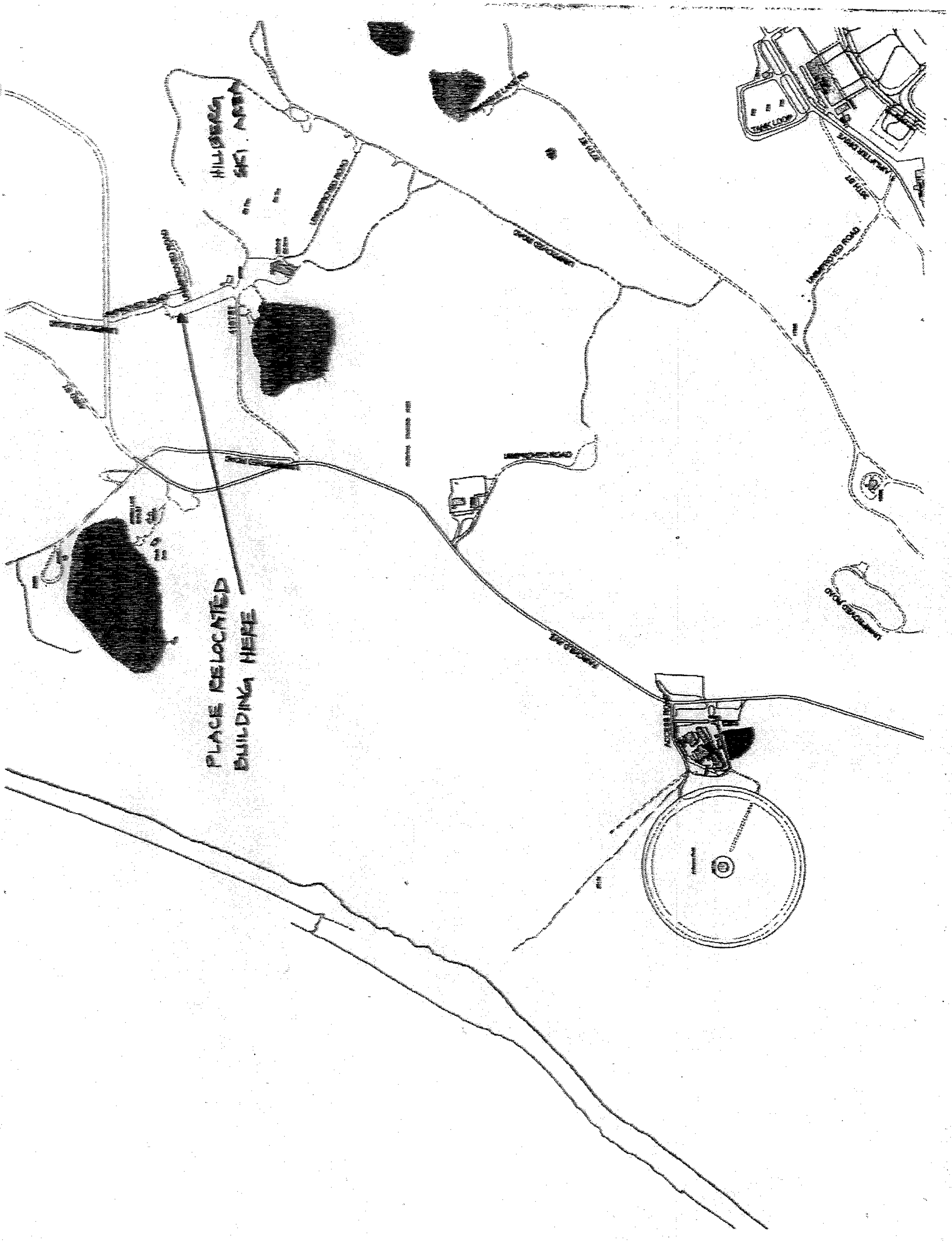
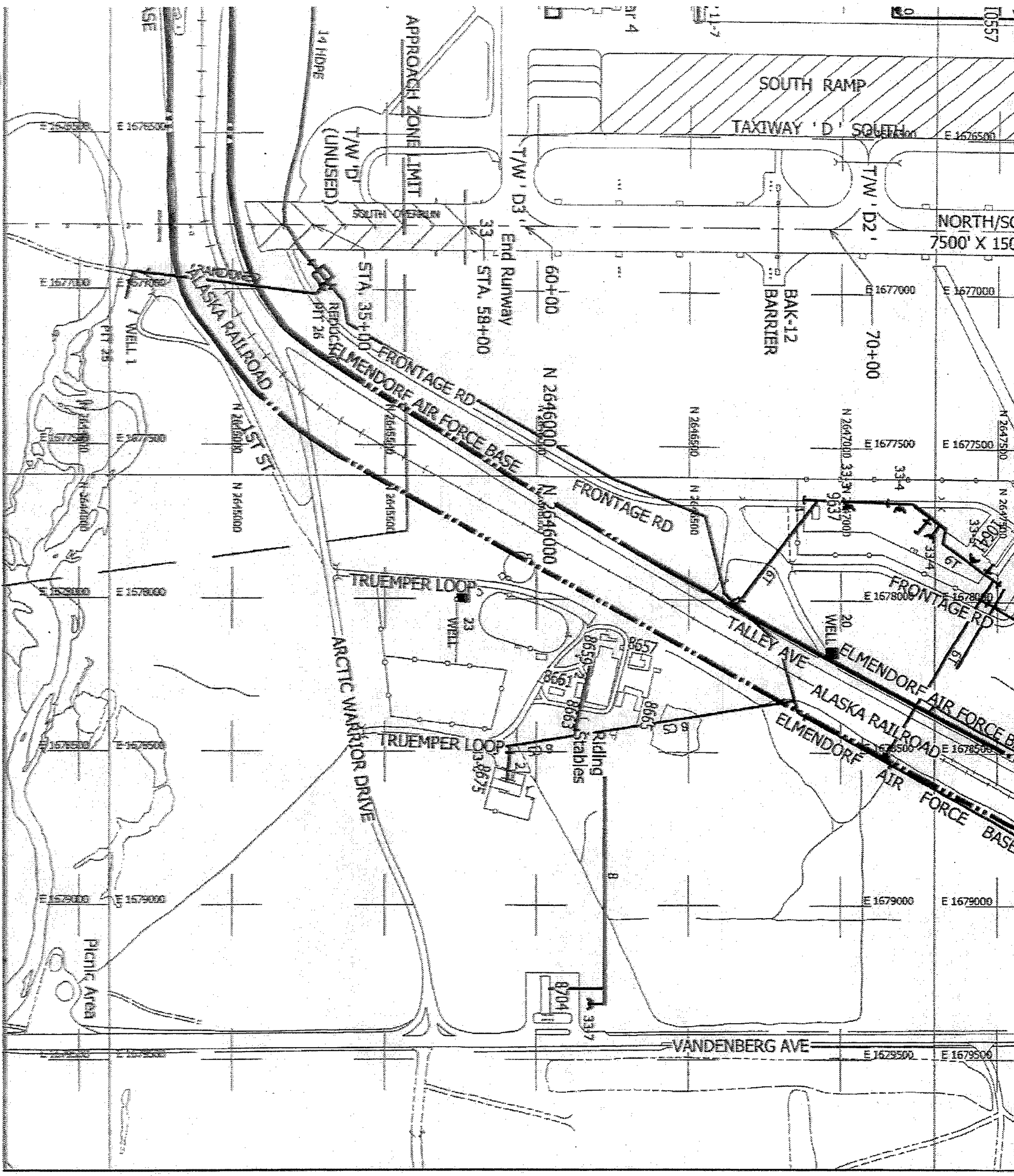

PLACE RELOCATED BUILDING HERE
HILLBERG SKI AREA

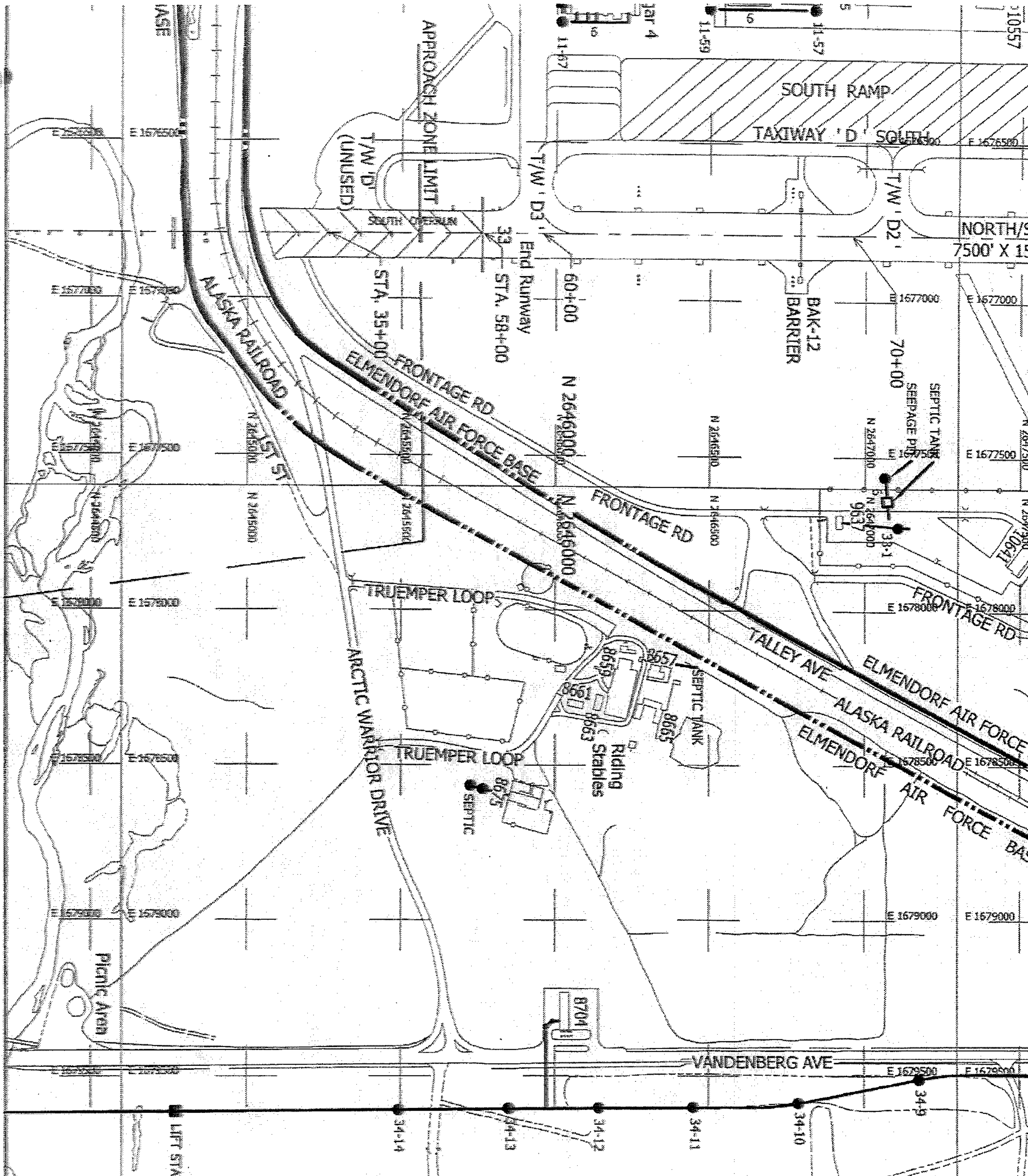


WATER

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

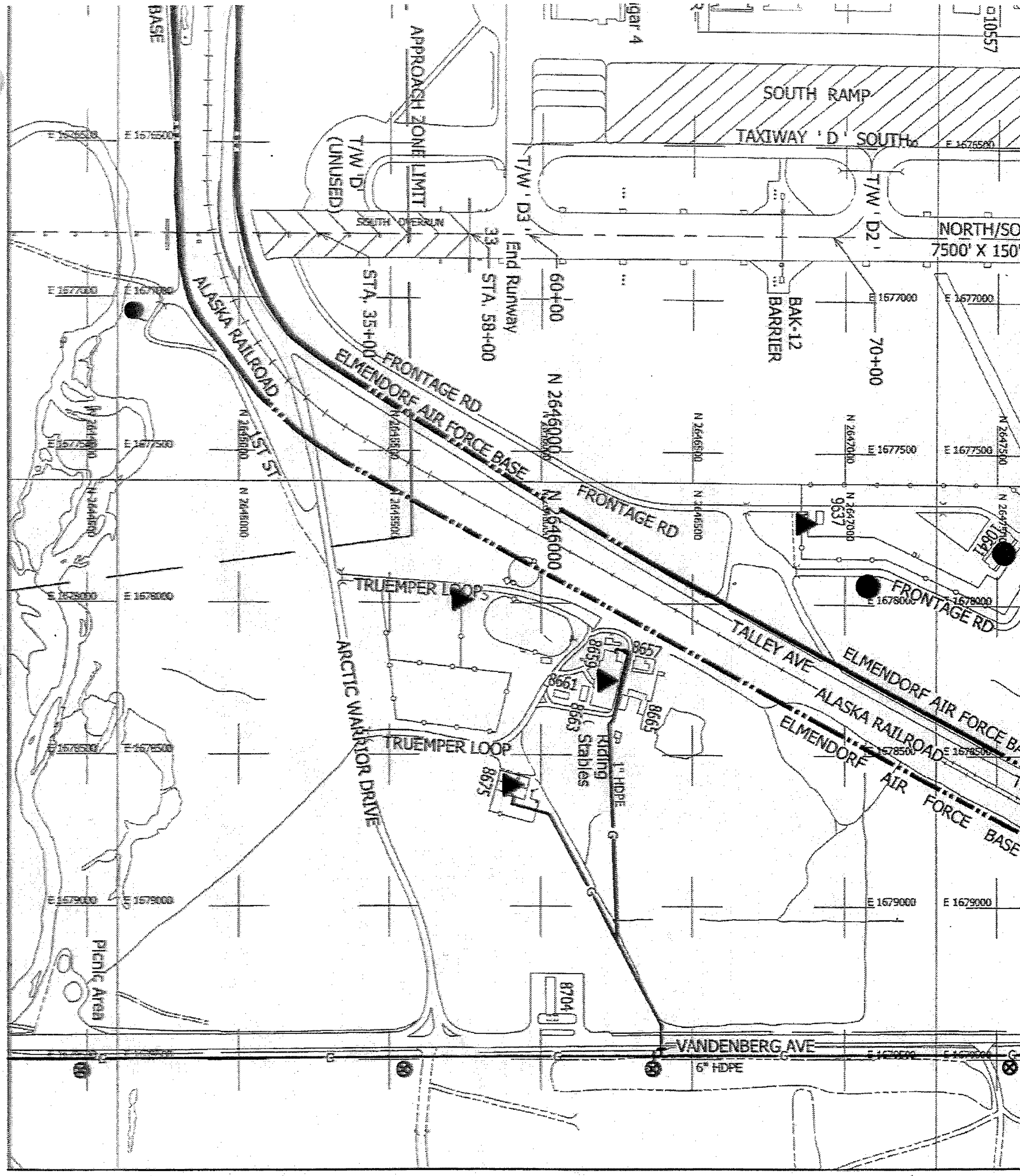


SEWER

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

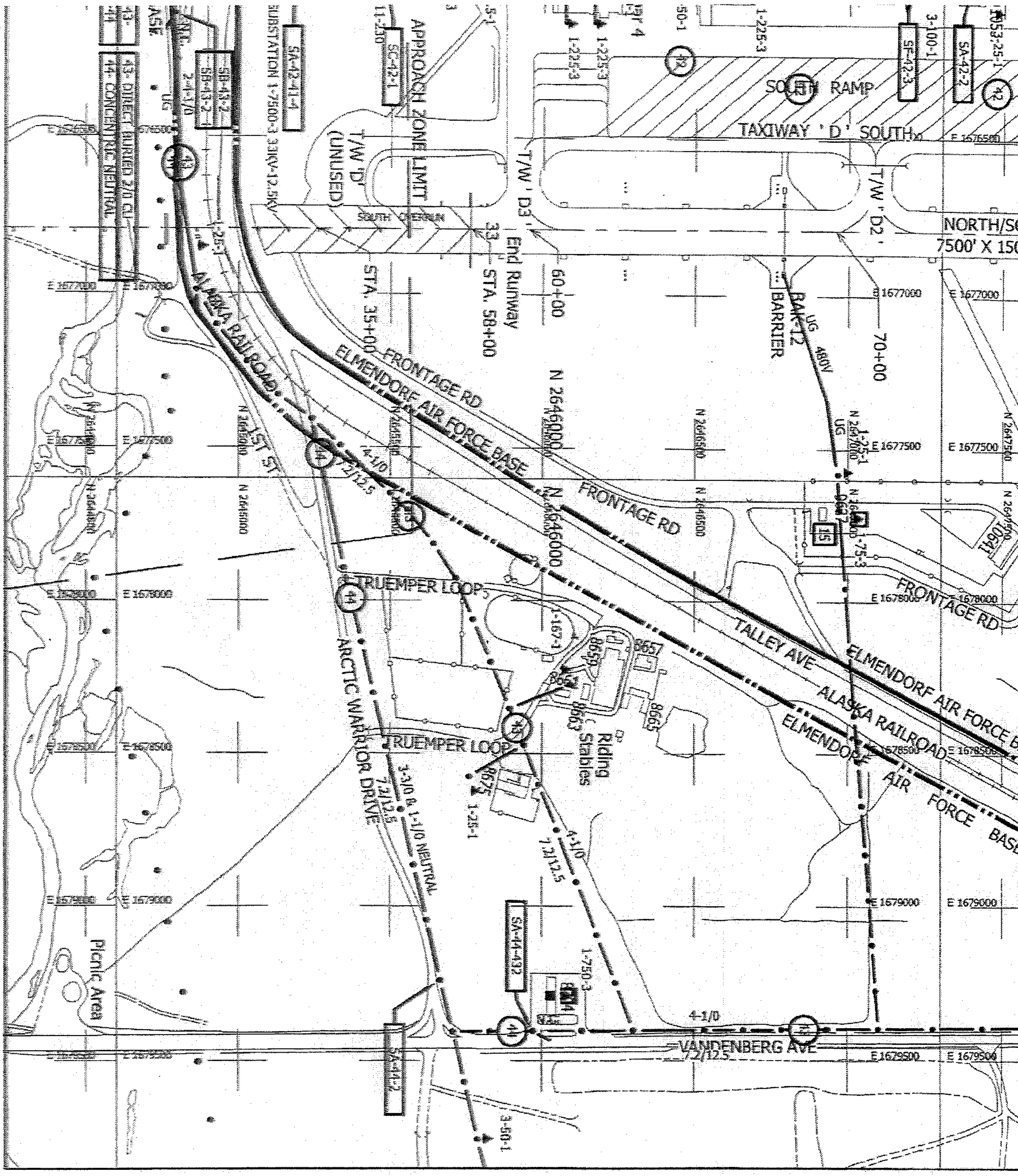


GAS

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

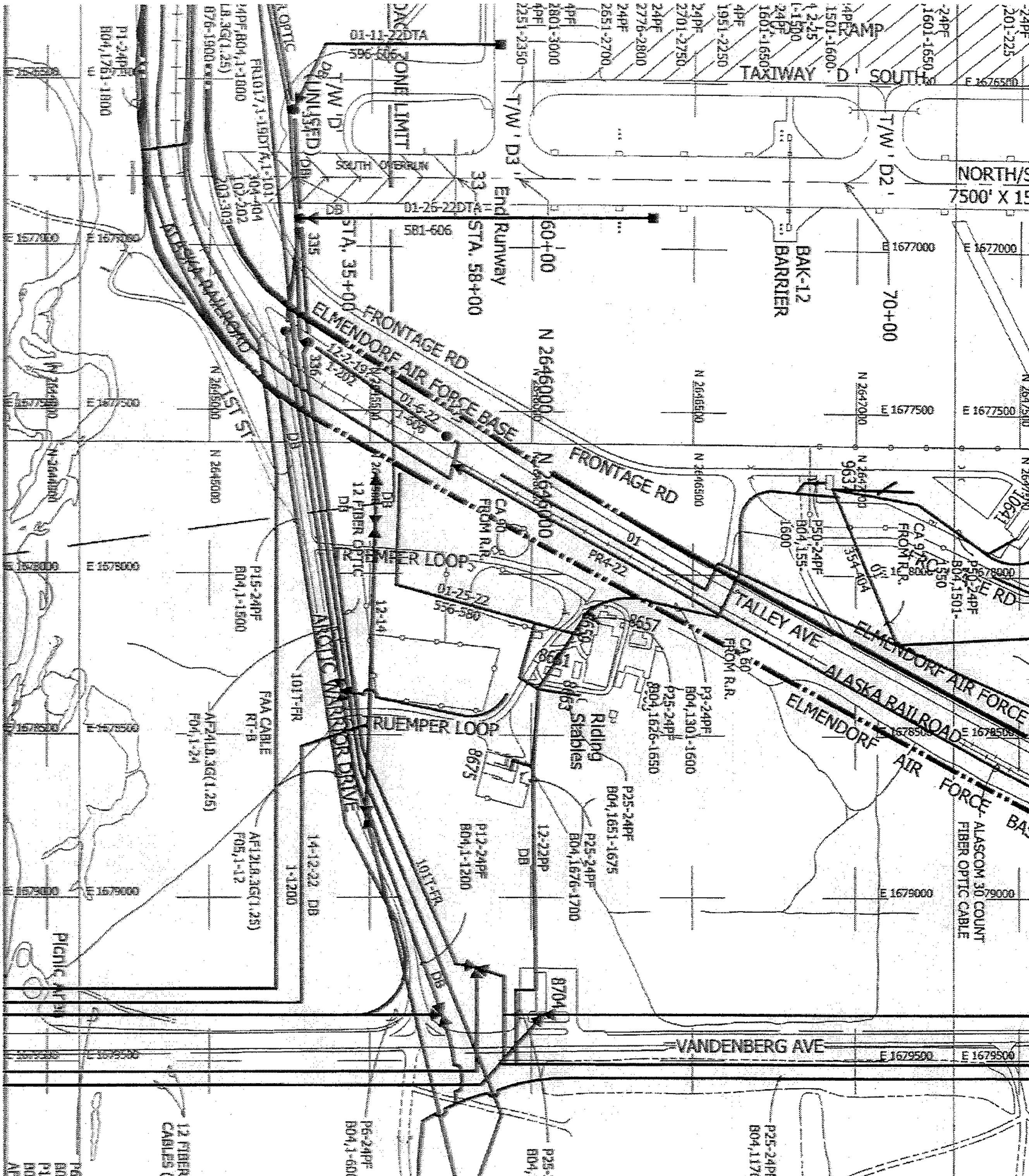


ELECTRICAL

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

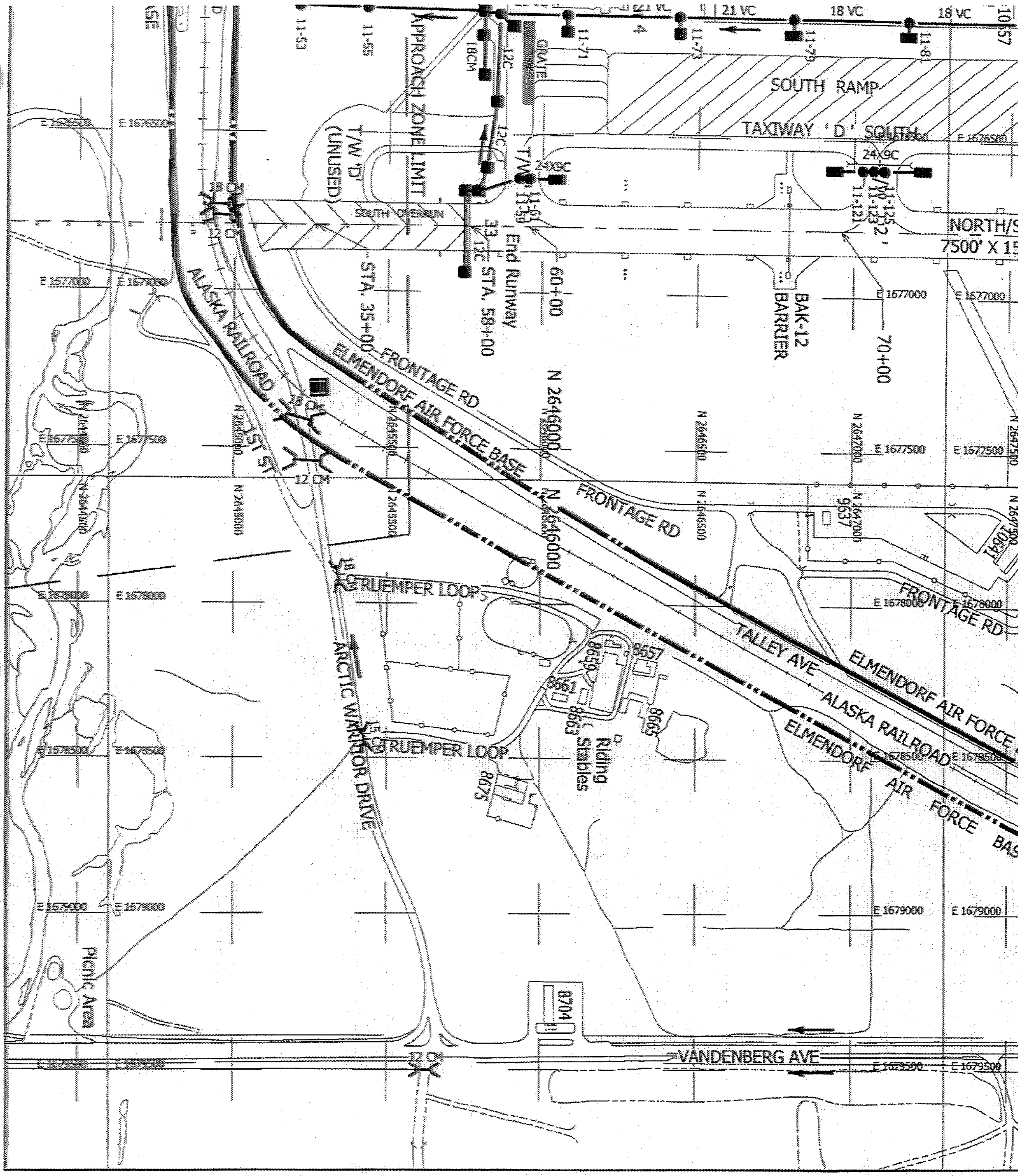


COMMUNICATIONS

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

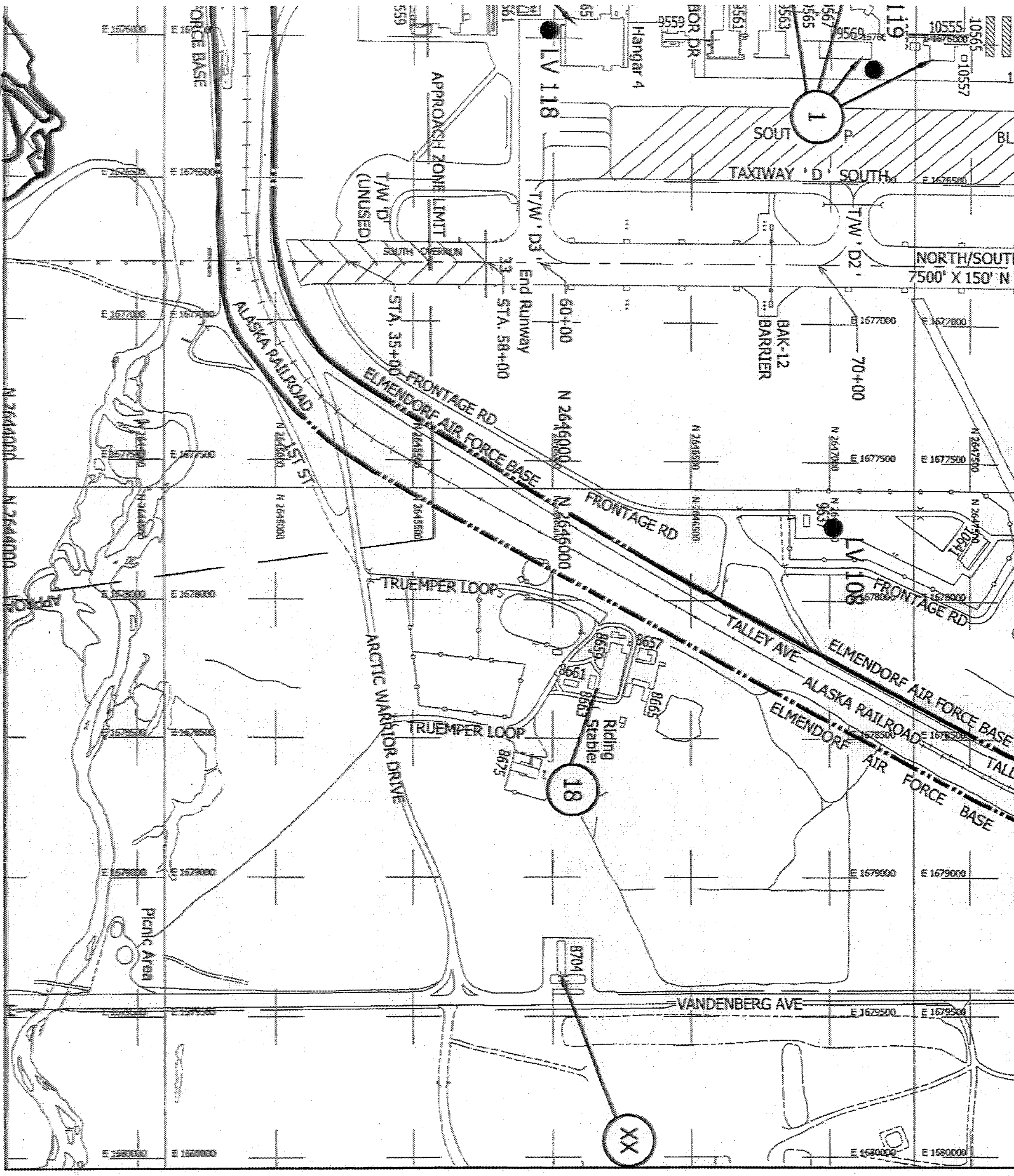


DRAINAGE

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

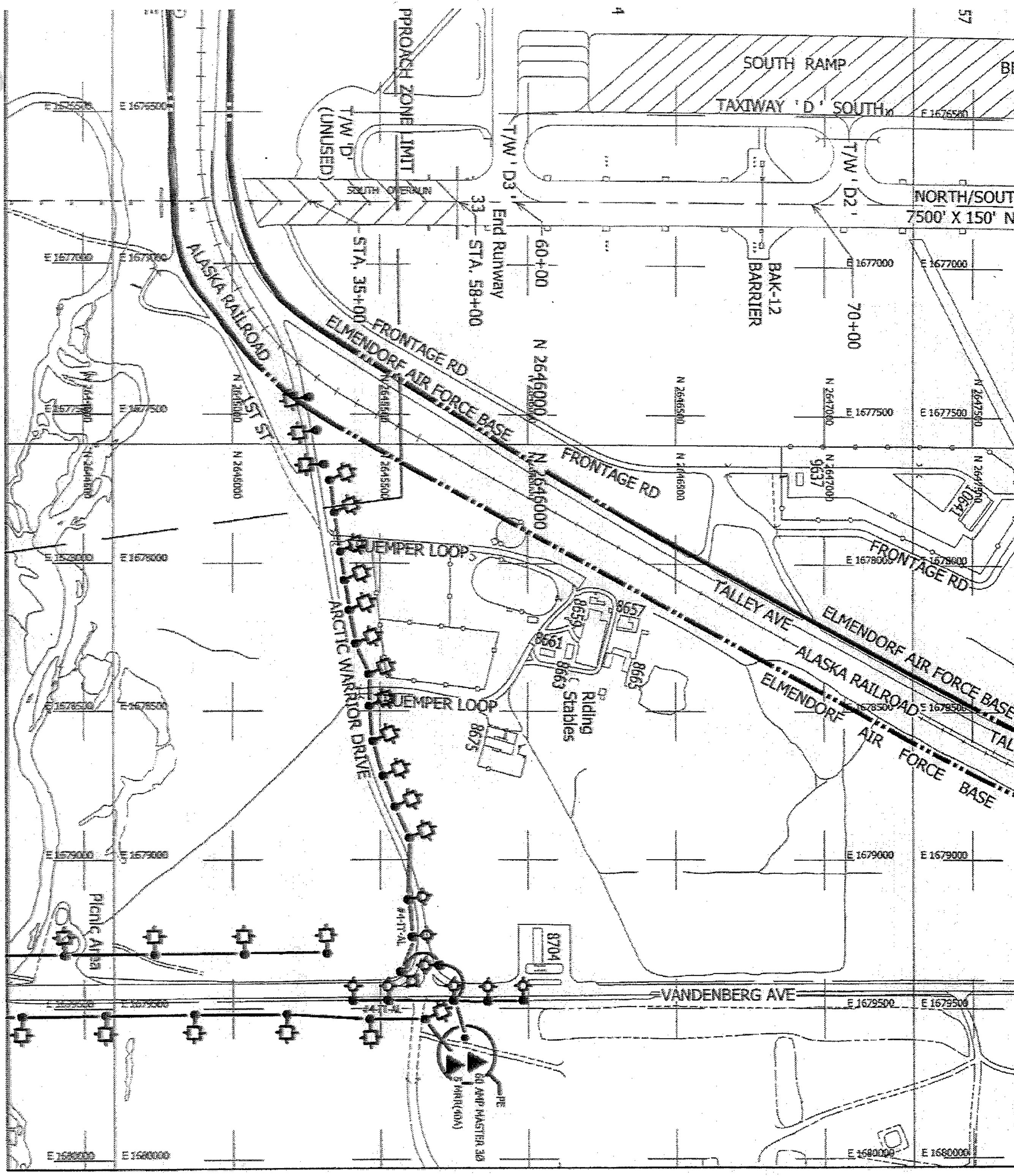


FIRE ALARM

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

N

NO SCALE

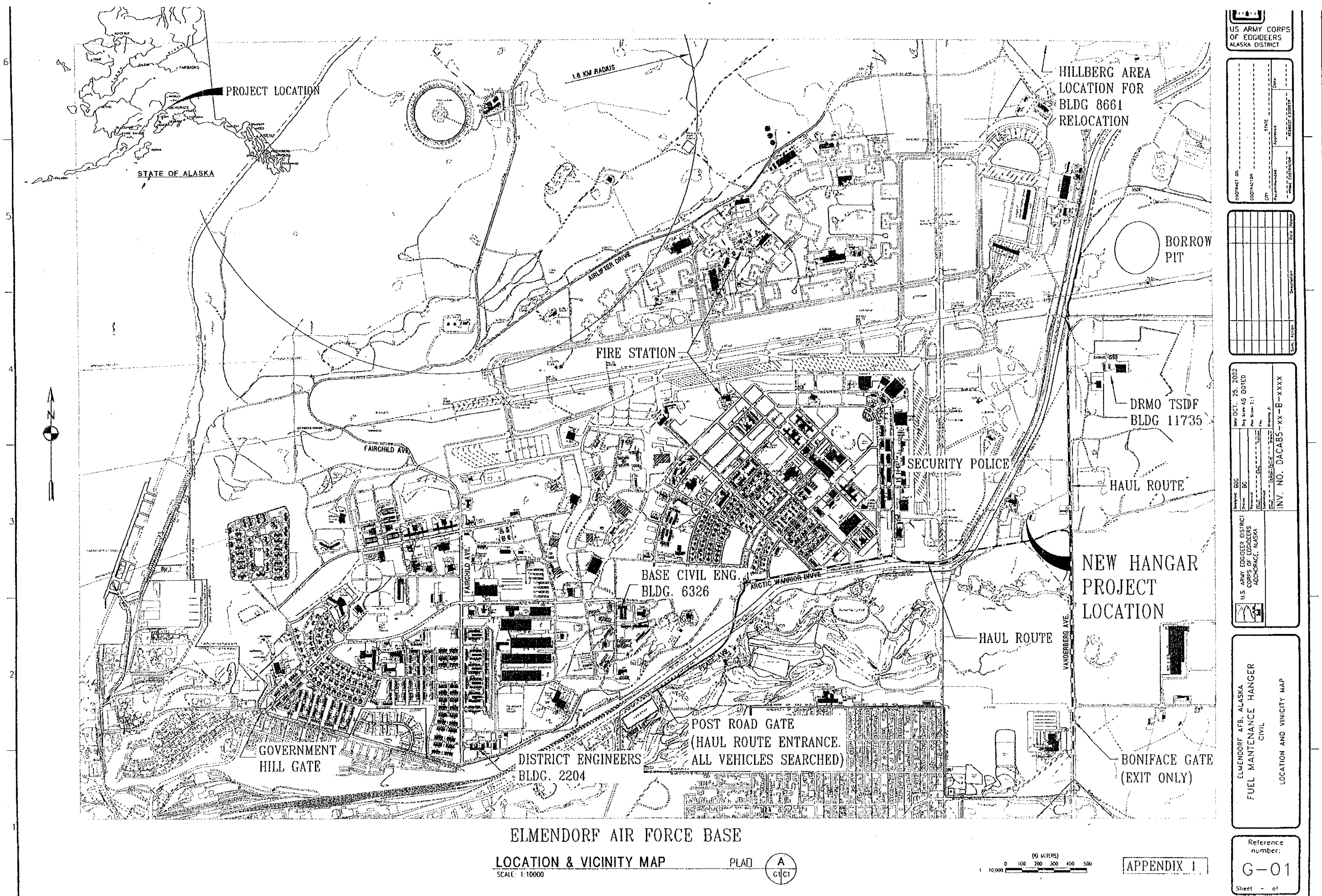


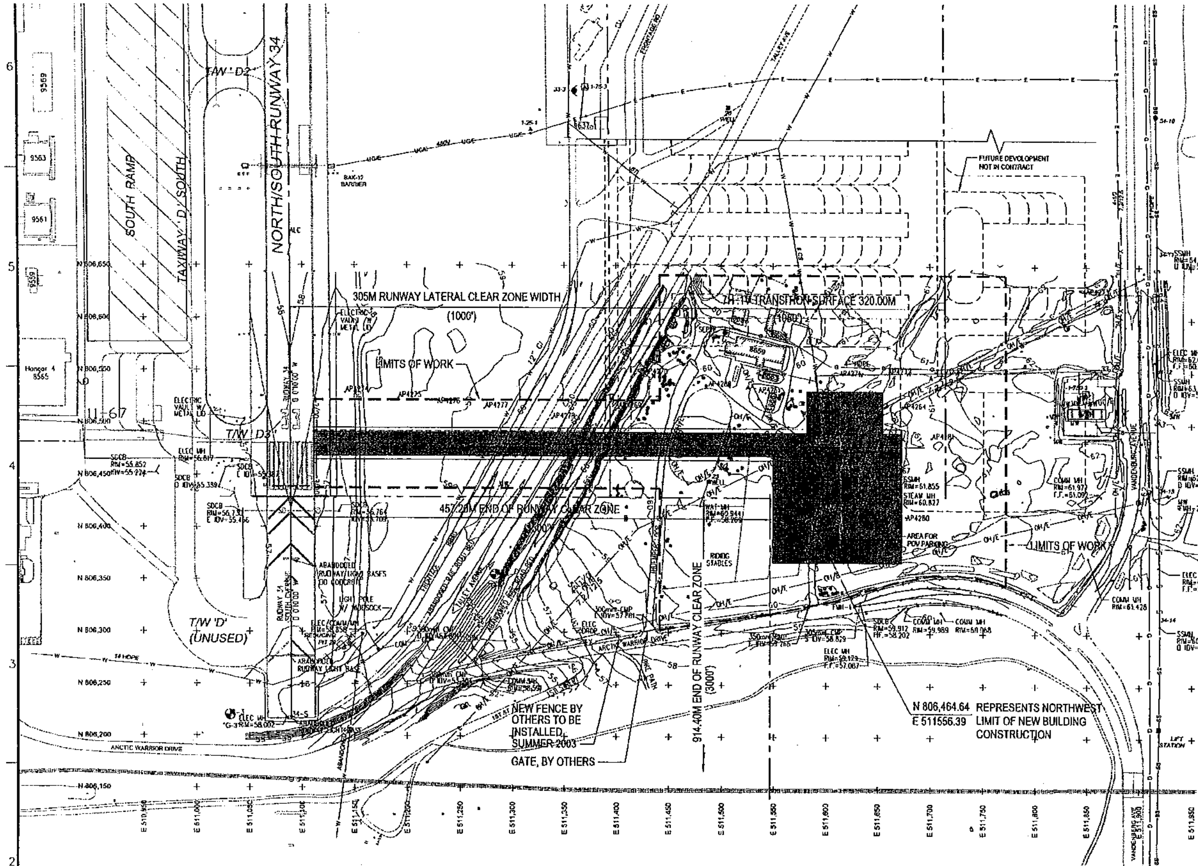
STREET LIGHTING

NEW FUEL SYSTEMS MAINTENANCE HANGAR
ELMENDORF AFB ELM 179
EXISTING UTILITIES

NO SCALE

--END OF APPENDIX 9--


PROJECT LOCATION
STATE OF ALASKA
1.6 KM RADIUS
HILLBERG AREA LOCATION FOR BLDG 8661 RELOCATION
BORROW PIT
AIRLIFTER DRIVE
FIRE STATION
DRMO TSDF BLDG 11735
FAIRCHILD AVE.
SECURITY POLICE
HAUL ROUTE
NEW HANGAR PROJECT LOCATION
BASE CIVIL ENG. BLDG. 6326
ARCTIC WARRIOR DRIVE
HAUL ROUTE
VANDERBERG AVE.
POST ROAD GATE (HAUL ROUTE ENTRANCE. ALL VEHICLES SEARCHED)
GOVERNMENT HILL GATE
DISTRICT ENGINEERS BLDG. 2204
BONIFACE GATE (EXIT ONLY)
ELMENDORF AIR FORCE BASE
LOCATION & VICINITY MAP
SCALE: 1:10000
PLAN
A
G1 C1
APPENDIX 1
US ARMY CORPS OF ENGINEERS ALASKA DISTRICT
U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ANCHORAGE, ALASKA
OCT. 25, 2002
INV. NO. DACA85-xx-B-xxxx
ELMENDORF AFB, ALASKA
FUEL MAINTENANCE HANGER
CIVIL
LOCATION AND VICINITY MAP
Reference number:
G-01



SITE SURVEY

1 / C-1 SCALE: 1:200

Symbol	Description
	SURVEY MONUMENT
	FENCE LINE
	GUARD RAIL
	TREE
	EDGE OF VEGETATION
	OVERHEAD ELECTRIC
	UNDERGROUND ELECTRIC
	COMMUNICATION LINE
	SEWER LINE
	WATER LINE
	STORM DRAIN LINE
	STRUCTURE SUPPORT
	ELECTRIC UTILITY
	POWER POLE
	GUY POLE
	POWER POLE W/GUY ANCHOR
	POWER POLE W/LIGHT
	LIGHT POLE
	FLOOD LIGHT
	AVIATION LIGHT
	TRANSFORMER
	TRANSFORMER W/PAD
	PARKING CURB
	COMMUNICATION PEDESTAL
	FUEL ACCESS LID
	WATER WELL
	GAS VALVE
	GAS METER
	FIRE HYDRANT
	VALVE / KEY BOX
	MANHOLE
	STORM DRAIN
	VENT PIPE
	CLEANOUT
	CULVERT
	COMMUNICATION BCM
	GAS BGM
	SIGN
	SIGN W/POSTS
	GUARD POST/BOLLARD
	AUGER POINT
	MONITOR WELL
	FINISH FLOOR
	SPOT ELEVATION
	MINOR CONTOUR (0.25m INTERVAL)
	MAJOR CONTOUR (1m INTERVAL)
	EDGE OF GRAVEL
	EDGE OF PAVEMENT
	CURB
	BUILDING OUTLINE
	CONCRETE
	PROPOSED IMPROVEMENT AREA, THIS PROJECT

SURVEY CONTROL

HORIZONTAL CONTROL

Coordinates are ALASKA STATE PLANE, NAD83(2002), ZONE 4, METERS. The Basis of Coordinates is Monument "TT-AN-7", having a value of N=809,092.274, E=510,143.002, and holding Monument "N-1B-DE", having a value of N=807,850.788, E=511,871.186. Horizontal positions for other control points were determined by differential GPS observations made on September 6 & 7, 2002, using dual frequency recievers.

SCALE FACTOR

The Project Combined Scale Factor is 0.99989113. To convert ground distances to ASP grid distances, multiply by a combined scale factor of 0.99989113. To convert ASP grid distances to ground distances, multiply by a combined scale factor of 100000000/99989113.

VERTICAL CONTROL

Elevations are based on NAVD88 Datum for Monument "TT-AN-7", having an elevation of 51.675 meters above Mean Sea Level.

UTILITY NOTE

The underground utilities shown have been located from field survey information and existing drawings. The surveyor makes no guarantees that the underground utilities shown comprise all such utilities in the area, either in service or abandoned. The surveyor further does not warrant that the underground utilities shown are in the exact location indicated, although he does certify that they are located as accurately as possible from information available.

SURVEY CONTROL POINTS

NAME	NORTHING	EASTING	ELEV.	DESCRIPTION
TT-AN-7	806,092.274	510,143.002	51.675	BRASS CAP
N-1B-DE	807,850.788	511,871.186	67.659	BRASS CAP
CSF-1	807,379.316	511,874.312	65.123	ALUM. MON
CSF-2	806,938.847	511,940.907	66.212	ALUM. MON
G-5	807,070.624	511,682.715	62.589	BRASS CAP
FMH-2	806,422.583	511,937.510	62.303	ALUM. MON
FMH-1	806,327.319	511,628.569	60.078	BRASS CAP
G-4	806,354.567	511,284.260	59.361	BRASS CAP
G-1	805,147.288	510,449.694	54.015	BRASS CAP
ELMEN	806,072.981	510,064.430	52.170	BRASS CAP
G-3	806,219.539	511,032.070	57.989	BRASS CAP
34-S	806,217.326	511,089.853	58.075	BRASS CAP
ALC	807,699.881	511,085.544		BRASS CAP

US ARMY CORPS OF ENGINEERS ALASKA DISTRICT

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ANCHORAGE, ALASKA

Date: OCT. 25, 2002

INV. NO. DACA85-xx-B-xxxx

ELMENDORF AFB, ALASKA
FUEL MANTENANCE HANGER
CIVIL
SITE SURVEY

Reference number: C-1

Sheet - of

UFC 1-200-01
31 JULY 2002

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL BUILDING REQUIREMENTS

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

UFC 1-200-01
31 JULY 2002

UNIFIED FACILITIES CRITERIA (UFC)

DESIGN: GENERAL BUILDING REQUIREMENTS

U.S. ARMY CORPS OF ENGINEERS

NAVAL FACILITIES ENGINEERING COMMAND (Preparing Activity)

AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

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

Change No.	Date	Location

31 JULY 2002

FOREWORD

The Unified Facilities Criteria (UFC) system as prescribed by MIL-STD 3007, provides planning, design, construction, sustainment, restoration, and modernization criteria, and applies to the Military Departments, the Defense Agencies, and the DoD Field Activities in accordance with USD(AT&L) Memorandum dated 29 May 2002. UFC will be used for all service projects and work for other customers where appropriate.

UFC are living documents and will be periodically reviewed, updated, and made available to users as part of the Services' responsibility for providing technical criteria for military construction. Headquarters, U.S. Army Corps of Engineers (HQUSACE), Naval Facilities Engineering Command (NAVFAC), and Air Force Civil Engineer Support Agency (AFCESA) are responsible for administration of the UFC system. Defense agencies should contact the preparing service for document interpretation and improvements. Technical content of UFC 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 (CCR). The form is also accessible from the Internet sites listed below.

UFC are effective upon issuance. UFC are distributed only in electronic media from the following sources:

- Unified Facilities Criteria (UFC) Index http://65.204.17.188//report/doc ufc.html.
- USACE TECHINFO Internet site **http://www.hnd.usace.army.mil/techinfo/index.htm.**
- NAVFAC Engineering Innovation and Criteria Office Internet site http://criteria.navfac.navy.mil.
- Construction Criteria Base (CCB) system maintained by the National Institute of Building Sciences at Internet site **http//www.nibs.org/ccb.**

Hard copies of UFC printed from electronic media should be checked against the current electronic version prior to use to ensure that they are current.

AUTHORIZED BY:

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Department of the Air Force

Frank Lane
Director of Analysis & Investment
Deputy Under Secretary of Defense
for Installations and Environment
Department of Defense

INTRODUCTION

1-1 **PURPOSE.** This UFC provides guidance for the use of model building codes for design and construction of Department of Defense (DOD) facilities.

1-2 **AUTHORITY.** Public Law 104-113, *National Technology Transfer and Advancement Act of 1995,* requires Federal use of private sector consensus standards wherever practicable. The goal of the law is to reduce reliance on Federal standards by using industry standards when there is potential to simplify contracting, increase timeliness and cost effectiveness, and promote the safety and welfare of users.

1-3 **POLICY.** Model building codes must be used as a basis of future development of criteria, standards and guide specifications by all DOD components. This UFC will be revised to address new and updated industry standards as they become available. It is DOD policy to select the best model code provisions and industry standards for military use.

1-4 **IMPLEMENTATION.** This UFC is effective immediately.

1-5 **STRUCTURE OF THE UFC.** This UFC references IBC 2000 and other government and nongovernment standards and criteria. Paragraph 1-6 provides modifications to IBC 2000 and is structured around its format. The IBC has 35 chapters and 10 appendices that contain both technical and administrative provisions. The administrative portions of the code are not applicable to the military construction process. Technical portions of the code are applicable as modified herein.

1-6 **MODIFICATIONS.** The *IBC 2000* provisions are directed toward public health, safety, and general welfare, and represent minimum standards that must be met by the private-sector construction industry. The use of industry standards for DOD projects is intended to promote communication in the marketplace, improve competition, and result in cost savings. However, the military often requires higher standards to achieve more stringent life-cycle performance, or to construct facilities that do not exist in the private sector. Modifications to the model code provisions contained herein are based upon those unique military requirements. In the case of conflicts between the model code and military criteria, use military requirements.

1-6.1 **Fire Protection and Life Safety.** For fire protection and life safety requirements, refer to *MIL-HDBK-1008C, *Fire Protection for Facilities Engineering, Design and Construction.*

1-6.2 **Chapter 1 - ADMINISTRATION.** Delete.

1-6.3 **Chapter 2 - DEFINITIONS.** Definitions apply to terms used in the model codes and are not intended to replace definitions and terms in military documents.

1-6.4 **Chapter 3 - USE AND OCCUPANCY CLASSIFICATION.** Use Chapter 3 and *MIL-HDBK-1008/C.

1-6.5 **Chapter 4 - SPECIAL DETAILED REQUIREMENTS BASED ON USE AND OCCUPANCY.** Delete Sections 412.1, 412.2, 414 and 415. Refer to applicable DOD and individual military service standards.

1-6.6 **Chapter 5 - GENERAL BUILDING HEIGHTS AND AREAS.** Refer to *MIL-HDBK-1008/C for limitations on the use of Table 503. In Section 506.3, the area limitations in Table 503 may be increased by 300 percent for Air Force facilities when an approved automatic sprinkler system is installed, regardless of building height.

1-6.7 **Chapter 6 – TYPES OF CONSTRUCTION.** Use this chapter.

1-6.8 **Chapter 7 – FIRE-RESISTANCE-RATED CONSTRUCTION.** Use this chapter.

1-6.9 **Chapter 8 - INTERIOR FINISHES.** Use Chapter 8 and *MIL-HDBK-1008/C.

1-6.10 **Chapter 9 – FIRE PROTECTION SYSTEMS.** Use *MIL-HDBK-1008/C.

1-6.11 **Chapter 10 - MEANS OF EGRESS.** Use *MIL-HDBK-1008/C.

1-6.12 **Chapter 11 - ACCESSIBILITY.** Delete Chapter 11 and use the *Uniform Federal Accessibility Standards (UFAS)* and the *Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).*

1-6.13 **Chapter 12 - INTERIOR ENVIRONMENT.**

1-6.13.1 **Paragraph 1202.2.1.** Delete the last sentence and substitute "Combustion air shall be obtained from attic areas only in accordance with Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria and guidance documents."

1-6.13.2 **Paragraph 1202.3.2, Subparagraph 4.** Delete "in accordance with the International Energy Conservation Code."

1-6.13.3 **Paragraph 1202.4.2.** Delete "the International Mechanical Code and the International Fire Code" and substitute "Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria and guidance documents."

1-6.13.4 **Paragraph 1203.1.** Delete, including the exception, and substitute "Temperature control shall be in accordance with Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria and guidance documents."

1-6.13.5 **Paragraphs 1206.2 and 1206.3.** Delete and replace with the following:

Table 1-1 Sound Transmission Standards for Party Walls and Floor/Ceiling Construction

Area	FSTC [1]	FIIC [2]
Party Walls (unit Separation)	52	-
Primary Habitable Areas (Living, Dining, Family Room, Bedrooms, Circulation)	52	65
Habitable Wet Areas (Kitchen, Bath, Utility, Laundry, Equipment)	52	57
Habitable Areas Over Garages	52	-

Note [1] Field Sound Transmission Class. See ASTM E336-97, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings.
Note [2] Field Impact Isolation Class. See ASTM E1007-97, Standard Test Method for Field Measurement of Tapping Machine Impact sound Through Floor-Ceiling Assemblies and Associated Support Structure.

IBC- Air-borne Sound = 50 STC; 45 FSTC ASTM E 90-99, Standard Test Method for Laboratory Measurement of Sound Transmission Loss of Building Partition Elements.

IBC- Structure-borne Sound = 50 IIC; 45 FIIC ASTM E 492-90, Standard Test Method for Laboratory Measurement of Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine.

1-6.13.6 **Paragraph 1207.3.** Delete and replace with following: "Use the latest DoD approved minimum sizes for barracks and dormitory rooms."

1-6.13.7 **Paragraph 1207.4.** Delete. The services define their own parameters for dwelling units.

1-6.14 **Chapter 13 - ENERGY EFFICIENCY.** Delete Chapter 13 and replace with "Federal facilities are required to comply with Public Laws, Executive Orders, Federal Regulations and other mandates regarding energy use, conservation and efficiency standards. In addition, the military has other unique requirements to ensure the planning, design and construction of energy efficient, cost effective facilities that meet mission requirements. These requirements are reflected in criteria and standards used by each military service. Compliance with Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria documents will ensure that facilities meet all applicable mandates."

1-6.15 **Chapter 14 - EXTERIOR WALLS.** Use Army Technical Instruction 800-01, *Design Criteria* for guidance for air infiltration, glazing area, and moisture migration pertaining to exterior wall systems.

1-6.16 **Chapter 15 - ROOF ASSEMBLIES AND ROOFTOP STRUCTURES.** Use Chapter 15 for basic guidance and NRCA, *Roofing and Waterproofing Manual* and UFGS Division 7 Thermal and Moisture Protection for technical criteria. The use of any asbestos containing materials in roofing products such as mastics, felts, etc. is prohibited.

1-6.17 **Chapter 16 – STRUCTURAL DESIGN.** Use Chapter 16 in its entirety with the following revisions:

1-6.17.1 **Paragraph 1616.2.3**. Buildings classified as Seismic Use Group III; as defined in Table 1604.5; and within Seismic Design Category D, E, or F; as defined by paragraph 1616.3, require enhanced performance objectives for earthquake response. These facilities will require, in addition to the requirements of Chapter 16, a linear elastic analysis utilizing 'm' factors in accordance with the requirements contained in the Technical Instruction TI 809-04 *Seismic Design for Buildings*. For this analysis, use the applicable ground motion and design procedures as defined in TI 809-04. In addition, nonlinear design procedures may be required for these facilities according to Paragraph 5-4.b of TI 809-04. (The classification of a building as Seismic Use Group III should only be used for essential facilities that are required for post-earthquake recovery, and/or house mission-essential functions, with no redundant back-up facility on- or off-site. Mission-essential functions are those absolutely critical to mission continuation of the activity.)

1-6.17.2 **Paragraph 1622.3.7**. Replace the second sentence with the following: "The seismic design of Navy piers and wharves will be according to the Technical Report TR-2069-SHR, *Design Criteria for Earthquake Hazard Mitigation of Navy Piers and Wharves*."

1-6.17.3 Use Appendices B and C for design at locations outside of CONUS.

1-6.17.4 All inhabited buildings must meet the requirements of **UFC 4-010-01, *DoD Minimum Antiterrorism Standards for Buildings*.

1-6.18 **Chapter 17 – STRUCTURAL TESTS AND INSPECTIONS.** Use Chapter 17 and the requirements in the Unified Facilities Guide Specifications.

1-6.19 **Chapter 18 – SOILS AND FOUNDATIONS.** Use Chapter 18 for basic guidance and ***DM 7.2, *Foundations and Earth Structures* for detailed requirements. For Section 1802.2, the foundation and soils investigation requirements are provided as a minimum. Additional requirements provided by the design agency will take precedence. Also use supplemental requirements in UFGS Division 2, Site Work.

1-6.20 **Chapter 19 – CONCRETE.** Use Chapter 19, and UFGS Division 3, Concrete. Chapter 19 supersedes MIL-HDBK 1002/4, *Concrete Structures*.

1-6.21 **Chapter 20 – ALUMINUM.** Use Chapter 20 and UFGS 05500 (Navy or Army as appropriate) *Miscellaneous Metals*. Chapter 20 supersedes MIL-HDBK-1002/6, *Aluminum Structures, Composite Structures, Structural Plastics, and Fiber-Reinforced Composites*.

1-6.22 **Chapter 21 – MASONRY.** Use Chapter 21 and UFGS Division 4, Masonry. Chapter 21 supercedes Army TM 5-809-3, NAVFAC DM-2.9, AFM 88-3, Chapter 3, *Masonry Structural Design for Buildings*. Give special attention to control cracking in concrete masonry structures using the guidance contained in Tables 1-2 and Table 1-3. Because the Masonry Society has a waiver for use of metric products, brick and concrete masonry units (CMU) are normally not available in metric sizes.

Table 1-2 Recommended Joint Control Spacing[a]

Vertical Spacing Of Joint Reinforcement With 2-#9 Wires[b] (in)	Maximum Ratio Of Panel Length To Wall Height (L/H)[c]	Maximum Spacing Of Control Joints [d] (ft)
None [e]	2	18
16	3	24
8	4	30

[a] Based on moisture-controlled, type I, concrete masonry in intermediate humidity conditions (ASTM C 90). The designer should adjust the control joint spacing for local conditions. The recommended spacing may be increased 6 ft in humid climates and decreased 6 ft in arid climates.
[b] Joint reinforcement will be cold-drawn deformed wire with a minimum 9-gauge longitudinal wire size.
[c] L is the horizontal distance between control joints. H is generally the vertical distance between structural supports.
[d] The spacing will be reduced approximately 50% near masonry-bonded corners or other similar conditions where one end of the masonry panel is restrained.
[e] Not recommended for walls exposed to view where control of cracking is important.

Table 1-3 Maximum Spacing of Vertical Expansion Joints in Brick Walls, $\Delta T=100^0F$

EXP.JT Width (in)	W x in	Max. Spacing of BEJs [a]
3/8	3/16	22
1/2	1/4	30
3/4	3/8	44
1 (MAX)	1/2	60

[a] Provide expansion joints at 6 to 10 ft from corners.
Recommended vertical BEJ locations.

a. At regular intervals as noted in table above.
b. At changes in wall height or thickness
c. Near wall intersections in "L", "T", and "U"-shaped buildings at approximately 6 to 10 ft) from corners.
d. At other points of stress concentration.
e. At edges of openings.

1-6.23 **Chapter 22 – STEEL.** Use Chapter 22 and UFGS Division 5, Metals. Chapter 22 supersedes MIL-HDBK 1002/3, *Structural Engineering Steel Structures*.

1-6.24 **Chapter 23 – WOOD.** Use Chapter 23 and UFGS Division 6, Wood and Plastics. Chapter 23 supersedes MIL-HDBK 1002/5, *Timber Structures*.

1-6.25 **Chapter 24 - GLASS AND GLAZING.** Use Chapter 24 and MIL-HDBK-1013/12, *Evaluation and Selection Analysis of Security Glazing for Protection Against Ballistic, Bomb, and Forced Entry Tactics* for force protection.

1-6.26 **Chapter 25 – GYPSUM BOARD AND PLASTER.** Use this chapter and applicable UFGS.

1-6.27 **Chapter 26 – PLASTIC.** Use this chapter.

1-6.28 **Chapter 27 – ELECTRICAL.** Delete and use NFPA 70, *National Electrical Code.*

1-6.29 **Chapter 28 – MECHANICAL SYSTEMS.** Delete Section 2801 and substitute "Mechanical appliances, equipment and systems shall be planned, designed and constructed in accordance with Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria and guidance documents. This will ensure energy efficient, cost effective facilities are provided that meet mission requirements and are in compliance with Public Laws, Executive Orders, Federal Regulations and similar mandates. Also comply with NFPA 54, *National Fuel Gas Code.*"

1-6.30 **Chapter 29 – PLUMBING SYSTEMS.** Delete Paragraph 2901.1 and substitute "Plumbing appliances, equipment and systems shall be planned, designed and constructed in accordance with the Unified Facility Criteria documents, Unified Facility Guide Specifications and military criteria and guidance documents. This will ensure energy efficient, water conserving and cost effective facilities are provided that meet mission requirements and are in compliance with Public Laws, Executive Orders, Federal Regulations and similar mandates."

1-6.31 **Chapter 30 – ELEVATORS AND CONVEYING SYSTEMS.** ITG 01-01, *Interim Technical Guidance Elevator Design* supersedes Chapter 30 wherever applicable.

1-6.32 **Chapter 31 - SPECIAL CONSTRUCTION.** Use entire chapter except Sections 3107 and 3108.

1-6.33 **Chapter 32 - ENCROACHMENT INTO THE PUBLIC RIGHT-OF-WAY.** Delete.

1-6.34 **Chapter 33 - SAFEGUARDS DURING CONSTRUCTION.** Delete.

1-6.35 **Chapter 34 - EXISTING STRUCTURES.** Delete entire chapter and refer to *MIL-HDBK-1008/C and ASCE 11-99, *Guidelines for Structural Condition Assessment of Existing Buildings.* Use ASCE 11-99 to conduct structural condition assessment of existing buildings prior to major additions, alterations or repairs.

1-6.36 **Chapter 35 - REFERENCED STANDARDS.** Use the chapter.

1-6.37 **Appendixes A, B, D, E, G, and J.** Delete.

1-6.38 **Appendix H - SIGNS.** Delete Appendix H. Follow the requirements of ADAAG and individual signage publications for each military service.

APPENDIX A

REFERENCES

GOVERNMENT PUBLICATIONS:

1. Unified Facilities Criteria

http:/criteria.navfac.navy.mil/criteria

http:/www.hnd.usace.army.mil/techinfo/index.asp

**UFC 4-010-01, Minimum Antiterrorism Standards for Buildings. (This UFC is due to be published 1 Aug 2002. For questions, please contact the preparing activity.)

2. Naval Facilities Engineering Command (NAVFAC)
1510 Gilbert Street
Norfolk, VA 23511-2669

http://criteria.navfac.navy.mil/criteria
http://www.nfesc.navy.mil

ITG 01-01, Interim Technical Guidance Elevator Design

*MIL-HDBK-1008C, Fire Protection for Facilities Engineering, Design and Construction. (Will be replaced by UFC 3-600-01, Fire Protection for Facilities Engineering, Design and Construction, September 2002. For questions, please contact the preparing activity.)

MIL-HDBK-1013/12, Evaluation and Selection Analysis of Security Glazing for Protection Against Ballistic, Bomb, and Forced Entry Tactics. (Restricted access. Contact your government sponsor if required.)

***DM 7.2, Foundations and Earth Structures. (This Design Manual is due to be replaced by UFC 3-220-01, Geotechnical Engineering by the end of calendar year 2002. For questions, please contact the preparing activity.)

Technical Report, TR-2069-SHR, Design Criteria for Earthquake Hazard mitigation of Navy Piers and Wharves, February 1987.

3. U.S. Army Corps of Engineers (USACE)
4820 University Square,
Huntsville, Al, 35816

Technical Instruction 800-01, Design Criteria

Technical Instruction 809-04, Seismic

http://www.hnd.usace.army.mil/techinfo/index.asp	Design for Buildings Technical Instruction 809-29, Structural Considerations for Metal Roofing Technical Instruction 809-53, Commentary on Roofing Systems
4. National Archives and Records Administration (NARA) gpoaccess@gpo.gov Telephone (202) 512-1530 Toll Free (888) 293-6498 Fax (202) 512-1262	Public Law 104-113, National Technology Transfer and Advancement Act of 1995
5. http://www.access-board.gov/ufas/ufas-html/ufas.htm	Uniform Federal Accessibility Standards (UFAS)
6. http://www.access-board/adaag/html/adaag.htm	Americans with Disabilities Act Accessibility Guidelines for Building and Facilities (ADAAG)

NON-GOVERNMENT PUBLICATIONS:

1. International Code Council (ICC) 5203 Leesburg Pike, Suite 600 Falls Church, VA 22041 (703) 931-4533 (703) 379-1546 fax http://www.intlcode.org/	International Building Code (IBC) 2000
2. National Fire Protection Association (NFPA) 1 Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 (617) 770-3000 www.nfpa.org	NFPA 70, National Electrical Code NFPA 54, National Fuel Gas Code
3. ASTM International 100 Barr Harbor Drive PO Box C700 West Conshohocken, PA 19428-2959	ASTM E336-97, Standard Test Method for Measurement of Airborne Sound Insulation in Buildings ASTM E1007-97, Standard Test Method

www.astm.org

for field Measurement of Tapping Machine Impact Sound Through Floor-Ceiling Assemblies and Associated Support Structure

ASTM E90-99, Standard Test Method for Laboratory Measurement of Sound Transmission Loss of Building Partition Elements.

ASTM E492-90, Standard Test Method for Laboratory Measurement of Sound Transmission Loss Through Floor-Ceiling Assemblies Using the Tapping Machine

4. American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191-4400
1-800-548-2723 toll free
(703) 295-6300 international
(703) 295-6222 fax
(703) 295-6444 faxback

http://www.asce.org

ASCE 7, Minimum Design Loads for Buildings and Other Structures.

ASCE 11-99, Guidelines for Structural Condition Assessment of Existing Buildings.

5. National Roofing Contractors Association (NRCA)
10255 W. Higgins Road, Suite 600,
Rosemont, IL 60018
(847) 299-9070;
fax (847) 299-1183;
e-mail nrca@nrca.net

http://www.nrca.net/

Roofing and Waterproofing Manual, 5th Edition, 2001

APPENDIX B

Wind Parameters (as published in ITG 01-2, *Minimum Design Loads for Buildings and Other Structures*)

ID	Name	Ground Snow Load (PSF)	Frost Penetration (in)	Basic Wind Speed (MPH)
1	Woomera, Australia	0	0	80
2	Chievres, Belgium	15	25	115
3	Manama, Bahrain	0	5	80
4	Guantanamo Bay, Cuba	0	5	90
5	Copenhagen, Denmark	25	35	90
6	Diego Garcia, Diego Garcia	0	5	105
7	Stuttgart, Germany	25	40	60
8	Heidelberg, Germany	25	30	60
9	Bad Kreuznach, Germany	25	30	60
10	Grefrath, Germany	25	20	60
11	Wuerzburg, Germany	25	35	60
12	Grafenwoehr, Germany	25	5	60
13	Hanau, Germany	25	25	60
14	Berchtesgaden, Germany	30	50	60
15	Landstuhl, Germany	25	40	60
16	Spangdahlem, Germany	25	35	60
17	Crete, Greece	5	5	85
18	Thule, Greenland	25	255	130
19	Agana Fleet Activities, Guam	0	5 (1)	155(2)
20	Agana Ship Repair, Guam	0	5(1)	155(2)
21	Agana Anderson AFB, Guam	0	5(1)	155(2)
22	Keflavik, Iceland	25	50	110
23	Vicenzia, Italy	35	25	80
24	Gaeta, Italy	20	5	80
25	La Maddalena, Italy	20	5	80
26	Naples, Italy	20	5	80
27	Sigonella, Italy	20	5	80
28	Pordenone, Italy	35	25	80
29	Atsugi, Japan	15	25(3)	120
30	Iwakuni, Japan	0	10(3)	120
31	Sagamihara, Japan	10	5(3)	110
32	Okinawa, Japan	0	5(3)	110
33	Naha, Japan	0	5(3)	110
34	Koza City, Japan	0	5(3)	110
35	Misawa, Japan	40	50(3)	110
36	Tokyo, Japan	10	5(3)	110
37	Sasebo, Japan	10	5(3)	100
38	Atsugi, Japan	20	25(3)	120

ID	Name	Ground Snow Load (PSF)	Frost Penetration (in)	Basic Wind Speed (MPH)
39	Yokosuka NCTC, Japan	20	5(3)	110
40	Yokosuka CFA, Japan	20	5(3)	110
41	Yokosuka Ship Repair, Japan	20	5(3)	110
42	Teague, Korea	20	40(4)	110
43	Pyongtaek, Korea	20	50(4)	100
44	Uijongbu, Korea	20	45(4)	105
45	Seoul, Korea	20	45(4)	105
46	Chinhae, Korea	20	15(4)	105
47	Kunsan, Korea	20	30(4)	100
48	Songtan, Korea	20	50(4)	95
49	Port Lyautey, Morocco	0	5	85
50	Schirmen, Netherlands	15	20	80
51	Antarctica	30	190	105
52	Balboa, Panama	0	5	110
53	Panama City, Panama	0	5	90
54	Colon, Panama	0	5	95
55	Galeta Island, Panama	0	5	90
56	Panama Canal, Panama	0	5	110
57	Terceira, Portugal-Azores	0	5	120
58	Guaynaba, Puerto Rico	0	5	120(5)
59	San Juan, Puerto Rico	0	5	120(5)
60	Sabana Seca, Puerto Rico	0	5	120(5)
61	Roosevelt Roads, Puerto Rico	0	5	140(5)
62	Rota, Spain	5	5	85
63	Adana, Turkey	0	5	70
64	Diyarbakir, Turkey	15	25	105
65	Southampton, England	15	10	85
66	London, England	15	15	100
67	Edzell, England	15	25	85
68	Croughton, England	15	15	100
69	Lakenheath, England	15	15	100
70	Mildenhall, England	15	15	100
71	Antigua, Virgin Islands	0	5	140(6)

Notes:

(1) No frost in Guam or Diego Garcia. Need to identify as minimum footing depth.
(2) ASCE 7 recommends 170 m.p.h. Use ASCE value.
(3) Need to confirm large variance in frost penetration for Japan.
(4) Need to confirm large variance in frost penetration for Korea.
(5) ASCE 7 recommends 145 m.p.h. Use ASCE value.
(6) ASCE 7 recommends 145 m.p.h. Use ASCE value.

