DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

OCT 11 2001

FROM: HQ AFCESA/CES
139 Barnes Drive, Suite 1
Tyndall AFB FL 32403-5319

SUBJECT: **Engineering Technical Letter (ETL) 01-1: Reliability and Maintainability (R&M) Design Checklist**

1. Purpose. This ETL provides a generic design checklist to be used in developing functional, reliable, and maintainable facilities constructed by or for the Air Force. The checklist will help personnel in charge of the planning, designing, constructing, operating, and maintaining of Air Force real property.

1.1. This ETL is intended to serve as a convenient guide to be used in the review of plans and specifications for construction projects. It can also be used in the early planning stages to determine if all R&M requirements are being considered for the project.

1.2. This ETL identifies the most prevalent omissions and discrepancies in facility designs. The checklist is not intended to cover every situation; it is a tool to aid the planner, designer, and maintainer to focus on materials, methods, and system components to enhance R&M throughout the life of each facility.

2. Application: All new construction and major rehabilitation, alteration, and repair of existing Air Force facilities and systems.

2.1. Authority:
- AFPD 32-10, *Installations and Facilities*
- AFI 32-1023, *Design and Construction Standards and Execution of Facility Construction Projects*

2.2. Effective Date: Immediately.

2.3. Ultimate Recipients: All Air Force civil engineer (CE) organizations.

3. References.

3.1. Air Force:
- AFI 31-210, *The Air Force Antiterrorism/Force Protection (AT/FP) Program Standards*
- AFI 32-1024, *Standard Facility Requirements*
- AFI 32-1042, *Standards for Marking Airfields*

- AFMAN 32-1076, *Design Standards For Visual Air Navigation Facilities*
- AFMAN (I) 32-1123, *Airfield and Heliport Planning and Design*
- AFJMAN 32-1008, *Installation Design*
- AFJMAN 32-1080, *Electrical Power Supply and Distribution*
- AFH 32-1084, *Facility Requirements Handbook*
- HQ AFCEE Design Criteria, *Installation Force Protection Guide* (available at http://www.afcee.brooks.af.mil/dc/dcd/arch/force.pdf)
- ETL 90-1, *Built-Up Roof (BUR) Repair/Replacement Guide Specification*

3.2. Army:
- Technical Manual (TM) 5-803-7, *Airfield and Heliport Planning and Design*
- Technical Manual (TM) 5-822-10, *Standard Practice for Pavement Recycling*
- TM 5-822-11, *Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements*
- TM 5-826-1, *Airfield Pavement Evaluation Concepts*
- TM 5-826-2, *Engineering and Design: Airfield Flexible Pavement Evaluation*
- TM 5-826-3, *Airfield Rigid Pavement Evaluation*
- TM 5-826-4, *Army Airfield-Heliport Pavement Reports*
- TM 5-826-6, *Procedures For U.S. Army and U.S. Air Force Airfield Pavement Condition Surveys*

3.3. Department of Defense (DoD):
- MIL-HDBK-1022, *Petroleum Fuel Facilities*
- MIL-HDBK-1110, *Handbook for Paints and Protective Coatings for Facilities*

3.4. Unified Facilities Criteria (UFC):
- UFC 3-240-03, *Industrial Water Treatment Operations and Maintenance*
- UFC 3-250-02, *Standard Practice Manual for Rigid Pavements*
- UFC 3-250-03, *Standard Practice Manual for Flexible Pavements*
- UFC 3-260-01, *Airfield and Heliport Planning and Design*
- UFC 3-260-02, *Pavement Design for Airfields*
- UFC 3-260-03, *Airfield Pavement Evaluation*

3.5. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- SMACNA *Fibrous Glass Duct Construction Standards*
- SMACNA *High Pressure Duct Construction Standards*
- SMACNA *Low Pressure Duct Construction Standards*

3.6. Other References:
- Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*
- Federal Specification W-H-196, *Heater, Water, Electric, Residential*
- Federal Information Processing Standard (FIPS) Publication 195, *Federal Building Grounding and Bonding Requirements for Telecommunications*

- American National Standards Institute (ANSI) A13.1, *Scheme for Identification of Piping Systems*
- Institute of Electrical & Electronics Engineers (IEEE) Standard 142, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems*
- InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications (ATS) 1999
- National Roofing Contractors Association (NRCA), *Roofing and Waterproofing Manual*
- *National Electrical Code*
- *Uniform Plumbing Code*

4. Acronyms and Terms.

AC - alternating current
ADP - automated data processing
AFFF - aqueous film forming foam
AHU - air handling unit
ANSI - American National Standards Institute
API - American Petroleum Institute
ASTM - American Society for Testing and Materials
ATS - Acceptance Testing Specifications
$Btu/hr/ft^2$ - British thermal units per hour per square foot
$Btu/hr/ft^3$ - British thermal units per hour per cubic foot
$Btu/hr/m^2$ - British thermal units per hour per square meter
$Btu/hr/m^3$ - British thermal units per hour per cubic meter
CADP - computer aided design program
C-CS - communication-computer system
CO_2 - carbon dioxide
CP - cathodic protection
CRCP - continuously reinforced concrete pavement
DDC - direct digital control
DoD - Department of Defense
EMCS - energy monitoring and control system
EPR - ethylene propylene rubber
ESP - electrostatic precipitator
FAR - Federal Aviation Regulation
FIPS - Federal Information Processing Standards
FOD - foreign object damage
HVAC - heating, ventilation, and air conditioning
IEEE - Institute of Electrical & Electronics Engineers
IWT - industrial water treatment
LOX - liquid oxygen
MAJCOM - major command
MCM - thousand circular mils
MCP - military construction plan

MEP	- mobile electric power
NACE	- National Association of Corrosion Engineers
NEC	- National Electric Code
NEMA	- National Electrical Manufacturer's Association
NETA	- InterNational Electrical Testing Association
NFPA	- National Fire Protection Agency
NiCad	- nickel cadmium
NRCA	- National Roofing Contractor's Association
O&M	- operation and maintenance
PACAF	- Pacific Air Forces
PCC	- Portland cement concrete
PCCIE	- power conditioning and continuation interfacing equipment
pH	- hydrogen-ion concentration
PIP	- pavement improvement plan
PMR	- protected membrane roof
POL	- petroleum, oil, lubricants
PVC	- polyvinyl chloride
R&M	- reliability and maintainability
RFI	- radio frequency interference
SF_6	- sulfur hexafluoride
SMACNA	- Sheet Metal and Air Conditioning Contractors National Association
SSMRS	- standing seam metal roofing system
SSUPS	- solid-state uninterruptible power supply
TM	- Technical Manual
UFC	- Unified Facilities Criteria
USAFE	- United States Air Forces in Europe
UV	- ultraviolet
VAV	- variable air volume
XLPE	- cross-linked polyethylene

6. Point of Contact: Recommendations for improvements to this ETL are encouraged and should be furnished to: HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB, FL 32408-5319, Attention: Mr. Larry Spangler, DSN 523-6180, commercial (850) 283-6180, FAX DSN 523-6219, email larry.spangler@tyndall.af.mil.

NOTE: The size of AF Form 2519, **All Purpose Checklist**, has been reduced in this ETL to accommodate document format requirements.

