ice Runway Surface Evaluation—Flexural Failure.**

### **B-4.3.1**

The ice sheet at the Pegasus site is approximately 30 meters (100 feet) thick. Depending on the temperature and crystallographic structure and impurities content of the ice, this ice has flexural strength on the order of 5 to 10 kilograms per square centimeter (490 to 980 kPa or 75 to 150 psi). The large thickness of the ice sheet reduces the bending stresses in response to heavy wheeled aircraft to levels that can easily be carried by the ice. A PCASE analysis routine for rigid portland cement concrete, modified for glacial ice, was used to determine the minimum thickness of glacial ice needed to support the heaviest aircraft load (a fully burdened C-17) without flexural cracking. To be conservative, a flexural strength of only 0.4 kilogram per square centimeter (39.2 kPa or 5.7 psi) was used (this value is based on the weakest ice found in the area). Also, the sub-base material for this analysis is water since the Pegasus runway is floating on the sea. The results indicate that a C-17 at 263,600 kilograms' (580,000 pounds) gross load requires an ice thickness of 2.25 meters (7.4 feet) for a safety factor of 1.0. Given that impurities and closed cracks certainly exist in the ice, a factor of safety of 3.0 is recommended. Thus, the Pegasus runway shall have an ice thickness of at least 6.8 meters (22.3 feet) to support the anticipated aircraft and loads.

**Note:** Sea ice has a much greater flexural strength than glacial ice so a significantly thinner layer of sea ice is sufficient to support aircraft.

### **B-4.3.2**

The present 30-meter (100-foot) thickness of ice at the site suffices for all anticipated aircraft operations. However, if the site experiences appreciable thinning, or if this FC is used for another site, or aircraft other than the C-130 or C-17 are operated, a new analysis is prudent.

**B-5 WHITE ICE STRUCTURAL EVALUATION PROCEDURE****B-5.1 White Ice Pavement Thickness.****B-5.1.1**

There is no limit on the thickness of the white ice pavement on top of the supporting glacial ice. However, the white ice strength profile must be verified using a DCP or RSP. The white ice strength profile must meet the following two requirements:

1. The strength of the white ice layer must be greater than or equal to the values listed in Table B-1 throughout the layer.
2. The strength profile must show that there is no weak zone beneath a strong surface. The strength of the white ice may not decrease by more than 25% from the overlying material.

**B-5.1.2**

If either of the above conditions are not satisfied, contact the person(s) listed in paragraph 1-3 for recommendations on how to proceed.

**B-5.2 White Ice Runway Surface—Deformation Failure.**

It is required that the glacial ice (surface and flexural characteristics) be evaluated according to Appendix B-4 as part of the certification of a thin processed snow operating surface at the Pegasus PLZ. Being a thin processed snow pavement overlying a thick and sufficiently strong base, the principal structural requirement of the white ice is its ability to support tire contact pressures.

**B-5.3 White Ice Runway Surface—Snow Pavement Strength Determination.****B-5.3.1**

A penetration resistance index will be used as the basis for evaluation of snow strength. Measurements may be taken with either a DCP or an RSP. See Appendix B-1 for test procedures for both devices. The correlation between RSP and DCP index strengths is shown in Figure B-1. The correlation between DCP and the traditional pavement strength index—CBR, developed in soils—is shown in Figure B-2. A correlation by calculation between the RSP and CBR indices is shown in Figure B-3.

Figure B-1 Correlation Between RSP and DCP

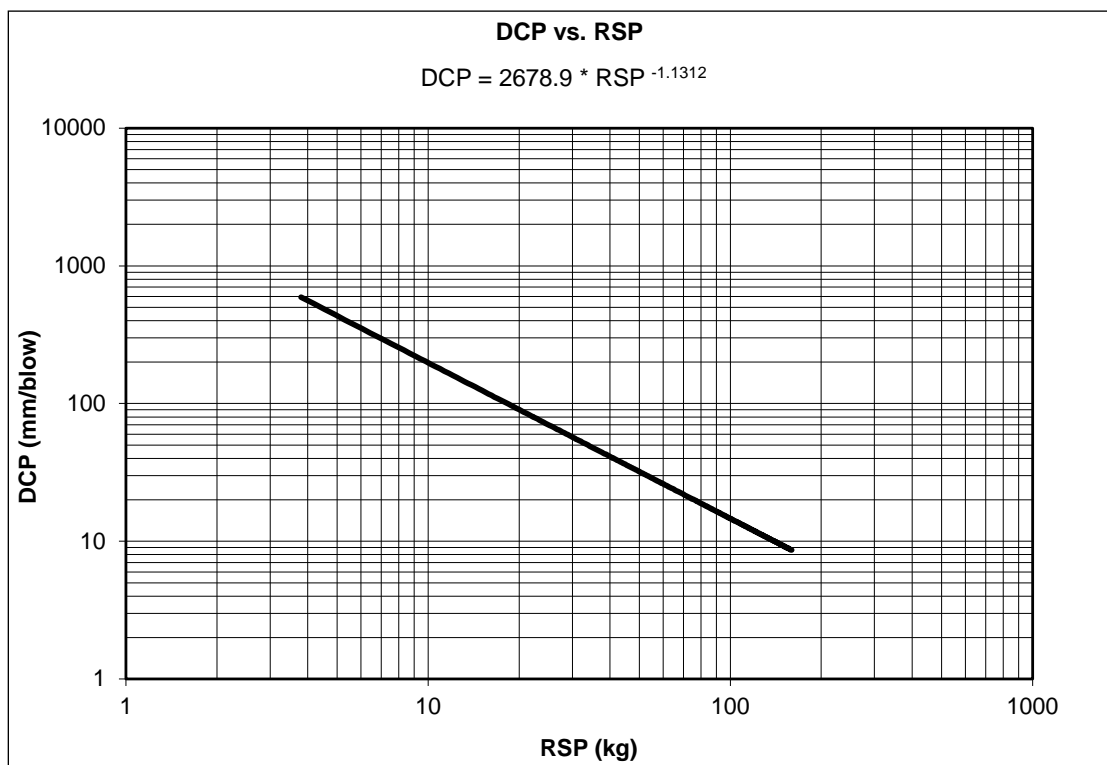
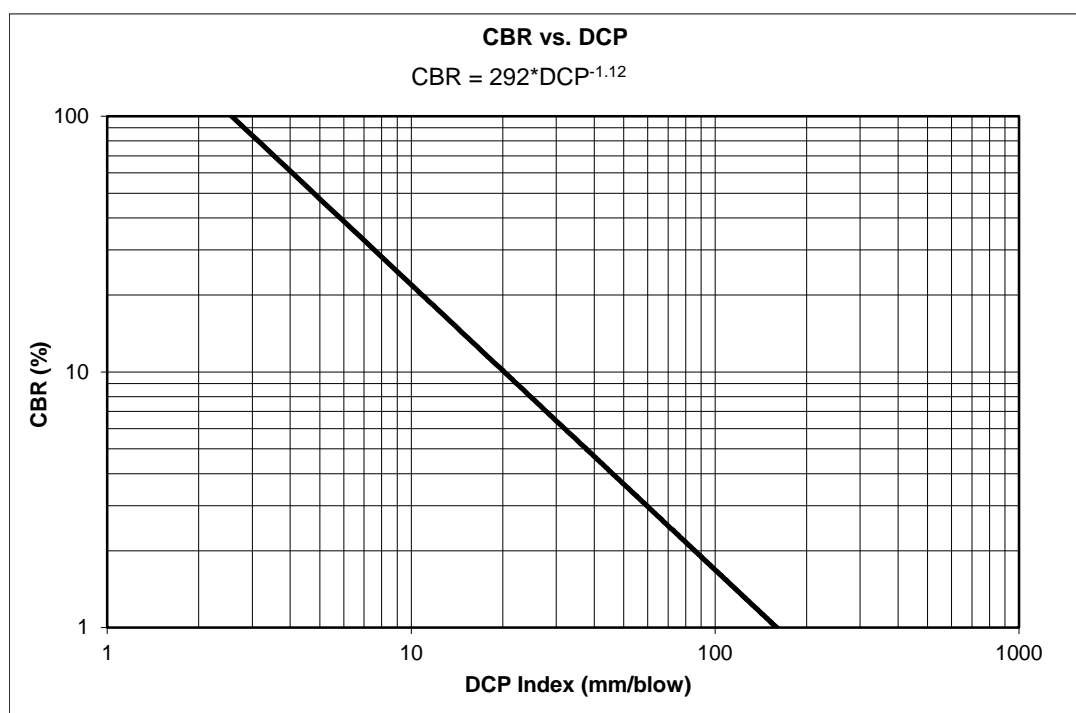
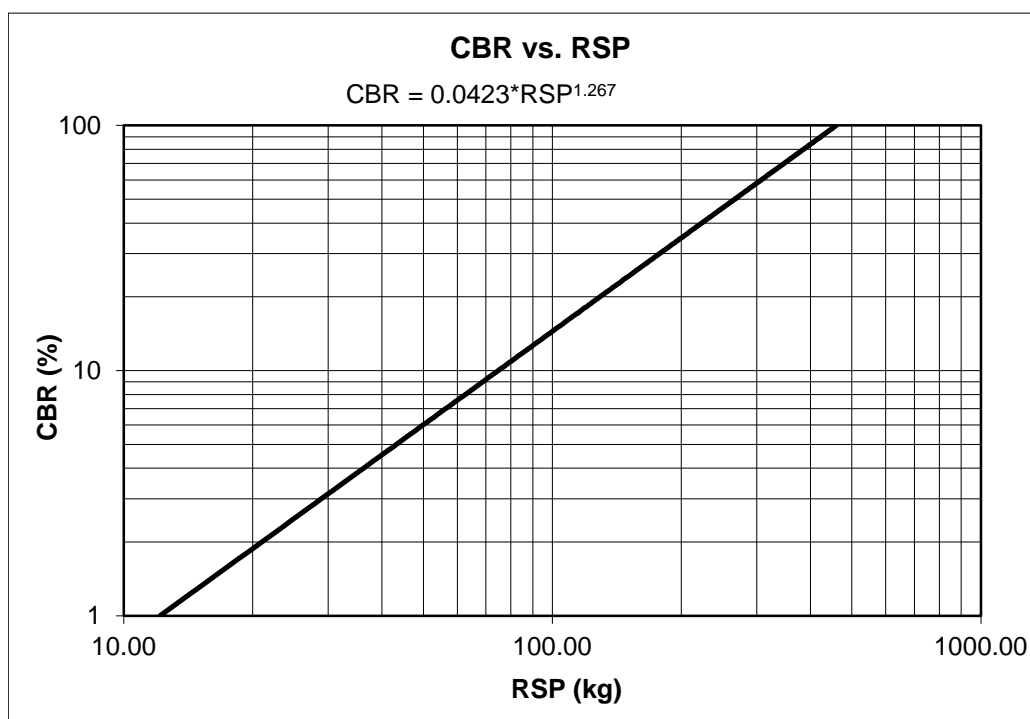


Figure B-2 Correlation Between DCP Index and CBR



**Figure B-3 Correlation Between RSP Index and CBR****B-5.3.2**

Performance of a strength survey shall follow the procedure given in Appendix B-11. For the runway to be considered adequate for aircraft operations, two conditions must be met, as described in paragraphs B-5.3.2.1 and B-5.3.2.2.

**B-5.3.2.1**

All individual penetrometer test site values must be equal to or stronger than the required minimum strength value listed in Table B-1 and shown in Figure B-4.

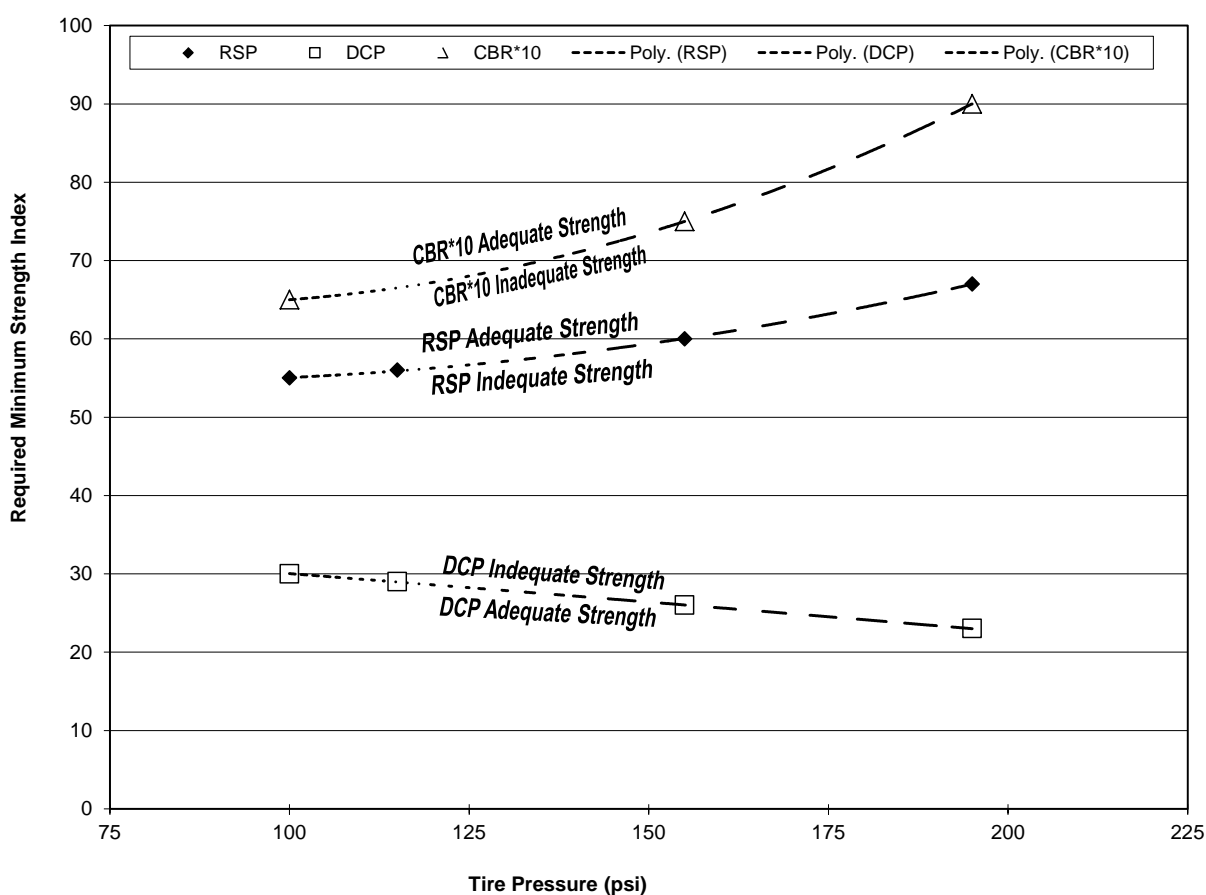
**B-5.3.2.2**

Maintenance (scarify and recompact) is required in areas that do not meet the minimum strength to increase the compacted snow strength. The area must be retested after maintenance is complete.

Table B-1 Minimum Snow Strength Required for White Ice Pavement

Aircraft	Tire Pressure (psi)	Minimum RSP Index	Maximum DCP Index	Minimum CBR Index
C-130	95	55	29	6.8
C-5A	111	56	28	6.9
C-17	155	61	26	7.7
757-200	180	65	24	8.4
P-3	200	69	22	9.1
767-300ER	205	70	22	9.3
A319	210	72	21	9.5

Figure B-4 Strength Criteria for White Ice Pavement



## B-5.3.3

Appendix B-11 suggests a graphical method of quickly assessing the distribution of strength measurements using the White Ice Runway Strength Survey Tool program (contact the National Science Foundation operations manager [see paragraph 1-3] for a copy of this Microsoft® Excel-based program). **Note:** This approach makes it easier to



locate regions of substandard snow strength so maintenance and repair activities can be quickly focused on trouble spots.

#### **B-5.4 White Ice Runway Surface—Allowable Aircraft Loads/Contact Pressures.**

##### **B-5.4.1**

Physical testing and aircraft validation activities at the Pegasus PLZ during the 2001–02 austral summer season (November to March) established the minimum thin snow pavement strength levels for C-130 and C-17 operations. These are shown in terms of several parameters in Table B-1. Note that with a thin processed snow pavement over a strong base material, white ice strength requirements are sensitive to aircraft contact pressure (tire pressure) but quite insensitive to aircraft gross load (since tire and gear load is being supported by the base material). Thus, Table B-1 values are for fully loaded or partially loaded aircraft operating at the noted tire pressures.

##### **B-5.4.2**

The allowable gross load and contact pressure will be applicable to aircraft both landing and taking off. These criteria are based on a condition of negligible surface deformation or rutting. Negligible is defined here as surface damage in isolated areas and not exceeding 25 millimeters (1 inch) in depth. The values in Table B-1 and Figure B-4 are conservative with respect to the vertical bearing load of wheeled aircraft; the values chosen ensure that surface deformations do not occur as a result of other aircraft loads, particularly shear loading of the white ice when aircraft brake or turn sharply.

**FC 3-260-06F**  
**1 June 2015**

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**B-6 SEA ICE STRUCTURAL EVALUATION PROCEDURE****B-6.1 Introduction****B-6.1.1**

Sea ice is often categorized as first-year or multi-year ice. This characterization of the ice indicates much about its nature, with multi-year ice having significantly greater complexity. However, for the purposes of a sea ice runway for heavy wheeled aircraft, this FC will treat both types the same, using overall ice thickness and ice temperature as governors for ice strength, which ultimately determines its ability to support a given aircraft operation.