APPENDIX C

Seismic Parameters

			Ss	S1
AFRICA	ALGERIA	Alger	1.24	0.56
		Olan	1.24	0.56
	ANGOLA			
		Luanda	0.06	0.06
	BENIN			
		Cotonou	0.06	0.06
	BOTSWANA			
		Gaborone	0.06	0.06
	BURUNDI			
		Bujumbura	1.24	0.56
	CAMEROON			
		Douala	0.06	0.06
		Yaounde	0.06	0.06
	CAPE VERDE			
		Praia	0.06	0.06
	CENTRAL AFRICAN REPUBLIC			
		Bangui	0.06	0.06
	CHAD			
		Ndjamena	0.06	0.06
	CONGO			
		Brazzaville	0.06	0.06
	DJIBOUTI			
		Djibouti	1.24	0.56
	EGYPT			
		Alexandria	0.62	0.28
		Cairo	0.62	0.28
		Port Said	0.62	0.28
	EQUATORIAL GUINEA			
		Malabo	0.06	0.06
	ETHIOPIA			
		Addis Ababa	1.24	0.56
		Asmara	1.24	0.56
	GABON			
		Libreville	0.06	0.06
	GAMBIA			
		Banjul	0.06	0.06
	GHANA			
		Accra	1.24	0.56
	GUINEA			
		Bissau	0.31	0.14
		Conakry	0.06	0.06
	IVORY COAST			
		Abidijan	0.06	0.06
	KENYA			
		Nairobi	0.62	0.28

	LESOTHO			
		Maseru	0.62	0.28
	LIBERIA			
		Monrovia	0.31	0.14
	LIBYA			
		Tripoli	0.62	0.28
		Wheelus AFB	0.62	0.28
	MALAGASY REPUBLIC			
		Tananarive	0.06	0.06
	MALAWI			
		Blantyre	1.24	0.56
		Lilongwe	1.24	0.56
		Zomba	1.24	0.56
	MALI			
		Bamako	0.06	0.06
	MAURITANIA			
		Nouakchott	0.06	0.06
	MAURITIUS			
		Port Louis	0.06	0.06
	MOROCCO			
		Casablanca	0.62	0.28
		Port Lyautey	0.31	0.14
		Rabat	0.62	0.28
		Tangier	1.24	0.56
	MOZAMBIQUE			
		Maputo	0.62	0.28
	NIGER			
		Niamey	0.06	0.06
	NIGERIA			
		Ibadan	0.06	0.06
		Kaduna	0.06	0.06
		Lagos	0.06	0.06
	REPUBLIC OF RWANDA			
		Kigali	1.24	0.56
	SENEGAL			
		Dakar	0.06	0.06
	SEYCHELLES			
		Victoria	0.06	0.06
	SIERRA LEONE			
		Freetown	0.06	0.06
	SOMALIA			
		Mogadishu	0.06	0.06
	SOUTH AFRICA			
		Cape Town	1.24	0.56
		Durban	0.62	0.28
		Johannesburg	0.62	0.28
		Natal	0.31	0.14
		Pretoria	0.62	0.28
	SWAZILAND			
		Mbabane	0.62	0.28
	TANZANIA			
		Dar es Salaam	0.62	0.28

		Zanzibar	0.62	0.28
	TOGO			
		Lome	0.31	0.14
	TUNISIA			
		Tunis	1.24	0.56
	UGANDA			
		Kampala	0.62	0.28
	UPPER VOLTA			
		Ougadougou	0.06	0.06
	ZAIRE			
		Bukavu	1.24	0.56
		Kinshasa	0.06	0.06
		Lubumbashi	0.62	0.28
	ZAMBIA			
		Lusaka	0.62	0.28
	ZIMBABWE			
		Harare		
ASIA	AFGHANISTAN			
		Kabul	1.65	0.75
	BAHRAIN			
		Manama	0.25	0.10
	BANGLADESH			
		Dacca	1.24	0.56
	BRUNEI			
		Bandar Seri Begawan	0.31	0.14
	BURMA			
		Mandalay	1.24	0.56
		Rangoon	1.24	0.56
	CHINA			
		Canton	0.62	0.28
		Chengdu	1.24	0.56
		Nanking	0.62	0.28
		Peking	1.65	0.75
		Shanghai	0.62	0.28
		Shengyang	1.65	0.75
		Tibwa	1.65	0.75
		Tsingtao	1.24	0.56
		Wuhan	0.62	0.28
	CYPRUS			
		Nicosia	1.24	0.56
	HONG KONG			
		Hong Kong	0.62	0.28
	INDIA			
		Bombay	1.24	0.56
		Calcutta	0.62	0.28
		Madras	0.31	0.14
		New Delhi	1.24	0.56
	INDONESIA			
		Bandung	1.65	0.75
		Jakarta	1.65	0.75
		Medan	1.24	0.56

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		Surabaya	1.65	0.75
	IRAN			
		Isfahan	1.24	0.56
		Shiraz	1.24	0.56
		Tabriz	1.65	0.75
		Tehran	1.65	0.75
	IRAQ			
		Baghdad	1.24	0.56
		Basra	0.31	0.14
	ISRAEL			
		Haifa	1.24	0.56
		Jerusalem	1.24	0.56
		Tel Aviv	1.24	0.56
	JAPAN			
		Fukuoka	1.24	0.56
		Itazuke AFB	1.24	0.56
		Misawa AFB	1.24	0.56
		Naha, Okinawa	1.65	0.75
		Osaka/Kobe	1.65	0.75
		Sapporo	1.24	0.56
		Tokyo	1.65	0.75
		Wakkanai	1.24	0.56
		Yokohama	1.65	0.75
		Yakota	1.65	0.75
	JORDAN			
		Amman	1.24	0.56
	KOREA			
		Kwangju	0.31	0.14
		Kimhae	0.31	0.14
		Pusan	0.31	0.14
		Seoul	0.06	0.06
	KUWAIT			
		Kuwait	0.31	0.14
	LAOS			
		Vientiane	0.31	0.14
	LEBANON			
		Beirut	1.24	0.56
	MALAYSIA			
		Kuala Lumpur	0.31	0.14
	NEPAL			
		Kathmandu	1.65	0.75
	OMAN			
		Muscat	0.62	0.28
	PAKISTAN			
		Islamabad	1.68	0.75
		Karachi	1.65	0.75
		Lahore	0.62	0.28
		Peshawar	1.65	0.75
	QUATAR			
		Doha	0.06	0.06
	SAUDI ARABIA			

		Al Batin	0.31	0.14
		Dhahran	0.31	0.14
		Jiddah	0.62	0.28
		Khamis Mushayf	0.310.14	
		Riyadh	0.06	0.06
	SINGAPORE			
		All	0.31	0.14
	SOUTH YEMEN			
		Aden City	1.24	0.56
	SRI LANKA			
		Colombo	0.06	0.06
	SYRIA			
		Allepo	1.24	0.56
		Damascus	1.24	0.56
	TAIWAN			
		All	1.65	0.75
	THAILAND			
		Bangkok	0.31	0.14
		Chinmg Mai	0.62	0.28
		Dongkhia	0.06	0.06
		Udorn	0.31	0.14
	TURKEY			
		Adana	0.62	0.28
		Ankara	0.62	0.28
		Istanbul	1.65	0.75
		Izmir	1.65	0.75
		Karamursel	1.24	0.56
	UNITED ARAB EMIRATES			
		Abu Dhabi	0.06	0.06
		Dubai	01.06	0.06
	VIETNAM			
		Ho Chi Minh City		
		(Saigon)	0.06	0.06
	YEMEN ARAB REPUBLIC			
		Sanaa	1.24	0.56
ATLANTIC OCEAN AREA	AZOREA			
		All	0.62	0.28
	BURMUDA			
		All	0.31	0.14
CARIBBEAN SEA	BAHAMA ISLANDS			
		All	0.31	0.14
	CUBA			
		All	0.62	0.28
	DOMINICAN REPUBLIC			
		Santo Domingo	1.24	0.56
	FRENCH WEST INDIES			
		Martinique	1.24	0.56
	GRENADA			
		Saint Georges	1.24	0.56

	HAITI			
		Port au Prince	1.24	0.56
	JAMAICA			
		Kingston	1.24	0.56
	LEEWARD ISLANDS			
		All	1.24	0.56
	TRINADAD AND TOBAGO			
		All	1.24	0.56
CENTAL AMERICA	BELIZE			
		Beimopan	0.26	0.28
	CANAL ZONE			
		All	0.62	0.28
	COSTA RICA			
		San Jose	12.4	0.56
	EL SALVADORE			
		San Salvador	1.65	0.75
	GUATEMALA			
		Guatemala	1.65	0.75
	HONDURAS			
		Tegucigalpa	1.24	0.56
	NICARAGUA			
		Managua	1.65	0.75
	PANAMA			
		Colon	1.24	0.56
		Galeta	0.83	0.38
		Panama	1.24	0.56
	MEXICO			
		Ciudad Juarez	0.62	0.28
		Guadalajara	1.24	0.56
		Hermosillo	1.24	0.56
		Matamoros	0.06	0.06
		Mazatlan	0.60	0.28
		Merida	0.06	0.06
		Mexico City	1.24	0.56
		Monterrey	0.06	0.06
		Nuevo Laredo	0.06	0.06
		Tijuana	1.24	0.56
EUROPE	ALBANIA			
		Tirana	1.24	0.56
	AUSTRIA			
		Salzburg	0.62	0.28
		Vienna	0.62	0.28
	BELGIUM			
		Antwerp	0.31	0.14
		Brussels	0.62	0.28
	BULGARIA			
		Sofia	1.24	0.56
	CZECH REPUBLIC			
		Prague	0.31	0.14
	DENMARK			
		Copenhagen	0.31	0.14

	FINLAND			
		Helsinki	0.31	0.14
	FRANCE			
		Bordeaux	0.62	0.28
		Lyon	0.31	0.14
		Marseille	1.24	0.56
		Nice	1.24	0.56
		Strasbourg	0.62	0.28
	GERMANY, FEDERAL REPUBLIC			
		Berlin	0.06	0.06
		Bonn	0.62	0.28
		Bremen	0.06	0.06
		Dusseldorf	0.31	0.14
		Frankfurt	0.62	0.28
		Hamburg	0.06	0.06
		Munich	0.31	0.14
		Stuttgart	0.62	0.28
		Vaihigen	0.62	0.28
	GREECE			
		Athens	1.24	0.56
		Kavalla	1.65	0.75
		Makri	1.65	0.75
		Rhodes	1.24	0.56
		Souda Bay	1.65	0.75
		Thessaloniki	1.65	0.75
	HUNGARY			
		Budapest	0.62	0.28
	ICELAND			
		Keflavik	1.0	0.40
		Reykjavik	1.65	0.75
	IRELAND			
		Dublin	0.06	0.06
	ITALY			
		Aviano AFG	1.24	0.56
		Brindisi	0.06	0.06
		Florence	1.24	0.56
		Gaeta	0.50	0.21
		Genoa	1.24	0.56
		La Maddalena	0.22	0.09
		Milan	0.62	0.28
		Naples	0.67	0.27
		Palermo	1.24	0.56
		Rome	0.62	0.28
		Sicily	1.20	0.31
		Trieste	1.24	0.56
		Turin	0.62	0.28
	LUXEMBOURG			
		Luxembourg	0.31	0.14
	MALTA			
		Valletta	0.62	0.28
	NETHERLANDS			
		All	0.06	0.06

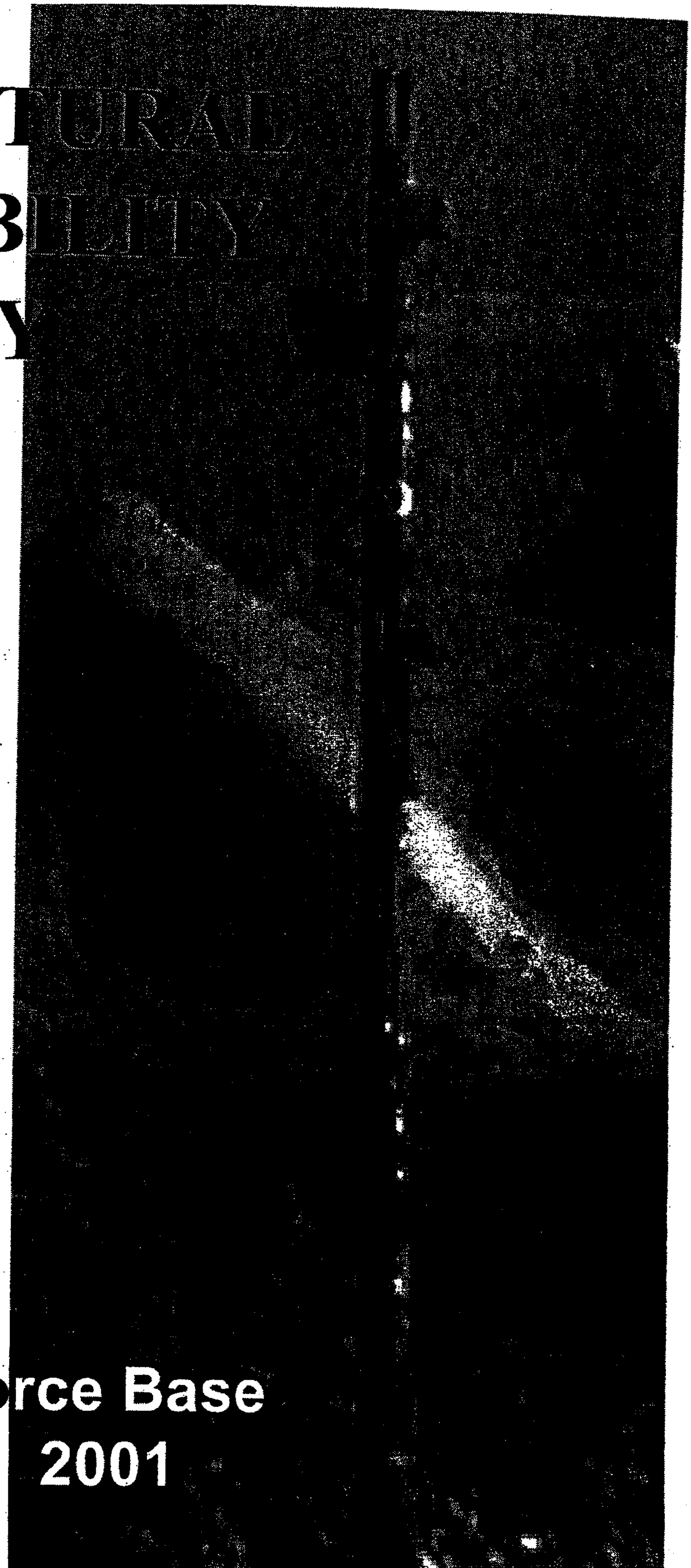
	NORWAY			
		Oslo	0.62	0.28
	POLAND			
		Krakow	0.62	0.28
		Poznan	0.31	0.14
		Waraszawa	0.31	0.14
	PORTUGAL			
		Lisbon	1.65	0.75
		Oporto	1.24	0.56
	ROMANIA			
		Bucharest	1.24	0.56
	SLOVAK REPUBLIC			
		Bratislava	0.62	0.28
	SPAIN			
		Barcelona	0.62	0.28
		Bilbao	0.62	0.28
		Madrid	0.06	0.06
		Rota	0.75	0.30
		Sevilla	0.62	0.28
	SWEDEN			
		Goteborg	0.62	0.28
		Stockholm	0.31	0.14
	SWITZERLAND			
		Bern	0.62	0.28
		Geneva	0.31	0.14
		Zurich	0.62	0.28
	UNITED KINGDOM			
		Belfast	0.06	0.06
		Edinburgh	0.31	0.14
		Edzell	0.31	0.14
		Glasgow/Renfrew	0.31	0.14
		Hamilton	0.31	0.14
		Liverpool	0.31	0.14
		London	0.125	0.025
		Londonderry	0.31	0.14
		St. Mawgan	0.20	0.04
		Thurso	0.31	0.14
	USSR			
		Kiev	0.06	0.06
		Leningrad	0.06	0.06
		Moscow	0.06	0.06
	YUGOSLAVIA			
		Belgrade	0.62	0.28
		Zagreb	1.24	0.56
NORTH AMERICA	GREENLAND			
		All	0.31	0.14
	CANADA			
		Argentina NAS	0.62	0.28
		Calgary, Alb	0.31	0.14
		Churchill, Man	0.06	0.06

		Cold Lake, Alb	0.31	0.14
		Edmonton, Alb	0.31	0.14
		E. Harmon, AFB	0.62	0.28
		Fort Williams, Ont	0.06	0.06
		Frobisher N.W. Ter	0.06	0.06
		Goose Airport	0.31	0.14
		Halifax	0.31	0.14
		Montreal, Quebec	1.24	0.56
		Ottawa, Ont	0.62	0.28
		St. Johns Nfld	1.24	0.56
		Toronto, Ont	0.31	0.14
		Vancouver	1.24	0.56
		Winnepeg, Man	0.31	0.14
SOUTH AMERICA	ARGENTINA			
		Buenos Aires	0.25	0.10
	BRAZIL			
		Belem	0.06	0.06
		Belo Horizonte	0.06	0.06
		Brasilia	0.06	0.06
		Manaus	0.06	0.06
		Porto Allegre	0.06	0.06
		Recife	0.06	0.06
		Rio de Janeiro	0.06	0.06
		Salvador	0.06	0.06
		San Paulo	0.31	0.14
	BOLIVIA			
		La Paz	1.24	0.56
		Santa Cruz	0.31	0.14
	CHILE			
		Santiago	1.65	0.75
		Valparaiso	1.65	0.75
	COLOMBIA			
		Bogotá	1.24	0.56
	ECUADOR			
		Quito	1.65	0.75
		Guayaquil	1.24	0.56
	PARAQUAY			
		Asuncion	0.06	0.06
	PERU			
		Lima	1.65	0.75
		Plura	1.65	0.75
	URUGUAY			
		Montevideo	0.06	0.06
	VENEZUELA			
		Maracaibo	0.62	0.28
		Caracas	1.65	0.75
PACIFIC OCEAN AREA	AUSTRALIA			
		Brisbane	0.31	0.14
		Canberra	0.31	0.14
		Melbourne	0.31	0.14

		Perth	0.31	0.14
		Sydney	0.31	0.14
	CAROLINE ISLANDS			
		Koror, Paulau Is	0.62	0.28
		Ponape	0.06	0.06
	FIJI			
		Suva	1.24	0.56
	JOHNSON ISLAND			
		All	0.31	0.14
	MARIANA ISLANDS			
		Saipan	1.24	0.56
		Tinian	1.24	0.56
	MARSHAL ISLANDS			
		All	0.31	0.14
	NEW ZEALAND			
		Auckland	1.24	0.56
		Wellington	1.65	0.75
	PAPAU NEW GUINEA			
		Port Moresby	1.24	0.56
	PHILLIPINE ISLANDS			
		Cebu	1.65	0.75
		Manila	1.65	0.75
		Baguio	1.24	0.56
	SAMOA			
		All	1.24	0.56
	WAKE ISLAND			
		All	0.06	0.06

--END OF APPENDIX 2--

ARCHITECTURAL COMPATIBILITY STUDY



Elmendorf Air Force Base
5 - 9 November 2001

SECTION 1
INTRODUCTION

PURPOSE

This report presents the findings and recommendations developed by an Architectural Assistance Team which conducted an evaluation and validation process on-site at Elmendorf Air Force Base. The goal of the study was to produce an enforceable set of design recommendations to set a base-wide standard for Elmendorf. The process involved researching existing design documents, touring facilities, and interviewing appropriate base personnel. After gathering information, the team organized the data and developed the standards. The team focused mainly on architectural compatibility issues.

SCOPE AND USE

The team addressed its efforts to the entire base. This document is to be used by Headquarters Pacific Air Forces Command (PACAF) and local base leaders as a guideline for the continued development of Elmendorf Air Force Base. This document provides the basic standards from which a consistent regional, or "Alaskan" theme, incorporating sound cold-weather design principles, can be implemented across the base.

COLD-CLIMATE DESIGN PRINCIPLES

The average temperature in January ranges from 6 to 20 degrees; in summer temperatures range from 59 to 70 degrees. Annual precipitation is 15.9 inches, with 69 inches of snowfall. Cold-climate design strategies are required at Elmendorf Air

Force Base.
The building should have a southern exposure to capture as much solar gain as possible. The overall shape of the building should minimize surface area to conserve energy.

Protected, arctic entries are required which are kept at a lower temperature to save energy by providing a transition from outside to inside the building.

Pitched roof forms have and inherent strength to resist snow loads. However, movement of the roofing material as temperatures change can lead to leaks. Additionally, snow tends to stack unevenly, resulting in non-uniform loading. For long spans, sloped roofs are more difficult to accomplish and the large snow loads can be extremely dangerous when they slide. In general, sloped roofs are preferred at Elmendorf, however, care should be taken to address potential leak and snow slide problems. For large buildings, with large spans, "flat" roofs may be a more practical solution. Properly designed flat roofs can offer the added benefit of additional insulation due to a layer of snow.

Building orientation is very important to capture as much sunlight as possible to provide natural lighting and maximize solar gain. An "L" shaped building facing south, southeast or southwest will trap sunlight and provide a pleasant space for people to use.

Exterior lighting is important to encourage people to go outdoors during the winter when daylight is limited.

SECTION 2
DESIGN GUIDELINES

GENERAL DESIGN GUIDELINES

The compatibility guidelines presented here establish the framework to support new construction, renovation of existing structures, material and color selection. They provide a way of informing architects and designers of certain standards of construction materials and architectural styles that have been adopted by Elmendorf Air Force Base, and must be adhered to when developing projects on the base.

The general design concepts shown here should be used for all construction and upgrade work at Elmendorf Air Force Base.

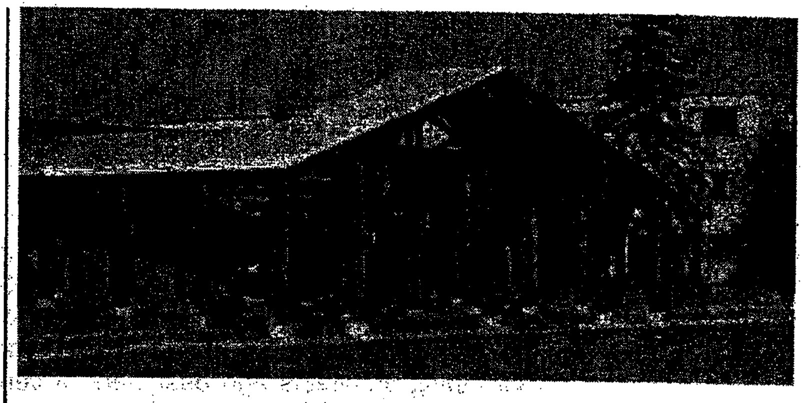
ALASKAN ARCHITECTURAL THEME

Surprisingly, an Alaskan architectural paradigm has not been established. Several buildings on base, convey the rustic, qualities one would expect to find in the Alaskan "final frontier." Characteristics these facilities have in common include:

- Gabled roof forms
- Natural materials and colors
- Expressed truss structure
- Protected entry or arcade, I
- Arctic entries
- Building orientation to maximize solar gain
- Roof forms direct snow and ice away from entries and walks
- Indigenous landscaping (spruce, birch, wildflowers)

These characteristics can be adapted with different materials and incorporated into the design of buildings across the base.

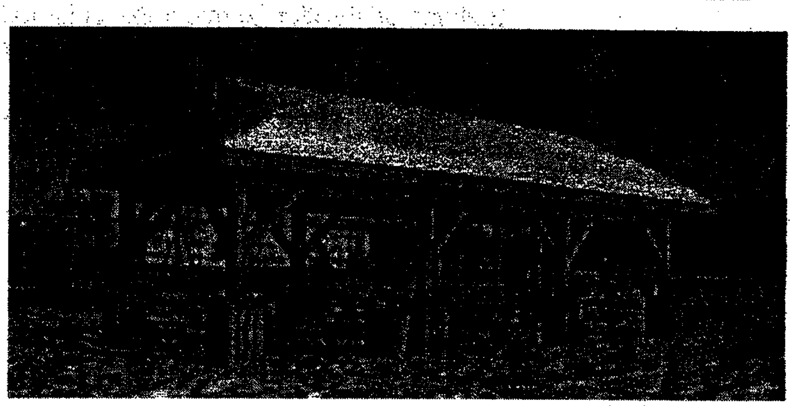
Kenei Dining Hall



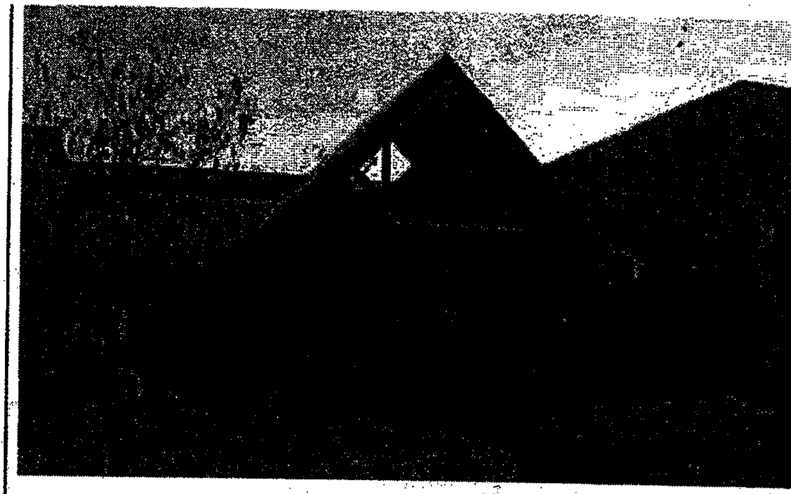
Kenei Dining Hall

Family Support Center

Recreation Pavilion



U-Fix-It Shop



BX/Commissary

ARCHITECTURAL ELEMENTS

The following is a list of general architectural elements which establish the physical appearance and visual character of buildings base-wide.

CONTEXT

The relationship of an individual building to its function and its surroundings creates it's context. The primary consideration for the visual environment is whether a building has a "foreground" context or "background" context. **Destination buildings** refer to those such as the chapel or the Wing Headquarters Building whose function or location makes it visually prominent. **Background buildings** (such as warehouses or industrial buildings) are those which do not require a prominent visual image or location.

MASS/SCALE

The mass of a building refers to the volume which a building encloses. Scale compares the elements of the building (doorways, windows, and details) to the human body.

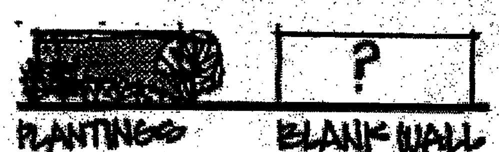
- A proposed building should be scaled to be compatible with the overall mass and individual parts of buildings in its area of the base.

- New construction on the base should avoid designs using a single rectangular mass.

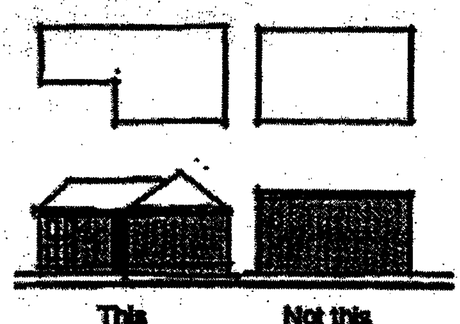
- Major administrative buildings will have a more formal massing than other building types, signifying their relative importance.

- Scale and relief should be provided through roof form, fenestration, building articulation and landscape plantings.

- Blank walls provide little visual interest and should be avoided, especially in pedestrian areas.



- Except for major buildings, the scale for all buildings should be human, not monumental.



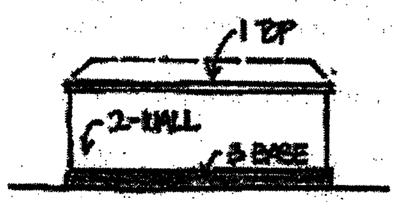
FORM/ PROPORTION

The form and proportion of a building are basic elements which relate a building to its setting.

- Use building shapes and roof forms similar to appropriate adjacent buildings. There should be no use of flat roofs except where fiscally imperative where building size makes a sloped roof impracticable. Primary roof forms to be considered are hip, gable and shed. Roof shapes should be simple to minimize construction cost and reduce snow buildup.

- Use proportions appropriate to the facility type in the design of the facade. Design windows, entrances and detailing to complement those proportions.

- Emphasize the parts of all buildings to clearly show a division of roof, walls, and base. Utilize color, materials, and/or details to express these divisions.



- Use roof overhangs, floor overhangs, porches, trellises, exterior louvers and other similar elements to shade exterior walls and glazing.

FENESTRATION/ OPENINGS

Fenestration is the design and rhythm of window and door openings within the building envelope. Window and door frames should have a complementary accent color; usually dark brown anodized aluminum, tan, gray or a lighter shade of the wall color. Exterior doors can be either aluminum or steel. Aluminum storefront doors should match the windows. Steel doors should blend with the surrounding wall color.

- Design openings to form a unified composition in proportion to the building elevation.

- Window placement should relate to internal areas. Mullion spacing should provide a good module for internal layout of office space, entrances, common use areas, etc.

- Locate windows to overlook exterior pedestrian areas or landscaped grounds.

- Glazing should be placed to maximize interior exposure to the sun on the south, east and west sides of each building. With the exception of major buildings, oversized fenestration elements which create monumental scale should be avoided.

- Use predominant and secondary facade materials consistently and uniformly on all sides of the building.

- Graphics and stripes should not be used.

- Reflective glass curtain walls, corrugated fiberglass, aluminum siding, and materials that are applied to imitate other materials, except for exterior insulation and finish systems (EIFS) to simulate stucco, are not considered appropriate as facade materials.

- Locate all above-grade utility connections, vents, and other projections through the building away from high visibility areas. Do not locate any utility projections, such as air conditioning units, on the street side of the building.

- For freestanding walls, use materials and colors similar to those on adjacent buildings.

ENTRANCES

The scale and detailing of an entrance give the pedestrian a sense of the function and importance of a building. Along with providing a visual break in building facades, they provide a readily identifiable point of building entry, and refuge from inclement weather. Arctic entries shall be used in all buildings, except for industrial, warehouse and vehicle storage and maintenance facilities including hangars.

Alaskan themed entries include the following characteristics:

- Orient entry to the south
- Exposed or expressed structure (truss form) in wood or finished metal

- Open beam design
- Oversized, exposed, round or square columns
- Covered arcade element
- Shelter the entrance (provide arctic entrance, a protective, transitional space, such as a vestibule, at a temperature between the exterior and interior temperatures)
- Maximize glazing for solar gain

ROOFS

- Gable roofs are the preferred roof form at a minimum slope of 4 in 12.
- Limit use of gutters and downspouts.
- Skylights shall not be used.
- Low-sloped roofs shall be sloped at 1 ½ inch per foot, minimum.
- "Flat" roofs shall be sloped at ¼ inch per foot, minimum (½ inch per foot recommended).
- Internal roof drains shall be used on "flat" roofs.
- "Cold roof" design shall be employed for sloped roofs.
- Slopes may be varied for retrofitting large buildings.
- Vary roof eave elevations within building groupings to create interest.
- Orient roof forms to divert snow and ice away from entries and walks.
- Maintenance should be considered before selecting flat roofs.

MATERIALS

Exterior materials give color, texture and scale to a building's appearance. Architectural details such as cornices, reveals, or masonry patterns create interest and scale.

- Roofs.
- Sloped roofs should be of standing seam metal or shingles, depending on the scale of the building and adjacent building materials.

- Four-ply Built Up Roofing System (BURS) designed for arctic conditions is the preferred "flat" roof system.
- Use an average R-38 minimum insulation on all roofs (new or renovation).
- Consider recycled materials.
- Walls.
- CMU (smooth, split face or ribbed)
- Textured concrete (e.g. prefabricated panels, cast- in-place or tilt-up) – or –
- Exterior Insulation and Finish System (EIFS)
- Low profile or striated metal wall system

COLORS

Color unifies or emphasizes elements of a building. Related colors are a means to harmonize different elements while maintaining visual interest.

- Building colors should be in the local vernacular. No more than three materials and two colors should be used on a single building. For example, a building may have a base of concrete masonry units; EIFS walls and steel framed exposed truss work on a gabled entry feature.
- Dark bronze should be used for non-residential roofs. Residential shingled roofs should be shades of gray, tan or brown.
- Wall colors include light earth colors such as light brown, beige and light gray.
- Modest use of accent colors is encouraged. Extend use of accent colors to site furnishings and other amenities.
- Not all buildings, or parts of buildings, need to be painted the same color scheme, but should blend well to create a consistent image in each visual district.

SITE LOCATION

Site planning is one of the more important elements of any

ANALYSIS

project design and can "make or break" the overall success of the project. The art of site planning requires an interdisciplinary involvement of the community planner, landscape architect, architect, interior designer, and civil, mechanical and electrical engineers.

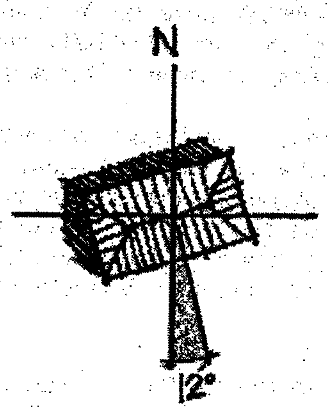
- Site Development and Design: The general location of buildings or groups of buildings must be in conformance with the approved land use plan. Individual buildings should be related to patterns of access, circulation, utilities and service.
- To eliminate inconsistent and chaotic development, and to enhance the visual and environmental quality of the base, the site designer should analyze the surrounding framework of buildings, roads, pedestrian circulation, etc. by identifying on plans and sketches how new development is to be integrated and coordinated with adjacent buildings and circulation.

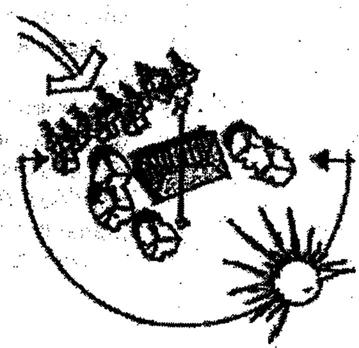
SITING REQUIREMENTS

To achieve the optimum site plan, each design discipline must work in concert with one another. The following siting requirements must be evaluated and analyzed to ensure the optimal solution is selected:

- Pay special attention to building orientation, mass and scale in developing the site plan. Develop a sense of order, arrival, orientation and community in planning the site. Insofar as possible, facilities must not be overwhelming in apparent size. Site facilities in relationship to one another to create outdoor spaces. Achieve spatial balance and scale through thoughtful placement and arrangement of structures, landscaping and landforms.
- If the potential for adding to a project is identified during the initial programming stage, allow space in the site development plan for additional structures and size site utilities accordingly.
- The climate of the Anchorage area is cool and dry, with long periods of sunshine during the summer. Winters are cold with heavy snow and long periods of dusk and darkness.
- Buildings and site designs should maximize the psychological as well as physical benefits of solar radiation and reduce the effects of cold winds during winter. Shade during summer months *is* desirable to provide visual relief.

- Important climatic considerations for building and site
- Design are to:
- Orient active outdoor pedestrian areas and building entrances to the south. Optimum sun orientation lies 12 degrees east of south.





Environmental Considerations

- Create protected sun pockets for outdoor use.
- Utilize evergreen plantings and walls to provide wind screens on north-facing buildings and entrances. Plant deciduous trees along east, south and west building walls to provide desirable shade during summer months.
- Minimize window areas on north-Facing building walls. Use large, south-facing windows to capture warming solar radiation.
- Use medium-colored finishes on surfaces exposed to the sun, and dark colors on recessed surfaces to absorb solar radiation.
- Minimize walking distances between buildings to provide a sheltering effect against the cold and wind. Force protection requirements mandate a 30 foot separation for troop billeting and "primary gathering" facilities.

BUILDING DESIGN CONSIDERATIONS

Many design techniques can be utilized to improve the quality-of-life for a building's occupants, reduce energy consumption, reduce maintenance requirements, and enhance the aesthetics of the built environment. Buildings should be designed using passive heating principles. The following items should be considered for any new facility:

- Orient buildings and design roof overhangs to work with sun angles to provide solar gain.
- Employ natural day-lighting features whenever possible, particularly in warehouse spaces.
- Maximize the length of the north and south walls and reduce the size of east west walls
- Provide arctic entries that protect from weather extremes.
- Consider berming to regulate exterior wall temperatures.
- All exterior walls should be thermally insulated. Exterior insulation and finish systems (EIFS) should be considered for renovations as well as new construction. While these systems provide excellent thermal and moisture retarding characteristics, care must be taken to specify heavy-duty systems where EIFS is subject to impact damage. Also, such systems require a high level of skill by the applicator.
- All windows should have thermal pane glass and high quality metal or vinyl frames. Double or triple paned windows are required. Frames should have integral thermal breaks. Force protection construction standards require laminated glass.
- Windows should be operable so that they may be opened during mild weather.
- Install pitched roofs with adequate ventilation. Gable vents relying on natural air movement are insufficient. Soffit vents and ridge vents are generally required
- Do not use incandescent lamps in light fixtures except in spaces where the fixture is rarely used. Use warm fluorescent lamps for maximum efficiency.
- Install timed switches, photo sensors, motion sensors and other devices to keep lights off in unoccupied spaces.
- Use photo sensors to switch off or dim artificial lighting where natural daylighting has been incorporated into the design.
- Specify high-efficiency heating and cooling equipment.

- Specify programmable thermostats
- Maximize design features to reduce the size and cost of mechanical equipment.
- Explore options of capturing waste heat from the cooling system to heat hot water.
- Locate hot water tanks as close as possible to the end use area. Small, under-counter on-demand water heaters are very efficient for locations where large capacity is unnecessary.
- Insulate all hot water pipes. Insulated exterior pipe shall be covered with sheet metal or other weatherproof material.
- Use low-maintenance materials such as concrete and tile, and avoid high-maintenance materials such as wood and painted metal.
- Allow materials with inherent finishes to remain unpainted. Concrete should not be painted.

SIGNAGE

- Signs are most effective when they are part of a total orientation system that includes base maps, street signs, building signs, and guidance from gate personnel. An effective orientation system is logical, easy to follow, and leads the visitor from the point of entry to the desired destination with no confusion.
- In order to design an effective orientation system, the following points should be considered. Identify each decision point with a sign that clearly indicates the options. Keep names of destinations consistent throughout the system, including the names on maps and the names used by security forces when they are directing visitors to points on base. Do not provide more than four destinations per sign.
- Do not omit a destination from a series of direction signs until that destination is reached. A sign series leading a visitor to a particular building should culminate in the building identification sign.

- It is important to minimize the number of signs on base. A primary objective of a sign system is to reduce the number of signs and eliminate the visual clutter that results from over-signage. Locate signs only where they are absolutely needed to provide orientation. As a general rule, provide one sign for each building. The number of directional signs can be minimized if the streets are properly identified in accordance with the Federal Highway Administration's Manual on Uniform Traffic Control Devices, and if good base maps are made available at entry points.

- Signs are an important part of the impression made by a base. Use signs of high quality design and construction in order to present a professional image for both the Air Force and Elmendorf Air Force Base.

- *Air Force Interim Policy and Guidance on use of Air Force Symbols on Base Entrance Signs* dated August 14, 2001 establishes guidelines for Base Entrance signs Air Force wide. This guidance is available from the following web site: www.af.mil/airforcestory/guidelines.shtml

- The 3rd Wing (PACAF) has established standards for all signs on Elmendorf AFB. This instruction (3WGI 32-1011, dated 1 Feb 2001) is consistent with Air Force Pamphlet 32-1097, *Sign Standards* sets standards for identification, direction, regulation, morale, and information signs, street address signs, base destination signs, parking regulation signs, and interior signs.

- The Uniform Federal Accessibility Standards (UFAS) and the Federal Highway Administration's Manual on Uniform Traffic Control Devices are national standards for sign design and traffic control device placement.

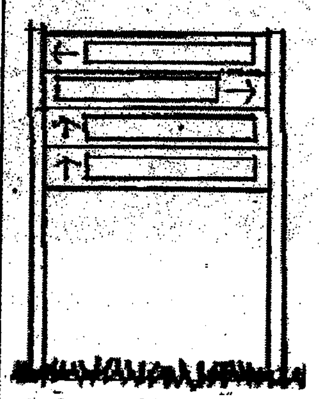
- An effective sign system can make the base and facilities more inviting, attractive and easier to use. Following are standards to be followed on Elmendorf AFB:

- Facility numbers shall be on a vinyl plate, 8 inches by 32 inches, attached to the facility facing the street to which it is addressed. Facility numbers shall be 6 inches in height. The plastic Celtech sign background color shall be 3M high performance vinyl, 180-29 Russet Brown with 3M 3290 reflective white numbers applied to the surface.

Alaskan Theme Buildings:

- Signs for facilities architecturally designed around an Alaskan theme may consist of a rough-sawn spruce slab either engraved with the facility name or with mounted raised letters (e.g., "Kenal Dining Facility").

- Directional signs shall be mounted on metal posts and consist of 64-inch wide by 12-inch tall by. 125-inch thick aluminum metal plate. The posts will be either sleeved or painted A704 brown. Back of the metal plate will be sheeted with 3M high performance vinyl, 180-29 Russet Brown.



- Street Signs:

- Street name signs shall be metal plates, 30 inches in length by 6 inches in height. The metal plate will be sheeted with 3M 3290 White Scotchlite (engineer grade).

Lettering and a 3/8-inch white border will be cut out of Avery XL-6009 Brown overlay film. The border and lettering will be placed on both sides of these signs.

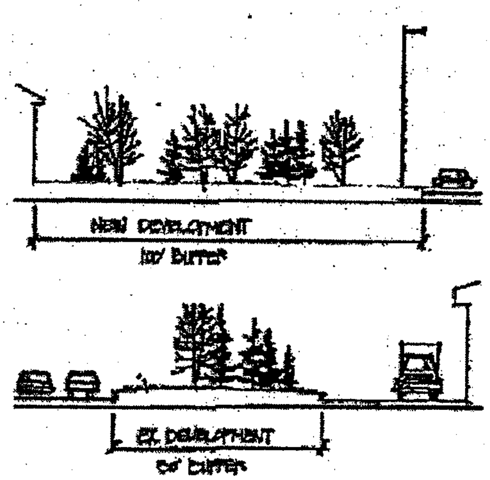
- Street signs shall bear the PACAF shield (4 inches in diameter placed 1.25 inches from the left edge of the sign), street name in 3-inch lettering, and street type (i.e., Ave, Rd, St) in 1-inch lettering.

The bottom edge of street signs shall be mounted 7 feet above the ground. When mounted on' the same pole as a stop sign, the bottom of the street sign shall be 9 feet above ground

ROADWAYS

Roadways provide the primary vantagepoint in which visitors observe the base. The treatment of the roadways and views from roads are important components in improving the base's visual image. Three roadway classifications have been identified. The following design considerations should apply to these classifications:

- Primary Roads provide access through and between the major functional areas of the base, as well as, access to and from the gate areas. Primary roads will typically have 4 –12 foot wide driving lanes. A turning lane will be provided as needed. Access and egress points should be allowed only for secondary streets and major facilities. New buildings and parking lots should be set back a minimum of 100 feet from the road edge.



Streetscape Treatments

- Existing parking and storage areas should be relocated or re-designed to provide a minimum setback of 50 feet. Site furnishings including fire hydrants, light poles, bus shelters, and signing should be located a minimum distance of 8 feet from the edge of the pavement. Overhead utility lines should be placed underground or relocated behind buildings whenever possible. Pedestrian paths, where needed, should be separated by a minimum of 15 feet from the pavement edge.

- Secondary Roads supplement the primary road system by providing access to, between and within the functional land use areas. Secondary roads should be at least 24 feet wide with 2 – 12-foot-wide driving lanes and turning lanes as required.

- New buildings and parking areas should be set back a minimum of 100 feet. Pedestrian walks aligned to the road should be separated with a 10-foot-wide grass buffer. Landscape plantings, lighting and signing should be provided in high-use areas. On-street parking should be limited to short periods of time.

- Tertiary Roads handle local traffic and provide direct access to individual buildings and parking areas. In the main base area they should have 2 - 12-foot-wide driving lanes, with continuous curb and gutter on both sides. A minimum setback distance of 50 feet is required, with a 75-foot setback preferred. Pedestrian walks not separated from the road should be a minimum of six feet wide. A minimum five-foot grass buffer is recommended.

Streetscape Treatment

The appearance and safety of roadways can be improved by reducing visual clutter and coordinating the design of street-scape.

- Provide pedestrian crosswalks where pedestrian and vehicular traffic intersects. Crosswalks on primary and heavily traveled secondary streets should be identified with signs (similar to the existing sign at the base exchange) and reflective paint strips in the road.

- No on-street parking should be allowed along primary roads. Parking along secondary streets should be limited--allowed only where additional pavement width is provided, and only for short-term use. Parking on tertiary streets should be allowed only in the homing areas.

- Landscape Plantings. Landscape plantings along roadways should be restricted to canopy trees and evergreens. New plantings should be placed 15 to 20 feet from the edge of the pavement. Plantings should reduce negative views, screen parking areas, direct traffic and stop blowing snow.
- Roadway lighting should reinforce the road hierarchy and promote safe travel through the base during periods of darkness. Poles, fixtures and type of light source should be consistent. Fixtures should be spaced according to required light intensity and height of pole.
- The coordination of directional, informational and regulatory signing is the easiest way to reduce clutter and improve the way one finds his way around the base. Signs should be of a standard format, size, color, material and placement, and provided only on an as-needed basis.
- Roadways should intersect at right angles (90 degrees), although 85 to 95 degrees is acceptable. This standard should be used when designing new roads or realigning existing intersections which do not conform. Clear lines of sight should be provided at all intersections.
- Road sections when placed in straight alignment can become monotonous and uninteresting. A curved alignment creates a more pleasant and interesting visual environment.

New roads should be designed to minimize disturbance to existing vegetation. Disturbed areas should be replanted to minimize their visual impact. Irregular or free form clearing areas with undulating edges will promote a natural landscape appearance. Mass planting techniques should be used to avoid a spotty appearance.

PEDESTRIAN PATHS/BIKEWAYS

- Pedestrian-oriented site planning and design contributes to the comfort and enjoyment of outdoor activities. A well-planned bikeway system provides recreational opportunities, as well as an alternate mode of on-base transportation.

- Walkway and bikeway systems should be safe to use, properly constructed of durable materials, and free from obstructions and hazards. They must have adequate width to handle expected types and volumes of traffic. The system should create a unified, continuous route responsive to desired circulation patterns.

- Walkway Classification systems are categorized by the volume of pedestrian traffic a walkway should accommodate.

- Primary- Walks are those segments that carry the highest volume of pedestrians, generally between major buildings and/or parking lots. This system of walks should be eight to twelve feet wide. A buffer strip between the walk and road is recommended but not necessary. Primary walks should have hard surface paving (concrete or decorative pavers), pedestrian amenities including lighting, benches and landscaping.

Primary Walk

- Secondary Walks accommodate moderate pedestrian volumes and provide connections between activity centers. Walk widths will range from six to ten feet, depending on traffic volume. When located along a roadway, they should be a minimum of 8 feet wide. In areas where there is a buffer strip between the road and the walk, a width of six feet is adequate. Secondary walks should have hard paving surfaces, moderate levels of lighting, seating in designated areas, and landscaping.


Secondary Walk

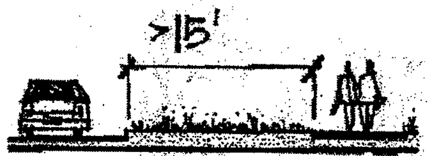
- Tertiary Walks carry low volumes of pedestrian traffic and provide access to secondary building entrances. In open, scenic areas, these walks can be indirectly routed. Tertiary walks are typically four to eight feet wide and characterized by hard surface materials, such as concrete or bituminous asphalt. Other elements include seating and landscape plantings at designated nodes.


Tertiary Walk

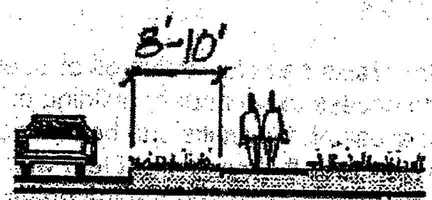
General Design Considerations

- Existing walkways have generally been located parallel and immediately adjacent to an existing road, or are separated from it by small lawn panels, usually three to four feet wide. To reduce maintenance, it is recommended that the lawn be removed and the walk widened to the curb.

- New walks should not be located immediately adjacent to the primary road system. Instead, a buffer of 15 to 20 feet is recommended to provide a psychological separation between the vehicle and pedestrian. New walks abutting secondary and tertiary roads are acceptable if these walks are a minimum of eight feet wide (secondary) and six feet wide (tertiary). However, an eight- to ten-foot buffer is preferable if space is available.



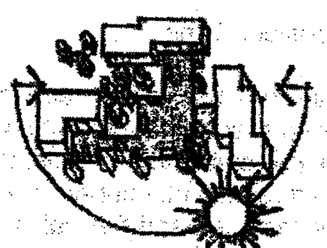
Primary Walk Setback



Secondary Walk Setback

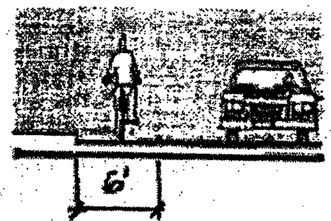
- In open areas, a staggered or meandering alignment should be used to visually create interest and variety. A landscaped buffer of 30 - 50 feet should be used to visually and physically separate the walk and roadway.

- Pedestrian spaces are "outdoor rooms" defined by buildings, and should relate to buildings and exterior circulation. These areas can help identify the importance of a single building or visually link several buildings together.



Pedestrian Spaces

- Bikeways should provide continuous, direct routes between primary origin and destination points on the base. Since only low-to-moderate use is anticipated, bikeways can be combined with secondary and tertiary pedestrian paths by widening walks an extra four feet in areas of anticipated bike use.



Bikeway in Street

Walkway, Bikeway and Pedestrian Space Amenities

- Paving material and surfaces should be durable, hard, dry, and not slippery. Primary materials for pedestrian spaces and walkways should be poured-in-place concrete, although decorative concrete pavers may be used in important areas to provide interest and visual relief. The paver should be medium brown color. Bituminous asphalt should be used for bikeways not connected to pedestrian walks. It may also be used on tertiary walks in areas of low visibility.

- Landscape plantings create an enjoyable pedestrian environment. The plantings should respect sightlines, provide focal points block winds, and screen unsightly views.

- Pedestrian lighting can be used to provide safety and security. Lighting in pedestrian spaces can be wall-or pole-mounted. Pole-mounted or low-level fixtures should be used to define pedestrian walks.

- Site Furnishings, such as benches, trash receptacles, kiosks and bike racks should be integrated into the design of pedestrian pathways and spaces. Furnishings should be convenient and encourage use. Too many site furnishings will contribute to a cluttered appearance.

VEHICLE PARKING

Vehicle parking areas consume more site space and impact more on the physical environment than any other site feature. Parking facilities that are located with a good relationship to the building entry and properly designed are easy to use.

Paving

- Concrete and bituminous asphalt shall be used as paving material

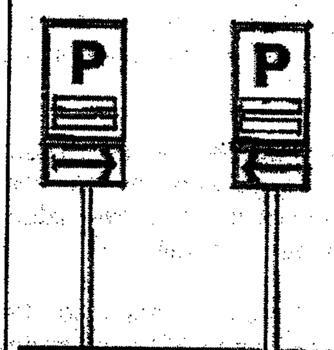
- Gravel may be used in vehicle storage and "rustic" recreational areas

Curbs and Gutters

- Concrete shall be used as curb and gutter material
- Curbs and gutters shall define parking lot perimeter, islands, medians, entrances and exits
- Ramped curbs shall be used at handicapped access and may be used at entries into facilities

Signage

- Reserve parking signs shall be 254mm (10") wide by 203mm (8") high metal signs with 25.5mm (1") pressure sensitive, reflective white, Helvetica medium letters on a dark bronze, non-reflective background; on a 2134mm (7'-0") high bronze colored post.
- Handicap parking signs shall be 203mm (8") wide by 254mm (10") high metal signs with pressure sensitive, reflective white handicap symbol on a blue, non-reflective background on a 2134mm (7'-0") high bronze colored post.



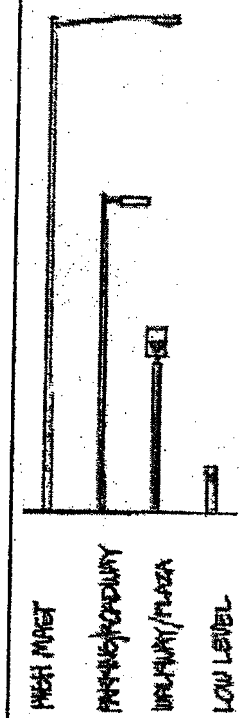
Parking Signs

Lighting

- Locate light standards in islands, medians and perimeter of lot. Standards shall be dark anodized bronze aluminum.

- High mast lighting shall be mounted at an average height between 25 and 40 feet. Light source shall be mercury vapor or high-pressure sodium. Poles shall be dark bronze in color. Illumination level shall be from 0.5 foot-candles in low use areas such as remote parking to 2.0 foot-candles in high use areas such as a BX or

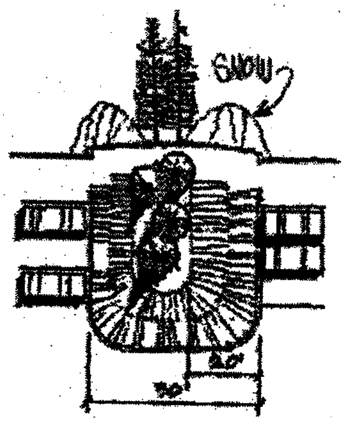
Commissary parking area.



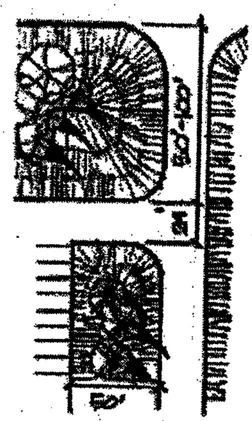
Lighting Standards

Landscaping

- Landscaping shall be incorporated into medians, islands and perimeter of parking areas and shall be located no closer than 3m (10') from curbs.
- Islands shall be located at the ends of the parking aisles and 3.6m (12') wide x 12m (40') long.
- Adjustments to parking lot layout shall be made to accommodate existing trees.



Planting Islands



Parking Lot Buffers

- Headbolt outlets shall be located 762mm (30") minimum from curb to center of headbolt post. Place sidewalks on building side of headbolt outlet posts to reduce tripping hazard from cords.

Parking layout

- Preferred stall layout is 90° angled stalls. Other stall angles (60° or 45°) may be utilized where site restrictions prevent use of 90° angle stalls.

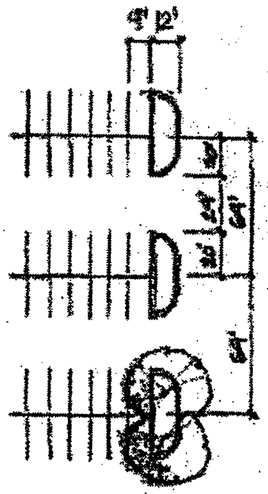
- Minimize vehicle-pedestrian conflicts by orienting traffic aisles perpendicular to building entrances.
- Provide a 15.2m (50') buffer to separate parking lots from streets.

- Access to parking lots should be off secondary and tertiary streets. Entrances to lots shall be 30.5m (100') from intersection of secondary roads and 15.2m (50') of tertiary roads. Entrances shall have 7.6m (25') curb radius.

- Parking lots shall be located convenient to facility entrances.

- Sidewalks adjacent to parking lots shall be used in determining design and layout of buffer areas.

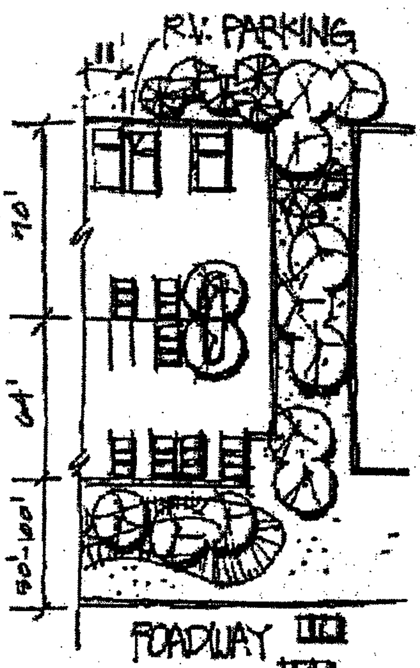
- Snow plowing shall be used in determining designed layout of buffer areas.



Parking Lot Layout

Recreational Vehicles

- Provide 3.7m (11'-0") by 8m (26'-0") stalls
- Stalls shall be placed away from roadways and screened y vegetation.
- Stalls should be located away from other non-recreational vehicles.
- Parking bays shall be 22m (70'-0").
- When practical stalls shall be drive through type to avoid backing into traffic.



R.V. Parking

Avoid the following:

- Locating parking lots within a group of buildings.
- Locating parking lots and drives closer than 25m (82') to any facility with an occupant load greater than 1 person per 37.2 sm (400sf).
- Parking isles perpendicular to facilities without periodic gaps to allow convenient pedestrian access through isles.
- Parking areas without curbed islands and landscaping.

MECHANICAL, ELECTRICAL, AND UTILITY CONSIDERATIONS

The design of utility systems often ignores aesthetics in favor of function. Utilities are often located without consideration of their visual impact and contribute to a negative appearance.

- Avoid placement in high use areas.
- Mechanical intake and exhaust devices should not be allowed on wall surfaces. For force protection, locate intakes on the roof for one-story buildings and above the first floor ceiling on buildings with two or more floors.

Resist access to the intakes.

- Flush wall louvers are permitted, but they should be painted the same color as the surrounding wall, and should not be located on entry or principal wall elevations.

- Mechanical intake and exhaust devices mounted on roofs should be of the same color (preferably factory finished) as the surrounding roof. Natural aluminum or unpainted galvanized steel should be avoided.

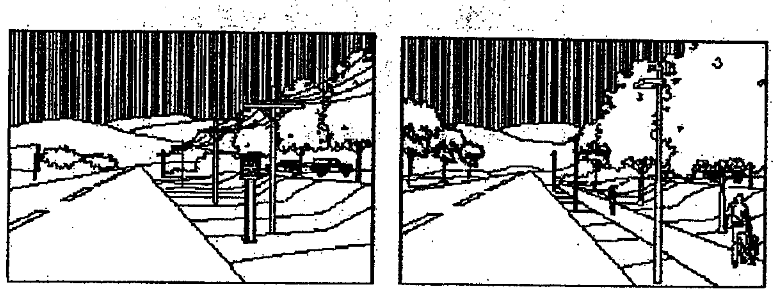
- Mechanical air handlers should be mounted in yards with screen walls as space allows and should not conflict with adjacent activities. If such devices must be located on roofs, then they should be screened.

- For force protection purposes, distances from trash dumpsters and mechanical yards to buildings shall be 30 feet from "inhabited" and 80 feet from troop billeting and "primary gathering" structures.

- Screen utility yards, air-handling equipment, propane tanks, transformers, other outside mounted mechanical equipment, and trash dumpsters with a screen wall. Use the same design screen wall throughout the site. The enclosure should be poured-in-place concrete or concrete block construction. A concrete pad should be provided for the dumpster. Wood gates should be provided in high visibility areas. Landscape plantings should be used around the dumpster to soften the impact of the enclosure and dumpster, but should not restrict truck access.

- Utilities shall be underground where practical.

Underground utilities reduces visual clutter

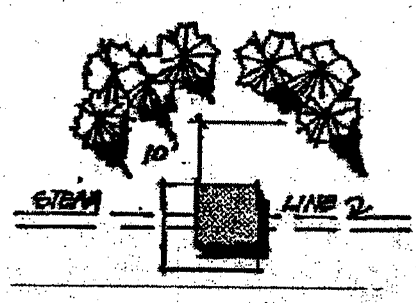


- Coordinate with Base Communications so that telephone, LAN and other communications cabling is installed during construction within wall ducts; not surface mounted after construction is complete.

- Eliminate unnecessary signs and street markings.
- Do not allow exterior storage sheds, trailers or temporary structures.

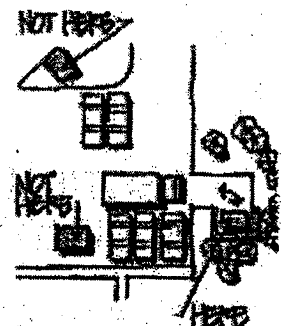
Eliminate as much exterior wall and roof appurtenances as possible. Where not possible, finish the same color as the surrounding surface. Fire devices such as bells and horns should be painted the same color as the surrounding wall, however, fire alarm pull stations should be painted red.

- Steam line service vent boxes should be located and designed to minimize their visual impact. Boxes should be painted a color compatible with adjacent buildings; light colors are preferable to dark. Landscape plantings should be used to screen existing vent boxes and should be located a minimum of 10 feet from the boxes. This distance will allow sufficient room for maintenance and minimize the negative effect of heated soil on the plantings during the winter months.
- Substations should be screened from public view. Careful site planning and screening can minimize their impact. Locate substations a minimum distance of 100 feet from the road edge. Existing vegetation in the setback area should be preserved. Provide additional plantings as needed to screen substations from view.



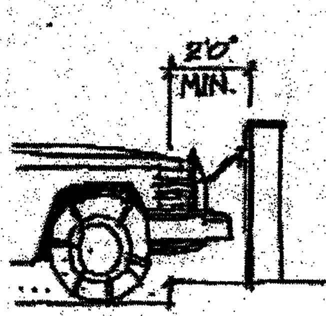
Above Grade Utilities

Screened Dumpster



Dumpster Location

- Head Bolt Heaters should be located a minimum distance of two feet from the back of curb or wheel stop to prevent them from being damaged by parked vehicle. When placed in sidewalk, the width of the walk should be widened a minimum of two feet so that pedestrian movement is not impeded. A standardized heater design should be used throughout the base. An 8"x8" extruded aluminum housing with a dark bronze finish is recommended.

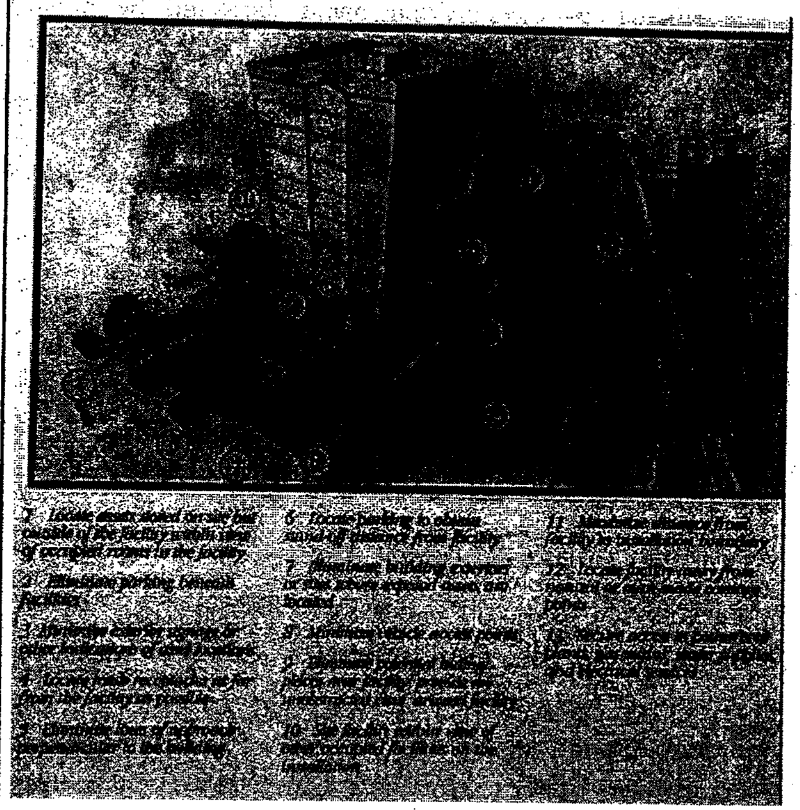


Head Bolt Heaters

SECTION 3
SECURITY DESIGN

FOCUS

The focus of this chapter is the application of architectural design to security measures. Requirements of this section should be validated against latest DoD Anti-Terrorism/Force Protection Guidelines.

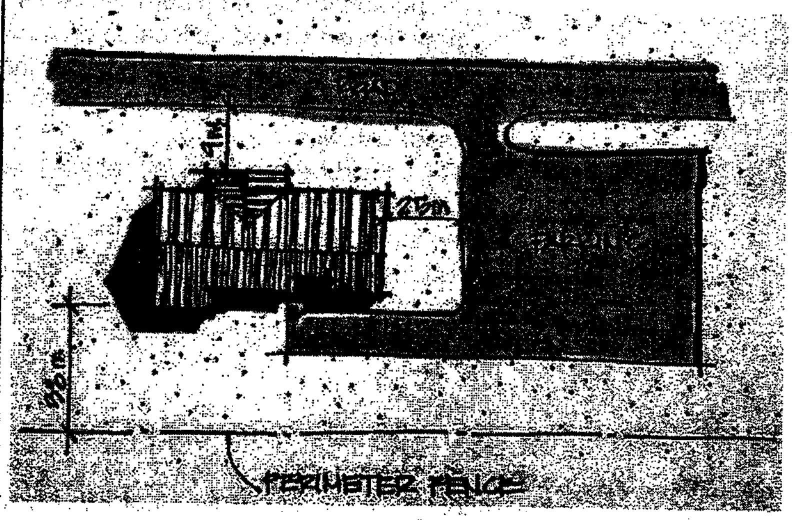


GENERAL DESIGN CRITERIA

Sitework Elements

- Eliminate potential hiding places near the facilities
- Provide an unobstructed view around the facilities
- Locate assets stored on-site within view of occupied rooms in the facility
- Minimize exterior signage indicating location of assets

- Provide a 125' minimum facility separation from installation boundaries
- Eliminate lines of approach perpendicular to the facility
- Do not design parking beneath facilities
- Secure access to power/heat plants, gas mains, water supplies and electrical service
- Locate public parking within view of occupied rooms
- Locate trash receptacles at least 30' away
- Locate parking at least 30' from facilities



Building Elements

- Locate critical assets on the interior of facilities
- Minimize window area
- Layout buildings to eliminate hiding places – this does not preclude use of landscaping, site amenities or more contemporary designs
- Design circulation to provide unobstructed views of people/vehicles approaching controlled areas, use of closed circuit cameras is acceptable
- Locate activities attracting large visitor populations away from assets whenever possible
- Locate activities attracting large visitor populations remote from assets where possible
- Place mailrooms/orderly rooms on facility perimeters
- Design narrow and recessed windows and openings
- Minimize the number and size of doors and windows
- Avoid indented corners & large recesses in building design
- Locate mechanical rooms on the facility exterior with an exterior entrance only

- Locate mailrooms and orderly rooms on facility perimeters or in a separate facility

FRONT GATE

- Particular attention must be given to the streets and pavement at the installation entry gates to assure adequate security, safety and control of visitors.
- The main gate should have a minimum of dual traffic lanes in each direction to facilitate high traffic volumes during peak periods. Lane width or spacing should permit safety for security personnel standing between lanes.
- The guard house should be located on a traffic island located between the entry and departure traffic lanes. Curving the entrance drive will reduce the approach speed of potential aggressor vehicles.
- Pull-offs should be provided for vehicles requiring clearance to avoid blocking traffic lanes.
- Vehicle lanes should be provided in front of and behind the guard house to allow vehicles to make a U-turn or to cross over from one traffic lane to another under the positive control of the gate guard

GATES

Entry gates must have a positive means of securing the installation perimeter. Gate mechanisms should be discreetly concealed from all directions using decorative walls or landscaping. This concealment feature should be incorporated into the design of the new gate facilities. Control of an automated gate should be designed for quick activation during increased Threat Conditions.

BARRICADES

Barricades must be provided around the guard house to prevent errant vehicles from crashing into the guardhouse. Barricades should be integrated into the facility design disguised as planters or decorative walls.

PASSIVE BARRIERS

Passive barriers rely on bulk or mass (without moving parts) to impede vehicular attack. Passive barriers include Jersey barriers, earthwork or berms, steel posts, large concrete planters, guardrails, and reinforced fences with aircraft barriers.

SECURITY LIGHTING

Lighting in and of itself does not provide security, but it helps to assess aggressor activity and enhance physical safety.

Security lighting is also a psychological deterrent to potential aggression.

Aggressors can use lighting to their advantage. Coordinate lighting design with Security Forces to determine potential liability. Lighting falls into the following categories:

- Boundary and entry control point (ECP) lighting should be focused on the perimeter of the bordering area, with light directed outward (with minimal light cast toward security). The perimeter should be illuminated on both the exterior and interior of the perimeter barriers. Install lighting at each ECP to facilitate identification of personnel or vehicles accessing the base.
- Area lighting is provided to illuminate the area under protection. Uniform lighting should be augmented by "fill-in" lighting at locations where structures, utilities, or vegetation create shadows or reduced lighting levels.

VEGETATION AND PLANT SELECTION

Vegetation can be used to define property and standoff zone boundaries as well as obscure lines of sight.

Plant selection requires definite determination as to which plant materials will fulfill the protective measures needed. Consider the following items when specifying plants:

- Indigenous plant species (xeriscaping)
- size
- shapes
- density

- thorn/spike bearing plants
- growth characteristics
- layout pattern
- attraction to wildlife

STANDOFF ZONES

Standoff zones shall strictly adhere to DoD Antiterrorism/Force Protection Construction Standards and shall be coordinated and approved by Base Civil Engineering

LANDFORMS

Landforms inherently have positive and negative effects upon protective measures. Landforms should:

- define boundaries of property
- provide a barricade/obstacle to moving vehicles
- hinder aggressor movement on foot
- obscure sightlines advantageous to agressors (constructed high enough to achieve the desired effect, or combined with vegetation/construction elements)
- landforms should be located at appropriate standoff distances from assets where practical

Landforms used for security applications include:

- slopes and berms
  - Should be designed with a minimum rise of 1000mm (36 inches)
  - Must be stabilized with rolling terrain and irregularities to provide obstacles and drop offs to deter vehicular movement
  - Slopes should be designed that are at a slope of 1:1 or steeper with a minimum rise of 3 feet to deter vehicle movement
  - Recommend rolling terrain and include irregularities to provide obstacles and drop-offs to deter vehicular movement

Ditches, swales and depressions

- Should be constructed with 1:5 (rock lined slope) and 2:2.5 (non-rock lined slopes
- Slopes and berms should be integrated with ditches for greates effect
- Ditches should be constructed at a slope of 1:5 for rock lined slopes or 1:2.5 for non-rock lined slopes.
- Integrate slopes and berms with ditches for greater effect.

FENCING

- Enhanced fencing can facilitate limited sight lines and stop moving vehicles. Additional screening material can assist in obscuring sight lines in conjunction with the protective features of the fencing.

- Standard security fencing is 6' high. Where specified to protect high priority Air Force assets the fence must be 7' high with 15 inch long outriggers each with 3 strands of barbed wire, for a total height of 8'.
- Reinforced fences integrated into chain-link fencing require two 3/4 aircraft cables (general purpose galvanized , class 2, 6 by 19). Placement of cables should be at a height of 30-35 inches above finished grade. These cables should be secured to the line posts with connections of equal or greater strength than the shear strength of the cable.

BUILDING SYSTEMS

Preferred materials for security design

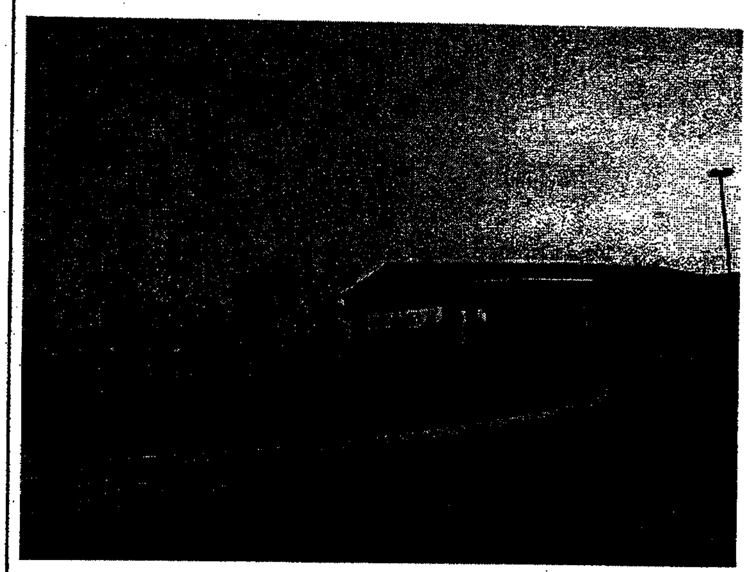
- reinforced concrete or CMU
- double wythe masonry

SECTION 4
LANDSCAPE DESIGN GUIDELINES

GENERAL DESIGN GUIDES

The Landscape Design Guidelines will direct the planning and design of all future landscape development at Elmendorf Air Force Base. These guidelines should be used in conjunction with the current D.O.D. Antiterrorism/ Force Protection Construction Standards and the Elmendorf A.F.B. Landscape Development Plan. These guidelines have been designed to:

- Promote a sense of pride and well being among the people who live and work on base.
- Provide an aesthetically pleasing way implement and maintain force protection measures.
- Improve the environmental quality of the base.
- Minimize landscape maintenance.



LANDSCAPE ZONES

Seven different landscape zones are identified below. Each of these zones have unique landscape requirements.

- Base Entrances: Base entrances should be well landscaped and maintained. Plantings in these areas should generally be formal in appearance and announce themselves as entrances to a military installation. Deciduous trees should be regularly spaced and provide an ordering element. Double and triple groupings of trees may be planted in staggered rows to emphasize visual effect and channel views. Evergreen trees and large flowering shrubs should backdrop the main entrance sign to help visually anchor it down. Shrub beds should be incorporated in a way in which they accentuate the entrance sign, buildings and other amenities.

- Landscape Buffers: These landscapes will incorporate large undulating earth berms with upright and dense material planted close together to provide the appropriate climatic effect and screen undesirable views and noise. Shelter belts intended to moderate blowing winds are to be planted at right angles to prevailing winds with adequate setback to allow for snow drop. These buffers should consist of both evergreen and deciduous plant material planted in loosely staggered rows to moderate wind velocity. The use of fruit bearing trees and shrubs (i.e., mountain ash, Canada red cherry, etc.) that attract high concentrations of birds should be avoided in buffer plantings immediately adjacent to airfield flightline operations. Generally, noise levels cannot be controlled effectively through the use of landscape plantings alone. Solid vertical surfaces, such as earth berming or walls, must be included to have a significant effect on noise pollution. Earth berms should not exceed a 1:3 slope.

- Street Trees:

Street tree plantings define the basic roadway organization of the base. Plantings are to be irregularly spaced, with a minimum setback of 20 feet along major roadways. Deciduous shade trees, such as birch, aspen, chokecherry and norway maples, are to be used for all street plantings. Evergreen trees should be avoided within 50 feet of streets to allow for clear viewing. All street trees should have straight trunks, 1-3/4" caliper minimum, with branching starting at 6 foot height.

- Residential Areas:

Residential areas are to be planted with a mix of deciduous and evergreen plant materials. Deciduous trees provide shade during summer months and allow the warmth of the sun in winter, while properly placed evergreens provide year-round foliage and massing and mitigate the winter environment. Earth berming and contouring is encouraged to help create visual interest year round. The use of evergreen trees is desirable between units were visual privacy may be a issue. Because of snow shed from roofs, no foundation plantings will be used were this problem may occur. However, foundation plantings are encouraged to help identify entrances or areas needing special treatment. Plantings are to be informal and should provide a naturalistic appearance to the housing areas.