MICHAEL J. COOK, Colonel, USAF
Director of Technical Support

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1. Checklist
2. Lessons Learned Letter
3. Distribution List

ALL PURPOSE CHECKLIST		PAGE 1 OF 78 PAGES		
TITLE/SUBJECT/ACTIVITY/FUNCTIONAL AREA RELIABILITY AND MAINTAINABILITY CHECKLIST		OPR	DATE	
NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 1. SITE WORK			
1.1.	GENERAL:			
1.1.1.	Siting causes no obstruction to airspace, frangibility issues, or interference with existing facilities and utilities, and coordination was obtained from Airfield Management, Airfield Operations, Environmental, Communications, Safety, and Logistics for any facility sited on or near the airfield?			
1.1.2.	Adequately sized service drives and turnarounds are provided for maintenance vehicles?			
1.1.3.	Curbs and gutters are provided on streets and parking areas to contain traffic and protect pavement edges?			
1.1.4.	Large parking lots are designed in compliance with AFJMAN 32-1008, *Installation Design*? (Be aware of problems associated with pavement cleaning and snow removal.)			
1.1.5.	Proper pavement type is designed for areas subject to kerosene, gasoline, or oil spills? (Portland cement concrete [PCC] should be used to minimize surface deterioration. In areas subject to acid spills, an acid-resistant coating should be applied to PCC pavement.)			
1.1.6.	Storm drainage system is designed to minimize maintenance? (Velocities in open ditches and swales are controlled to avoid erosion of embankments and or other damage.)			
1.1.7.	Erosion control methods (e.g., curb and gutter, inlets, flumes, sodding, rip-rap) are employed as required?			
1.1.8.	Headwalls are selected in consideration of lateral scour, bank erosion, and undercutting of headwall?			
1.1.9.	Scour aprons or other suitable protection is provided at the downstream end of culverts and storm drain outlets?			
1.1.10.	Sodding is used to establish turfed areas, and lawn sprinkler systems are provided in areas where establishment and maintenance of lawn areas are difficult to achieve by natural methods?			
1.1.11.	Facility draining and grading design provides an easily maintained surface and considers future site development and or expansion? (Ensure that all areas drain away from the facility.)			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
1.1.12	Refuse collection pads with privacy screens are sized and provided with necessary access space to accommodate a large pickup vehicle? (Access space allows straight access to the dumpster, and allows safe, easy backing and turnaround.)			
1.1.13.	Landscaping plan precludes: indiscriminate planting of trees and shrubs over water and sewage lines; under power lines; too close to sidewalks, buildings, roadways, or parking lots; planting of excessively large trees; planting of trees which may clog sewer lines?			
1.1.14.	If an arid region, full consideration given to maximum use of desert landscaping (earth shaping, rock ground cover or gardens, drought-resistant planting) instead of irrigation systems?			
1.1.15.	Design provides for any underground nonmetallic pipe to be marked along the full length of the pipe with metallic tape, buried 254 millimeters (10 inches) to 381 millimeters (15 inches) below the surface? (Tape should have a metallic center of aluminum foil, coated on both sides with polyethylene.)			
1.1.16.	If the facility is vulnerable to terrorist attack, does the siting incorporate anti-terrorist features as indicated in AFI 32-210, *The Air Force Antiterrorism/Force Protection (AT/FP) Program Standards*?			
1.1.17.	On gutterless roof lines, is gravel, lava rock, or crushed stone splash area provided in the design to prevent mud splatter on lower outside walls?			
1.1.18.	In areas where mowing will be difficult, or where shade or other conditions do not support lawn growth, is a low-maintenance ground cover specified?			
1.1.19.	If the building design includes a courtyard, is adequate entry provided for maintenance equipment?			
1.1.20.	Sufficient motorcycle parking lots are indicated in the design and shown in the paint-striping plan?			
1.1.21.	Concrete kickstand pads are provided for motorcycle slots on asphalt parking pavements?			
1.1.22.	Facility is sited in accordance with the base comprehensive plan?			
1.1.23.	Facilities sited within the airfield environment comply with the frangibility requirements within AFMAN (I) 32-1123, *Airfield and Heliport Planning and Design*?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
1.1.24.	Federal Aviation Administration (FAA) Form 7460-1, *Notice of Proposed Construction or Alteration*, has been filed with the appropriate FAA regional office at least 30 days before application of permit for construction will be filed, or at least 30 days before construction begins, whichever is earlier? (See Federal Aviation Regulation (FAR) Part 77, *Objects Affecting Navigable Airspace*.)			
1.1.25.	All foundations located within the airfield environment designed to be flush with grade?			
1.1.26.	All hand holes and manholes located within the shoulder areas of aprons, taxiways, tow ways, runways, and overruns designed to accept a 34,000-kilogram (75-kip) wheel load?			
1.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 2. ARCHITECTURAL			
2.1.	GENERAL:			
2.1.1.	All comments in the minutes of the design and review conferences have been considered to preclude later costly and disruptive changes?			
2.1.2.	Using agency comments have been received and considered?			
2.1.3.	Specifications and or drawings provide for special loading conditions (e.g., hurricane winds) that would affect anchorages, door design, and window design?			
2.1.4.	Prefabricated structures:			
2.1.4.1.	Design provides for a sturdy, well-caulked building?			
2.1.4.2.	Windows, doors, and hardware are high quality?			
2.1.4.3.	Wall panels have sufficient intermediate supports to limit deflection under maximum designed wind loads so weather seals will not be destroyed?			
2.1.4.4.	Weather vestibules are provided at main entrances in areas where wind-driven rain prevails?			
2.1.5.	Utility and mechanical rooms:			
2.1.5.1.	Power and generator room doors open to the exterior of the building?			
2.1.5.2.	Adequate space is provided for the operation and maintenance (O&M) of installed equipment? (Check manufacturer's catalogs for equipment sizes. Ensure mechanical specifications include the maximum allowable equipment sizes.)			
2.1.5.3.	In multistory buildings:			
2.1.5.3.1.	Mechanical and electrical equipment rooms are on the ground floor, with doors of adequate size to accommodate installation and removal of equipment for repair and maintenance?			
2.1.5.3.2.	Boiler and mechanical rooms at grade level provided with doors to the exterior of the building?			
2.1.6.	Stairways provided with non-slip nosing and tread?			
2.1.7.	Chair rails considered for offices and conference rooms subject to hard use to reduce scratches, scuffs, and repainting of walls?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
2.1.8.	Plastic or metal corner protectors specified for corridors?			
2.1.9.	Structural and mechanical drawings checked to determine that access openings are provided and properly sized and located for servicing?			
2.1.10.	Fascia or trim is low-maintenance metal, stucco, or other material?			
2.1.11.	Siding is low-maintenance brick, stucco-concrete, or other material?			
2.1.12.	Buildings with gutters provided with concrete splashblocks, or downspouts connected to storm drainage system?			
2.1.13.	If the design requires exterior wooden doors, only solid-core wooden doors are specified when canopy protection is provided?			
2.1.14.	Three-ply membrane waterproofing provided for toilet, laundry, and shower areas over occupied spaces?			
2.1.15.	Metal pans specified for shower areas that are located in areas other than on grade?			
2.1.16.	Access ladder or stairway provided in the design for servicing of roof-mounted equipment?			
2.1.17.	Floor finishes are high quality, low maintenance, and appropriate for the intended use (e.g., ceramic tile, terrazzo, carpeting)?			
2.1.18.	Interior wall finishes or wainscot materials are durable and low maintenance (e.g., fabric wall covering rather than paint)?			
2.1.19.	Exterior improved finishes specified to ensure a longer cycle between recoatings?			
2.1.20.	Thermal-pane windows in aluminum casing with baked-on finishes specified for low maintenance and energy efficiency (when justified by life-cycle cost)?			
2.1.21.	Exposed concrete floors will receive a hardener and sealer (not paint)?			
2.1.22.	Pitched roofs, rather than low-slope roofs, specified where possible?			
2.1.23.	Exterior doors at arctic bases are heavy-duty industrial type, with maximum weather seal and vestibules?			
2.1.24.	Drinking fountains and fire extinguisher cabinets are recessed in hallways to prevent damage?			
2.1.25.	Interior and exterior painting schedule conforms to the approved base master color plan?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
2.1.26.	Flag poles are specified as low-maintenance aluminum, rather than painted steel?			
2.1.27.	Effective expansion joints detailed for roofs, floors, and walls at required intervals?			
2.1.28.	Bumper rails or hard-surface wainscot specified in high-traffic corridors?			
2.1.29.	Design complements adjacent facilities and is in accordance with the base architectural compatibility plan?			
2.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 3. INTERIOR ELECTRICAL			
3.1.	GENERAL:			
3.1.1.	Surge lightning and transient protection installed on service entrances, solid-state uninterruptible power supplies, and isolation transformers?			
3.1.2.	Ground fault protection (National Electrical Code [NEC] requires ground fault protection on grounded Wye services of 150 volts or more to ground, and 1000 amperes or more.):			
3.1.2.1.	Installed on service entrance feeders?			
3.1.2.2.	Installed on all feeder circuits to ensure electrical coordination?			
3.1.3.	Sensitive electronic equipment installed in accordance with Federal Information Processing Standard (FIPS) Publication 195, *Federal Building Grounding and Bonding Requirements for Telecommunications*?			