**B-6.1.2**

Annually, before commencing aircraft operations (in Antarctica, flights on the sea ice runway usually begin in early October each season), the sea ice runway will be evaluated using the structural evaluation criteria in this FC. In addition, the airfield manager will conduct interim evaluations for quality assurance and validation of localized repairs.

**B-6.2 Sea Ice Operating Surface.**

The sea ice operating surface is an exposed, graded sea ice surface, or an ice surface overlain by either a moderately processed thin snow cap (less than 50 millimeters [2 inches]) or a thin layer (less than 75 millimeters [3 inches]) of fresh, loose snow.

**B-6.2.1 Sea Ice Runway Evaluation—Deformation Failure.**

A sea ice surface must be shown to be capable of supporting C-130, C-17, and C-5 aircraft contact pressure levels without compressive or shear failure. The primary sources of ice surface weakness at a sea ice runway site are melt-pockets and brine leaching features. When these occur, they may show minimal surface expression and may give the runway a deceptive appearance of strength. Rigorous maintenance, including the use of a reflective snow cap, can avoid melt problems. Brine leaching occurs as a function of time and such weak areas may become prevalent if the runway is sited on progressively older (multi-year) sea ice. Generally, brine leaching features will not reach a point of concern for a sea ice runway until the ice is four years of age or older. If there is any doubt, or if the conditions described in paragraph B-6.2.1.2 apply, the runway's structural strength must be certified daily. Adequate surface strength will generally be demonstrated by some form of proof rolling to detect zones of weakness.

**B-6.2.1.1 Proof Rolling.**

Full-scale proof rolling tests (see CRREL Monograph 98-1) are required before the first flight of the season following sea ice runway construction.

**B-6.2.1.2 Inspection Requirements.**

During runway operations, if the ice temperature exceeds  $-5^{\circ}\text{C}$  ( $23^{\circ}\text{F}$ ) for an exposed sea ice surface, or  $-3^{\circ}\text{C}$  ( $26.5^{\circ}\text{F}$ ) for a processed or loose snow surface, then a **rigorous daily visual inspection**, especially in the aircraft wheel tracks, is required. Any surface failure detected will require patching (Appendix B-3) and re-certification.

**B-6.2.2 Sea Ice Runway Evaluation—Flexural Failure (Landing and Take-Off).****B-6.2.2.1 Flexural Strength.**

Flexural strength of sea ice is a function of ice temperature, ice thickness, and salinity. Correspondingly, the maximum load capacity of sea ice under aircraft loads is a function of flexural strength and the landing-gear-assembly geometry of each aircraft. Determining the maximum allowable aircraft load from ice thickness and temperature measurements establishes the load capacities for landings and takeoffs on a sea ice runway.

**B-6.2.2.2 Ice Temperature Measurement.****B-6.2.2.2.1**

Collecting ice temperature measurements through the entire ice sheet at many locations on a frequent basis along a sea ice runway is onerous when using traditional technologies (drilling). At McMurdo Sound, seasonal time periods have been established to simplify the analytical process. The method combines ice surface temperatures into “bins,” such that each “bin” represents a period of the operational season. Each time period contains a maximum and minimum surface temperature. Current criteria divide the operational season (October to February) into four periods:

- Mid-October to late November (Period 1:  $-20^{\circ}\text{C}$  to  $-10^{\circ}\text{C}$  [ $-4^{\circ}\text{F}$  to  $14^{\circ}\text{F}$ ])
- Late November to mid-December (Period 2:  $-10^{\circ}\text{C}$  to  $-5^{\circ}\text{C}$  [ $14^{\circ}\text{F}$  to  $23^{\circ}\text{F}$ ])
- Mid-December to late December (Period 3:  $-5^{\circ}\text{C}$  to  $-2^{\circ}\text{C}$  [ $23^{\circ}\text{F}$  to  $28^{\circ}\text{F}$ ] with at least a small temperature gradient (minimum of  $1^{\circ}\text{C}$  per meter [ $0.7^{\circ}\text{F}$  per foot] within a vertical column of ice, with the warmest temperatures at the ice surface and cooler temperatures at some depth)
- Late December through January (Period 4:  $-3^{\circ}\text{C}$  to  $-2^{\circ}\text{C}$  [ $26^{\circ}\text{F}$  to  $28^{\circ}\text{F}$ ] with ice temperature uniform throughout an entire vertical column; this is called an “isothermal condition”)

**B-6.2.2.2.2**

At McMurdo Sound, collect ice temperatures (measured at a depth of 150 millimeters [6 inches]) at a minimum of four locations on the runway proper and at two locations in the apron/parking area. Temperature data will be collected at a minimum of the following

frequencies to verify that the calendar-suggested period is confirmed by ice temperatures. In all cases, actual ice temperatures will govern which period's standards to apply.

- Period 1: Once every two weeks
- Period 2: Once every week
- Period 3: Three times per week and 24 hours before each C-17 aircraft flight
- Period 4: Once every day

### **B-6.2.2.3 Ice Thickness Measurement.**

#### **B-6.2.2.3.1**

Sea ice thickness is the most critical parameter to be established for calculating safe aircraft operations. Sea ice thickness—much more than ice temperature—tends to be slow to change and quite ubiquitous in the McMurdo Sound region. Its annual trend, irrespective of the initial ice thickness in late August, is well established from more than 20 years of data. However, under some circumstances, ice thickness can have considerable local variations. When this situation exists, and ice thicknesses are near the limits for desired aircraft operations, a statistical approach is used to establish sea ice thickness.

#### **B-6.2.2.3.2**

For initial certification, actual ice thickness must be measured at no less than 16 random locations spread throughout the runway surface, with no less than half located within a 15-meter (50-foot) -wide swath down the center of the runway. Since a statistical approach is used, more measurements will lead to greater confidence levels. Following the initial set of thicknesses used to certify opening the sea ice runway, it is acceptable to reduce the number of sea ice thickness measurements to a minimum five on the runway and one on the apron. When only five tests are completed on the runway, the minimum measured thickness will be the controlling thickness for strength evaluation purposes.

#### **B-6.2.2.3.3**

Thickness measurements must begin at least 10 days before the intended onset of flight operations. Measurements will continue throughout the entire duration of flight operations. Measurement frequency will be the same as for temperature measurements (see paragraph B-6.2.2.2).

#### **B-6.2.2.3.4**

Increased measurement density is only required during operating periods when the average thickness of the sea ice is nearing the point where it may limit gross aircraft weights and parking times for the aircraft type to be operated. For large aircraft, this will

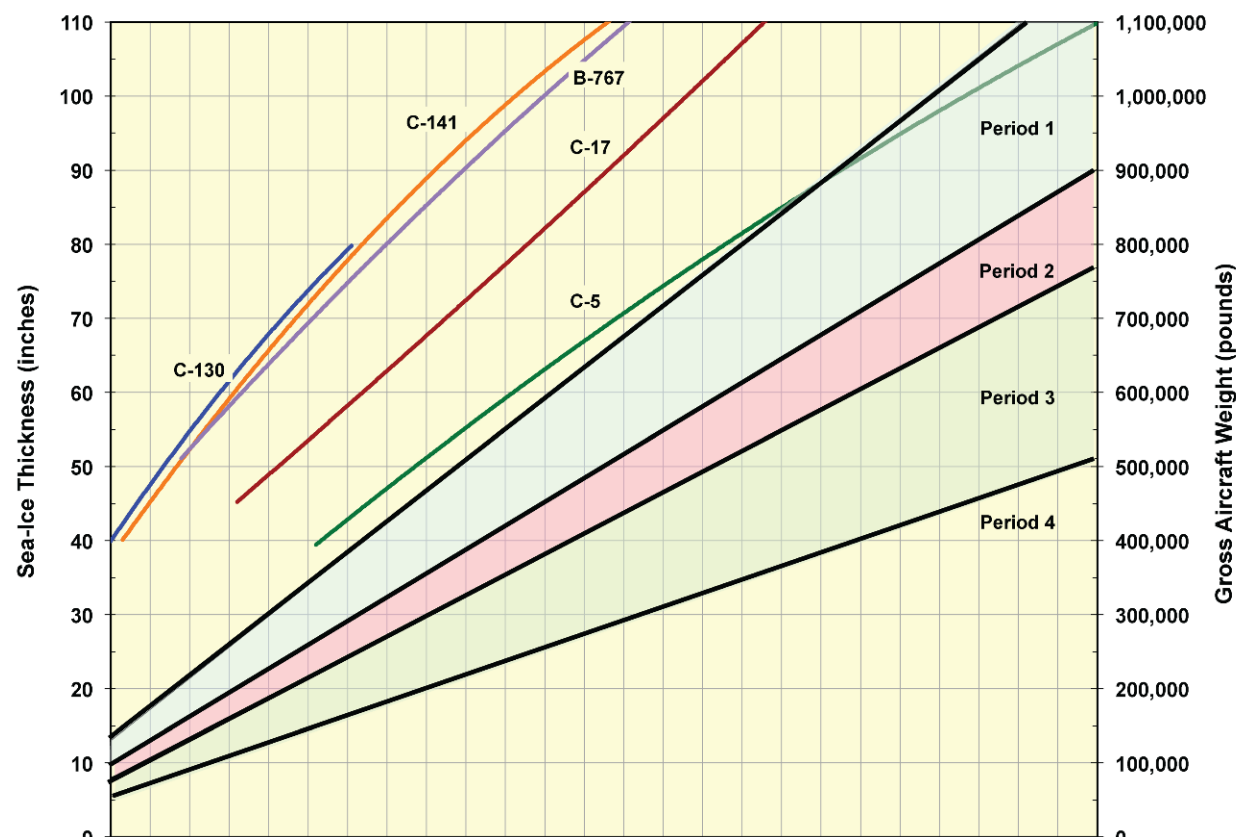
likely be the case any time first-year sea ice is encountered. Appendix B-7 describes the process for establishing the statistically sea ice thickness used for evaluation.

#### **B-6.2.2.4 Factors of Safety.**

Maximum allowable ice stresses have been determined for each of the four temperature-based operational periods using a computer program designed to calculate the flexural beam strength of sea ice. The allowable stresses have factors of safety between 1.3 and 1.4 (25% to 30% of flexural strength).

#### **B-6.2.2.5 Maximum Allowable Stresses.**

Maximum allowable stresses calculated for the four periods of the operational season at McMurdo Sound, combined with ice thickness and landing gear assembly geometry, were input to a model maintained by CRREL to predict the maximum allowable loads of C-130, C-17, and C-5 aircraft operating on the sea ice in McMurdo Sound. A range of sea ice thickness values experienced throughout the operational season were input and the model calculated the maximum allowable aircraft load given as a function of the sea ice runway thickness and the period of operation. Results from the model are presented in Figure B-5 and constitute the operational strength criteria for landing, taxiing, and take-off. The curves in Figure B-5 were developed based on the parameters described above, and each is specific to aircraft type and gear assembly geometry. The Figure B-5 nomograph may be worked from either direction; that is, if one knows the ice thickness and aircraft type to be operated, the maximum landing and take-off load may be calculated. Conversely, knowing what aircraft type and load are desired to be flown to/from the sea ice runway, the required ice thickness can be determined.

**Figure B-5 Landing and Take-off Nomograph for the  
McMurdo Sound Sea Ice Runway****Notes:**

- (1) The relationship between ice thickness, temperature and aircraft load is specific to each aircraft and cannot be used for any other aircraft. Other aircraft of interest will require a new model run to develop allowable load/thickness curves (see FC paragraph 1-3 for contact information if a new analysis is needed).
- (2) Examples of uses for this nomograph are provided in Appendix B-7. See Appendix B-14 for metric conversion factors.
- (3) The nomograph has limited ability to provide a precise answer because of the thickness of lines on the chart, interpolation of temperature or load within bands on the chart, and an individual's technique. While time-consuming, the model used to develop the nomograph can be operated to produce tabulated results that provide a more user-independent solution. Examples of such tables were produced for the C-17 and are included in paragraph B-9.2.

**B-6.2.3 Sea Ice Runway Surface Evaluation—Creep Failure (Parking).****B-6.2.3.1**

Long-term parking at warm ice temperatures can lead to creep deformation of the sea ice. Long-term parking is defined here to mean any time an aircraft is stationary anywhere on sea ice for more than 30 minutes. At ice temperatures below  $-5^{\circ}\text{C}$  ( $23^{\circ}\text{F}$ ), creep deformation is relatively slow. Since the sea ice runway at McMurdo Sound is operated principally as a “turn-around” runway (i.e., arriving aircraft debark within a few

hours, spending limited time on site), it is expected that creep deformation will be negligible. However, if aircraft will be parked for extended time periods, or very heavy loads or thin ice conditions are present, aircraft may have to be periodically moved to avoid excessive creep deformation of the sea ice. A maximum allowable deflection limit of 10% of the ice thickness has been set for parked aircraft. Field tests indicate no major cracking or failures on sea ice until deflections are in excess of 25% of the ice thickness (Vaudrey, 1977). The 10% deflection value was selected because this is the freeboard limit for the ice sheet; although the ice is safe at this point (10% deflection), water could penetrate through existing cracks and holes to the runway surface, raising concern and causing operational difficulties (Barthelemy, 1992). Parking curves have been developed for each aircraft. The curves indicate the maximum time an aircraft can remain stationary as a function of the period (ice temperature), ice thickness, and aircraft type and load. The aircraft must change parking locations if it remains on the ice longer than indicated by the curves. The center of the new parking position must be at least 152.5 meters (500 feet) removed from the original location.

### **B-6.2.3.2**

Care must also be exercised for other concentrated loads, such as fuel tanks. A similar analysis for the safe residence time for a given concentrated infrastructure load for the prevailing ice temperature and thickness will allow for decisions about total loads and placement geometry. Such infrastructure loads must also be taken into account when locating primary or secondary aircraft parking spots.

### **B-6.2.3.3**

Operational strength criteria for aircraft parked on sea ice are presented in Figure B-6. Contact the person(s) listed in paragraph 13 for recommendations on how to analyze for infrastructure or long-term (12 or more hours) group aircraft parking loads.

#### **Figure B-6 Notes:**

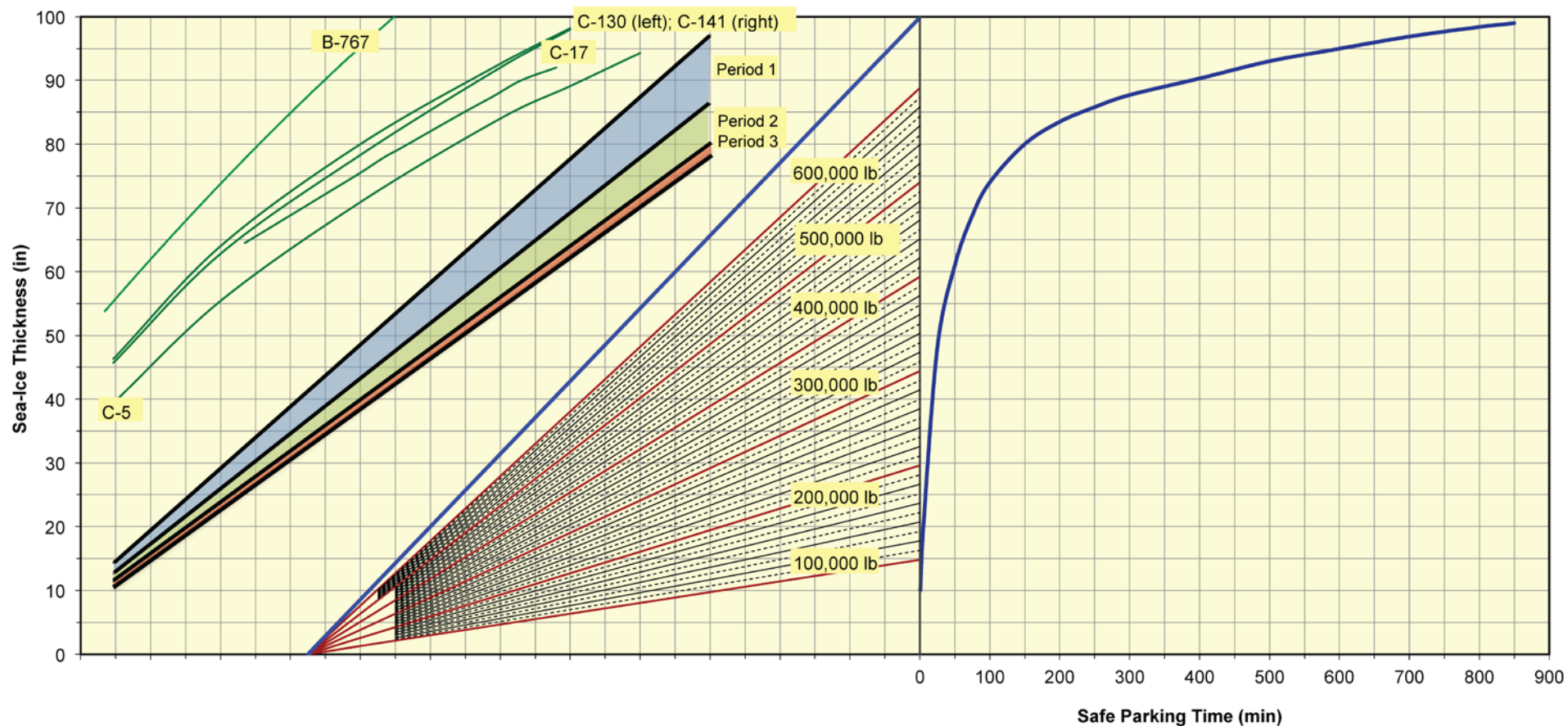
(1) Examples of nomograph use are provided in Appendix B-8. See Appendix B-14 for metric conversion factors.