- Key Feature Areas:

Key feature areas include the Wing Headquarters, administrative/community center core, and boulevard roadways. These areas will be intensively landscaped and maintained to provide a more formal appearance. Large deciduous trees are to be mixed with evergreens to screen unsightly views. Flowering trees can be used to provide accent and interest. Foundation plantings will be selected for their minimum maintenance requirements and for aesthetic reasons are to be planted in simple masses of no more than two or three plant types per definable area. Earth berming and contouring is encouraged to help create visual interest year round.

- Support Facility Areas:

Support facility areas are areas within the base that have low-to-moderate visibility but will be planted to have a natural, utilitarian appearance. Specific areas include the community services district and the industrial area. The amount of landscape planting to be done in each area will be accomplished on a case-by-case basis. Specific site conditions and building use will dictate where landscape planting can be installed.

Support facility areas will be planted with a mix of deciduous and evergreen trees. If used, they will be planted away from facilities and in masses to minimize maintenance requirements. Planting should be informal to provide a natural appearance. Evergreens will be used to screen unsightly views, as well as provide visual interest during winter. Earth berming and contouring is encouraged to help create visual interest year round.

- Parking Lots:

  Landscape plantings should be incorporated into medians, islands and along the perimeters of parking lots. Perimeter plantings should maintain a minimum setback of 10 to15 feet from the curb to allow for pushed snow. Landscape islands are recommended for use at the end of the parking aisles closest to the building to help buffer views. The use of islands at both ends of the aisle is optional and can he used to define parking areas during wintertime. Islands should be a minimum of 12 feet wide by 40 feet long. Raised center landscape islands, used to separate parallel parking bays, should be a minimum width of 50 feet to provide for landscape plantings and plowed snow. Adjustments in parking lot layout should be made to accommodate existing trees.

- Park Land and Open Areas

  Park land and open area landscapes are to be informal and asymmetrically spaced. Plantings will be grouped to provide a natural appearance and consist of a mix of deciduous and evergreen native or naturalized material. Earth berming and contouring is encouraged in the treed areas, to help create visual interest year round and create a more natural look. Open lawn areas should remain fairly flat. These areas are used for recreational activities and will comprise between 40 to 60 percent of the park area, with trees to cover the balance. These areas will provide the basis of knitting the existing native woodlands together with the main base area. Out of the way and seldom used areas shall be allowed to grow naturally with minimal maintenance. Plant material shall be picked to correspond to the particular site character.

LANDSCAPE PLANTS

The plant list is divided into three categories: (1) trees, (2) large shrubs, and (3) low shrubs and ground covers. Each plant appears in alphabetical order by the botanical name, followed by the common name. Future landscape projects should use only plants listed below (see the Landscape Development Plan for detailed plant information).

- Trees

  Botanical Name/ Common Name

  Betula papyrifera/ White Paper Birch
  Betula prapyrifera 'Gracilis'/ Cutleaf Weeping Birch
  Larix siberica/ Siberian Larch

Malas baccata/ Columnar Siberian Crabapple
Malas 'Dolgo'/ Dolgo Crabapple
Malas 'flame'/ Flame Crabapple
Malas 'Radiant'/ Radiant Crabapple
Malas 'Royalty'/ Royalty Crabapple
Picea glauca/ White Pine/
Picea pungens/ Colorado Spruce
Picea pungens 'Glauca'/ Colorado Blue Spruce
Picea sitcihensis/ Sitka Spruce
Pinus contorta 'Contorta'/ Shore Pine
Pinus contorta 'Latifolia'/ Lodgepole Pine
Pinus sylvestrus/ Scotch Pine
Prunus maacki/ Amur Chokecherry
Prunus padus/ European Bird Cherry
Prunus v. melanocarpa 'Shubert'/ Canada Red Cherry
Sorbus aucuparia/ European Mountain Ash

- Large Shrubs

Botanical Name/ Common Name

Sorbus decora/ Showy Mountain Ash
Tsuga hetcropbylla/ Western Hemlock
Acer ginnala/ Amur Maple
Anielancbier alnifolia/ Saskatoon Serviceberry
Caragana arbotescens/ Siberian Pea Shrub
Caragana a. 'Sutherland'/ Columnar Siberian Pea Tree
Cornus stolonifera/ Redosier Dogwood
Cotoneaster acutifolia/ Peking Cotoneaster
Lonicera tatarica/ Tatarian Honeysuckle
Lonicera zabelil/ Zabelii Honeysuckle
Potentilla fruticosa 'Abbotswood'/ Abbotswood Potentilla
Potentilla fruticosa 'Kathryn Dikes'/ Kathryn Dikes Potentilla
Potentilla fruticosa Tangerine'/ Tangerine Potentilla
Prunus tomentosa/ Nanking Cherry
Ribes alpinum/ Alpine Currant
Ribes odoratum/ Missouri Currant
Rosa rubifolia/ Red Leaf Rose
Rosa rugosa/ Rugosa Rose
Spiraea bumalda 'Goldflame'/ Gold flame Spiraea
Spiraea bumalda 'Froebeli'/ Anthony Waterer Spiraea
Syringa prestoniae hybrids/ Canadian Hybrid Lilacs
Syringa villosa/ Late Lilac
Syringa vulgaris/ Common Lilac
Viburnum trilobum/ American Cranberry

- Low Shrubs and Ground Cover

  Botanical Name/ Common Name

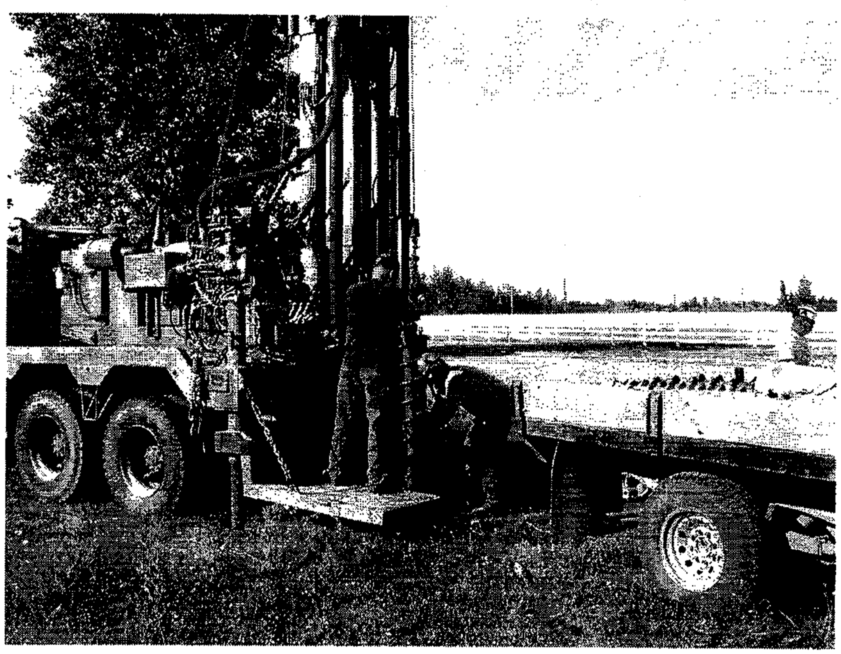
  Arctostaphylos rubra Fragaria/ Red-fruit Bearberry
  Parthenocissus quinquefolia 'Saint-Paulii'/ Boston Ivy
  Parthenocissus tricuspidata/ Virginia Creeper
  Pinus mugo 'Pumilio'/ Pumilio Mugo Pine
  Spiraea 'Daphne Japonica' alpina/ Daphne Spiraea
  Strawberry

--END OF APPENDIX--

US Army Corps of Engineers
Alaska District
Soils and Geology Section

GEOTECHNICAL FINDINGS REPORT
NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)

ELMENDORF AIR FORCE BASE, ALASKA



October 2002

GEOTECHNICAL FINDINGS REPORT
For
NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)
ELMENDORF AIR FORCE BASE, ALASKA

October 2002

1. Scope

This subsurface exploration was conducted for the proposed New Fuel Systems Maintenance Dock, Site 3, at Elmendorf Air Force Base (AFB), Alaska.

The purpose of the exploration is to identify the geotechnical and site conditions related to the proposed project. This report presents a summary of the findings based on the results of laboratory testing, field explorations, and a general knowledge of the site.

2. Project Location and Description

The project site is located in the vicinity of building 8675 and the equestrian riding stables. The site is north of Arctic Warrior Drive between Vandenberg Avenue and Tally Avenue. The site location is shown on the enclosed Project Location and Vicinity Map (Figure 1).

The planned project consists of a heated, three-bay Fuel Systems Maintenance hangar, with conventional spread footings and slab on grade floor and an aircraft taxiway. The hanger will be capable of simultaneously housing three F-15 or F-22 aircraft for fuel systems maintenance. The proposed approach taxiway runs from the south end of the existing poor-weather runway east to the proposed new facility.

3. Field Exploration

The field exploration was conducted from 1 August 2002 to 7 August 2002 and consisted of twenty-four test borings. The test borings were drilled to depths from 4.9 to 15.5 meters (m).

Denali Drilling Inc., under contract with the Corps of Engineers, drilled the test borings using a CME 85 drill rig with Automatic Hammer and a continuous flight, 203 millimeter (mm) outside diameter (O.D.) hollow stem auger. A Corps of Engineers' technician supervised the drilling and logged the test borings in accordance with ASTM D 2488-93, "Standard Practice for Description and Identification of Soils (Visual - Manual Procedure)". A Corps of Engineers chemist, using a photo-ionization detector (PID) (HNU systems model PI-101), scanned the collected soil samples for volatile organic compounds (VOC). Dowl

Engineers, under contract with the Corps of Engineers, surveyed the boring locations using Alaska State Plane Coordinate Zone 4, NAD83. Elevations are NAVD 88 based on mean sea level (MSL). All measurements are in meters. The test boring locations are shown on the enclosed Test Boring Location Map (Figure 2).

Soil samples were procured at frequent intervals in the test borings, generally 1.5 m. Drive samples were taken with a 64-millimeter inside diameter (I.D.) split spoon sampler driven with a 1.33-kiloNewton (kN) automatic hammer falling 760 millimeters. The sampler typically was driven about 450 millimeters ahead of the auger or to refusal. The number of blows required to drive each 150-millimeter increment is recorded on the exploration logs. The blow count is an indication of the relative density or consistency of the soil.

A 3-centimeter natural gas line was severed in AP-4273 at an approximate depth of 600 centimeters necessitating the abandonment of that boring. It was not located during the field survey.

Despite a low PID reading of 5 ppm in sample 5 of AP-4279, a noticeable hydrocarbon odor was present. In accordance with the site approved sampling plan, drilling was halted and the on-site chemist notified the Environmental Program Manager and the Pollution Prevention Coordinator of the 3rd CES/CEVR and the Corps of Engineers' project manager. Upon notification, the Pollution Prevention Coordinator directed the field crew to terminate the boring at the current depth. The COE project manager requested the field crew continue the boring at a nearby location. The crew moved the drilling equipment 2 meters south of AP-4279 and labeled the continuation boring as AP-4282.

4. Laboratory Testing and Soil Classification

A testing program was established to classify and determine the physical and engineering properties of the soils encountered. The test methods implemented for this program are listed below.

- ASTM D 422-63 (Reapproved 1998), "Standard Test Method for Particle size Analysis of Soils".
- ASTM D 2216-98, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass".
- ASTM D 2487-98, "Standard Practice for Classification of Soils for Engineering Purposes (Uniform soil Classification System)".
- TM 5-822-5, "Pavement Design for Roads Streets, walks, and Open Storage Areas

The soil descriptions and classifications contained in this report and presented on the exploration logs as Appendix A are the project technician's interpretation of the field logs and laboratory testing results. Furthermore, the stratification lines represent approximate boundaries between soil types; the transitions are often gradual or not discernible by drill action. Gradation curves and laboratory test results for selected samples are enclosed as Appendix B.

In addition to field screening the soil samples for VOCs, the chemist also collected soil for environmental contamination testing. The test results are presented separately in a Chemical Data Report prepared by the Alaska District Corps of Engineers materials section.

5. Regional Geology

Elmendorf AFB is located within an area locally referred to as the Anchorage Bowl. The Anchorage Bowl is located within the Cook Inlet-Susitna Lowland Section of the Coastal Trough Physiographic Province of Alaska. The Anchorage Bowl is bordered by the Chugach Mountains on the east, the Turnagain Arm on the south, the Knik Arm on the west, and the Elmendorf Moraine on the north. Glacial features including ground moraines, drumlins, eskers and outwash plains characterize the Cook Inlet-Susitna Lowlands. Five major glacial advances of the Quaternary Period (Pleistocene and Holocene or Recent) can be recognized in the Cook Inlet-Susitna Lowlands (Karlstrom 1957). These glacial advances are discussed further in the following paragraph. Most of Elmendorf AFB lies less than 100 meters above sea level.

The Anchorage Bowl is near the east border of a deep structural trough filled with moderately consolidated Tertiary rocks that underlie Cook Inlet and extend northeastward toward Mount McKinley (Capps 1940). These Tertiary rocks are overlain by Pleistocene deposits as a result of repeated glacial advances during that epoch. These deposits accumulated to thicknesses of greater than 180 meters and appear to thicken westward from the mountain front toward Cook Inlet. They consist chiefly of three categories of material: 1) glaciofluvial consisting primarily of outwash sands and gravels, 2) proglacial silty clays of estuarine-marine or lacustrine-estuarine origin, including Bootlegger Cove Clay, and 3) glacial till deposited as ground moraine. Most of the Anchorage Bowl is overlain by relatively clean coarse-grain soils derived from outwash and glacial debris deposited in front of the youngest Pleistocene glacier, Naptowne-Wisconsin, which migrated into the area. This glacier produced a large east-west end moraine, know as the Elmendorf moraine, across Fort Richardson and the north side of Elmendorf AFB. Outwash from this glacier spread southward across the Anchorage Bowl and buried ground moraine and the proglacial silty clays. The thickness of the outwash is estimated to be about 18 meters under most of Elmendorf AFB and Fort

Richardson, but is not at a constant depth (Cederstrom and Trainer 1953). The outwash thins toward the west and south away from its source and tends to become coarser toward the mountains, grading laterally into cobble and boulder sizes. The silty clays below the outwash are inter-bedded with silt and fine sand. The clay deposit extends to depths on the order of 61 to 76 meters within the Anchorage Bowl and "pinches-out" on the east near the Chugach Mountains and on the north near a line connecting Dishno Pond and Sixmile Lake. Glacial till, consisting of boulders, cobbles, gravels, sand, and fine-grain soils, underlies the silty clays (where encountered) and extends to the Tertiary rock. Ground moraine of the Naptown glaciation overlies the advance outwash of that glaciation and glacial till of the earlier Knik glaciation to the north of the Elmendorf moraine.

Seismic Zone: Elmendorf Air Force Base is located in a seismic locale where great earthquakes occur. Structures should be designed according to Technical Instructions Manual, TI 809-4, "Seismic Design for Buildings." The in-situ mineral soils at the site, as a minimum, meet the characteristics of Site Class D soils specified in TI 809-4.

6. Site Conditions

Surface: The project site is essentially flat. Site vegetation consists of mostly grass and weeds with areas of medium to large Birch and Cottonwood trees ranging from 15 to 18 meters in height. Where there is no vegetation, the ground surface is composed of gravel or covered with asphaltic concrete pavement. Overhead and underground utilities may be present; however, utility locations and depths were not within the scope of work of this investigation.

Subsurface: Some of the surficial soils appear to be made up of fill; this is most likely due to previous land use and construction activities. Sampling showed that these fill soils varied greatly in type and somewhat in depth, generally ranging approximately 0.5 to 2.75 meters below the surface. Fill soils were moist and predominantly olive or brown in color. Table 1 shows specific soil types and depths listed by hole number.

Surficial soils in non-fill areas, and some fill areas, are yellow to brown, moist, frost susceptible (F1 to F4), and classify as silty sand with gravel (SM), silty gravel with sand (GM), and silt, silt with sand or sandy silt with gravel (ML). Test borings indicate these soils to extend from approximately 0.5 to 1.5 m below the surface.

The soils underlying the surficial soils, to the limit of the exploration, are tan, brown, gray or olive, moist, sands and gravels. These soils predominately classify as non-frost susceptible or potentially frost susceptible with occurrences of slightly frost susceptible (NFS to S2), poorly to well-graded gravels and sands (GP, GW, SP, SW), occasionally well or poorly graded sand or gravel with silt (SP-SM, SW-SM, GW-GM) and rarely silty gravel or sand (GM, SM). Generally, the fines content ranges from 2 to 10 percent. The blow counts indicate the soil to be medium dense to dense.

TABLE 1: SOIL BORINGS SHOWING EVIDENCE OF FILL

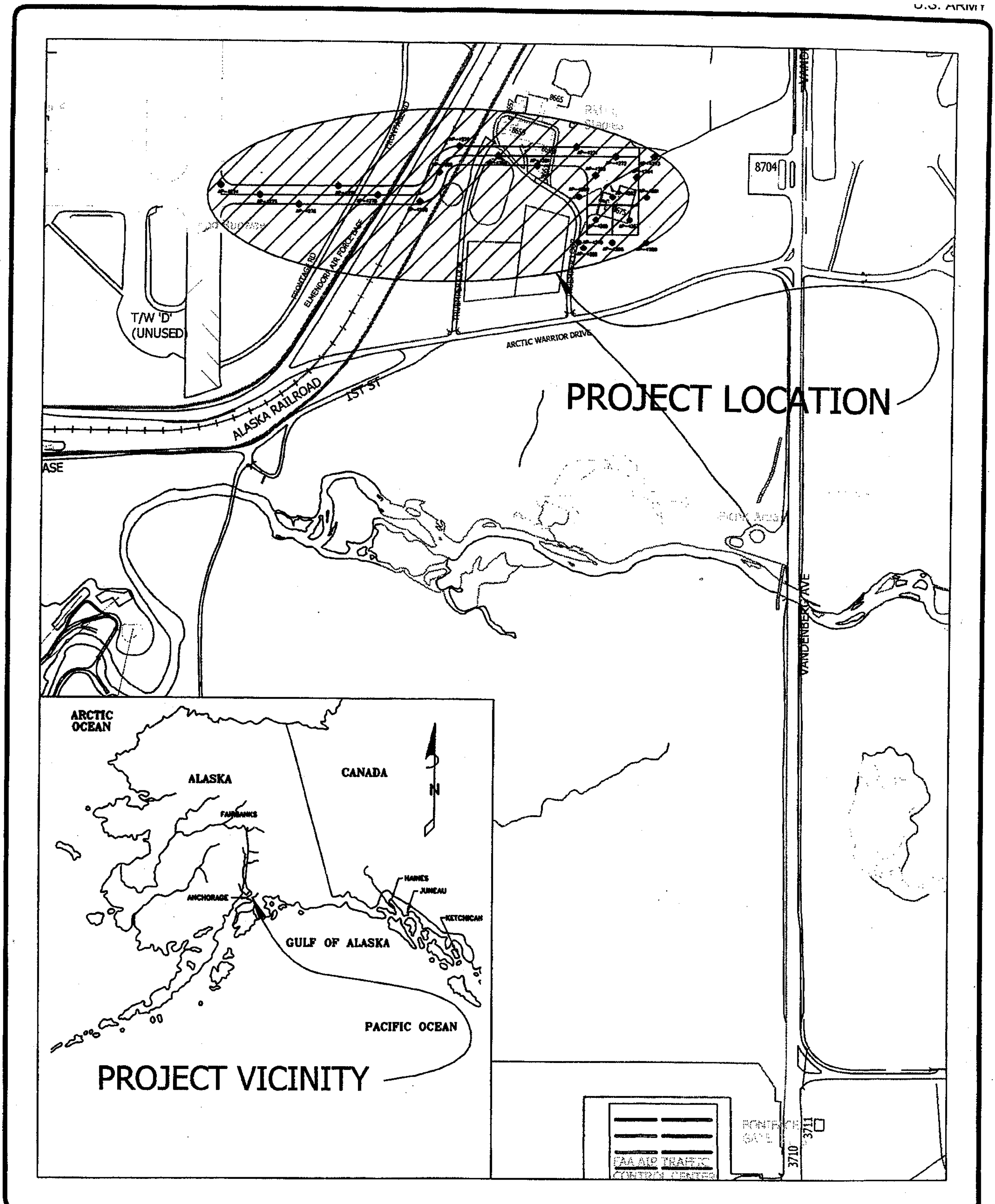
Hole #	Symbol	Type of Soil	To Depth (m)
AP-4263	ML	Sandy Silt with Gravel	0.75
AP-4263	GM	Silty Gravel with Sand and Cobbles	2.5
AP-4268	SW	Well-graded SAND with Gravel	1
AP-4268	GW	Well-graded GRAVEL with Sand	2.25
AP-4269	SP	Poorly graded SAND with Gravel	1
AP-4274	GW	Well-graded GRAVEL with Sand and Cobbles	0.75
AP-4275	GW	Well-graded GRAVEL with Sand	0.75
AP-4275	SP-SM	Poorly graded SAND with Silt	1.75
AP-4276	ML	SILT	1
AP-4276	SM	Silty SAND	2
AP-4280	ML	SILT	2.5
AP-4281	ML	SILT	0.5
AP-4281	SW-SM	Well-graded SAND with Silt and Gravel	1.7

Groundwater was encountered in the two deepest borings (AP-4281 and AP-4282) between 10 and 11 meters below the ground surface. The water depth while drilling is recorded on the exploration logs. On the basis of these two borings, the elevation of the groundwater table is approximately 50 meters MSL. Groundwater elevations can fluctuate seasonally with changes in precipitation, snowmelt, and runoff conditions.

Drilling took place in early August, so no seasonally frozen soil was encountered during drilling. However, the seasonal frost can penetrate to 3 meters or more below the ground surface under conditions of shallow or no snow cover during a cold winter.

Enclosures:

1. Figure 1 – Project Location and Vicinity Map
2. Figure 2 – Test Boring Location Map
3. Appendix A – Exploration Logs (AP-4260 to AP-4283)
4. Appendix B – Laboratory Test Results of Selected Soil Samples

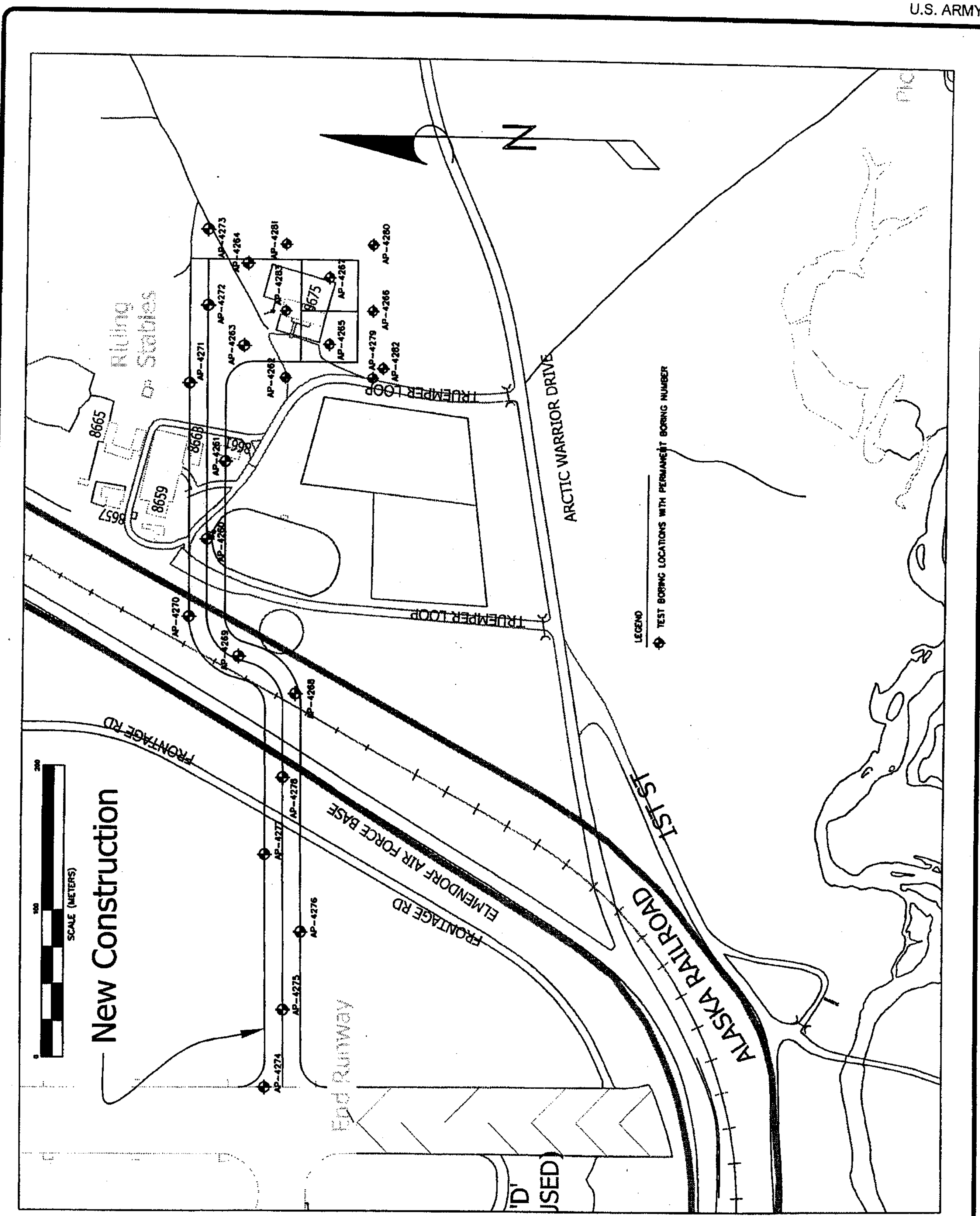


ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS AND GEOLOGY

LOCATION AND VICINITY MAP
NEW FUEL SYSTEMS MAINTENANCE DOCK,
SITE 3 (ELM179)
ELMENDORF AFB, ALASKA

SCALE: NTS
DATE: OCTOBER 2002
DRAWN/RVW: MDP/CRW
FIGURE 1

U.S. ARMY



ALASKA DISTRICT
CORPS OF ENGINEERS
SOILS & GEOLOGY SECTION

TEST BORING LOCATION MAP
NEW FUEL SYSTEMS MAINTENANCE DOCK,
SITE 3 (ELM179)
ELMENDORF AFB, ALASKA

SCALE: GRAPHICAL	
DATE: OCTOBER 2002	
DRAWN/RVW: RW/CRW	
FIGURE 2	

Appendix A

Exploration Logs

(AP-4260 to AP-4283)

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA
Page	1 of 1
Date:	1 Aug 2002
Drilling Agency:	☐ Alaska District ☒ Other Denali Drilling
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: 806,538 m Easting: 511,491 m
Top of Hole Elevation:	60.1 m
Hole Number, Field:	SB-1
Permanent:	AP-4260
Operator:	Jason Love
Inspector:	James Robson
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	NE
Depth Drilled:	4.4 m
Total Depth:	4.9 m
Hammer Weight:	154 kg
Split Spoon I.D:	63.5 mm
Size and Type of Bit:	203.2 mm HSA with bullet bit
Type of Equipment:	CME85 with Automatic Hammer
Type of Samples:	Grab and Drive

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
													Surface: Grass and gravel
0	1		F1	Grab	GM	Silty GRAVEL with Sand				57.2	1.0		Dark brown, moist, subangular gravel, fine to coarse sand, nonplastic (NP) fines
1	2		PFS	7 20 29	GW	Well-graded GRAVEL with Sand	67	30	3	57.2	1.9	2	Brown, moist, angular to subrounded gravel, fine to coarse sand
3	3		NFS	7 13 17	GW	Well-graded GRAVEL with Sand				63.5	0.5		Brown, moist, subangular to subrounded gravel, fine to coarse sand, gravel fractured while driving
4	4		NFS	10 16 14	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.7		Brown, moist to wet, angular to subrounded gravel, fine to coarse sand
5													Bottom of Hole 4.9 m Elevation 55.2 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

NPA Form 19-E May 94 Prev. Ed. Obsolete	Project: NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)	Hole Number: AP-4260

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	*NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*
Page	1 of 1
Date:	*1 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,529 m* Easting: *511,542 m*
Top of Hole Elevation:	*60.3 m*
Hole Number, Field:	*SB-2*
Permanent:	*AP-4261*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*4.4 m*
Total Depth:	*4.9 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class, TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass
0–1		1		F3	Grab	SM	Silty SAND with Gravel	20	55	25	19.1	0.2	14	Brown, moist, subangular gravel, fine to coarse sand, low plastic fines
1–2.4		2		NFS	2 5 10	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.3		Brown, moist, angular gravel, fine to coarse sand, cobbles fractured while driving
2.4–3.9		3		NFS	6 7 10	SW	Well-graded SAND with Gravel				19.1	0.3		Brown, moist, subangular gravel, fine to coarse sand, bits of coal in sample
3.9–4.9		4		NFS	7 12 19	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.3		Brown, moist to wet, subrounded gravel, fine to coarse sand
5														Bottom of Hole 4.9 m Elevation 55.4 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4261*

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*
ELMENDORF AIR FORCE BASE, ALASKA

Page 1 of 1

Date: *1 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,482 m* Easting: *511,609 m*

Top of Hole Elevation: *60.9 m*

Hole Number, Field: *SB-3* Permanent: *AP-4262*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *9.0 m*

Total Depth: *9.4 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: Grass)
1		F3	Grab	SM	Silty SAND with Gravel	16	56	28	6.4	0.2	22	Brown, moist, subangular gravel, fine to coarse sand, nonplastic (NP) fines
2		NFS	11 16 20	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.2		Brown, moist, subangular gravel, fine to coarse sand
3		NFS	10 20 22	GP-GM	Poorly graded GRAVEL with Silt and Sand	54	41	5	63.5	0.1	3	Brown, moist, subangular gravel, fine to coarse sand
4		NFS	8 12 15	GW	Well-graded GRAVEL with Sand				50.8	0.1		Gray with orange staining, moist to wet at 4.4 to 4.6 meters, subangular gravel, fine to coarse sand, gravel fractured while driving
5			4 10 20	SW-SM	Well-graded SAND with Silt and Gravel				69.9	0.3		Olive, moist, subangular gravel, fine to coarse sand
6			4 11 16	SW	Well-graded SAND with Gravel				38.1	0.2		Brown, moist, subangular to subrounded gravel, fine to coarse sand
7			5 14 17	SW	Well-graded SAND with Gravel				19.1	0.1		Olive with orange staining, moist, subangular to subrounded gravel, fine to coarse sand, gravel fractured while driving

Depth (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Bottom of Hole 9.4 m
Elevation 51.4 m
Groundwater Not Encountered
PID = (Hot) Photo-Ionization Detector

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4262*

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*

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Date: *1 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,510 m* Easting: *511,619 m*

Top of Hole Elevation: *60.3 m*

Hole Number, Field: *SB-4* Permanent: *AP-4263*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D.: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: 60-foot Cottonwoods)
		1		F4	Grab	ML	Sandy SILT with Gravel				38.1	0.4		Olive, moist, angular gravel, fine to coarse sand, nonplastic (NP) fines, FILL
1		2		F1	2 2 4	GM	Silty GRAVEL with Sand and Cobbles				>76.2	0.2		Brown, moist, angular to subrounded gravel, fine to coarse sand, FILL
		3		F1	5 2 3	GM	Silty GRAVEL with Sand	44	35	21	50.8	0.3	6	Olive, moist, subangular gravel, fine to coarse sand, FILL
2														
3		4		PFS	11 22 19	GW-GM	Well-graded GRAVEL with Silt, Sand, and Cobbles				>76.2	0.3		Brown, moist, subrounded gravel, fine to coarse sand, NP fines, cobbles fractured while driving
4		5		NFS	9 8 8	SW	Well-graded SAND with Gravel				69.9	0.4		Brown, moist to wet, subangular gravel, fine to coarse sand
5														Bottom of Hole 4.9 m Elevation 55.4 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4263*

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	*NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*
Page	1 of 1
Date:	*1 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,517 m* Easting: *511,674 m*
Top of Hole Elevation:	*60.6 m*
Hole Number, Field:	*SB-5*
Permanent:	*AP-4264*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*4.4 m*
Total Depth:	*4.9 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: 60-foot Cottonwoods)
0	1		PFS	Grab	GW	Well-graded GRAVEL with Sand	57	39	4	12.7	0.6	3	Olive, moist, subangular gravel, fine to coarse sand
	1a		F1	Grab	GM	Silty GRAVEL with Sand				12.7			Brown, moist, subangular gravel, medium sand
1	2		NFS	5 14 18	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.4		Dark brown, moist, subangular gravel, fine to coarse sand, cobbles fractured while driving, 8-cm fine sand lenses at 1.4 m
3	3		NFS	11 18 15/8 cm	SW	Well-graded SAND with Gravel and Cobbles				>76.2	0.3		Tan, moist, subangular gravel, fine to coarse sand, cobbles fractured while driving
4	4			5 11 12	GW	Well-graded GRAVEL with Sand				31.8	0.3		Brown, moist, subangular to subrounded gravel, fine to coarse sand, gravel fractured while driving

Bottom of Hole 4.9 m
Elevation 55.7 m
Groundwater Not Encountered
PID = (Hot) Photo Ionization Detector

Depth scale: 1 2 3 4 5 6 7 8 9 10

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)* Hole Number: *AP-4264*

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA
Page	1 of 1
Date:	2 Aug 2002
Drilling Agency:	☐ Alaska District ☒ Other Denali Drilling
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: 806,457 m Easting: 511,617 m
Top of Hole Elevation:	61.0 m
Hole Number, Field:	SB-6
Permanent:	AP-4265
Operator:	Jason Love
Inspector:	James Robson
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	NE
Depth Drilled:	9.0 m
Total Depth:	9.4 m
Hammer Weight:	154 kg
Split Spoon I.D.:	63.5 mm
Size and Type of Bit:	203.2 mm HSA with bullet bit
Type of Equipment:	CME85 with Automatic Hammer
Type of Samples:	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: 60-foot Cottonwoods
0		1		F4	Grab	ML	Sandy SILT with Gravel				25.4			Brown, moist, subangular gravel, fine to coarse sand, nonplastic (NP) fines
1		2		PFS	5 8 9	SP	Poorly graded SAND with Gravel	44	52	4	69.9	0.0	2	Brown, moist, subrounded gravel, fine to coarse sand
3		3		NFS	5 14 16	GW	Well-graded GRAVEL with Sand	55	41	4	63.5	0.1	3	Brown, moist, angular to subrounded gravel, fine to coarse sand
4		4		NFS	6 10 14	SW	Well-graded SAND with Gravel				69.9	0.0		Brown, moist, subrounded gravel, fine to coarse sand
6		5			5 18 17	SP	Poorly graded SAND with Gravel				50.8	0.0		Brown, moist, subrounded gravel, fine to medium sand
7		6			8 16 22	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.1		Tan, moist, subangular to subrounded gravel, fine to coarse sand, bits of coal in sample, cobbles and gravel fractured while driving
9		7			5 19 25	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Tan, moist, subangular gravel, fine to coarse sand, bits of coal in sample, cobbles and gravel fractured while driving
10														Bottom of Hole 9.4 m Elevation 51.6 m Groundwater Not Encountered PID = (Hnu) Photo Ionization Detector

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)
Hole Number: AP-4265

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	*NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*
Page	1 of 1
Date:	*2 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,415 m* Easting: *511,648 m*
Top of Hole Elevation:	*60.8 m*
Hole Number, Field:	*SB-7*
Permanent:	*AP-4266*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*9.0 m*
Total Depth:	*9.4 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: 60-foot Cottonwoods
		1		F4	Grab	ML	SILT					0.0		Olive, moist, nonplastic (NP) fines
1		2		F4	1 2 3	ML	SILT					0.0		Olive, moist, nonplastic (NP) fines
2		3		F4	1 2 3	CL-ML	Silty CLAY with sand		28	72		0.0	27	Olive, moist, medium to coarse sand, low plasticity fines
3		4		NFS	9 12 12	GW	Well-graded GRAVEL with Sand and Cobbles	65	31	4	>76.2	0.0	4	Gray, moist, subrounded gravel, fine to coarse sand
4		5		NFS	9 12 12	GP	Poorly graded GRAVEL with Sand				69.9	0.0		Gray, moist, subrounded gravel, fine to medium sand
6		6			5 11 17	SW	Well-graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, fine to coarse sand
7		7			18 18 19	SW	Well-graded SAND with Gravel and Cobbles				>76.2	0.0		Dark gray, moist, subrounded gravel, fine to coarse sand, bits of coal in sample, cobbles and gravel fractured while driving
9		8			6 16 20	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, green, moist, subangular gravel, fine to medium sand
10														Bottom of Hole 9.4 m Elevation 51.3 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4266*

EXPLORATION LOG ELM179SITE3.GPJ ACE_ANC.GDT 10/15/02

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*

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Date: *2 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,453 m* Easting: *511,667 m*

Top of Hole Elevation: *61.1 m*

Hole Number, Field: *SB-8* Permanent: *AP-4267*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *9.0 m*

Total Depth: *9.4 m*

Hammer Weight: *154 kg*

Split Spoon I.D.: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: Grass)
0		1		PFS	Grab	GW-GM	Well-graded GRAVEL with Silt and Sand	65	29	6	63.5	0.1	2	Olive, moist, angular to subrounded gravel, fine to coarse sand, nonplastic (NP) fines
1		2		NFS	6 11 15	GW	Well-graded GRAVEL with Sand				69.9	0.0		Brown, moist, subrounded gravel, fine to coarse sand, gravel fractured while driving
3		3		NFS	6 16 21	GW	Well-graded GRAVEL with Sand and Cobbles	60	37	3	>76.2	0.0	2	Brown to gray, moist, subangular gravel, fine to coarse sand
4		4		NFS	7 11 23	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, fine to medium sand, cobbles fractured while driving
6		5			15 15 17	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, fine to medium sand
7		6			7 14 14	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, wet, subrounded gravel, fine to coarse sand, bits of coal in sample, cobbles fractured while driving
9		7			7 17 21	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subangular gravel, fine to coarse sand
10														Bottom of Hole 9.4 m Elevation 51.6 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

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Hole Number: *AP-4267*

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Date: *5 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,485 m* Easting: *511,387 m*

Top of Hole Elevation: *56.1 m*

Hole Number, Field: *SB-9* Permanent: *AP-4268*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Fill in railroad cut
		1		NFS	Grab	SW	Well-graded SAND with Gravel				50.8	0.0		Brown, moist, subangular gravel, fine to coarse sand, FILL
1		2		NFS	5 6 10	GW	Well-graded GRAVEL with Sand	73	25	2	63.5	0.0	2	Brown, moist, angular to subangular gravel, fine to coarse sand, FILL
3		3		PFS	11 13 14	SW	Well-graded SAND with Gravel and Cobbles				>76.2	0.0		Brown, green, moist, subangular to subrounded gravel, fine to coarse sand, cobbles fractured while driving
4		4		NFS	7 18 19	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Tan to gray, moist, subangular gravel, fine to coarse sand, cobbles and gravel fractured while driving
5														Bottom of Hole 4.9 m Elevation 51.3 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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Hole Number: *AP-4268*

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Date: *5 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,514 m* Easting: *511,402 m*

Top of Hole Elevation: *56.6 m*

Hole Number, Field: *SB-10* Permanent: *AP-4269*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Fill in railroad cut
0–1		1		NFS	Grab	GP	Poorly graded GRAVEL with Sand	53	43	4	38.1	0.1	2	Brown, moist, subrounded to rounded gravel, fine to medium sand, FILL
1–2		2		NFS	7 8 11	GW	Well-graded GRAVEL with Sand				50.8	0.1		Olive, gray, moist, angular to subrounded gravel, fine to coarse sand, gravel fractured while driving
3		3		PFS	6 10 13	GW-GM	Well-graded GRAVEL with Silt and Sand				69.9	0.0		Brownish gray, moist, angular to subrounded gravel, fine to coarse sand
4–5		4		PFS	8 8 11	GW-GM	Well-graded GRAVEL with Silt and Sand				63.5	0.0		Brown, moist, subrounded gravel, fine to coarse sand, gravel fractured while driving
5														Bottom of Hole 4.9 m Elevation 51.7 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Hole Number: *AP-4269*

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Date: *5 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,547 m* Easting: *511,435 m*

Top of Hole Elevation: *60.1 m*

Hole Number, Field: *SB-11* Permanent: *AP-4270*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass and gravel
0		1		F4	Grab	ML	SILT					0.1		Yellow, moist, nonplastic (NP) fines
1		2		NFS	4 6 7	GP	Poorly graded GRAVEL with Sand	56	42	2	44.5	0.0	2	Dark gray, moist, subrounded gravel, fine to medium sand
3		3		NFS	8 8 8	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Dark gray, moist, subrounded gravel, fine to medium sand
4		4		NFS	4 8 19	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subangular to subrounded gravel, fine to coarse sand, cobbles fractured while driving
5														Bottom of Hole 4.9 m Elevation 55.2 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Hole Number: *AP-4270*

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Date: *5 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,548 m* Easting: *511,660 m*

Top of Hole Elevation: *60.3 m*

Hole Number, Field: *SB-13* Permanent: *AP-4272*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: Birch forest)
		1		F4	Grab	ML	SILT					0.2		Yellow, moist, nonplastic (NP) fines
		2		S1	10 19 32	GW	Well-graded GRAVEL with Sand and Cobbles	57	38	5	>76.2		3	Gray, moist, subangular gravel, fine to coarse sand, NP fines, cobbles fractured while driving
1		3		PFS	6 8 6	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Brown, moist, subangular gravel, fine to coarse sand, bits of coal in sample, cobbles fractured while driving
3		4		S1	11 11 12	GW-GM	Well-graded GRAVEL with Silt, Sand, and Cobbles				>76.2	0.0		Brown, moist, subangular gravel, fine to coarse sand, bits of coal in sample, cobbles and gravel fractured while driving
4		5		S1	15 11 19	GW-GM	Well-graded GRAVEL with Silt, Sand, and Cobbles				>76.2	0.0		Brown, moist to wet, subangular to subrounded gravel, fine to coarse sand, NP fines
5														Bottom of Hole 4.9 m Elevation 55.4 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4272*

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Date:	*5 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☐ MSL ☐ other
Location:	Northing: Easting:
Top of Hole Elevation:	
Hole Number, Field:	*SB-14*
Permanent:	*AP-4273*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*0.6 m*
Total Depth:	*0.6 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Grass
														Hit 1 in gas line. Abandoned hole
1														**Bottom of Hole 0.6 m Groundwater Not Encountered**
2														
3														
4														
5														
6														
7														
8														
9														
10														

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Hole Number: *AP-4273*

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*	Page 1 of 1	Date: *6 Aug 2002*
Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*	Elevation Datum: ☒ MSL ☐ other	
Location: Northing: *806,529 m* Easting: *511,141 m*	Top of Hole Elevation: *57.2 m*	
Hole Number, Field: *SB-15* Permanent: *AP-4274*	Operator: *Jason Love*	Inspector: *James Robson*
Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer	Depth to Groundwater: *NE*	Depth Drilled: *4.4 m* Total Depth: *4.9 m*
Hammer Weight: *154 kg* Split Spoon I.D: *63.5 mm* Size and Type of Bit: *203.2 mm HSA with bullet bit*	Type of Equipment: *CME85 with Automatic Hammer*	Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass, edge of runway
0–0.8		1		NFS	Grab	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Brown, moist, subangular to subrounded gravel, fine to coarse sand, 13-cm cobbles in cuttings, FILL
0.8–2.4		2		NFS	16 7 12	GP	Poorly graded GRAVEL with Sand	61	35	4	50.8	0.0	2	Brown, moist, subangular gravel, medium to coarse sand
2.4–3.9		3		NFS	12 7 12	SW	Well-graded SAND with Gravel and Cobbles				>76.2	0.0		Gray to brown, moist, subangular gravel, fine to coarse sand, cobbles fractured while driving
3.9–4.9		4		NFS	10 12 15	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray to brown, moist, angular to medium sand, cobbles fractured while driving

Bottom of Hole 4.9 m
Elevation 52.4 m
Groundwater Not Encountered
PID = (Hot) Photo Ionization Detector

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Project:	*NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*
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Date:	*6 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,524 m* Easting: *511,191 m*
Top of Hole Elevation:	*58.7 m*
Hole Number, Field:	*SB-16*
Permanent:	*AP-4275*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*4.4 m*
Total Depth:	*4.9 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
													Surface: Grass
0	1		PFS	Grab	GW	Well-graded GRAVEL with Sand	62	34	4	38.1	0.0	2	Brown, moist, subangular gravel, fine to medium sand, FILL
1.5	2a		S2	3 4 3	SP-SM	Poorly graded SAND with Silt					0.0		Brown, moist, medium sand, FILL
1.8	2b		F4		ML	SILT					0.0		Olive, moist, nonplastic (NP) Fines
3	3		NFS	5 10 12	GW	Well-graded GRAVEL with Sand				50.8	0.0		Brown, moist, subangular gravel, fine to coarse sand, gravel fractured while driving
4.5	4		NFS	5 7 11	GW	Well-graded GRAVEL with Sand				50.8	0.0		Brown, moist, subangular to subrounded gravel, fine to coarse sand, coal bits in sample
4.9													Bottom of Hole 4.9 m Elevation 53.9 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

Depth scale: 1 2 3 4 5 6 7 8 9 10

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4275*

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*

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Date: *6 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,521 m* Easting: *511,235 m*

Top of Hole Elevation: *58.8 m*

Hole Number, Field: *SB-17* Permanent: *AP-4276*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ____ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass
0		1		F4	Grab	ML	SILT					0.0		Brown, moist, nonplastic (NP) fines, FILL
1		2		F2	2 2 2	SM	Silty SAND		72	28		0.0	18	Brown, moist, fine to coarse sand, NP fines, 10-cm sand and silt lenses, FILL
2		3		F4	2 2 9	ML	Sandy SILT with Gravel	18	30	52		0.0	19	Olive, moist, subangular gravel, fine to coarse sand, NP fines
3		4		NFS	5 15 13	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Brown, moist, subangular gravel, fine to coarse sand
4		5		NFS	8 12 14	GW	Well-graded GRAVEL with Sand				63.5	0.0		Gray, brown, moist, subangular gravel, fine to coarse sand
5														Bottom of Hole 4.9 m Elevation 53.9 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4276*

ALASKA DISTRICT
CORPS OF ENGINEERS
ENGINEERING SERVICES

Soils and Geology Section
EXPLORATION LOG

Project:	NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA
Page	1 of 1
Date:	6 Aug 2002
Drilling Agency:	☐ Alaska District ☒ Other Denali Drilling
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: 806,514 m Easting: 511,273 m
Top of Hole Elevation:	59.3 m
Hole Number, Field:	SB-18
Permanent:	AP-4277
Operator:	Jason Love
Inspector:	James Robson
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	NE
Depth Drilled:	4.4 m
Total Depth:	4.9 m
Hammer Weight:	154 kg
Split Spoon I.D:	63.5 mm
Size and Type of Bit:	203.2 mm HSA with bullet bit
Type of Equipment:	CME85 with Automatic Hammer
Type of Samples:	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Grass
0		1		F3	Grab	SM	Silty SAND	5	57	38	12.7	0.0	18	Orange, brown, moist, subangular gravel, fine to medium sand, nonplastic (NP) fines
1		2		NFS	2 4 5	SP	Poorly graded SAND				25.4	0.0		Brown, moist, fine to medium sand
3		3		PFS	5 16 16	SW	Well-graded SAND with Gravel				44.5	0.0		Brown, moist, subangular to subrounded gravel, fine to coarse sand
4		4		NFS	6 10 14	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Brown, moist, subangular to subrounded gravel, fine to coarse sand, cobbles and gravel fractured while driving
5														Bottom of Hole 4.9 m Elevation 54.4 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Project: NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)

Hole Number: AP-4277

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*

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Date: *6 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,504 m* Easting: *511,338 m*

Top of Hole Elevation: *59.9 m*

Hole Number, Field: *SB-19* Permanent: *AP-4278*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *4.4 m*

Total Depth: *4.9 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass
		1		F4	Grab	ML	SILT				50.8	0.0		Yellow to olive, moist, subangular gravel, fine to coarse sand
1														
		2		F2	9 6 7	SW-SM	Well-graded SAND with Silt and Gravel	21	68	11	19.1	0.0	7	Grayish brown, moist, subrounded gravel, fine to medium sand, 6-mm lenses of NP fines
2														
3		3		NFS	9 9 9	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Brown, gray, moist, subangular to subrounded gravel, fine to coarse sand, cobbles fractured while driving
4														
		4		NFS	13 10 12	GW	Well-graded GRAVEL with Sand				63.5	0.0		Brown, moist, subrounded gravel, fine to coarse sand
5														Bottom of Hole 4.9 m Elevation 55.1 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector
6														
7														
8														
9														
10														

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4278*

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*

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Date: *6 Aug 2002*

Drilling Agency: ☐ Alaska District ☒ Other *Denali Drilling*

Elevation Datum: ☒ MSL ☐ other

Location: Northing: *806,420 m* Easting: *511,600 m*

Top of Hole Elevation: *60.6 m*

Hole Number, Field: *SB-20* Permanent: *AP-4279*

Operator: *Jason Love*

Inspector: *James Robson*

Type of Hole: ☐ other ______ ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: *NE*

Depth Drilled: *5.9 m*

Total Depth: *6.6 m*

Hammer Weight: *154 kg*

Split Spoon I.D: *63.5 mm*

Size and Type of Bit: *203.2 mm HSA with bullet bit*

Type of Equipment: *CME85 with Automatic Hammer*

Type of Samples: *Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass, edge of roadway
0		1		F3	Grab	SM	Silty SAND	10	46	44	19.1	0.0	18	Brown, moist, subangular gravel, fine to medium sand, nonplastic (NP) fines
1–2		2		S1	6 18 20	GW-GM	Well-graded GRAVEL with Silt and Sand				63.5	0.0		Brown, moist, subangular to subrounded gravel, fine to coarse sand
3		3		S2	10 13 17	SP-SM	Poorly graded SAND with Silt, Gravel, and Cobbles	42	51	7	>76.2	0.0	4	Brown, moist, subangular gravel, fine to medium sand, cobbles fractured while driving
4–5		4		NFS	8 10 11 12	GW	Well-graded GRAVEL with Sand				50.8	0.4		Brown, black, moist, subangular to subrounded gravel, fine to coarse sand, gravel fractured while driving
6		5										5.0		Because of a heavy hydrocarbon odor, Elemendorf environmental section directed field crew to terminate boring. Reference boring AP-4282 for continuation

Bottom of Hole 6.6 m
Elevation 54.1 m
Groundwater Not Encountered
PID = (Hot) Photo Ionization Detector

Depth scale: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4279*

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Project:	*NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA*
Page	1 of 1
Date:	*6 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,412 m* Easting: *511,677 m*
Top of Hole Elevation:	*60.9 m*
Hole Number, Field:	*SB-21*
Permanent:	*AP-4280*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*NE*
Depth Drilled:	*9.0 m*
Total Depth:	*9.4 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Birch forest
		1		F4	Grab	ML	SILT					0.0		Olive to yellow, moist, nonplastic (NP) fines, possible FILL
1														
		2		F4	4 4 3	ML	SILT					0.0		Yellow, brown, medium sand, NP fines, organics, 3% roots, possible FILL
2														
3		3		S1	8 14 18	GP-GM	Poorly graded GRAVEL with Silt and Sand	55	37	8	57.2	0.2	3	Tan, moist, subangular gravel, fine to coarse sand, NP fines, gravel fractured while driving
4														
		4		PFS	10 12 12	GP-GM	Poorly graded GRAVEL with Silt, Sand, and Cobbles	49	48	3	>76.2	0.0	3	Gray, moist, subangular gravel, fine to coarse sand, cobbles and gravel fractured while driving
5														
6		5			7 7 9	GP-GM	Poorly graded GRAVEL with Silt and Sand				25.4	0.0		Gray, moist, subrounded gravel, medium to coarse sand, low plasticity fines, gravel fractured while driving
7														
		6			11 12 12	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, medium to coarse sand, cobbles fractured while driving
8														
9		7			6 9 11	SW	Well-graded SAND with Gravel				57.2	0.0		Gray with orange staining, moist to wet, subangular gravel, fine to coarse sand
10														Bottom of Hole 9.4 m Elevation 51.4 m Groundwater Not Encountered PID = (Hot) Photo Ionization Detector

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Project: *NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179)*

Hole Number: *AP-4280*

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Drilling Agency: ☐ Alaska District ☒ Other Denali Drilling	Elevation Datum: ☒ MSL ☐ other	
Location: Northing: 806,487 m Easting: 511,701 m	Top of Hole Elevation: 61.0 m	

Hole Number, Field:	Permanent:	Operator:	Inspector:
SB-22	AP-4281	Jason Love	James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer	Depth to Groundwater: 10.2 m GE	Depth Drilled: 15.1 m	Total Depth: 15.5 m

Hammer Weight:	Split Spoon I.D:	Size and Type of Bit:	Type of Equipment:	Type of Samples:
154 kg	63.5 mm	203.2 mm HSA with bullet bit	CME85 with Automatic Hammer	Grab and Drive

Surface: Birch forest

Depth (m)	Sample	Frozen ASTM D 4083	Frost Class, TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
	1		F4	Grab	ML	SILT					0.0		Yellow, moist, nonplastic (NP) fines, FILL
1	2a		S2	3 3 4	SW-SM	Well-graded SAND with Silt and Gravel	4	85	11		0.0	15	Brown, moist, fine to coarse sand, NP fines, FILL
2	2b		F4		ML	SILT with Gravel	16	33	51	19.1	0.0	18	Brown, moist, fine to medium sand, NP fines
3	3		S1	8 8 10	GP-GM	Poorly graded GRAVEL with Silt, Sand, and Cobbles	55	40	5	>76.2	0.0	5	Olive, brown, moist, subangular gravel, fine to coarse sand, NP fines, cobbles fractured while driving
4	4a		S1	5 6 10	GP-GM	Poorly graded GRAVEL with Silt, Sand, and Cobbles				>76.2	0.0		Olive, brown, moist, subangular gravel, fine to coarse sand, NP fines, cobbles fractured while driving
5	4b				GW	Well-graded GRAVEL with Sand and Cobbles				>76.2			Gray, moist, subangular to subrounded gravel, fine to coarse sand, cobbles and gravel fractured while driving
6	5			10 10 15	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, fine to coarse sand, cobbles and gravel fractured while driving
7–8	6			9 16 16	SP	Poorly graded SAND with Gravel				69.9	0.0		Gray, moist, subrounded gravel, fine to medium sand, gravel fractured while driving
9	7			6 12 15	GP	Poorly graded GRAVEL with Sand				69.9	0.0		Gray, moist, subrounded gravel, fine to coarse sand
10													

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EXPLORATION LOG

Project: NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA

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Date: 7 Aug 2002

Drilling Agency: ☐ Alaska District ☒ Other Denali Drilling

Elevation Datum: ☒ MSL ☐ other

Location: Northing: 806,487 m Easting: 511,701 m

Top of Hole Elevation: 61.0 m

Hole Number, Field: SB-22 Permanent: AP-4281

Operator: Jason Love

Inspector: James Robson

Type of Hole: ☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer

Depth to Groundwater: 10.2 m GE

Depth Drilled: 15.1 m

Total Depth: 15.5 m

Hammer Weight: 154 kg

Split Spoon I.D: 63.5 mm

Size and Type of Bit: 203.2 mm HSA with bullet bit

Type of Equipment: CME85 with Automatic Hammer

Type of Samples: Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Birch forest
		8			8 13 18	GW-GM	Well-graded GRAVEL with Silt, Sand, and Cobbles				>76.2	0.0		Gray, wet, subangular to subrounded gravel, fine to coarse sand, NP fines
11														
12		9			11 14 17	GP	Poorly graded GRAVEL with Sand				25.4	0.0		13 cm of heaving sand Gray, wet, subangular gravel, fine to coarse sand
13														
14		10			11 9 15	SP	Poorly graded SAND with Gravel				44.5	0.0		Gray, wet, subangular gravel, medium to coarse sand
15		11			6 11 28	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, wet, subrounded gravel, fine to coarse sand
16														Bottom of Hole 15.5 m Elevation 45.4 m Groundwater Encountered: at depth 10.2 m PID = (Hot) Photo Ionization Detector
17														
18														
19														
20														

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Project:	NEW FUEL SYSTEMS MAINTENANCE DOCK, SITE 3 (ELM179) ELMENDORF AIR FORCE BASE, ALASKA
Page	1 of 2
Date:	7 Aug 2002
Drilling Agency:	☐ Alaska District ☒ Other Denali Drilling
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: 806,417 m Easting: 511,600 m
Top of Hole Elevation:	60.6 m
Hole Number, Field:	SB-23
Permanent:	AP-4282
Operator:	Jason Love
Inspector:	James Robson
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	10.2 m GE
Depth Drilled:	15.1 m
Total Depth:	15.5 m
Hammer Weight:	154 kg
Split Spoon I.D:	63.5 mm
Size and Type of Bit:	203.2 mm HSA with bullet bit
Type of Equipment:	CME85 with Automatic Hammer
Type of Samples:	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks Surface: Grass
0–6														This boring is located 2 meters south of AP-4279. Reference AP-4279 for soil sampling from the surface to 6 meters
6		4			7 17 21 20	SP	Poorly graded SAND with Gravel				63.5	0.0		Gray, moist, subrounded gravel, fine to medium sand, bits of coal in sample
7		5			13 15 11 14	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subrounded gravel, fine to coarse sand, cobbles and gravels fractured while driving
9		6			8 27 22/8 cm	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subangular to subrounded gravel, fine to coarse sand, cobbles fractured while driving
10		6b			10 19	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist to wet, subrounded gravel, fine to coarse sand, cobbles fractured while driving,

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Page	2 of 2
Date:	*7 Aug 2002*
Drilling Agency:	☐ Alaska District ☒ Other *Denali Drilling*
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: *806,417 m* Easting: *511,600 m*
Top of Hole Elevation:	*60.6 m*
Hole Number, Field:	*SB-23*
Permanent:	*AP-4282*
Operator:	*Jason Love*
Inspector:	*James Robson*
Type of Hole:	☐ other ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	*10.2 m GE*
Depth Drilled:	*15.1 m*
Total Depth:	*15.5 m*
Hammer Weight:	*154 kg*
Split Spoon I.D:	*63.5 mm*
Size and Type of Bit:	*203.2 mm HSA with bullet bit*
Type of Equipment:	*CME85 with Automatic Hammer*
Type of Samples:	*Grab and Drive*

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	Grain Size %Gravel	Grain Size %Sand	Grain Size %Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks
														Surface: Grass
					21 20									bits of coal in sample
12		8			12 12 14	SW	Well-graded SAND with Gravel				69.9	0.0		30 cm of heaving sand. Gray, wet, subrounded gravel, fine to coarse sand
13–14		9			19 13 12	GW	Well-graded GRAVEL with Sand					0.0		Gray, wet, subrounded gravel, fine to coarse sand
15		10			32 22 26	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, wet subangular to subrounded gravel, fine to coarse sand, cobbles fractured while driving

Bottom of Hole 15.5 m
Elevation 45.1 m
Groundwater Encountered: at depth 10.2 m
PID = (Hot) Photo Ionization Detector

Depth scale: 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

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Date:	7 Aug 2002
Drilling Agency:	☐ Alaska District ☒ Other Denali Drilling
Elevation Datum:	☒ MSL ☐ other
Location:	Northing: 806,492 m; Easting: 511,641 m
Top of Hole Elevation:	60.9 m
Hole Number, Field:	SB-24
Permanent:	AP-4283
Operator:	Jason Love
Inspector:	James Robson
Type of Hole:	☐ other; ☐ Test Pit ☒ Auger Hole ☐ Monitoring Well ☐ Piezometer
Depth to Groundwater:	NE
Depth Drilled:	9.0 m
Total Depth:	9.4 m
Hammer Weight:	154 kg
Split Spoon I.D:	63.5 mm
Size and Type of Bit:	203.2 mm HSA with bullet bit
Type of Equipment:	CME85 with Automatic Hammer
Type of Samples:	Grab and Drive

Depth (m)	Lithology	Sample	Frozen ASTM D 4083	Frost Class. TM 5-822-5	Blow Count	Symbol	Classification ASTM: D 2487 or D 2488	%Gravel	%Sand	%Fines	Max Size (mm)	PID (ppm)	% Water	Description and Remarks (Surface: Grass)
0		1		F4	Grab	ML	SILT				6.4	0.0		Yellow, moist, subangular gravel, fine to coarse sand, nonplastic (NP) fines
1.5		2		NFS	12 10 11	GW	Well-graded GRAVEL with Sand				38.1	0.0		Grayish brown, moist, subangular gravel, fine to coarse sand
3		3a		NFS	19 19	GW	Well-graded GRAVEL with Sand and Cobbles				>76.2	0.0		Gray, moist, subangular gravel, fine to coarse sand, cobbles fractured while driving
		3b		NFS	10	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subangular gravel, fine to medium sand, cobbles fractured while driving
4.5		4		NFS	16 10 10	SP	Poorly graded SAND with Gravel				69.9	0.0		Gray, moist, subangular gravel, fine to medium sand
6		5			15 13 18/8 cm	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subangular gravel, fine to medium sand, cobbles fractured while driving
7.5		6			14 14 13	SP	Poorly graded SAND with Gravel and Cobbles				>76.2	0.0		Gray, moist, subangular gravel, fine to medium sand, cobbles fractured while driving
9		7			15 12 12	SP-SM	Poorly graded SAND with Silt, Gravel, and Cobbles				>76.2	0.0		Gray, moist, subangular to subrounded gravel, fine to medium sand, cobbles fractured while driving, 8-cm sand lense
10														Bottom of Hole 9.4 m; Elevation 51.4 m; Groundwater Not Encountered; PID = (Hot) Photo Ionization Detector

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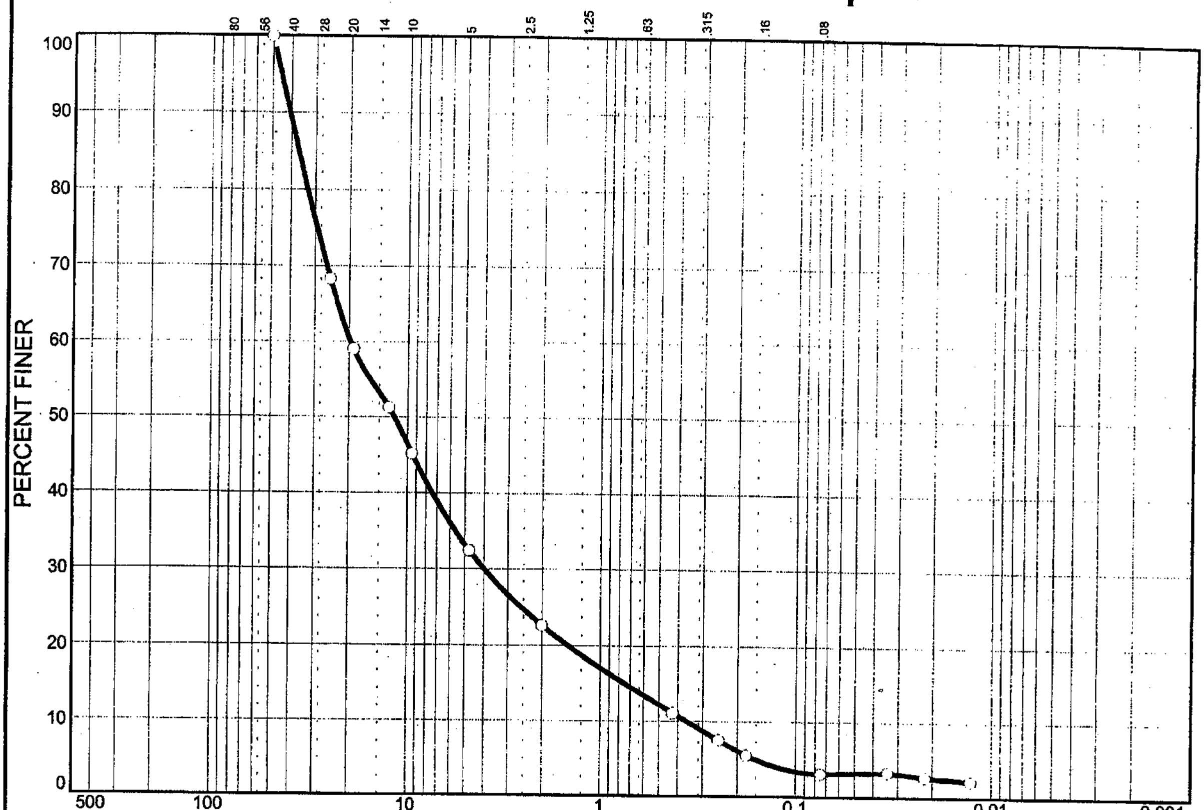
Project: NEW FUEL SYSTEMS MAINTENANCE DOCK,

Hole Number: AP-4283

Appendix B

Laboratory Test Results of
Selected Soil Samples

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	67.6	29.3	3.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	68.3		
19 mm.	59.0		
12.5 mm.	51.3		
9.5 mm.	45.2		
4.75 mm.	32.4		
2.0 mm.	22.6		
.425 mm.	11.1		
.250 mm.	7.5		
.180 mm.	5.5		
.075 mm.	3.1		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 36.6 D_{60}= 19.7 D_{50}= 11.7
D_{30}= 3.99 D_{15}= 0.753 D_{10}= 0.362
C_u= 54.46 C_c= 2.23

Classification

USCS= GW AASHTO= A-1-a

Remarks

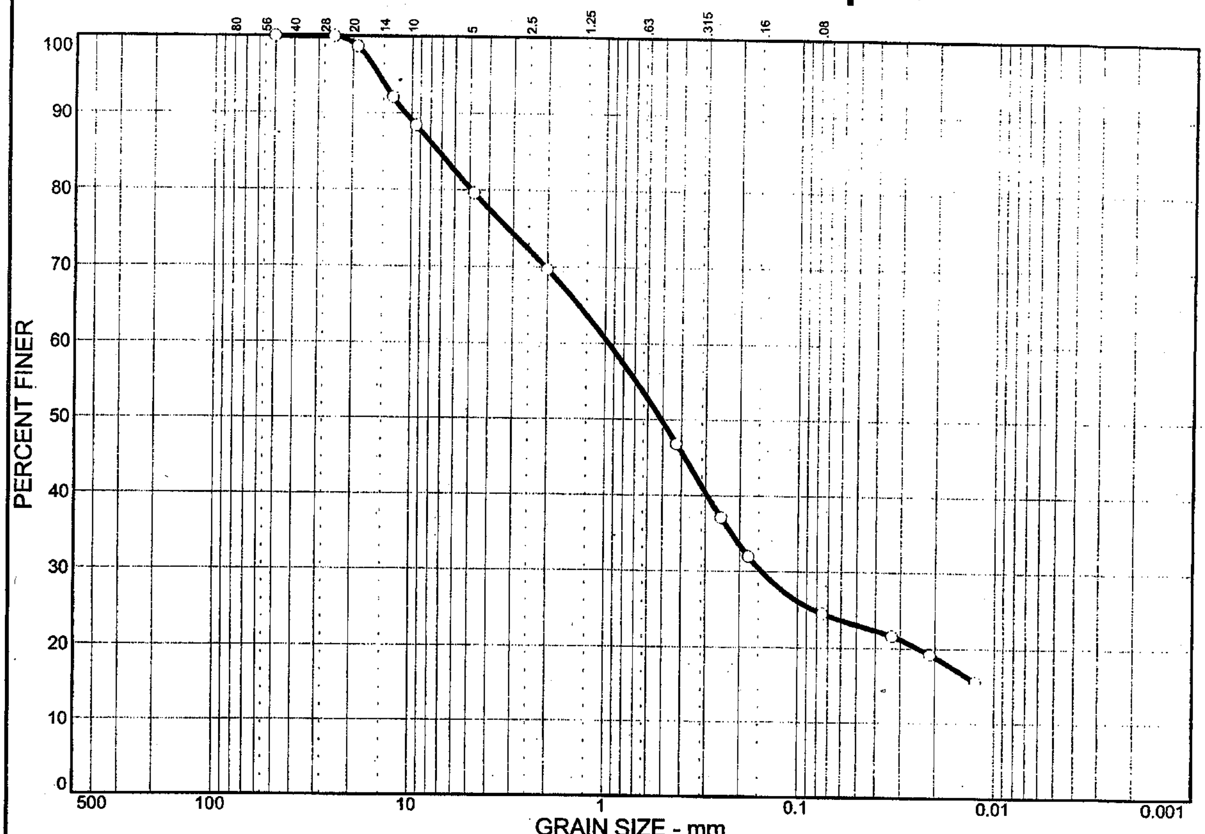
Moisture Content = 1.7 %
Percent Finer Than the 0.02 mm size =2.6 %
Frost Design Soil Classification = PFS(a)

Sample No.: 2836 **Source of Sample:** Client Samples **Date:**
Location: SB-1 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	20.4	55.1	24.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	100.0		
19 mm.	98.7		
12.5 mm.	92.1		
9.5 mm.	88.4		
4.75 mm.	79.6		
2.0 mm.	69.7		
.425 mm.	46.8		
.250 mm.	37.1		
.180 mm.	32.0		
.075 mm.	24.5		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 7.28 D_{60}= 0.955 D_{50}= 0.509
D_{30}= 0.153 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

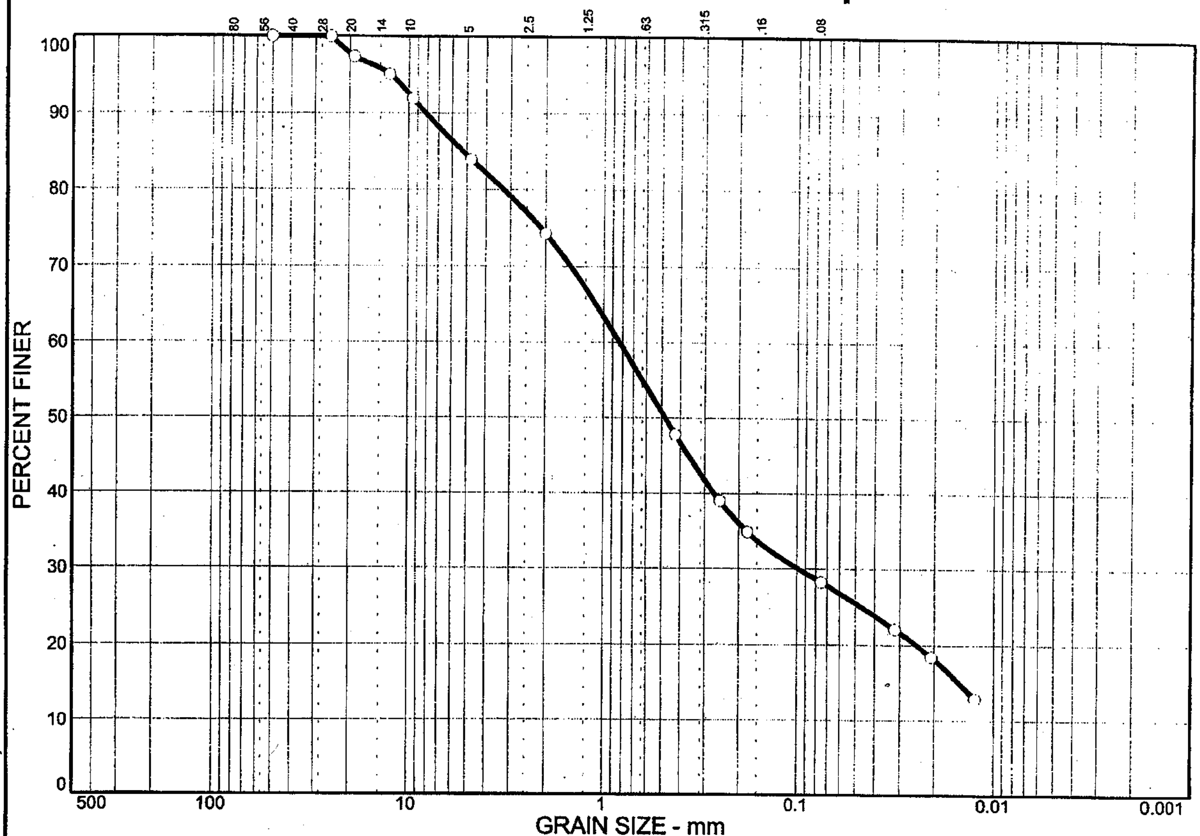
Moisture Content = 13.6 %
Percent Finer Than the 0.02 mm size = 18.8 %
Frost Design Soil Classification = F3(b)

Sample No.: 2837 **Source of Sample:** Client Samples **Date:**
Location: SB-2 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	16.1	55.6	28.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	100.0		
19 mm.	97.4		
12.5 mm.	95.1		
9.5 mm.	91.9		
4.75 mm.	83.9		
2.0 mm.	74.3		
.425 mm.	47.8		
.250 mm.	39.0		
.180 mm.	34.9		
.075 mm.	28.3		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.27 D_{60}= 0.826 D_{50}= 0.480
D_{30}= 0.0980 D_{15}= 0.0150 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