3.1.4.	Isolation transformers grounded in accordance with NEC for separately derived sources?			
3.1.5.	Maintenance-free gel cel-type batteries used in all emergency lights, except fluorescent lights (where NiCad is acceptable)?			
3.1.6.	Correct overloads specified for motors? (Overloads should be no larger than specified by the NEC.)			
3.1.7.	Adequate workspace around equipment?			
3.1.8.	Electrical equipment room with dry transformers ventilated for maximum temperature of 32 °C (90 °F)?			
3.1.9.	Grounding systems in compliance with NEC? (No separate grounds for computers are permitted.)			
3.1.10.	Computerized short circuit analysis and coordination study performed for large or complex systems?			
3.1.11.	Breaker and fuse interrupter ratings are adequate according to findings of the short circuit analysis?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
3.1.12.	Electrical superintendent has reviewed drawings and his comments considered?			
3.1.13.	Vaporproof fixtures provided in rooms containing moisture (e.g., dishwashing rooms)?			
3.1.14.	Alternate feed to facility required to provide increased reliability? (Hospitals and mission-essential facilities may benefit from dual feeders.)			
3.1.15.	Spare stub-up provided at pad-mounted transformers?			
3.1.16.	Circuit breakers used instead of fuses? (Use of circuit breakers increases R&M, as spare fuses do not need to be stored and circuit restoration is not dependent on the availability of a fuse.)			
3.1.17.	Bus duct use considered, rather than cabling, for circuits of 600 amperes or greater? (It is difficult for electricians to work with such a circuit, as it requires a conductor greater than 500 MCM (thousand circular mils) [or 500 MCM in parallel].)			
3.1.18.	Motor control centers have drawout breakers, where applicable? (Fused disconnects should be avoided, since breakers provide greater R&M.)			
3.1.19.	Motor size and application warrant use of undervoltage motor protection? (History of motor failures at the base should be a factor.)			
3.1.20.	Motor control center has adequate workspace to ensure maintainability?			
3.1.21.	Switchgear has:			
3.1.21.1.	Drawout breakers?			
3.1.21.2.	Lifting brackets for breaker maintenance?			
3.1.21.3.	Easy accessibility for maintenance?			
3.1.21.4.	Cable trenches?			
3.1.21.5.	Emergency lighting?			
3.1.21.6.	Adequate instrumentation?			
3.1.22.	Neutral wires reduced according to NEC? (Neutral sizes should not be reduced, even though allowed by NEC. Neutral reduction can cause problems in locations where harmonics are present, such as for electrical loads.)			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
3.1.23.	Power conditioning and continuation interfacing equipment (PCCIE) provided, instead of dedicated or isolated circuits for communication-computer systems (C-CS)? (Large voltage transients have occurred on isolated or dedicated circuits during transient disturbances.)			
3.1.24.	Explosion-proof fixtures or systems provided in areas subject to flammable vapors? (Hazardous areas are refueler vehicle maintenance bays, paint rooms, and aircraft fuel system docks.)			
3.1.25.	Electrical acceptance testing on complex facilities specified to be accomplished in accordance with NETA ATS 1999?			
3.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 4. EXTERIOR ELECTRICAL			
4.1.	GENERAL:			
4.1.1.	Computerized short circuit analysis and coordination study completed? (Study should include line-to-ground faults and coordinate the largest transformer on the feeder. Previous analysis may be acceptable, if updated.)			
4.1.2.	Adequate workspace around distribution equipment (pad-mounted transformer, switches, substation equipment)?			
4.1.3.	System has sufficient looping capability? (Feeders must be designed to have adequate ampacity and switching to permit backfeeding.)			
4.1.4.	Adequate feeder sectionalizing capability?			
4.1.5.	Distribution transformers have taps with external changers?			
4.1.6.	Pad-mounted transformers have traffic barriers in high-traffic areas (e.g., highly visible painted concrete posts)?			
4.1.7.	Electrical superintendent has reviewed design drawings?			
4.1.8.	Power transformers have:			
4.1.8.1.	External tap changer?			
4.1.8.2.	Pressure-relief valve with alarm contacts?			
4.1.8.3.	Thermal relay with alarm contacts?			
4.1.8.4.	Magnetic oil gauge?			
4.1.8.5.	Oil drain and sample valve?			
4.1.8.6.	Filter press connections (25 millimeters [1 inch] top and bottom)?			
4.1.8.7.	Undercoating?			
4.1.8.8.	Test report?			
4.1.8.9.	Alarm well with silencing relays, pushbutton, and indicating light, in weatherproof enclosure?			
4.1.9.	National Electrical Manufacturer's Association (NEMA) standard voltages and frame size specified for motors?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
4.1.10.	Compression or blast-on connections specified? (Split-bolt connections should not be specified, as the quality of installation is inconsistent.)			
4.1.11.	Standard transformers (not self-protecting transformers) specified? (Maintenance of self-protecting transformers is difficult.)			
4.1.12.	Neutral conductor is not less than half the size of the phase conductors?			
4.1.13.	Electrical items, devices, and equipment that are located in areas subject to mowing or weed removal are protected (e.g., paving at runway lights to prevent weed growth and allow mowers a wider margin of safety)?			
4.1.14.	Vacuum switches specified to be thoroughly tested (e.g., hipot) after installation and before being placed into service?			
4.2.	OVERHEAD DISTRIBUTION:			
4.2.1.	Corner poles are as clean as possible (e.g., no switches)? (This ensures an easier replacement process.)			
4.2.2.	Overhead construction is armless?			
4.2.3.	Adequate lightning and surge protection (e.g., MOVs on corner poles, risers, deadends, switches, transformers)? (Arresters must be of proper ratings and installed with short leads.)			
4.2.4.	Underbuild:			
4.2.4.1.	Quadraplex or triplex secondary underbuild?			
4.2.4.2.	Adequate ground clearance maintained?			
4.2.5.	Pole riser conduits are steel or aluminum? (Polyvinyl chloride [PVC] riser conduits deteriorate from the ultraviolet [UV] rays in sunlight. Aluminum corrodes in contact with concrete. Steel conduits should be hot-dipped galvanized, rigid, or intermediate. Metal riser conduits must be bonded to the ground at both ends and include cable supports and seals.)			
4.2.6.	Intermediate class surge arresters installed on riser poles?			
4.2.7.	Sectionalizing switches are load-break type, with operating handle at ground level?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
4.2.8.	Appropriate places on overhead lines specified to have stirrups? (Use of stirrups prevents damage to conductor when a connection is made.			
4.3.	UNDERGOUND DISTRIBUTION:			
4.3.1.	Underground primary cables are cross-linked polyethylene (XLPE) or ethylene propylene rubber (EPR), with 133% insulation level with outer jacket? (Outer jacket is only necessary to protect concentric neutral from corrosion.)			
4.3.2.	Underground switches are oil-less, with deadfronts? (Vacuum or SF_6 switches are preferred.)			
4.3.3.	Fault indicators on underground switches? (Fault indicators are essential for quickly locating faults on underground circuits. Fault locators should automatically reset.)			
4.3.4.	Manholes:			
4.3.4.1.	Sufficient working space for two people?			
4.3.4.2.	Sump holes (sealed sump holes in high-water areas) and pulling irons opposite all duct entrances, plus one on center of floor? (Consider reinforcing duct entrances to reduce shearing. Specify sealed duct ends to prevent rodent intrusion.)			
4.3.5.	Duct line markers used to locate duct routes and turns?			
4.3.6.	Underground cable ampacity designed for future growth? (Cable size should take into account any derating requirements, such as multi-cable ducts.)			
4.3.7.	Cable warning tapes required above all underground cables? (See AFJMAN 32-1080, *Electrical Power Supply and Distribution*).			
4.3.8.	Concrete cable markers required at each change of direction, and at approximately 69.9-meter (200-foot) intervals to indicate location of underground cables?			
4.3.9.	Underground cable splices:			
4.3.9.1.	Prohibited, or allowed only where necessary?			
4.3.9.2.	Employ maintenance-free methods and materials (e.g., heat shrink, resin casting)?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
4.4.	SUBSTATIONS:			
4.4.1.	Adequate bypass capability so breakers can be serviced?			
4.4.2.	Substation locations:			
4.4.2.1.	Located away from base perimeter fences and heavy-traffic roads?			
4.4.2.2.	Access roads able to accommodate line maintenance vehicles?			
4.4.3.	Two sets of multi-ratio current transformers (one set each for instruments and relays)?			
4.4.4.	Low-maintenance breakers (e.g., vacuum, SF_6, air)?			
4.4.5.	Any special maintenance tools included as part of facility?			
4.4.6.	Two power transformers, each capable of carrying the load, considered for reliability and ease of maintenance?			
4.4.7.	Permanent schematics specified to be installed?			
4.5.	AIRFIELD LIGHTING:			
4.5.1.	Airfield lighting vault:			
4.5.1.1.	Designed with 480-volt overhead bus duct distribution system?			
4.5.1.2.	Designed with devices and equipment to facilitate removal and replacement of regulators, such as an overhead crane?			
4.5.1.3.	Heat loading considered? (Vault may require air conditioning.)			
4.5.1.4.	Adequate work space, storage area, and a latrine?			
4.5.2.	Isolation transformers installed in cans, not directly buried? (Consider installing transformers 15.2 meters (50 feet) from the edge of the runway to allow maintenance during runway use.)			
4.5.3.	All elevated visual navigational aids incorporate frangible, low-impact resistant, or semi-frangible design principles in accordance with AFMAN 32-1076, *Design Standards For Visual Air Navigation Facilities*?			
4.5.4.	All foundations designed to be flush with grade?			
4.5.5.	All hand holes and manholes within apron, taxiway, tow way, runway, and overrun shoulder areas designed for a 34,000-kilogram (75-kip) wheel load?			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