(2) The nomograph has limited ability to provide a precise answer because of the thickness of lines on the chart, interpolation of temperature or load within bands on the chart, and an individual's technique. While time-consuming, the model used to develop the nomograph can be operated to produce tabulated results which provide a more user-independent solution. Examples of such tables were produced for the C-17 and are included in paragraph B-9.2.



**Figure B-6 Allowable Parking Times for the McMurdo Sound Sea Ice Runway**

(See Appendix B-8 for Usage Directions, Appendix B-9 for an Example Conversion of the Nomograph to Solution Tables for the C-17, and Appendix B-14 for Metric Conversion Factors)



**B-6.2.4****WARNING**

Both landing/take-off and parking criteria must be determined and compared before each aircraft operation. In most cases, the minimum required sea ice thickness will be different for landing/take-off and for parking. The **GREATER** of the two calculated thicknesses must be used in planning for the aircraft mission. At times, adjustment of one or more controllable variables can allow performing an aircraft mission that, as initially planned, would not be allowed. See examples in Appendix B-8 for an illustration of this process.

**B-6.2.5**

The primary source of ice mass weakness at the sea ice runway site is weakening during mid- to late-season operations as sea and air temperatures rise. Cracks may also form in the sea ice sheet at any point during the operational season due to tidal and other ice forces active in the region. Though not unsafe, the cracks may limit mobility and must be repaired before aircraft operations. The sea ice crack-repair procedure is described in Appendix B-3.

**B-6.2.6**

A format for guiding sea ice runway certification is outlined in Appendix B-4. Recall that two conditions must be met for the runway to be considered structurally adequate for aircraft operations, as described in paragraphs B-5.3.2.1 and B-5.3.2.2.

**B-6.2.7**

This FC is written specifically for C-130, C-17, and C-5 aircraft. The load capacity of a sea ice runway changes according to aircraft landing-gear assemblies. Contact the person(s) listed in paragraph 1-3 for recommendations on how to proceed if operational needs are encountered when the ice thickness and temperature restrict necessary flight operations or if a different type of aircraft or landing gear configuration is proposed for operation on the McMurdo Sound sea ice runway.

**B-7**                      **EXAMPLE CALCULATIONS TO ESTABLISH THE STATISTICAL  
SEA ICE THICKNESS VALUE****B-7.1**                    **Example Data**

Twenty runway thickness measurements were made on the sea ice (all measurements in inches): 110, 74, 104, 77, 72, 74, 83, 79, 72, 77, 71, 72, 84, 78, 81, 78, 69, 88, 70, and 74.

**B-7.2**                    **Data Manipulation**

Rank the measurements in ascending order on a spreadsheet and then calculate the percent of thickness measurements equal to or greater than each unique value.

**B-7.3**                    **Data Plotting**

Plot thickness versus percent “equal to or greater than” as shown in Figure B-7.

**B-7.4**                    **Data Application**

Enter Figure B-7 at 85%. Continue to the plotted curve then down to the evaluation thickness of 72 inches for this example.

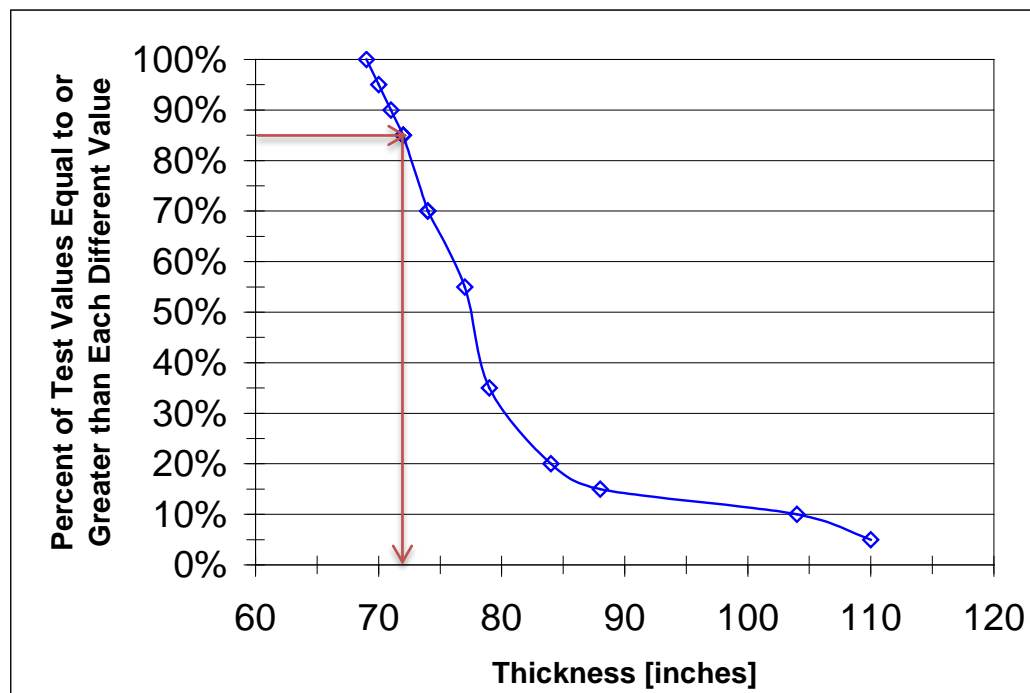
**B-7.5**                    **Data Validation**

If a test measurement is so low that it is clearly an outlying data point (e.g., 10% less than the next lowest measurement) and therefore not representative of other tests on the runway, then additional tests must be completed to determine the extent of the thin area and whether special consideration is required. When the extent is determined, a separate structural analysis of the thin area may be appropriate, resulting in applying appropriate aircraft weight restrictions to the thin area.

**Note:** Sea ice thickness typically increases daily as the season progresses. Therefore, up-to-date thickness measurements are essential to determining the appropriate evaluation thickness.

**Figure B-7 Tabular and Graphical Examples of Statistical Analysis of Sea Ice Thickness Data to Determine a Representative Value****(Defined as the thickness for which less than 15% of the samples are thinner)**

Thickness Measurement [inches]	Number of Tests Equal to or Greater than Each Value	Percent of Tests Equal to or Greater Than Each Value
69	20	100%
70	19	95%
71	18	90%
72	17	85%
72	17	85%
72	17	85%
74	14	70%
74	14	
74	14	70%
77	11	
77	11	55%
78	9	
78	9	
79	7	35%
81	6	
83	5	
84	4	20%
88	3	15%
104	2	10%
110	1	5%



**B-8** **EXAMPLE CALCULATIONS USING LANDING AND TAKE-OFF  
AND PARKING NOMOGRAPHS****B-8.1** **Example 1.****B-8.1.1**

A measured mean sea ice thickness of 1.83 meters (72 inches) exists on McMurdo Sound. The date is 1 November and the measured mean sea ice temperature for the past week is  $-17^{\circ}\text{C}$  ( $1^{\circ}\text{F}$ ). An oversize load, critical to USAP operations, is required in McMurdo Sound. Because of the cargo's size and critical nature, it must be delivered by C-5. In planning for this flight operation, what is the maximum safe gross aircraft landing load given the current sea ice conditions?

**B-8.1.2**

On the landing and take-off nomograph (Figure B-8) locate 1.83 meters (72 inches) on the left-side vertical axis and draw a horizontal line intersecting the C-5 curve (a). Draw a vertical line from this intersection point to a position representing the scaled location of  $-17^{\circ}\text{C}$  ( $1^{\circ}\text{F}$ ) (vertically between the Period 1 band limits of  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ ) (upper line in band) and  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ ) (lower line in band) (b). From this position, draw a horizontal line to the right-side vertical axis where it can be seen that a maximum C-5 gross weight of 620,000 pounds can be safely supported for take-offs and landings (c).

**B-8.2** **Example 2.****B-8.2.1**

Preliminary flight planning for the USAP field season favors operating C-17 aircraft well into Period 2 ice conditions. The final C-17 flight is desired for 12 December. The anticipated gross C-17 weight will be about 370,000 pounds for this final flight. What sea ice thickness will be required to support landing this planned flight?

**B-8.2.2**

On the landing and take-off nomograph (Figure B-9) locate 370,000 pounds on the right-side vertical axis and draw a horizontal line to a position representing the scaled location of 12 December vertically between the Period 2 band limits of about 25 November (upper line in band) and about 15 December (lower line in band) (a). Draw a vertical line from this point to the C-17 curve (b). From this intersection point, draw a horizontal line to intersect the left-side vertical axis, showing that about 78 inches of sea ice must be present for safe take-offs and landings.

**B-8.2.3**

Planners can use historical ice data to determine if there is a good likelihood of this ice thickness being present at a particular time. In any case, as the time nears 12 December, actual measured sea ice thicknesses will govern (via use of the nomograph

as depicted in Example 1 [Figure B-8]) exactly what gross C-17 weight can safely be supported.

### **B-8.3                    Example 3.**

#### **B-8.3.1**

The C-5 operation presented in Example 1 (Figure B-8) determined that a maximum gross weight of 620,000 pounds for landing and take-off is dictated by the sea ice conditions. It is known that about 1.5 hours will be required after the C-5 is parked for off-loading, refueling, and pre-flight preparations. Can the C-5 at 620,000 pounds safely park on the sea ice for 1.5 hours?

#### **B-8.3.2**

On the parking nomograph (Figure B-10) locate 72 inches on the left-side vertical axis and draw a horizontal line to intersect with the C-5 curve (a). Then draw a vertical line from this intersection point to a position representing the scaled location of  $-17^{\circ}\text{C}$  ( $1^{\circ}\text{F}$ ) vertically between the Period 1 band limits of  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ ) (upper line in band) and  $-10^{\circ}\text{C}$  ( $14^{\circ}\text{F}$ ) (lower line in band) (b). From this position, draw a horizontal line to a point representing the gross aircraft weight (vertically scaled location between provided weight curves) (c). Now draw a vertical line upward to the reflection surface (d). A horizontal line from the reflection surface is then drawn to intersect the parking curve (e). Lastly, a vertical line is then drawn to intersect the horizontal safe parking time axis where it can be seen that the C-5 mission considered will only allow about 25 minutes of parking time before creep failure of the sea ice.

#### **B-8.3.3**

Two possibilities exist for alleviating this situation. First, and easiest, is to minimize the gross weight of the C-5. While the landing nomograph (Figure B-8) indicates that a maximum gross weight of 620,000 pounds can be safely landed, a lesser weight is certainly also safe. If the C-5 gross arrival weight could be reduced to about 475,000 pounds, a parking time of about 75 minutes could be achieved. If the aircraft cannot be reduced to this load level, an alternative is to minimize the landing/parking weight as possible and plan for moving the parked aircraft one or more times during the off-loading process. This is quite inefficient and requires significant planning but has occasionally been necessary. The distance moved must be greater than two times the overall width of the aircraft (wingspan) and can be in any direction. As soon as the aircraft is parked in its new location the parking time clock restarts.

### **B-8.4                    Example 4.**

#### **B-8.4.1**

A two-hour parking time is required to achieve unloading and back-loading of a C-17 mission very late in the life of the annual McMurdo Sound sea ice runway (30 December). It is expected that the C-17 will have an average weight of 500,000 pounds

during a large part of its parked time. What sea ice thickness will be necessary to support this flight?

**B-8.4.2**

On the parking nomograph (Figure B-11), locate 120 minutes on the horizontal safe parking time axis and draw a vertical line to intersect the parking curve (a). From this intersection point, draw a horizontal line to the reflection surface (b). From there, drop vertically to the 500,000 pounds aircraft load line (c). A horizontal line from this point to a temperature-representative point within Period 3 follows (d). Then draw a line vertically to intersect the C-17 curve (e). From here, a horizontal line can be seen to intersect the sea ice thickness axis at about 90 inches (f).

Figure B-8 Example 1  
(See Attachment B-14 for Metric Conversion Factors)