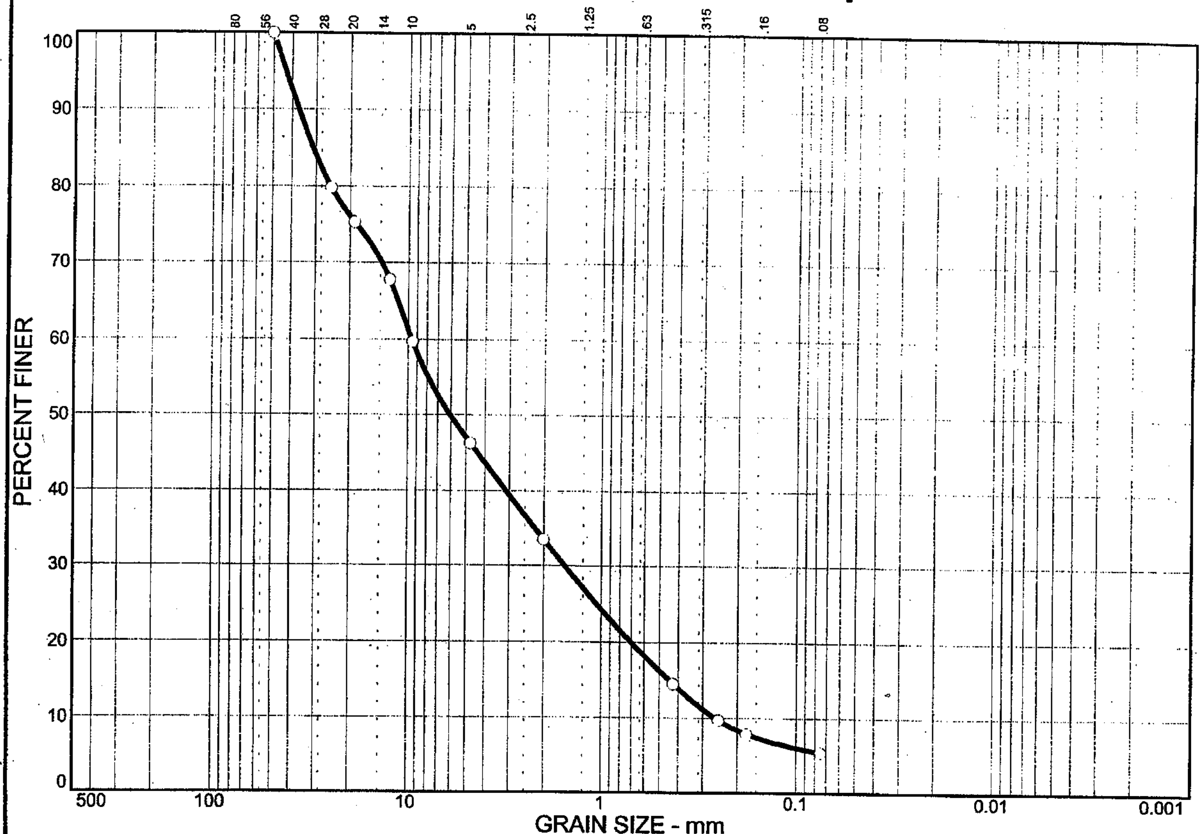
Moisture Content = 21.7 %
Percent Finer Than the 0.02 mm size =18.1 %
Frost Design Soil Classification = F3(b)

Sample No.: 2838 **Source of Sample:** Client Samples **Date:**
Location: SB-3 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	53.7	40.9	5.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	79.8		
19 mm.	75.3		
12.5 mm.	67.8		
9.5 mm.	59.7		
4.75 mm.	46.3		
2.0 mm.	33.5		
.425 mm.	14.5		
.250 mm.	9.7		
.180 mm.	7.9		
.075 mm.	5.4		

* (no specification provided)

Soil Description

Poorly graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 31.1 D_{60}= 9.60 D_{50}= 6.04
D_{30}= 1.55 D_{15}= 0.446 D_{10}= 0.261
C_u= 36.82 C_c= 0.96

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

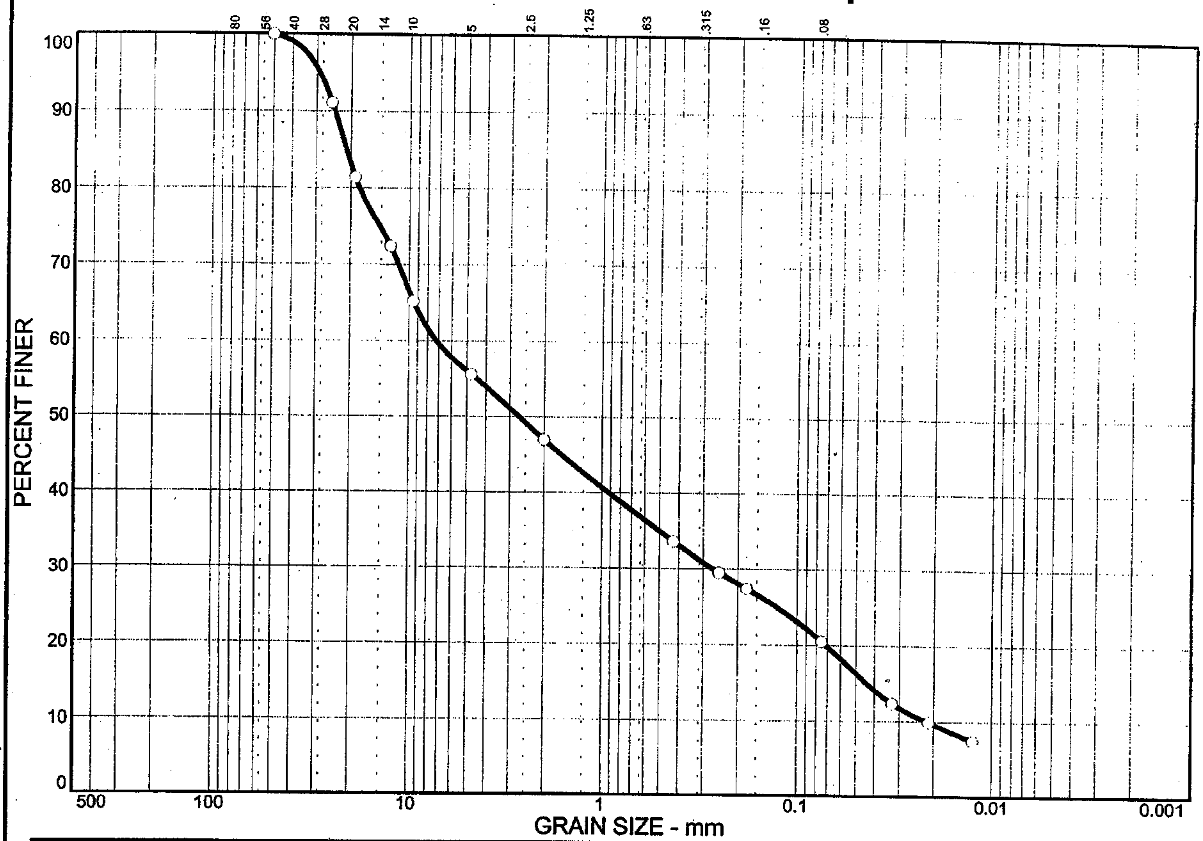
Moisture Content = 3.0 %

Sample No.: 2839 **Source of Sample:** Client Samples **Date:**
Location: SB-3 Sample 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	44.4	35.1	20.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	91.1		
19 mm.	81.4		
12.5 mm.	72.4		
9.5 mm.	65.2		
4.75 mm.	55.6		
2.0 mm.	47.0		
.425 mm.	33.6		
.250 mm.	29.5		
.180 mm.	27.4		
.075 mm.	20.5		

* (no specification provided)

Soil Description

Silty gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 21.1 D_{60}= 7.21 D_{50}= 2.69
D_{30}= 0.269 D_{15}= 0.0440 D_{10}= 0.0217
C_u= 332.19 C_c= 0.46

Classification

USCS= GM AASHTO= A-1-b

Remarks

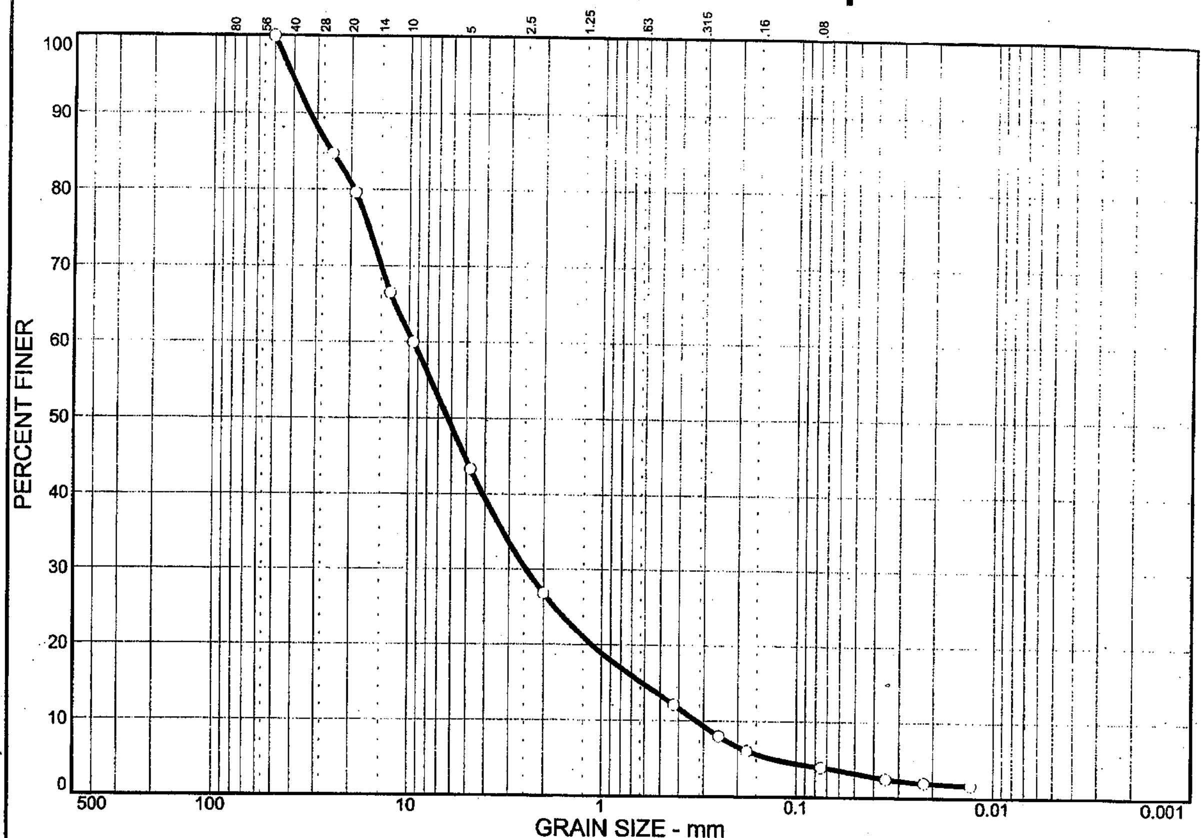
Moisture Content = 6.3 %
Percent Finer Than the 0.02 mm size =9.6 %
Frost Design Soil Classification = F1

Sample No.: 2840 **Source of Sample:** Client Samples **Date:**
Location: SB-4 Sample 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	56.7	39.3	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	84.7		
19 mm.	79.6		
12.5 mm.	66.5		
9.5 mm.	60.0		
4.75 mm.	43.3		
2.0 mm.	26.8		
.425 mm.	12.1		
.250 mm.	8.0		
.180 mm.	6.1		
.075 mm.	4.0		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 25.4 D_{60}= 9.50 D_{50}= 6.26
D_{30}= 2.45 D_{15}= 0.622 D_{10}= 0.327
C_u= 29.09 C_c= 1.94

Classification

USCS= GW AASHTO= A-1-a

Remarks

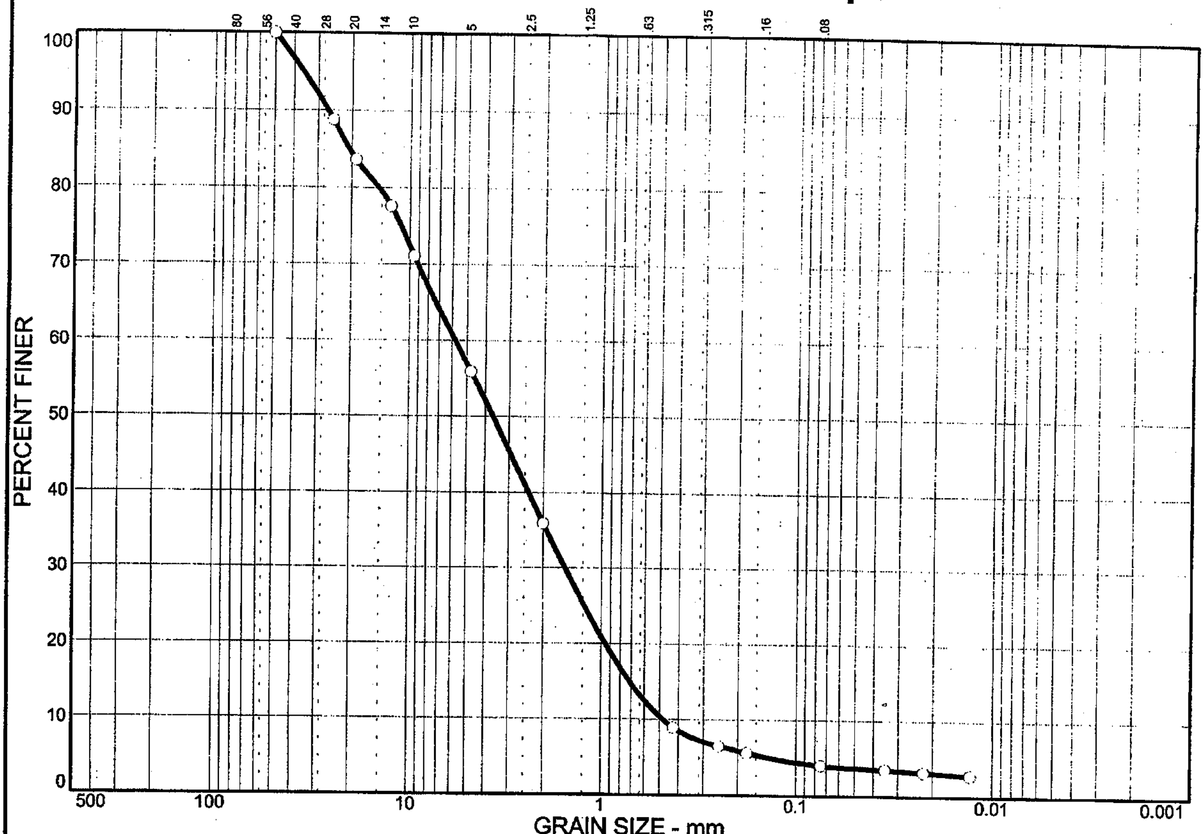
Moisture Content = 3.0 %
Percent Finer Than the 0.02 mm size =1.9 %
Frost Design Soil Classification = PFS(a)

Sample No.: 2841 **Source of Sample:** Client Samples **Date:**
Location: SB-5 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	44.1	51.9	4.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	88.8		
19 mm.	83.6		
12.5 mm.	77.6		
9.5 mm.	71.1		
4.75 mm.	55.9		
2.0 mm.	35.9		
.425 mm.	8.9		
.250 mm.	6.5		
.180 mm.	5.6		
.075 mm.	4.0		

* (no specification provided)

Soil Description

Poorly graded sand with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 20.6 D_{60}= 5.76 D_{50}= 3.65
D_{30}= 1.55 D_{15}= 0.713 D_{10}= 0.482
C_u= 11.96 C_c= 0.86

Classification

USCS= SP AASHTO= A-1-a

Remarks

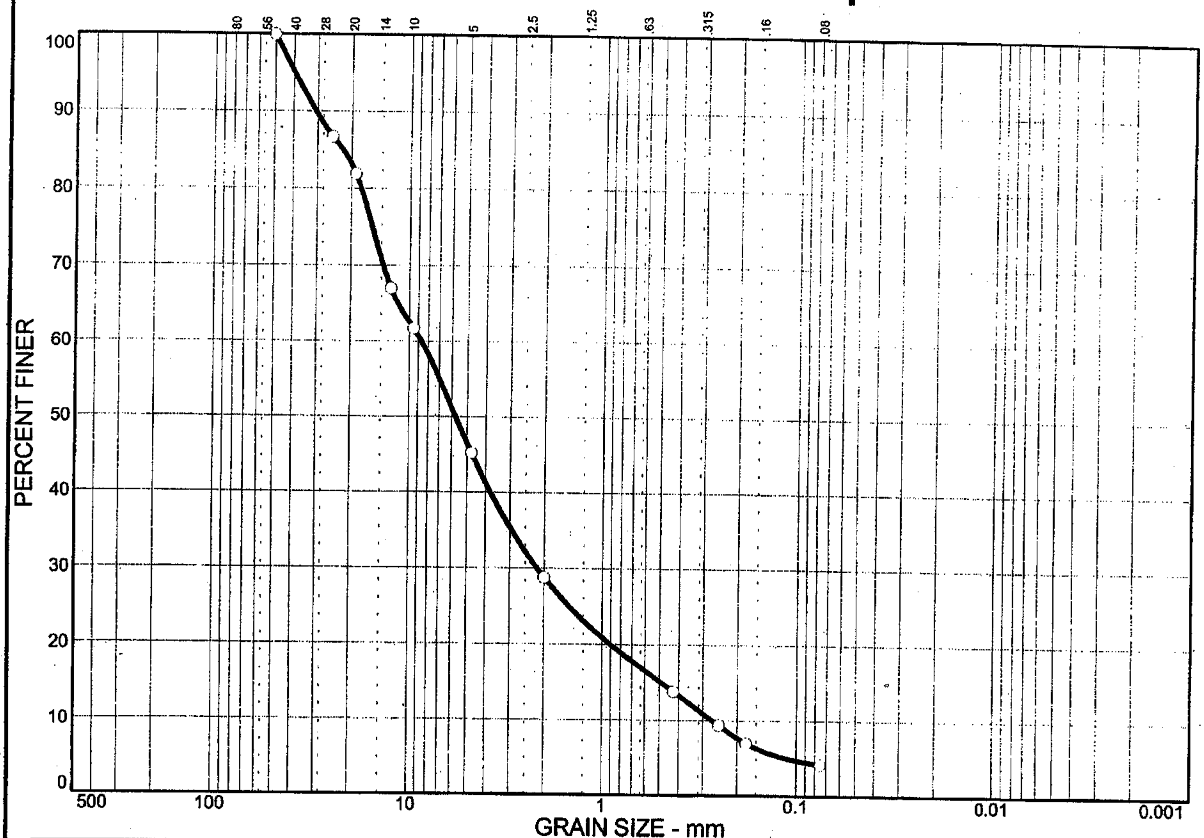
Moisture Content = 2.0 %
Percent Finer Than the 0.02 mm size =3.1 %
Frost Design Soil Classification = PFS(b)

Sample No.: 2842 **Source of Sample:** Client Samples **Date:**
Location: SB-6 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	54.8	41.0	4.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	86.7		
19 mm.	81.9		
12.5 mm.	67.0		
9.5 mm.	61.7		
4.75 mm.	45.2		
2.0 mm.	28.8		
.425 mm.	13.8		
.250 mm.	9.4		
.180 mm.	7.0		
.075 mm.	4.2		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 22.2 D_{60}= 8.68 D_{50}= 5.74
D_{30}= 2.17 D_{15}= 0.493 D_{10}= 0.269
C_u= 32.26 C_c= 2.02

Classification

USCS= GW AASHTO= A-1-a

Remarks

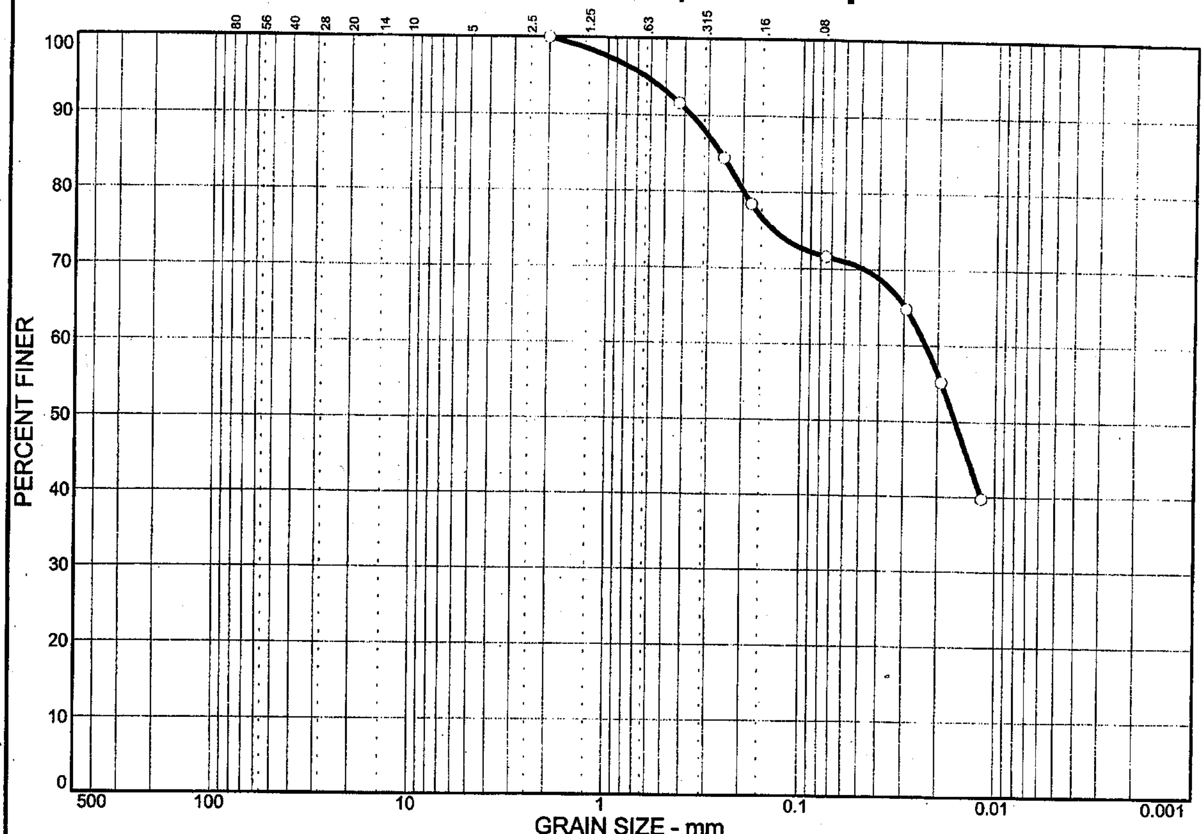
Moisture Content = 3.1 %

Sample No.: 2843 **Source of Sample:** Client Samples **Date:**
Location: SB-6 Sample 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	28.4	71.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0 mm.	100.0		
.425 mm.	91.6		
.250 mm.	84.4		
.180 mm.	78.4		
.075 mm.	71.6		

* (no specification provided)

Soil Description

Silty clay with sand

Atterberg Limits

PL= 20 LL= 24 PI= 4

Coefficients

D_{85}= 0.259 D_{60}= 0.0231 D_{50}= 0.0162
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(0)

Remarks

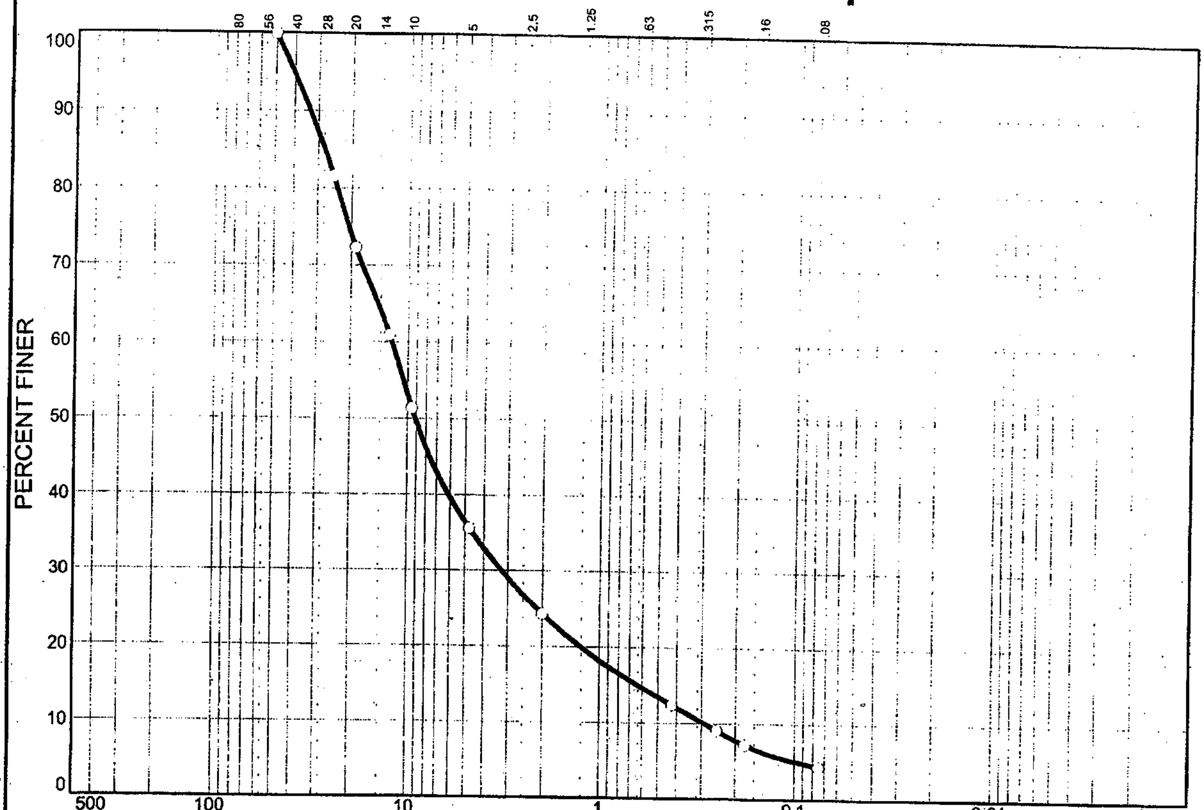
Moisture Content = 26.6 %
% Finer Than the 0.02 mm = 56.3 %
Frost Design Soil Classification = F4(d)

Sample No.: 2845 **Source of Sample:** Client Samples **Date:**
Location: SB-7 Sample # 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	64.4	31.3	4.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	81.6		
19 mm.	72.3		
12.5 mm.	60.9		
9.5 mm.	51.4		
4.75 mm.	35.6		
2.0 mm.	24.3		
.425 mm.	12.4		
.250 mm.	9.1		
.180 mm.	7.2		
.075 mm.	4.3		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 27.8 D_{60}= 12.2 D_{50}= 9.10
D_{30}= 3.24 D_{15}= 0.639 D_{10}= 0.289
C_u= 42.02 C_c= 2.99

Classification

USCS= GW AASHTO= A-1-a

Remarks

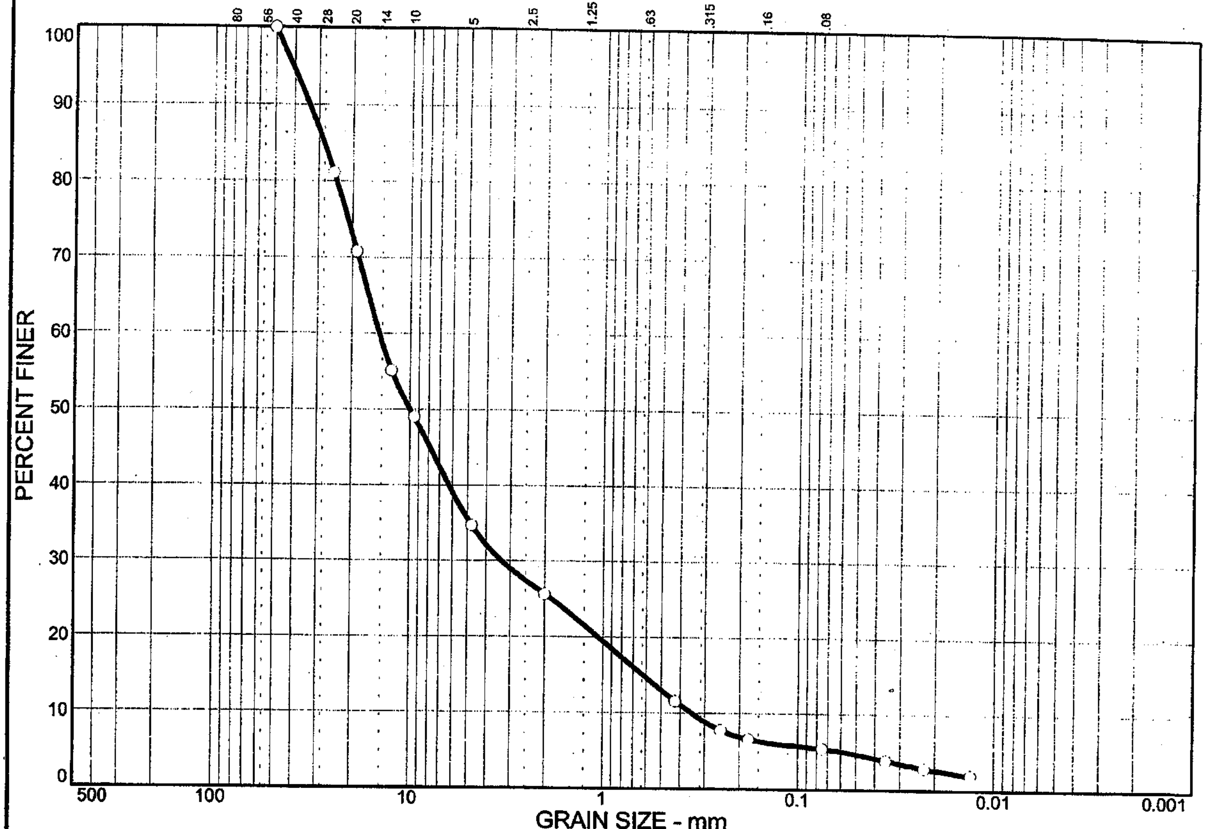
Moisture Content = 3.5 %

Sample No.: 2844 **Source of Sample:** Client Samples **Date:**
Location: SB-7 Sample 4 **Elev./Depth:** 9.5 - 11.0 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	65.3	29.3	5.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	81.1		
19 mm.	70.8		
12.5 mm.	55.1		
9.5 mm.	49.0		
4.75 mm.	34.7		
2.0 mm.	25.6		
.425 mm.	11.6		
.250 mm.	7.8		
.180 mm.	6.6		
.075 mm.	5.4		

* (no specification provided)

Soil Description

Well-graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 28.2 D_{60}= 14.5 D_{50}= 9.99
D_{30}= 3.34 D_{15}= 0.622 D_{10}= 0.350
C_u= 41.47 C_c= 2.20

Classification

USCS= GW-GM AASHTO= A-1-a

Remarks

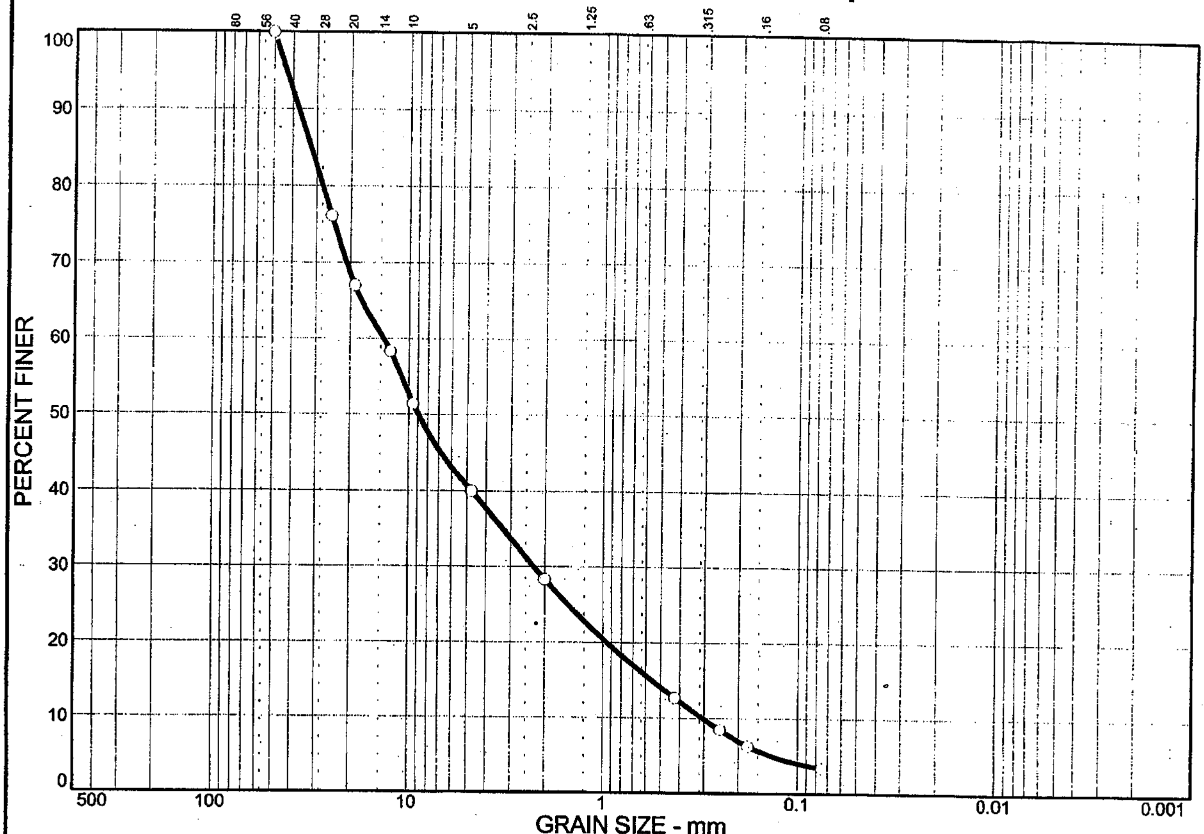
Moisture Content = 1.8 %
% Finer Than the 0.02 mm = 2.7 %
Frost Design Soil Classification = PFS(a)

Sample No.: 2846 **Source of Sample:** Client Samples **Date:**
Location: SB-8 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	60.0	36.6	3.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	76.1		
19 mm.	67.0		
12.5 mm.	58.3		
9.5 mm.	51.4		
4.75 mm.	40.0		
2.0 mm.	28.3		
.425 mm.	12.7		
.250 mm.	8.5		
.180 mm.	6.3		
.075 mm.	3.4		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 32.2 D_{60}= 13.6 D_{50}= 8.94
D_{30}= 2.28 D_{15}= 0.557 D_{10}= 0.304
C_u= 44.54 C_c= 1.26

Classification

USCS= GW AASHTO= A-1-a

Remarks

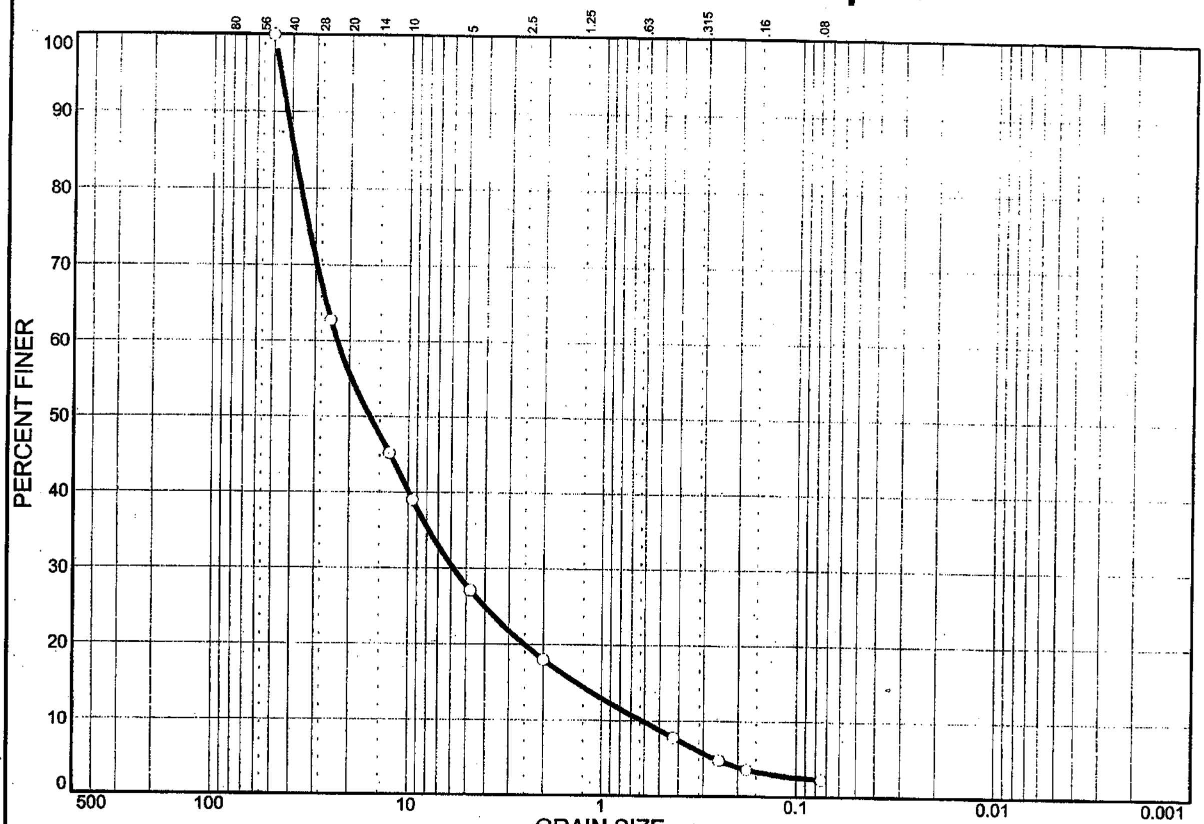
Moisture Content = 2.2 %

Sample No.: 2847 **Source of Sample:** Client Samples **Date:**
Location: SB-8 Sample 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	72.9	24.8	2.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	62.8		
12.5 mm.	45.2		
9.5 mm.	39.0		
4.75 mm.	27.1		
2.0 mm.	18.0		
.425 mm.	7.8		
.250 mm.	4.8		
.180 mm.	3.6		
.075 mm.	2.3		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 39.0 D_{60}= 23.1 D_{50}= 15.7
D_{30}= 5.82 D_{15}= 1.35 D_{10}= 0.614
C_u= 37.68 C_c= 2.38

Classification

USCS= GW AASHTO= A-1-a

Remarks

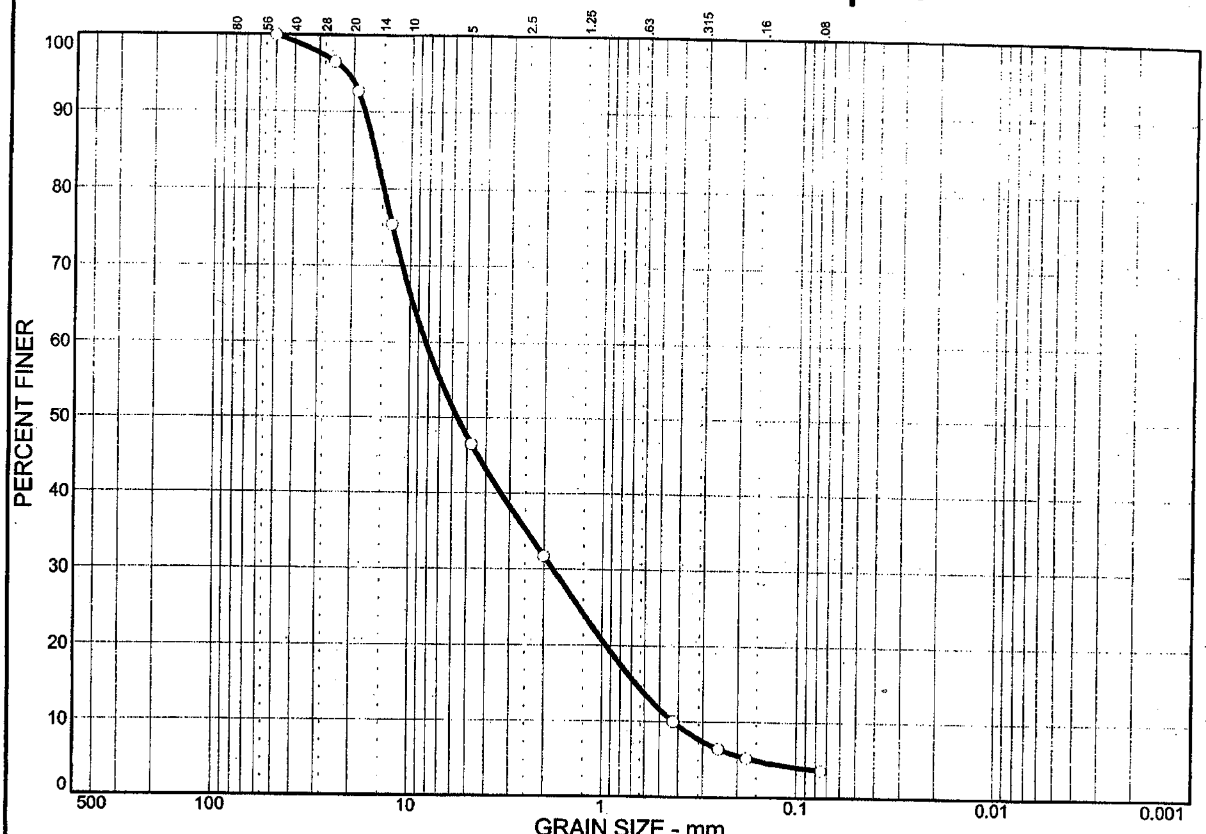
Moisture Content = 1.7 %

Sample No.: 2848 **Source of Sample:** Client Samples **Date:**
Location: SB-9 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	53.5	42.9	3.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	96.5		
19 mm.	92.7		
12.5 mm.	75.4		
4.75 mm.	46.5		
2.0 mm.	31.7		
.425 mm.	10.0		
.250 mm.	6.4		
.180 mm.	5.2		
.075 mm.	3.6		

* (no specification provided)

Soil Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 15.4 D_{60}= 8.26 D_{50}= 5.61
D_{30}= 1.80 D_{15}= 0.665 D_{10}= 0.425
C_u= 19.43 C_c= 0.92

Classification

USCS= GP AASHTO= A-1-a

Remarks

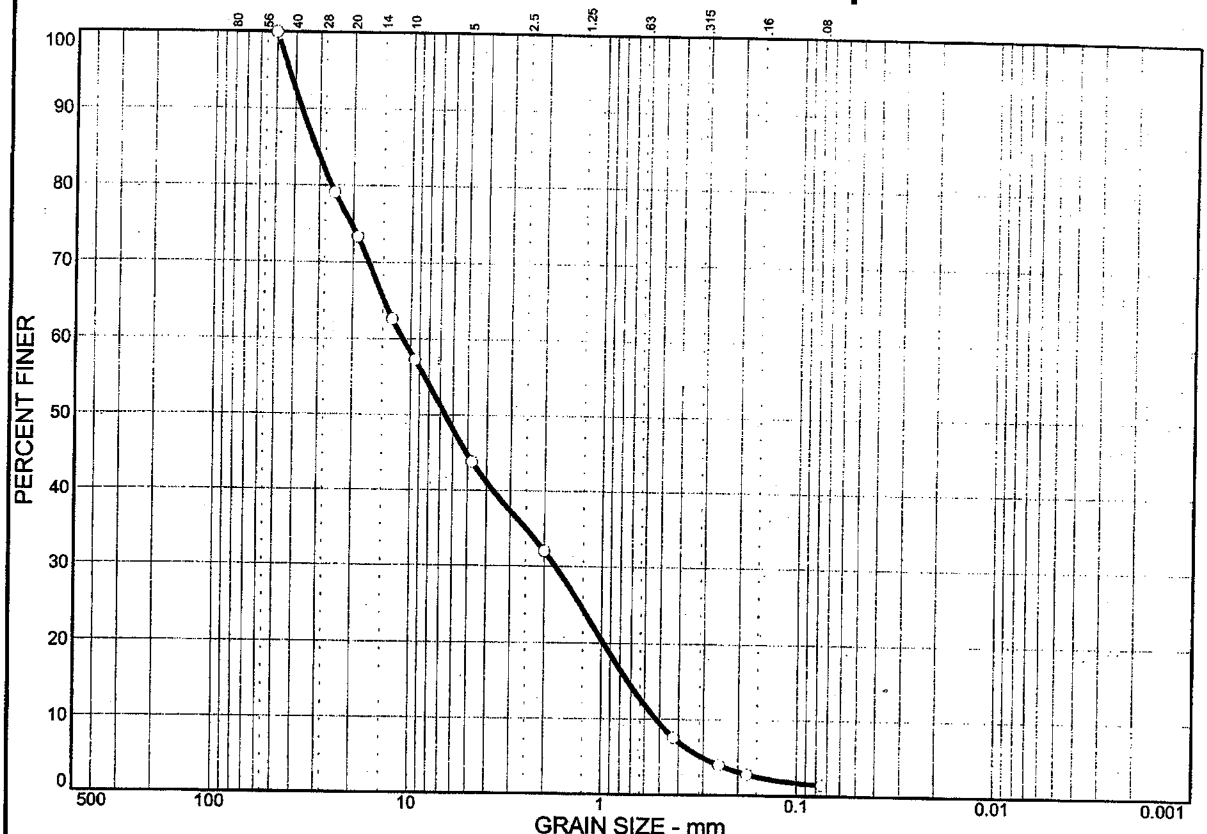
Moisture Content = 1.8 %

Sample No.: 2849 **Source of Sample:** Client Samples **Date:**
Location: SB-10 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	56.2	42.3	1.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	79.1		
19 mm.	73.3		
12.5 mm.	62.6		
9.5 mm.	57.3		
4.75 mm.	43.8		
2.0 mm.	32.0		
.425 mm.	7.6		
.250 mm.	4.0		
.180 mm.	2.8		
.075 mm.	1.5		

* (no specification provided)

Soil Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 31.4 D_{60}= 11.0 D_{50}= 6.58
D_{30}= 1.75 D_{15}= 0.730 D_{10}= 0.522
C_u= 21.08 C_c= 0.53

Classification

USCS= GP AASHTO= A-1-a

Remarks

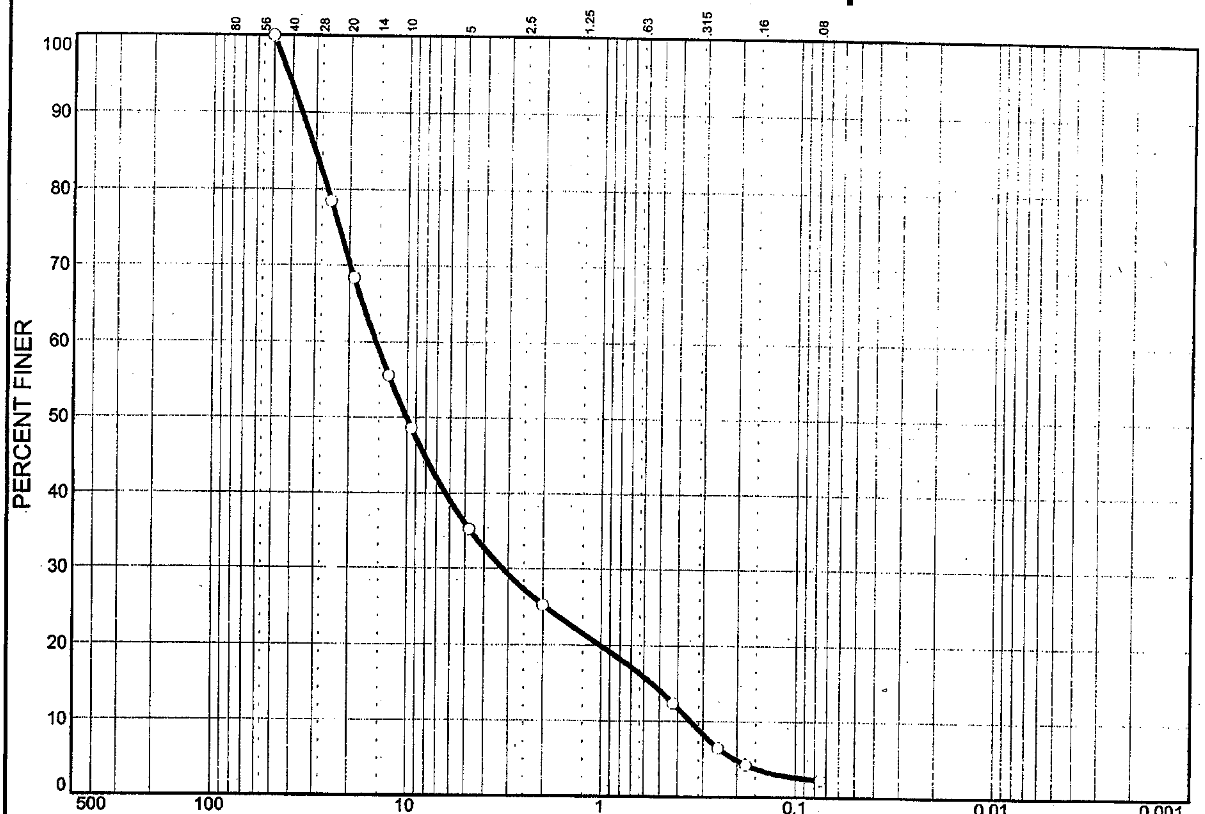
Moisture Content = 1.5 %

Sample No.: 2850 **Source of Sample:** Client Samples **Date:**
Location: SB-11 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	64.8	32.9	2.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	78.5		
19 mm.	68.4		
12.5 mm.	55.6		
9.5 mm.	48.6		
4.75 mm.	35.2		
2.0 mm.	25.2		
.425 mm.	12.4		
.250 mm.	6.5		
.180 mm.	4.3		
.075 mm.	2.3		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 30.2 D_{60}= 14.6 D_{50}= 10.1
D_{30}= 3.22 D_{15}= 0.548 D_{10}= 0.346
C_u= 42.27 C_c= 2.06

Classification

USCS= GW AASHTO= A-1-a

Remarks

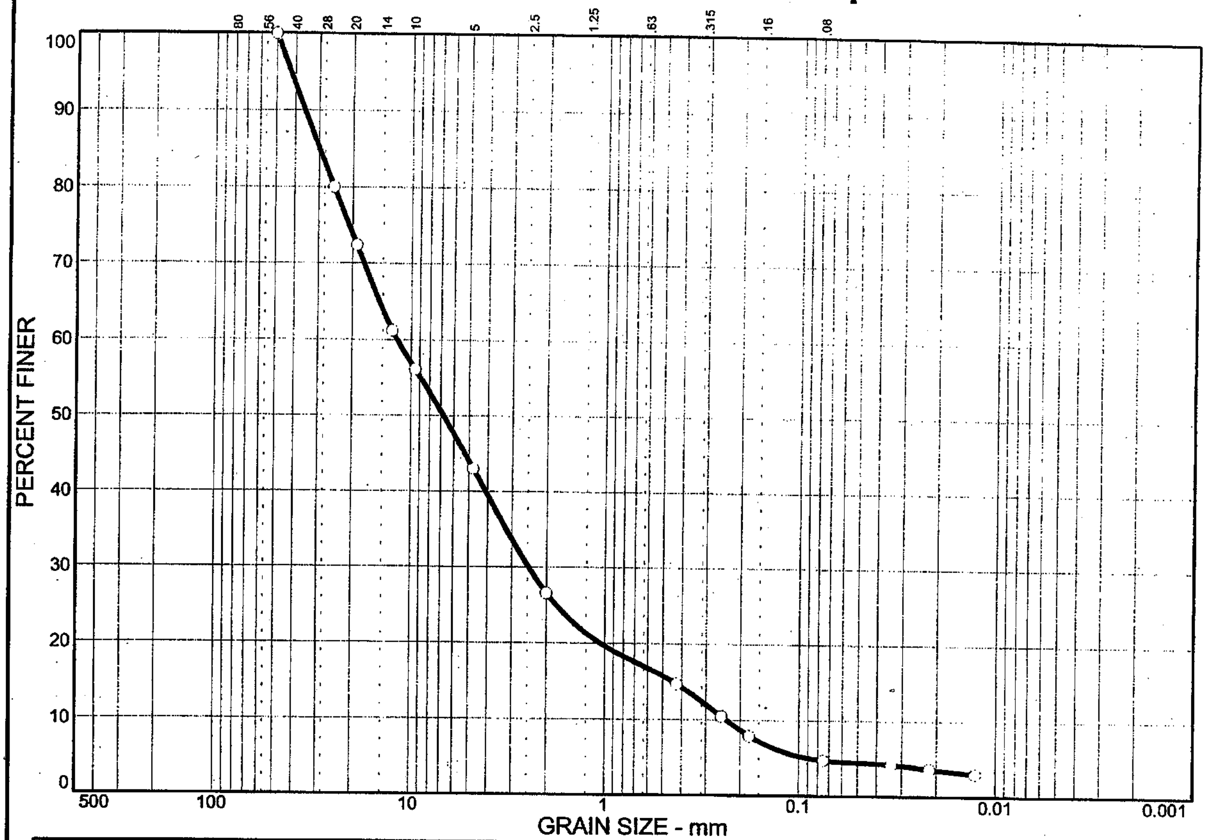
Moisture Content = 2.2 %

Sample No.: 2851 **Source of Sample:** Client Samples **Date:**
Location: SB-12 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	57.0	38.3	4.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	80.0		
19 mm.	72.4		
12.5 mm.	61.2		
9.5 mm.	56.1		
4.75 mm.	43.0		
2.0 mm.	26.6		
.425 mm.	14.7		
.250 mm.	10.5		
.180 mm.	7.9		
.075 mm.	4.7		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 29.9 D_{60}= 11.8 D_{50}= 6.78
D_{30}= 2.47 D_{15}= 0.445 D_{10}= 0.236
C_u= 50.09 C_c= 2.19

Classification

USCS= GW AASHTO= A-1-a

Remarks

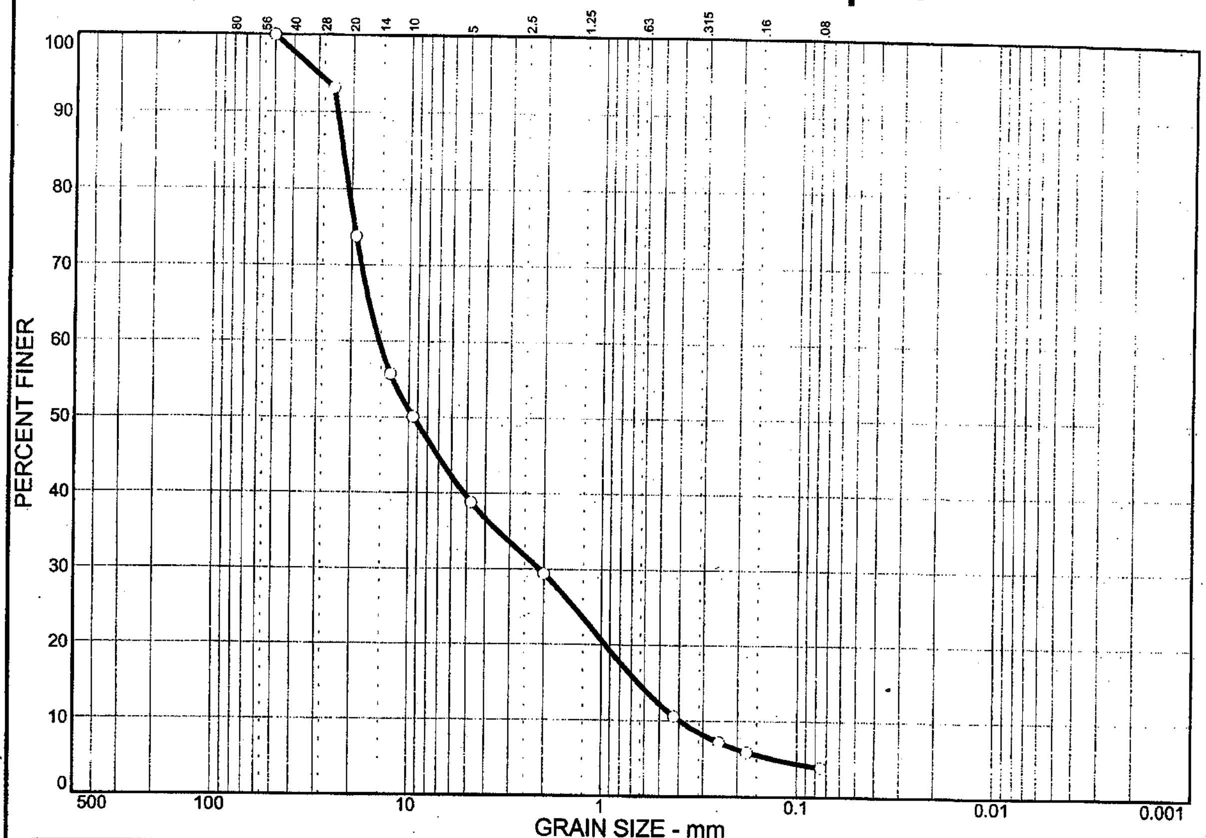
Moisture Content = 2.6 %
%Finer Than the 0.02 mm size = 3.5 %
Frost Design Soil Classification = S1

Sample No.: 2852 **Source of Sample:** Client Samples **Date:**
Location: SB-13 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	61.2	34.9	3.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	93.2		
19 mm.	73.8		
12.5 mm.	55.7		
9.5 mm.	50.1		
4.75 mm.	38.8		
2.0 mm.	29.4		
.425 mm.	10.6		
.250 mm.	7.2		
.180 mm.	5.9		
.075 mm.	3.9		

* (no specification provided)

Soil Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 22.4 D_{60}= 14.3 D_{50}= 9.45
D_{30}= 2.11 D_{15}= 0.646 D_{10}= 0.395
C_u= 36.23 C_c= 0.79

Classification

USCS= GP AASHTO= A-1-a

Remarks

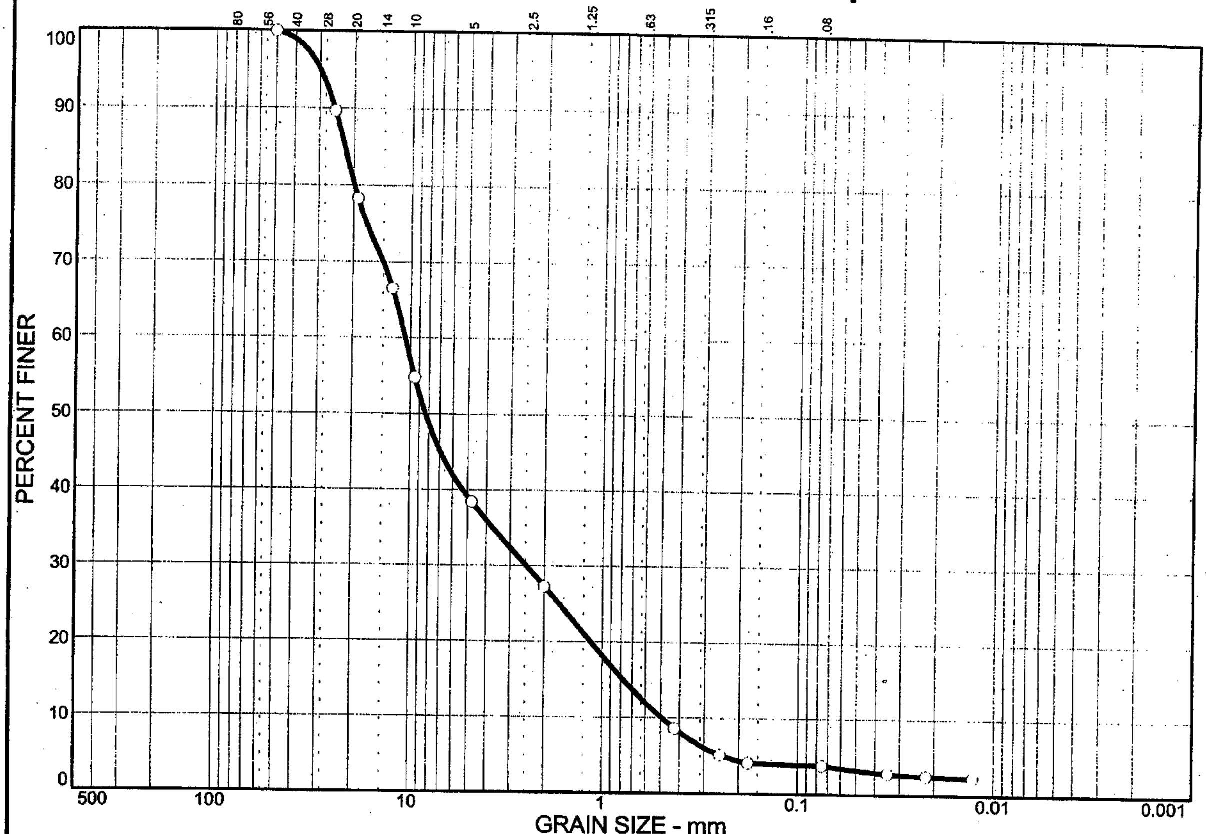
Moisture Content = 2.2 %

Sample No.: 2853 **Source of Sample:** Client Samples **Date:**
Location: SB-15 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	61.6	34.6	3.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	89.7		
19 mm.	78.3		
12.5 mm.	66.5		
9.5 mm.	54.8		
4.75 mm.	38.4		
2.0 mm.	27.3		
.425 mm.	8.6		
.250 mm.	5.1		
.180 mm.	4.1		
.075 mm.	3.8		

* (no specification provided)

Soil Description

Well-graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 22.3 D_{60}= 10.7 D_{50}= 8.33
D_{30}= 2.48 D_{15}= 0.775 D_{10}= 0.494
C_u= 21.65 C_c= 1.16

Classification

USCS= GW AASHTO= A-1-a

Remarks

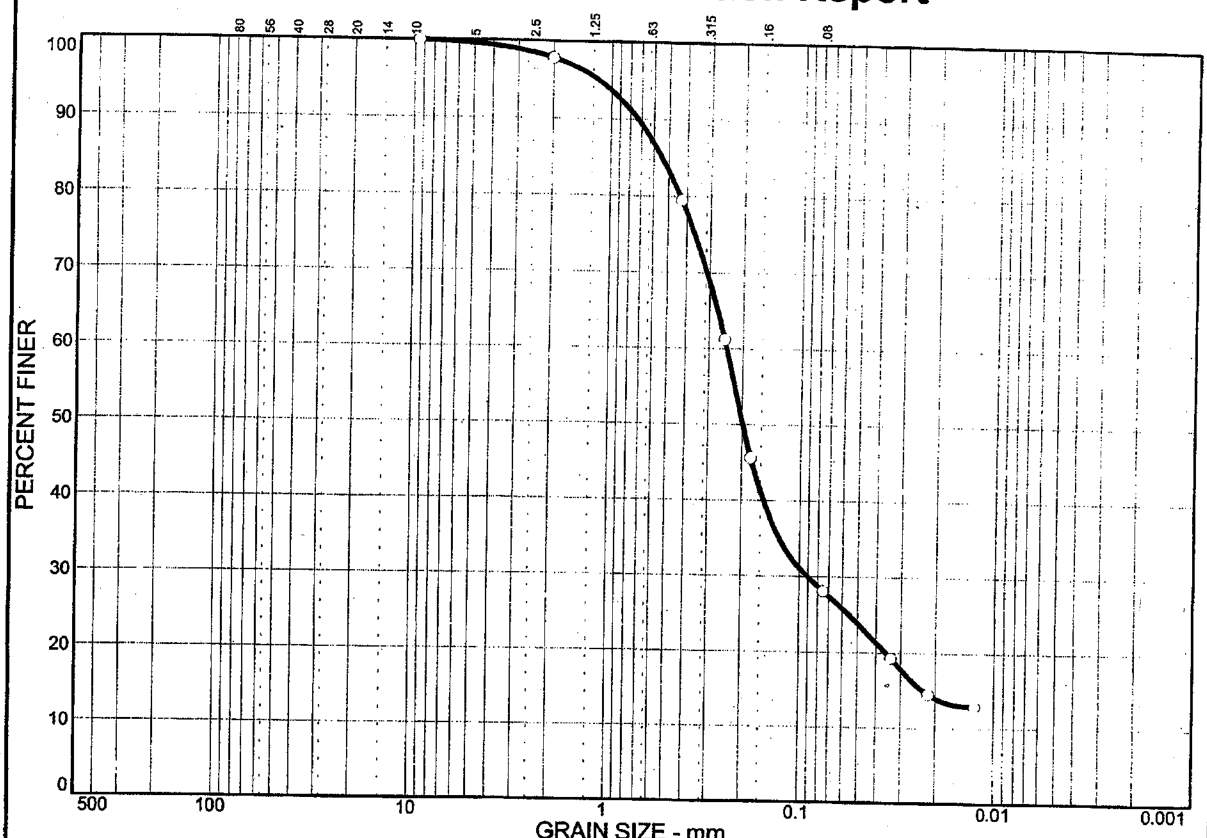
Moisture Content = 2.2 %
% Finer Than the 0.02 mm size = 2.5 %
Frost Design Soil Classification = PFS(a)

Sample No.: 2854 **Source of Sample:** Client Samples **Date:**
Location: SB-16 Sample 1 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.4	71.5	28.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5 mm.	100.0		
2.0 mm.	97.8		
.425 mm.	79.5		
.250 mm.	61.2		
.180 mm.	45.6		
.075 mm.	28.1		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.542 D_{60}= 0.244 D_{50}= 0.198
D_{30}= 0.0907 D_{15}= 0.0232 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

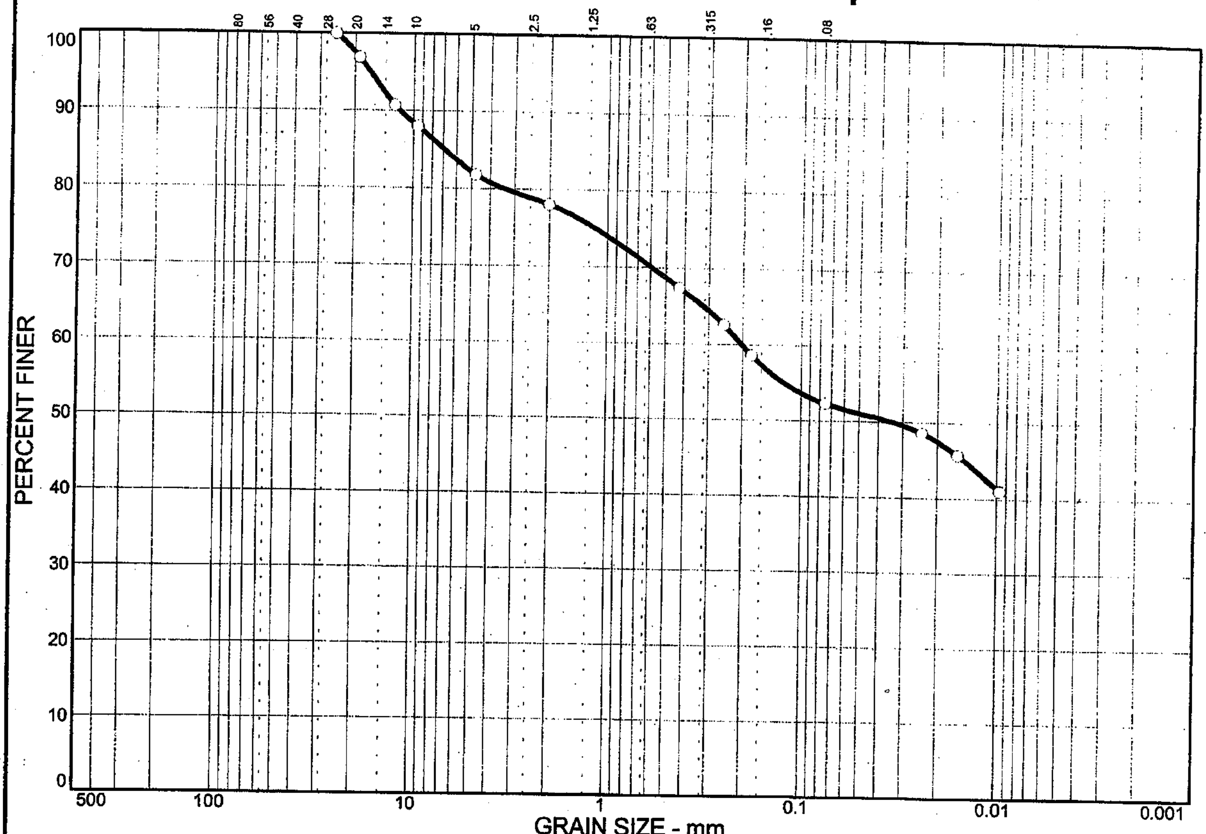
Moisture Content = 18.3 %
% Finer Than the 0.02 mm size = 13.9%
Frost Design Soil Classification = F2(b)

Sample No.: 2855 **Source of Sample:** Client Samples **Date:**
Location: SB-17 Sample 2 **Elev./Depth:** 4.5 - 6.0 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	18.2	29.5	52.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
25 mm.	100.0		
19 mm.	96.9		
12.5 mm.	90.7		
9.5 mm.	88.0		
4.75 mm.	81.8		
2.0 mm.	78.0		
.425 mm.	67.4		
.250 mm.	62.6		
.180 mm.	58.6		
.075 mm.	52.3		

* (no specification provided)

Soil Description

Sandy silt with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 6.92 D_{60}= 0.202 D_{50}= 0.0339
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

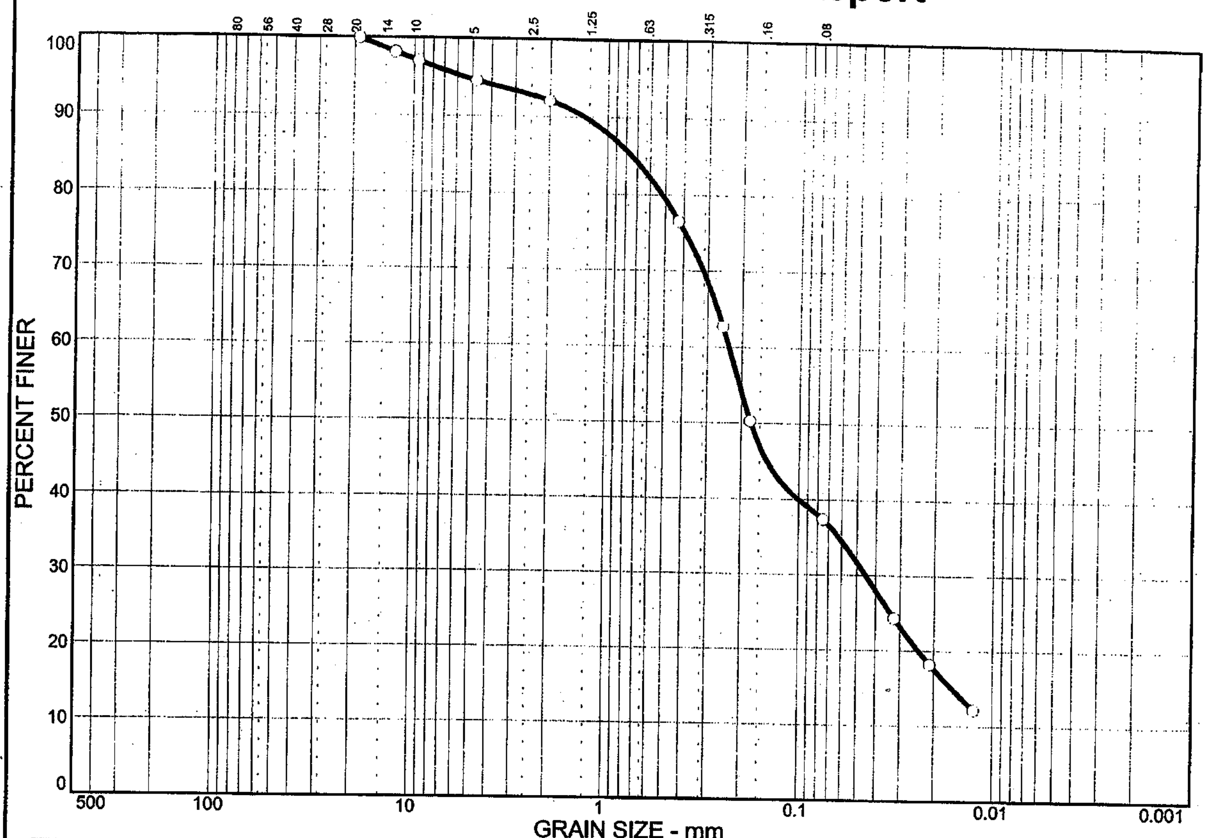
Moisture Content = 19.3 %
% Finer Than the 0.02 mm size = 47.5 %
Frost Design Soil Classification = F4(a)