4.6.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 5 EXTERIOR STRUCTURAL SYSTEMS			
5.1.	GENERAL:			
5.1.1.	Materials are suitable for the environment?			
5.1.2.	Components are accessible for periodic inspection and maintenance?			
5.1.3.	Structural design provides the lowest possible maintenance effort?			
5.1.4.	Roof drains designed to avoid water damage to structural system?			
5.1.5.	Expansion and control joints located to accommodate building movement?			
5.1.6.	Joint sealant selected to provide long-term maintenance-free joint?			
5.1.7.	Crawl space or attic ventilated to prevent moisture damage?			
5.1.8.	Maintenance of structural system within local capability?			
5.1.9.	Maintenance requirements identified in the plans and specifications?			
5.1.10.	Waterproof grout or mortar specified for tile installation in wet areas?			
5.1.11.	Masonry and concrete surfaces will be sealed to prevent efflorescence and leaching?			
5.1.12.	Ventilation designed to prevent moisture accumulation?			
5.1.13.	Vapor and moisture barriers included in the design, where necessary?			
5.1.14.	Doors and windows designed to seal correctly?			
5.1.15.	Settlement:			
5.1.15.1.	Any potential settlement problems?			
5.1.15.2.	Design considers possible settlement?			
5.1.16.	Protective coatings specified that have been proven satisfactory for the intended use?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
5.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 6. INTERIOR STRUCTURAL SYSTEMS			
6.1.	GENERAL:			
6.1.1.	Basis of design reviewed to justify that all deviations from the approved criteria are warranted, and will increase reliability or decrease maintenance requirements and life cycle costs?			
6.1.2.	Technical and using agency comments reviewed for compliance and impact on reliability and maintainability?			
6.1.3.	All openings (e.g., windows, doors, ports) adequately sealed?			
6.1.4.	Interior finishes are durable and require minimal maintenance?			
6.1.5.	Closures between areas with controlled and uncontrolled environments checked to prevent loss of conditioned air?			
6.1.6.	Mechanical equipment rooms:			
6.1.6.1.	On ground floor, are exterior doors large enough to move equipment in or out?			
6.1.6.2.	Sufficient space to permit routine maintenance?			
6.1.6.3.	Interior mechanical equipment rooms designed with sound attenuation measures (especially doors)?			
6.1.7.	Support system or hangers above suspended ceilings (especially in corridors) for future installation of ADP (automated data processing) equipment and cables?			
6.2.	CARPENTRY:			
6.2.1.	Doors wide enough for furniture and equipment access?			
6.2.2.	Treated wood specified in areas exposed to moisture or insects?			
6.2.3.	Access specified to wood trusses or other areas that require periodic inspection?			
6.2.4.	Wood and protective coatings are compatible?			
6.2.5.	Drainage and ventilation adequate for confined areas subject to condensation?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
6.3.	FLOORING:			
6.3.1.	Base-level maintenance capabilities compatible with flooring selection and installation?			
6.3.2.	Dark grout specified for ceramic tile bath floors? (Consider epoxy grout in heavy-use areas.)			
6.3.3.	Floor finishes selected by considering moisture, soiling (abrasiveness and staining), chemicals, wheel loads, dropped objects, movable furniture, foot traffic, and traffic patterns?			
6.4.	PAINTING:			
6.4.1.	Application complies with MIL-HDBK-1110, *Handbook for Paints and Protective Coatings for Facilities*?			
6.4.2.	Paint is acceptable for local environmental standards?			
6.5.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 7. ROOFING			
7.1.	GENERAL. Low-slope roofs (slope is less than 76.2 millimeters [3 inches] per 0.3 meter [1 foot]) have historically experienced poor performance due to a variety of factors. Some of the conditions that contribute to early failures are identified in this section.			
7.1.1.	Can facility be designed with a pitched roof?			
7.1.2.	Does low-slope roof design provide for a minimum slope of 6 millimeters (0.25 inch) per 0.3 meter to ensure positive drainage of the roof surface?			
7.1.3.	Roof-mounted equipment properly mounted and flashed? (Mounting of mechanical and electrical equipment on the roof should be avoided. Rooftop equipment creates difficult flashing details, obstructs drainage paths, increases repairman traffic, accelerates corrosion and equipment weathering, and negatively affects maintainability of both the roof and equipment.)			
7.1.4.	Drains located at low points, with consideration given to the deflected position of the structure under load? (Interior roof drains are preferred over perimeter drains on low-slope roofs in cold climates.)			
7.1.5.	Design provides for sloping the frame of the building? (This is preferred over other methods of tapering the roof to achieve a positive slope.)			
7.1.6.	Roof drains to cold eaves? (Low-slope roofs should not drain to cold eaves in cold climates, as ice dams can develop and result in ponding.)			
7.1.7.	Scuppers provided at the proper height as a secondary means for drainage if the primary drains are blocked? (Scuppers should be approximately 50 to 76 millimeters [2 to 3 inches] above the level of the primary drains.)			
7.1.8.	Expansion joints:			
7.1.8.1.	If expansion joints are required, are they placed at the high point, with drainage directed away? (Expansion joints must allow movement in three directions.)			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
7.1.8.2.	Specified where the deck material changes (e.g., from steel to concrete)?			
7.1.8.3.	Specified where the span of the deck changes direction?			
7.1.8.4.	Specified between an existing building and an addition?			
7.1.8.5.	Specified wherever the wall can move relative to an abutting wall, curb, or other building component?			
7.1.8.6.	Specified at a maximum spacing of 45.7 meters (150 feet) to 91.4 meters (300 feet)?			
7.1.9.	Curbs for expansion joints, area dividers, and rooftop equipment sized to permit a minimum base flashing height of 203 millimeters (8 inches) and a maximum height of 0.3 meter?			
7.1.10.	Tapered insulation used correctly? (Use of tapered insulation for new construction to provide positive drainage is prohibited. Tapered insulation on re-roofing of low-slope roofs is acceptable.)			
7.1.11.	Positive drainage (slope) added for re-roofing projects on dead-level roofs?			
7.1.12.	Walkway pads provided on low-slope roofs subject to heavy foot traffic to prevent roof damage?			
7.1.13.	Steel framing around all equipment openings provided to ensure steel deck integrity?			
7.1.14.	Steel decks have a minimum thickness of 20 gauge?			
7.1.15.	Insulation specified with a minimum compressive strength of 206.9 kPa (30 psi) to resist traffic loads, hailstones, and dropped tools?			
7.1.16.	Insulation properly applied? (On steel decks, mechanical fastening of the first layer of insulation is required. The second layer should be hot-mopped, using a bitumen adhesive. Use of cold-applied adhesives for anchoring insulation is prohibited.)			
7.1.17.	Double layers of insulation placed with vertically offset joints (for superior performance)?			
7.1.18.	Design specifies a minimum 18-gauge metal gravel stop or fascia strips?			
7.1.19.	Flashed joints are located above the roof waterline, or, if that is impractical, flashings are kept out of low areas where ponding may occur?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
7.1.20.	Protected membrane roof (PMR) system design specified to enhance R&M (based on life-cycle costs)?			
7.1.21.	Single-ply elastomeric membrane use, if specified, has been approved by major command (MAJCOM)?			
7.2.	GENERIC ROOFING SYSTEMS:			
7.2.1.	Built-up roofing design, for re-roofing or replacement projects, incorporates specifications in ETL 90-1, *Built-Up Roofing (BUR) Repair/Replacement Guide Specification*?			
7.2.2.	Standing seam metal roofing system (SSMRS):			
7.2.2.1.	Designer has investigated the use of a SSMRS based on life-cycle costs?			
7.2.2.2.	Is the optimum material specified? (Specify the use of aluminum alloy rather than aluminum/zinc-coated steel, as the estimated service life is up to 75% greater with aluminum panels.)			
7.2.2.3.	Design slopes are correct? (The design must provide for a minimum slope of 6 millimeters per 0.3 meter under normal atmospheric conditions. Near salt water areas, the minimum slope required is 12 millimeters [0.5 inch] per 0.3 meter to enhance the life of the panel.)			
7.2.2.4.	Design provides for a minimum of 50 millimeters of vapor-retarding faced insulation for noise and condensation control under the metal panel, regardless of the thermal insulation values desired?			
7.2.2.5.	Where roof traffic is expected for equipment maintenance, does design provide a pre-designed serviceway to keep foot traffic, tools, and equipment from damaging the roof surface?			
7.2.2.6.	Is it required that the SSMRS be manufactured by a provider who has been regularly engaged in the fabrication of SSMRSs for at least ten years?			
7.2.2.7.	Is it required that the contractor installing the SSMRS has a minimum experience of two years?			
7.2.3.	Steep roofing (materials include rolled asphalt, asphalt strip shingles, clay tile, concrete tile, slate tile, wood shingles, and wood shake roofing systems):			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
7.2.3.1.	Are special installation techniques used, as detailed in the NRCA *Roofing and Waterproofing Manual*?			
7.2.3.2.	Does the roof installation design, flashing, underlayment, nailing, and ventilation meet the requirements of the NCRA manual?			
7.2.3.3.	Is the roofing system selected on a life-cycle cost basis? (To enhance maintainability, selection of a long-lasting premium roofing system should be specified commensurate with the facility life cycle and architectural theme.)			
7.3.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 8. WATER AND WASTEWATER			
8.1.	GENERAL:			
8.1.1.	Structural support members and hoists provided over large pieces of equipment to allow removal for maintenance?			
8.1.2.	Large equipment requiring installation or removal has an adequate building opening and associated passageway?			