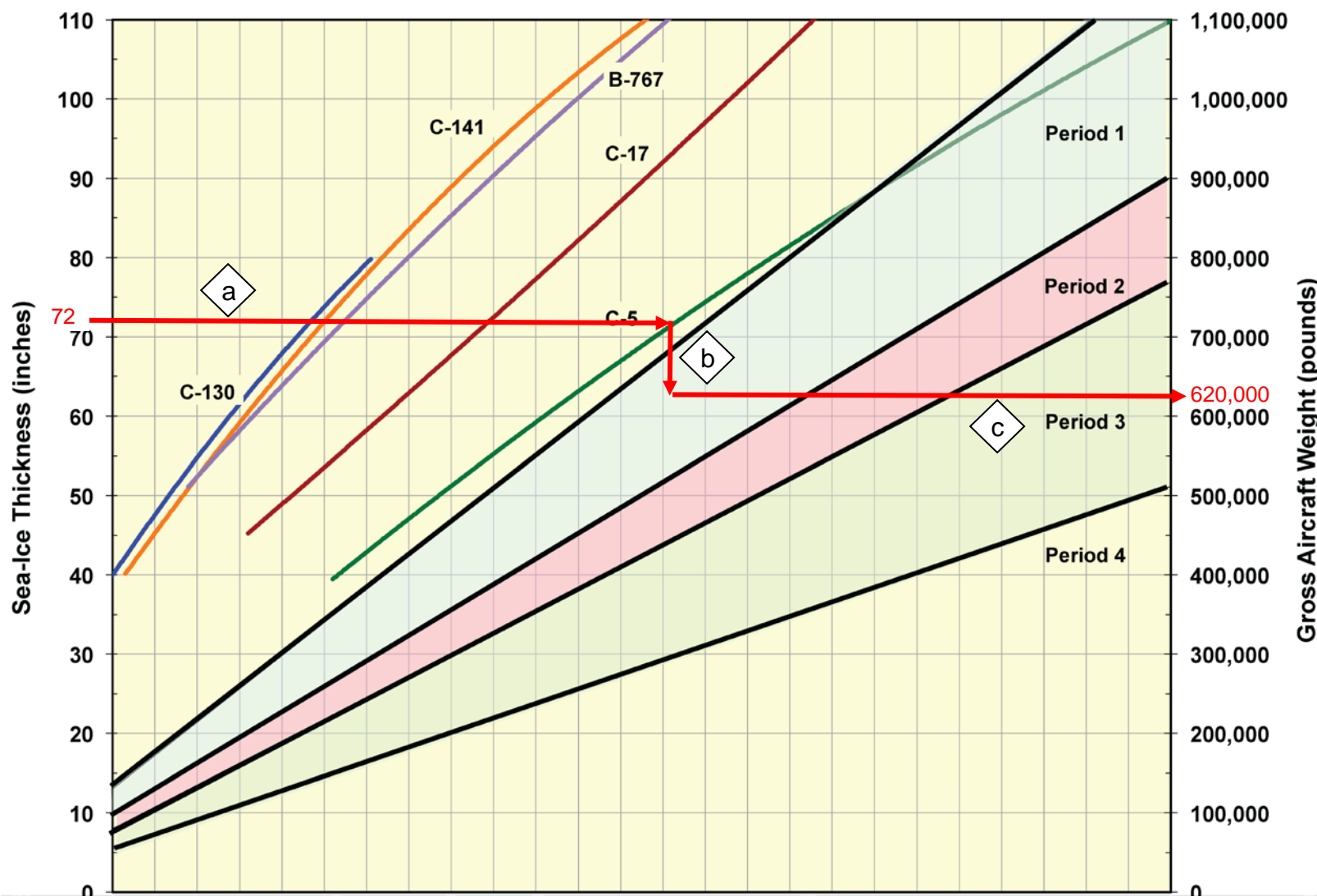
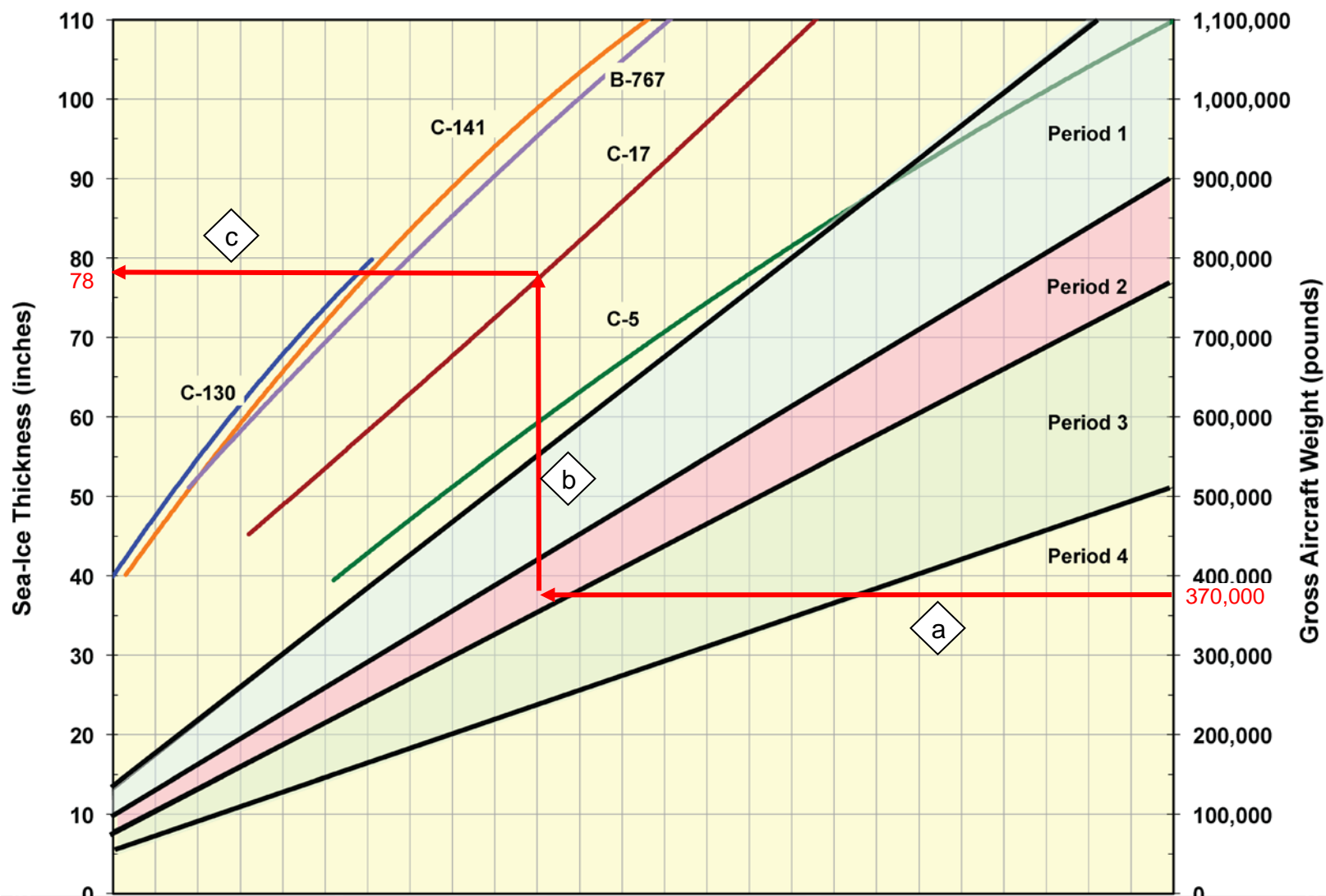
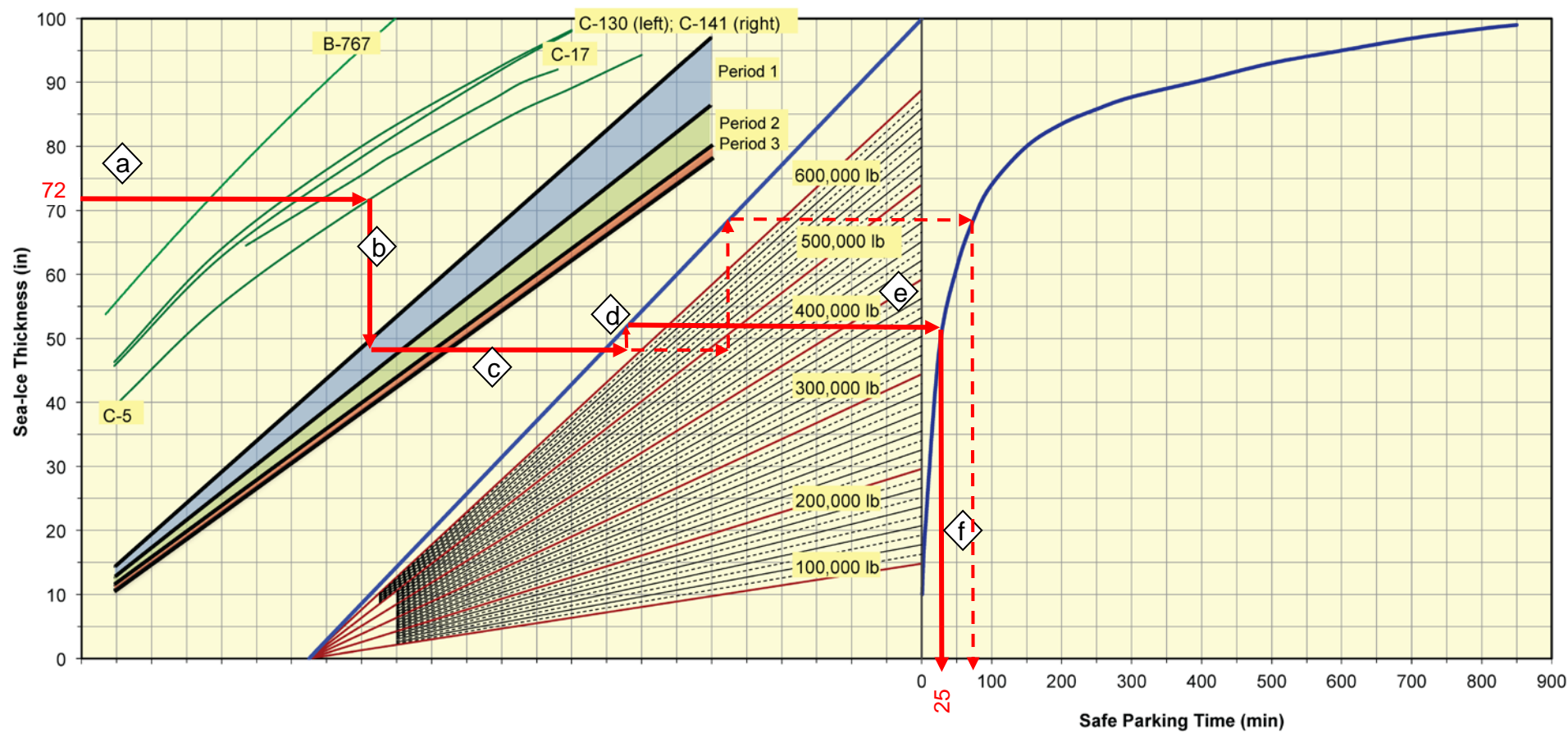




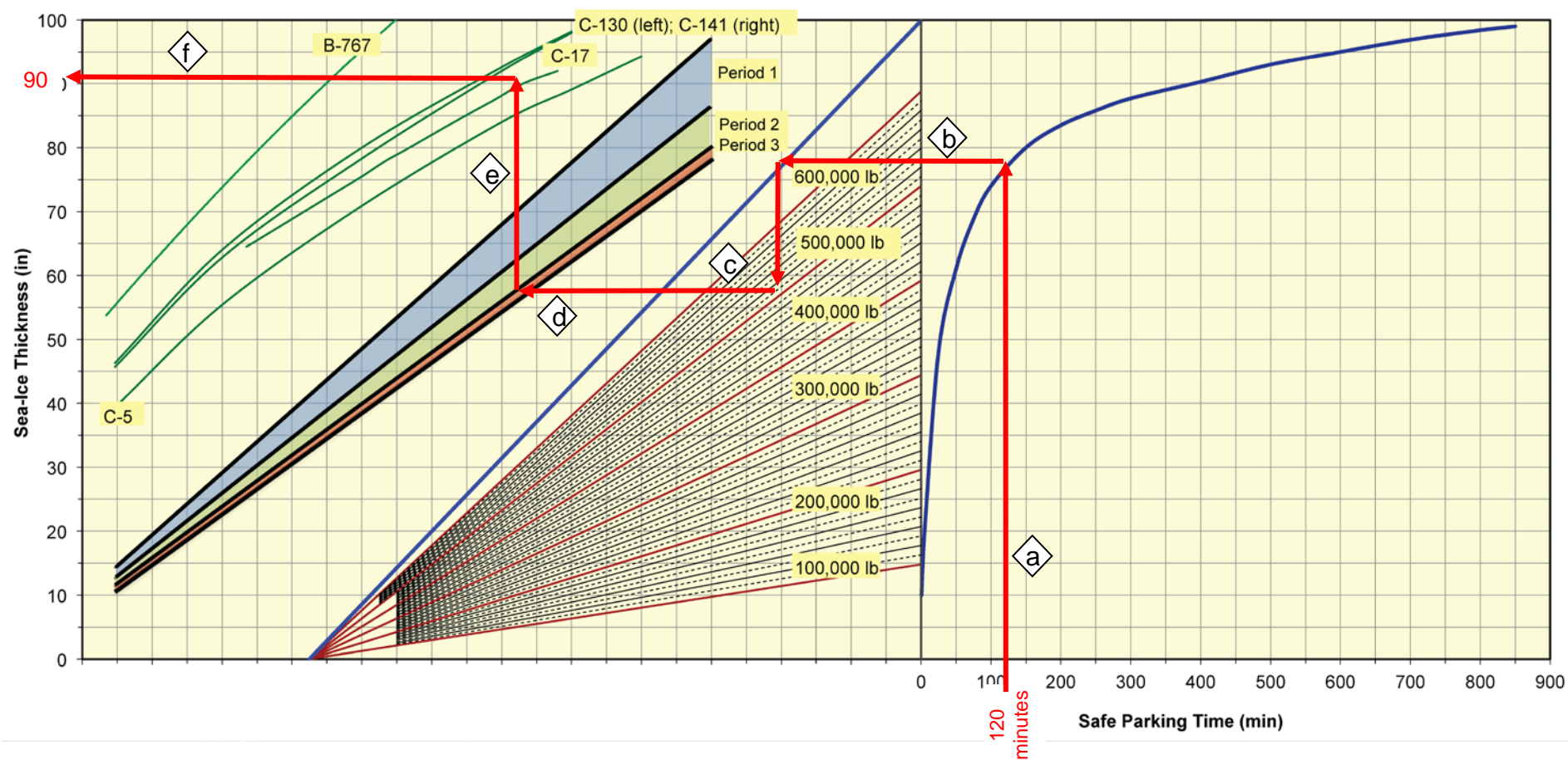
Figure B-9 Example 2  
(See Attachment B-14 for Metric Conversion Factors)



**Figure B-10 Example 3**  
(See Attachment B-14 for Metric Conversion Factors)



**Figure B-11 Example 4**  
(See Attachment B-14 for Metric Conversion Factors)



**FC 3-260-06F**  
**1 June 2015**

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**B-9                    TABULATED RESULTS FROM APPLICATION OF LANDING/TAKE-OFF AND PARKING NOMOGRAPHS TO C-17 AND BOEING 767-300ER AIRCRAFT AT MCMURDO SOUND SEA ICE RUNWAY****B-9.1                Nomographs - General**

The nomographs for safe landing/take-off (Figure B-5) and safe parking time (Figure B-6) have limited ability to provide a precise answer because of the thickness of lines on the chart, interpolation of temperature or load within bands on the chart, and an individual's technique. By applying the mathematical relationships used to generate the nomographs, tables of values for discrete temperatures and loads can be produced.

**B-9.2                C-17 Nomographs**

Figure B-12 depicts the safe landing and take-off loads (in pounds) for the C-17 aircraft between the temperature limits represented by McMurdo Sound Period 1 to Period 4. Figures B-14 to B-37 give safe parking times (in hours) for individual temperatures at 10,000-pound (4500-kilogram) increments of gross C-17 weight.

**B-9.3                B767 Nomographs**

Figure B-13 depicts the safe landing and take-off loads (in pounds) for the B767-300ER aircraft between the temperature limits represented by McMurdo Sound Period 1 to Period 4. Figures B-38 to B-61 give safe parking times (in hours) for individual temperatures at 10,000-pound (4500-kilogram) increments of gross B767-300ER weight.



**Figure B-12 Tabular Representation of Landing/Take-Off Nomograph for C-17**

**(Values in Table are Gross Aircraft Weight in Pounds)**

[illegible]

**FC 3-260-06F**  
**1 June 2015**

**Figure B-13 Tabular Representation of Landing/Take-Off Nomograph for B767-300ER**

**(Values in Table are Gross Aircraft Weight in Pounds)**

Ice Thickness (Inches)	Ice Temperature																		
	28.0	27.0	26.1	25.0	24.1	23.0	21.9	21.0	19.9	19.0	17.1	16.0	15.1	14.0	12.0	10.0	8.1	6.1	3.9
	-2.2	-2.8	-3.3	-3.9	-4.4	-5	-5.6	-6.1	-6.7	-7.2	-8.3	-8.9	-9.4	-10	-11.1	-12.2	-13.3	-14.4	-15.6
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(Values in Table are Parking Time in Hours at a Single Location)

80



**Figure B-15 Tabular Representation of Parking Nomograph for C-17 on -2 °F (-19 °C) Sea Ice**

**(Values in Table are Parking Time in Hours at a Single Location)**

[illegible]

**(Values in Table are Parking Time in Hours at a Single Location)**

		Gross C-17 Weight (lb)																																																											
		280,000	290,000	300,000	310,000	320,000	330,000	340,000	350,000	360,000	370,000	380,000	390,000	400,000	410,000	420,000	430,000	440,000	450,000	460,000	470,000	480,000	490,000	500,000	510,000	520,000	530,000	540,000	550,000	560,000	570,000	580,000	590,000	600,000																											
50	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																									
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
52	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
54	55	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
56	57	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
58	59	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3																										
		0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
60	61	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		0.7	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
62	63	1.2	1.0	1.0	0.7	0.7	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3																										
		1.5	1.2	1.0	0.8	0.7	0.7	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3																										
64	65	1.8	1.5	1.3</																																																									



**(Values in Table are Parking Time in Hours at a Single Location)**

84

**Figure B-19 Tabular Representation of Parking Nomograph for C-17 on 6 °F (-14 °C) Sea Ice**

**(Values in Table are Parking Time in Hours at a Single Location)**

[illegible]

(Values in Table are Parking Time in Hours at a Single Location)

86

(Values in Table are Parking Time in Hours at a Single Location)

87



**(Values in Table are Parking Time in Hours at a Single Location)**

88



FC 3-260-06F  
1 June 2015

Figure B-23 Tabular Representation of Parking Nomograph for C-17 on 14 °F (-10 °C) Sea Ice

(Values in Table are Parking Time in Hours at a Single Location)

14 F	280,000	290,000	300,000	310,000	320,000	330,000	340,000	350,000	360,000	370,000	380,000	390,000	400,000	410,000	420,000	430,000	440,000	450,000	460,000	470,000	480,000	490,000	500,000	510,000	520,000	530,000	540,000	550,000	560,000	570,000	580,000	590,000	600,000
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
63	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
64	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
65	1.3	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
66	1.7	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
67	2.0	1.7	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
68	2.5	2.0	1.7	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
69	3.2	2.7	2.2	1.8	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
70	4.0	3.3	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
71	5.2	4.2	3.3	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
72	6.5	5.2	4.2	3.3	2.7	2.3	1.8	1.7	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
73	8.2	6.5	5.2	4.2	3.3	2.8	2.3	2.0	1.7	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
74	10.3	8.0	6.3	5.2	4.2	3.3	2.8	2.3	2.0	1.7	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
75	13.2	10.2	8.0	6.3	5.2	4.2	3.3	2.8	2.3	2.0	1.7	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
76	16.8	12.8	10.0	7.8	6.3	5.2	4.2	3.5	3.0	2.5	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
77	21.3	16.2	12.5	9.8	7.8	6.3	5.2	4.3	3.5	3.0	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2
78	27.3	20.5	15.7	12.3	9.7	7.8	6.3	5.2	4.3	3.7	3.0	2.7	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3
79	34.8	26.0	19.8	15.3	12.0	9.7	7.8	6.3	5.3	4.3	3.7	3.2	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3
80	44.7	33.2	25.0	19.2	15.0	12.0	9.5	7.8	6.3	5.3	4.5	3.8	3.2	2.8	2.3	2.0	1.8	1.7	1.3	1.2	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3
81	57.5	42.2	31.7	24.2	18.7	14.8	11.8	9.5	7.8	6.5	5.3	4.5	3.8	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3
82	74.2	54.0	40.2	30.3	23.3	18.3	14.5	11.7	9.5	7.8	6.5	5.5	4.7	4.0	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3
83	95.8	69.2	51.0	38.3	29.3	22.8	18.0	14.3	11.7	9.5	7.8	6.5	5.5	4.7	4.0	3.5	3.0	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.3
84	124.2	88.8	65.0	48.5	36.8	28.5	22.3	17.7	14.3	11.7	9.5	8.0	6.7	5.7	4.8	4.2	3.5	3.0	2.7	2.3	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.7	0.7	0.7
85	161.3	114.3	83.0	61.3	46.3	35.5	27.7	21.8	17.5	14.2	11.7	9.7	8.0	6.7	5.7	4.8	4.2	3.7	3.2	2.8	2.5	2.2	2.0	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.7	0.7
86	>200	147.7	106.2	78.0	58.3	44.5	34.5	27.0	21.5	17.3	14.2	11.7	9.7	8.2	6.8	5.8	5.0	4.3	3.7	3.3	2.8	2.5	2.2	2.0	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8
87	>200	191.5	136.5	99.5	73.8	55.8	43.0	33.5	26.5	21.3	17.2	14.2	11.7	9.7	8.2	7.0	6.0	5.2	4.5	3.8	3.3	3.0	2.7	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.0	1.0	1.0
88	>200	>200	175.8	127.2	93.7	70.3	53.8	41.7	32.8	26.2	21.0	17.2	14.2	11.7	9.8	8.3	7.0	6.0	5.2	4.5	4.0	3.5	3.0	2.7	2.3	2.2	2.0	1.7	1.5	1.3	1.2	1.0	1.0
89	>200	>200	>200	163.0	119.2	89.0	67.5	52.0	40.7	32.2	25.9	21.0	17.2	14.2	11.8	10.0	8.5	7.2	6.2	5.3	4.7	4.0	3.5	3.2	2.8	2.5	2.2	2.0	1.8	1.7	1.5	1.3	1.2
90	>200	>200	>200	>200	152.2	112.7	84.8	65.0	50.5	39.8	31.7	25.7	20.8	17.2	14.3	12.0	10.2	8.7	7.3	6.3	5.5	4.8	4.2	3.7	3.3	2.8	2.5	2.2	2.0	1.8	1.7	1.5	1.3
91	>200	>200	>200	>200	194.8	143.2	107.2	81.5	62.8	49.3	39.0	31.3	25.5	20.8	17.2	14.3	12.2	10.3	8.8	7.5	6.5	5.7	5.0	4.3	3.8	3.3	3.0	2.7	2.3	2.2	2.0	1.8	1.7
92	>200	>200	>200	>200	>200	182.5	135.5	102.5	78.7	61.2	48.2	38.5	31.2	25.3	20.8	17.3	14.5	12.3	10.5	9.0	7.7	6.7	5.8	5.2	4.5	4.0	3.5	3.2	2.8	2.5	2.3	2.0	1.8
93	>200	>200	>200	>200	>200	172.2	129.2	98.5	76.2	59.8	47.5	38.2	31.0	25.3	21.0	17.5	14.7	12.5	10.7	9.2	7.8	6.8	6.0	5.2	4.7	4.2	3.7	3.2	2.8	2.7	2.3	2.2	2.2
94	>200	>200	>200	>200																													