Sample No.: 2865 **Source of Sample:** Client Samples **Date:**
Location: SB-17 Sample 3 **Elev./Depth:** 7.5 - 9.0 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	5.4	57.2	37.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19 mm.	100.0		
12.5 mm.	98.2		
9.5 mm.	97.1		
4.75 mm.	94.6		
2.0 mm.	92.1		
.425 mm.	76.5		
.250 mm.	62.7		
.180 mm.	50.3		
.075 mm.	37.4		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.746 D_{60}= 0.233 D_{50}= 0.178
D_{30}= 0.0450 D_{15}= 0.0161 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

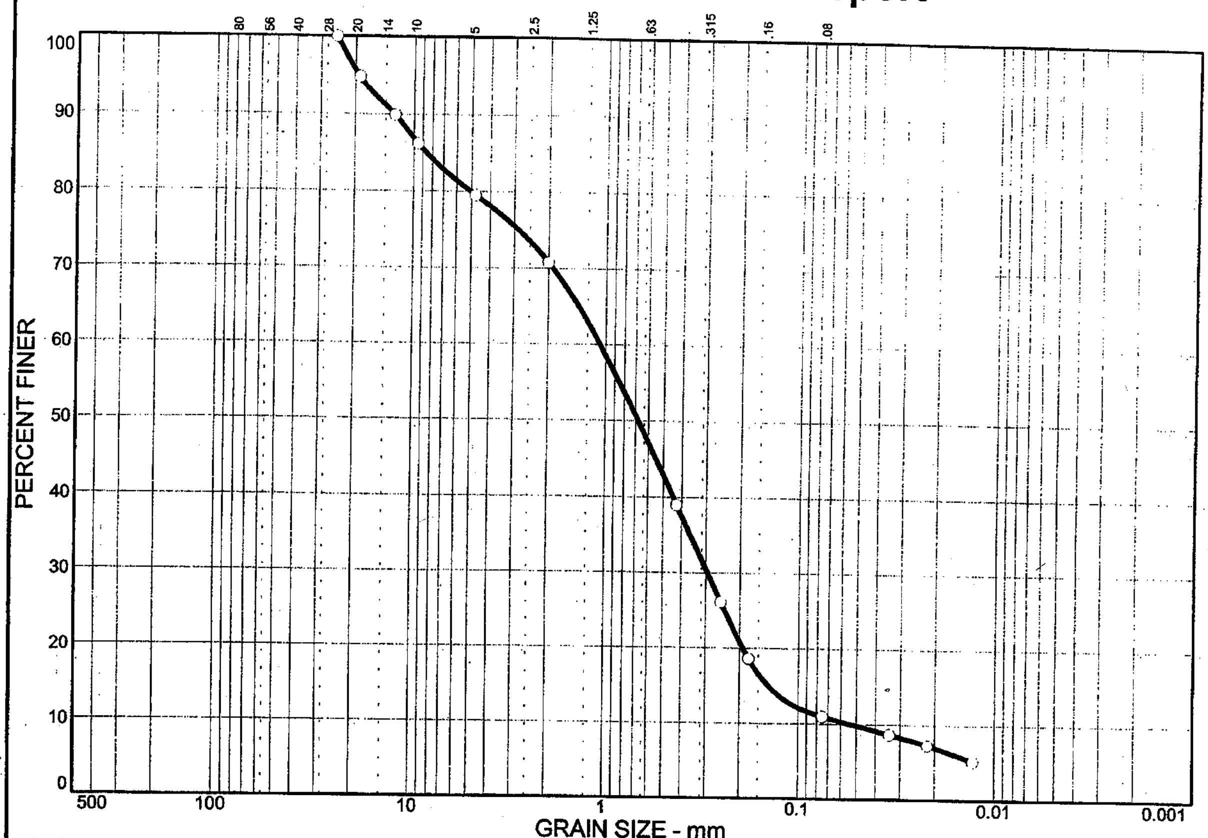
Moisture Content = 18.0 %
% Finer Than the 0.02 mm size = 17.6 %
Frost Design Soil Classification = F3(b)

Sample No.: 2856 **Source of Sample:** Client Samples **Date:**
Location: SB-18 Sample 1 **Elev./Depth:** 0 - 2 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	20.5	68.5	11.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
25 mm.	100.0		
19 mm.	94.8		
12.5 mm.	89.9		
9.5 mm.	86.2		
4.75 mm.	79.5		
2.0 mm.	70.8		
.425 mm.	39.0		
.250 mm.	26.1		
.180 mm.	18.6		
.075 mm.	11.0		

* (no specification provided)

Soil Description

Well-graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.62 D_{60}= 1.07 D_{50}= 0.676
D_{30}= 0.293 D_{15}= 0.142 D_{10}= 0.0538
C_u= 19.89 C_c= 1.49

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

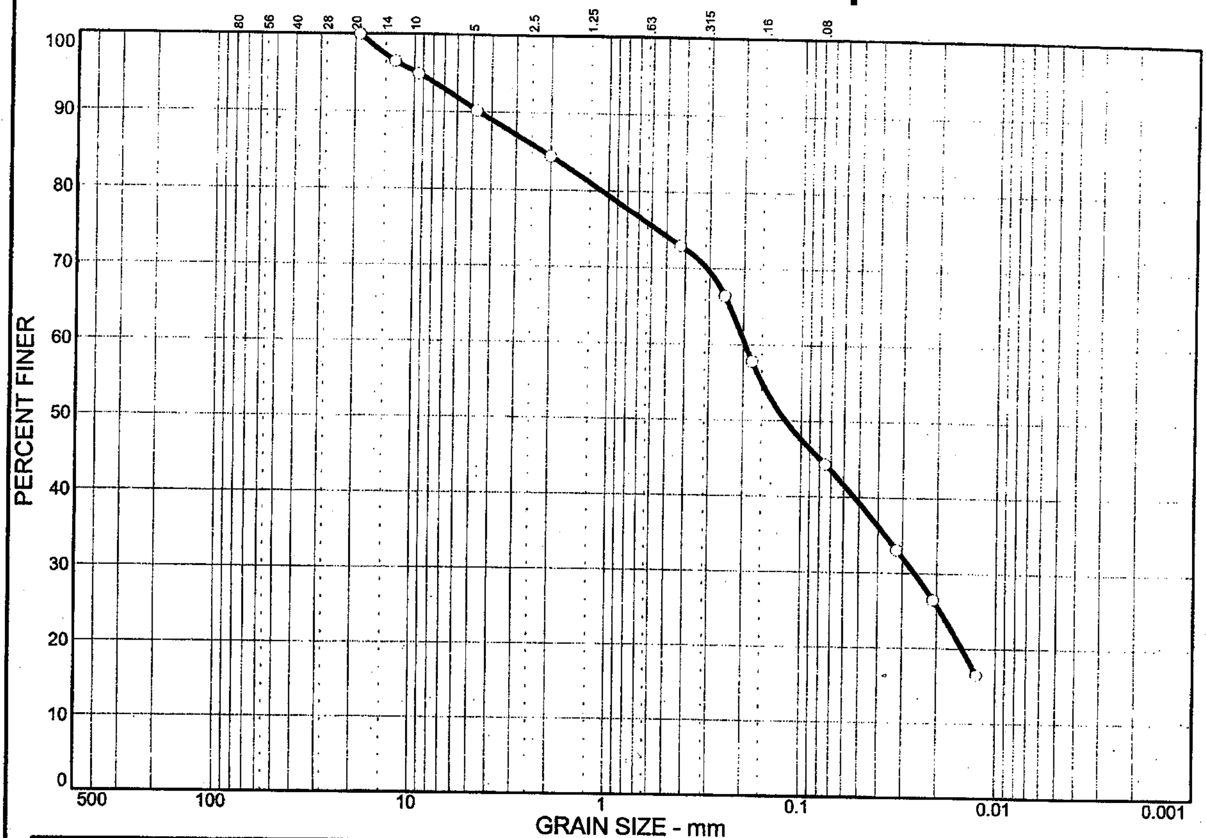
Moisture Content = 7.2 %
% Finer Than the 0.02 mm size = 7.0 %
Frost Design Soil Classification = F2(b)

Sample No.: 2857 **Source of Sample:** Client Samples **Date:**
Location: SB-19 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	9.8	45.9	44.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19 mm.	100.0		
12.5 mm.	96.5		
9.5 mm.	94.9		
4.75 mm.	90.2		
2.0 mm.	84.4		
.425 mm.	72.9		
.250 mm.	66.4		
.180 mm.	57.8		
.075 mm.	44.3		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 2.18 D_{60}= 0.196 D_{50}= 0.120
D_{30}= 0.0260 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

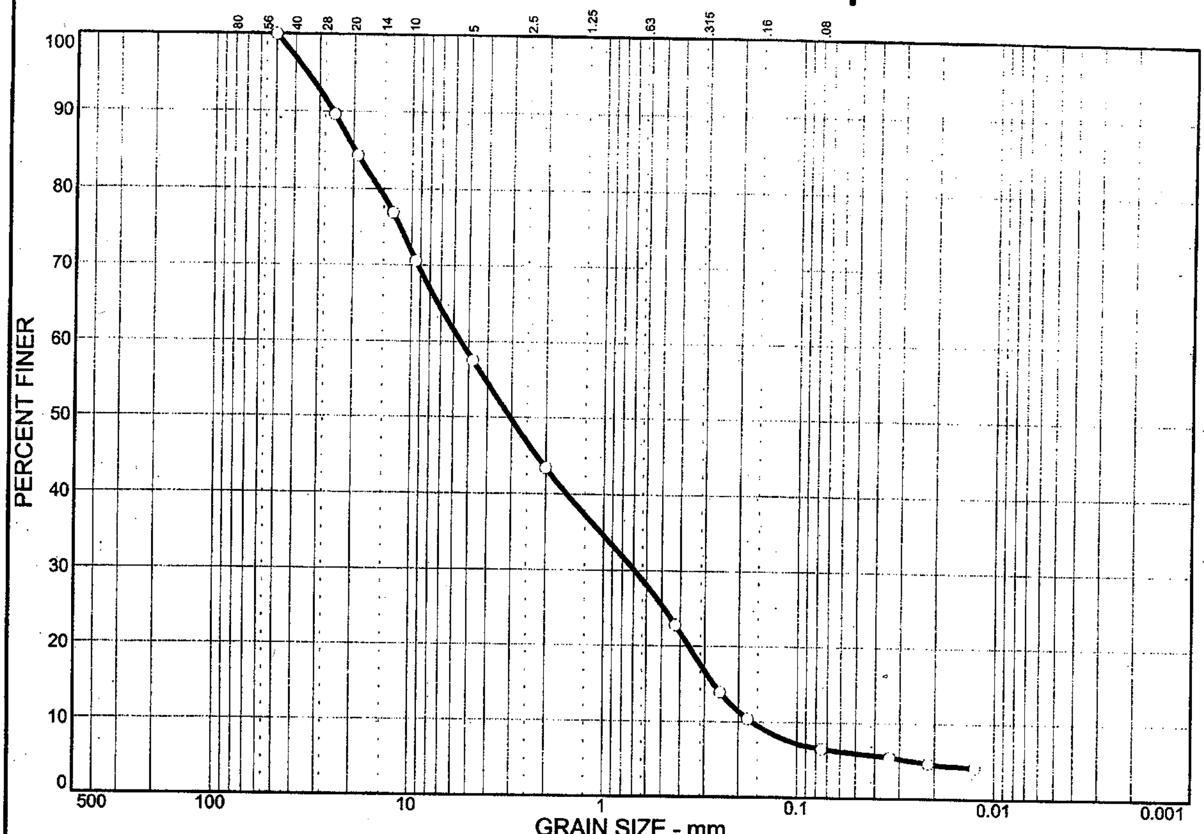
Moisture Content = 18.0 %
% Finer Than the 0.02 mm size = 25.8 %
Frost Design Soil Classification = F3(b)

Sample No.: 2858 **Source of Sample:** Client Samples **Date:**
Location: SB-20 Sample 1 **Elev./Depth:** 0 - 2 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	42.5	51.0	6.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	89.6		
19 mm.	84.3		
12.5 mm.	76.9		
9.5 mm.	70.6		
4.75 mm.	57.5		
2.0 mm.	43.4		
.425 mm.	22.8		
.250 mm.	13.9		
.180 mm.	10.4		
.075 mm.	6.5		

* (no specification provided)

Soil Description

Poorly graded sand with silt and gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 19.7 D_{60}= 5.50 D_{50}= 3.05
D_{30}= 0.692 D_{15}= 0.270 D_{10}= 0.171
C_u= 32.12 C_c= 0.51

Classification

USCS= SP-SM AASHTO= A-1-a

Remarks

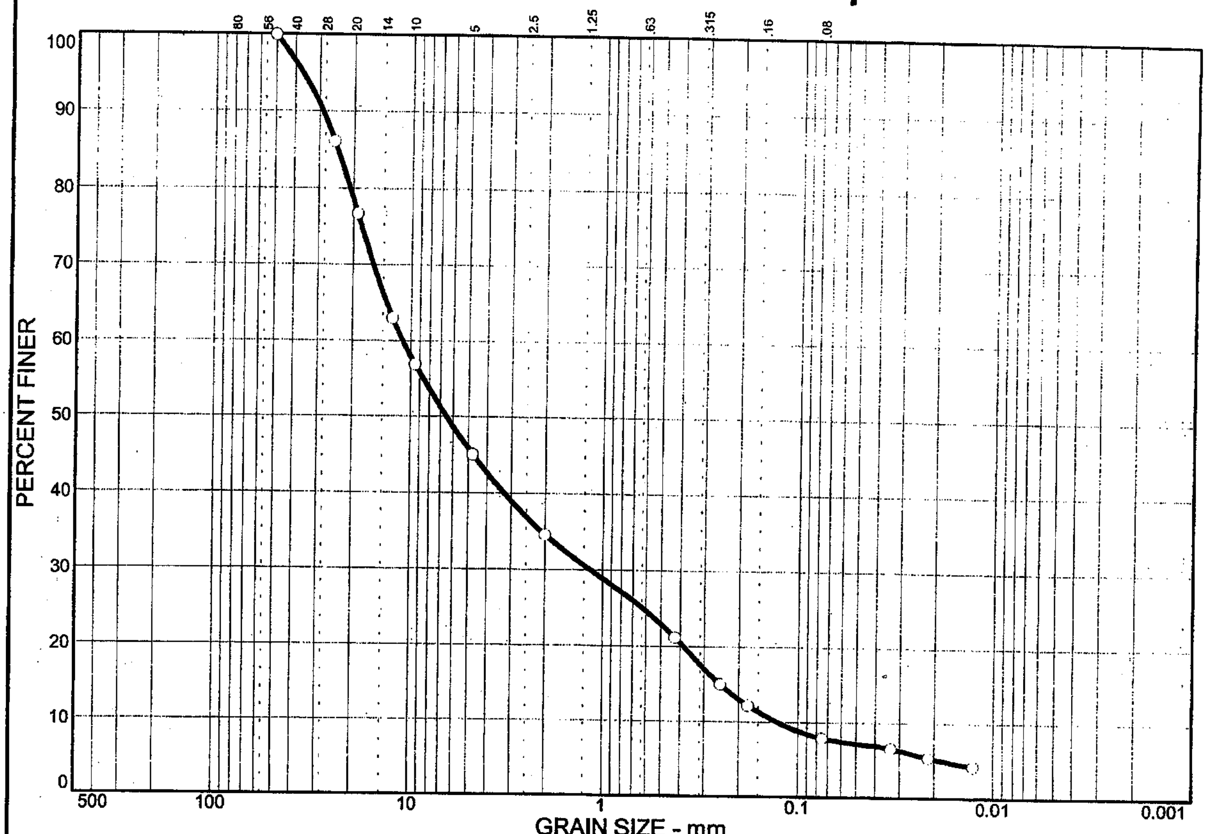
Moisture Content = 3.8 %
% Finer Than the 0.02 mm size = 4.6 %
Frost Design Soil Classification = S2

Sample No.: 2859 **Source of Sample:** Client Samples **Date:**
Location: SB-20 Sample 3 **Elev./Depth:** 9.5 - 11.0 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	54.9	37.2	7.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	86.1		
19 mm.	76.7		
12.5 mm.	63.0		
9.5 mm.	56.9		
4.75 mm.	45.1		
2.0 mm.	34.6		
.425 mm.	21.2		
.250 mm.	15.0		
.180 mm.	12.2		
.075 mm.	7.9		

* (no specification provided)

Soil Description

Poorly graded gravel with silt and sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 24.1 D_{60}= 11.0 D_{50}= 6.49
D_{30}= 1.16 D_{15}= 0.250 D_{10}= 0.127
C_u= 86.71 C_c= 0.95

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

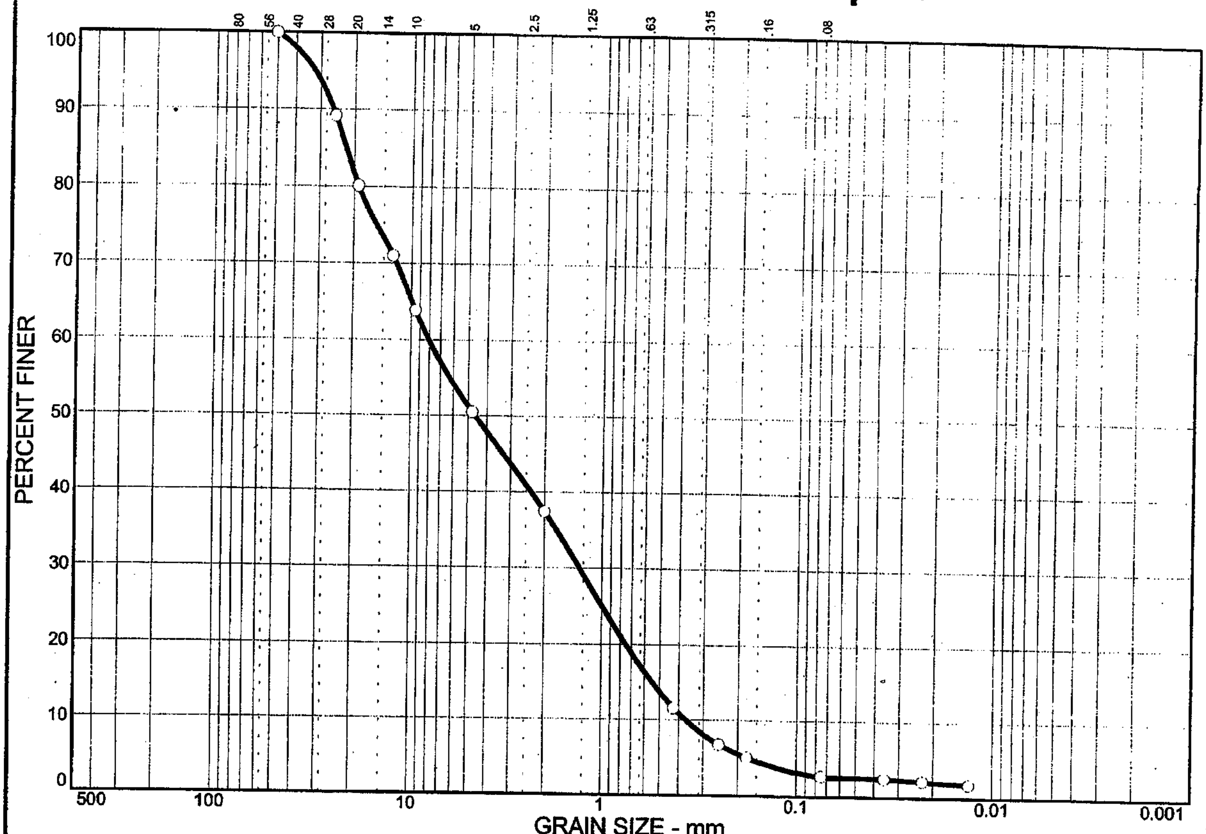
Moisture Content = 3.2 %
% Finer Than the 0.02 mm size = 5.2 %
Frost Design Soil Classification = S1

Sample No.: 2861 **Source of Sample:** Client Samples **Date:**
Location: SB-21 Sample 3 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	49.5	47.8	2.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	89.2		
19 mm.	80.1		
12.5 mm.	71.0		
9.5 mm.	63.9		
4.75 mm.	50.5		
2.0 mm.	37.4		
.425 mm.	11.6		
.250 mm.	6.8		
.180 mm.	5.1		
.075 mm.	2.7		

* (no specification provided)

Soil Description

Poorly graded gravel with sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 22.0 D_{60}= 8.06 D_{50}= 4.60
D_{30}= 1.31 D_{15}= 0.547 D_{10}= 0.368
C_u= 21.89 C_c= 0.58

Classification

USCS= GP AASHTO= A-1-a

Remarks

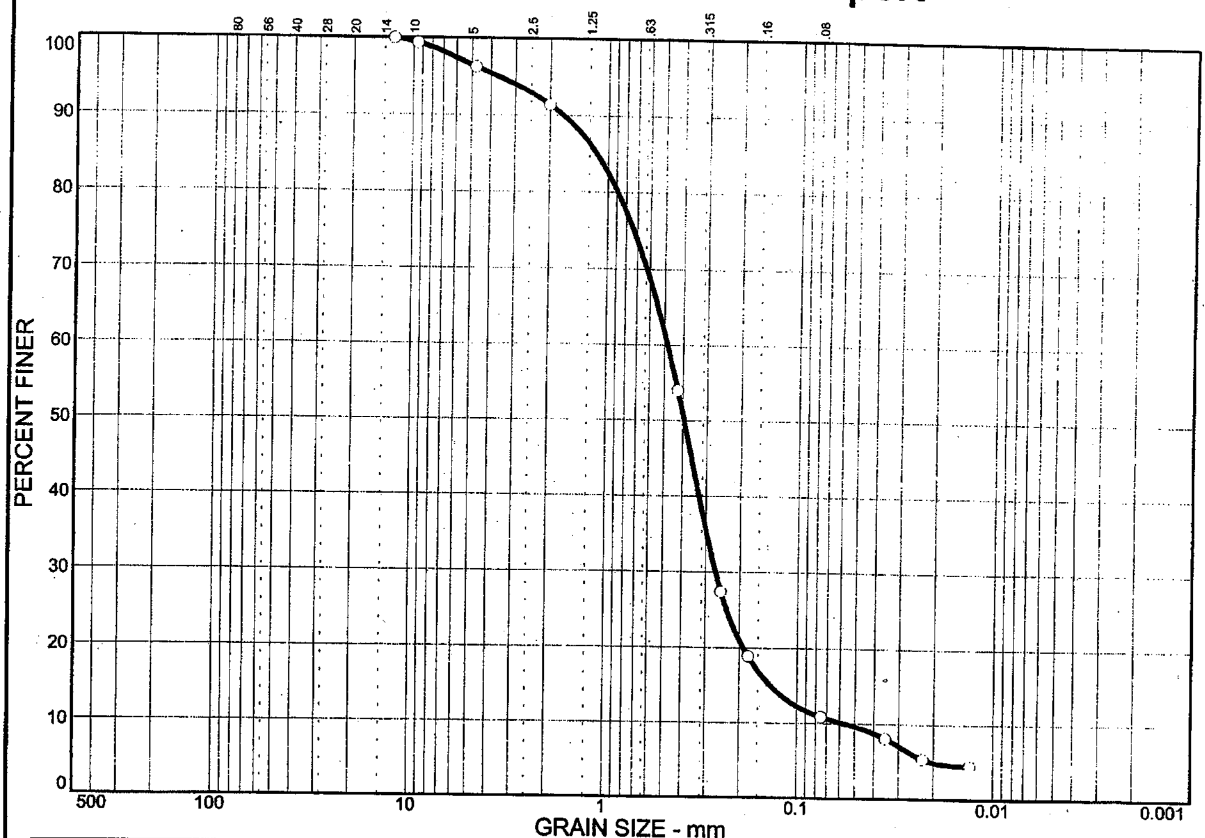
Moisture Content = 3.2 %
% Finer Than the 0.02 mm size = 2.1 %
Frost Design Soil Classification = PFS(a)

Sample No.: 2860 **Source of Sample:** Client Samples **Date:**
Location: SB-21 Sample 4 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.7	85.4	10.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
12.5 mm.	100.0		
9.5 mm.	99.4		
4.75 mm.	96.3		
2.0 mm.	91.4		
.425 mm.	54.0		
.250 mm.	27.4		
.180 mm.	18.9		
.075 mm.	10.9		

* (no specification provided)

Soil Description

Well-graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.14 D_{60}= 0.482 D_{50}= 0.393
D_{30}= 0.267 D_{15}= 0.137 D_{10}= 0.0567
C_u= 8.51 C_c= 2.60

Classification

USCS= SW-SM AASHTO= A-2-4(0)

Remarks

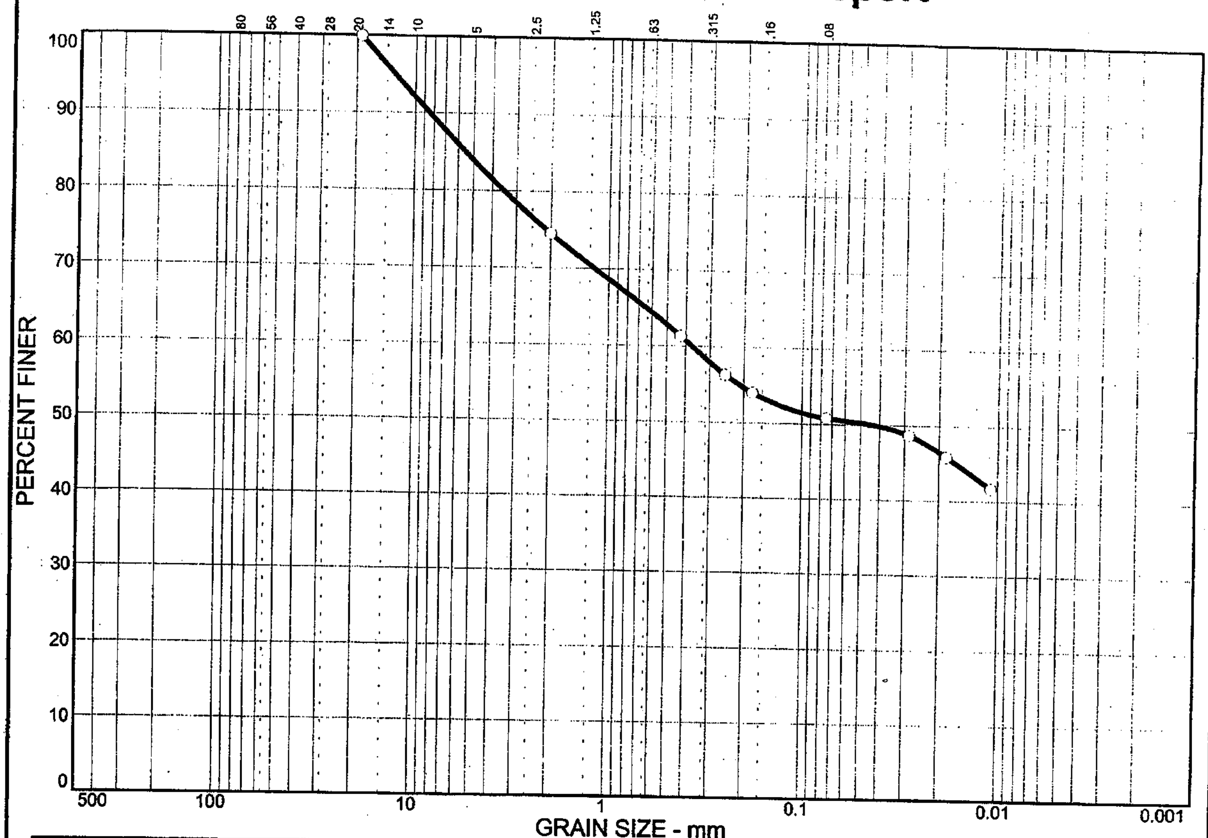
Moisture Content = 15.0 %
% Finer Than the 0.02 mm size = 5.0 %
Frost Design Soil Classification = S2

Sample No.: 2862 **Source of Sample:** Client Samples **Date:**
Location: SB-22 Sample 2 **Elev./Depth:**

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	16.6	32.6	50.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
19 mm.	100.0		
2.0 mm.	74.5		
.425 mm.	61.3		
.250 mm.	56.3		
.180 mm.	54.0		
.075 mm.	50.8		

* (no specification provided)

Soil Description

Sandy silt with gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 5.49 D_{60}= 0.372 D_{50}= 0.0435
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

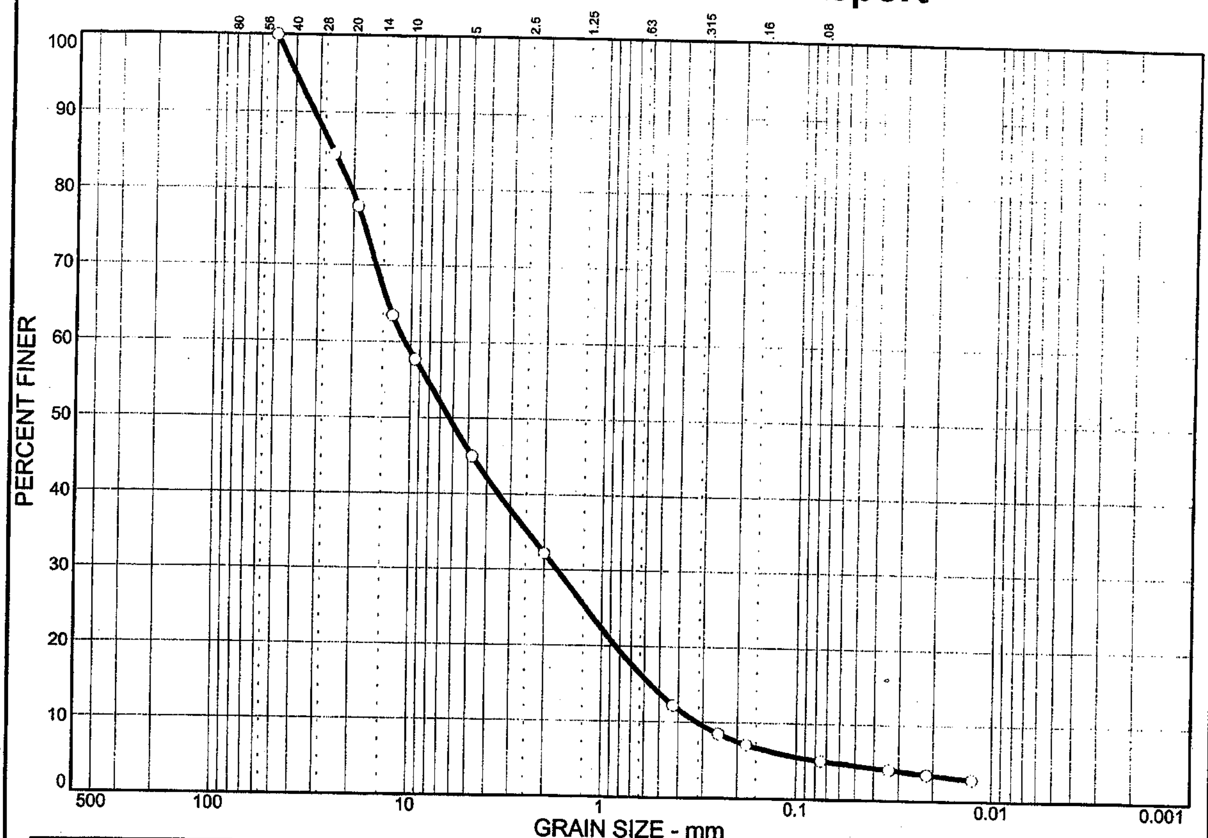
Moisture Content = 17.6 %
% Finer Than the 0.02 mm size = 46.5 %
Frost Design Soil Classification = F4(a)

Sample No.: 2876 **Source of Sample:** Client Samples **Date:**
Location: SB-22 Sample 2b **Elev./Depth:** 5.5 - 6.0 ft

Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	55.0	39.9	5.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
50 mm.	100.0		
25 mm.	84.6		
19 mm.	77.7		
12.5 mm.	63.4		
9.5 mm.	57.7		
4.75 mm.	45.0		
2.0 mm.	32.2		
.425 mm.	12.2		
.250 mm.	8.5		
.180 mm.	7.1		
.075 mm.	5.1		

* (no specification provided)

Soil Description

Poorly graded gravel with silt & sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 25.5 D_{60}= 10.8 D_{50}= 6.27
D_{30}= 1.71 D_{15}= 0.561 D_{10}= 0.322
C_u= 33.52 C_c= 0.85

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

Moisture Content = 4.9 %
% Finer Than the 0.02 mm size = 3.4 %
Frost Design Soil Classification = S1

Sample No.: 2863 **Source of Sample:** Client Samples **Date:**
Location: SB-22 Sample 3 **Elev./Depth:** 9.5 - 11.0 ft

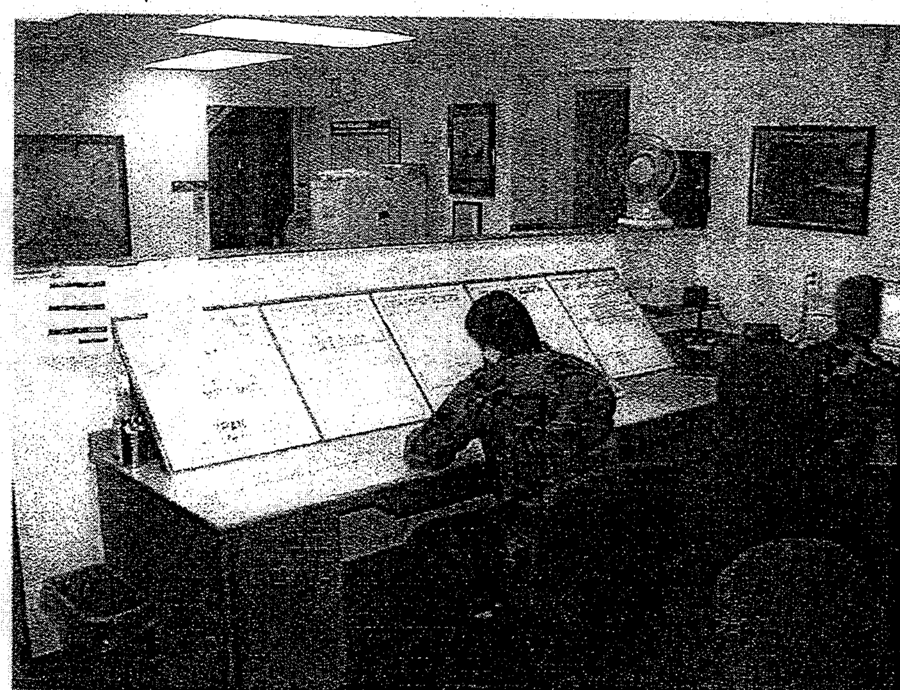
Mappa TestLab

Client: U.S. Army Corps of Engineers
Project: New Fuel Systems Maintenance Dock Site # 3
Elmendorf AFB, Ak.
Project No: 2002-170 **Plate**

--END OF APPENDIX--

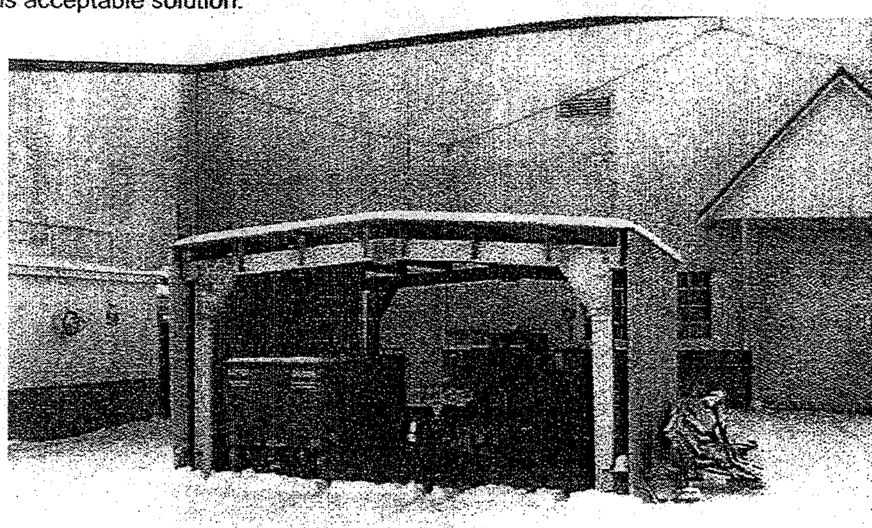
DISPATCH STATUS BOARD

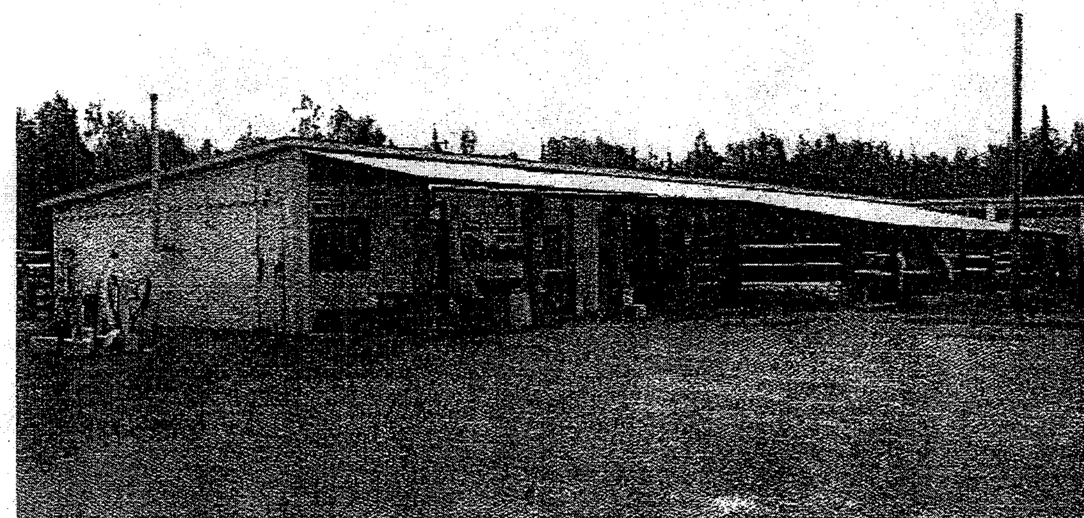
Existing Dispatch Status Board; users would like a similar set-up in the Dispatch Office



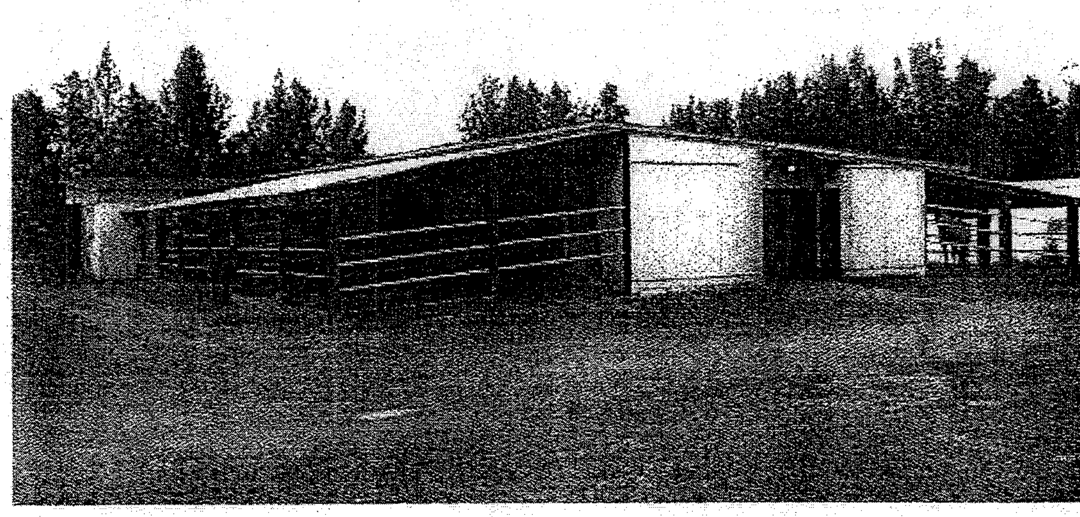
OUTDOOR EQUIPMENT SHELTER

Shelter for Outdoor Equipment such as: snowplow, servicing carts, bobcat; roof overhang at building is acceptable solution.

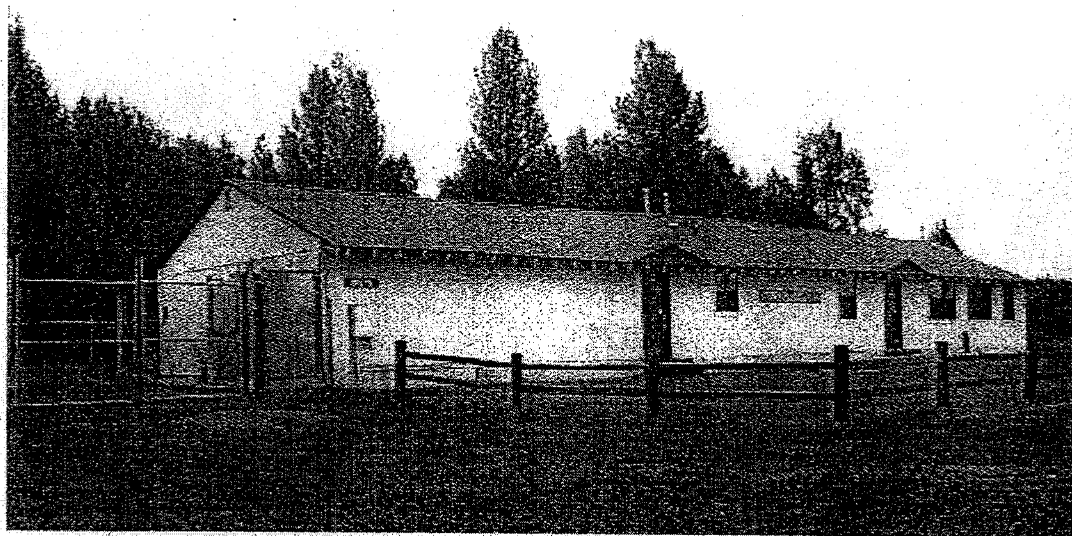




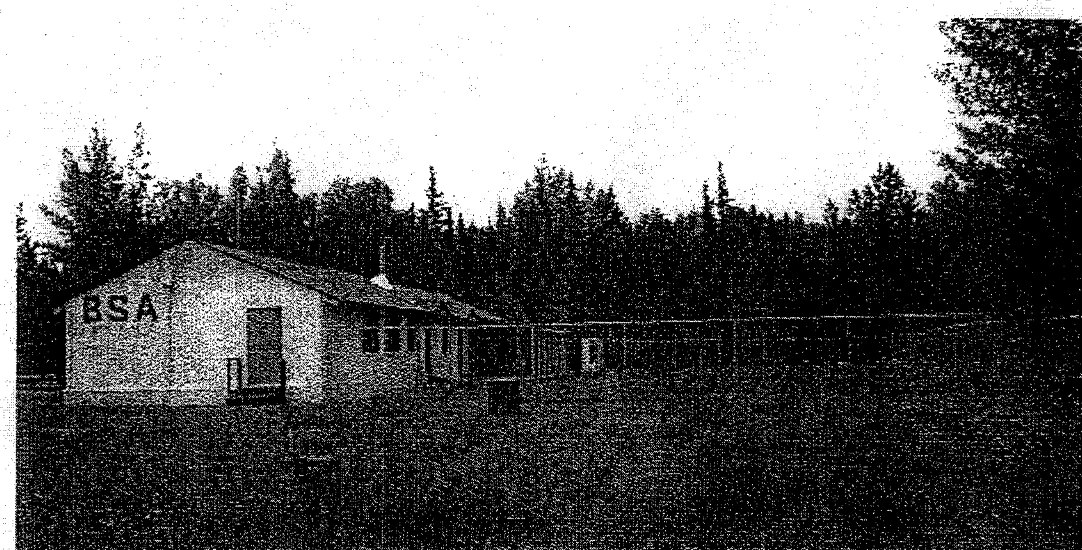
BUILDING # 8659 – VIEW FROM SOUTH WEST



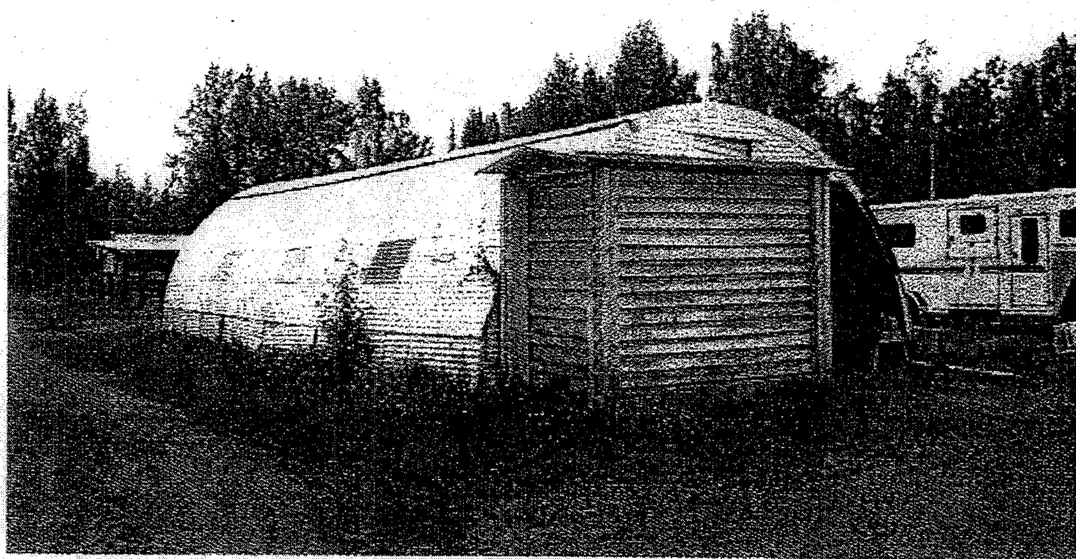
BUILDING # 8659 – VIEW FROM SOUTH EAST



BUILDING # 8675 (BSA) – VIEW FROM WEST

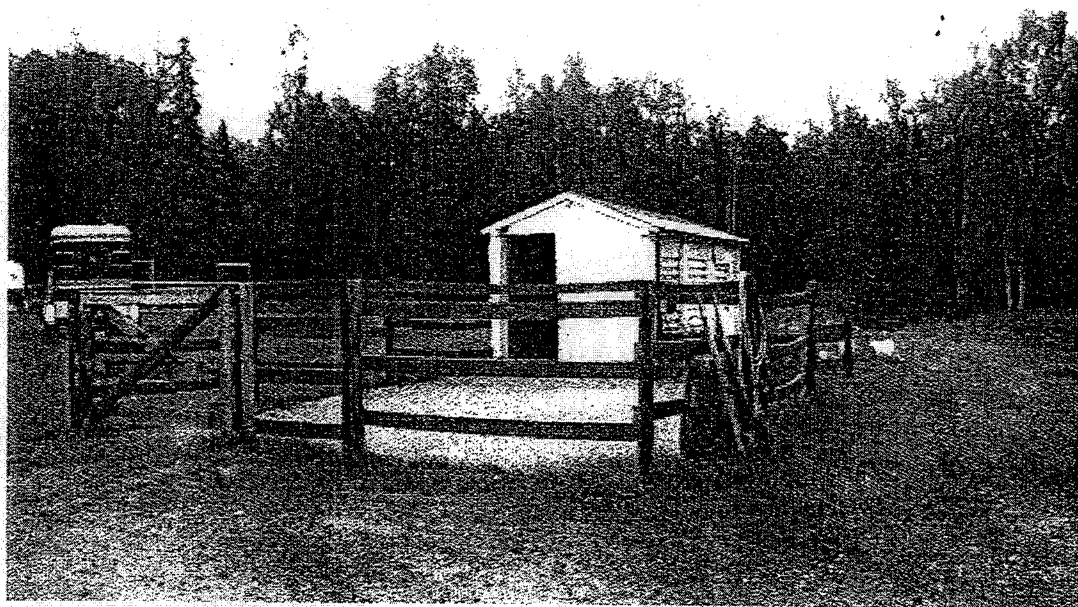


BUILDING # 8675 (BSA) – VIEW FROM SOUTH

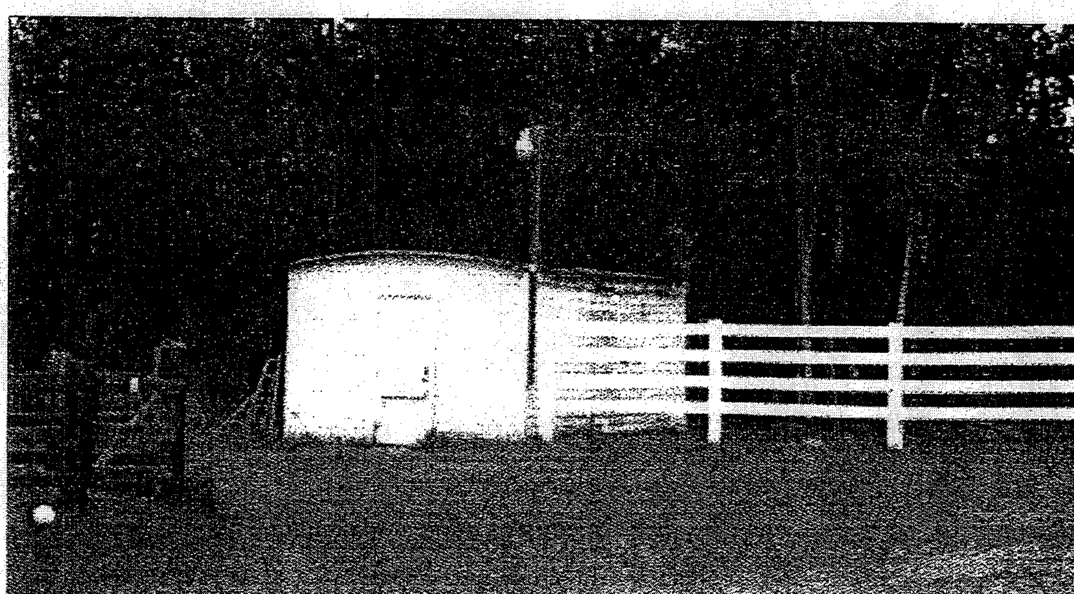


BUILDING # 8665 – VIEW FROM EAST

BUILDING (NO NUMBER) – VIEW FROM SOUTH WEST



BARN 2 – VIEW FROM WEST



BARN 3 – VIEW FROM SOUTH

--END OF APPENDIX--

SECTION III

AIRCRAFT FUEL SYSTEMS MAINTENANCE FACILITIES AND AREAS

3-1 GENERAL.

The use of segregated facilities and areas for fuel systems repair is essential for safe and efficient fuel systems maintenance operations. These facilities provide a safer place to perform fuel system repair and provide the needed climatic conditions to ensure quality fuel systems maintenance. The areas and facilities described in this section provide necessary protection for both the aircraft and personnel from a variety of hazards.

WARNING

- This section is not intended to be used as design criteria for facility construction. The requirements of this section are extracted from referenced documents or provided by safety and civil engineering functions. Use of this section as a design document could cause serious injury or mission impairment.
- Use of a facility which does not meet the requirements of the applicable design criteria could create a fire hazard risk. Permanent waivers to fire protection requirements shall be approved in accordance with ETL 96-1. Temporary waivers to fire protection requirements until corrections can be made may be approved by the MAJCOM fire protection engineer (or MAJCOM fire protection manager in the absence of a MAJCOM fire protection engineer (refer to paragraph 3-1.2.1)).

3-1.1 Permitted Operations. Fuel system maintenance facilities are intended to support the complete range of operations related to fuel system maintenance including those normally restricted from being conducted inside hangars or other structures. These normally restricted operations, which are permitted in fuel system maintenance facilities, include but are not limited to: Partial and complete defuel/refuel of aircraft; depuddling and purging of fuel tanks; cells and components; fuel transfers within the aircraft; and pressurization testing.

3-1.2 Approval. Facilities and areas shall be designated and approved for fuel system maintenance use based on the requirements of this technical order.

3-1.2.1 Facilities not meeting the requirements of this technical order may be approved based on an approved Wing/base corrective action plan coordinated through Wing/base Safety, LG/CC, and Civil Engineering (Fire Protection) by restricting some of the normally permitted operations listed above and implementing other actions until corrections can be made. The approved base corrected action plan shall include the Risk Assessment Code (RAC)/project code, proposed completion date, and proposed operating procedures. In the absence of MAJCOM policy directing otherwise, the corrected action plan shall be forwarded to the following agencies in the MAJCOM: Fire Protection, Ground Safety, and LG.

3-1.2.2 Facilities may be temporarily approved for emergency or minor repairs in non-approved areas (except repairs that are performed in accordance with paragraph 2-7.10) by the LG/CC upon evaluation and concurrence by the Fuel Element Chief, Wing Safety, Fire Protection and Bio-Environmental. The use of temporary facilities should only be considered after priority of the mission and the availability of other facilities (primary fuel systems docks/repair facilities shall be utilized first). The use of a temporary facility shall be approved on a case-by-case basis. [redacted]

3-1.3 Exceptions. Fuel systems maintenance may be performed in any hangar on aircraft which have never been fueled or on aircraft which have been completely fluid purged and drained in accordance with this technical order

3-1.4 New Facilities Requirements. MIL-HDBK 1190, MIL-HDBK 1008 (current edition) and Engineering Technical Letter 96-1 Fire Protection Engineering Criteria - New Aircraft Hangars provide guidance for the construction of new fuel system maintenance facilities.

3-1.5 Existing/Modified Facilities Requirements. The requirements of this technical order shall be used to evaluate existing/modified fuel system maintenance facilities. For facilities not meeting these requirements refer to paragraph 3-1.2.1.

3-1.5.1 When facilities must be converted to permit fuel system maintenance activities or major improvements to an existing facilities, improvements will be based on the requirements of paragraph 3-1.4.

3-1.6 Temporary Facilities. The requirements of this technical order shall be used to evaluate existing facilities for limited use as a fuel system maintenance facility.

3-1.7 Open (Outside) Fuel Systems Repair Areas. The requirements of this technical order shall be used to evaluate outside areas for fuel system maintenance.

3-2 FUEL SYSTEM REPAIR FACILFTIES REQUIREMENTS.

3-2.1 New Facilities. All new fuel system maintenance facilities shall provide:

3-2.1.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3-2.1.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

3-2.1.3 Emergency eye wash fountains and personnel showers shall be provided.

3-2.1.4 Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided. Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3-2.1.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3-2.1.6 Aircraft maintenance area, tank exhaust, and trench ventilation/ exhaust systems are required to meet current bio-environmental instructions for personnel safety.

3-2.1.7 Climatic Control Units (CCU) are required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3-2.1.8 Sufficient grounding points provided throughout the facility.

3-2.1.9 Electrical systems shall have the following:

3-2.1.9.1 Class I, Division 1, below the floor level, Class I, Division 1, through out foam/cell rooms, Class I, Division 2, through-out the hangar aircraft maintenance area up to 18 inches and Class I, Division 2, within 5 feet of the aircraft, and all wall mounted outlets and switches Class I, Division 2.

3-2.1.10 Office space, break room, support equipment/tool room, and restrooms with climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for tele-communications, utility/mechanical, and fire protection systems.

3-2.1.11 Shop space including foam/cell rooms to service/repair fuels system components as required for the specific aircraft(s) maintenance.

3-2.2 Existing Definitive Facilities. Existing structures designed specifically for fuel systems maintenance (commonly referred to as definitive docks) shall have the following:

3-2.2.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3-2.2.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

3-2.2.3 Emergency eye wash fountains and personnel showers shall be provided.

3-2.2.4 Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided.

Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3-2.2.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in an sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3-2.2.6 Aircraft maintenance area, tank exhaust and trench exhaust/ventilation systems required to meet current bio-environmental instructions for personnel safety.

3-2.2.7 Climatic Control Units (CCU) required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3-2.2.8 Sufficient grounding points provided throughout the facility.

3-2.2.9 Electrical systems shall meet one of the following criteria depending upon when facility was constructed:

3-2.2.9.1 Class I, Division 1, below the floor level, Class I, Division 1, through out foam/cell rooms, Class I, Division 2, through out the hangar aircraft maintenance area up to the height of the hangar door and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitably cut off from the hangar aircraft maintenance area.

3-2.2.9.2 Class I, Division 1, through out foam/cell rooms, Class I, Division 1, below the floor level and through out the hangar aircraft maintenance area to 4 foot above the floor and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitable cut off from the hangar aircraft maintenance area.

3-2.2.10 Office space, break room, support equipment/tool room, and restrooms with climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area. Rooms shall also be provided for tele-communications, utility/mechanical, and fire protection systems.

3-2.2.11 Shop space including foam/cell rooms to service/repair fuels system components as required for the specific aircraft(s) maintenance.

3-2.3 Existing Modified Facilities. Existing facilities modified for limited fuel systems maintenance (commonly referred to as modified docks) shall have the following:

3-2.3.1 As a minimum, if not a separate structure, the fuel system maintenance facility must be separated from all other areas of the building by not less than a one-hour masonry fire resistive construction.

3-2.3.2 An operational fire suppression system suitable for aircraft hangar operations and wet pipe sprinklers in all adjacent areas. For fighter type aircraft provide at least a complete automatic overhead water deluge, foam-water deluge, closed-head pre-action foam-water, wet pipe foam-water, or high expansion foam system. For large frame aircraft provide one of the previous systems and an under aircraft fixed or automatic oscillating foam-water nozzle system.

3-2.3.3 Emergency eye wash fountains and personnel showers shall be provided.

3-2.3.4 Flightline type 150 lb. HALON 1211 wheeled fire extinguishers shall be provided. Existing installed HALON 1211 systems with wall mounted hose reels are acceptable alternatives to the wheeled fire extinguishers.

3-2.3.5 Forced air heating supplied by steam or hot water heating will be provided throughout the facility. Radiant tube heating systems may be used in the aircraft maintenance area, if the flame is contained in a sealed chamber with combustion air taken from outside the aircraft maintenance area and combustion products exhausted outside the aircraft maintenance area.

3-2.3.6 Aircraft maintenance area and tank exhaust systems required to meet current bio-environmental instructions for personnel safety and health.

3-2.3.7 Climatic Control Units (CCU) or approved portable support equipment required to provide environmentally stable air for air purging, sealant curing and general maintenance.

3-2.3.8 Sufficient grounding points provided throughout the facility.

3-2.3.9 Electrical systems shall meet one of the following criteria depending upon when facility was constructed:

3-2.3.9.1 Class I, Division 1, below the floor level, Class I, Division 1, throughout foam/cell rooms, Class I, Division 2, through out the hangar aircraft maintenance area up to the height of the hangar door and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitable cut off from the hangar aircraft maintenance area.

3-2.3.9.2 Class I, Division 1, throughout foam/cell rooms, Class I, Division 1, below the floor level and through out the hangar aircraft maintenance area to 4 foot above the floor and Class I, Division 2, up to 18 inches above the floor in all adjacent areas not suitably cut off from the hangar aircraft maintenance area.

3-2.3.10 If used office space, break room, support equipment/tool room, and restrooms will have climate control and ventilation to prevent fumes and vapors from migrating from the aircraft maintenance area.

3-2.4 Temporary Repair Facilities Requirements.

3-2.4.1 All aircraft fuel tanks (to be worked) shall be defueled and initially drained prior to entry into facility. Additional draining shall be accomplished using approved drain containers/ methods. Temporary facility doors shall remain open during tank purging and depuddling operations until a entry safe condition is reached and maintained.

3-2.4.2 Only equipment approved for fuel systems maintenance will be used in temporary facilities.

3-2.4.3 Exhaust ducts shall be positioned outside the facility doors, and positioned to prevent fuel fumes from traveling back into the facility. These ducts will be marked off an additional 50 foot radius from the end of the duct.

3-2.4.4 All safety requirements outlined in section II of this Technical Order shall be met prior to using a temporary facility.

3-2.4.5 Any adjoining offices shall be isolated/ evacuated during fuel systems maintenance to prevent unauthorized entry and endangerment of personnel not associated with the on-going fuel systems maintenance. Controlled entry into the area is paramount.

3-2.4.6 Fuel transfer, defuel or refuel operations shall not be accomplished in a temporary facility.

3-3 OPEN (OUTSIDE) FUEL SYSTEM REPAIR AREA REQUIREMENTS.

3-3.1 An open fuel system repair area is any area that has been approved by the LG/CC with coordination from the Fuel Systems Element Chief, Wing Safety, Bio-environmental, Fire Protection and the Airfield Manager to perform aircraft fuel systems repairs in an open/outside area.

3-3.1.1 The area shall be marked off in accordance with Section II of this manual. An additional 50-feet may be required if exhaust purge is used (refer to paragraph 2-7.7.4).

3-3.1.2 The fuel systems work accomplished in an outside area is highly dependent upon weather conditions and available authorized portable equipment. All portable electrical equipment and connections used in hazardous areas shall meet the requirements of the NEC for Class I, hazardous locations.

3-3.1.3 All outside areas shall be equipped with at least two 150 pound HALON 1211 fire extinguishers. Additional extinguishers shall be provided as required by the base fire Marshall.

3-3.1.4 Adjacent aircraft shall not be allowed to operate under their own power within 100 feet of the repair area (refer to paragraph 2-7.9). They shall also be limited from operations where jet blasts or noise factors could affect safety as outlined in Section II of this T.O. and the applicable aircraft systems technical orders.

3-3.1.5 Portable eye wash must be available at the job site.

3-4 OPERATIONS.

3-4.1 Fuel systems repair facilities and areas shall: be kept clean, maintained in good repair, and be off limits to non-essential personnel. The areas and facilities shall be inspected at the start of each shift and more often as deemed necessary to ensure safe working conditions are maintained. Due to the non-standard equipment installed in some facilities, the Fuel Element Chief shall ensure operating, inspection, and maintenance instructions are available and followed for equipment installed in facilities.

3-4.2 The storage of materials or non-fuel system equipment in the maintenance area increases the risk of fire and unnecessarily complicates fire fighting operations. Materials should be stored in equipment or tool rooms. Equipment not used for fuel system maintenance will not routinely be stored in the maintenance area. Should local conditions necessitate the use of the maintenance area for equipment storage.

3-4.2.1 Fire Department, Ground Safety, and the Fuel Element Chief will concur to the storage.

3-4.2.2 All batteries will be disconnected and terminals tagged. No batteries shall be connected or disconnected during periods of open-tank maintenance. Keys will be secured in the Element Chief's office.

3-4.2.3 Sufficient space will remain around the aircraft to permit egress and eliminate hazards.

3-4.2.4 Equipment will not be parked under the shadow of the aircraft or within a 10-foot radius of fuel vents or tank openings.

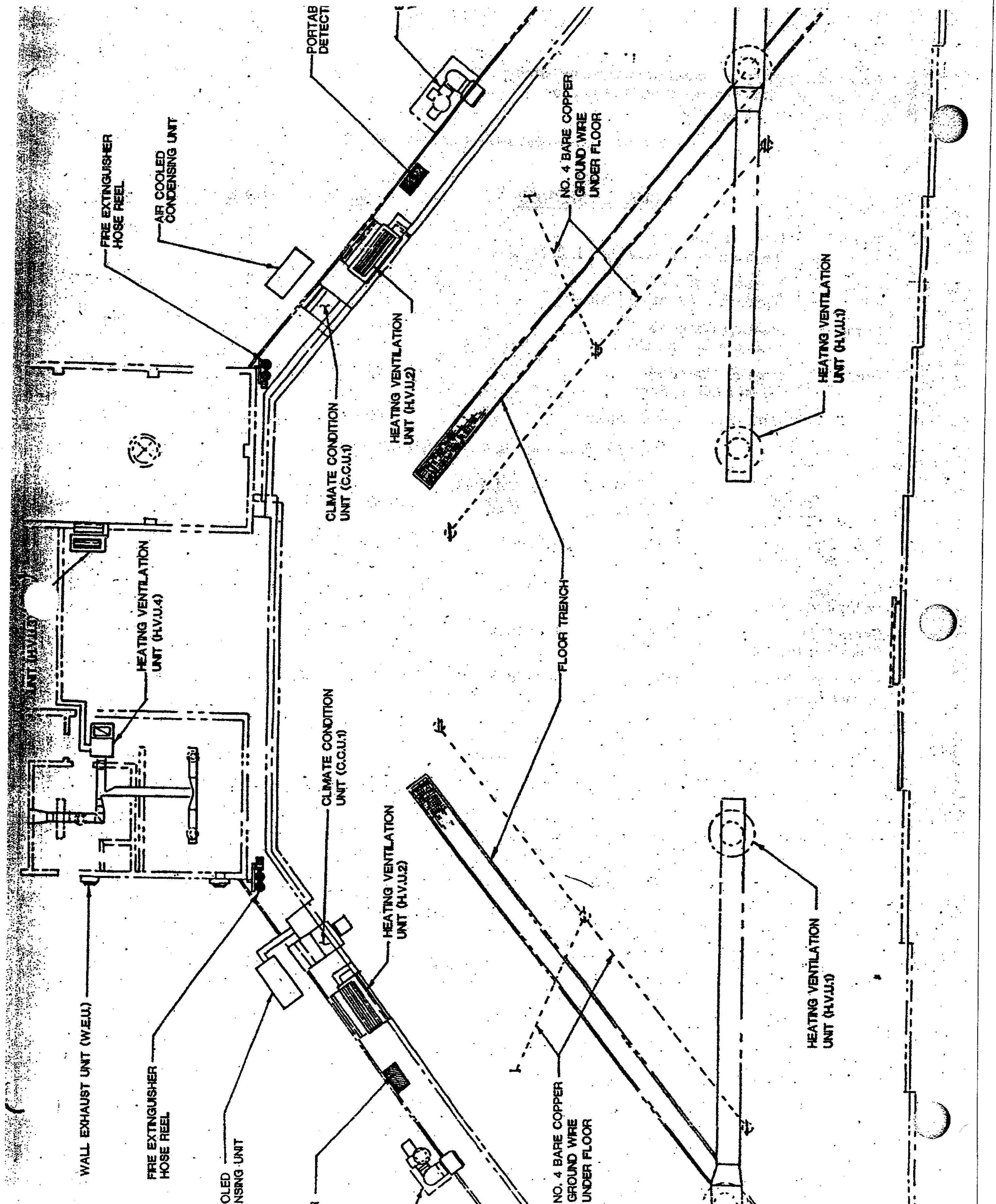
3-4.2.5 Emergency communications will be established with the maintenance control center (or equivalent) from the job site.

Table 3-1. Recommend Facility Pump Performance Criteria

MARK	AREA USUALLY SERVED	G.P.M.	HEAD	H.P.	R.P.M.
Pump 1	Heating Water #1 (Heating Ventilating Unit 1, 2, 3)	256	67 ft	7.5	1750
Pump 2	Heating Water #2 (Heating Ventilating Unit 4)	6	29 ft	0.75	1750
Pump 3	Heating Water #3 (Climate Control Unit)	118	43 ft	3.0	1750
Pump 4	Heating Water #4 (Snow Melting Pad)	40	57 ft	1.5	1750
	Converter Water Circulator	60	11 ft	0.25	1750

Table 3-2. Recommend Facility Fan Performance Criteria

TYPE	CFM AT 70°	S.P.M. IN H_2O	RPM	H.P.	ENTERING AIR °F
Axial Flow (Trench Exhaust)	20,400	1.5 inch	1320	10.0	50
Centrifugal (Wing Exhaust)	4,000	1.5 inch	1780	2.0	105
Centrifugal (Constant Purge)	2,500	0.75 inch	670	0.75	50
Wall Exhaust (Office Area)	460	0.25 inch	1550	0.067	90


PORTAB
DETECT
FIRE EXTINGUISHER
HOSE REEL
AIR COOLED
CONDENSING UNIT
NO. 4 BARE COPPER
GROUND WIRE
UNDER FLOOR
HEATING VENTILATION
UNIT (H.V.U.2)
CLIMATE CONDITION
UNIT (C.C.U.1)
HEATING VENTILATION
UNIT (H.V.U.1)
FLOOR TRENCH
HEATING VENTILATION
UNIT (H.V.U.4)
UNIT (H.V.U.3)
CLIMATE CONDITION
UNIT (C.C.U.1)
HEATING VENTILATION
UNIT (H.V.U.2)
HEATING VENTILATION
UNIT (H.V.U.1)
WALL EXHAUST UNIT (W.E.U.)
FIRE EXTINGUISHER
HOSE REEL
COOLED
DENSING UNIT
NO. 4 BARE COPPER
GROUND WIRE
UNDER FLOOR

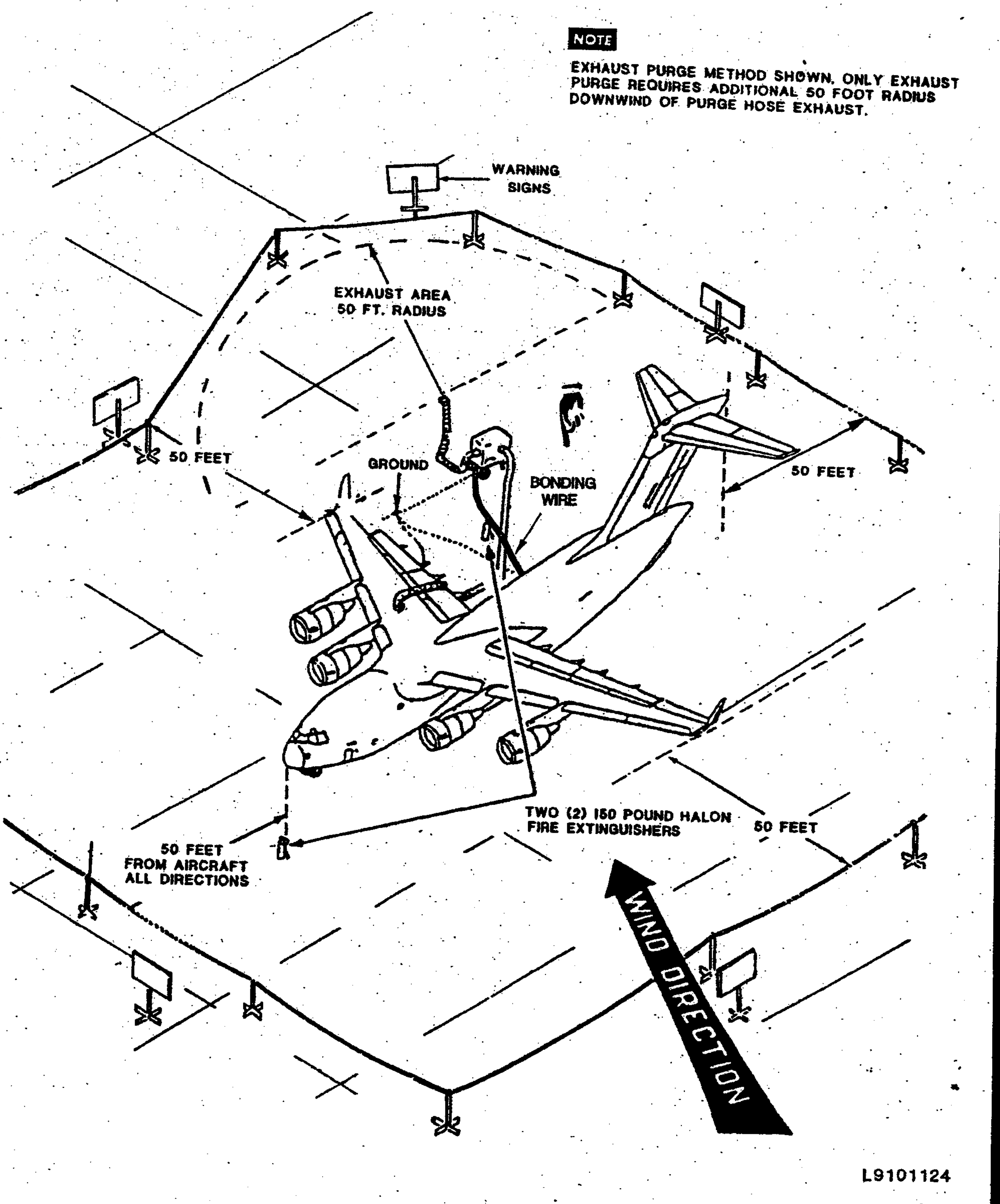


Figure 3-2. Exhaust or Blow Purge Open Area Typical

--END OF APPENDIX--

2.9.4.2. **Width:** Equivalent to the runway width specified in paragraph 2.5.

2.9.4.3. **Construction:** Flexible pavement is defined in AFM 88-6, and (future) AFJMAN 32-1014.

Section C--Taxiway Criteria

2.10. Category Code 112-211, Taxiway. Taxiways are the pavements provided for the ground movement of aircraft. Taxiways connect the parking and maintenance areas of the airfield with the runways and provide access to hangars, docks, and various parking aprons and pads. Taxiways are normally parallel to runways to facilitate aircraft ground movement on the taxiways during landings and takeoffs on the runway.