8.1.3.	Equipment has adequate space (horizontal and vertical) for a work area to allow repair, adjustment, or removal? (In some places, a maintenance platform may be necessary.)			
8.1.4.	Access to equipment and tank sidewalls, with walkways and stairs, provided for maintenance and cleaning?			
8.1.5.	Water and sewer lines located in readily accessible areas for cleaning and/or repair (not under paved roads or in heavy traffic areas, when possible)?			
8.1.6.	Adequate spare parts and equipment for critical system repairs? (All pumping facilities must have spare pumps and on-line standby generator power to run all equipment.)			
8.1.7.	Movable building louvers provided to be closed in cold weather to protect equipment and ensure comfort for O&M personnel?			
8.1.8.	Piping and valves are adequate for isolating or bypassing treatment plant components to ensure operational flexibility and for maintenance purposes?			
8.1.9.	Equipment is durable, reliable, requires minimal maintenance, and is designed for water or sewage treatment plant environments?			
8.1.10.	Pipes and valves are color-coded and have flow direction arrows?			
8.1.11.	Sampling taps are provided throughout the system for adequate testing and process control?			
8.1.12.	Access roads and service areas are provided around outdoor equipment for removing large internal equipment?			
8.1.13.	Thrust blocks and supports are provided where flow changes direction and at automatic valve locations?			
8.1.14.	Floor trenches are provided around pumps to carry water spills to sumps?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
8.1.15.	Piping supported by walkways is centered or located and supported to ensure walkways will not tilt or twist under increased loads?			
8.1.16.	Pressure gauges provided on upstream and downstream sides of altitude valves to allow checking and adjustment of the valves?			
8.1.17.	Electronic or automatically controlled valves have manual override or bypass capability for maintenance, or during power outages?			
8.1.18.	Pressure gauges are specified on the discharge side of all major pumps?			
8.1.19.	Air bleed-off valves provided at high points in pump discharge lines to allow removal of air locks?			
8.1.20.	Isolation transformer is provided to separate laboratory electrical circuits from plant equipment circuits?			
8.1.21.	Complete treatment plant as-built wiring drawings, schematics, and logic circuits are provided, and actual wires are labeled with identification lists at circuit breaker boxes?			
8.1.22.	Quick-disconnect electrical plugs are provided on submerged equipment to allow rapid replacement during maintenance?			
8.1.23.	Potential freezing problems for piping and plant components have been considered?			
8.1.24.	Pipe penetrations in concrete tanks are properly caulked and provided with embedded sleeves?			
8.1.25.	Sufficient ground cover provided for load protection of buried lines?			
8.1.26.	Calibration equipment, special tools, and spares provided to maintain meters and other controls?			
8.1.27.	Dry chemical feed systems and storage areas have humidity controls?			
8.1.28.	Operational lighting is provided for night operations?			
8.1.29.	Provision has been made for locating nonmetallic buried pipe?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
8.2.	WATER SUPPLY, TREATMENT, AND DISTRIBUTION SYSTEMS:			
8.2.1.	Distribution systems are looped for backfeed capabilities, with adequate valving for safe, effective troubleshooting, isolation and repair? (Valve box covers should be metal, or have metal tags, for locating with a metal detector.)			
8.2.2.	Well details and data are provided to allow for later servicing, repair, and redevelopment?			
8.2.3.	Potable water storage facilities are designed to preclude water stagnation?			
8.2.4.	Pneumatic tank systems specify cutoff pressure, start pressure, and associated tank volume percentages for ease of startup and servicing?			
8.2.5.	Raw water is used in lieu of oil to lubricate well pump bearings (where practical)?			
8.3.	SEWAGE TREATMENT AND COLLECTION SYSTEMS:			
8.3.1.	Manholes and cleanouts provided to permit maintainability?			
8.3.2.	Cleanouts on pressure lines equipped with clamp-on caps?			
8.3.3.	Manholes and tanks have ladders securely anchored to the wall? (Ladders should be constructed of corrosion-resistant materials, and if the manhole depth is at least 6 meters [20 feet] secured safety belts should be installed).			
8.3.4.	Ladders or handrails exposed to sewage gases are made of galvanized ferrous metal? (Black iron is prohibited.)			
8.3.5.	Paint specifications that require intermediate and finish paint coats are lead-free, mercury-free, fumeproof, and suitable for sewage atmosphere containing hydrogen sulfide?			
8.3.6.	Traps and separators are provided to prevent oil and grease from entering sewage system?			
8.3.7.	Minimum pipe size for house connections is 152 millimeters (6 inches), and 203 millimeters for all other sewer lines?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
8.3.8.	Sewer lines have a sufficient slope to maintain full flow velocity of 0.6 meter (2 feet) per second, and an average flow velocity of 0.4 meter (1.6 feet) per second?			
8.3.9.	Lift stations have:			
8.3.9.1.	Dual submersible pumps, with automatic alternating lead pump controls with manual override?			
8.3.9.2.	Wastewater storage for short power outages or maintenance downtime?			
8.3.9.3.	Adequate heat and lighting?			
8.3.9.4.	Explosion-proof switches?			
8.3.9.5.	Easy access for maintenance personnel and pump replacement?			
8.3.9.6.	External switch for quick connection of mobile emergency generator?			
8.3.10.	Drains from possibly oil- or grease-contaminated sources have separator units?			
8.3.11.	Digester tanks have ground-level entry and low-point pump-out capability?			
8.4.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 9. INDUSTRIAL WATER TREATMENT (IWT)			
9.1.	GENERAL:			
9.1.1.	System or facility requires IWT?			
9.1.2.	Current water analysis used in the design of the IWT system?			
9.1.3.	Water treatment program complies with UFC 3-240-03, *Industrial Water Treatment Operations and Maintenance*?			
9.1.4.	Backflow prevention device specified between the potable water supply and the treated industrial water?			
9.1.5.	Water pre-treatment required (e.g., softener, dealkalizer, demineralizer), and, if so, is it included?			
9.1.6.	Feed equipment that is reliable and maintenance-free specified? (Continuous feed systems are preferred.)			
9.1.7.	Feed equipment is easily accessible for the operator to perform O&M?			
9.1.8.	Chemical feed tanks are of sufficient size for efficient operation?			
9.1.9.	Feed pumps are of the proper type and size?			
9.1.10.	Nearby space is available for storage of treatment chemicals?			
9.1.11.	Sampling points provided for:			
9.1.11.1.	Makeup water?			
9.1.11.2.	System water?			
9.1.11.3.	Condensate?			
9.1.11.4.	Feedwater?			
9.1.12.	Sample coolers specified, where required?			
9.1.13.	Adequate space is available for setting up a water sample testing laboratory?			
9.1.14.	Corrosion test racks included in the design?			
9.1.15.	Mechanical, rather than water-lubricated, seal pumps specified for closed systems?			
9.1.16.	System capacities provided to calculate amount of treatment chemicals required?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
9.1.17.	Cover over cooling racks specified to inhibit algae growth?			
9.1.18.	Freeze-protection features specified for systems subject to freezing?			
9.1.19.	Meters for makeup and blowdown water?			
9.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 10. PLUMBING			
10.1.	GENERAL:			
10.1.1.	Pipe concealment spaces, furring, or chases are of adequate size?			
10.1.2.	Distance from vent to fixture trap conforms to the Uniform Plumbing Code?			
10.1.3.	Food service equipment provided with an air gap or indirect waste line, in accordance with the Uniform Plumbing Code?			
10.1.4.	Drain line grades are accurately calculated, and invert elevations are established and indicated on the drawings?			
10.1.5.	Equipment schedules indicate the necessary units, capacities, types, sizes, and special notes?			
10.1.6.	Air chambers for fixtures are provided for groups of approximately four fixtures, instead of at each faucet, control valve, or flush valve, except where quick-acting valves are installed?			
10.1.7.	Electric water heaters that conform to Federal Specification W-H-196, *Heater, Water, Electric, Residential*, have a dual-type heating element, and a minimum size of 113.5 liters (30 gallons)?			
10.1.8.	Extra-heavy soil pipe (not service-weight pipe) is specified for buildings taller than two stories, or where the total stack height is greater than 10.6 meters (35 feet)?			
10.1.9.	Drawings provide enlarged doubleline piping plans for equipment rooms or other congested areas of pipe and or equipment?			
10.1.10.	Raw, saline, or other available nonpotable water could be used in secondary paths where costly treatment is not required?			
10.1.11.	Complete legend and list of abbreviations for plumbing and heating, ventilation, and air conditioning (HVAC) are provided?			
10.1.12.	Electric heating elements in food warming tables have automatic shutoffs to prevent element failure when low-water situations occur?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
10.1.13.	Shop floors slope away from equipment and hydraulic lift shafts, and toward adequately-sized drains?			
10.1.14.	Air (for tires) and water (for radiators) is available outside shops and maintenance bays?			
10.1.15.	Water has been analyzed for hardness if no central water softening system is available? (If required, provide appropriate water softeners.)			
10.1.16.	Backflow prevention program devices are accessible to craftsmen for inspection?			
10.1.17.	Hose bibs provided on exterior walls at appropriate locations?			
10.1.18.	Freeze-proof hose bibs specified in cold climate areas?			
10.1.19.	Sufficient valving provided to isolate minimum system sections (e.g., by floor, wing, bay) for repair or maintenance?			
10.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