(Values in Table are Parking Time in Hours at a Single Location)

90

**(Values in Table are Parking Time in Hours at a Single Location)**

91

(Values in Table are Parking Time in Hours at a Single Location)

92

**(Values in Table are Parking Time in Hours at a Single Location)**

93

(Values in Table are Parking Time in Hours at a Single Location)

94

**(Values in Table are Parking Time in Hours at a Single Location)**

95



**(Values in Table are Parking Time in Hours at a Single Location)**

		Gross C-17 Weight (lb)																																																											
		280,000	290,000	300,000	310,000	320,000	330,000	340,000	350,000	360,000	370,000	380,000	390,000	400,000	410,000	420,000	430,000	440,000	450,000	460,000	470,000	480,000	490,000	500,000	510,000	520,000	530,000	540,000	550,000	560,000	570,000	580,000	590,000	600,000																											
50	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	56	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	57	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	58	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	59	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	60	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
	61	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	62	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	63	0.7	0.5	0.5	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	64	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	65	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	66	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0																										
	67	1.7	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0																										
	68	2.2	1.7	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0																										
	69	2.7	2.2	1.7	1.5	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0																										
70	3.3	2.7	2.2	1.8	1.5	1.3	1.0	0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
71	4.2	3.3	2.7	2.2	1.8	1.5	1.3	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
72	5.2	4.2	3.3	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
73	6.5	5.2	4.2	3.3	2.7	2.3	1.8	1.7	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
74	8.2	6.2	5.2	4.2	3.3	2.8	2.3	2.0	1.7	1.5	1.2	1.0	1.0	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
75	10.3	8.0	6.3	5.2	4.2	3.3	2.8	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
76	13.0	10.0	7.8	6.3	5.2	4.2	3.5	2.8	2.5	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
77	16.5	12.7	9.8	7.8	6.3	5.2	4.2	3.5	2.8	2.5	2.2	1.8	1.5	1.3	1.2	1.0	1.0	0.8	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
78	21.0	15.6	12.3	9.7	7.7	6.2	5.2	4.2	3.5	3.0	2.5	2.2	1.8	1.7	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2																											
79	26.7	20.0	15.3	12.0	9.7	7.7	6.2	5.2	4.3	3.5	3.0	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2																											
80	33.8	25.3	19.3	15.0	11.8	9.3	7.7	6.2	5.2	4.3	3.7	3.0	2.7	2.3	2.0	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3																											
81	43.3	32.0	24.2	18.7	14.7	11.7	9.3	7.5	6.2	5.2	4.3	3.7	3.2	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.2	1.0	0.8	0.8	0.7	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3																											
82	55.3	40.7	30.5	23.3	18.2	14.3	11.5	9.3	7.5	6.3	5.2	4.3	3.7	3.2	2.8	2.3	2.2	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3																											
83	71.0	51.8	38.5	29.2	22.5	17.7	14.0	11.3	9.2	7.5	6.3	5.3	4.5	3.8	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3																											
84	91.3	66.0	48.8	36.7	28.2	21.8	17.3	13.8	11.2	9.2	7.7	6.3	5.3	4.5	3.8	3.3	2.8	2.5	2.2	2.0	1.7	1.5	1.3	1.2	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3																											
85	117.8	84.5	61.8	46.2	35.2	27.2	21.3	17.0	13.7	11.2	9.2	7.7	6.3	5.5	4.7	4.0	3.5	3.0	2.7	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5																											
86	152.3	108.3	78.3	58.3	44.0	33.8	26.3	20.8	15.7	13.5	11.2	9.2	7.7	6.6	5.5	4.7	4.0	3.5	3.0	2.7	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5																											
87	197.8	139.3	100.3	73.8	55.3	42.2	32.7	25.8	20.5	16.5	13.5	11.2	9.3	7.8	6.5	5.7	4.8	4.2	3.7	3.2	2.8	2.5	2.2	2.0	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7																											
88	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
89	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
90	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
91	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
92	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
93	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																											
94	>200</																																																												



**(Values in Table are Parking Time in Hours at a Single Location)**

Gross C-17 Weight (lb)																																																											
	280,000	290,000	300,000	310,000	320,000	330,000	340,000	350,000	360,000	370,000	380,000	390,000	400,000	410,000	420,000	430,000	440,000	450,000	460,000	470,000	480,000	490,000	500,000	510,000	520,000	530,000	540,000	550,000	560,000	570,000	580,000	590,000	600,000																										
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
56	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
57	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
58	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
59	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
60	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
61	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
62	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
63	0.7	0.5	0.5	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
64	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
65	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
66	1.3	1.0	0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0																										
67	1.7	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0																										
68	2.0	1.7	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0																										
69	2.5	2.0	1.7	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
70	3.2	2.5	2.2	1.7	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
71	4.0	3.2	2.7	2.2	1.8	1.5	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
72	5.0	4.0	3.2	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
73	6.3	5.0	4.0	3.2	2.7	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
74	8.0	6.2	5.0	4.0	3.3	2.7	2.3	1.8	1.7	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
75	10.0	7.8	6.2	5.0	4.0	3.3	2.7	2.3	2.0	1.7	1.5	1.2	1.0	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
76	12.7	9.7	7.7	6.2	5.0	4.0	3.3	2.8	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
77	16.0	12.2	9.5	7.5	6.0	5.0	4.0	3.3	2.8	2.3	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2																										
78	20.2	15.3	11.3	8.5	6.5	5.0	4.0	3.3	2.8	2.3	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2																										
79	25.7	19.3	14.8	11.3	8.2	6.0	5.0	4.2	3.5	3.0	2.6	2.2	1.8	1.7	1.5	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2																										
80	32.5	24.3	18.7	14.5	11.3	9.2	7.3	6.0	5.0	4.2	3.5	3.0	2.5	2.2	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3																										
81	41.5	30.8	23.3	18.0	14.2	11.2	9.0	7.3	6.0	5.0	4.2	3.5	3.0	2.7	2.3	2.0	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3	0.3																										
82	53.2	39.2	29.3	22.5	17.5	13.8	11.0	9.0	7.3	6.0	5.0	4.3	3.7	3.2	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3	0.3	0.3																										
83	68.0	49.7	37.0	28.2	21.7	17.0	13.5	11.0	8.8	7.3	6.2	5.2	4.3	3.7	3.2	2.8	2.3	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.3																										
84	87.5	63.3	46.8	35.3	27.0	21.2	16.7	13.3	10.8	8.8	7.3	6.2	5.2	4.3	3.8	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5																										
85	112.7	80.8	59.3	44.3	33.8	26.2	20.5	16.3	13.2	10.8	8.8	7.3	6.2	5.3	4.5	3.8	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5																										
86	145.7	103.5	75.5	56.0	42.5	32.5	25.0	19.3	15.2	12.3	10.8	8.8	7.3	6.2	5.3	4.5	3.8	3.3	2.7	2.2	1.8	1.7	1.5	1.3	1.2	1.0	1.0	0.8	0.8	0.7	0.7	0.5	0.5																										
87	188.8	133.0	96.0	70.7	53.2	40.7	31.5	24.8	19.8	16.0	13.0	10.8	9.0	7.5	6.3	5.5	4.7	4.0	3.5	3.0	2.7	2.3	2.2	1.8	1.7	1.5	1.3	1.2	1.2	1.0	0.8	0.8	0.8																										
88	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
89	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
90	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
91	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
92	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
93	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																										
94	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200	>200																												

FC 3-260-06F  
1 June 2015

Figure B-32 Tabular Representation of Parking Time in Hours at a Single Location

(Values in Table are Parking Time in Hours at a Single Location)

23 F		Gross C-17 Weight (lb)																																																											
		280,000	290,000	300,000	310,000	320,000	330,000	340,000	350,000	360,000	370,000	380,000	390,000	400,000	410,000	420,000	430,000	440,000	450,000	460,000	470,000	480,000	490,000	500,000	510,000	520,000	530,000	540,000	550,000	560,000	570,000	580,000	590,000	600,000																											
50	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																											
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0.3	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																										
		0.1	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																									
		0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		1.8	1.5	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		2.2	1.8	1.5	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		2.7	2.2	1.8	1.5	1.3	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
		3.5	2.8	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																										
4.3	3.5	2.8	2.3	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																												
5.3	4.2	3.5	2.8	2.3	2.0	1.7	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																												
6.7	5.3	4.2	3.5	2.8	2.3	2.0	1.7	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																												
8.3	6.5	5.2	4.2	3.5	2.8	2.3	2.0	1.7	1.5	1.2	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																												
10.5	8.2	6.5	5.2	4.2	3.5	2.8	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																												
13.3	10.2	8.0	6.3	5.2	4.2	3.5	2.8	2.5	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2																												
16.7	12.8	10.0	7.8	6.3	5.2	4.2	3.5	3.0	2.5	2.2	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2																												
21.2	16.0	12.3	9.7	7.8	6.3	5.2	4.2	3.5	3.0	2.5	2.2	1.8	1.7	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2																												
26.7	20.2	15.5	12.0	9.5	7.7	6.2	5.2	4.3	3.5	3.0	2.7	2.2	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3																												
33.8	25.3	19.3	15.0	11.8	9.3	7.7	6.2	5.2	4.3	3.7	3.0	2.7	2.3	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3																												
43.2	32.0	24.2	18.7	14.5	11.5	9.3	7.5	6.2	5.2	4.3	3.7	3.2	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3																												
55.0	40.3	30.3	23.2	18.0	14.2	11.3	9.2	7.5	6.2	5.2	4.3	3.7	3.2	2.7	2.3	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3																												
70.2	51.2	38.2	29.0	22.3	17.5	14.0	11.2	9.2	7.5	6.3	5.2	4.5	3.8	3.3	2.8	2.5	2.2	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5																												
90.0	65.2	48.2	36.2	27.8	21.7	17.2	13.7	11.2	9.2	7.5	6.3	5.3	4.5	3.8	3.3	2.8	2.5	2.2	2.0	1.7	1.5	1.3	1.2	1.0	0.8	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.5																												
115.7	83.0	60.8	45.5	34.7	26.8	21.0	16.7	13.5	11.0	9.0	7.5	6.3	5.3	4.5	4.0	3.3	3.0	2.5	2.3	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.5	0.5	0.5	0.5	0.5																												
149.2	106.0	77.0	57.2	43.2	33.2	26.0	20.5	16.5	13.3	11.0	9.0	7.5	6.3	5.5	4.7	4.0	3.5	3.0	2.7	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.7	0.7	0.7																												
192.8	135.8	98.0	72.2	54.2	41.3	32.0	25.2	20.2	16.2	13.2	11.0	9.2	7.7	6.5	5.5	4.7	4.0	3.5	3.2	2.7	2.3	2.2	1.8	1.7	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.7	0.7																												
>200	174.7	125.0	91.3	68.0	51.5	39.7	31.2	24.7	19.8	16.0	13.2	11.0	9.2	7.7	6.5	5.7	4.8	4.2	3.7	3.2	2.8	2.5	2.2	2.0	1.8	1.5	1.3	1.2	1.0	0.8	0.7	0.7	0.7																												
>200	>200	159.8	115.8	85.7	64.5	49.3	38.3	30.3	24.2	19.5	16.0	13.2	11.0	9.2	7.8	6.7	5.7	4.8	4.3	3.7	3.3	2.8	2.5	2.3	2.0	1.8	1.5	1.3	1.2	1.0																															

**(Values in Table are Parking Time in Hours at a Single Location)**

99

(Values in Table are Parking Time in Hours at a Single Location)

100

(Values in Table are Parking Time in Hours at a Single Location)

[illegible]

**(Values in Table are Parking Time in Hours at a Single Location)**

102

(Values in Table are Parking Time in Hours at a Single Location)

103



(Values in Table are Parking Time in Hours at a Single Location)

104



**(Values in Table are Parking Time in Hours at a Single Location)**

105

**(Values in Table are Parking Time in Hours at a Single Location)**

106

**(Values in Table are Parking Time in Hours at a Single Location)**

107



(Values in Table are Parking Time in Hours at a Single Location)

108

(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

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**(Values in Table are Parking Time in Hours at a Single Location)**

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(Values in Table are Parking Time in Hours at a Single Location)

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121

(Values in Table are Parking Time in Hours at a Single Location)

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(Values in Table are Parking Time in Hours at a Single Location)

123



**(Values in Table are Parking Time in Hours at a Single Location)**

124

(Values in Table are Parking Time in Hours at a Single Location)

125

**(Values in Table are Parking Time in Hours at a Single Location)**

126



**(Values in Table are Parking Time in Hours at a Single Location)**

127

**FC 3-260-06F**  
**1 June 2015**

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**B-10 TEST PLAN FOR SEA ICE RUNWAY WHEELED AIRCRAFT OPERATIONS CERTIFICATION****B-10.1 Introduction.**

This test plan documents and explains the required steps, methods, and tools required to certify the sea ice runway for wheeled aircraft operations. The primary attributes that govern certification are dimensions and grades, markings, pavement strength (short and long term), and ice temperature profiles.

**B-10.2 Certification Process.****B-10.2.1 Dimensions and Grades.****B-10.2.1.1**

Measure features in the airfield area (as depicted in Figures 2-1, 2-3, and 2-5). Use available and expedient survey methods and tools (e.g., taping, measuring wheel, transit, laser) to verify that the dimensions and grades of the following airfield components are as required in Tables 2-1 through 2-4.

- Runway
- Shoulders
- Overrun area (each end, if present)
- Taxiway
- Apron (refuel, load/unload, turnaround)
- End clear areas
- Lateral clear areas

**B-10.2.1.2**

Verify dimensions and grades of each feature at the approximate locations shown in Figures 2-1, 2-3, and 2-5. Note that some areas and zones will blend seamlessly (without indication) into other areas, such as where the runway width transitions to the shoulders. In these situations, simply measure and verify that the combined dimensions of the features are per specification.

**B-10.2.1.3**

On Figures 2-1, 2-3, and 5, place a check mark (✓) by each dimension and grade that has been measured and approved and place an X by any dimension that fails the

inspection, noting where the failure is located. Measurements that fail the inspection must be documented and brought to the attention of the airfield manager.

## **B-10.2.2 Markings, Lighting, and NAVAIDS.**

UFC 3-535-01 governs the placement of markings and NAVAIDS.

### **B-10.2.2.1**

Check that markings, lighting, and NAVAIDS are in the correct positions and properly annotated as described in paragraphs 2-3, 2-4, and 2-5. **Note:** Direct on-snow marking is prohibited.

### **B-10.2.2.2**

Verify that the bottom of the marker (flag) is at least 0.3 meter (1 foot) above the snow surface. Marker dimensions (which vary depending on required markings) must conform to Figure 2-6, Detail 3.

### **B-10.2.2.3**

Check that flags are attached to frangible (break-away or bend-away) poles. Suitable poles can be made of common bamboo or lightweight plastic, but must not be metal or large, solid wood (e.g., 100-millimeter by 100-millimeter [4-inch by 4-inch] posts).

### **B-10.2.2.4**

Each flag will be stretched out between two poles and attached to the poles by means that are wind-proof and sturdy (but removable), such as with clamps and cords.

### **B-10.2.2.5**

On Figure 2-5, place a check mark (✓) by each flag that is properly placed and marked, and place an X by any missing, misplaced, or improperly marked flags. Flagging problems must be documented and brought to the attention of the airfield manager.

## **B-10.2.3 Sea Ice Temperature.**

**Note:** Required with or without the presence of snow cap on sea ice surface.

### **B-10.2.3.1**

The importance of temperature measurements for structural certification cannot be overstressed. Sea ice temperature is ideally measured with a continuously recording imbedded sensor string located at a number of representative locations. If such sensors are not available, manual temperature readings must be taken during the warmest (air temperature) three-hour period during the day. Collect ice temperatures (measured at a depth of 150 millimeters [6 inches]) at a minimum of four locations on the runway proper

and at two locations in the apron/parking area. Temperature data will be collected at a minimum of the following frequencies:

- Period 1: Once every two weeks
- Period 2: Once every week
- Period 3: Three times per week; and 24 hours before each C-17 aircraft flight.
- Period 4: Once every day

#### **B-10.2.3.2 Sea Ice Evaluation Temperature.**

The sea ice temperature used for evaluating the structural capacity (referred to as the “evaluation temperature”) shall be determined by calculating the simple average of the measured temperatures at the (minimum) six locations sampled. For example, if the measured temperatures are 10, 12, 13, 11, 14 and 10 °F, the evaluation temperature is equal to  $(10+12+13+11+14+10) \div 6 = 11.7$  °F. The evaluation temperature is then used, with sea ice thickness to determine safe landing and parking parameters.