2.11. Taxiway Width. A taxiway width of 15.2 m (50 ft) and 22.9 m (75 ft) are standard for class A and B runways, respectively, with the following exceptions:

2.11.1. **Shortfield** - 15.2 m (50 ft) with a turning radii of 21.3m (70 ft).

2.11.2. **ACR** - 10.7 m (35 ft); **C-17** - 15.2 m (50 ft).

2.11.3. **Helicopter** - 15.2 m (50 ft)

2.11.4. **Taxiways supporting towed aircraft only** - Outside gear width of design aircraft plus 3.05 m (10 ft) or 15.2 m (50 ft), whichever is less.

2.12. Taxiway Pavement Strength. All taxiways are built of heavy-load, medium-load, light-load, shortfield-load or ACR pavement, as specified in Section A of this chapter. The strength of pavement in segments of a taxiway system varies according to the requirements of the critical aircraft. For example, on a base supporting heavy bomber, cargo, and fighter aircraft, the principal taxiways are heavy-load pavement; at aircraft facilities restricted to cargo or fighter aircraft by their dimensions and location, taxiways are medium-load strength.

2.13. Treatment of Shoulders. A taxiway shoulder width of 15.2 m (50 ft) is standard at all air bases with the following exceptions: shortfield, helicopter, and auxiliary airfields have 7.6 m (25 ft) shoulders; and ACR have 1.2 m (4 ft) shoulders. Airfields supporting wide-bodied aircraft may require soil stabilization beneath outer engines.

Section D--Apron Criteria

2.14. Description of Apron. Aprons are paved areas provided for aircraft parking, servicing, and loading. Apron space is required for:

2.14.1. **Operational Aircraft.**

2.14.2. **Alert Aircraft.**

2.14.3. **Transient Aircraft.**

2.14.4. **Cargo Aircraft - loading and unloading.**

2.14.5. **Base Flight Aircraft.**

2.14.6. **Aircraft Undergoing Depot Maintenance.**

2.14.7. **Aircraft Access to Hangars, Docks, and Shelters.**

2.15. Apron Pavement Strength. All aprons are built of heavy, modified-heavy, medium, light load, and auxiliary-load pavement as described in paragraphs 2.2 and 2.3. Note exception in paragraph 2.17.7, relative to hangar access, aprons, and floors.

2.16. Treatment of Shoulders. Apron shoulders are constructed of existing soils, thoroughly compacted and covered with turf or a soil binder. Paved Shoulders, category code 116-642, are authorized as indicated under Section G of this chapter.

2.17. Category Code 113-321, Apron.

2.17.1. **Size and Configuration of Aprons.** There are no standard apron sizes. Aprons are individually designed to support specific aircraft and missions at specific installations. The detailed dimensions are determined by the size, type, and number of aircraft requiring parking and maneuvering space; the type of activity the apron serves; the physical characteristics of the project site; and the objectives of the installation master plan. The dimensions in Table 2.4 through Table 2.7 on aircraft size, taxi lane widths, and wingtip separations are the basis for design.

2.17.1.1. Table 2.4 provides variable wingtip separations for C-5 and C-17 aircraft. Use the maximum wingtip separations for these aircraft when planning and programming new Air Mobility Command (AMC) aprons. EXCEPTION: When you are planning to rehabilitate an existing apron, provide the maximum wingtip separation the existing apron size will allow. Do not exceed the maximum clearance provided within Table 2.4.

2.17.1.2. At non-AMC bases, the maximum separation which can reasonably be provided for these aircraft is desirable. As a minimum, these separations must always meet current aircraft Technical Order (TO) requirements.

2.17.2. **Apron Allowances.** A proper apron allowance is the amount required to afford maximum operational efficiency with a minimum amount of paving. The paragraphs below describe the basis for calculating apron allowances for various types of operations. Paragraph 2.19 describes a method for estimating apron requirements. High threat areas may require additional pavement to meet aircraft dispersal requirements.

2.17.3. **Assigned Aircraft.** Assigned aircraft will at a minimum consist of Primary Assigned Aircraft (PAA) inventory established from funded flying program for the base. Many bases will have other aircraft inventory that will require a parking apron. This inventory will vary by base and depot repair cycles. These aircraft may be annotated as backup inventory, ready reserve, or attrition reserve. The monthly average of these non-primary assigned aircraft remaining on station must be accounted for in determining apron requirements.

2.17.4. **Aprons for Operational Aircraft.** Operational aircraft are parked on mass aprons, strip aprons, or where authorized, on dispersed stubs. To determine how many operational aircraft require apron space, proceed as follows: Begin with 100 percent of the assigned aircraft as established by official documents (see exceptions in 2.17.3.3 for Air Mobility Command (AMC) aircraft); subtract the number of aircraft located on separate aprons, such as alert aircraft; subtract the number of aircraft located in maintenance hangars or docks under normal maintenance schedules; finally, subtract aircraft that are parked elsewhere on existing paving of a suitable nature and location. Other factors affecting the size and configuration of aprons for operational aircraft follow;

2.17.4.1. **Aircraft Parking Arrangements.** On a typical mass apron, aircraft are parked in rows and spaced according to the dimensions given in Table 2.4 through Table 2.7. This spacing permits aircraft to move in and out of parking places under their own power. Parking arrangements should be studied carefully to achieve the parking layout that requires the least amount of pavement per parked aircraft. The following example is typical of the possibilities for economy: On an apron for eight aircraft, changing the parking arrangement from four rows of two aircraft to two rows of four aircraft reduced pavement requirements by 20 percent.

2.17.4.2. **Parking, Fighter Type Aircraft:**

2.17.4.2.1. As indicated by Table 2.6 and Figure 2.1, some aircraft are often parked at a 45° angle. This is an efficient way to achieve adequate clearance to dissipate the temperature and velocity of jet blast to levels that will not endanger aircraft or personnel; that is, about 38° C (100° F), and 56 kph (30.4 knots).

2.17.4.2.2. To achieve adequate dissipation of heat and blast, some aircraft such as the F-111 and FB-111 require a wider lane than shown in Figure 2.1. To achieve a safe lane width; obtain the minimum safe distance to the rear of a jet engine operating at 80 percent power, unaugmented, from the appropriate aircraft technical order. If this distance exceeds 38.1 m (125 ft), minimize pavement requirements by parking aircraft so that two rows of aircraft blast into a common lane, with alternate lanes of minimum taxiway width.

2.17.4.3. Parking for Air Mobility Command Aircraft (AMC) Tanker aircraft (KC-10 and KC-135) require apron parking spots for 100 percent of the Primary Assigned Aircraft (PAA). Strategic Airlift (C-5, C-17, and C-141) require apron parking spots for 75 percent of the PAA. The load bearing pavement extends 11.4m (37.5 ft) beyond the centerline of the aircraft (the same as the peripheral taxiway). Any pavement beyond is shoulder pavement.

2.17.4.4. Parking Air Combat Command (ACC) alert aircraft. Paragraph 2.18 gives special criteria for minimum wingtip clearances.

Table 2.4. Aircraft Block Dimensions.

Aircraft	Wingspan		Length		Height		Min. Distance Between Wings, Parked Aircraft	
	m	ft	m	ft	m	ft	m	ft
B-1	22.7 to 41.7	77.8 to 136.7	46.0	150.7	10.3	33.6	6.1	20.0[3]
B-2	See MAJCOM							
B-52	56.4	185.0	47.8	156.6	12.4	40.8	7.7	25.0[3]
C-5	67.9	222.7	75.6	247.8	19.9	65.1	7.7 to 15.3	25 to 50
C-9	28.5	93.4	36.4	119.3	8.4	27.5	3.1	10.0
C-17	51.8	170	52.7	173	16.8	55.1	7.7 to 15.3	25 to 50
C-130	40.4	132.6	30.4	99.5	11.7	38.5	6.1	20.0
KC-135	39.9	130.8	41.5	136.2	12.7	41.7	15.3	50.0[4]
KC-10	50.4	165.3	55.5	182.1	17.7	58.1	15.3	50.0[4]
C-137	44.4	145.7	45.1	147.7	12.8	41.8	6.1	20.0
C-141B	48.8	160.0	51.3	168.4	12.0	39.3	6.1	20.0
E-3	44.4	145.7	46.6	152.9	12.9	42.2	6.1	20.0
B-4	59.7	195.7	70.7	231.8	19.6	64.3	6.1	20.0
T-1A	13.3	43.5	14.7	48.4	4.1	13.8	3.1	10.0
T-3A	10.6	35.0	7.3	24.8	2.4	7.8	3.1	10.0
T-33	11.8	38.9	11.5	37.8	3.5	11.3	3.1	10.0
T-37	10.3	33.8	8.9	29.3	2.8	9.2	3.1	10.0
T-38	7.7	25.3	14.1	46.3	3.9	12.9	3.1	10.0
T-41	10.9	35.8	8.2	26.9	2.7	8.8	3.1	10.0
T-43	28.4	93.0	30.5	100.0	11.3	37.0	3.1	10.0

1. Dimensions vary for different models and configurations of aircraft.
2. Setback distances for peripheral or through taxilanes should be based on the largest wingspan of aircraft that frequently uses the taxiway. Example: If E-4s taxi past a ramp of F-16s, taxilane should be based on the wingspan of the E-4.
3. See paragraph 2.18.1.2.
4. Tankers require a 15.2 m (50 ft) separation from wingtip to wingtip to accommodate fuel load change requirements.
5. For aircraft not listed, the minimum wingtip clearance is 3 - 7.7 m (10 - 25 ft) for wingspans < 33.5 m (110 ft) and 7.7 - 15.3m (25 - 50 ft) for wingspans > 33.5 m (110 ft).
6. The criteria within Table 2.4 does not apply during contingencies. In these cases, refer to the current aircraft Technical Order.

Table 2.5. Wingtip Clearances for Taxiing Aircraft.

Minimum Clearance Where Taxi Lanes are Marked on the Pavement	Aircraft with Wingspans		Aircraft with Wingspans	
	>33.5 m	≥110 ft	<33.5 m	<110 ft
	m	ft	m	ft
Wingtip clearance of moving aircraft taxiing on peripheral or through length of apron taxi lanes	15	50	9	30
Wingtip clearance on each side of moving aircraft taxiing in lanes between parked aircraft	9	30	6	20[1]

1. For transient aircraft, the minimum is 7.6 m (25 ft).
2. Another factor requiring evaluation when developing aircraft parking plans is aircraft exhaust wake velocity. Check the particular aircraft performance guide for wind velocity and temperature ranges to assess safe distances for nearby aircraft facilities.

Table 2.6. Aircraft Parked at 45° Angle; Aircraft Dimensions and Separation Distances.

Aircraft	Wing Span		Length		Height		Dimension C		Dimension D	
	m	ft	m	ft	m	ft	m	ft	m	ft
A-10	17.5	57.5	16.2	53.3	4.5	14.9	14.3	47.0	29.3	96.0
ATA	see MAJCOM									
F-4	11.7	38.4	19.2	63.0	5.0	16.5	15.5	51.0	21.0	69.0
F-5	8.5	28.0	15.8	51.7	4.0	13.2	12.2	40.0	16.5	54.0
F-15	13.0	42.8	19.4	63.8	5.9	19.2	16.5	54.0	22.9	75.0
F-16	10.0	32.8	14.5	47.6	5.0	16.4	12.2	40.0	18.6	61.0
F-22	13.6	44.5	18.9	62.1	5.1	16.6		Note 3		Note 3
F-111	9.8 to 19.2	32.0 to 63.0	22.4	73.5	5.2	17.0	18.3	60	31.7	104
F-117	13.2	43.4	19.8	65.1	3.8	12.4		Note 3		Note 3

1. Dimensions vary between different models and configurations of aircraft.
2. See Figure 2.1 for parking layout and dimensions C and D.
3. Not known at time of publication. Contact HQ USAF/LGMM.

2.17.4.5. **Taxi Lanes.** Interior and peripheral taxi lanes must exceed the required width for aircraft parked in the area if larger aircraft must taxi through en route to docks, hangars, or pads. Confine this width variation to the fewest taxi lanes possible.

2.17.4.6. **Peripheral Taxi Lanes.** Taxi lanes are not provided along the rear edge of aprons unless required for access to docks or hangars or to meet a critical need for alternate circulation routes for aircraft operating on the apron. On peripheral taxi lanes, aircraft are expected to taxi along the outer 22.9 m (75 ft) of pavement. Therefore, wing overhang areas beyond this strip are not paved. For these taxi lanes see Table 2.5.

2.17.4.7. **Other Variables.** These include such variables as the arrangement of refueling outlets, explosives clearances, required clearances to fixed or mobile objects (AFR 86-14, future AFJMAN 32-1013) and the siting of blast deflectors.

Table 2.7. Helicopter Apron Parking Data.

Helicopter Type	Operating Length		Operating Width		Minimum Distance Between Centerline of Parked Aircraft		Minimum Interior and Perimeter Taxi Lane Width	
	m	ft	m	ft	m	ft	m	ft
CH/HH-53B/C	26.9	88.3	22.0	72.3	44.0	144.5	55.1	180.7
HH-1H	17.4	57.1	14.7	48.3	29.5	96.7	44.2	145.0
UH-1N 57	17.5	57.3	14.6	48.0	29.3	96.0	43.9	144.0
UH/TH-1F/P	17.4	57.1	14.6	48.0	29.3	96.0	43.9	144.0
HH-60	19.8	64.9	16.4	53.7	32.7	107.4	40.9	134.2
CV-22	17.5	57.3	25.9	85.0	29.4	96.5	44.2	145.0

1. Dimensions vary between different models and configurations of helicopters.
2. Distances represent two rotor diameters between center lines of parked aircraft.
3. Widths represent two and one-half rotor diameters for wheeled helicopters and three-rotor diameters for skid-mounted helicopters.

2.17.5. **Apron for Cargo Loading:**

2.17.5.1. AMC aircraft are authorized an apron for terminal operations. Apron size is determined by the type of cargo aircraft involved, the volume of traffic, and the nature of the loading and unloading operation and associated equipment and facilities.

2.17.5.2. Commercial aircraft operations under Air Force contract are provided an additional apron for terminal operations. Apron size is based on individual projects and missions but does not exceed the size required to operate 10 large commercial aircraft.

2.17.5.3. Aircraft carrying hazardous cargo do not use the apron. Category code 116-662, Dangerous Cargo Pad, serves this need.

2.17.6. **Apron for Mission Support Aircraft (Base Flight).** All assigned mission support aircraft are provided apron space.

2.17.7. **Apron for Transient Aircraft.** Transient aircraft such as courier aircraft, personnel airlifts, administrative flights, AMC aircraft, and en route aircraft stopped by bad weather are provided an apron. The apron is designed to accommodate the average daily number of transient aircraft requiring parking space. The average daily number is determined from base records from previous years. A maximum of 16,700 m^2 (20,000 square yards) is permitted at new bases where the demand cannot be predicted.

2.17.8. **Apron for Access to Hangars, Docks and Shelters.**

2.17.8.1. Apron configuration is influenced by the size of the door openings and by the dimensions and turning radius of the largest aircraft using the buildings. A mass apron or a taxiway configuration is used, depending on access requirements. To avoid building non-usable pavement, design for adequate wingtip clearances of any obstacles near the apron. (AFJMAN 32-1013).

2.17.8.2. **Pavement Strength:**

2.17.8.2.1. Hangar access aprons and floors are designed to support a maximum aircraft load of 163,000 kg (360,000 pounds) for heavy and modified heavy-load pavements and a maximum load of 118,000 kg (260,000 pounds) for a medium-load pavement. This pavement is capable of supporting the basic, empty weight of all aircraft undergoing maintenance, including the largest aircraft. (The basic empty weight is the weight of the aircraft stripped of cargo, ammunition, and all but entrapped fuel.)

2.17.8.2.2. Pavement for alert hangar and shelter floors are designed for either light-load, medium-load, modified heavy-load or heavy-load as specified in Section A of this chapter.

2.17.9. **Apron for Helicopters:**

2.17.9.1. Parking space is provided for helicopters as follows: For six or more assigned helicopters, provide apron space for 80 percent of the total; for fewer than six assigned helicopters, provide apron space for all. Apron dimensions are based on the separation distances for parked helicopters given in Table 2.7.

2.17.9.2. For a rough estimate of the apron area needed, obtain the block area each helicopter occupies by multiplying its operating length by its operating width, then multiply each block area by 13.

2.17.9.3. The apron is usually part of, or contiguous to, the main airfield apron. Helicopter Pads, category code 116-663, are built for isolated operations.

2.18. **ACC Alert Area Parking Criteria.** The established, day-to-day, ACC alert parking areas must conform to the standards outlined below:

2.18.1. **Parking Separation:**

2.18.1.1. Table 2.8 shows the distance from the nose or wingtip of the parked aircraft to the centerline of the egress taxiway, measured perpendicular to the taxiway centerline.

Table 2.8. Nose-to-Centerline Distances.

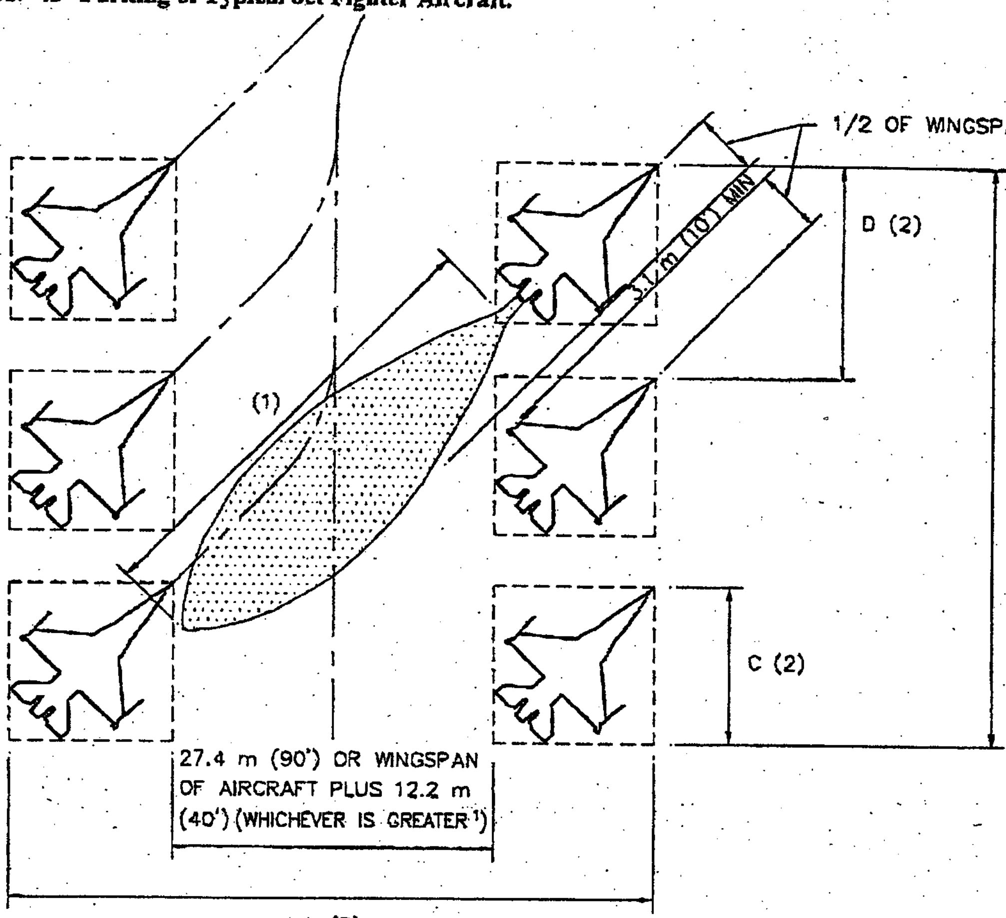
Aircraft Types	Desired Separations		Minimum Separations	
	m	ft	m	ft
B-52, B-1, or B-52 mixed force	45.7	150.0	38.1	125.0
KC-135	38.1	125.0	30.5	100.0

2.18.1.1.1. Nose or wingtip to centerline criteria are based on the largest aircraft taxied along the egress taxiway regardless of the type of aircraft being parked.

2.18.1.1.2. Desired distances are reduced as required down to, but not below, the specified minimum when space is limited due to a lack of ramp area.

2.18.1.2. The wingtip clearance between parked alert aircraft is 15.2 m (50 ft). Distances are measured along a line perpendicular to the aircraft centerline to provide a 15.2 m (50 ft) wingtip passing clearance when aircraft exit the parking spot.

Figure 2.1. 45° Parking of Typical Jet Fighter Aircraft.



Notes:

1. See paragraph 2.17.3.2.2. for additional criteria.
2. See Table 2.6 for Dimensions C and D.
3. Find dimensions W and L as follows:

   $W = D(N_W - 1) + C$

   $L = CN_L = 90(N_L - 1)$ (for aircraft with wingspan less than 15.2 m (50 ft)).

   Where:

   W = Width of operational parking apron.
   L = Length of operational parking apron.
   C = Block dimension of aircraft.
   D = 1.414 (wingspan + 3.1 m (10 ft)).
   N_W = Number of aircraft per row in width of apron.
   N_L = Number of aircraft per row in length of apron.

4. Aircraft with forward-firing munitions should be reviewed as to safety concerns and a Commander's Risk Assessment performed according to AFMAN 91-201.

2.18.1.3. The above criteria are minimums. Further separation is permitted and desired. To facilitate flexibility in future operations, new alert ramp construction should conform to the desired aircraft standards.

2.18.2. **ACC Waivers:**

2.18.2.1. ACC Numbered Air Force (NAF) director of operations may grant waivers to the 15.2 m (50 ft) wingtip clearance when sufficient ramp area is unavailable. In no case may the wingtip clearance be waived to less than 9.1 m (30 ft).

2.18.2.2. If the distance between the nose or wingtip and the egress taxiway centerline is below the desired distance stated in Table 2.8, the NAF minimum waiverable wingtip distance, 9.1 m (30 ft), must be increased by 0.31 m (1 ft) for each 0.31 m (1 ft) reduction in nose-to-taxiway centerline distance. For example: A B-52 nose-to-taxiway centerline of 43 m (140 ft) is 3.1 m (10 ft) below the desired distance. Therefore, the minimum NAF waiverable wingtip distance is 12.2 m (40 ft). If the B-52 nose-to-centerline distance is 39.6 m (130 ft) or less, the minimum wingtip clearance of 15.2 m (50 ft) would be required.

2.18.3. **Initial Turn.** In no case will the initial turnout of the alert parking spot exceed 90 degrees.

2.19. Estimating New Apron Requirements. For broad planning purposes, use the following method to estimate new apron requirements: Multiply the wingspan of the selected aircraft by its length. Multiply the product by a factor of 5.3. (Use a factor of 4.4 for fighter type aircraft and FB-111 aircraft.) Example: To estimate apron requirements for 10 C-141 aircraft, multiply: 48.8 m x 51.3 m x 10 aircraft x 5.3 factor = 133,000 m^2 of apron needed. This is a planning tool for sizing new aprons only. Do not use it to estimate the number of aircraft (specifically, large aircraft) that can park on an existing apron. Many variables (such as length, width, and taxi lane locations) determine an existing apron's suitability to support specific aircraft types. At existing bases, develop a conceptual aircraft parking plan to determine the apron square meter requirements.

Section E—Shortfield Facility

2.20. Category Code 116-116, Shortfield Takeoff and Landing Zone.

2.20.1. **Definition.** The facility is used to train crews of cargo aircraft (C-130 or C-17) to conduct airlift operations in the type of airfield environment found at forward operating locations.

2.20.2. **Description.** The facility is normally a paved strip, 1,070 m (3,500 ft) long and 27.4 m (90 ft) wide, with 91 m (300 ft) paved overruns on each end and 15.2 m (50 ft) wide access taxiways. Other restrictions in physical dimensions and clearances help create the desired airfield environment. The pavements are designed for shortfield load in accordance with criteria in paragraphs 2.2 and 2.3. Lighting is provided as described under Special Airfield Lighting, category code 136-666, and Taxiway Lighting, category code 136-667.

Section F—Alternate Combat Runway (ACR)

2.21. Alternate Combat Runway.

2.21.1. **Definition.** An ACR is a contingency runway for launch and recovery of aircraft while a bomb damaged, main runway is under repair. The requirement for an ACR applies only to air bases in high threat areas without a secondary runway. An ACR can be used as a Minimum Operating Strip (MOS) during rapid runway repair operations.

2.21.2. **Description.** The ACR facility is a paved strip, 2,300 m (7,500 ft) long, 27.4 m (90 ft) wide, with 91 m (300 ft) paved overruns on each end, and 11 m (36 ft) wide access taxiways. It may be superimposed on a secondary runway, taxiway, or parking apron that meets the desired criteria. There is no specific category code assigned to ACR facilities. Use the code which most closely relates to adjacent pavement. For example, if the ACR is a separate runway use category code 111-111; or if it is superimposed on a taxiway use category code 112-211. See AFJPAM 32-8013, *Planning and Design of Roads, Airfields, and Heliports in the Theater of Operations*, and AFMAN 32-1013 for additional design criteria.

6.14.2. **Siting Requirements**: New, renovated or expanded facilities must be sited according to AF ETL 91-4. Locate facilities to comply with explosives safety standards.

Chapter 7

CATEGORY GROUP 21 MAINTENANCE FACILITIES

Section A—Covered Space for Aircraft Maintenance

7.1. General Criteria.

7.1.1. Hangars and docks provide space for scheduled inspections, landing gear retraction tests, aircraft weighing, major maintenance on fuel systems, airframe repairs, and technical order (TO) compliance and modifications. Special purpose space may be authorized when justified.

7.1.2. The total space requirements for hangars or docks at any air base vary with climate, mission, type and number of assigned aircraft, programmed flying hours and maintenance concept. The factor in Table 7.1 expresses these variables for each type of aircraft. The formula in Table 7.1 estimates the number of covered maintenance spaces required under average conditions.

7.1.3. Locate facilities to comply with explosives safety standards.

7.2. Computing Covered Maintenance Spaces.

7.2.1. Calculate the number of authorized covered maintenance spaces by using the procedures in Table 7.1 or paragraph 7.3 or both. Dock space (paragraph 7.13) and hangar space (paragraph 7.4) may be used to meet the space requirements.

7.2.2. To determine the most efficient combination of facility use and aircraft positioning, use templates representing the aircraft (see Chapter 2 for aircraft dimensions) and floor plans of existing and proposed docks and hangars made to the same scale. Arrange the templates in various combinations to find the arrangement that most efficiently conserves space and permits maintenance operations. Do not overlook tail heights, the height and width of door openings, structural protuberances in facilities, and the turn radius of tow vehicles connected to aircraft.

7.2.3. One additional covered work space is authorized if the corrosion control workload exceeds the covered work space allocated under Table 7.1 or paragraph 7.3. An excessive corrosion control workload occurs with some combinations of numbers and types of aircraft, environmental and climatic factors, and the availability of scheduled depot maintenance. The additional space must be provided as a single aircraft space because of isolation requirements stipulated in TO 42A-1-1.

7.2.4. To determine the interior dimensions of dock and hangar bays, use the dimensions of the largest aircraft that occupies the bay plus the minimum clearances shown in Table 7.2. To compute the gross area of the hangar, multiply the interior dimensions by a factor of 1.15.

Table 7.1. Requirements for Covered Aircraft Maintenance Space[1].

Factors							
Aircraft	Factor	Aircraft	Factor	Aircraft	Factor	Aircraft	Factor
B-1	.30	C-21	.25	E-4	.30	T/A-37	.25
B-52	.15	C/KC-135	.15	F-5E/F	.25	T-43A	.15
C-5	.16	C-130	.15	F-15	.25	UH-1	.25
C-9	.18	C-141	.16	F-16	.27	CH-3	.25
C-12F	.10	KC-10	.25	F-111	.30	HH-53	.25
C-17	.20	E-3A	.15	F-117	1.25	HH-60	.25

1. Not all AF weapons systems are shown above. For weapon systems not shown consult your MAJCOM/LG

Formula:

Multiply the Number of Aircraft by the Factor for Type = Required Covered Spaces.[1]

Example:

Authorized Aircraft	Number x Factor	Required Covered Spaces
C-141	32 x .16 = 5.12	5 large
B-52	16 x .15 = 2.4	2 large
KC-135	10 x .15 = 1.5	2 medium
F-16	6 x .27 = 1.62	2 small

1. For guidance on the number of spaces to be provided in hangars and fuel systems maintenance docks, see criteria under codes 211-111 and 211-179, respectively. Maintenance spaces are otherwise provided in docks; 211-173, 211-175, 211-177.

7.3. Computation for Special Missions.

7.3.1. The formula in Table 7.1 applies only to units with repetitive flying hour programs or relatively constant monthly operations in non-arctic conditions. To calculate the number of authorized covered spaces for Air Force Materiel Command (AFMC), and for installations in arctic climates, use the following formula:

S = H x A / 176
Where:
S = Spaces authorized.
H = Average number of hours in dock per aircraft, based on maintenance experience or development and test experience data for new aircraft.
A = Average number of aircraft programmed for maintenance each month.
176 = Hours per month (22 x 8).

Section B—Aircraft Maintenance Facilities

7.4. Category Code 211-111, Maintenance Hangar.

7.4.1. **Functional Requirements.** Maintenance hangars provide space for aircraft maintenance, tool rooms, aircraft weighing, and other tasks identified in paragraph 7.1.

7.4.1.1. **Contractor Operated Maintenance Base Supply (COMBS).** Space will be provided for COMBS. Space requirements will be determined by the existing contract. The facility will be located in close proximity to the flight line containing areas for receiving, inspection, storing, parking material, issuing, support equipment maintenance, and office functions.

7.4.1.2. Locate facilities to comply with explosives safety standards. Special consideration may be needed for storage of explosives components such as egress seats, aircraft gun systems and life support shops.

Table 7.2. Aircraft Separation Dimensions Inside Hangars.

	Minimum Clearances from Hangar Elements[1]					
Aircraft Element	**Door**		**Walls**		**Roof Framing**	
	m	**ft**	**m**	**ft**	**m**	**ft**
F15 Wing Tip - under 30.5 m (100 ft) span	3	10	3	10	-	-
F16 Fuselage - under 30.5 m (100 ft) span	3	10	3	10	3	10
C 130 Wing Tip - over 30.5 m (100 ft) span	3	10	4.6	15	-	-
C-130 Fuselage - over 30.5 m (100 ft) span	3	10	4.6	15	3	10
Tail - Vertical	2.1	7	-	-	3	10
Tail - Horizontal	3	10	3	10	3	10
Helicopter Rotor Blade	3	10	3	10	3	10

1. Clearances between aircraft components should be at least 3 m (10 ft) where two or more aircraft are housed. None of the above clearances requires a waiver for existing facilities.

2. For KC-10 general purpose maintenance hangars, provide 10 m (32 ft) of clearance from the tail of the KC-10 aircraft tot he hangar door. The engine maintenance stand for the number two engine extends aft 5 m (17 ft) beyond the tail of the KC-10 aircraft.

7.4.2. **Spatial Requirements.** Determine the square footage requirements for maintenance hangars by the method described in paragraph 7.2.2.

7.4.3. **Criteria, Applicability and Justification.** Hangars must support aircraft maintenance, repair and inspection activities that are most efficiently done under complete cover. One maintenance space may be provided in a hangar sized for the largest aircraft assigned to the base. Separate studies are used to determine hangar requirements to accommodate C-5, E-3A, E-4, and KC-10 aircraft.

7.4.4. **Special Features.** Floors of maintenance hangars should allow aircraft loadings as listed in Chapter 2. Door openings must be wide and tall enough for aircraft to be pulled into and out of the facility. Siting of new hangars must comply with AFI 32-1026.

7.4.5. **Waiver Process, Coordination, Source of Information.** Reserved.

7.5. Category Code 211-147, Aircraft Weapons Calibration Shelter.

7.5.1. **Functional Requirements.** The facility provides space for boresighting and harmonization of fire control and reconnaissance equipment. Most maintenance hangars and docks are inappropriate because the structure interferes with the radar or lacks a clear target area nearby.

7.5.2. **Spatial Requirements.** A shelter is authorized for every 18 aircraft for, F-15, F-16, and A-10 aircraft.

7.5.3. **Criteria, Applicability and Justification.** This facility is necessary to calibrate fire control systems.

7.5.4. **Special Features.** The shelter is open in warm climates and closed in cold climates. The shelter needs an open area for an optical target area.

7.5.5. **Waiver Process, Coordination, Source of Information.** Reserved.

7.6. Category Code 211-152, General Purpose Aircraft Maintenance Shop.

7.6.1. **Functional Requirements.** The shop provides space for specialized maintenance activities such as fabrication shops, aerospace systems shops, egress shop and reclamation operations on crash damaged aircraft and equipment. The shop also has space for work, administration, telecommunications, tool cribs, bench stocks, lockers, storage and security of supplies and reparable parts. Reclamation and fabrication activities may require an open storage yard for aircraft, aircraft parts, and equipment awaiting repairs (see 452-252).

7.6.1.1. The Aircraft Electrical and Environmental (E&E) Element inspects, maintains, repairs, and services aircraft electrical and environmental related equipment. It normally includes work benches, bench stock, battery servicing area (two separate areas, if Ni-Cad and lead acid batteries both require servicing), cryogenics maintenance area, generator and constant speed drive (CSD) test stand area (if required), life raft bottle servicing area, tool crib, administrative space, and personnel locker space.

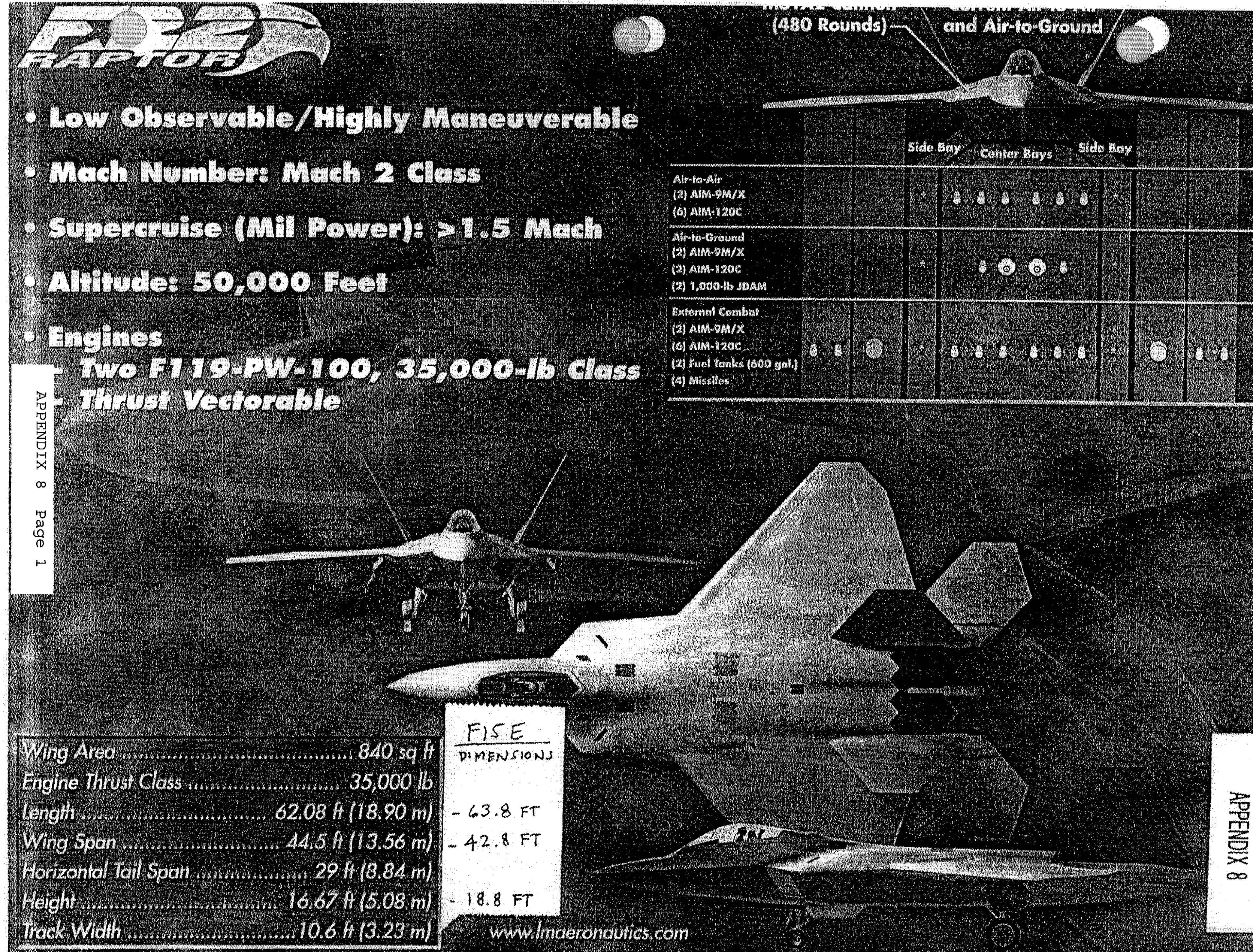
7.6.1.2. Locate facilities to comply with explosives safety standards. Special consideration may be needed for storage of explosives components such as egress seats, aircraft gun systems and life support shops.

7.6.2. **Spatial Requirements.** Table 7.3 lists total space requirements. These may be in one building or several buildings. Dispersing the shops allows use of space in suitable existing buildings such as hangars.

7.6.2.1. When possible, within funding constraints, the E&E functions should be as closely collocated as possible within the same building. Actual space requirements will depend on the mission and size of related E&E support equipment and the working area required to perform assigned functions.

--END OF APPENDIX--

APPENDIX 8


F-22 RAPTOR
• Low Observable/Highly Maneuverable
• Mach Number: Mach 2 Class
• Supercruise (Mil Power): >1.5 Mach
• Altitude: 50,000 Feet
• Engines
– Two F119-PW-100, 35,000-lb Class
– Thrust Vectorable
(480 Rounds)
and Air-to-Ground
Side Bay
Center Bays
Side Bay
Air-to-Air
(2) AIM-9M/X
(6) AIM-120C
Air-to-Ground
(2) AIM-9M/X
(2) AIM-120C
(2) 1,000-lb JDAM
External Combat
(2) AIM-9M/X
(6) AIM-120C
(2) Fuel Tanks (600 gal.)
(4) Missiles
Wing Area .... 840 sq ft
Engine Thrust Class .... 35,000 lb
Length .... 62.08 ft (18.90 m)
Wing Span .... 44.5 ft (13.56 m)
Horizontal Tail Span .... 29 ft (8.84 m)
Height .... 16.67 ft (5.08 m)
Track Width .... 10.6 ft (3.23 m)
F15E
DIMENSIONS
- 63.8 FT
- 42.8 FT
- 18.8 FT
www.lmaeronautics.com

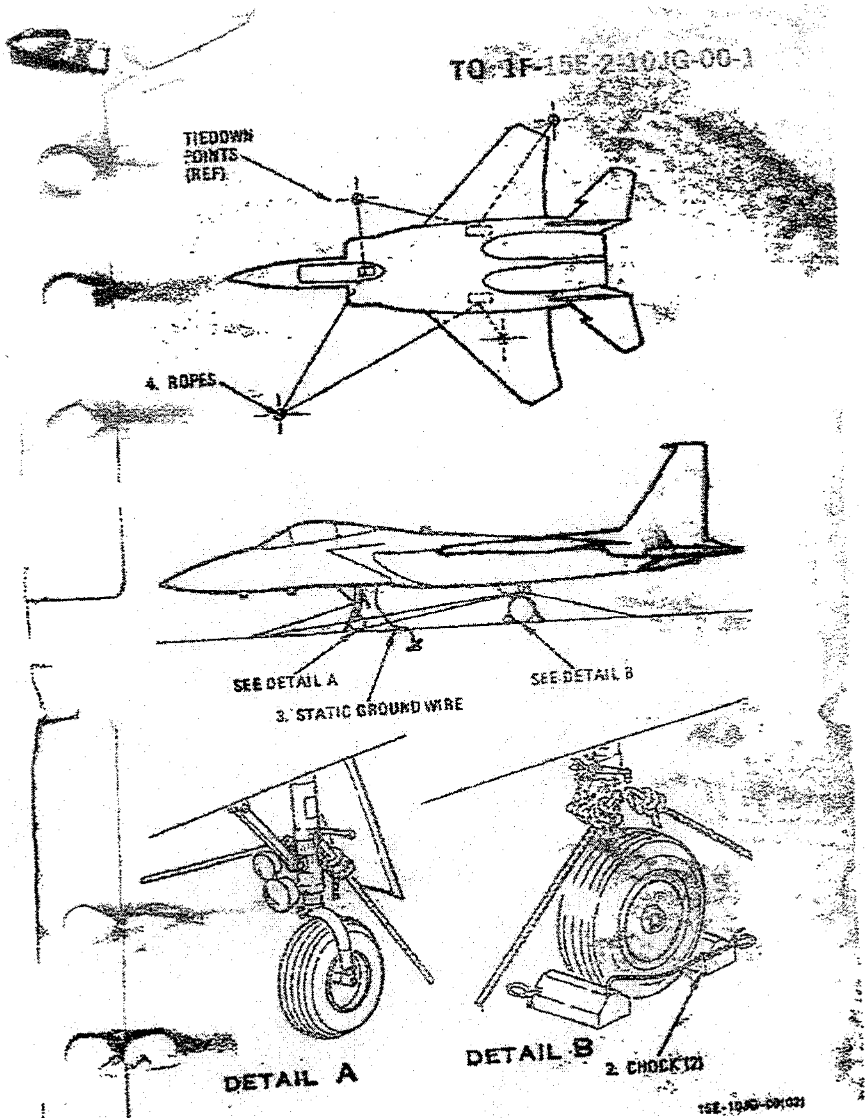


Figure 02. Sheet 1

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Nose 90° LT + RT From Strut Tie Down Rings

Main Fore + AFT of MAIN gear Tie Down Ring

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--END OF APPENDIX--

ENGINEERING AND MANUFACTURING DEVELOPMENT PROGRAM

F22

LOCKHEED MARTIN•BOEING
PRATT & WHITNEY

(EXCERPTED)

FACILITIES REQUIREMENTS PLAN

REVISION N
10 NOVEMBER 2000

CONTRACT
F33657-91-C-0006
F33657-91-C-0007

(FORMERLY CDRL A221)

DI-S-6173B/T

WBS 4243

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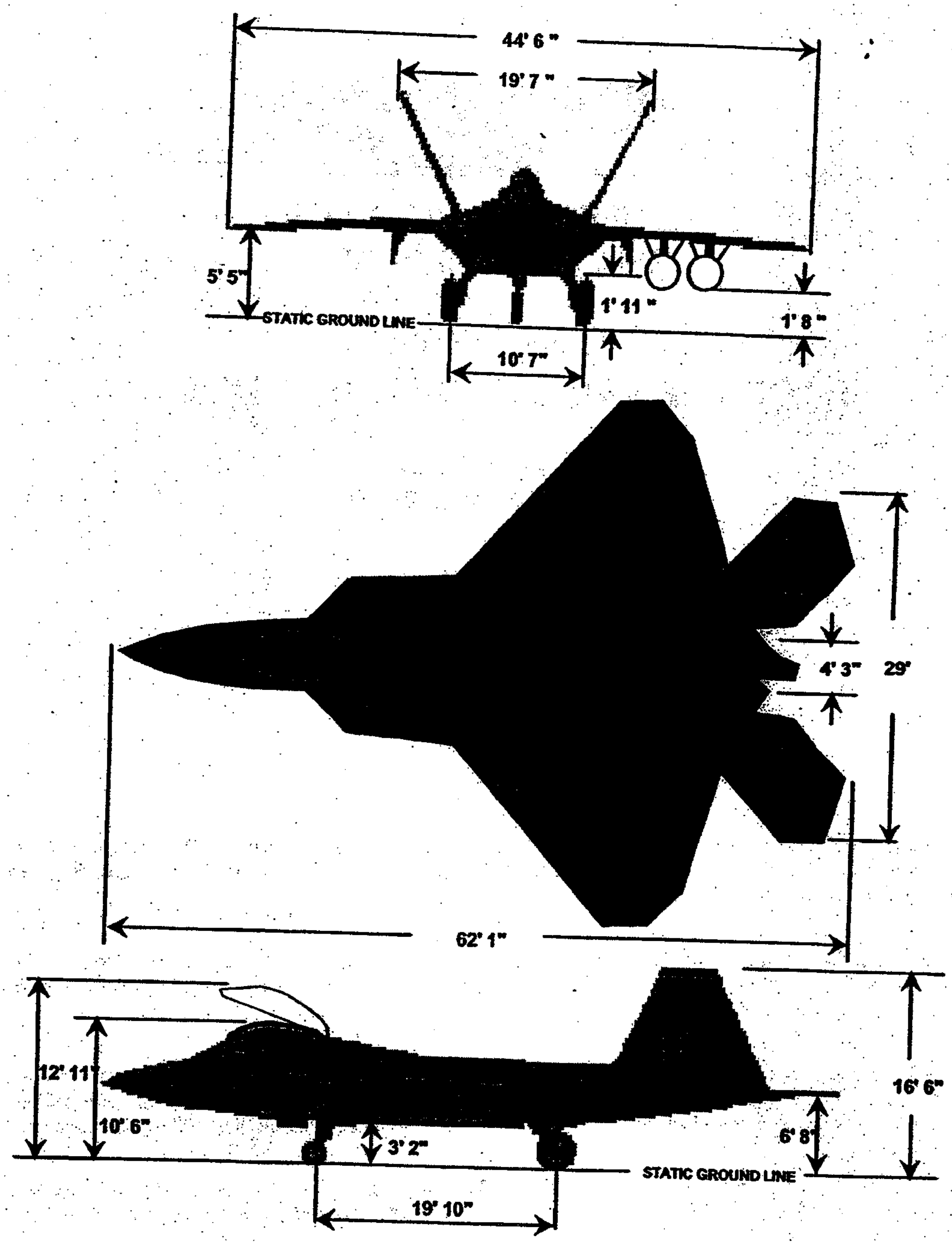


NOTE: HEIGHT DIMENSIONS ARE TYPICAL FOR AN AIRCRAFT FULLY SERVICED AND WITH FULL INTERNAL FUEL.

Figure 1-1 Aircraft Dimensions (Block Dimensions)

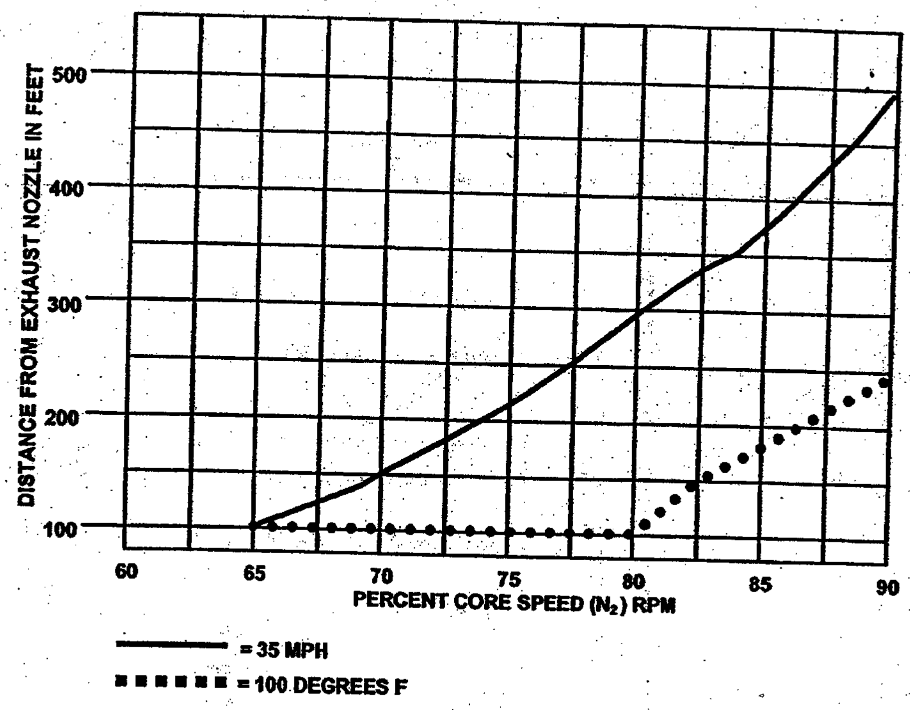


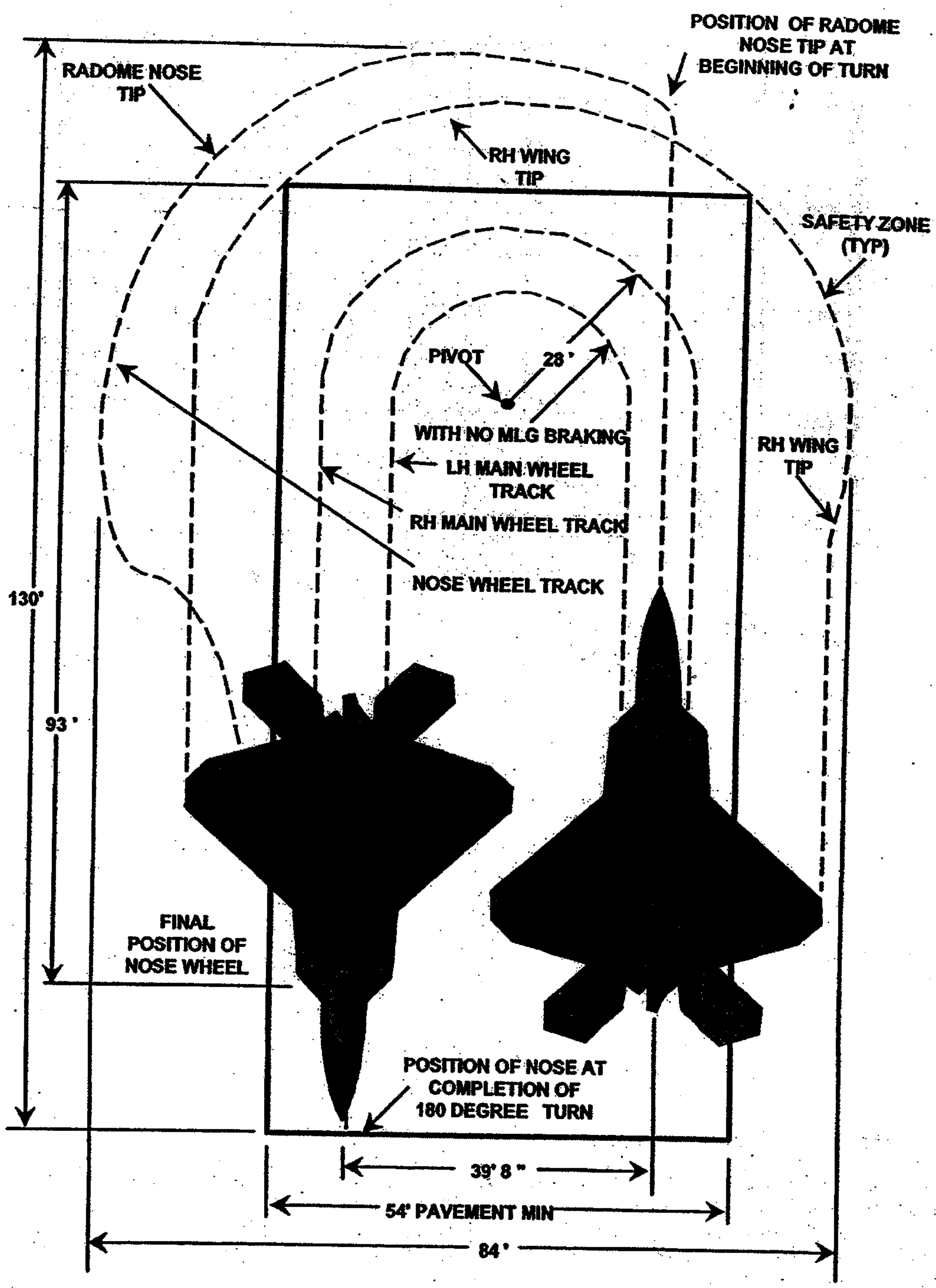
Figure 1-8 F119 Exhaust Wake Data

1.3.5 Take-off and Landing Data

The complete and detailed take-off and landing data are currently provided in the Flight Manual for the F-22. Aircraft take-off and landing distances are based on a variety of data including engine thrust, temperature, altitude, wind, runway slope, aircraft gross weight and drag index. Aircraft mission configuration (external stores) affect aircraft gross weight and drag index. However, to date the F-22 has demonstrated Normal Take-off and landing parameters similar to current tactical fighters, namely the F-15.

1.3.6 Taxi Turn Radius and Ground Clearance

Taxi turn radius is 42' with a minimum paved area of 54' wide by 93' as shown in Figure 1-9.



NOTE: TURN RADIUS DEPICTS GEOMETRIC TURN RADIUS AND DOES NOT INCLUDE A NOSE WHEEL SLIP ANGLE. ACTUAL TURN RADIUS WILL BE LARGER DEPENDING UPON SURFACE CONDITION AND TAXI SPEED. OVERALL DIMENSIONS INCLUDES 2' CLEARANCE BETWEEN WHEEL TRACKS AND PAVEMENT EDGES.

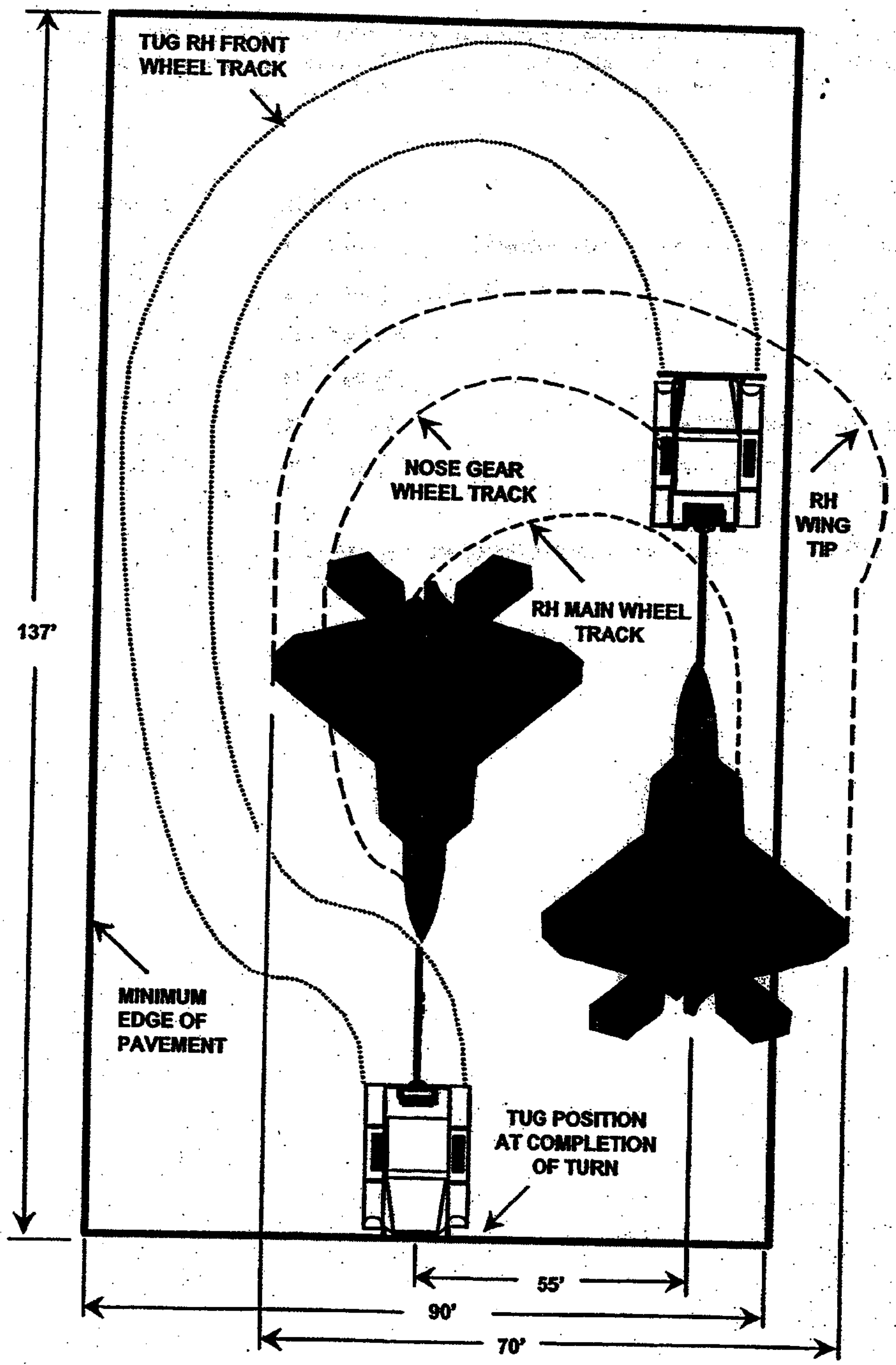
Figure 1-9 Taxiing and Turn Radius

1.4 AIRCRAFT GROUND SUPPORT/PARKING PROVISIONS

Aircraft ground support characteristics of towing turn radius (turn radius of the F-22 is 35' with a minimum paved area of 90' by 137'), jacking/hoisting provisions with support equipment locations, tire pressure/ground loading, aircraft ground service points, and the aircraft parking plan layout (temperature and velocity range). Details are provided in the following figures:

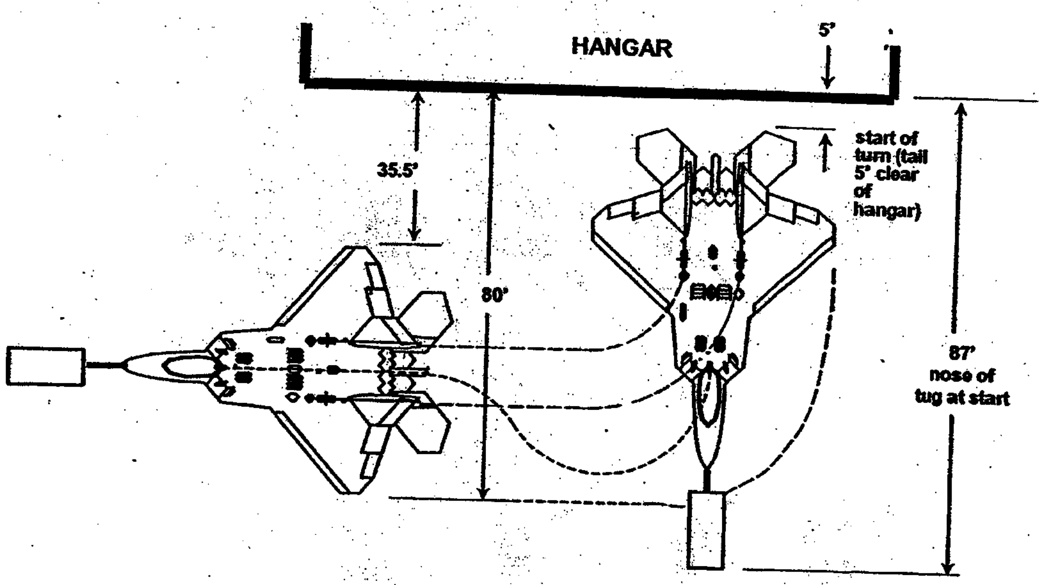
Towing/Turn Radius	Figure 1 - 10
Towing Out of Hangar Turn Radius and Dimensions	Figure 1 - 11
Aircraft Parking Plan	Figure 1 - 12
Jacking Provisions	Figure 1 - 13
Hoisting Provisions	Figure 1 - 14
Tire Pressure/Ground Loading	Figure 1 - 15
Aircraft Service Points (Lower View)	Figure 1 - 16

(Note: Refer to Chapter 7 for pavement requirements, mooring layout, and large scale parking plans.)



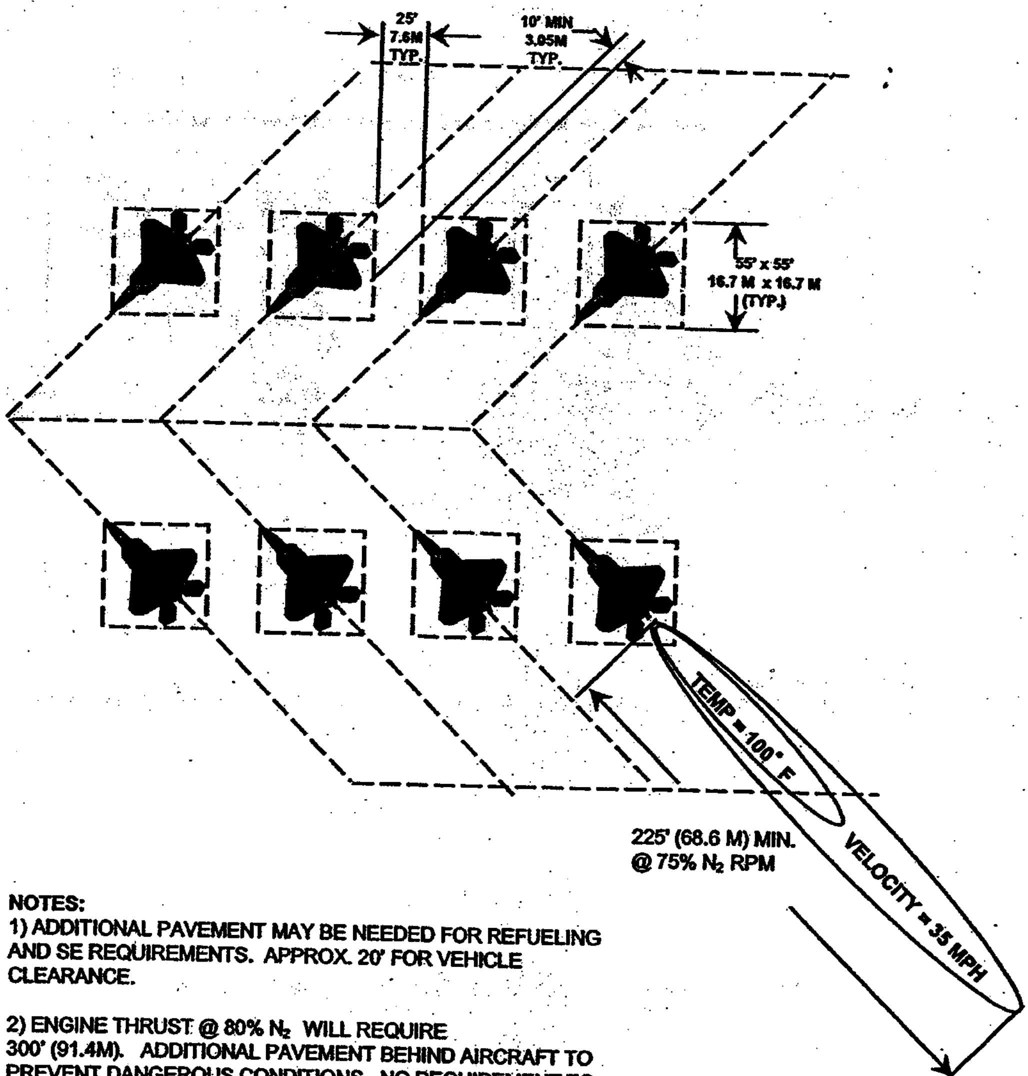
NOTE: OVERALL DIMENSIONS INCLUDE 2' EDGE CLEARANCE FOR AIRCRAFT AND TUG

Figure 1-10 Towing / Turn Radius



NOTES:
1) TUG: 13' 10" LONG
2) MINIMUM REQUIRED CLEARANCES FOR TOWED AND TAXIING AIRCRAFT ARE DEFINED IN AFM 32-1123

Figure 1-11 Towing Out of Hangar Turn Radius and Dimensions

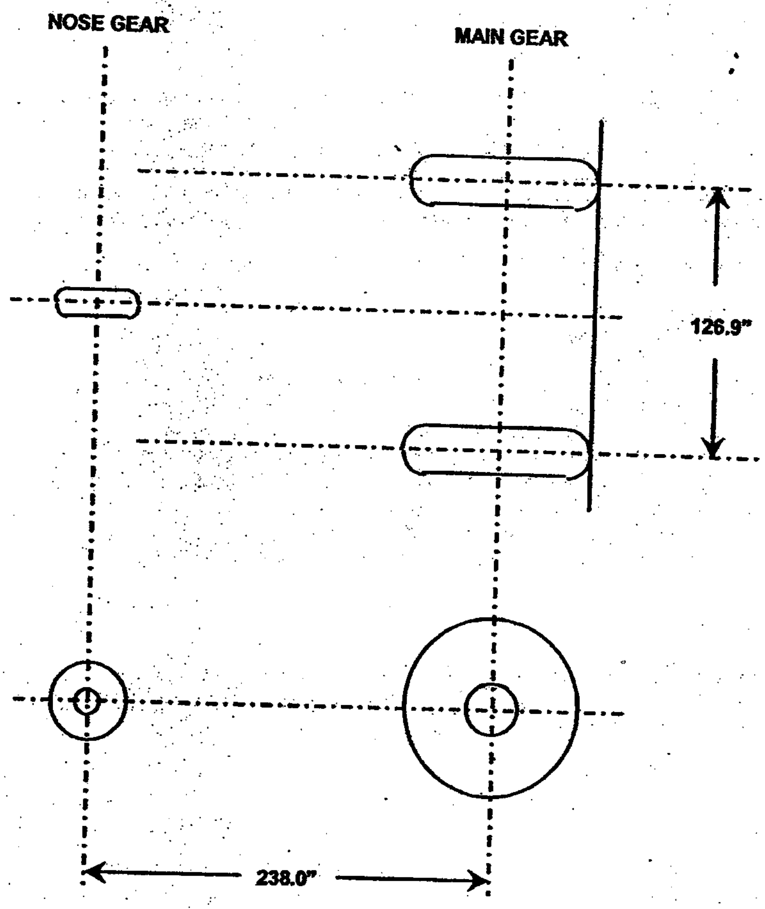


NOTES:
1) ADDITIONAL PAVEMENT MAY BE NEEDED FOR REFUELING AND SE REQUIREMENTS. APPROX. 20' FOR VEHICLE CLEARANCE.

2) ENGINE THRUST @ 80% N_2 WILL REQUIRE 300' (91.4M). ADDITIONAL PAVEMENT BEHIND AIRCRAFT TO PREVENT DANGEROUS CONDITIONS. NO REQUIREMENT TO RUN @ 80% CURRENTLY EXISTS.

3) SEE FIGURE 1-8 FOR F119 EXHAUST WAKE DATA.

Figure 1-12 Aircraft Parking Plan Block Dimensions



WEIGHT UP TO 70,000 LBS	NOSE GEAR	MAIN GEAR
TIRE SIZE	23.5 X 7.5R10	37 X 11.5R-18
INFLATION - PSI	210	210
PLY RATING (PR)	22	28
DEFLECTION - %	36	41
WEIGHT RATIO - % MAX	15	85
- % MIN	10	90
SINGLE WHEEL - CONTACT PRESSURE (PSI)	256	292
SINGLE WHEEL - TIRE CONTACT AREA (SQ. IN.)	41	102

NOTE: WEIGHTS ARE CLASSIFIED. CONTACT LOCKHEED MARTIN AERONAUTICS OR F-22 SPO FOR ADDITIONAL INFORMATION.

Figure 1-15 Tire Pressure/Ground Loading

Control of the Hydraulic Power System is provided by the redundant microprocessor architecture of the IVSC. The Hydraulic Computer Software Configuration Item (CSCI) provides control of the Reservoir Level Sensing (RLS) system, unloading (de-pressurization) of the main and auxiliary pumps, and maintenance valve mode selection. Monitoring functions performed by the CSCI include hydraulic Built-In Test (BIT), Integrated Caution, Advisory, and Warning (ICAW), and Diagnostic Health Maintenance (DHM).

The system utilizes MIL-H-83282 Fire Resistant Hydraulic Fluid operating over the temperature range of -40° F to 275° F. 5-micron fluid filtration is provided for pump discharge, pump case drain, and return system flows. Cooling of the hydraulic system fluid is provided by one fuel/oil heat exchanger per system.

The F-22 can complete the mission safely with any single hydraulic failure. In addition, aircraft control and landing can be accomplished with any two-branch failures or any combination of a single pump and single branch failure.

The major components of the Hydraulic Power Systems (HPS) are:

QTYS	DESCRIPTION
4	4,100 psi, 72 gpm variable delivery main pumps
1	3,850 psi, 27 gpm variable delivery auxiliary pump
2	1,800 cu in bootstrap reservoirs
2	140 cu in piston-type nitrogen/oil system (pump) accumulators
2	45 cu in piston-type nitrogen/oil reservoir pressurization accumulators
2	5-micron absolute pressure filter modules
2	5-micron absolute return/case drain filter modules
1	Electrically-controlled maintenance switching valve

1.6.7 Fuel System

This description will cover the various subsystems of the fuel system including the fuel containment, engine feed, fuel transfer, heat sink, refueling and defueling, fuel tank pressurization and venting and the fuel tank explosion suppression subsystems as well as the Fuel Management System (FMS).

The fuel system consists of integral fuel tanks within the aircraft fuselage and wing structure as well as the pumps, valves, plumbing, and components necessary to supply the required fuel flows and pressures to the engines during all flight conditions that will be encountered by the aircraft when performing within normal operating limits.

The fuel system is required to be operational for a host of fuel types. The primary fuel is MIL-T-83133, grade JP-8 fuel. Alternate fuels are MIL-T-5624, grade JP-5 fuel; Jet A and Jet A-1 in accordance with ASTM-D-1655; NATO F-44 (equivalent to JP-5); NATO F-34 (equivalent to JP-8); and NATO F-35 (equivalent to Jet A-1 or JP-8 without anti-icing additive and corrosion inhibitor).

1.6.7.1 Fuel Containment

The fuel is contained within six fuselage fuel tanks and two wing tanks. The forward tank system consists of the F-1 feed tank and the F-2 transfer tank. The F-1 feed tank consists of an F-1A forward compartment and a F-1B pump box. The aft tank system consists of the A-1L and the A-1R feed tanks with their respective left and right A-2 wing and A-3 fuselage transfer tanks. All of the tanks are of integral type construction. Fuel system provisions also include the capability of carrying fuel externally with two tanks per wing. The external tanks are 600-gallon fuel tanks.

1.6.7.2 Engine Feedback System

The system utilizes a multiple feed tank concept whereby the engines are fed fuel from a common forward and independent aft feed tank system. Aft feed is regulated to a prescribed percentage of total engine consumption in a manner that automatically maintains proper aircraft CG control during all flight conditions. The aft feed regulation function is automatically controlled by a flow regulator in the each aft feed manifold. Automatic positioning of the regulator flow area is accomplished by software logic within the fuel management portion of the IVSC (Integrated Vehicle Subsystem Controller).

Each A-1 aft feed tank contains two (2) electrically driven, variable speed, 270 VDC fuel boost pumps (pumps #4, #5, #6, and #7) while the pump box of the F-1 forward feed tank contains two (2) hydraulically driven fuel boost pumps (pumps #1 and #2) and one (1) electrically driven, variable speed, 270 VDC boost pump (pump #3).

Pump #1 is dedicated to feeding the left engine while pump #2 is dedicated to feeding the right engine. They normally provide the required forward feed pressure and flow requirements and are available for providing flow and pressure in the event of a dual generator out condition where a momentary loss of electrical power is encountered. They are also configured to provide flow and pressure during inverted or negative g type flight conditions.

Pump #3 in the F-1 feed tank can supply fuel to either engine and is normally powered to a low rotational speed so as to maintain the normal forward feed pressure in the event of failure to either one of the hydraulically driven fuel boost

Engine FADEC (Full Authority Digital Electronic Control) electronics, the comprehensive engine diagnostics unit (CEDU) and the engine optical pyrometer are cooled with fuel provided by the forward feed boost system. Fuel flow for engine electronics cooling purposes is provided by pumps #1 and #2 to their respective engines via a dedicated system of plumbing that routes the flow to engine interface and returns the flow from the engine interface to the F-1 tank.

1.6.7.5 Refueling and Defueling

Aerial refueling capability is provided by a fixed receptacle and slipway configuration that is compatible with the KC-10A and KC-135 tanker boom systems. Luminescent lighting provisions on the aerial refuel receptacle bay doors are utilized in lieu of area floodlights for low light or nighttime aerial refuel operations. Aerial refuel receptacle bay door operation is carried out by a single linear hydraulic actuator concept.

Ground refueling can be accomplished through a single point fitting located at lower left aft side of the aircraft. The single point fitting is a standard type refuel/defuel adapter in accordance with the standards of STANAG 3105. The adapter ties into the same refueling manifolds utilized by the aerial refuel receptacle.

The refuel system utilizes high level sensing pilot float valves in combination with refuel shutoff valves to accomplish refuel without external power assistance. High-level shutoff group provisions are provided to allow for the simultaneous fill of 4 fuel tank systems. An electrical pre-check system provides a functional checkout of each refuel circuit for proper float and shutoff valve operation for maintenance purposes utilizing the PMA.

A defuel valve, when manually opened, connects the engine feed manifolds to the refuel manifolds and allows boost pump pressure to assist in defueling the aircraft from the ground refuel/defuel adapter.

All the equipment necessary to perform the normal ground refuel and defuel functions are located in a dry bay recessed into the A-1L fuel tank and are accessed through a bay door that is flush with the outer contour. The bay is located just aft of the main landing gear wheel well.