SECTION 11. AIRCRAFT FUEL FACILITIES

For new construction, refer to MIL-HDBK-1022, *Petroleum Fuel Facilities*.
All fuels projects must be designed by a fueling systems expert.

11.1. RECEIPT:

11.1.1. Tanker offloading:

11.1.1.1. Articulated marine loading arms preferred.

11.1.1.2. Drawings provide containment from all fuel spill sources?

11.1.1.3. Strainers located on shore?

11.1.1.4. Piping is sloped toward shore?

11.1.1.5. Fuel stripping points provided to remove fuel for maintenance?

11.1.2. For pipeline receipt, thermal relief valves provided with isolation valves on the relief line around all aboveground valves where piping is blocked from thermal pressure relief?

11.1.3. For truck or rail receipt, preferred offload is by gravity to a drop tank or low profile tank. If offload pump is provided, use manifold and vacuum rated hoses. Locate pump as low and as close to the truck or rail car as possible to minimize suction losses. Provide means to remove air and mitigate static electricity buildup.

11.1.4. Filtration:

11.1.4.1. Strainers provided with easily removed covers?

11.1.4.2. Receipt filtration designed for the anticipated product quality? Prefiltration may be needed where heavy particulates or water are expected. Last stage of prefiltration should normally be horizontal filter/separators with American Petroleum Institute (API) elements specified.