#### **B-10.2.4 Sea Ice Thickness.**

##### **B-10.2.4.1**

The sea ice thickness used for evaluating the structural capacity (referred to as the “evaluation thickness”) will be determined using a statistical approach applied to the set of measured thickness data points. The evaluation thickness shall be equal to or less than 85% of all the measured thicknesses. This corresponds to an evaluation thickness of one standard deviation below the mean. If 10 or less thickness measurements are made then the lowest of the measured values shall be used as the evaluation thickness. An example calculation to establish the statistical sea ice thickness used for evaluation purposes is detailed in Appendix B-7.

##### **B-10.2.4.2**

Actual ice thickness must be measured at no less than 16 random locations spread throughout the runway surface, with no less than half being located within a 15-meter (50-foot) -wide swath down the center of the runway. Ideally, since a statistical approach is used, more measurements will lead to greater confidence levels. Thickness measurements must begin at least 10 days before the intended onset of flight operations. Measurements will continue throughout the entire duration of flight operations. Measurement frequency will be the same as for temperature measurements (see paragraph B-10.2.3.1).

#### **B-10.2.5 Measurement Density.**

Increased measurement density over that given in paragraph B-10.2.3.1 (for temperature or thickness) is only required during operating periods when the average

thickness of the sea ice is nearing the point where it may limit gross aircraft weights and parking times for the aircraft type to be operated. For large aircraft, this will likely be the case any time first-year sea ice is encountered. See Appendix B-7 for a description of the process for statistically establishing sea ice thickness.

#### **B-10.2.6            Approval and Documentation Storage.**

The certification team leader and the airfield manager will sign the final results from the data analysis. These signed documents and the electronic and hardcopy data and analysis results will be provided to and maintained by the airfield manager and will also be provided to the certification team leader for forwarding to HQ AMC/A7OI.

**B-11 TEST PLAN FOR PEGASUS RUNWAY WHEELED AIRCRAFT OPERATIONS CERTIFICATION****B-11.1 Introduction.**

This test plan documents and explains the required steps, methods, and tools required to certify the Pegasus runway for wheeled aircraft operations. The primary attributes that govern certification are dimensions and grades, markings, pavement strength (hardness), and snow and ice temperature profiles. Use this test plan, the accompanying charts (Figures B-62 and B-63), and the Ice Runway Strength Survey Tool program to achieve a satisfactory runway evaluation and analysis.

**B-11.2 Certification Process.****B-11.2.1 Dimensions and Grades.****B-11.2.1.1**

Measure features in the runway area (as depicted in Figures 2-1, 2-2, and 2-3). Use available and expedient survey methods and tools (e.g., taping, measuring wheel, transit, laser) to verify that the dimensions and grades of the following characteristics are as required in Tables 2-1 through 2-4.

- Runway
- Shoulders
- Overrun area (each end, if present)
- Taxiway
- Apron (refuel, load/unload, turnaround)
- End clear areas
- Lateral clearance areas

**B-11.2.1.2**

Dimensions and grades of each feature will be verified at the approximate locations shown in Figures 2-1 through 2-4. Note that some areas and zones will blend seamlessly (without indication) into other areas, such as where the runway width transitions to the shoulders. In these situations, simply measure and verify that the combined dimensions of the features are per specification.

**B-11.2.1.3**

On Figures 2-1 through 2-4, place a checkmark (✓) by each dimension and grade that has been measured and approved, and place an X by any dimension that fails the inspection, noting where the failure is located. Measurements that fail the inspection must be documented and brought to the attention of the airfield manager.

**B-11.2.2 Markings, Lighting, and NAVAIDS.**

Markings and NAVAIDS placement is governed by UFC 3-535-01.

**B-11.2.2.1**

Check that markings, lighting, and NAVAIDS are in the correct positions and properly annotated as described in paragraphs 2-3, 2-4, and 2-5. **Note: Direct on-snow marking is prohibited.**

**B-11.2.2.2**

Verify that the bottom of the marker (flag) is at least 0.3 meter (1 foot) above the snow surface. Marker dimensions (which vary depending on required markings) must conform to Figure 2-6, Detail 3.

**B-11.2.2.3**

Check that flagging is attached to frangible (break-away or bend-away) poles. Suitable poles can be made of common bamboo or lightweight plastic but must not be metal or large, solid wood (e.g., 102-millimeter by 102-millimeter [4-inch by 4-inch] posts).

**B-11.2.2.4**

Each flag will be stretched out between two poles and attached to the poles by means that are wind-proof and sturdy (but removable), such as clamps and cords.

**B-11.2.2.5**

On Figure 2-5, place a checkmark (✓) by each flag that is properly placed and marked and place an X by any missing, misplaced, or improperly marked flags. Flagging problems must be documented and brought to the attention of the airfield manager.

**B-11.2.3 Pavement Hardness (Strength).****B-11.2.3.1**

Measure snow pavement hardness with a DCP or RSP at the locations shown in Figure B-62 (on the circles). Penetrometer measurements can be taken at any time of day, at any air temperature, and in any weather conditions, following the procedures presented in Appendix B-1. A field data sheet (Figure B-63) is provided for logging measurements made with a DCP. The various Pegasus runway surfaces are comprised of a

compacted snow pavement built upon a very thick, solid ice base. All runway surface features meant to carry an aircraft wheel load will be required to achieve the same strength rating.

### **B-11.2.3.2**

The layout of data entry in the field data sheet (Figure B-63) is designed to allow the certification team to walk the runway in an efficient path while taking DCP or RSP hardness and temperature measurements. This field data will later be entered at McMurdo Station into a computer database for analysis and results.

## **B-11.2.4            Compacted Snow Temperature.**

### **B-11.2.4.1**

Surface and subsurface temperatures will be measured with a portable thermometer on the day of review at the locations shown in Figure B-62 (marked with an X). Enter these data into the field data sheet (Figure B-63). Snow temperature measurements can be taken at any time of day, at any air temperature, and in any weather conditions, but ideally will coincide with strength measurements.

### **B-11.2.4.2**

For the portable thermometer test, a stainless-steel temperature probe is pushed into the snow on the surface and at depths of 50 millimeters, 100 millimeters (4 inches), and 150 millimeters (6 inches) (or the base of the white ice pavement), and is held against the snow for 30 seconds to gain an accurate reading. If the snow is too hard to insert the probe, a small trench will be cut out of the snow pavement to allow the probe to be inserted horizontally. The temperature probe shall be calibrated yearly.

### **B-11.2.4.3**

If glacial ice temperatures (from either the buried probes or portable thermometer measurements) are above or have been above  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ), proof rolling tests are required to inspect for potential melt damage in the warm areas. Proof rolling is described in paragraph B-4.1.1 and further described in CRREL Monograph 98-1.

## **B-11.2.5            Data Reduction and Analysis.**

With the field data sheet in hand, re-enter the penetrometer data (blows, and penetration per blow set) and the portable thermometer temperature data into the Ice Runway Strength Survey Tool program (contact the National Science Foundation POC in paragraph 1-3 for access to this Microsoft® Excel-based program). The program will process the data and graph the DCP index value for each runway location tested, and the results will also be automatically compared to the strength go/no-go criteria given in Table B-1. Finally, the temperature data will be automatically compared to the upper limit of  $-4^{\circ}\text{C}$  ( $25^{\circ}\text{F}$ ), with a final result provided.

**B-11.2.6            Approval and Documentation Storage.**

The certification team leader and the airfield manager will sign the final results from the data analysis. These signed approvals and the electronic and hardcopy data and analysis results will be provided to and maintained by the airfield manager and will also be provided to the certification team leader for forwarding to HQ AMC.



Figure B-62 Locations for Surface Properties Measurements

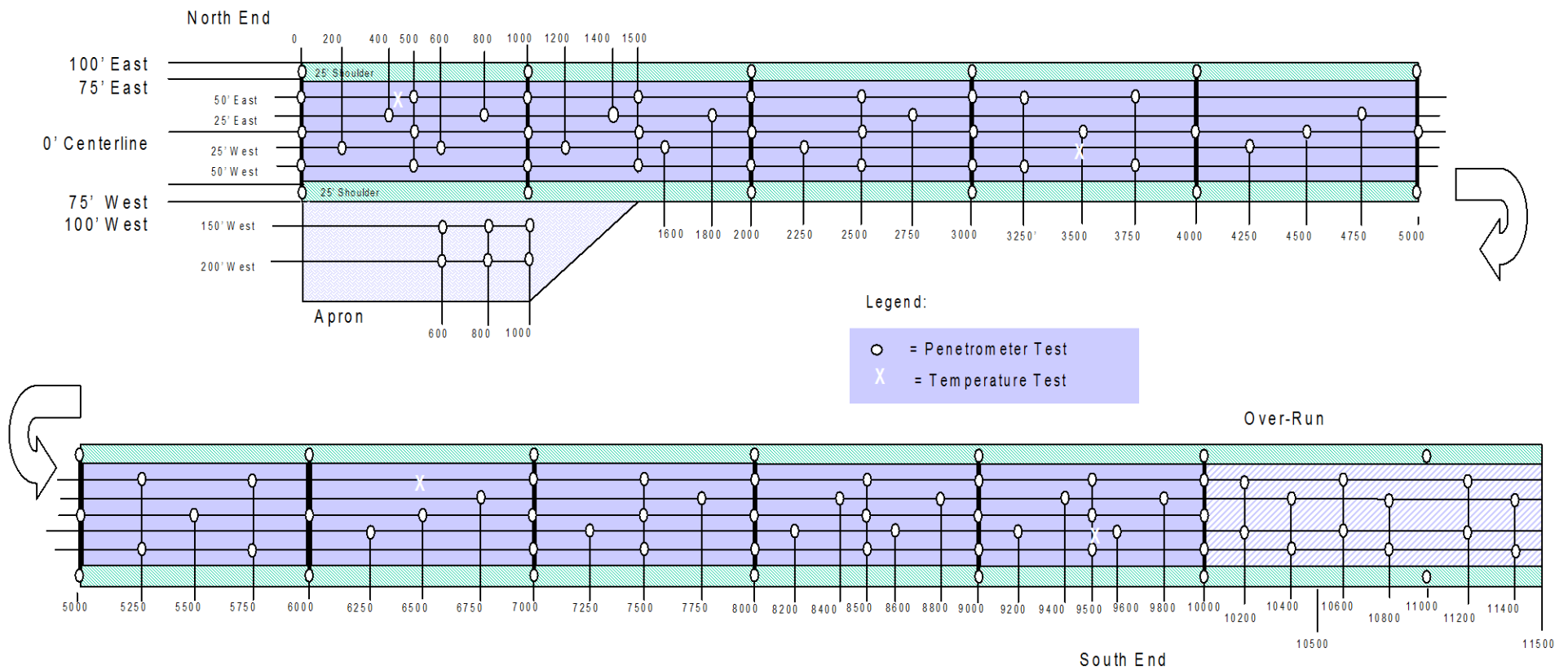


Figure B-63 Sample Field Data Sheet (Configured for DCP Measurements)

**Pegasus Runway Hardness and Temperature - Field Data Sheet**  
**DCP - Dynamic Cone Penetrometer**

1. Read Separate Instructions On Proper Use and Care Of The DCP Device
2. Obtain Penetration and Temperature Data at Locations Shown Below (Also See Fig. XX).
3. Re-enter all Field Data (Blows, Accumulated Depths, Temperature) into the Runway Hardness and Temperature Analysis Program (Excel).
4. Print out Field Data Sheet and Analysis Program Results and retain at on-site location.

The Data Entry Block  
(See Example Data in chart below)

Number of Blows (Blow Set) → **6**    **25** ← Accumulated Penetration Depth (mm) Per Blow Set  
(goal is a minimum of 25 mm for each blow set)

**DCP Penetrometer Field Data**

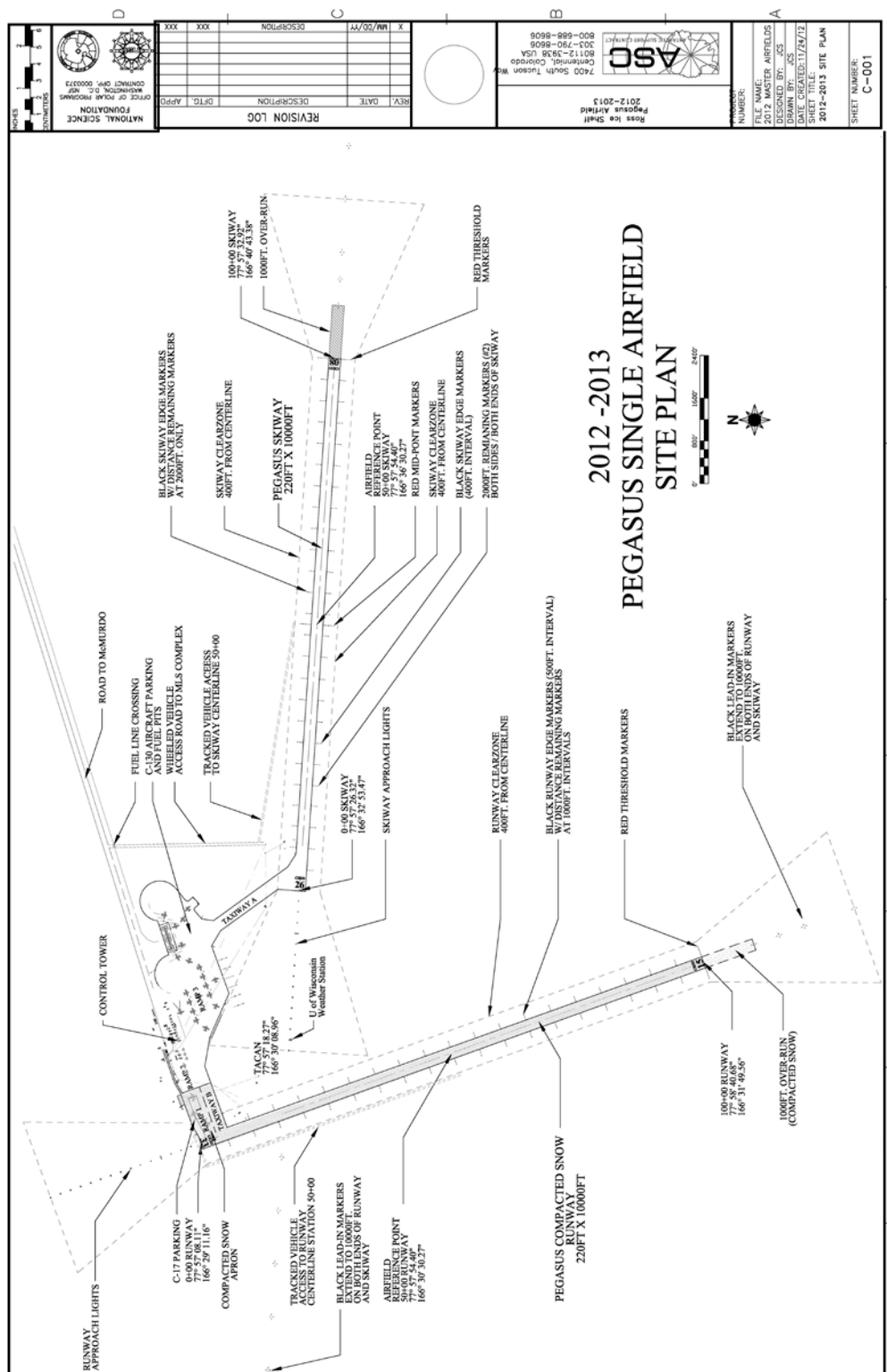
Data Collection Locations		DCP Data Collected By: _____ Date: _____ DCP Drop Weight: 17.6 lb (8.6 kg)															
Distance Down Runway, Feet (Starting at North End)	Lateral Location, Feet (From Runway Centerline)	Accumulating Depth (mm) → (Note: The depth achieved with each Blow Set should be at least 25 mm)															
		Blow Set 1		Blow Set 2		Blow Set 3		Blow Set 4		Blow Set 5		Blow Set 6		Blow Set 7		Blow Set 8	
		Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth	Number of Blows	Accum. Depth
	Example Data →	7	25	8	50	8	75	7	100	5	125	5	150	6	175	6	200
(-) 1000 North OverRun	0																
(-) 500 North OverRun	0																
0	(+) 50																
0	0																
0	(-) 50																
200	(-) 25																
400	(+) 25																
500	(+) 50	Temperature Test. Surface: _____ °C, 5cm: _____ °C, 10cm: _____ °C, 15cm: _____ °C															
500	(+) 50																
500	0																
500	(-) 50																
600	(-) 25																
800	(+) 25																
1000	(+) 50																
1000	0																
1000	(-) 50																
1200	(-) 25																
1400	(+) 25																