1.6.7.6 Pressurization and Venting

Utilizing permeable membrane fiber technology, the On-Board Inert Gas Generating System (OBIGGS) receives ECS cooled engine compressor bleed air and produces NEA (nitrogen-enriched air) for fuel tank inerting and pressurization purposes. To preclude fuel boiloff and fuel pump cavitation, the tanks are normally pressurized between 2.0 and 3.5 psig. An internal tank vent and pressurization valve receives the OBIGGS supplied gas and regulates it to the required pressure for distribution to the tanks.

Each external tank is pressurized (27±2 psig) with inert OBIGGS gas supply or cooled engine bleed air for fuel transfer purposes via an external tank vent and pressurization valve group mounted in each pylon.

Internal tank venting takes place from the A-3L tank via the vent and pressurization valve positioned at the highest possible location in the tank. The available vapor space or ullage designed into this tank coupled with that provided in the other tanks achieves the required 3% thermal expansion space.

A vent line mounted to the vent and pressurization valve allows for tank ullage gas to be vented overboard during normal refuel and climb conditions, and for fuel to be vented overboard during refuel failure conditions through a flush port in the bottom skin of the left wing.

1.6.7.7 On-Board Inert Gas System (OBIGGS)

Fuel tank explosion protection is provided by an on-board inert gas system (OBIGGS). The OBIGGS consists of an air separation module (ASM), which produces nitrogen-enriched air (NEA) from compressed engine bleed air. The NEA is supplied to the tanks for ullage wash and pressurization. The air supplied to the ASM is conditioned for temperature and contaminants using a heat exchanger and a filter. A differential pressure sensor provides a signal indicating that the filter needs replacement. The ASM consists of two sub-modules to conserve engine bleed air: the smaller designated ASM A and the larger ASM B. ASM A supplies inerting for the periods of low pressurization flow demand and operates continuously following engine start. ASM A NEA flow is controlled by an orifice and an aneroid flow control valve. This flow control valve allows pressurization flow for max A/B fuel flow at high altitudes using ASM A only. ASM B operates when ASM A flow cannot meet pressurization flow demands. During this condition the fuel tank pressure regulator, inlet pressure drops and controls the air conservation valve at the ASM B inlet to an open position. ASM B flow control valve regulates NEA flow according to ASM pressure to maintain a required oxygen concentration of 9% maximum. It also regulates tank pressure regulator inlet pressure proportionately to prevent dynamic instabilities between the air conservation valve, ASM B flow control valve and the fuel tank pressure and vent control valve. The health of the ASM is monitored by an oxygen sensor in the ASM NEA output flow line.

As the aircraft performs initial climbout, dissolved oxygen will evolve out of the fuel. For conditions where the absolute pressure in the fuel tanks decreases by 1 psia, the wash valve is commanded open and NEA flow, in excess of engine feed pressurization demand, enters the tanks to purge the evolved oxygen from the tanks. The valve closes after approximately 5 minutes of wash operation unless a further 1 psia reduction in tank pressure is realized.

mission scenarios and environmental conditions to assist the facility planners to determine unique facilities requirements. The system and subsystem maintenance concept, as addressed in the Logistics Support Analysis (LSA) database, provided insight to the facilities planners as to the projected maintenance and frequency necessary to support the F-22. Facility layouts in Chapter 7 are presented as models only for the purposes of determining space requirements for discrete operations/activities. These layouts represent the compilation of findings obtained from the sources discussed above.

Facilities Planners using the FRP should familiarize themselves with AFH 32-1084, logistics modeling and the F-22 LSA database.

A goal of the facilities planners is to insure that the F-22 will utilize the existing F-15 facilities where applicable with an absolute minimum expenditure for facility construction or modifications. New facilities may be required where the F-22 is an additive mission.

IMPORTANT – NOTE THE FOLLOWING

The FRP outlines minimum requirements. Requirements may differ depending on local conditions. The actual working and storage areas required for each function at the site will be determined upon completion of the facilities site specific survey. Mission requirements will be the main factor in determining actual requirements.

Floor plans in the FRP are generally only given to show square foot requirements, not to specify detailed layout of a given facility. Layout and total square foot requirements should be accomplished by a team including architects, engineers, users, SPO Chief of Facilities, and contractor representatives during the design process.

Ensure the impact of requirements on facility systems is captured when programming for funds. HVAC, electrical, structural, aircraft pavements, security systems, and overall square footage (common areas, mechanical rooms, etc.) have been underestimated in the past when programming.

7.2 *F-22 UNIQUE FACILITY CONSIDERATIONS*

7.2.1 Security Requirements

The Air Force designated the F-22 aircraft a "PL-3" (Priority Level 3) asset. The specific protection requirements for the air vehicle can be found in AFI 31-101. However, the document does not discuss the protection criteria for support elements associated with the F-22 (i.e., IMIS, MSS, ODS, PTS, MTS, TSSC, TMS etc.). The F-22 falls under a Special Access Program (SAP). A SAP is any approved program, which imposes need-to-know, or access controls beyond those normally required for access to CONFIDENTIAL (C), SECRET (S) or TOP SECRET (TS) information. This is known as SAR, Special Access Required. Each element of the F-22 weapons system must be afforded protection commensurate with the classification of the information contained in, or processed by, the individual system. Components and information may have no classification, collateral (C, S, or TS), or SAR (C, S, or TS). Some information may also be further compartmentalized under certain projects.

This section primarily explains what regulations govern construction of areas to protect and control access based on classification and gives an overview of what areas/facilities must provide protection. **Para 7.2.1.3** provides the security specific construction requirements for the support systems. Specific facility requirements will be determined during facility design and the Site Specific Activation Planning for each location.

Areas where physical security must be addressed can be delineated into the following areas: ramp & apron, hangar bays, storage rooms, classified briefing areas, classified computer equipment rooms and office and training areas.

7.2.1.1 Locations

Ramp & Apron: F-22 aircraft is a "PL-3" asset. No additional physical structures, fences, etc. will be used above normal "PL-3" protection.

Hangar Bays: Bays, booths, etc., where aircraft are parked or stored and where aircraft will not be supervised by a program cleared individual at any time must 1) be physically secured, and 2) be alarmed (see table in paragraph 7.2.1.4). Note that other than the LO facility, bays will not actually be accredited as a Special Access Program Facility (SAPF). Applicable facilities include AMU hangars, fuel barn, and possibly the hush house. Additional facilities could be alarmed based on unit preference. Bays also require controlled area red security lines for each aircraft.

Other Classified Areas: Includes classified storage rooms, classified briefing areas, and classified computer equipment rooms.

7.2.1.2 Regulations & Authority

7.2.1.2.1 General Information

Two regulations primarily addressed physical construction requirements: 1) DCID 1/21, Physical Security Standards for Sensitive Compartmented Information Facilities (SCIFs), and 2) DoD 5200.1-R, Information Security Regulation. SAF/AQ deemed that SAPF facility construction requirements would be covered by DCID 1/21, not DoD Regulation 5200.1-R.

7.2.1.2.2 DCID 1/21, Physical Security Standards for Sensitive Compartmented Information Facilities (SCIFs)

This is a CIA directive (Director of Central Intelligence). ***This is the governing directive for F-22 facilities.*** It covers policy, accreditation, construction, and intrusion detection among other subjects. It doesn't delineate between S and TS, as this generally does not affect the physical construction requirements. The SCIF facility requirements directly apply to a SAPF. The base security office should have a copy of this document.

CSA decisions in DCID 1/21 are delegated to regional PSOs.

7.2.1.2.3 DoD 5200.1-R, Information Security Regulation

This is a DoD regulation covering protection and classification of all official information requiring such protection. Appendix G covers physical security standards. This appendix gives basics for vaults and storage rooms, but does not cover briefing rooms and sound attenuation. As noted, DCID 1/21, not DoD 5200.1-R, governs SAPF construction.

7.2.1.2.4 Interim Department of Defense Antiterrorism/Force Protection Construction Standards

Follow as required.

7.2.1.2.5 The Physical Security Program (AFI 31-101)

Follow as required.

7.2.1.3 Construction Standards

7.2.1.3.1 Vault vs. Secure Area

Vault: A "hardened" and alarmed storage or briefing area; walls are usually reinforced concrete. Not required except in rare cases.

Secure Area: An alarmed storage or briefing area; walls and ceilings must reveal penetrations. Permanent drywall construction is usually sufficient.

No vault-level construction is required for the F-22 (i.e., reinforced concrete walls, etc.) except possibly some cases of open storage outside the U.S. (depends on CSA decision; see paragraph on open storage).

7.2.1.3.2 Briefing vs. Storage

Areas may be certified for briefing and/or storage. In the case of storage, area must meet DCID 1/21 requirements, but does not need to meet sound attenuation requirements.

7.2.1.3.3 Open Storage

As noted before, this is when items are not secured in a GSA approved container. This may occur in aircraft parts storage areas or in computer areas where removal of hard drives is infeasible. IAW DCID 1/21, there are two scenarios affecting F-22 facilities at MOBs.

Inside U.S. & within U.S. government compound:

- Permanent Drywall construction sufficient.
- Security response force must be capable of 5-minute response with reserve force available.
- CSA may require exterior ground-level perimeter walls to meet equivalent protection afforded by Expanded Metal.

Outside U.S. and within U.S. government compound:

- Security response force must be capable of 5-minute response with reserve force available.
- Meet vault criteria, or if approved by CSA & having an immediate response force, expanded metal, steel plate, or GSA approved modular vault in lieu of actual vault criteria.

7.3 BASE OPERATIONS FACILITIES

Airfield pavements are the portions of an air base used for aircraft take-offs, landings, servicing and parking. The designation of airfield pavements applies to runways, taxiways, aprons, pads, paved shoulders and overruns. All pavement joints should be sealed to aid in the prevention of Foreign Object Damage (FOD) to the aircraft and engines.

7.3.1 Runway (AF Category 111-111)

The runway is the paved surface provided for normal aircraft landings and take-offs. The F-22 requires a medium-load runway, 150 feet (45.75 m) wide by 8,000 feet (2440 m) long with supporting taxiways, aprons, pads, paved shoulders, and paved overruns, as specified in AFM 32-8008. Aircraft take-off and landing distances are based upon a variety of data including engine thrust, temperature, altitude, wind, runway slope, aircraft gross weight and drag index. The aircraft mission configuration (external stores) affects aircraft gross weight and drag index affecting the overall distance requirements. The runway must be sized to support the longest required takeoff and landing distance.

7.3.1.1 Construction Criteria

Pavement grades must be in the direction of drainage limited to 0.5% minimum to 1.5% maximum. Pavement grades and drainage of the runway, runway shoulders, lateral safety zones, and clear zone will be IAW AFI 32-1026. All airfield markings will be IAW AFI 32-1042. All joints must be sealed with jet fuel resistant joint sealant.

7.3.2 Paved Overrun (AF Category 111-115)

The paved overrun provides a supplemental deceleration area for the F-22 that may abort a takeoff or experience brake failure while landing. The overrun also provides a safe landing surface in the event of short landings or approach-end arresting cable engagements.

7.3.2.1 Construction Criteria

A standard flexible base overrun 1000 feet (305 m) long by 150 feet (45.75 m) wide (16,667 sq yd/13,933.6 sm) will be required at each end of the primary runway. The first 150 feet (45.75 m) adjacent to the primary runway will have 2 inches of dense grade hot plant mixed asphaltic concrete as a surface course to resist jet blast. The remaining length of the overrun (850 ft/259.25 m) will have a double bituminous surface treatment finished flush with the blast resistant surface.

7.3.3 Taxiway (AF Category 112-211)

Taxiways are the pavements provided for the ground movement of aircraft. They connect the parking and maintenance areas of the airfield with the runways and provide access to hangars, docks and various parking aprons and pads. Taxiways are normally located parallel to and connected with runways to permit aircraft ground movement at the same time landings and take-offs are being made from the runway.

7.3.3.1 Construction Criteria

The standard taxiway width of 75 feet (22.87 m) is adequate for F-22 operations. Medium load pavement strength is appropriate for this aircraft. Paved shoulders are recommended to reduce taxiway shoulder deterioration. The F-22 can be safely operated on dry pavement with a slope up to 3 degrees uphill or downhill.

7.3.4 Operational Apron and Aircraft Parking (AF Category 113-321)

Aprons are paved areas provided for aircraft parking, mooring, servicing, and loading and launch/recovery operations. The apron is where all F-22 flight support operations are conducted.

The aircraft does not normally require mooring, however, if wind velocities and surface conditions are unsafe, the aircraft should be headed into the wind and the nose and main landing gears tied down to the ground as required by wind velocity. Mooring secures the aircraft against movement that may result in aircraft damage. Mooring requirements are based on wind velocity; aircraft gross weight, and ramp surface conditions.

7.3.4.1 Construction Criteria

The F-22 will require a medium-load pavement. The pavement area should use the most economical means of providing adequate clearance to allow for the dissipation of jet blast (temperature 100°F and velocity 35 mph) for personnel safety on the apron. The 45-degree parking area includes jet blast corridors.

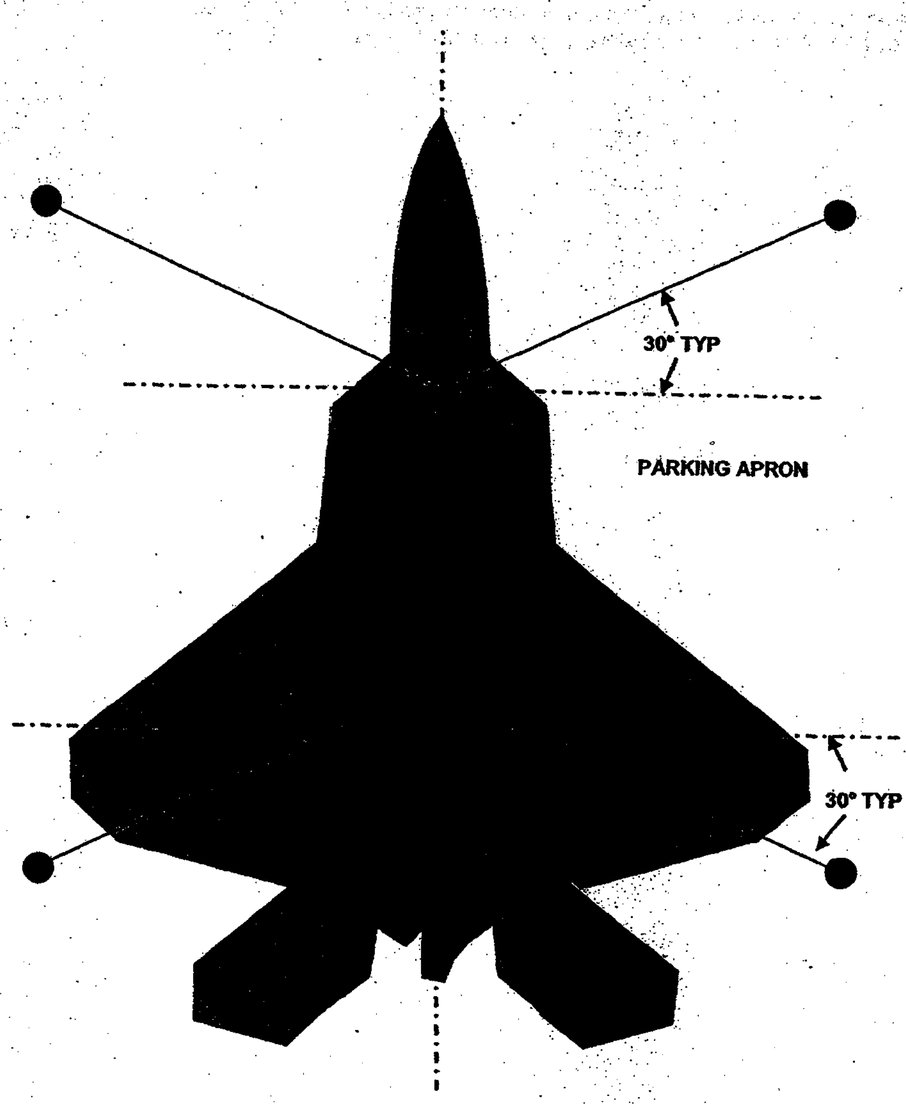
Pavement grades must be in the direction of drainage limited to 0.5% minimum to 1.5% maximum. Pavement grades and drainage of the operational apron will be IAW AFI 32-1026. All airfield markings will be IAW AFI 32-1042. All joints must be sealed with jet fuel resistant joint sealant.

7.3.4.2 Area

The apron area requirements without blast deflectors for parking 72 F-22 aircraft are shown in **Figures 7-3** and **7-4.** Refer to AFMAN 32-1123, Airfield and Heliport Planning and Design, for additional guidance.

7.3.5 Moorings

The installation of aircraft moorings is an operational site decision and should be based upon weather history and the probability of experiencing subject conditions. Aircraft moorings should be installed where weather conditions are expected to cause frequent moorings. For those bases with moorings, four (4) moorings per aircraft should be installed as shown in **Figure 7-5**. This will assure repetitive angles and relatively short rope lengths from each aircraft mooring location. The standard USAF spacing on 30 feet (9.2 m) centers in rows 30 feet (9.2 m) apart with staggered spacing in alternate rows or other grid patterns may be used in emergency situations.



NOTE:
DISTANCE FROM TIRE CENTERLINE TO TIE DOWN CENTERLINE MEASURED FROM PARKING SPACE CENTERLINE STRIPE.

NOSE LANDING GEAR 15'
MAIN LANDING GEAR 9.6'

Figure 7-5 Aircraft Mooring

Aircraft Covered Maintenance 6 Bay Hangar			
Name	SF	SM	[illegible]
Maint. Docks (Main Hangar Area)	32,560	3,024.9	
Mech Room	1,200	111.5	Estimate only, TBD during design phase
Elec Room	200	18.6	
Comm Room	60	5.6	
Door Pockets	(TBD)	(TBD)	TBD during design
Men / Women	(see notes)	(see notes)	
Tool Room	(see notes)	(see notes)	
Admin IMIS	(see notes)	(see notes)	
Storage	(see notes)	(see notes)	
Subtotal	(see notes)	(see notes)	
Hallways and circulation (10%)	34,020	3,160.6	
Total Gross SF	3,410	320.0	
	37,430	3,480.6	

NOTE:

If any bays are located separate from Sqd Operations (Maintenance Facility), additional space will be required for restrooms, tool room, storage room, and IMIS equipment. All 6-Bays do not have to be located together.

Table 7-5 Aircraft Covered Maintenance 6 Bay Hangar

7.3.16.5 Rest Rooms

Separate sanitary facilities with ventilation systems are required for men and women.

7.3.16.6 Fire Protection

Use fire safety standards to include, but not limited to materials, lighting, emergency exits and fire protection systems IAW NFPA and NEC requirements to ensure maximum protection against loss of life and property by fire. The aircraft maintenance area must be protected with a foam-water system. Reference MIL-HDBK 1008B and Air Force ETLs 98-7 (new hangar) and 98-8 (existing hangar).

7.3.16.7 Floor Coverings

Dock area floors should be sealed with static-free, chemical-resistant urethane. Skid resistance may be added.

7.3.16.8 Floor Drains

Floor drains or trenches may be installed to correspond with the installed fire protection system. Trench drains at the entrance of hangars and docks from the flightline reduce flooding of the hangar floor by rain/snow runoff. Drains will be connected to holding tanks, as required by existing local environmental requirements.

7.3.16.9 Floor Loading

The dock floors in aircraft maintenance stations will be medium load parking apron pavement strength and include in the design a means to eliminate cracking.

7.3.16.10 Security Requirements

Storage: Area will be required for the storage of classified components temporarily removed from the aircraft (canopies, leading edge flaps etc.). Additional requirements are noted in the "IMIS Requirements" paragraph of this section.

Entry Control in Bays: Discussions are on-going as to how bays must be controlled when classified maintenance procedures are in progress.

Alarms: Classified secure areas will be alarmed IAW applicable local security directives.

7.3.16.11 Guidelines

Each aircraft maintenance dock should have yellow towing/positioning guidelines and fire and safety lines painted on the floor as applicable. The towing guidelines are aids for centering the aircraft in the maintenance dock and ensuring a 10 ft (3.05 m) clearance between wing tip and facility structure, IAW AFH 32-1084.

7.3.16.12 Grounding

Each aircraft maintenance dock should be equipped with static grounding electrodes of 25 Ohms for each aircraft space.

7.3.16.13 Lighting

Light intensities are required to be a minimum of 50 footcandles as measured 30 inches (76.2 cm) off the floor.

7.3.16.14 Compressed Air

Provide 2 outlets, 80-125 psi, and 15 cfm.

7.3.16.15 Water

One standard hose bib outlet, 50 psi, and 10 gpm. Provide both hot and cold water in showers and latrines.

7.3.16.16 Electrical

Provide the following IAW NEC:

- 120 VAC, 60 Hz, 1Ø, 3-wire, 20 Amps per outlet
- 277/480 VAC, 60 Hz, 3Ø, 6-pole, 200 Amps per phase, two (2) outlets per aircraft space (for support equipment). This installation must comply with MIL-SPEC MIL-C-38159.
- 115 VAC, 400 Hz, 3Ø, 90 kVA per para 5.2 and sub-para MIL-STD-704, one (1) outlet per aircraft space (this outlet powers the EPC, which powers the aircraft).

NOTE: The 400 Hz power may be supplied by support equipment. If this option, or other options, such as Edwards FCX units are used, a third 277/480 VAC, 60 Hz, 3Ø, 200Amp outlet or junction box (if hardwired) should be installed instead of the 400 Hz outlet.

7.4 OPERATIONS SQUADRON

7.4.1 Operations Facilities (AF Category 141-753)

7.4.1.1 General Information

The Operations Facility is required to support each operations squadron and contains the space for flight planning, air crew briefing and debriefing, training and administration of the squadron. Space must be provided for the storage, care and issue of flight crew life support system equipment and personal space is required for changing into and out of flight clothing. Due to a change in the operations alignment operational and on-equipment maintenance activities are combined into one organization. To support this concept it is recommended that these facilities be located in close proximity to one another. Existing facilities should be surveyed to determine the most cost-effective approach in achieving this operating environment. It is the responsibility of the using activity to organize and administer each section according to the desired maintenance concept.

7.4.1.2 Construction Criteria

7.4.1.2.1 Area

The facilities required for planning and administration functions are typically office spaces. Area for storage, testing and issue of flight clothing and equipment is also required. The area involved in processing classified data will require appropriate construction in accordance with **Section 7.2**, F-22 Unique Facility Considerations. Nominal space required for each section/function can be obtained from **Figure 7-12**.

Nomenclature [illegible]	Qty	Wt [illegible]	[illegible]	Size [illegible]	[illegible]	Electrical	[illegible] Remarks
Support Ejection Seat	3	150	40	60	30		
Adapter Seat Dolly	3	10	24	6	DIA		
PMA w/Receptacle w/Attach Keyboard	2	21	7	18	21	115/220 V, 1Ø, 50/60 Hz	Wt & size is for each
MSW w/Monitor & Keyboard	1	85	21	20	27	115/220 V, 1Ø, 50/60 Hz	Wt. & Size is for each

Table 7-10 Egress Facility Shop Equipment List

7.6.9.5 Rest Rooms

Separate sanitary facilities with ventilation systems are required for men and women.

7.6.9.6 Fire Protection

Use fire safety standards to include, but not limited to materials, lighting, emergency exits and fire protection systems IAW NFPA and NEC requirements to ensure maximum protection against loss of life and property by fire. Reference MIL-HDBK 1008B and Air Force ETL 98-7, 98-8.

7.6.9.7 Grounding

A low resistance grounding strap system or grounding points are required to ground the seats. All conductive parts of equipment must be grounded through a resistance of 25 ohms or less. See AFM 91-201.

7.6.9.8 Lighting

Lighting intensities are required to be 50 footcandles as measured 30 inches (76.2 cm) off the floor. Explosion proof fixtures are required.

7.6.9.9 Safety

All safety requirements are specified in AFMAFM 91-201 and NFPA 70 (NEC) Explosives Safety Standards and other applicable safety standards.

7.6.9.10 Compressed Air

Shop air (80-125 psi, 15 cfm) outlets should be provided at workstations.

7.6.9.11 Electrical

There are no F-22 peculiar equipment electrical requirements. Install 120 VAC 60 Hz 1Ø 3-wire, 20-Amps, duplex convenience outlets. (Some overseas locations will require different power requirements)

7.6.9.12 Ventilation

Vents and windows should be covered with rust resistant number 9 steel mesh. Exhaust fans must conform to requirements specified in AFMAFM 91-201.

7.6.10 Fuel Systems Maintenance Dock (AF Category 211-179)

The Fuel Systems Maintenance Dock provides space for covered aircraft maintenance, shop and administrative functions and contains utilities and safety systems required to perform fuel systems maintenance. Aircraft dock space is required for on-aircraft open fuel cell maintenance. Shop space is required for external fuel tank maintenance.

7.6.10.1 Siting

It would be extremely advantageous for the maintenance shop to be located in the dock even though co-location is not a requirement. The dock should be separated from adjacent facilities to assure safety due to hazardous operations.

The Fuel System Maintenance Dock will be constructed IAW the requirements defined in AFH 32-1084 and T.O. 1-1-3. The concepts discussed below apply to a combined dock.

7.6.10.2 Area

This facility requires a minimum of 10,170 sf (944.8 sm). Refer to **Figure 7-20** for proposed layout and **Table 7-11** for typical facility installed equipment list.

7.6.10.3 IMIS Requirements

Space for two (2) MSW (12 sf or 1.1 sm each) and five (5) PMAs (18 sf or 1.6 sm each, assuming a stand-alone configuration) will be required. PMAs actual location and activity will be maintained and controlled by supervision. Connectivity to support the IMIS will be via the base-level unclassified MSU using the unclassified Type II encrypted network.

7.6.10.4 Ceiling Height

The minimum ceiling or clear height required is 27 feet (8.2 m) in the aircraft maintenance dock.

7.6.10.5 Doors

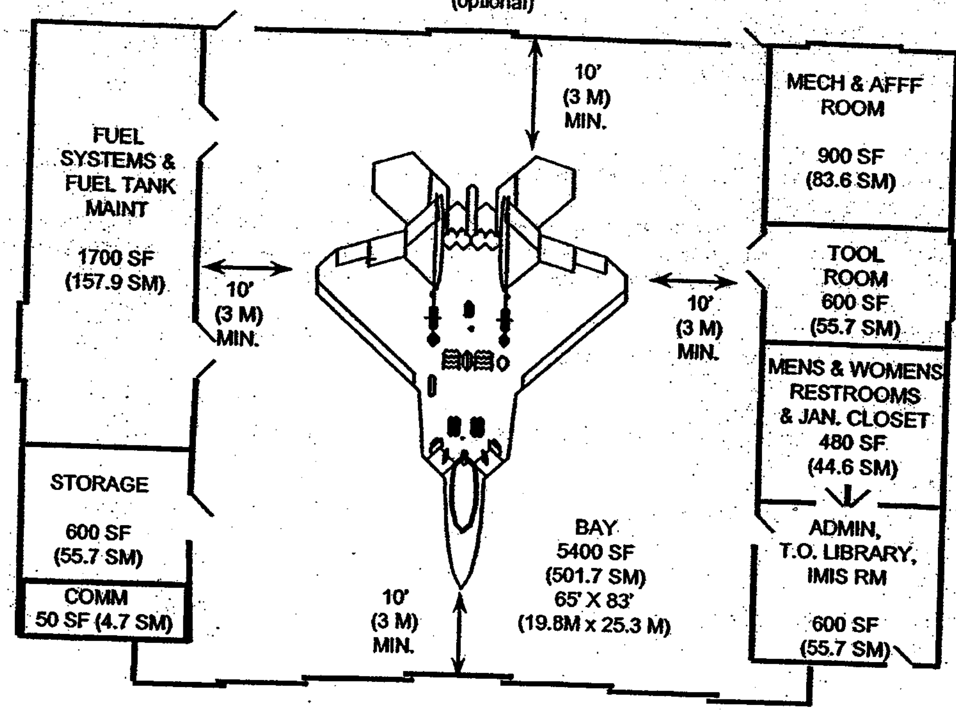
Provide fire resistant interior and exterior personnel doors with panic hardware and automatic closure as required. Install fire resistant doors as required.

7.6.10.6 Environmental Control

Provide environmental controls in fuel hangar to maintain temperatures, which satisfies personnel comfort.

7.6.10.7 Rest Rooms

Separate sanitary facilities with ventilation systems are required for men and women.



TOTAL: NET 10,330 SF (960.5 SM)
GROSS 12,400 SF (1152.0 SM)
(ADD ADDITIONAL SF FOR DOOR POCKETS WHEN REQUIRED)

Figure 7-20 Fuel Systems Maintenance Hangar

7.6.10.8 Equipment Installation Provisions

Provide roll-up doors for access into the mechanical equipment room for installation of equipment.

7.6.10.9 Fire Protection

Use fire safety standards to include, but not limited to materials, lighting, emergency exits and fire protection systems IAW NFPA and NEC requirements to ensure maximum protection against loss of life and property by fire. The aircraft maintenance area must be provided with a pre-action closed-head aqueous film forming foam-water sprinkler system. System detection shall be provided by a rate compensated detection system. Combustible vapor detectors must be provided at low points. Also, a vapor extraction system must be provided. Reference MIL-HDBK 1008B and Air Force ETL 98-7, 98-8.

7.6.10.10 Floor Drains

Provide floor drainage to restrict the spread of fuel and to reduce the fire and explosive hazards resulting from fuel spillage. Drains must have sufficient capacity to handle water at a rate equal to 25% of the maximum foam-water solution discharge rate from a single sprinkler system. Drains, curbs or ramps must be provided to prevent the flow from aircraft storage areas through openings to shops, offices, or other areas during fuel spill or fire emergencies. Drains should be connected to holding tanks or an oil separator, as required by local environmental and EPA regulations.

7.6.10.11 Floor Leveling

Floors should be sloped, as required to allow for drainage.

7.6.10.12 Floor Coating

Dock area floors are recommended to be sealed with static free chemical resistant urethane.

7.6.10.13 Grounding

Provide low resistance grounding points or straps to allow for grounding of equipment. The grounding should be IAW AFOSH STD 127-38, T.O. 00-25-172, MIL-HDBK-419 Vol I and II, and AFH 32-1084.

7.6.10.14 Lighting

Provide explosion proof lighting intensities of 30 footcandles in the aircraft dock area and 50 footcandles in the shop areas as measured 30 inches (76.2 cm) off the floor.

7.6.10.15 Safety

Exposure to fuels poses special hazards to personnel in addition to the obvious fire hazard. Personnel breathing fuel vapor may suffer eye, nose and throat irritation. Physical contact with fuel can cause dryness and irritation of the skin. Some compounds may be absorbed through the skin and damage internal organs. Personnel engaged in fuel system repairs should use appropriate clothing and safety equipment. Combustible fume indicator units should be provided in the dock area and shop areas. Provide emergency deluge showers and eye wash units in dock area.

7.6.10.16 Compressed Air

Provide four shop air (80-125 psi, 15 cfm) outlets in the dock area and two shop air outlets in the tank maintenance repair area.

7.6.10.17 Electrical

Estimated electrical requirements are:

- 120 VAC, 60 Hz, 1Ø, 20Amp convenience outlets, as required
- 277/480 VAC, 60 Hz, 3Ø, 4-wire 150Amp, four outlets required
- 480 VAC, 60 Hz, 3Ø, 4-wire one outlet required

Provide fixtures and outlets as required IAW NEC Article 513.

(Some overseas locations will require different power requirements)

7.6.10.18 Water

Provide 1 ¼ inch water outlets, to permit connection with hoses for flushing the dock and maintenance shop floors in the event of an accidental fuel spill. Flushing connector should be provided in the bottom of the door trench to remove debris. The estimated demand for water is 5 gpm hot and 47 gpm cold at 50-60 psi.

7.6.10.19 Ventilation

Provide a two-speed explosion proof exhaust located on the wall in center line of the dock space for direct exhausting of fumes from fuel cells. Discharge should be ducted to the outside of building. Provide a rigid duct with soldered joints from the mid point of the aircraft to the exhaust fan. A flexible duct should extend from the rigid duct to the vicinity of dock floor. Provide for raising and lowering of flexible duct into fuel cells and out of dock working zone. Ducts and motors must be effectively grounded. The fuel maintenance areas should have outside air ventilation to meet local and state regulations.

7.6.11 External Fuel Tank Storage (AF Category 442-628)

Storage space is required for the external fuel tanks. Depending on the climate, the user may elect to cover the tank storage area to protect the tanks from the environment. The fuel tanks are approximately 30 inches (76.2 cm) in diameter by 18 feet (5.49 m) long. The Fuel tank storage area will require approximately 288 sf (26.8 sm) of storage space for each aircraft assigned (4 tanks per aircraft). This calculation should only be used for fuel tanks that are in operational use. It is desirable that this area be close to the fuel maintenance facility. The pavement should be sealed with jet fuel resistant material and IAW AFH 32-1084. Grounding electrodes are required. Reference MIL-HDBK-419 Vol I and II.

If a decision is made to store fuel tanks in their original shipping containers the following chart can be used to determine indoor square footage storage requirements.

Bases may also want to pursue an optional vertical storage system provided by AFMC.

	Length [illegible]	Width [illegible]	Height (in.)	Area Per Item [illegible] (l x w)	Cubic [illegible] Per Item [illegible] (lxwxh)	Weight [illegible]
600 Gallon Fuel Tank (Uncrated)	246	33	36	8,118	292,248	343
600 Gallon Fuel Tank (Crated)	260	42	48	10,920	524,160	645

Table 7-12 External Fuel Tank Storage Requirements

7.6.11.1 Siting

The external fuel tank storage area should be located within the off-equipment maintenance complex preferably next to the fuel systems maintenance shop to enhance control and security.

7.6.11.2 Area

This facility requires a minimum of 25,800 sf (2,397 sm). Refer to **Figure 7-21** for proposed layout.

7.6.11.3 Security

A security fence 6' minimum height with a 10' minimum length gate with lock is required to ensure base security and control regulations are complied with.

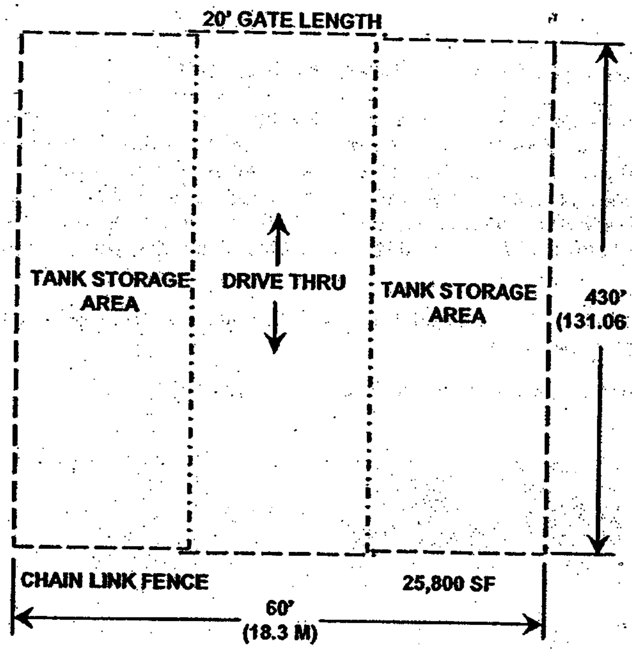


Figure 7-21 External Tank Storage Area

7.6.12.6 Ceiling Height

Clear ceiling heights of 15 feet (4.6 m) in the maintenance stalls and 8 feet (2.4 m) in office and storage areas are recommended.

7.6.12.7 Doors

Provide interior and exterior personnel doors with panic hardware and automatic closure. Provide two overhead roll-up doors, 12 feet (3.66 m) wide and 15 feet (4.6 m) high.

7.6.12.8 Rest Rooms

Separate sanitary facilities with ventilation systems are required for men and women.

7.6.12.9 Equipment Fueling Provisions

The facility will require a 10,000-gallon JP-8 storage tank. One commercial fuel stand with island and two pumps is required. The island shall be located in the AGE storage yard to allow for easy access for equipment being towed for refueling.

7.6.12.10 Equipment Installation Provisions

A one-ton capacity monorail hoist over the equipment maintenance stalls is recommended.

7.6.12.11 Fire Protection

Use fire safety standards to include, but not limited to materials, lighting, emergency exits and fire protection systems IAW NFPA and NEC requirements to ensure maximum protection against loss of life and property by fire. Reference MIL-HDBK 1008B and Air Force ETLs.

7.6.12.12 Floor Coverings

The shop floors should be coated with chemical resistant concrete sealer and painted white for improved appearance, ease of maintenance and visibility. Pigmented concrete is an alternative.

7.6.12.13 Floor Drains

A central floor drain or trench drain is required in the wash area. Floor drains are recommended in the facility to allow for drainage of water used for wash-down and water brought in by vehicles and equipment. Floor drains should be connected to holding tanks or an oil separator, as required for pollution control.

7.6.12.14 Lighting

Provide a minimum lighting intensity of 50 footcandles in the shop and administrative areas as measured 30 inches (76.2 cm) off the floor. Provide flood lighting around the standby storage yard to allow for maneuvering equipment during night operations.

7.6.12.15 Security

A fence with a minimum of 8 feet (2.4 m) high with a gate 12 feet (3.66 m) wide should be provided around the standby storage area.

7.6.12.16 Compressed Air

Provide 15 roll-up type shop air (80-125 psi, 15 cfm) outlets in the maintenance area; one outlet per maintenance stall. One outlet is required for outside service island.

7.6.12.17 Electrical

Provide the following IAW NEC Article 513 and 514 (Some overseas locations will require different power requirements):

- 115 VAC, 60 Hz, 1Ø, 20 Amps, 3-wire, 30 duplex outlets
- 115 VAC, 60 Hz, 1Ø, 3-wire, seven outlets, 30 Amps each, 25.2 kVA connected load, 10.1 kVA demand load
- 115 VAC, 60 Hz, 3Ø, 4-wire, five outlets, 32.3 kVA connected load, 12.9 kVA demand load
- 115 VAC, 60 Hz, 3Ø, 4-wire, four outlets, 177 kVA connected load, 70.8 kVA demand load

7.6.12.18 Water

Provide one each hot and cold water outlets with hose bib connections in wash area, 50-60 psi @ 10 gpm and one external hose bib at the fuel island.

7.6.12.19 Ventilation

Provide an exhaust duct manifold system to remove exhaust fumes from powered AGE that is operated in the shop. Discharge should be ducted to the outside of the building. Provide rigid duct with soldered joints over maintenance stalls. Flexible ducts should extend from rigid duct to the shop floor in each maintenance bay. Provide for stowing flexible ducts out of maintenance stalls when not in use. Variable speed fan should be used in duct system to allow for use of one or all exhaust ducts.

DESTRUCTION NOTICE:

Destroy by any method that will prevent disclosure of contents or reconstruction of the document.

--END OF APPENDIX--

END

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

MEMORANDUM FOR 3 CES/CEVP

3 Dec 01

FROM: 3 CES/CEVQ

SUBJECT: General Environmental Quality Comments Regarding Projects or Contractor Work on Elmendorf Air Force Base

1. Minimize use of hazardous material requirements during construction. Insure facility is built to reduce future maintenance that requires use of toxic or hazardous chemicals. Purchase and manage all hazardous materials in accordance with Air Force Instruction 32-7086, *Hazardous Materials Management*, and the 3rd Wing Operations Plan 19-3, *Hazardous Waste, Used Oil Management and Hazardous Materials Management Plan* (OPlan 19-3).

2. Air Force Policy (HQ USAF/ILEV Memo, 6 Feb 2001) directs diversion of non-hazardous waste from the landfill by reduction, reuse, salvage, recycling, or composting. Generate the least amount of construction and demolition debris possible that must be landfilled due to error, poor planning, breakage, mishandling, contamination, or other factors. As many of the waste materials as feasible shall be reused, salvaged, or recycled. Waste disposal in landfills shall be minimized. HQPACAF/CEV Memo, 3 Aug 2001, directs 3 CES/CEVQ to report once a month the amount (in tons or cubic yards) of material landfilled from the project, the identity of the landfill, the total amount of tipping fees paid at the landfill, and the total disposal cost. Report the amount in tons or cubic yards of material recycled or otherwise diverted from the landfill and the identity of the recycler or other recipient of diverted materials, and tipping cost, if any. Include manifests, weight tickets, receipt, and invoices.

3. Minimize hazardous waste generation in accordance with OPlan 19-3. Training for hazardous waste generators is available through the 3 CES/CEVQ office and an accumulation point manager and alternate shall be appointed. Hazardous waste shall be separated, stored, and disposed of and documented according to OPlan 19-3, available on the 3rd Wing website, www.topcover.af.mil.

4. All sampling and disposal costs for solid waste, hazardous material or hazardous waste shall be paid by the project/contractor. This includes lead/asbestos and PCB abatement and disposal.

5. The project shall pay for the remediation and subsequent disposal of any contaminated soils encountered during construction. Contaminated soils must be managed in accordance with state and federal regulations and Oplan 19-3.

6. Contractor is responsible for reimbursing the Government any costs related to spills of hazardous materials/wastes that may occur from contractor's actions while the contractor is working on base. Spills must be managed in accordance with Oplans 19-1 and 19-3.

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

7. Please call Jim Miller, 552-1967, if you have any questions.

//s//
JAMES R. MILLER, GS-13
Chief, Environmental Quality

PACIFIC AIR FORCES

03 AUG 2001

MEMORANDUM FOR 3 CES/CC 8 CES/CC 15 CES/CC 18 CES/CC
35 CES/CC 36 CES/CC 51 CES/CC 354 CES/CC
374 CES/CC 611 CES/CC

FROM: HQ PACAF/CEV
25 E St Ste D306
Hickam AFB HI 96853-5412

SUBJECT: Tracking and Reporting Solid Waste Disposal and Diversion from Landfills

1. The DoD implemented new Measures of Merit (MoM) for non-hazardous waste in FY99. Based on semi-annual review of the data submitted, it appears we are not capturing all the data required to fulfill the MoM requirement. We need your installation's support, primarily within Engineering, Operations, and Environmental Flights, to improve the process.

2. The new MoM requires the Air Force to report all solid waste that is disposed in landfills and also the solid waste which is diverted from landfills through reuse and recycling. This includes construction and demolition (C&D) debris. Data reviewed indicates some installations may not be including all their C&D debris in their disposal and diversion measurements while other installations are consistently reporting no C&D debris generated. Request you direct your design and construction agent to include these reporting requirements in the contract specifications.

3. This is a PACAF/CEC and CEO coordinated memo. If you have any questions, please contact our POC, Mr Robert Leong, HQ PACAF/CEVQ, DSN 449-6536, email: robert.leong@hickam.af.mil.

TIMOTHY K. BRIDGES, Lt Col, USAF
Chief, Environmental Quality Division
Directorate of The Civil Engineer

Attachment:
HQ USAF/ILE memo, 6 Feb 01

cc:
HQ PACAF/CEO
HQ PACAF/CEC

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON DC

MEMORANDUM FOR ALMAJCOM/CE
HQ USAFA/CE

06 FEB 2001

FROM: HQ USAF/ILE
1260 Air Force Pentagon
Washington DC 20330-1260

SUBJECT: Tracking and Reporting Solid Waste Disposal and Diversion from Landfills

The DoD implemented a new Measure of Merit (MoM) for non-hazardous solid waste in FY99 (Atch 1). ILEV, in conjunction with the AFCEE, has been working with your solid waste program managers to ensure the data collected is complete and accurate. Based on semi-annual In-Progress Review data calls and feedback from MAJCOM/installation program managers, we believe we are not capturing all of the data required to fulfill the MoM requirement. We need your installations' support, primarily within the Engineering, Operations, and Environmental Flights, to improve this process.

The new MoM requires the Air Force to report all solid waste that is disposed in landfills and also the solid waste which is diverted from landfills through reuse or recycling. This includes construction and demolition (C&D) debris. Data reviewed during the In-Progress Reviews indicates some installations may not be including all their C&D debris in their disposal and diversion measurements while other installations are consistently reporting no C&D debris generated. To ensure accurate reporting of C&D debris for both contracted and in-house projects, it is essential for Engineering and Operations Flights to work closely with their Environmental Flight Chief. For contracted operations, this may involve contract modification to include MILCON, non-appropriated funds, and MFH to ensure C&D debris data is captured. Request you direct your design and construction agent to include these reporting requirements in the contract specification. However, until this can be accomplished, reasonable estimates of contractor-generated C&D debris should be provided. Attachment 2 provides further guidance in this regard.

If you or members of your staff have any questions, please contact our POCs, Mr. Jeffrey Domm, HQ USAF/ILEVQ, DSN 327-0194, e-mail: jeffrey.domm@pentagon.af.mil or Ms. Nancy Carper, HQ AFCEE/EQT, DSN 240-4964, e-mail: nancy.carper@hqafcee.brooks.af.mil.

EARNEST O. ROBBINS II
Major General, USAF
The Civil Engineer
DCS/Installations & Logistics

Attachments:
1. DUSD(ES) Memo, 13 May 98
2. C&D Debris Measurement & Reporting Guidance

cc:
HQ AFCEE/CC/EQ
HQ USACE CEMP-M
HQ NAVFAC

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION AND TECHNOLOGY

13 MAY 1998

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, LOGISTICS & ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY (INSTALLATIONS & ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (MANPOWER, RESERVE AFFAIRS, INSTALLATIONS & ENVIRONMENT)

DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: New DoD Pollution Prevention Measure of Merit

This memorandum establishes a new DoD Pollution Prevention Measures of Merit, the "Non-Hazardous Solid Waste Diversion Rate" measure. In addition, two existing measures, the "Non-Hazardous Solid Waste Disposal" and "Non-Hazardous Solid Waste Recycling" measures, published in enclosure 4 to DoD Instruction 4715.4, "Pollution Prevention" (June 18, 1996), are canceled effective the end of FY 1998. The new MoM will replace the two canceled measures effective the beginning of FY 1999.

The new "Non-Hazardous Solid Waste Diversion Rate" Measure of Merit is:

"By the end of FY2005, ensure the diversion rate for non-hazardous solid waste is greater than 40%, while ensuring integrated non-hazardous solid waste management programs provide an economic benefit when compared with disposal using landfilling and incineration alone."

Components shall begin reporting using the new MoM for FY 1999. Installations generating less than one ton of solid waste per day are exempt from the reporting requirement, thus components need not include data for these installations in their annual reports. The new MoM will be included in the next revision of DoDI 4715.4. The attachment describes in detail how the new MoM will be reported.

I am pleased to announce that DoD achieved the goal contained in the current recycling MoM several years early. The current recycling MoM required DoD to increase the amount of solid waste that it recycled by 50 per cent using FY 1992 as a base line. For FY 1995, DoD reported that it had increased its recycling by 59 per cent from the FY 1992 base line. DoD has also made substantial progress in meeting the current solid waste MoM, achieving in FY 1995 a

Environmental Security *Defending Our Future* reduction of 23 per cent from the FY 1992 base line. Please pass on my thanks to all those who have helped achieve these successes.

Questions regarding the new MoM should be directed to Mr. Karl Weiss at (703) 604-1846.

Sherri W. Goodman
Deputy Under Secretary of Defense
(Environmental Security)

Attachment:
as stated

Attachment

Non-Hazardous Solid Waste Diversion Rate Measure of Merit

"By the end of FY2005, ensure the diversion rate for non-hazardous solid waste is greater than 40%, while ensuring integrated non-hazardous solid waste management programs provide an economic benefit when compared with disposal using landfilling and incineration alone."

Under this MoM, components shall report their 1.) diversion rate, and, 2.) cost avoidance (or additional costs) resulting from the use of integrated solid waste management, and, optionally, may report the amount of solid waste disposed through waste-to-energy incineration. Components shall report annually on a fiscal year basis, using the following units, as appropriate: percentage, tons (2,000 pounds per ton), and dollars. In preparing reports, components need not include data from installations generating less than one ton of solid waste per day. The methods for calculating the data are explained in detail below:

Diversion Rate Calculation

The diversion rate equals the rate at which non-hazardous solid waste is diverted from entering a disposal facility. Disposal facilities include landfills (both solid waste and inert) and incinerators. Composting, mulching, recycling, reuse, and donation are generally accepted waste diversion methods. The diversion rate equals:

$$(R/(R+L))*100 = \text{diversion rate (per cent)}$$

R = amount (in tons) of non-hazardous solid waste (including construction and demolition debris) that is composted, mulched, recycled, reused, donated, or otherwise diverted from a disposal facility.

L = amount (in tons) of solid waste (including construction and demolition debris) transferred to a disposal facility.

For example, if an installation composts 750 tons, recycles 1,500 tons, landfills 3,750 tons, and incinerates 1,000 tons in a waste-to-energy program from its total of 7,000 tons of solid waste generated, it would report as follows:

$$R = 750 \text{ tons} + 1{,}500 \text{ tons} = 2{,}250 \text{ tons}$$

$$L = 3{,}750 \text{ tons} + 1{,}000 \text{ tons} = 4{,}750 \text{ tons}$$

$$(R/(R+L))*100 = (2250/2250+4750)*100 = 32.1\% = \text{diversion rate (higher is better)}$$ [1]

[1] Note that although the diversion rate is the MoM, each level (installation, major command, and service) will be required to report the diversion rate itself, along with R, L, and R+L, in order to permit roll-up of the data.

Waste-to-Energy Incineration (Optional)

Components may also report the amount of solid waste disposed through waste-to-energy incineration. (Whether waste-to-energy incineration provides an environmental benefit when compared to ordinary incineration, or to landfilling, is debatable. Components that believe their waste-to-energy incineration projects do result in an environmental benefit may report the percentage so disposed.)

Continuing the above example, 7,000 tons of solid waste were generated, with 1,000 tons going to a waste-to-energy incinerator. R+L = Total amount generated. I = Total amount disposed by waste-to-energy incineration.

R+L = 7,000 tons   I = 1,000 tons

I/R+L= 14.3%[2]

Economic Benefit of Integrated Solid Waste Management Calculation

In achieving the 40 percent diversion rate, components should ensure that the cost of integrated non-hazardous solid waste management is less than the potential cost of disposing of all solid waste by traditional means, such as landfilling and incineration. The following calculation compares the costs for a hypothetical installation that generates a total of 10,300 tons of solid waste, including 1,350 tons of construction demolition debris[3]:

PDC - ADC = cost avoidance due to integrated solid waste management (dollars)

PDC = potential disposal cost if all waste were to be landfilled or incinerated (in dollars).[4]

ADC = actual cost of integrated solid waste management (in dollars).

For example, if an installation:

- Spent $300K operating a QRP
- Received $330K in proceeds from the sale of 1500 tons of recyclables through its QRP
- Spent $75K operating a composting program
- Received $80K in proceeds from composting 750 tons

---

[2] Note that if the rate of waste-to-energy incineration is reported, each level (installation, major command, and service) must also report R, L, and R+L, in order to permit roll-up of the data.

[3] For this example the installation pays $38 per ton for solid waste that it disposes of in the local municipal landfill. The installation operates its own on-base inert landfill. The estimated direct costs of disposing inert material in the on-base landfill is $5 per ton.

[4] Actual cost per ton of disposal (tipping fee or incineration fee) multiplied by total tons generated during the year.

- Paid a contractor an extra $10K to pick up and recycle 300 tons of glass, which the QRP found uneconomic to recycle.
- Donated 50 tons of construction demolition debris to a local community (in return for hauling)
- Recycled 300 tons of construction demolition debris for on-base use at a cost of $4K
- Disposed of 1000 tons of construction demolition debris in an on-base inert landfill at an estimated cost of $5 per ton
- Disposed of 6,400 tons of solid waste in a municipal landfill at $38 per ton

it would report as follows:

PDC = (8950 tons * $38 per ton) + (1350 tons * $5 per ton) = $346,950

ADC = $300,000[5] - $330,000[6] + $75,000[7] - $80,000[8] + $10,000[9] + $4,000[10] + (1000 tons *$5)[11] + (6,400 tons * $38 per ton)[12] = $238,200

$346,950 - $227,200 = $119,750 (cost avoidance resulting from integrated solid waste management)

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[5] Cost of operating QRP
[6] Proceeds from sales by QRP
[7] Cost of operating composting program
[8] Proceeds form sales by composting program
[9] Cost to pickup and recycle glass (note that this is less than the cost of disposing of the glass by landfilling)
[10] Cost to reuse construction and demolition debris on base
[11] Estimated cost (hauling, covering, and other direct costs) for disposing of 1,000 tons of construction and demolition debris in an on-base inert landfill at the hypothetical installation. Each installation that operates an on-base landfill will have to calculate its own actual costs per ton.
[12] Cost of disposing of 6,400 tons of solid waste in the local municipal solid waste landfill at $38 per ton

WASHINGTON, DC

26 JAN 1999

MEMORANDUM FOR ALMAJCOM/CEV
HQ USAFA/CEV

FROM: HQ USAF/ILEV
1260 Air Force Pentagon
Washington, DC 20330-1260

SUBJECT: Non-Hazardous Solid Waste Diversion Rate Measure of Merit (MoM)

References: (a) New DoD Pollution Prevention Measures of Merit (MoM), 6 Aug 98

(b) DUSD(ES) Pollution Prevention Measures of Merit (MoM), 13 May 98

The purpose of this memorandum is to provide Air Force policy on the new Pollution Prevention Non-Hazardous Solid Waste Diversion Rate MoM. The attached guidance defines Air Force Non-Hazardous Solid Waste Diversion Rate goals and highlights MAJCOM/Installation reporting instructions. This policy replaces the Non-Hazardous Solid Waste Disposal and Non-Hazardous Solid Waste Recycling MoM previously required under DoD Instruction 4715.4, *Pollution Prevention.*

If the members of your staff have any questions, please have them contact our POC, Capt Dwayne Thomas, AF/ILEVQ, DSN 664-0649, e-mail: dwayne.thomas@pentagon.af.mil.

TERESA R. POHLMAN
Chief, Environmental Division
DCS/Installations & Logistics

Attachment:
Air Force Policy Guidance w/ Sample Reporting Worksheet

cc:
HQ AFCEE/CC/EQ

1. Diversion Rate Definition: Non-Hazardous Solid Waste Diversion Rate MoM is *"By the end of FY2005, ensure the diversion rate for non-hazardous solid waste is greater than 40 percent, while ensuring integrated non-hazardous solid waste management programs provide an economic benefit when compared with disposal using landfilling and incineration alone."*

2. AIR FORCE GOALS: As indicated in the DUSD(ES) 13 May 98 memo, the purpose of the new MoM is to achieve the maximum possible economically viable non-hazardous solid waste diversion rate. While our goal is for all MAJCOMs and installations to achieve a diversion rate of at least 40 percent by FY 2005, this must be accomplished while achieving an economic benefit (i.e. total integrated solid waste management program costs must be less than or equal to the equivalent cost of landfilling or incineration). We encourage MAJCOMs/Installations to evaluate their existing programs, develop methodologies to accomplish the measure of merit, and consider long-term economics of diversion rate investments. The following outlines Air Force diversion rate goals by fiscal year and establishes when Air Force non-hazardous solid waste programs should break even and show an economic benefit.

FISCAL YEAR	DIVERSION RATE (PERCENTAGE)	ECONOMIC BENEFIT
1999	15	*N/A
2000	20	N/A
2001	25	N/A
2002	30	N/A
2003	35	N/A
2004	40	BREAK EVEN PERIOD
2005	40	ECONOMIC BENEFIT

*** Economic benefit glide path guidance will follow at the end of FY99.**

3. Construction and Demolition Debris: The new MoM includes construction debris within total yearly non-hazardous solid waste calculations. MAJCOMs/Installations are encouraged to meet this challenge aggressively with new approaches and methods. Future construction contracts must include non-hazardous solid waste reporting requirements. We encourage installations to find innovative methods to promote cost-effective non-hazardous solid waste diversion within construction contracts. MAJCOM cross-feeds and AFCEE/EQ are excellent resources to begin working construction and demolition debris into existing and future contracts.

Capt Dwayne E. Thomas/AF/ILEVQ/20 Jan 99/703-604-0649

1. Definitions: See referenced DUSD(ES) package for sample calculations and definitions of the variables: R, L, I, R_C, L_C, PDC, and ADC.

2. Applicability: Detailed reporting requirements apply to all Air Force installations. Although the DUSD (ES) memorandum stipulates installations generating less than one ton of solid waste per day are exempt from the reporting requirements, all Air Force installations are required to report non-hazardous solid waste using the new diversion rate.

3. Waste-to-Energy Incineration. MAJCOMs/Installations that have waste-to-energy incineration projects must report the percentage disposed.

4. Reporting Requirements: The following information will need to be tracked and reported on a quarterly basis to AF/ILEV with a courtesy copy to AFCEE/EQ.

MAJCOM reports should be installation-specific with totals annotated for the command. The following information is required (See sample worksheet):

- R (tons) - Amount of non-hazardous solid waste diverted (listed separately)
  - Composted
  - Mulched
  - Recycled
  - Reused
  - Donated
- L (tons) - Amount of non-hazardous solid waste sent to disposal facilities
- (R/(R+L))*100 (percent) - Diversion Rate
- I (tons) - Amount of non-hazardous solid waste disposed by waste-to-energy incineration
- (I/(R+L))*100 (percent) - Incineration Rate
- PDC (dollars) Potential cost if all non-hazardous solid waste were landfilled or incinerated
- ADC (dollars) - Actual cost of integrated solid waste management (includes recycling cost, composting cost, hauling, covering, and any other direct/indirect cost)
- PDC-ADC (dollars) - Cost avoidance due to integrated solid waste management
- R_C (tons) Amount of non-hazardous solid waste attributable to construction and demolition diverted
- L_C (tons) Amount of non-hazardous solid waste attributable to construction or demolition debris sent to disposal facilities

Capt Dwayne E. Thomas/AF/ILEVQ/20 Jan 99/703-604-0649

Quarterly Report	Due Date
Oct - Dec	*31 Jan
Jan - Mar	30 Apr
Apr - Jun	31 Jul
Jul - Sep	31 Oct

* FY99 first quarter data is not required. First report is due 30 Apr 99 and should include all first quarter data.

Capt Dwayne E. Thomas/AF/ILEVQ/20 Jan 99/703-604-0649

C&D DEBRIS MEASUREMENT AND REPORTING

The Solid Waste Measure of Merit (MoM) requires the Air Force to report all non-hazardous solid waste diversion, including construction and demolition (C&D) debris. Data is collected by each installation CEV for upward reporting semiannually. The total amount of debris disposed in landfills must be reported, and the total amount of debris diverted from landfills by reuse or recycling must also be reported. This applies to contracted and in-house projects. The total weight of C&D debris sent to the landfill, and the total weight diverted from the landfill, need to be provided by CEC and CEO to CEV.

Contract specifications must require contractors to report both the weight of C&D debris disposed in landfills and the weight diverted from landfills. "WasteSpec", a tool produced by the Triangle J Council of Governments, can help project teams modify their specifications to support solid waste reduction goals. Visit www.tjcog.dst.nc.us/wastspec.pdf for more information.

Installations should estimate contractors' C&D waste generation if actual data is not available. HQ AFCEE/EQ has produced a C&D Waste Management Guide to assist in this task. Use the self-calculating Excel spreadsheets included in the Guide to create engineering estimates of C&D waste, until contracts are revised to allow for actual data collection. These are available on AFCEE's website at www.afcee.brooks.af.mil/eq/programs/summary.asp?rscID=870.

MAJCOMs with contractor-operated locations should ensure environmental reporting requirements are incorporated into contracts when the contracts are amended or renewed, or when the option years are executed. Along with reporting, MAJCOMs should ensure these contracts include requirements for reducing solid waste generation, and promoting recycling and reuse. The clause at FAR 52.223-10, "Waste Reduction Program," is used to promote cost-effective waste reduction in all solicitations and contracts for contractor operation of Government facilities and all contracts for support services at Government facilities.

In-house generation of C&D waste must be tracked and reported to CEV along with the data provided by contractors. Provide the actual weights if data is available, or use the spreadsheets in the C&D Waste Management Guide to calculate reasonable estimates of the waste generated by in-house projects. Spreadsheets are provided for new construction and renovation for two types of projects, residential and non-residential.

In addition to the spreadsheets, the C&D Waste Management Guide provides environmental program managers, design engineers, and operations personnel with a comprehensive resource for C&D waste management planning and execution.

A "pocket" version of the C&D Waste Management Guide is also available in hard copy from AFCEE's PRO-ACT service at DSN 240-4214. It is a summary of the Guide and has been designed as a quick reference for field personnel.

--END OF APPENDIX 10--

CECW-ETE

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
Washington, D.C. 20314-1000

ETL 1110-3-491

Technical Letter
No. 1110-3-491

1 May 2001

EXPIRES 31 MARCH 2005
Engineering and Design
SUSTAINABLE DESIGN FOR MILITARY FACILITIES

1. Purpose. This letter provides basic criteria and information pertaining to the incorporation of sustainable design concepts in the design and construction of Military facilities.

2. Applicability. This letter applies to all HQUSACE elements and USACE commands having Army military construction and design responsibility.

3. Distribution. Approval for public release; distribution is unlimited

4. References. See Appendix A.

5. Objective. Sustainable Design is the design, construction, operation, and reuse/removal of the built environment (infrastructure and buildings) in an environmentally and energy efficient manner. The major tenet of sustainable design is to meet the needs of the present without compromising the ability of future generations to meet their own needs. Synonymous with Sustainable Design is "Green Building." Sustainable design includes efficient use of natural resources, better performing, more desirable, and more affordable infrastructure and buildings. Sustainable design incorporates the energy efficiency concerns of the 1970's with the concerns in the 1990's related to damage to the natural environment; emissions of greenhouse gases and ozone depleting chemicals; use of limited material resources; management of water as a limited resource; reductions in construction, demolition and operational waste; indoor environmental quality; and occupant/worker health, productivity and satisfaction. This ETL provides designers with guidance on sustainable design for the design and construction of all new Army facilities, and the rehabilitation/renovation of existing facilities.

6. Action. The guidance in Appendix B to this technical letter will be used for planning, design and construction of Army facilities to incorporate Sustainable Design or Green Building concepts. Effective immediately all of our deign for military facilities shall phase in SDD and shall strive to achieve SPiRiT Bronze level AS DEFINED IN Appendix C.

This engineer technical letter supersedes ETL 110-3-491 dated 31 Jan 2000

7. Imnlementation. This technical letter will have immediate application, as defined in paragraph 6c, ER 1110-345-100.

FOR THE COMMANDER:

For

DWIGHT A. BERANEK, P.E.
Chief, Engineering and Construction Division
Directorate of Civil Works

3 Appendices
APP A - References and Bibliography
APP B - Sustainable Design for Military Facilities
APP C - Sustainable Project Rating Tool (SPiRiT)

APPENDIX A

REFERENCES AND BIBLIOGRAPHY

1. Referenced Laws, Regulations And Publications

a. Alternative Motor Fuels Act (AMFA) of 1988, P.L. 100-494 (42 USC 6374).

b. Energy Policy Act (EPACT), P.L. 102-486, December 1992.

c. National Environmental Policy Act (NEPA) of 1969; as amended by P.L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970; P.L. 94-52, July 3, 1975; P.L. 94-83, August 9, 1975, and P.L. 97-258, 4(b), Sept. 13, 1982.

d. National Pollution Discharge Elimination System (NPDES), established by Clean Water Act, 33 U.S.C. Chapter 26, established 1972 and as amended.

e. Executive Order 12873, Federal Acquisition, Recycling, and Waste Prevention, signed on August 6, 1993.

f. Executive Order 12902, Energy Efficiency and Water Conservation at Federal Facilities, signed on March 8, 1994.

g. Executive Order 13123, Greening the Government Through Efficient Energy Management, signed on June 3, 1999.

h. Executive Memorandum, Environmentally and Economically Beneficial Practices on Federal Landscape Grounds, signed on April 26, 1994.

i. Technical Manual 5-803-13, Landscape Design and Planting

j. Technical Manual 5-803-14, Site Planning and Design

k. MIL-HDBK 1165, Military Handbook, Water Conservation.

l. Engineering Regulation (ER) 1110-345-100, Design Policy for Military Construction.

m. Comprehensive Procurement Guidelines I (CPG I) for Products Containing Recovered Materials; Final Rule [60 FR 21370, May 1, 1995].

n. Comprehensive Procurement Guidelines II (CPG II) for Products Containing Recovered Materials; Final Rule [62 FR 6096, November 13, 1997].

o. Recovered Materials Advisory Notice I (RMAN I); Final Notice of Availability, [60 FR 21386, May 1, 1995].

p. Recovered Materials Advisory Notice II (RMAN II); Final Notice of Availability, [62 FR 60995, Nov 13, 1997].

q. American Society of Heating, Refrigerating and Air-Conditioning Engineers ASHRAE) Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.

r. Federal Recycling Guide for Waste Prevention, Recycling and Buying Recycled, EPA-904B95007, USEPA Region 4 Library, 345 Courtland Street, N.E., Atlanta, GA.

s. Illumination Engineering Society of North America (IESNA), 120 Wall Street, New York, NY.

t. Leadership in Energy and Environmental Design (LEED) Building Rating System, U.S. Green Building Council, 90 Montgomery St., Suite 1001, San Francisco, CA.

2. Bibliography

a. Recommendations for Incorporating Green Building Concepts in USACE Guidance Documents, Prepared by the Civil Engineering Research Foundation (CERF) for Headquarters, U.S. Army Corps of Engineers, Washington, DC, 1995.

b. Sustainable Building Technical Manual--Green Building Design, Construction, and Operations. Prepared by Public Technology, Inc., for the U.S. Green Building Council. Sponsored by U.S. Department of Energy and U.S. Environmental Protection Agency, 1996.

c. U.S. Air Force Environmentally Responsible Facilities Guide (Draft), Prepared by Hellmuth, Obata & Kassabaum (HOK), Inc., for the U.S. Air Force Center for Environmental Excellence, Brooks AFB, San Antonio, TX, 1996.

d. Sustainable America: A New Consensus for Prosperity, Opportunity, and a Healthy Environment for the Future, 1996, The President s Council on Sustainable Development (PCSD). US Government Printing Office, Superintendent of Documents, Washington, DC 20402-9328.

e. Sustainable Communities: A New Design Synthesis for Cities, Suburbs and Towns, 1986, Sierra Club Books, PO Box 7959, San Francisco, CA, 94120-7959.

f. A Sustainable World: Defining and Measuring Sustainable Development, 1994, International Center for the Environment and Public Policy, P.O. Box 189040, Sacramento, CA 95818.

g. Community Energy Workbook: A Guide to Building a Sustainable Economy, 1995, Rocky Mountain Institute, 1739 Snowmass Creek Road, Snowmass, CO, 81654.

APPENDIX B

SUSTAINABLE DESIGN FOR MILITARY FACILITIES

APPENDIX B
SUSTAINABLE DESIGN FOR MILITARY FACILITIES

1. Background

a. On June 3, 1999 Executive Order (E.O.) 13123, "Greening the Government Through Efficient Energy Management" was signed. This E.O. establishes goals for greenhouse Gases (GHG) reduction, energy efficiency improvement, industrial and laboratory facilities, renewable energy, petroleum, source energy, and water conservation. E.O. 13123, Part 2 – GOALS, lists seven goals for facilities. Six of the seven specifically emphasize that "life-cycle cost-effective" means are to be used to comply with these goals. The E.O. specifically states that: "agencies shall apply such principles to the siting, design, and construction of new facilities. Agencies shall optimize life-cycle costs, pollution, and other environmental and energy costs associated with the construction, life-cycle operation, and decommissioning of the facility." This emphasis on life-cycle cost effectiveness may, in many occasions, make it more difficult to achieve goals established by this E.O.. E.O.'s 12902, 12845 and 12795 are revoked by E.O. 13123.

b. On August 6, 1993 Executive Order (EO) 12873, "Federal Acquisition, Recycling, and Waste Prevention," was signed. Section 401 of this E.O. states that "In developing plans, drawings, work statements, specifications, or other product descriptions, agencies shall consider the following factors: elimination of virgin material requirements; use of recovered materials; reuse of product; life cycle cost; recyclability; use of environmentally preferable products; waste prevention (including toxicity reduction or elimination); and ultimate disposal, as appropriate." The EO also directed the Environmental Protection Agency (EPA) develop guidance to help federal agencies incorporate environmental preferability into their purchasing procedures.

c. In response to EO 12873, EPA developed Comprehensive Procurement Guidelines (CPG I and II). These are the first formal regulations implementing sustainability requirements. The companion Recovered Materials Advisory Notices (RMAN I and II) contain EPA's recommendations for purchasing all items designated in the final CPGs. Currently, EPA has designated 36 items that are, or can be, manufactured using recycled and recovered materials. Construction, landscape, park and recreation products are among the designated items. Federal Agencies are required to purchase EPA-designated items meeting minimum recycled-content standards unless they are not available within a reasonable period of time; fail to meet reasonable specification standards; are not available from two or more sources (to maintain competition); or are unreasonably priced (5% higher than comparable non-recycled products). Recycled-content purchase requirements are discussed in EPA's "Federal Recycling Guide for Waste Prevention, Recycling and Buying Recycled."

2. Definition

a. Sustainable Design (Green Building) is the design, construction, operation, and reuse/removal of the built environment (infrastructure as well as buildings) in an environmentally and energy efficient manner. Sustainable Design is meeting the needs of today without compromising the ability of future generations to meet their needs. Sustainable Design includes not only efficient use of natural resources, but it can also translate into better performance, desirability, and affordability.

b. Sustainable Design incorporates the energy concerns of the 1970's with new concerns in the 1990's, including damage to the natural environment; emissions of greenhouse gases and ozone depleting chemicals; use of limited material resources; management of water as a limited resource; reductions in waste; indoor environmental quality; and occupant/worker health, productivity and satisfaction. Ideally, we would only use resources in the built environment at the speed at which they naturally regenerate, and discard them at or below the rate at which they could be absorbed by natural ecological systems.

c. While the ideal may not be achievable at present, those involved in designing, constructing, operating, maintaining, and retiring the components of the built environment, such as the U.S. Army Corps of Engineers (USACE), can take steps now to maximize energy efficiency and minimize environmental impact. Green Building goes beyond simple green products and recycled materials. Green Building is an environmental consciousness or resource awareness about using or not using our valuable natural resources in an energy-conscious or conservative way. This is an important concept. It is an attitude about applying sound design principles and practices to create a built environment, which optimizes the functionality and operability of the total system while incorporating sustainable design principals.

3. Goals and Objectives of Sustainable Design

a. The overall USACE goal of Sustainable Design is to be environmentally responsible in the delivery of facilities. The key traditional elements for decision making in the facility delivery process are cost, quality and time. These elements need to be expanded to include the ecological and human health impacts of all decisions.

b. Each project generates its own set of goals. However, sustainable design goals should apply to all projects. The goals for improving the environmental performance of facilities include: (a) use resources efficiently and minimize raw material resource consumption, including energy, water, land and materials, both during the construction process and throughout the life of the facility, (b) maximize resource reuse, while maintaining financial stewardship, (c) move away from fossil fuels towards renewable energy sources, (d) create a healthy and productive work environment for all who use the facility, (e) build facilities of long-term value, and (f) protect and, where appropriate, restore the natural environment.

c. Identify environmental goals and requirements from paragraph 3A and 3B above to be implemented during the design process, and include them in the project development document. Integrate into the project planning and goal setting process applicable requirements from the installation Pollution Prevention (P2) Program. Make decisions during the planning and design process to support installation-wide reduction in the release of ozone depleting chemicals (ODC) and greenhouse gases; reduction in the use of hazardous materials and pesticides, and the generation of solid wastes; and support the EPA 33/50 Program (a voluntary program targeting 17 chemicals for reduction).

d. Where possible, budget for environmental and energy-efficient equipment, systems, and design solutions based on life cycle cost assessment (LCCA). Consider potential for cost-effective use of photovoltaics, on-site wastewater treatment, and graywater systems. Generally the potential for these is greatest in remote areas. Where those technologies show promise, include as special requirements in the project description, and budget accordingly.

e. While developing the DD1391, identify funding sources for sustainable features that cannot be addressed within the Programmed Amount (PA). Also identify, by line item, resources required for desired level of Systems Commissioning and for the preparation of O&M Manuals.

4. Project Design Team

a. Only through an interdisciplinary approach can true sustainability be achieved. Technical Manual 5-803-14, Site Planning and Design, describes the design team. Guidelines set forth in the AEI on Installation Support should be followed in establishing the design team. The makeup of the team will be determined by the particular type of project, but members must achieve a common understanding of environmental and energy conservation concerns. All members of the design team should participate in initial goal setting and should also attend the design charette.

b. Set clear and specific environmental and energy conservation goals for the project. Quantify goals wherever possible; for example, energy use, water use, allowable levels of volatile organic compounds (VOC) emissions, etc. The Environmental members of the design team shall educate the entire team about opportunities for incorporating sustainable design.

c. Consideration of many more system options will require extensive training, criteria, policy, additional computer modeling software, and additional experience to enable the selection of the most Life-Cycle Cost Effective solutions. Building Commissioning will be necessary to initiate proper operation of these more complex systems. Facilities will require the installation, periodic calibration, maintenance, and repair of additional meters.