11.2. STORAGE:

11.2.1. Underground cut and cover (normally in USAFE and PACAF):

11.2.1.1. Panic hardware provided on all pump house doors and horizontal entries?

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.2.1.2.	Three manways (more or less, depending on the tank diameter), of 0.9 meter (3 feet) minimum dimension, provided outside the pump house up to ground level? (One manway will have a ladder. Use a safety rail system instead of a safety cage to allow easier access with respiratory protective gear and other safety wear. There should be no tank openings in the pump house.)			
11.2.1.3.	High-level float valve pilot tubing is piped back through the flange downstream of the high-level control valve? (This prevents the free-fall of fuel from the float valve pilot.)			
11.2.1.4.	All jet fuel tanks are coated?			
11.2.2.	Aboveground (vertical steel tanks with floating pans and cone down bottoms with sump and fuel recovery systems):			
11.2.2.1.	Level alarms and high-level float control and arms are accessible from the exterior tank stairway?			
11.2.2.2.	Roof access stairways extend to the ground and, in cold climates, are on the east side of the tank where practical to take advantage of heat from morning sun?			
11.2.2.3.	Manways aligned with prevailing winds?			
11.2.2.4.	Manway covers provided with davits for easier removal? (Davits allow horizontal rotation of the cover without removal from the tank.)			
11.3.	TRANSFER SYSTEMS:			
11.3.1.	Pumping:			
11.3.1.1.	Flow switches with time delay installed on all pumps to protect the pump under no-flow conditions?			
11.3.1.2.	Deepwell turbine pumps provided with mechanical couplers so shaft seal can be removed without removing the pump motor?			
11.3.1.3.	Dedicated on/off switch (lockable type) provided near each pump motor for local manual operation?			
11.3.1.4.	API 610 pumps used for aircraft fueling systems?			
11.3.1.5.	Pumps larger than 15 horsepower have soft-start controller (solid-state closed transition type preferred) to minimize fuel surge in the system?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.3.1.6.	Deepwell turbine discharge head flange bolts attaching the pump to a tank flange are accessible (not imbedded in concrete), and at least 101 millimeters (4 inches) are available underneath the flange to facilitate pump removal?			
11.3.2.	Piping:			
11.3.2.1.	Isolation valves provided to allow pipeline maintenance (lift plug design or ball valves)?			
11.3.2.2.	Thermal relief with isolation valves provided around all aboveground valves where piping is blocked? (This permits relief of excessive pressure when fuel temperatures increase from exposure to the elements.)			
11.3.2.3.	Duplex strainers provided where strainers are required and pumping cannot be interrupted to clean strainers (such as off-loading headers)?			
11.3.2.4.	Steel sleeve used on all pipe penetrations through concrete? (Install positive mechanical-type seal on all pipe penetrations. Spacers must be installed between pipe and sleeve to ensure the pipe does not touch the sleeve. Do not use caulk.)			
11.3.2.5.	Low-point stripping connection, with valve, provided on all accessible pipe, and in pits where the low-point is buried?			
11.3.2.6.	Isolation valves (lift plug or ball valve design) provided every 0.8 kilometer (0.5 mile), or as system dictates on all piping systems?			
11.4.	HYDRANT SYSTEMS:			
11.4.1.	Operational tanks:			
11.4.1.1.	Underground tanks should not be used. Contact MAJCOM/CE for assistance.			
11.4.1.2.	Aboveground tanks conform to the parameters in paragraph 11.2.2?			
11.4.2.	Pumping:			
11.4.2.1.	Hardened pump houses with deepwell turbine pumps follow the parameters in paragraph 11.3.1?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.4.2.2.	Aboveground pump houses follow the parameters in paragraph 11.3.1.4?			
11.4.3.	Filter/separators:			
11.4.3.1.	Horizontal filter/separators with API elements used? (Provide a minimum 1.5-meter [5-foot] clearance in front of the vessel to allow filter removal, and 0.9 meter on all other sides. The bottom of the door will be a maximum of 1.5 meters above the finished floor.)			
11.4.3.2.	Piston-type differential pressure gauges used for filter/separators? (Do not use dial-type differential gauges.)			
11.4.3.3.	Weighted float feature used for automatic slug valves? (This permits testing of the float. Automatic drain feature is normally not used due to environmental concerns.)			
11.4.3.4.	Pilot piping for the float control rotary disc is from a filtered fuel source?			
11.4.3.5.	Control tube connections and small valves are of leakproof design?			
11.4.4.	Pits:			
11.4.4.1.	Hydrant pits are large enough to permit at least 0.6 meter from the riser to the pit wall?			
11.4.4.2.	Sump with water draw-off capability provided for all pits?			
11.4.4.3.	Standpipe with quick-connect coupling installed at grade level?			
11.4.4.4.	Isolation valve pits provided with valve extension operators to the top of the pits?			
11.4.4.5.	Scaffolding in each pit is no more than 1.5 meters below grade?			
11.4.4.6.	All pits (except ramp pits) have rolling pit covers similar to the USAFE design?			
11.4.4.7.	Flanges, valves, strainers, and similar fittings have a minimum clearance of two pipe diameters, or 0.6 meter, whichever is greater?			
11.4.4.8.	Piping centered in valve pits smaller than 1.2 meters (4 feet) wide?			
11.4.5.	Controls:			
11.4.5.1.	Automatic flow control valves provided with valve position indicators?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.4.5.2.	Main valve body ports on automatic valves equipped with shutoff valves to control tubing of pilot system? (This allows isolation of pilots for maintenance, with less chance of a fuel spill.)			
11.5.	DISPENSING:			
11.5.1.	Truck fill stands:			
11.5.1.1.	Underground:			
11.5.1.1.1.	Pressure-type fill stands provided with hydrant deadman?			
11.5.1.1.2.	Pantograph-type loading arms specified?			
11.5.1.2.	Aboveground:			
11.5.1.2.1.	Thirty-second relaxation chambers are not required for JP-8 fuel.			
11.5.1.2.2.	Stage-two flow control is no longer required. This feature on the flow control valve sets flow rates at two different flows during initial fill and full flow.			
11.5.1.2.3.	Receipt line to the pump pitched to avoid loss of pump prime?			
11.5.1.2.4.	Pump flow provided with a time delay?			
11.5.1.2.5.	Pantograph (preferred) specified for connection to the truck? (If hoses are provided, provide a hose rack with cover to protect the hose from the sun.)			
11.5.1.3.	Meters (Do not include temperature compensation unless needed for custody receipt.):			
11.5.1.3.1.	Meters provided with inlet and outlet ports to permit calibration?			
11.5.1.3.2.	Meter stands or supports allow access to bottom drain valve?			
11.6.	GENERAL REQUIREMENTS:			
11.6.1.	Ball valves used for all applications where economy or quick closure are required, and lift-plug valves used for manual valve applications where quarter-turn shutoff is not required? (Do not use gate valves in any fuel system.)			
11.6.2.	Lift plug-type double block and bleed valves specified where a tight shut-off is required for repairs and where isolation is required for pressure testing lines?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.6.3.	Pipe supports are no closer than two pipe diameters from any fitting or valve?			
11.6.4.	Piping and valves are located aboveground, where possible, unless survivability requirements dictate a high level of protection?			
11.6.5.	Underground pipe cathodically protected? (Note: Stainless steel corrodes faster underground than carbon steel.)			
11.6.6.	Raised-face flanges only are specified?			
11.6.7.	Strainers provided with quick-opening yoke assembly?			
11.6.8.	Strainers with filter/separators have drain piping with valve?			
11.6.9.	Pressure reliefs (not thermal expansion reliefs) and air eliminators piped to the reclaim tank?			
11.6.10.	Aboveground valves, where piping is blocked from thermal relief, provided with thermal relief (with isolation valves on relief line)? (Do not pipe to reclaim tank.)			
11.6.11.	Reclaim tank or drain tank connected to all sources of fuel drain?			
11.6.12.	Reclaim tank or drain tank provided with pump-out capability through filter/separator into the operating tank?			
11.6.13.	Pump houses or pit design allows access by heavy equipment to large system components (e.g., pumps, motors) for removal?			
11.6.14.	Pump houses, where heavy equipment access is not anticipated, provided with overhead crane of structural beam type to allow component removal?			
11.6.15.	Flange bolts and nuts are hex head (not square head)? (Square head nuts round off prematurely.)			
11.6.16.	Electrical:			
11.6.16.1.	Voltages meet NEMA standards for economical replacement of motors and controls?			
11.6.16.2.	Three-phase motors provided with phase monitor protection?			
11.6.16.3.	Pumping system motors that must be installed in pits or locations subject to flooding are submersible and explosion-proof (to avoid damage if flooded), or designed for easy relocation? (Pumping systems should be designed to prevent motors being subject to flooding.)			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
11.7.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 12. HVAC			
12.1.	AIR MOVEMENT AND DISTRIBUTION:			
12.1.1.	Fans and air handlers:			
12.1.1.1.	Access openings are specified in fan guards for checking fan speed?			
12.1.1.2.	Variable inlet vanes, variable pitch blades, motor speed control, or variable discharge dampers provided for control of variable air volume (VAV) systems? (Do not rely on “fan tracking” as a control method.)			
12.1.1.3.	Extended grease fittings specified for bearings when required for access?			
12.1.1.4.	Access doors provided for cleaning coils, drain pans, and fan blades?			
12.1.1.5.	Equipment is in the mid-range of cataloged performance to allow for adjustment during commissioning?			
12.1.1.6.	Inside lights provided for air handlers with at least 2.3 square meters (25 square feet) of coil area? (Use exterior mounted switch with indicator light.)			
12.1.1.7.	Fan coils are installed to allow full opening of access doors?			
12.1.1.8.	Return fans are not used in systems with less than 248.8 pascals (1 inch water gauge [w.g.]) return loss?			
12.1.1.9.	Return fans (if required) provided with a minimum distance of 2.5 times (6 times for outlet velocities of at least 1828.8 meters per minute [6000 feet per minute]) the equivalent fan discharge duct diameter between the fan and return air and exhaust air dampers?			
12.1.1.10.	Exhaust fans with variable inlet vanes, variable pitch blades, variable discharge dampers, or motor speed control specified for systems with economizer control strategies? (Do not rely on relief vents to provide adequate exhaust capability.)			
12.1.1.11.	Air handling units installed in equipment rooms, where possible?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.1.1.12.	Air handlers above a suspended ceiling provided with servicing platforms, extending a minimum of 0.4 meter (1.5 feet) from the edge of the equipment, and a clear space 0.9 meter high on the control side and other side where access is necessary?			
12.1.1.13.	Servicing clearance available for coil removal and filter changing?			
12.1.2.	Coils:			
12.1.2.1.	Cleaning space specified between cooling and heating coils?			
12.1.2.2.	Copper tubing and fin coils specified for coastal areas?			
12.1.2.3.	Coils that can be drained and cleaned specified?			
12.1.2.4.	Steam-distributing tube-type steam coils, with adequate air bleeding provisions, specified?			
12.1.3.	Medium- and high-efficiency filter sections provided with magnahelic pressure gauges?			
12.1.4.	Louvers, dampers, and mixing boxes:			
12.1.4.1.	Fresh-air louvers are not located adjacent to heat rejection equipment (e.g., cooling towers)?			
12.1.4.2.	Pressure-independent balancing dampers specified downstream of VAV terminals?			
12.1.4.3.	Duct access doors specified on both sides of all dampers?			
12.1.4.4.	High-efficiency dampers specified for all fresh-air dampers and mixing boxes?			
12.1.5.	Ductwork:			
12.1.5.1.	Fiberglass ductwork constructed in accordance with SMACNA *Fibrous Glass Duct Construction Standards*?			
12.1.5.2.	Sheet metal ductwork constructed in accordance with SMACNA, *Low Pressure Duct Construction Standards*, or SMACNA*, High Pressure Duct Construction Standards*, as applicable?			
12.1.5.3.	Maximum leakage rates of 2% for round ductwork and 5% for square ductwork specified? (This will be tested and verified during air balance.)			
12.1.5.4.	Vapor barrier material specified for insulation intended for air conditioning ductwork?			
12.1.5.5.	Access doors and panels provided at locations which require cleaning (e.g., reheat coils, VAV terminals)?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.1.5.6.	Branch ducts are offset from main trunk duct (not opposite each other) for improved balance?			
12.1.5.7.	Lights (with exterior on/off switch and pilot light) provided in duct chases for maintenance use?			
12.1.5.8.	Supply and return ductwork design prevents stratification? (Use baffles if necessary.)			
12.1.5.9.	Manually operated, opposed blades, or single-blade, quadrant-type volume dampers specified for each branch duct take-off after exiting the main duct? (Splitter dampers and volume extractors are not suitable for volume control.)			
12.1.5.10.	Double-thickness or single-thickness extended-edge turning vanes specified in rectangular elbows?			
12.1.5.11.	Manual volume dampers specified at branch duct connections upstream of registers or diffusers? (Diffuser/damper combinations are acceptable only in addition to, not in lieu of, upstream volume dampers. Registers or diffuser dampers cannot reduce high volumes without creating high noise levels.)			
12.1.5.12.	Volume dampers are located at least two diameters from fittings, and as far as possible from outlets?			
12.1.5.13.	Straight duct sections are at least 7.5 duct diameters from fan discharge, elbows, or open duct ends, to ensure accurate traverse readings?			
12.1.5.14.	Duct drops to diffusers are at least two times the duct diameter to ensure even distribution from the outlet?			
12.1.5.15.	Diffuser registers and or light troffers are not located on the same branch duct, if possible? (This results in differences in pressure drop from inherently unbalanced conditions.)			
12.1.6.	Terminal devices:			
12.1.6.1.	Pressure-independent terminals are specified?			
12.1.6.2.	Duct access doors provided upstream of VAV terminals to allow cleaning and lubrication?			
12.1.6.3.	Reheat coils (even for VAV applications) are not specified, if avoidable?			