Comments or Observations  
Gas spill 2' away - soft, needs patch

**B-12**

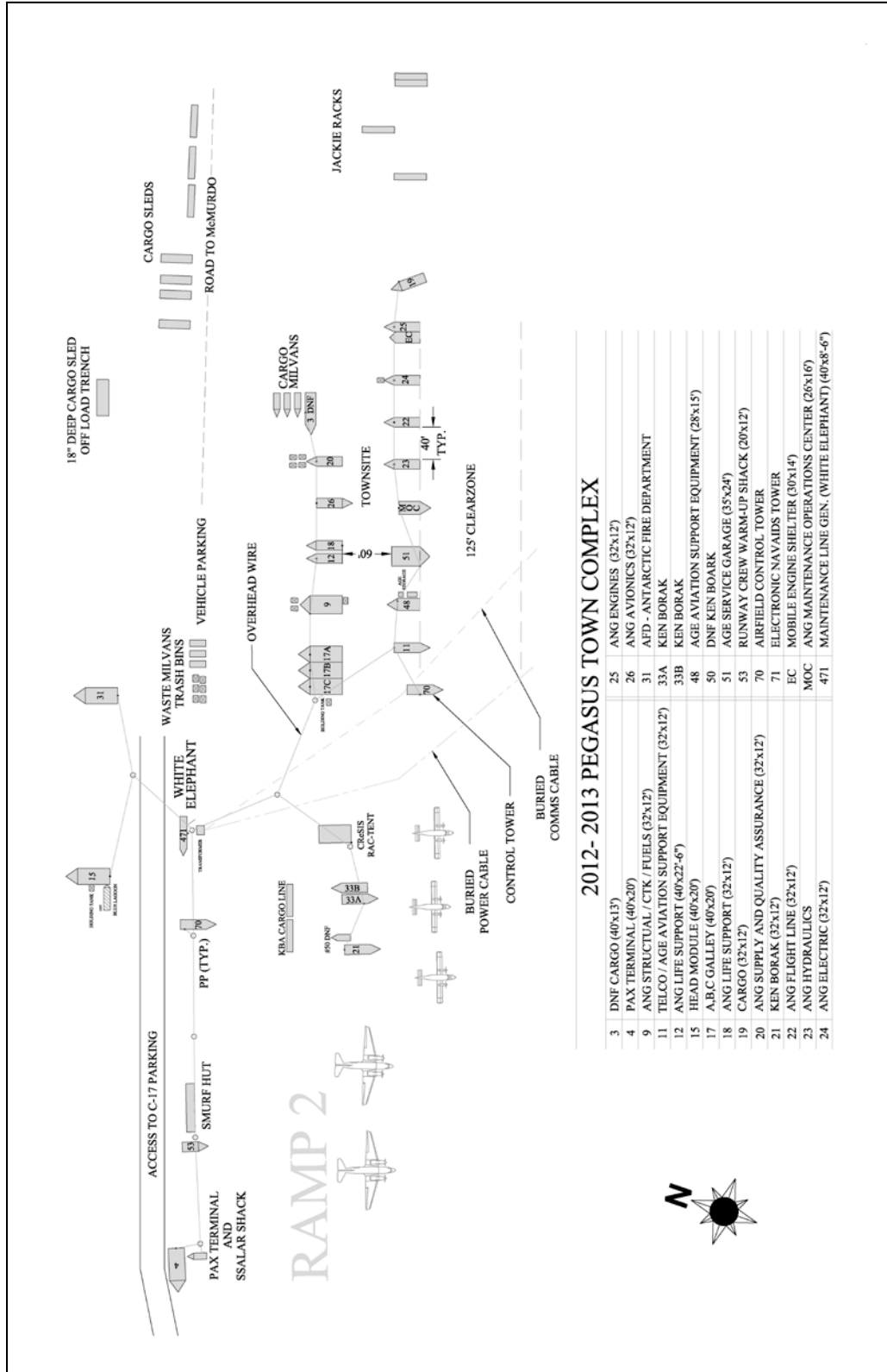
## TYPICAL AIRFIELD LAYOUT FOR PEGASUS GLACIAL ICE RUNWAY, ROSS ICE SHELF, ANTARCTICA

### Figure B-64 Pegasus Runway Site Plan



[illegible]

Figure B-66 Pegasus Town Complex



**FC 3-260-06F**  
**1 June 2015**

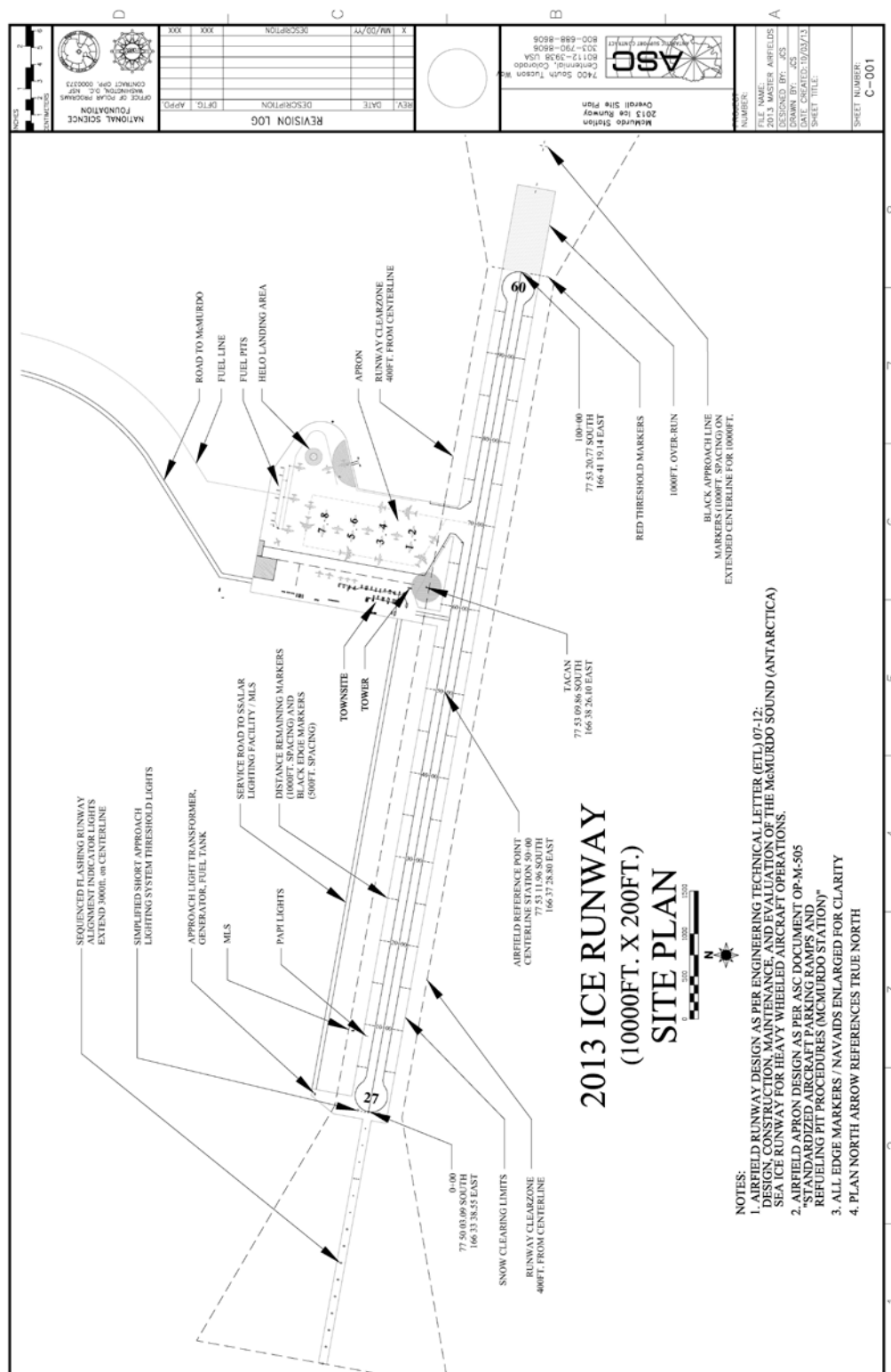
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FC 3-260-06F  
1 June 2015