5. Planning and Site Selection

a. Use the procedures described in Technical Manual 5-803-14, Site Planning and Design, to analyze the site. In addition, when planning and selecting a site, the following should be considered to minimize environmental impacts: (a) renovate and reuse existing buildings, where possible, (b) leave pristine areas untouched and minimize disturbance to wildlife habitats, (c) give priority to and build on previously disturbed or damaged sites, and, where possible, restore damaged areas, (d) minimize transportation requirements for the transport of goods and services and for employee, occupant, or customer commuting, (e) maximize existing transportation links, especially public transit, and minimize the need to build new links, and (f) maximize cluster development strategies to reduce disturbance of open areas and reduce utility and transportation costs.

b. Review the established Installation Master Plan, Installation Design Guide, general planning guidelines, or sub-installation area development plans to ensure an optimal coordinated site selection, as described in Technical Manual 5-803-14. Rank alternate sites for the proposed project based upon a comparative analysis of the issues. Consider the potential environmental impacts the proposed improvements will have on the surrounding environment, neighboring communities and cultural resources. Review the Environmental Impact Statement (EIS), and pay particular attention to impacts of decreased water quality, increased storm water runoff, increased erosion potential and ambient air quality. Ensure compliance with the National Environmental Policy Act (NEPA). Consider the reuse or rehabilitation of an existing previously developed site rather than altering undisturbed raw land, if an existing base is not to be utilized for the proposed improvements. Consider the location of the proposed site in relation to existing facilities to minimize transportation requirements and to provide opportunities for shared use of common areas wherever possible. Understand the micro-climate of each site and identify which sites have the best potential for sustainable design based on temperature, humidity, wind and solar orientation. Consider each site's potential for producing alternative forms of electricity. For example, remote guard shacks may be good candidates for the use of photovoltaics. Consider the vegetation and topography of each site and identify which site would require the least amount of disruption in order to accommodate the proposed improvements. Consider the geology and hydrology of each site and identify which sites are most suitable for the proposed improvements. Avoid development of sites that would adversely affect watersheds. Consider any potential for cleanup (Installation Restoration Program) requirements for the site. Understand the ecology of the site in order to identify natural habitats that may be endangered through its development, and select a site on which the proposed improvements can be developed in a manner that maintains the existing ecological balance.

6. Site Development

a. The project site should be developed as described in Technical Manual 5-803-14 and within the following guidelines to ensure minimum environmental disturbance: (a) protect site natural resources, such as water, soil, vegetation, natural amenities, etc., (b) place infrastructure and buildings on the site (cluster buildings, where possible) to minimize disturbance, preserve open space and environmentally sensitive areas, and to make beneficial use of renewable resources (sun, wind, rain, snow, etc.)., and (c) maximize the use of existing site conditions such as: natural drainage patterns, natural vegetation and soils, clean air, etc.

b. A complete site survey and soils report should be produced as described in Technical Manual 5-803-14. Include watersheds, drainage areas, stream corridors, wetlands, aquifer recharge zones, hundred year flood plains, special vegetative areas, and a tree survey (include location, genus and species) of all trees sized 15 cm DBH (diameter breast height) or greater. Identify locations of any special cultural or archaeological sites. Document all information on site analysis drawings. Test site radon levels if the region has potential for radon contamination. Develop a plant list to be used during the design process that identifies acceptable native plants and other plants that are suitable for use on the site based upon existing climate, soils and ecology and pest and disease considerations, as described in Technical Manual 5-803-13, Landscape Design and Planting.

7. Sustainable Design and Construction of the Built Environment

Design and construction of sustainable buildings should be in accordance with the following concepts:

a. Strategic Facility Planning and Programming--Analysis to determine whether to renovate or build new, sell existing facilities or lease, consolidate or decentralize, is critical to ensuring long-term viability, resource conservation and life-cycle cost benefits;

b. Site Work and Planning--Environmentally sensitive planning looks beyond the boundary of the project site to evaluate linkages to transportation and infrastructure, ecosystems and wildlife habitat and community identification. Site planning evaluates solar and wind orientation, local microclimate, drainage patterns, utilities and existing site features to develop optimal siting and appropriate low maintenance landscape plant material;

c. Building Layout and Design--Optimize building size, and maintain an appropriate building scale for the environment and context of the building or a building component. Layout the rooms of a building for energy performance and comfort, and design for standard sizes to minimize material waste. Pay careful attention to the location of exterior windows. Avoid structural over-design and the resultant waste. Design components of the built environment for durability and ease of adaptation to other uses, and for waste recycling.

d. Energy--Building orientation and massing, natural ventilation, day-lighting, shading and other passive strategies, can all lower a building's energy demand and increase the quality of the interior environment and the comfort and productivity of occupants. The efficiency of required systems is maximized through use of advanced computer modeling and life cycle cost analysis;

e. Building Materials--Environmentally preferable building materials are durable and low maintenance. Within the parameters of performance, cost, aesthetics and availability, careful selection and specification can limit impacts on the environment and occupant health;

f. Indoor Air Quality--Indoor air quality is most effectively controlled through close coordination of architecture, interiors and MEP design strategies that limit sources of contamination before they enter the building. Construction procedures for IAQ and post-occupancy user guides also contribute to good long-term IAQ;

g. Water--Site design strategies that maximize natural filtration of rainwater and consideration of on-site biological treatment systems for building gray water and waste water can enhance water quality. Water conservation is enhanced by low flow plumbing fixtures, water appropriate landscaping and HVAC and plumbing system design;

h. Recycling and Waste Management--Waste and inefficiency can be limited during construction by sorting and recycling demolition and construction waste, reuse of on-site materials and monitoring of material use and packaging. Accommodating recycling into building design reduces waste while generating revenues;

i. Building Commissioning, Operations and Management--Effective building commissioning is essential to ensure proper and efficient functioning of systems. Facilities operations benefit from the monitoring of indoor air quality and energy and water saving practices, waste reduction and environmentally sensitive maintenance and procurement policies; and

j. Strategic Environmental Management--By integrating long-range environmental considerations into their proactive planning process, manufacturing-based organizations (such as AMC) can eliminate emitted or discharged pollutants. Strategic environmental management helps to understand and assess environmental risks and opportunities so users can make informed decisions about their facilities and processes.

k. Construction Contracts—Administration of construction contracts with new incentive clauses and complex shop drawings will require additional training, experience, resources and acquisition strategies.

8. Maximizing User Health and Productivity

a. In order to maximize the health and productivity of inhabitants and users of sustainable projects, the following guidelines should be followed to the maximum extent practicable:

(1.) Pay particular attention to indoor air quality, i.e., minimize radon entry, exposure to electromagnetic fields, pesticides, products that release formaldehyde and volatile organic compounds, and other "sick building" factors, and

(2.) Provide adequate, efficient lighting, and where possible, incorporate into design of a building: day lighting, natural ventilation, views, greenery and other indoor environmental amenities.

(3.) Provide effective air distribution patterns and ensure that temperature and humidity comply with existing Corps criteria.

b. Use existing Corps criteria as well as ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, as a design guideline. Document IAQ related site characteristics. In urban, industrial or other areas with possible air quality problems, test ambient air quality on-site. Typical facility-related air pollutant emissions sources to be addressed include aircraft operations, motor vehicles, energy generators and boilers, incinerators, industrial processes (such as plating, spray-painting and abrasive blasting), volatile fuels and solvents, jet and rocket engine test facilities, asphalt/concrete plants, wastewater treatment facilities and bakeries and laundries. Determine air filtration requirements and ensure that the requirements of CEGS 15895, Air Supply and Distribution System, are met. Consider air filter alarms to notify building maintenance personnel so that excessive static pressure does not develop and compromise efficiency. Determine fresh air rates based on ASHRAE Standard 62-1989 and other Corps criteria. Do not underestimate occupant densities. Consider programmed number of occupants plus visitors and plan for possible future requirements.

9. Designing for Energy Efficient Operation

a. Sustainable design requires the use of energy efficient equipment and systems, such as the following:

(1.) Use high levels of insulation, tight construction, high-performance windows (superior insulating value), and glazing with low solar heat gain (in appropriate climates).

(2.) Make use of renewable energy sources, i.e., passive solar heating, natural cooling or ventilation, day-lighting, photovoltaic electricity production, etc, where life cycle cost effective.

(3.) Use energy conserving mechanical and electrical equipment and their accessories, as well as lighting, that meets or exceeds existing Corps criteria. Investigate the use of cleaner fuels such as natural gas and cogeneration where remote government owned power plants are available.

b. Ensure that the design methodology and other energy conservation criteria of Chapter 11, Architectural and Engineering Instructions--Design Criteria, are followed or exceeded, including the selection of equipment and systems based on life cycle cost and compliance with energy use budgets. Consider the use of low energy consuming systems such as geothermal heat pumps, desiccant cooling and thermal storage, as well as equipment that exceeds the minimum energy efficiencies contained in the CEGS and other Corps criteria.

c. Gather information on the climate including temperature, humidity, insulation, wind, precipitation and other weather anomalies. Identify aspects of the micro-climate that create opportunities for energy conservation such as solar orientation for passive and/or active solar strategies, and topography or vegetation for shade and windbreaks. Explore energy sources available at the site. Identify opportunities for the cost-effective use of alternative energy resources such as photovoltaic panels, wind, biofuels and geothermal. Review utility rate structures and identify demand charges. Evaluate potential for utility rebates. Investigate building usage patterns and occupant loading rates for optimum conditions.

d. Determine lighting levels for all programmed areas based on Illumination Engineering Society (IES) recommendations. Consider lighting strategy when determining foot-candle levels (e.g., uplighting, downlighting, etc.). When task lighting is anticipated, reduce ambient lighting levels accordingly. Determine plug loads for energy modeling purposes based on the probable usage. Consider difference between energy surge during equipment start up and actual energy usage of equipment, and factor in diversity to reflect actual number of equipment users at any given time. Plug loads are commonly overestimated. Require office equipment and appliances to meet the requirements of the EPA Energy Star program.

10. <u>Management of Water as A Limited Resource</u>

a. Water is one of our most important life sustaining resources; with potable water being critical in much of the U.S. Sustainable Design requires careful consideration of the following: (a) utilize xeriscape design principles, and water-efficient, low-maintenance, native landscape materials, (b) utilize water-efficient plumbing fixtures, (c) design for the reuse of rainwater and "graywater" (water from showers, sinks, and washing machines) where permitted, and (d) recycle sewage treatment plant sludge or minimize the environmental impact of its disposal.

b. The designer must evaluate the possibility of eliminating permanent irrigation systems through the use of plant materials that are appropriate for the site's climate and soils as described in TM 5-803-13. If plant materials with supplemental water requirements are desired, limit their use to a defined area and utilize efficient drip irrigation systems. The designer should evaluate potential for rainwater retention or graywater recycling as described in TM 5-803-14. Analysis using LCCA is required if systems were identified during the planning phase. Ideal applications are regions with limited water availability and where some landscape irrigation is desirable.

c. Since graywater reclamation and wastewater treatment facilities require regulatory authority approval, initiate the permitting process as soon as the requirement is known. Identify the personnel who will operate and maintain the treatment system and obtain their input before selecting a system. Evaluate potential for cost-effective mechanical or biological on-site wastewater treatment of wastewater or runoff from paved areas. Analysis using LCCA is required if these systems were identified during the Planning Phase. Ideal applications for wastewater include facilities with high water use requirements and localities where water treatment is limited and/or costly. Ensure that facility siting is in accordance with the wellhead protection plan of the installation. Develop water-conserving criteria for plumbing fixtures.

d. At a minimum, the designer must use low-flow fixtures as described in CEGS 15400, Plumbing, General Purpose, and CEGS 15405, Plumbing, Hospital. Evaluate requirements for National Pollution Discharge Elimination System (NPDES) permitting, resulting from facility operations or construction. Facilities and surrounding area should minimize potential for storm water runoff and resulting erosion.

11. <u>Resource-Efficient Materials In Design and Construction</u>

a. The designer must incorporate Sustainable Design by investigating the following:

(1.) Consider the total life-cycle costs and environmental impact of products and materials rather than just their initial price. Use durable products and materials. Select materials with low embodied energy.

(2.) Avoid environmentally harmful materials, i.e., those containing ozone-depleting chemicals or releasing gaseous pollutants, toxins, etc. Also avoid utilizing excessive packaging, where possible.

(3.) Buy locally produced materials to minimize the impact of transporting them.

(4.) Reuse salvaged materials, or use products made from recycled materials. Select materials that can be recycled at the end of their use.

(5.) Use integrated pest management practices to reduce the use of pesticides that may present a hazard to humans and the environment. In selecting pest management, preference should be given to practices that minimize or eliminate the need for chemical applications.

b. Designers will specify a preference for recycled-content building materials in accordance with EPA Guidelines. Designers should identify locally manufactured building materials and products, and create list of manufacturers/suppliers for the design team. This process will streamline materials research during design, and will enhance early consideration of locally manufactured types of products. This process will not be used to limit competition during bidding. As an exception, the designer of historic building renovations will identify building materials for renovation, etc. These materials are subject to the Secretary of Interior Standards.

12. <u>Green Building Rating System: Sustainable Project Rating Tool (SPiRiT)</u>

a. SPiRiT is a USACE developed rating tool that resulted from the Army Chief of Staff for Installation Management (ACSIM) memo, 1 May 2000 decreeing that all future facilities be designed and built according to sustainable principles as well as requesting USACE to provide technical guidance to support this initiative. USACE has a licensed agreement with the US Green Building Council permitting us to use its name Leadership in Energy and Environmental Design (LEED) as part of SPiRiT. The LEED Green Building Rating System is a proprietary program of the US Green Building Council. With the use of SPiRiT we will ensure that Sustainable Design and Development is considered in Army installation planning decisions and infrastructure projects to the fullest extent possible, balanced with funding constraints and customer requirements. Based on existing proven technology it evaluates environmental performance from a "whole building" perspective over a building's life cycle, providing a definitive standard for what constitutes a "green building". As a minimum we shall use SPiRiT to score our design and strive to meet the SPiRiT Bronze certification level. When the recommended Bronze level is not achieved, the District Project Delivery Team's Project Manager will report the issue to the MSC Program Manager and to the PM at HQUSACE with an explanation as to why this level can not be achieved. The HQUSACE PM will forward this information to Engineering Team of Technical Policy Branch, Engineering and Construction Division.

b. SPiRiT is based on accepted energy and environmental principles and strikes a balance between known effective practices and emerging concepts. Unlike other rating systems currently in existence, the development of SPiRiT uses applicable, equivalent military standards and regulations, where applicable.

c. SPiRiT is a self-evaluation system designed for the design agent and the owner to rate new and existing facilities. It is a feature-oriented system where credits are earned for satisfying each criteria. Different levels of SPiRiT certification levels are awarded based on the total credits earned. The system is designed to be comprehensive in scope, yet simple in operation.

d. For classification as a Green building, facilities must satisfy all of the prerequisites and a certain number of credits to attain different SPiRiT certification levels. Having satisfied the basic prerequisites of the rating tool, facilities are then rated according to its degree of compliance (on a percentage basis) with the credit system listed below.

e. SPiRiT is divided into eight categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality facility delivery process, current missions, and future missions. The following is a synopsis of SPiRiT.

Sustainable Sites (Score 20) SPiRiT minimizes the impact of placing a building on a site, with an eye to land use compatibility and biodiversity. It channels development to installation areas with existing infrastructure, rehabilitates damaged sites, and reduces impacts from automobile use. SPRT optimizes microclimate and minimizes effects on neighboring sites of noise, light, runoff, pollution, etc.

Water Efficiency (Score 5) SPiRiT minimizes the use of potable water for landscape irrigation and within the building.

Energy and Atmosphere (Score 28) SPiRiT ensures that buildings work as intended. It establishes energy efficiency and optimization for the base building and systems and encourages use of renewable and distributed energy systems. It reduces ozone depletion and supports early compliance with the Montreal Protocol.

Materials and Resources (Score 13) SPiRiT reduces waste from construction and building occupants and redirects recyclable material back to the manufacturing process. It extends the life cycle of existing building stock, in part by extending the life cycle of targeted building materials. It increases use of building products with recycled content material and of locally manufactured building products. It reduces depletion of finite raw materials and encourages environmentally responsible forest management.

Indoor Environmental Quality (IEQ) (Score 17) SPiRiT promotes indoor air quality (IAQ) and prevents exposure to Environmental Tobacco Smoke (ETS). It provides a high level of individual occupant control of thermal, ventilation, and lighting systems. SPiRiT provides a connection between indoor spaces and the outdoor environment through the introduction of sunlight and views into the occupied areas of the building. SPiRiT provides appropriate acoustic conditions for user privacy and comfort.

Facility Delivery Process (Score 7) SPiRiT delivers a facility that optimizes tradeoffs among sustainability, first costs, life cycle costs and mission requirements. It assures that the delivery process assures efficient operation and maintenance of the facility.

Current Mission (Score 6) SPiRiT assures that the delivery process establishes efficient operation and maintenance of the facility. It provides a high-quality, functional, healthy, and safe work environment to promote soldier and workforce productivity and retention.

Future Missions (Score 4) SPiRiT requires an understanding of: (1) The typical or likely lifespan of the function to be accommodated by the facility in order to recognize how soon the facility should be expected to adapt to a different use; and (2) The life spans of the building systems to understand when they will need to be updated during the lifespan of the facility and to design the facility in a manner that facilitates the updating of each system. It requires design of the facility to maximize accommodation of future uses. The greater the future flexibility, the less likely it is that the facility will become a source for waste materials, or that it will require additional materials.

SPiRiT Certification Levels

SPiRiT Bronze -- 25 to 34 Points
SPiRiT Silver -- 35 to 49 Points
SPiRiT Gold -- 50 to 74 Points
SPiRiT Platinum -- 75+ Points

SPRT is designed to be an easy-to-understand EXCEL worksheet that will allow self-scoring by building delivery teams and their members, either during the charrette process or by an independent panel.

Credit Equivalence: Under certain circumstances an action will be taken that will comply with the spirit, though not necessarily the letter, of the compliance criteria. Under these circumstances, the applicant must demonstrate that the actions taken are substantially similar in impact to the relevant criteria and request credit for those actions.

f. SPiRiT is the first edition of this program. The LEED Green Building Rating System criteria will be revised no later than every 3 years. It is intended that with the future edition of LEED 3.0 in 2003 all required applicable, equivalent military standards and regulations will be addressed availing us the use of LEED 3.0 upon release in order to design and build all future facilities according to sustainable principles.

13. Corps Of Engineers Green Building Criteria Update Program

In 1994, funding was provided for a 5-year program for the Corps to develop and update technical guidance and criteria for sustainable design and construction of Army facilities. The Corps continues this effort with steady stream funding programmed for FY00-05. The Corps has taken a comprehensive, ground-up approach to sustainable design technology in military construction. The Corps philosophy is to effect a fundamental and permanent change in the way all military projects are designed and constructed as opposed to a project-by-project basis. In order to institutionalize sustainable design into Corps design procedures, we are revising current construction guide specifications (CEGS) which are used to design and construct military projects. We have called this our Green Building Criteria Update Program (GBCUP). This provides a solid basis for incorporating a wide range of Green construction products and services into Corps projects, including:

- Floors, carpets, walls, doors, ceilings and roofing systems, including insulation and painting--Assessment of reusability, solid waste generation, and indoor air quality.
- Masonry, stucco, lathing and plastering--Environmental characteristics of recycled and composite materials.
- Metal studs in load-bearing walls as a substitute for wood.
- Scrap tire chips and cement and asphaltic concrete in pavements--Elimination and use of waste materials.
- Bottom ash used as fill, and waste materials in pavements--reusing construction waste materials.
- Recycled plastic composite railroad ties.
- Recycled site furnishings and playground equipment.
- Energy efficient HVAC controls, radiant heating systems and desiccant cooling systems.
- Water and energy conserving plumbing fixtures.

14. <u>List of Sustainable Design and Green Building Organizations</u>

a. Institute for Sustainable Design, University of Virginia, Charlottesville, Virginia, 22903.

b. Center for Sustainable Technology, Construction Research Center, Georgia Institute of Technology, 490 10th St NW, Atlanta, GA 30332-0519.

c. Centre for Sustainable Design, Faculty of Design, Surrey Institute of Art & Design, Falkner Road, Farnham, Surrey, GU9 7DS, United Kingdom.

d. Natural Resources Defense Council, 40 West 20th Street, New York, NY 10011.

e. U.S. Green Building Council, 90 Montgomery Street, Suite 1001, San Francisco, CA 94105.

f. Context Institute, PO Box 946, Langley, WA 98260.

g. Center of Excellence for Sustainable Development, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Denver Regional Support Office, 1617 Cole Boulevard, Golden, CO 80401.

h. Center for Environmental Design Research, 390 Wurster Hall, Berkeley, CA, 94720.

i. Green Building Information Council, Dr. Ray Cole, University of British Columbia, BC, Canada.

j. Design Center for Appropriate Technology, PO Box 41144 Tucson, Arizona 85717.

k. Energy Efficient Builders Association, 2950 Metro Drive, Suite 108, Minneapolis, MN, 55425.

l. Passive Solar Industries Council, 1511 K Street, NW, Suite 600, Washington DC, 20005.

m. Center for Building Science, Lawrence Berkeley National Laboratory, 1 Cyclotron Rd, Berkeley, CA 94720.

n. Sustainable Building Coalition, 3102 Breeze Terrace, Austin, TX, 78722.

o. Habitat for Humanity International, 121 Habitat Street, Americus, GA, 31709.

p. Alliance to Save Energy, 1200 18th Street, NW, Suite 900, Washington, DC, 20036.

q. American Council for an Energy-Efficient Economy, 1001 Connecticut Avenue, NW, Suite 801, Washington, D.C. 20036.

r. Geothermal Resources Council, PO Box 1350, 2001 Second Street, Suite 5, Davis, CA 95617-1350.

s. Ecology Action, 5798 Ridgewood Road, Willits, CA, 95490.

t. Rocky Mountain Institute, 1739 Snowmass Creek Road, Snowmass, Colorado 81654-9199.

APPENDIX C

SUSTAINABLE PROJECT RATING TOOL (SPiRiT)

Sustainable Project Rating Tool (SPiRiT)

Version 1.4

U. S. Army Corps of Engineers
U. S. Army Assistant Chief of Staff for Installation Management

April 2001

U. S. Army Corps of Engineers Disclaimer

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Content

SPiRiT Comment Sheet 22

NOTES

1) This Sustainable Project Rating Tool (SPiRiT) is derived from The U. S. Green Building Council LEED 2.0 (Leadership in Energy and Environmental Design) Green Building Rating System™.

2) The SPiRiT numbering scheme parallels, but does not match LEED 2.0. LEED does not number major sections, which it calls 'Credit Categories,' ex. 'Sustainable Sites,' rather it numbers criteria or 'credits' within each major section. SPiRiT credit numbers match those of LEED where there is a 1:1 comparison. Where additional credits have been added they fall at the end of major sections.

3) The SPiRiT Credits all follow the format: Intent, Requirement and Technologies/Strategies.

<u>Intent</u>: A statement of the primary goal for the credit;
<u>Requirement</u>: Quantifiable conditions necessary to achieve stated intent;
<u>Technologies/Strategies</u>: Suggested technologies, strategies and referenced guidance on the means to achieve identified requirements.

4) Projects are evaluated for each SPiRiT credit which are either 'Prerequisites' or result in a point score:

<u>Prerequisites</u>: These credits are a statement of minimum requirements and must be met. No further points will be awarded unless the minimum is achieved. These credits are recognizable by an 'R' in the number scheme, ex. 1.R1, and a 'Reqd.' in the score column.
<u>Point Score</u>: These credits are evaluated and result in a point score. Where the potential score is greater than 1, no partial points are granted.

5) <u>SPiRiT Sustainable Project Certification Levels:</u>

SPiRiT Bronze	25 to 34 Points
SPiRiT Silver	35 to 49 Points
SPiRiT Gold	50 to 74 Points
SPiRiT Platinum	75 to 100 Points

6) SPiRiT credits have been developed to address facility life cycle phases including programming, design, construction, and commissioning. Additional rating tools will be developed to address installation/base master planning and facilities operations and maintenance, rehabilitation, recycling, and disposal.

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9) Army/USACE employees are members of the USGBC with membership privileges accessible via the USGBC web site, http://www.usgbc.org. For information on membership and access to available LEED resources to support use of SPiRiT and sustainable design in your projects, contact Richard Schneider at (217) 373-6752 or richard.l.schneider@erdc.usace.army.mil (Annette Stumpf at (217) 352-6511 ext. 7542 or annette.l.stumpf@erdc.usace.army.mil alternate).

10) For the latest information on SPiRiT and for access to guidance, tools and resources supporting sustainable design initiatives, visit the CERL 'Sustainable Design and Development Resource' website, http://www.cecer.army.mil/SustDesign. There you may also join the CERL Sustainable Design ListServ to be directly notified of information pertinent to sustainable design.

1.0 Sustainable Sites — Score 20

1.R1 **Erosion, Sedimentation, and Water Quality Control** [(1)] Req'd

Intent: Control erosion and pollutants to reduce negative impacts on water and air quality.

Requirement: ☐ Design a site sediment and erosion control plan and a pollution prevention plan that conforms to best management practices in the EPA's Storm Water Management for Construction Activities, EPA Document No. EPA-833-R-92-001, Chapter 3, OR local Erosion and Sedimentation Control standards and codes, whichever is more stringent. The plan shall meet the following objectives:

- Prevent loss of soil during construction by storm water runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation of storm sewer or receiving streams and/or air pollution with dust and particulate matter.
- Prevent hazardous material discharge into storm water systems.
- Prevent petroleum oils and lubricants (POL) discharge into storm water systems.

Technologies /Strategies: The EPA standard lists numerous measures such as silt fencing, sediment traps, oil grit separators, construction phasing, stabilization of steep slopes, maintaining vegetated ground cover and providing ground cover that will meet this prerequisite.

1.C1 **Site Selection** [(1)]

Intent: Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site. Select site based on functional adjacencies/relationships and land use compatibility.

Requirement: ☐ Do not develop buildings on portions of sites that meet any one of the following criteria: 1

- Prime training or maneuver land.
- Land whose elevation is lower than 5 ft. above the 100-year flood elevation as defined by FEMA.
- Land that provides habitat for any species on the Federal or State threatened or endangered list.
- Within 100 feet of any wetland as defined by 40 CFR, Parts 230-233 and Part 22, OR as defined by local or state rule or law, whichever is more stringent.

☐ Select site based on functional adjacencies/relationships and land use compatibility. 1

- Select sites close to existing roads and utilities or use an existing structure to minimize the need for new infrastructure.
- Select site in area of high density.
- Site facilities based on the strength of their relationships to other facilities/land-uses to limit travel distances. The stronger the relationship/functional interaction, the closer the distance between two facilities.
- Select for distance to installation/base transit systems and access to pedestrian ways and bike paths.
- Select for development previously used or developed suitable and available sites.

Technologies /Strategies: Screen potential building sites for these criteria and/or ensure that these criteria are addressed by the designer during the conceptual design phase. Utilize landscape architects, ecologists, environmental engineers, civil engineers, and similar professionals for the screening process. New wetlands constructed as part of stormwater mitigation or other site restoration efforts are not affected by the restrictions of this prerequisite.

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(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

1.0 Sustainable Sites (Continued)

1.C2 **Installation/Base Redevelopment** [1]

Intent: Channel development to installation/base cantonment areas with existing infrastructure, protecting greenfields and preserving habitat and natural resources.

Requirement:

- ❑ Increase localized density to conform to existing or desired density goals by utilizing sites that are located within existing cantonment areas of high development density. **1**
- ❑ Select sites close to existing roads and utilities or use an existing structure to minimize the need for new infrastructure. **1**

Technologies /Strategies: During the site selection process give preference to previously developed sites with installation/base cantonment redevelopment potential such as facility reduction program cleared sites.

1.C3 **Brownfield Redevelopment** [1]

Intent: Rehabilitate damaged sites where development is complicated by real or perceived environmental contamination, reducing pressure on undeveloped land.

Requirement:

- ❑ Develop on a site classified as a brownfield and provide remediation as required by EPA's Brownfield Redevelopment program requirements OR Develop a brownfield site (a site that has been contaminated by previous uses). **1**

Technologies /Strategies: Screen potential damaged sites for these criteria prior to selection for rehabilitation.

Utilize EPA OSWER Directive 9610.17 and ASTM Standard Practice E1739 for site remediation where required.

1.C4 **Alternative Transportation** [1]

Intent: Reduce pollution and land development impacts from automobile use.

Requirement:

- ❑ Locate building within ½ mile of installation/base transit systems. **1**
- ❑ Provide suitable means for securing bicycles, with convenient changing/shower facilities for use by cyclists, for 5% or more of building occupants. **1**
- ❑ Locate building within 2 miles of alternative-fuel refueling station(s). **1**
- ❑ Size parking capacity not to exceed minimum installation/base cantonment requirements AND provide preferred parking for carpools or van pools capable of serving 5% of the building occupants, OR, add no new parking for rehabilitation projects AND provide preferred parking for carpools or van pools capable of serving 5% of the building occupants. **1**

Technologies /Strategies: Select sites near public installation/base transit served by safe, convenient pedestrian pathways.

[1] Adapted material not reviewed or endorsed by U. S. Green Building Council.

1.C5 **Reduced Site Disturbance** [1]

Intent: Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

Requirement:

- ☐ On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways, and main utility branch trenches; and 25 feet beyond pervious paving areas that require additional staging areas in order to limit compaction in the paved area; OR, on previously developed sites, restore a minimum of 50% of the remaining open area by planting native or adapted vegetation. 1
- ☐ Reduce the development footprint (including building, access roads and parking) to exceed the installation/base's/base's master plan local zoning's open space requirement for the site by 25% or in accordance with installation/base policy on open space set asides, whichever is greater. 1

Technologies /Strategies: Note requirements on plans and in specifications. Establish contractual penalties for destruction of trees and site areas noted for protection. Reduce footprints by tightening program needs and stacking floor plans. Establish clearly marked construction and disturbance boundaries. Delineate laydown, recycling, and disposal areas. Use areas to be paved as staging areas. Work with local horticultural extension services, or native plant societies, or installation/base agronomy staff to select indigenous plant species for site restoration and landscaping.

1.C6 **Stormwater Management** [1]

Intent: Limit disruption of natural water flows by minimizing storm water runoff, increasing on-site infiltration and reducing contaminants.

Requirement: Implement a stormwater management plan that results in:

- ☐ No net increase in the rate or quantity of stormwater runoff from undeveloped to developed conditions; OR, if existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff. 1
- ☐ Treatment systems designed to remove 80% of the average annual post development total suspended solids (TSS), and 40% of the average annual post development total phosphorous (TP), by implementing Best Management Practices (BMPs) outlined in EPA's Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (EPA-840-B-92-002 1/93). 1

Technologies /Strategies: Significantly reduce impervious surfaces, maximize on-site stormwater infiltration, and retain pervious and vegetated areas. Capture rainwater from impervious areas of the building for groundwater recharge or reuse within building. Use green/vegetated roofs. Utilize biologically-based and innovative stormwater management features for pollutant load reduction such as constructed wetlands, stormwater filtering systems, bioswales, bio-retention basins, and vegetated filter strips. Use open vegetated swales to reduce drainage velocity and erosion, reduce system maintenance, increase vegetative variety and support wildlife habitat where space permits.

1.C7 **Landscape and Exterior Design to Reduce Heat Islands** [2]

Intent: Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

Requirement:

- ☐ Provide shade (within 5 years) on at least 30% of non-roof impervious surface on the site, including parking lots, walkways, plazas, etc., OR, use light-colored/ high-albedo materials (reflectance of at least 0.3) for 30% of the site's non-roof impervious surfaces, OR place a minimum of 50% of parking space under-ground OR use open-grid pavement system (net impervious area of LESS than 50%) for a minimum of 50% of the parking lot area. 1
- ☐ Use ENERGY STAR Roof compliant, high-reflectance AND low emissivity roofing (initial reflectance of at least .65 and three-year-aged reflectance of at least .5 when tested in accordance with ASTM E408) for a minimum of 75% of the roof surface; OR, install a "green" (vegetated) roof for at least 50% of the roof area. 1

Technologies /Strategies: Employ design strategies, materials, and landscaping designs that reduce heat absorption of exterior materials. Note albedo/reflectance requirements in the drawings and specifications. Provide shade (calculated on June 21, noon solar time) using native or climate tolerant trees and large shrubs, vegetated trellises, or other exterior structures supporting vegetation. Substitute vegetated surfaces for hard surfaces. Explore elimination of blacktop and the use of new coatings and integral colorants for asphalt to achieve light colored surfaces.

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(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

(2)

1.0 Sustainable Sites (Continued)

1.C8 **Light Pollution Reduction** [1]

Intent: Eliminate light trespass from the building site, improve night sky access, and reduce development impact on nocturnal environments.

Requirement: ☐ Do not exceed Illuminating Engineering Society of North America (IESNA) footcandle level requirements as stated in the Recommended Practice Manual: Lighting for Exterior Environments, AND design interior and exterior lighting such that zero direct-beam illumination leaves the building site. 1

Technologies /Strategies: Consult IESNA Recommended Practice Manual: Lighting for Exterior Environments for Commission Internationle de l'Eclairage (CIE) zone and pre and post curfew hour descriptions and associated ambient lighting level requirements. Ambient lighting for pre-curfew hours for CIE zones range between .01 footcandles for areas with dark landscapes such as parks, rural, and residential areas, and 1.5 footcandles for areas with high ambient brightness such as installation/base areas with high levels of nighttime activity. Design site lighting and select lighting styles and technologies to have a minimal impact off-site and minimal contribution to sky glow. Minimize lighting of architectural and landscape features. Exterior lighting should be consistent with security lighting requirements.

1.C9 **Optimize Site Features**

Intent: Optimize utilization of the site's existing natural features and placement of man-made features on the site.

Requirement: ☐ Perform both of the following: 1

- Maximize the use of free site energy.
- Plan facility, parking and roadways to "fit" existing site contours and limit cut and fill.

Technologies /Strategies: Evaluate site resources to ascertain how each can enhance the proposed project and visa versa. Work to maximum advantage of the site's solar and wind attributes. Use landscaping to optimize solar and wind conditions and to contribute to energy efficiency; Locate and orient the facility on the site to optimize solar and wind conditions.

1.C10 **Facility Impact**

Intent: Minimize negative impacts on the site and on neighboring properties and structures; avoid or mitigate excessive noise, shading on green spaces, additional traffic, obscuring significant views, etc.

Requirement: ☐ Cluster facilities to reduce impact, access distance to utilities and sufficient occupant density to support mass transit. 1

☐ Collaborate with installation/base and community planners to identify and mitigate potential impacts of the project beyond site boundaries, and transportation planners to insure efficient public transport. 1

Technologies /Strategies: Involve local/regional planners and community members in installation/base master planning processes. Recognize the context and the impact of a project beyond site boundaries, and integrate it with the larger installation/base/community context/land use.

1.C11 **Site Ecology**

Intent: Identify and mitigate all existing site problems including contamination of soil, water, and air, as well as any negative impacts caused by noise, eyesores, or lack of vegetation, enhancing or creating new site habitat.

Requirement: ☐ Develop site environmental management and mitigation plan. 1

Technologies /Strategies: Understand site and surrounding ecosystem interdependence and interconnectivity. Plan landscaping scheme to incorporate biodiversity. Preserve/enhance existing trees, hydrological features, ecosystems, habitats, and cultural resources. Increase the existence of healthy habitat for native species. Reintroduce native plants and trees where they have been destroyed by previous development.

[1] Adapted material not reviewed or endorsed by U. S. Green Building Council.

2.0	Water Efficiency	Score	5

2.C1 **Water Efficient Landscaping** [2]

Intent: Limit or eliminate the use of potable water for landscape irrigation.

Requirement:

- ☐ Use high efficiency irrigation technology, OR, use captured rain or recycled site water to reduce potable water consumption for irrigation by 50% over conventional means. **1**
- ☐ Use only captured rain or recycled site water for an additional 50% reduction (100% total reduction) of potable water for site irrigation needs, OR, do not install permanent landscape irrigation systems. **1**

Technologies /Strategies: Develop a landscaping water use baseline according to the methodology outlined in the LEED Reference Guide. Specify water-efficient, native or adapted, climate tolerant plantings. High efficiency irrigation technologies include micro irrigation, moisture sensors, or weather data based controllers. Feed irrigation systems with captured rainwater, gray water, or on-site treated wastewater.

2.C2 **Innovative Wastewater Technologies** [2]

Intent: Reduce generation of wastewater and potable water demand, while increasing local aquifer recharge.

Requirement:

- ☐ Reduce the use of municipally provided potable water for building sewage conveyance by a minimum of 50%, OR, treat 100% of wastewater on site to tertiary standards. **1**

Technologies /Strategies: Develop a wastewater baseline according to the methodology outlined in the LEED Reference Guide. Implement decentralized on-site wastewater treatment and reuse systems. Decrease the use of potable water for sewage conveyance by utilizing gray and/or black water systems. Non-potable reuse opportunities include, toilet flushing, landscape irrigation, etc. Provide advanced wastewater treatment after use by employing innovative, ecological, on-site technologies including constructed wetlands, a mechanical recirculating sand filter, or aerobic treatment systems.

2.C3 **Water Use Reduction** [1]

Intent: Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirement:

- ☐ Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting Energy Policy Act (EPACT) of 1992 fixture performance requirements. **1**
- ☐ Exceed the potable water use reduction by an additional 10% (30% total efficiency increase). **1**

Technologies /Strategies: Develop a water use baseline including all water consuming fixtures, equipment, and seasonal conditions according to methodology guidance outlined in the LEED Reference Guide. Specify water conserving plumbing fixtures that exceed Energy Policy Act (EPACT) of 1992 fixture requirements in combination with ultra high efficiency or dry fixture and control technologies. Specify high water efficiency equipment (dishwashers, laundry, cooling towers, etc.). Use alternatives to potable water for sewage transport water. Use recycled or storm water for HVAC/process make up water. Install cooling tower systems designed to minimize water consumption from drift, evaporation and blowdown.

(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

[redacted]

3.R1 **Fundamental Building Systems Commissioning** [1] Req'd

Intent: Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.

Requirement: ☐ Implement all of the following fundamental best practice commissioning procedures.

- Engage a commissioning authority.
- Develop design intent and basis of design documentation.
- Include commissioning requirements in the construction documents.
- Develop and utilize a commissioning plan.
- Verify installation, functional performance, training and documentation.
- Complete a commissioning report.

Technologies /Strategies: Introduce standards and strategies into the design process early, and then carry through selected measures by clearly stating target requirements in the construction documents. Tie contractor final payments to documented system performance. Perform additional commissioning in accordance with the DOE Building Commissioning Guide, Version 2.2. Refer to the LEED Reference Guide for detailed descriptions of required elements and references to additional commissioning guides. Specify pre-occupancy baseline IAQ testing at time of commissioning. Test for indoor air concentrations of CO, CO2, total VOCs and particulates. Test to assure that adequate ventilation rates have been achieved prior to initial occupancy.

3.R2 **Minimum Energy Performance** [1] Req'd

Intent: Establish the minimum level of energy efficiency for the base building and systems.

Requirement: ☐ Design to meet building energy efficiency and performance as required by TI 800-01 (Design Criteria).

Technologies /Strategies: Use building modeling and analysis techniques to establish and document compliance. ASHRAE/IESNA 90.1-1999 provides guidance for establishing building base case development and analysis. Refer to the LEED Reference Guide for a wide variety of energy efficiency strategy resources.

Use a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting, and other energy producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads used in the design. Using established weather data files, the program will perform 8760 hourly calculations. BLAST, DOE-2 or EnergyPlus are acceptable programs for these purposes.

3.R3 **CFC Reduction in HVAC&R Equipment** [2] Req'd

Intent: Reduce ozone depletion.

Requirement: ☐ Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phaseout conversion.

Technologies /Strategies: Specify only non-CFC-based refrigerants in all base building HVAC&R systems.

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3.0 Energy and Atmosphere (Continued)

3.C1 **Optimize Energy Performance** (1)

Intent: Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirement: ☐ Reduce design energy usage (DEU) compared to the energy use budget (EUB) in joules per square meter per year for regulated energy components as described in the requirements of Chapter 11 of the TI 800-01 (Design Criteria), as demonstrated by a whole building simulation. **20**

- 1 Point will be awarded for every reduction in design energy use of 2.5% for both new and existing facilities for a maximum score of 20 points.

Regulated energy components include HVAC systems, building envelope, service hot water systems, lighting and other regulated systems as defined by ASHRAE.

Technologies /Strategies: Develop and use building modeling and analysis techniques to establish a base case that meets the minimum prerequisite standard. ASHRAE/IESNA 90.1-1999 provides guidance for establishing building base case development and analysis. Perform interactive energy use analysis for selected design elements that affect energy performance and document compliance.

Unit of measure for performance shall be annual energy usage in joules per square meter. Life-Cycle energy costs shall be determined using rates for purchased energy, such as electricity, gas, oil, propane, steam, and chilled water and approved by the adopting authority. Refer to the LEED Reference Guide or Whole Building Design Guide for a wide variety of energy efficiency resources and strategies including conservation measures, electromechanical energy efficiency technologies (for example ground-source heat pumps), passive heating and cooling strategies, solar hot water, and daylighting.

Life-Cycle costing will be done in accordance with 10 CFR 436.

Consider installation of an Energy Management and Control System (EMCS), which is compatible with exiting installation systems to optimize performance. Use sensors to control loads based on occupancy, schedule and/or the availability of natural resources use (day light or natural ventilation).

3.C2 **Renewable Energy** (1)

Intent: Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirement: ☐ Supply a net fraction of the building's total energy use through the use of on-site renewable energy systems.

% of Total Annual Energy Usage in Renewables	
5%	**1**
10%	**2**
15%	**3**
20%	**4**

Technologies /Strategies: Employ the use of on-site non-polluting-source renewable technologies contributing to the total energy requirements of the project. Consider and use high temperature solar and/or geothermal, photovoltaics, wind, biomass (other than unsustainably harvested wood), and bio-gas. Passive solar, solar hot water heating, ground-source heat pumps, and daylighting do not qualify for points under this credit. Credit for these strategies is given in Energy & Atmosphere Credit 1: Optimizing Energy Performance.

(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

3.C3 **Additional Commissioning** [2]

Intent: Verify and ensure that the entire building is designed, constructed, and calibrated to operate as intended.

Requirement: ☐ In addition to the Fundamental Building Commissioning prerequisite, implement the following additional commissioning tasks: 1

1. Conduct a focused review of the design prior to the construction documents phase.
2. Conduct a focused review of the construction documents when close to completion.
3. Conduct a selective review of contractor submittals of commissioned equipment.
4. Develop a system and energy management manual.
5. Have a contract in place for a near-warranty end or post occupancy review.

Items 1, 2, and 3 must be performed by someone other than the designer.

Technologies /Strategies: Introduce standards and strategies into the design process early, and then carry through selected measures by clearly stating target requirements in the construction documents. Tie contractor final payments to documented system performance. Refer to the LEED Reference Guide for detailed descriptions of required elements and references to additional guidelines.

3.C4 **<< Deleted >>** [1]

3.C5 **Measurement and Verification** [1]

Intent: Provide for the ongoing accountability and optimization of building energy and water consumption performance over time.

Requirement: ☐ Comply with the installed equipment requirements for continuous metering as stated in selected Measurement and Verification Methods - Option B: Retrofit Isolation of the US DOE's International Performance Measurement and Verification Protocol (IPMVP) for the following: 1

- Lighting systems and controls.
- Constant and variable motor loads.
- Variable frequency drive (VFD) operation.
- Chiller efficiency at variable loads (kW/ton).
- Cooling load.
- Air and water economizer and heat recovery cycles.
- Air distribution static pressures and ventilation air volumes.
- Boiler efficiencies.
- Building specific process energy efficiency systems and equipment.
- Indoor water risers and outdoor irrigation systems.

Technologies /Strategies: Design and specify equipment to be installed in base building systems to allow for comparison, management, and optimization of actual vs. estimated energy and water performance. Employ building automation systems to perform M&V functions where applicable. Tie contractor final payments to documented M&V system performance and include in the commissioning report. Provide for ongoing M&V system maintenance and operating plan in building operations and maintenance manuals. Consider installation/base of an Energy Management and Control System (EMCS), which is compatible with exiting installation/base systems to optimize performance.

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[1] Adapted material not reviewed or endorsed by U. S. Green Building Council.

3.C6 **Green Power** [1]

Intent: Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirement: ☐ Engage in a two year contract to purchase the amount of power equal to projected building consumption generated from renewable sources that meet the Center for Resource Solutions (CRS) Green-E requirements. **1**

Technologies /Strategies: Purchase power from a provider that guarantees a fraction of its delivered electric power is from net nonpolluting renewable technologies. Begin by contacting local utility companies. If the project is in an open market state, investigate Green Power and Power Marketers licensed to provide power in that state. Grid power that qualifies for this credit originates from solar, wind, geothermal, biomass, or low-impact hydro sources. Low-impact hydro shall comply with the Low Impact Hydropower Certification Program.

3.C7 **Distributed Generation**

Intent: Encourage the development and use of distributed generation technologies, which are less polluting than grid-source energy.

Requirement: ☐ Reduce total energy usage and emissions by considering source energy implications and local cogeneration and direct energy conversion. Generate at least 50% of the building's projected annual consumption by on-site distributed generation sources. **1**

Technologies /Strategies: Investigate the use of integrated generation and delivery systems, such as co-generation, fuel cells, micro-turbines and off-peak thermal storage.

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[1] Adapted material not reviewed or endorsed by U. S. Green Building Council.

4.0 Materials and Resources — Score 13

4.R1 **Storage & Collection of Recyclables** [1] — Req'd

Intent: Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirement:
- ☐ Provide an easily accessible area that serves the entire building that is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, glass, plastics, and metals.

Technologies /Strategies: Establish a waste management plan which meets requirements of the installation/base environmental and/or solid waste management plans in cooperation with users to encourage recycling. Reserve space for recycling functions early in the building occupancy programming process and show areas dedicated to collection of recycled materials on space utilization plans. Broader recycling support space considerations should allow for collection and storage of the required elements and newspaper, organic waste (food and soiled paper), and dry waste. When collection bins are used, bin(s) should be able to accommodate a 75% diversion rate and be easily accessible to custodial staff and recycling collection workers. Consider bin designs that allow for easy cleaning to avoid health issues.

4.C1 **Building Reuse** [1]

Intent: Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste, and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirement: Reuse large portions of existing structures during renovation or redevelopment projects.

- ☐ Maintain at least 75% of existing building structure and shell (exterior skin and framing excluding window assemblies). — 1
- ☐ Maintain an additional 25% (100% total) of existing building structure and shell (exterior skin and framing excluding window assemblies). — 1
- ☐ Maintain 100% of existing building structure and shell AND 50% non-shell (walls, floor coverings, and ceiling systems). — 1

Technologies /Strategies: Evaluate retention of existing structure. Consider facade preservation, particularly in installation/base areas. During programming and space planning, consider adjusting needs and occupant use patterns to fit within existing building structure and interior partition configurations. Identify and effectively address energy, structural, and indoor environmental (lead & asbestos) issues in building reuse planning and deconstruction documents. Percentage of reused non-shell building portions will be calculated as the total area (s.f.) of reused walls, floor covering, and ceiling systems, divided by the existing total area (s.f.) of walls, floor covering, and ceiling systems.

4.C2 **Construction Waste Management** [1]

Intent: Divert construction, demolition, and land clearing debris from landfill disposal. Redirect recyclable material back to the manufacturing process.

Requirement: Develop and implement a waste management plan, quantifying material diversion by weight:

- ☐ Recycle and/or salvage at least 50% (by weight) of construction, demolition, and land clearing waste. — 1
- ☐ Recycle and/or salvage an additional 25% (75% total by weight) of the construction, demolition, and land clearing debris. — 1

Technologies /Strategies: Develop and specify a waste management plan which meets requirements of the installation/base environmental and/or solid waste management plans that identifies licensed haulers and processors of recyclables; identifies markets for salvaged materials; employs deconstruction, salvage, and recycling strategies and processes, includes waste auditing; and documents the cost for recycling, salvaging, and reusing materials. Source reduction on the job site should be an integral part of the plan.

The plan should address recycling of corrugated cardboard, metals, concrete brick, asphalt, land clearing debris (if applicable), beverage containers, clean dimensional wood, plastic, glass, gypsum board, and carpet; evaluate the cost-effectiveness of recycling rigid insulation, engineered wood products and other materials; hazardous materials storage and management; and participation in manufacturers' "take-back" programs to the maximum extent possible. Refer to the LEED Reference Guide for guidelines and references that provide waste management plan development and implementation support including model bid specifications.

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[1] Adapted material not reviewed or endorsed by U. S. Green Building Council.

4.0 Materials and Resources (Continued)

4.C3 **Resource Reuse** [2]

Intent: Extend the life cycle of targeted building materials, reducing environmental impacts related to materials manufacturing and transport.

Requirement:
- ☐ Specify salvaged or refurbished materials for 5% of building materials. **1**
- ☐ Specify salvaged or refurbished materials for 10% of building materials. **1**

Technologies /Strategies: Commonly salvaged building materials include wood flooring/ paneling/cabinets, doors and frames, mantels, iron work and decorative lighting fixtures, brick, masonry and heavy timbers. See the LEED Reference Guide for calculation tools and guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars* (see exclusions) of the salvaged or refurbished material.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: In total dollar calculations, exclude; labor costs; all mechanical and electrical material and labor costs and project overhead and fees. *If the cost of the salvaged or refurbished material is below market value, use replacement cost to estimate the material value, otherwise use actual cost to the project.

4.C4 **Recycled Content** [1]

Intent: Increase demand for building products that have incorporated recycled content material, reducing the impacts resulting from extraction of new material.

Requirement:
- ☐ Specify a minimum of 25% of building materials that contain in aggregate a minimum weighted average of 20% post-consumer recycled content material, OR, a minimum weighted average of 40% post-industrial recycled content material. **1**
- ☐ Specify an additional 25% (50% total) of building materials that contain in aggregate, a minimum weighted average of 20% post consumer recycled content material, OR, a minimum weighted average of 40% post-industrial recycled content material. **1**

Technologies /Strategies: Specify building materials containing recycled content for a fraction of total building materials. Select products and materials with supporting information from the AIA Resource Guide or the EPA Environmentally Preferable Purchasing (EPP) Program. Common building materials and products with recycled content include; wall, partition, and ceiling materials and systems; insulation; tiles and carpets; cement, concrete, and reinforcing metals; structural and framing steel. For products/materials not listed, selection should be made on the basis of EPP criterion and/or:

- Toxicity;
- Embodied energy;
- Production use of water, energy and ozone depleting substances (ODSs);
- Production limits on toxic emissions and effluents;
- Minimal, reusable or recycled/recyclable packaging;
- Impact on indoor environmental quality (IEQ);
- Installation that limits generation of waste;
- Materials that limit waste generation over their life;
- EPA guideline compliance; and
- Harvested on a sustainable yield basis.

See the LEED Reference Guide for a summary of the EPA guidelines and calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of the material that contain recycled content.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees).

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4.C5 **Local/Regional Materials** [2]

Intent: Increase demand for building products that are manufactured locally, reducing the environmental impacts resulting from transportation, and supporting the local economy.

Requirement:

- ☐ Specify a minimum of 20% of building materials that are manufactured regionally within a radius of 500 miles. 1
- ☐ Of these regionally manufactured materials, specify a minimum of 50% that are extracted, harvested, or recovered within 500 miles. 1

Technologies /Strategies: Specify and install regionally extracted, harvested, and manufactured building materials. Contact the state and local waste management boards for information about regional building materials. See the LEED Reference Guide for calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of material that is locally or regionally manufactured.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees.

4.C6 **Rapidly Renewable Materials** [2]

Intent: Reduce the use and depletion of finite raw and long cycle renewable materials by replacing them with rapidly renewable materials.

Requirement:

- ☐ Specify rapidly renewable building materials for 5% of total building materials. 1

Technologies /Strategies: Rapidly renewable resources are those materials that substantially replenish them-selves faster than traditional extraction demand (e.g. planted and harvested in less than a 10 year cycle) and do not result in significant biodiversity loss, increase erosion, air quality impacts, and that are sustainably managed. See the LEED Reference Guide for calculation methodology guidelines. Determine percentages in terms of dollar value using the following steps:

1. Calculate total dollars (see exclusions) of materials that are considered to be rapidly renewable.
2. Calculate total dollars (see exclusions) of all building materials.
3. Divide Step 1 by Step 2 to determine the percentage.

Exclusions: Labor costs; all mechanical and electrical material and labor costs; project overhead and fees.

4.C7 **Certified Wood** [2]

Intent: Encourage environmentally responsible forest management.

Requirement:

- ☐ Use a minimum of 50% of wood-based materials certified in accordance with the Forest Stewardship Council guidelines for wood building components including but not limited to framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers. 1

Technologies /Strategies: Refer to the Forest Stewardship Council guidelines for wood building components that qualify for compliance to the requirements and incorporate into material selection for the project.

5.R1 **Minimum IAQ Performance** [1] Req'd

Intent: Establish minimum IAQ performance to prevent the development of indoor air quality problems in buildings, maintaining the health and well being of the occupants.

Requirement: ❑ Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality and approved Addenda.

Technologies /Strategies: Include proactive design details that will eliminate some of the common causes of indoor air quality problems in buildings. Introduce standards into the design process early. Incorporate references to targets in plans and specifications. Ensure ventilation system outdoor air capacity can meet standards in all modes of operation. Locate building outdoor air intakes (including operable windows) away from potential pollutants/contaminant sources such as sporulating plants (allergens), loading areas, building exhaust fans, cooling towers, sanitary vents, dumpsters, vehicular exhaust, and other sources. Include operational testing in the building commissioning report. Design cooling coil drain pans to ensure complete draining. Include measures to control and mitigate radon buildup in areas where it is prevalent. Limit humidity to a range that minimizes mold growth and promotes respiratory health.

5.R2 **Environmental Tobacco Smoke (ETS) Control** [2] Req'd

Intent: Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).

Requirement: ❑ Zero exposure of nonsmokers to ETS by prohibition of smoking in the building, OR, by providing a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room shall be directly exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, enclosed with impermeable structural deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least 7 Pa (0.03 inches of water gauge). Performance of smoking rooms shall be verified using tracer gas testing methods as described in ASHRAE Standard 129-1997. Acceptable exposure in non-smoking areas is defined as less than 1% of the tracer gas concentration in the smoking room detectable in the adjoining non-smoking areas. Smoking room testing as described in the ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.

Technologies /Strategies: Prohibit smoking in the building and/or provide designated smoking areas outside the building in locations where ETS cannot reenter the building or ventilation system and away from high building occupant or pedestrian traffic.

5.C1 **IAQ Monitoring** [1]

Intent: Provide capacity for indoor air quality (IAQ) monitoring to sustain long term occupant health and comfort.

Requirement: ❑ Install a permanent carbon dioxide (CO_2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments, AND specify initial operational set point parameters that maintain indoor carbon dioxide levels no higher than outdoor levels by more than 530 parts per million at any time. 1

Technologies /Strategies: Install an independent system or make CO_2 monitoring a function of the building automation system. Situate monitoring locations in areas of the building with high occupant densities and at the ends of the longest runs of the distribution ductwork. Specify that system operation manuals require calibration of all of the sensors per manufacturer recommendations but not less than one year. Include sensor and system operational testing and initial set point adjustment in the commissioning plan and report. Also consider periodic monitoring of carbon monoxide (CO), total volatile organic compounds (TVOCs), and particulates (including PM10).

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(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

5.0 Indoor Environmental Quality (IEQ) (Continued)

5.C2 **Increase Ventilation Effectiveness** [2]

Intent: Provide for the effective delivery and mixing of fresh air to building occupants to support their health, safety, and comfort.

Requirement:

- ☐ For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (E) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy. 1

Technologies /Strategies: Employ architectural and HVAC design strategies to increase ventilation effectiveness and prevent short-circuiting of airflow delivery. Techniques available include use of displacement ventilation, low velocity, and laminar flow ventilation (under floor or near floor delivery) and natural ventilation. Operable windows with an architectural strategy for natural ventilation, cross ventilation, or stack effect can be appropriate options with study of inlet areas and locations. See the LEED Reference Guide for compliance methodology guidelines.

5.C3 **Construction IAQ Management Plan** [2]

Intent: Prevent indoor air quality problems resulting from the construction/renovation process, to sustain long term installer and occupant health and comfort.

Requirement: Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building as follows:

- ☐ During construction meet or exceed the minimum requirements of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, AND protect stored on-site or installed absorptive materials from moisture damage, AND replace all filtration media immediately prior to occupancy (Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2-1999). 1
- ☐ Conduct a minimum two-week building flushout with new filtration media at 100% outside air after construction ends and prior to occupancy, OR, conduct a baseline indoor air quality testing procedure consistent with current EPA protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445. 1

Technologies /Strategies: Specify containment control strategies including protecting the HVAC system, controlling pollutant sources, interrupting pathways for contamination, enforcing proper housekeeping and coordinating schedules to minimize disruption. Specify the construction sequencing to install absorptive materials after the prescribed dry or cure time of wet finishes to minimize adverse impacts on indoor air quality. Materials directly exposed to moisture through precipitation, plumbing leaks, or condensation from the HVAC system are susceptible to microbial contamination. Absorptive materials to protect and sequence installation include: insulation, carpeting, ceiling tiles, and gypsum products. Appoint an IEQ Manager with owner's authority to inspect IEQ problems and require mitigation as necessary.

5.C4 **Low-Emitting Materials** [2]

Intent: Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.

Requirement: Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows:

- ☐ Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168 by, AND all sealants used as a filler must meet or exceed Bay Area Air Resources Board Reg. 8, Rule 51. 1
- ☐ Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements. 1
- ☐ Carpet systems must meet or exceed the Carpet and Rug Institute Green Label Indoor Air Quality Test Program. 1
- ☐ Composite wood or agrifiber products must contain no added urea-formaldehyde resins. 1

Technologies /Strategies: Evaluate and preferentially specify materials that are low emitting, non-irritating, nontoxic and chemically inert. Request and evaluate emissions test data from manufacturers for comparative products. Ensure that VOC limits are clearly stated in specifications, in General Conditions, or in each section where adhesives, sealants, coatings, carpets, and composite woods are addressed.

5.0 Indoor Environmental Quality (IEQ) (Continued)

5.C5 Indoor Chemical and Pollutant Source Control [(1)]

Intent: Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality.

Requirement:

- ❑ Design to minimize cross-contamination of regularly occupied areas by chemical pollutants: **1**
  - Employ permanent entryway systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all high volume entryways, AND provide areas with structural deck to deck partitions with separate outside exhausting, no air recirculation and negative pressure where chemical use occurs (including housekeeping areas and copying/print rooms), AND provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.

Technologies /Strategies: Design to physically isolate activities associated with chemical contaminants from other locations in the building, providing dedicated systems to contain and remove chemical pollutants from source emitters at source locations. Applicable measures include eliminating or isolating high hazard areas; designing all housekeeping chemical storage and mixing areas (central storage facilities and janitors closets) to allow for secure product storage; designing copy/fax/printer/printing rooms with structural deck to deck partitions and dedicated exhaust ventilation systems; and including permanent architectural entryway system(s) to catch and hold particles to keep them from entering and contaminating the building interior.

Consider utilization of EPA registered anti-microbial treatments in carpet, textile or vinyl wall coverings, ceiling tiles or paints where microbial contamination is a concern. Utilize "breathable" wall finishes where circumstances require, to reduce moisture build-up and prevent microbial contamination. Minimize selection of fibrous materials, e.g. insulation, carpet and padding and flexible fabrics, whose exposed surfaces when exposed to the air stream or occupied space can contribute significant emissions and absorb and re-emit other contaminants over time.

5.C6 Controllability of Systems [(2)]

Intent: Provide a high level of individual occupant control of thermal, ventilation, and lighting systems to support optimum health, productivity, and comfort conditions.

Requirement:

- ❑ Provide a minimum of one operable window and one lighting control zone per 200 s.f. for all occupied areas within 15 feet of the perimeter wall. **1**
- ❑ Provide controls for each individual for airflow, temperature, and lighting for 50% of the non perimeter, regularly occupied areas. **1**

Technologies /Strategies: Provide individual or integrated controls systems that control lighting, airflow, and temperature in individual rooms and/or work areas. Consider combinations of ambient and task lighting control and operable windows for perimeter and VAV systems for non perimeter with a 1:1: 2 terminal box to controller to occupant ratio.

5.C7 Thermal Comfort [(2)]

Intent: Provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants.

Requirement:

- ❑ Comply with ASHRAE Standard 55-1992, Addenda 1995 for thermal comfort standards including humidity control within established ranges per climate zone. **1**
- ❑ Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and effectiveness of humidification and/or dehumidification systems in the building. **1**

Technologies /Strategies: Integrated envelope and HVAC system design strategies that achieve thermal comfort conditions based on mean radiant temperature, local air velocity, relative humidity, and air temperature. Install and maintain a temperature and humidity monitoring system for key areas of the building (i.e., at the perimeter, and spaces provided with humidity control). This function can be satisfied by the building automation system. Specify in system operation manuals that all sensors require quarterly calibration. Include criteria verification and system operation in commissioning plan and report.

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(1) Adapted material not reviewed or endorsed by U. S. Green Building Council.

[redacted]

5.C8 **Daylight and Views** [2]

Intent: Provide a connection between indoor spaces and the outdoor environment through the introduction of sunlight and views into the occupied areas of the building.

Requirement:

- ☐ Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas. Exceptions include those spaces where tasks would be hindered by the use of daylight or where accomplishing the specific tasks within a space would be enhanced by the direct penetration of sunlight. **1**
- ☐ Direct line of sight to vision glazing from 90% of all regularly occupied spaces, not including copy rooms, storage areas, mechanical, laundry, and other low occupancy support areas. **1**

Technologies /Strategies: Implement design strategies to provide access to daylight and views to the outdoors in a glare-free way using exterior sun shading, interior light shelves, and /or window treatments. Orient buildings to maximize daylighting options. Consider shallow or narrow building footprints. Employ courtyards, atriums, clerestory windows, skylights, and light shelves to achieve daylight penetration (from other than direct effect or direct rays from the sun) deep into regularly occupied areas of the building.

5.C9 **Acoustic Environment /Noise Control**

Intent: Provide appropriate acoustic conditions for user privacy and comfort.

Requirement:

- ☐ Minimize environmental noise through appropriate use of insulation, sound-absorbing materials and noise source isolation. **1**

Technologies /Strategies: Evaluate each occupied environment and determine the appropriate layout, materials and furnishings design.

5.C10 **Facility In-Use IAQ Management Plan**

Intent: Insure the effective management of facility air quality during its life.

Requirement:

- ☐ Perform all of the following: **1**
  - Develop an air quality action plan to include scheduled HVAC system cleaning.
  - Develop an air quality action plan to include education of occupants and facility managers on indoor pollutants and their roles in preventing them.
  - Develop an air quality action plan to include permanent monitoring of supply and return air, and ambient air at the fresh air intake, for carbon monoxide (CO), carbon dioxide (CO 2), total volatile organic compounds (TVOCs), and particulates (including PM10).

Technologies /Strategies: Provide action plan for periodic system maintenance, monitoring, occupant/manager training.

6.0 Facility Delivery Process — Score 7

6.C1 **Holistic Delivery of Facility**

Intent: Encourage a facility delivery process that actively engages all stakeholders in the design process to deliver a facility that meets all functional requirements while effectively optimizing tradeoffs among sustainability, first costs, life cycle costs and mission requirements.

Requirement:

Requirement	Points
☐ Choose team leaders that are experienced in holistic delivery of facilities.	1
☐ Train the entire team in the holistic delivery process. The team must include all stakeholders in the facility delivery, including the users, the contracting staff, the construction representatives, project manager, and design/engineering team members.	1
☐ Identify project goals and metrics.	1
☐ Plan and execute charrettes with team members at critical phases of the facility delivery.	1
☐ Identify and resolve tradeoffs among sustainability, first costs, life cycle costs and mission requirements through charrettes and other collaborative processes.	2
☐ Document required results for each phase of project deliverables that achieve the project goals and are measurable throughout the facility life span.	1

Technologies /Strategies:

Develop performance specifications or choose competitive range of products that meet environmental criteria.

Use automated modeling and analysis tools to assess site and facility design alternatives.

Conduct life-cycle cost analysis (LCCA) in the design process according to the Federal Facilities Council Technical Report, Sustainable Federal Facilities: A Guide To Integrating Value Engineering, Life Cycle Costing, and Sustainable Development, FFC # 142, 2000.

Conduct a full ecological assessment to include soil quality, water resources and flows, vegetation and trees, wildlife habitats and corridors, wetlands, and ecologically sensitive areas to identify the least sensitive site areas for development. Evaluate space utilization/functions to reduce overall space requirements, considering networking, flextime, flexi-place, dual-use, and other strategies to reduce space requirements/optimize facility size.

7.0	Current Mission	Score	6

7.C1 **Operation and Maintenance**

Intent: Encourage the development of a facility delivery process that enhances efficient operation and maintenance of the facility.

Requirement:

- ☐ Develop a facility operations and maintenance program to include: **2**
  - Commissioning instructions for all facility systems.
  - Comprehensive facility operations and maintenance instructions for system operation, performance verification procedures and results, an equipment inventory, warrantee information, and recommended maintenance schedule. The instructions should include a comprehensive, preventive maintenance program to keep all facility systems functioning as designed.
  - A periodic training program for occupants, facilities managers, and maintenance staff in all facility operations and maintenance activities.
  - Instructions on sustainable cleaning and pest control practices.
  - Develop a comprehensive site/facility recycling/waste management plan.
- ☐ Provide surfaces, furnishings, and equipment that are appropriately durable, according to life cycle cost analysis. **1**

Technologies /Strategies: Maintain facility elements, systems and subsystems on a routine maintenance schedule to ensure integrity and longevity.

Perform scheduled cleaning and maintenance activities with nontoxic environmentally preferable cleaning products and procedures. Keep air ducts clean and free of microorganisms through a structured program of preventive maintenance. Clean lighting systems following a regular maintenance schedule to ensure optimum light output and energy efficiency.

Use pesticides and herbicides sparingly and only when necessary with preference to natural methods and materials over poisons and toxic agents.

Use automated monitors and controls for energy, water, waste, temperature, moisture, and ventilation monitors and controls. Turn off the lights, computers, computer monitors, and equipment when not in use. Enable power-down features on office equipment.

7.C2 **Soldier and Workforce Productivity and Retention**

Intent: Provide a high-quality, functional, healthy and safe work environment to promote soldier and workforce productivity and retention.

Requirement:

- ☐ Provide a high quality indoor environment to enhance user/occupant quality of life (QOL). **1**
- ☐ Provide a highly functional work environment to promote user/occupant work productivity. **1**
- ☐ Provide a healthy and safe work environment to sustain QOL and productivity. **1**

Technologies /Strategies: Use a registered/certified interior designer to provide stimulating interior environments with pleasant colors, surface treatments, room proportions and ceiling heights, external views, natural lighting, and quality detailing for interior furnishings, equipment, materials and finishes. Use IES standards to provide light to occupied space with variations in level, comfortable contrasts, natural color rendition, natural/man-made, and adequate controls to optimize light aesthetic qualities. Provide occupant control of individual work areas configuration, and lighting, thermal and ventilation systems.

Collaborate with end users to identify functional and technical requirements and to perform adjacency studies. Configure occupied space to address the specific workers/occupants functions and activities that will be carried out there. Meet TI 800-01 Design Guide requirements. Design and configure occupied space, and select furniture and equipment using human ergonomics. Identify existing user amenities, such as dining, recreation, socialization, shopping and child care facilities. Identify what amenities should be incorporated into the project or provided in the future, nearby facility. Provide ventilation air in sufficient volume free from natural and man made contaminants.

8.0	Future Missions	Score	4

8.C1 **Functional Life of Facility and Supporting Systems**

Intent: Assess the functional life of a facility and its supporting systems to optimize the infrastructure investment.

Requirement:

- ❑ Identify how long the designed function is likely to occupy the current facility. **1**
- ❑ Identify how long the envelope, structure, HVAC, plumbing, communications, electrical, and other systems are likely to last before requiring replacement or upgrade. Consider economic, functional and physical obsolescence. **1**

Technologies /Strategies: Assess the typical or likely lifespan of the function(s) to be accommodated to forecast eventual adaptation to a different use(s). Assess the life spans of the various building systems/components to forecast their revision/replacement during the facility lifespan and design in a manner that facilitates revision/replacement.

Consider the life span of the weapon systems, doctrines, or other programs supported by the facility.

Use life cycle data and other sources to identify the life span of the embodied systems.

8.C2 **Adaptation, Renewal and Future Uses**

Intent: Encourage facility design that is responsive to change over time to maximize accommodation of future uses without creating waste and insuring maximum useful life of products.

Requirement:

- ❑ Identify possible future uses for the facility; consider alternatives that expand the list of possible future uses. AND Design the building to accommodate as wide a range of future uses, as practical. AND Design the installation of building systems to accommodate foreseeable change with a minimum amount of disruption, cost, and additional materials. **1**
- ❑ Build the smallest facility necessary to meet current mission functional requirements, using the most efficient shape and form, while taking into consideration expansion capabilities and potential future mission requirements. AND Design the facility for recycling of materials and systems. **1**

Technologies /Strategies: Create durable, long-lasting and adaptable facility shell and structural system. Create an adaptable, flexible facility design using open planning, service corridors, interstitial space, access floors, demountable walls/partitions, modular furniture and other adaptable space configuration/utilization strategies.

Select materials that are recyclable, avoiding composite materials, such as reinforced plastics and carpet fibers and backing. Consider selecting materials and labeling construction materials with identification information to facilitate recycling. Use pre-cut/pre-fabricated materials and use standard lengths and sizes (dimensional modularity) in design. Design facility systems and subsystems for reconfiguration and/or disassembly/recycling using reversible/reusable connectors.

Facility Points Summary

1.0	Sustainable Sites (S)	Score	0	Max 20
1.R1	☐ Erosion, Sedimentation and Water Quality Control			Required
1.C1	☐ Site Selection			2
1.C2	☐ Installation/Base Redevelopment			2
1.C3	☐ Brownfield Redevelopment			1
1.C4	☐ Alternative Transportation			4
1.C5	☐ Reduced Site Disturbance			2
1.C6	☐ Stormwater Management			2
1.C7	☐ Landscape and Exterior Design to Reduce Heat Islands			2
1.C8	☐ Light Pollution Reduction			1
1.C9	☐ Optimize Site Features			1
1.C10	☐ Facility Impact			2
1.C11	☐ Site Ecology			1
			0	Max 5
2.C1	☐ Water Efficient Landscaping			2
2.C2	☐ Innovative Wastewater Technologies			1
2.C3	☐ Water Use Reduction			2
			0	Max 28
3.R1	☐ Fundamental Building Systems Commissioning			Required
3.R2	☐ Minimum Energy Performance			Required
3.R3	☐ CFC Reduction in HVAC&R Equipment			Required
3.C1	☐ Optimize Energy Performance			20
3.C2	☐ Renewable Energy			4
3.C3	☐ Additional Commissioning			1
3.C4	☐ <<Deleted>>			
3.C5	☐ Measurement and Verification			1
3.C6	☐ Green Power			1
3.C7	☐ Distributed Generation			1
4.0	Materials and Resources (M)	Score	0	Max 13
4.R1	☐ Storage & Collection of Recyclables			Required
4.C1	☐ Building Reuse			3
4.C2	☐ Construction Waste Management			2
4.C3	☐ Resource Reuse			2
4.C4	☐ Recycled Content			2
4.C5	☐ Local/Regional Materials			2
4.C6	☐ Rapidly Renewable Materials			1
4.C7	☐ Certified Wood			1
5.0	Indoor Environmental Quality (IEQ) [Q]	Score	0	Max 17
5.R1	☐ Minimum IAQ Performance			Required
5.R2	☐ Environmental Tobacco Smoke (ETS) Control			Required
5.C1	☐ IAQ Monitoring			1
5.C2	☐ Increase Ventilation Effectiveness			1
5.C3	☐ Construction IAQ Management Plan			2
5.C4	☐ Low-Emitting Materials			4
5.C5	☐ Indoor Chemical and Pollutant Source Control			1
5.C6	☐ Controllability of Systems			2
5.C7	☐ Thermal Comfort			2
5.C8	☐ Daylight and Views			2
5.C9	☐ Acoustic Environment /Noise Control			1
5.C10	☐ Facility In-Use IAQ Management Plan			1

Facility Points Summary (Continued)

			Score	Maximum Points
6.0	Facility Delivery Process (P)	Score	0	Max 7
6.C1	☐ Holistic Delivery of Facility			7
7.0	Current Mission	Score	0	Max 6
7.C1	☐ Operation and Maintenance			3
7.C2	☐ Soldier and Workforce Productivity and Retention			3
8.0	Future Missions	Score	0	Max 4
8.C1	☐ Functional Life of Facility and Supporting Systems			2
8.C2	☐ Adaptation, Renewal and Future Uses			2
		Total Score	0	Max 100

SPiRiT Sustainable Project Certification Levels

SPiRiT Bronze		25 to 34 Points
SPiRiT Silver		35 to 49 Points
SPiRiT Gold		50 to 74 Points
SPiRiT Platinum		75 to 100 Points

Project Points of Contact

SPiRiT Comment Sheet

Please forward any comments that you may have on this Sustainable Project Rating Tool, preferably by Email, to:

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SPiRiT Para.

--END OF APPENDIX 11--