B-13

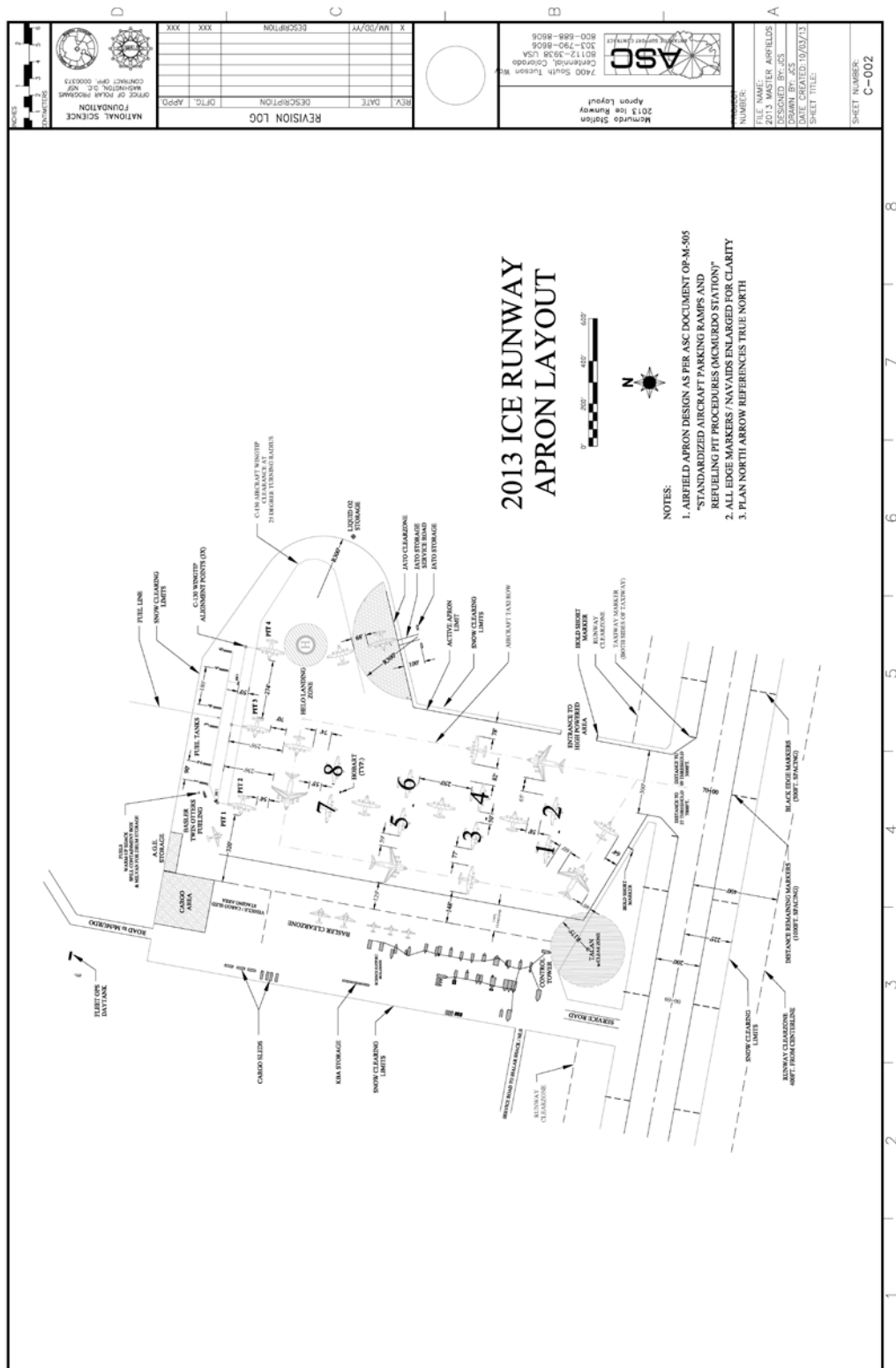
# TYPICAL AIRFIELD LAYOUT FOR SEA ICE AIRFIELD, MCMURDO SOUND, ANTARCTICA

Figure B-67 McMurdo Sound Runway Site Plan



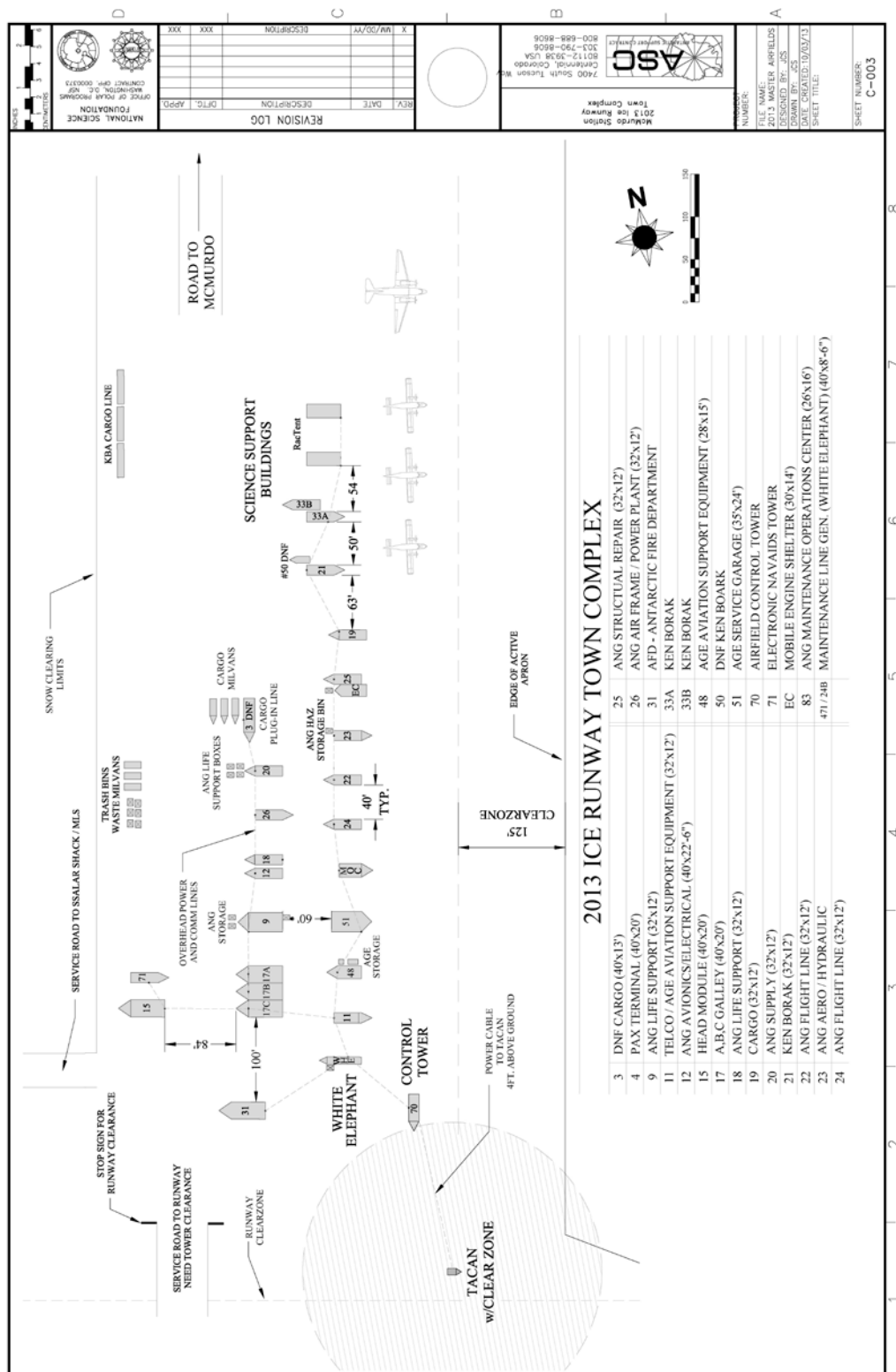


### Figure B-68 McMurdo Sound Apron Layout

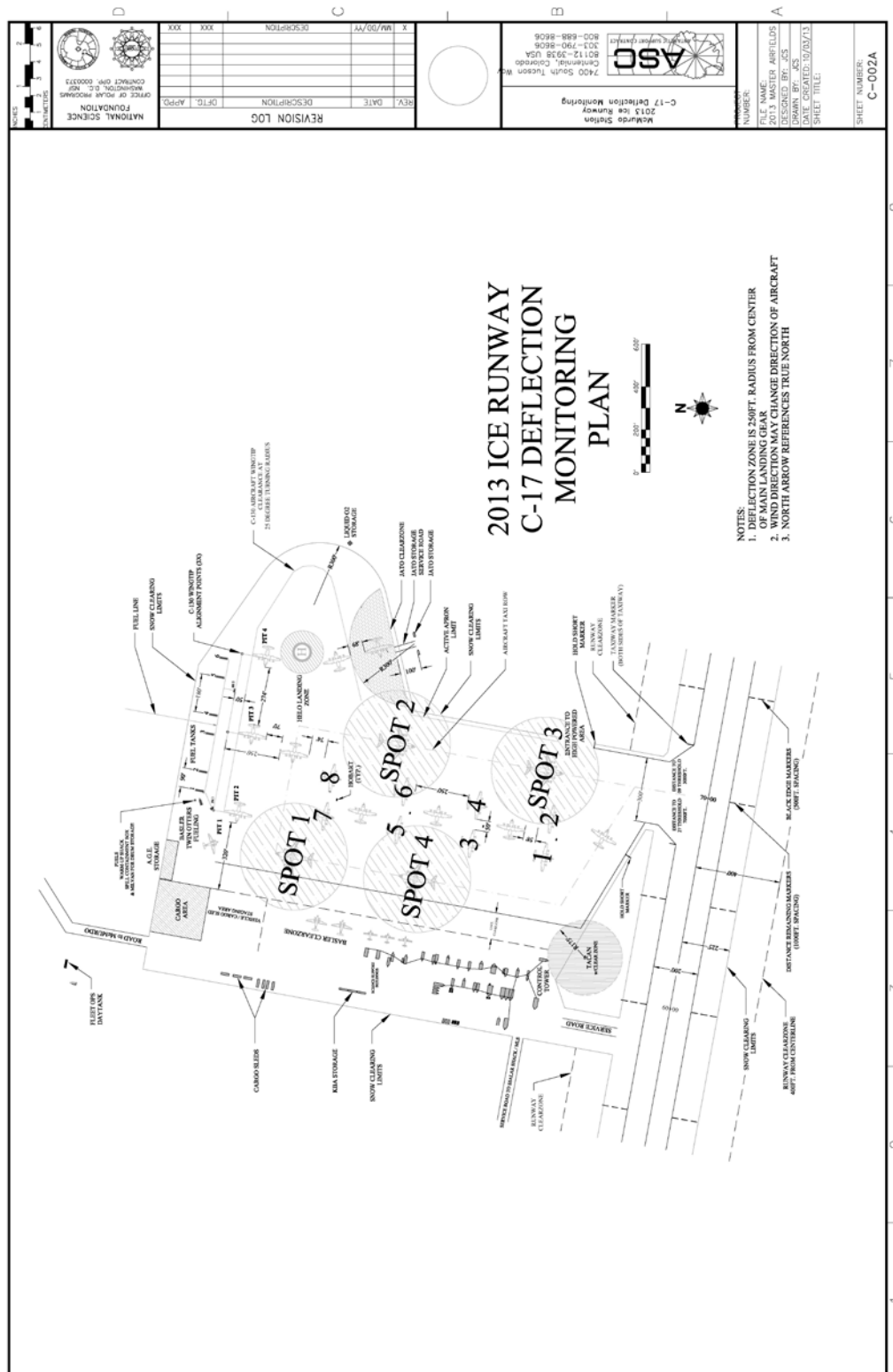


FC 3-260-06F  
1 June 2015

Figure B-69 McMurdo Sound Town Complex



### Figure B-70 McMurdo Sound C-17 Deflection Monitoring Plan



## B-14

## CONVERSION FACTORS

TO CONVERT	TO	DIVIDE BY
<b>LENGTH</b>		
millimeters (mm)	inches (in)	25.4
centimeters (cm)	inches (in)	2.54
meters (m)	inches (in)	0.0254
meters (m)	feet (ft)	0.3048
meters (m)	yards (yd)	0.9144
kilometers (km)	miles (mi)	1.60948
<b>AREA</b>		
square millimeters (mm <sup>2</sup> )	square inches (in <sup>2</sup> )	645.16
square centimeters (cm <sup>2</sup> )	square inches (in <sup>2</sup> )	6.4516
square meters (m <sup>2</sup> )	square inches (in <sup>2</sup> )	0.00064516
square meters (m <sup>2</sup> )	square feet (ft <sup>2</sup> )	0.09290
square meters (m <sup>2</sup> )	square yards (yd <sup>2</sup> )	0.83613
square kilometers (km <sup>2</sup> )	square miles (mi <sup>2</sup> )	2.59043
square kilometers (km <sup>2</sup> )	acres	0.000404
<b>VOLUME</b>		
cubic millimeters (mm <sup>3</sup> )	cubic inches (in <sup>3</sup> )	16,387
cubic centimeters (cm <sup>3</sup> )	cubic inches (in <sup>3</sup> )	16,487,000
cubic meters (m <sup>3</sup> )	cubic feet (ft <sup>3</sup> )	0.028317
cubic meters (m <sup>3</sup> )	cubic yards (yd <sup>3</sup> )	0.764559
<b>MASS</b>		
kilograms (kg)	pounds (lb)	0.45359
<b>FORCE</b>		
Newtons (N)	pounds (lbf)	4.44822
<b>STRESS</b>		
kiloPascals (kPa)	psi	6.89476
<b>TEMPERATURE</b>		
Degrees Centigrade (°C)	Degrees Fahrenheit (°F)	Multiply by 1.8, then add 32

**FC 3-260-06F**  
**1 June 2015**

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**APPENDIX C GLOSSARY****C-1****ACRONYMS**

13 AEG/CC	13th Air Expeditionary Group Commander
18 AF/CC	18 <sup>th</sup> Air Force Commander
A3	Operations Directorate
AFD	airfield database
AFI	Air Force Instruction
AMCI	Air Mobility Command Instruction
ASTM	American Society for Testing and Materials
AWOS	airport weather observation station
CBR	California bearing ratio
CRREL	U.S. Army Cold Regions Research and Engineering Laboratory
DCP	dynamic cone penetrometer
DOD	Department of Defense
ETL	Engineering Technical Letter
FC	Facilities Criteria
FAA	Federal Aviation Administration
ft	foot
GDSS	Global Decision Support System
HQ AMC	Headquarters, Air Mobility Command
HQ AMC/A3	Headquarters, Air Mobility Command, Operations Directorate
HQ AMC/A3V	Headquarters, Air Mobility Command, Operations Directorate, Aircrew Standardization Evaluation Division
HQ AMC/A3AS	Headquarters, Air Mobility Command, Operations Directorate, Airfield Operations Division, Airfield Suitability Branch
HQ AMC/A7	Headquarters, Air Mobility Command, Installations and Mission Support Directorate

HQ AMC/A7OI	Headquarters, Air Mobility Command, Installations and Mission Support Directorate, Operations Division
HQ AMC/A7OI	Headquarters, Air Mobility Command, Installations and Mission Support Directorate, Operations Division, Infrastructure Support Branch
HQ PACAF/A3	Headquarters, Pacific Air Forces, Operations Directorate
HQ PACAF/A7	Headquarters, Pacific Air Forces, Installations and Mission Support Directorate
IFR	instrument flight rules
ILS	instrument landing system
in	inch
kPa	kilopascals
m	meter
MAJCOM	major command
MALSR	medium-intensity approach lights
MATCT	mobile air traffic control tower
MLS	microwave landing system
mm	millimeters
MOG	maximum on ground
NAVAIDS	navigational aid system
OPCON	operational control
PAPI	precision approach path indicator
PCASE	Pavement Computer Assisted Structural Engineering
PLZ	prepared landing zone
psi	pounds per square inch
RAIL	runway alignment indicator light
REIL	runway end identifier light
RSP	Russian snow penetrometer



SFL	sequenced flashing strobe lights
SSALR	simplified short approach lighting with RAILS
TACAN	tactical air navigation
TCH	threshold crossing height
TERPS	terminal instrument procedures
UFC	Unified Facilities Criteria
USAF	United States Air Force
USAP	United States Antarctic Program
VFR	visual flight rules

**FC 3-260-06F**  
**1 June 2015**

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**C-2 DEFINITION OF TERMS**

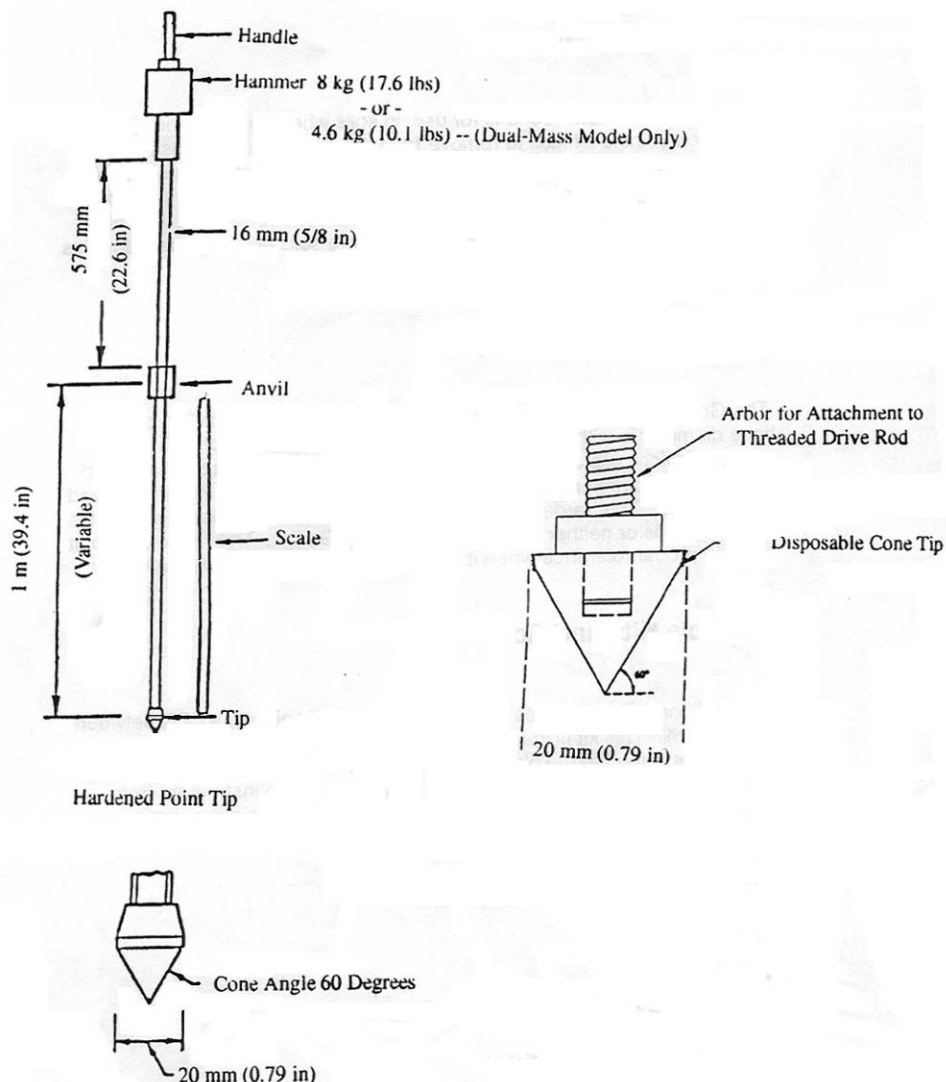
**California Bearing Ratio (CBR):** An index test of soil strength determined using a 1935.5-square-millimeter (3-square-inch) piston forced into the soil. The load required to achieve a 2.5- or 5-millimeter (0.1- or 0.2-inch) penetration (whichever provides lowest CBR value) is compared to a standard load for similar penetrations into a well-graded, crushed aggregate. The test is widely used for military structural airfield assessment; test procedures are in ASTM D1883.

**Dynamic Cone Penetrometer (DCP):** The DCP is a portable soil field test device to allow rapid measurement of soil strength (see Figure C-1). An 8-kilogram (17.6-pound) or 4.6-kilogram (10.1-pound) sliding hammer is used to drive a 60°, 20-millimeter (0.8-inch) -diameter cone into the soil. The DCP strength index, in units of millimeters per blow, is calculated as:

$$\text{DCP Index} = (P/N) F$$

where P is the accumulated cone penetration after each set of N hammer blows, and F is a configuration factor (F = 1.0 for 8-kilogram hammer DCP; F = 1.742 for 4.6-kilogram hammer DCP). The DCP strength index has been correlated to more time-consuming tests like CBR and is widely used in the military for expedient soil strength assessments for roads and airfields. A complete description of the DCP and its use are contained in U.S. Army Waterways Experiment Station Instructional Report GL-92-3 and ASTM D6951. See Attachment 1 for penetrometer user information.

Figure C-1 Dynamic Cone Penetrometer (DCP)



**Exposed Sea Ice Surface:** Whether graded or not, an exposed sea ice surface has little or no snow present to act as a cover. Such a surface will present poor braking resistance at temperatures above -8 °C (18 °F).

**Fresh, Loose Snow Surface:** Natural unprocessed snow resting on a runway surface. Such a cover of snow enhances braking resistance at all temperatures and assists in protecting against the damaging effects of solar heating at temperatures above -8 °C (18 °F). However, too much snow will produce additional drag on tires, making takeoffs difficult. Loose snow in excess of 25 millimeters (1 inch) in depth shall be removed from the runway.

**Glacial Ice Runway Surface:** A durable weather- and abrasion-resistant surface generated from level grading of natural glacial ice (alpine-, continental-, or shelf-type) that is derived from naturally consolidated snow. For a more detailed description see CRREL Monograph 98-1.

**Graded Sea Ice Surface:** To remove natural undulations in a sea ice surface, including adhered patches of snow, a serrated grader blade is used, often with a laser-guided leveling system, to prepare the runway surface. This surface has a high degree of small-scale (12 to 100 millimeters [0.5 to 4 inches]) roughness which is felt as “chatter” in a fast-moving aircraft.

**Processed Snow Surface:** Also called “white ice,” this is a durable weather- and abrasion-resistant surface made from processing (e.g., compacting or tilling) natural snow that overlies the graded glacial ice or sea ice surface. The processed snow surface is smooth and has good braking and solar insulation-blocking characteristics.

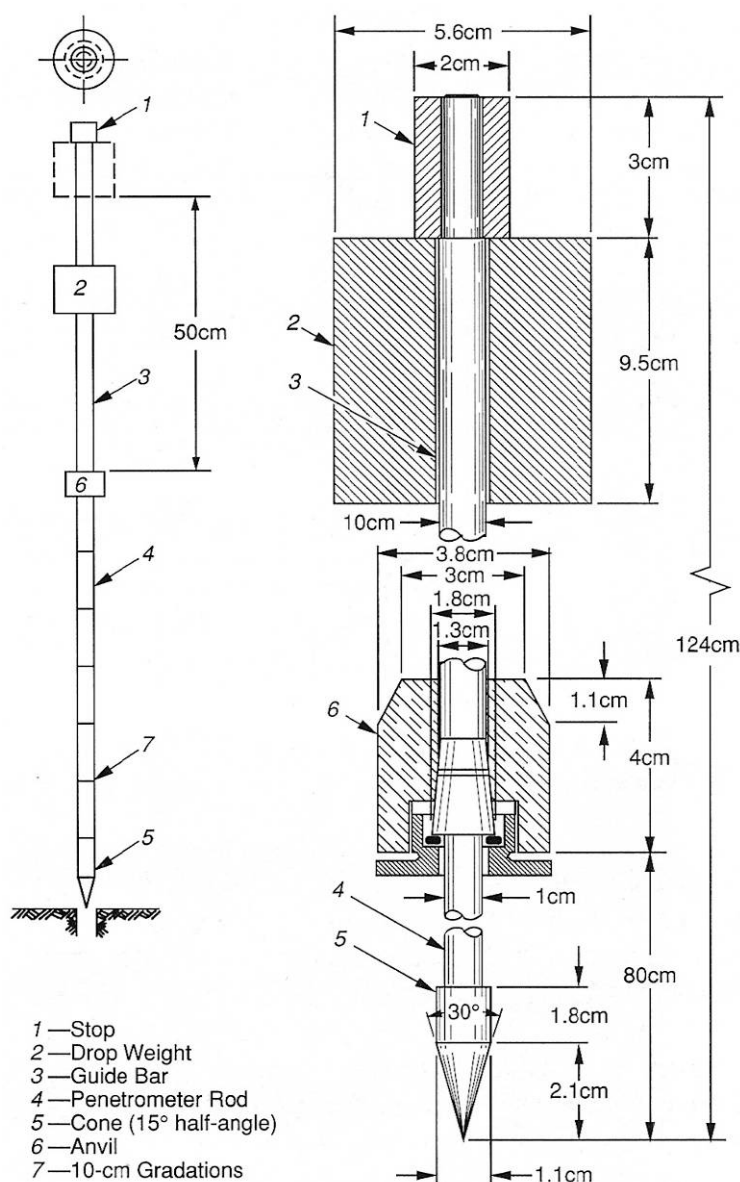
**Prepared Landing Zone (PLZ):** For the purposes of this FC, a PLZ refers to a landing zone constructed to support routine and moderately frequent (average one to two flights per day) wheeled cargo aircraft traffic, with no adverse effect on airframes, but that is not paved with traditional construction materials (i.e., asphalt or concrete). The amount of engineering effort required to develop a PLZ depends on the planned operation and the existing surface and weather conditions. Options for surface preparation are governed by the material present at the site and may include plowing, grading, planing, roller compaction, tilling, and vibratory compaction.

**Russian Snow Penetrometer (RSP):** The RSP is a portable test device to allow rapid measurement of snow strength (see Figure C-2). A 1.75-kilogram (3.85-pound) sliding hammer is dropped from a height of 500 millimeters (19.7 inches) to drive into the snow a 30° cone with a maximum diameter of 11 millimeters (0.4 inch). During a test, penetration distance and the number of blows to produce it are recorded. The RSP index, in units of kilograms, is calculated as:

$$\text{RSP Index} = (W h n L^{-1}) + W + Q$$

where W is the mass of the drop hammer (kilograms), h is the height of the hammer drop (millimeters), n is the number of hammer blows to generate L (millimeters) penetration, and Q is the total mass of the penetrometer (kilograms) less its hammer. Details of penetrometer testing in processed snow can be found in CRREL Technical Report 153. See Appendix B-1 for penetrometer user information.

### Figure C-2 Russian Snow Penetrometer (RSP)



**Sastrugi:** A long wavelike ridge of snow, formed by wind and found on the polar plains.

**Sea Ice Runway Surface:** The original exposed or level-graded surface of a floating slab of naturally frozen seawater.

**Seasonal Operations:** Seasonal operations denote aircraft activities being confined to certain periods of the year when flight and runway conditions are most favorable and when airlift is required. At McMurdo Station, the Pegasus runway is mostly operated when air temperatures are above -50 °C (-58 °F) and when sunlight is present. However, flights do sometimes occur in the shoulder seasons or during winter with alternative runway markers. The sea ice runway is only operated when (a) air temperatures are above -50 °C (-58 °F); (b) sunlight is present; and (c) when ice thickness and strength combine to allow safe landing and parking.