NO.	ITEM (Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)	YES	NO	N/A
12.1.6.4.	Distribution plates, orifice plates, or other similar devices susceptible to dirt entrapment, are not specified for VAV or dual-duct terminals?			
12.1.6.5.	Terminal devices are located over common-use areas (where possible) to reduce occupant interference during maintenance?			
12.2.	PIPING:			
12.2.1.	Chilled and hot water:			
12.2.1.1.	Thermometers and gauges specified at inlets and outlets of all heat-exchange devices (e.g., converters, chillers, water-cooled condensers, boilers)?			
12.2.1.2.	Air vents with isolation valves specified at all high points and heat exchangers?			
12.2.1.3.	Vapor barrier material specified for chilled water piping insulation?			
12.2.1.4.	Chemical feeders specified for water treatment?			
12.2.1.5.	Dielectric unions specified at connections of dissimilar metals?			
12.2.1.6.	Flow measurement equipment (e.g., orifice plates) specified for pumps and major heat exchange devices?			
12.2.2.	Steam and condensate return:			
12.2.2.1.	Condensate return lines slope in direction of flow?			
12.2.2.2.	Dielectric unions specified at connections of dissimilar metals?			
12.2.2.3.	Steam traps located to allow maintenance?			
12.2.3.	Refrigeration piping:			
12.2.3.1.	Piping is designed to provide adequate oil return?			
12.2.3.2.	Suction and discharge gas risers are sized for minimum gas velocities of 304.8 meters per minute (1000 feet per minute)?			
12.2.3.3.	Horizontal suction and discharge gas lines are sized for minimum gas velocities of 152.4 meters per minute (500 feet per minute)?			
12.2.3.4.	P-traps specified at the bottom of gas risers with at least 2.4 meters (8 feet) of vertical run?			
12.2.3.5.	Double gas risers specified for systems with unloading compressors?			
12.2.3.6.	Horizontal refrigerant lines are sloped 12 millimeters (0.5 inch) per 3 meters (10 feet) in the direction of flow?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.2.3.7.	Isolation valves provided at inlets and outlets of major system components, and on each end of long refrigeration lines? (Each separable element of the system must have provisions for localized evacuation. Critical systems must be provided with valved bypass lines at all filter dryer locations.)			
12.2.4.	Cooling coil condensate drain piping:			
12.2.4.1.	Drain diameter is at least 25 millimeters (1 inch)?			
12.2.4.2.	Piping is sloped at least 6 millimeters (0.25 inch) per 0.3 meter (12 inches) in the direction of flow?			
12.2.4.3.	Trap provides a minimum difference in inlet-to-outlet elevation of 12 millimeters, plus the air handling unit (AHU) total static pressure rating?			
12.3.	HEAT REJECTORS (TOWERS AND CONDENSERS):			
12.3.1.	General:			
12.3.1.1.	Domestic water lines with hose bibs provided adjacent to equipment for cleaning? (Hose bibs must be freeze-protected, where necessary.)			
12.3.1.2.	Extended grease fittings specified for internal bearings, where required for access?			
12.3.1.3.	Power outlet of 115 volts provided adjacent to equipment?			
12.3.2.	Cooling towers:			
12.3.2.1.	Automatically operated chemical water treatment system, with catch basins having drains to house chemical drums, specified?			
12.3.2.2.	Domestic water and drain connections, if practicable, specified to allow bypass of towers during maintenance?			
12.3.2.3.	Cooling towers are not located on roofs or in locations that can backfeed into building vent inlets?			
12.3.2.4.	Induced-draft towers specified?			
12.3.2.5.	Cooling towers are at adequate height above condenser water pump suction to provide the required net positive suction head?			
12.3.2.6.	Multiple cooling towers, supplied from a common header, provided with balancing valves for each tower?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.3.3.	Water-cooled condensers:			
12.3.3.1.	Ample space is provided to inspect and clean condenser tubes?			
12.3.3.2.	Flanges (or unions) and isolation valves in condenser water piping located to allow removal of piping and headers immediately in front of tubes?			
12.3.3.3.	Taps, with hose bibs, provided to allow chemical feeding for cleaning.			
12.3.4.	Air-cooled condensers:			
12.3.4.1.	Condensers provide a maximum temperature of 20 °F above design ambient?			
12.3.4.2.	Solar effects and other site-specific operating conditions considered when specifying capacity?			
12.3.4.3.	Multiple fans and necessary controls included for head pressure control?			
12.3.4.4.	If units are installed on roofs (which is discouraged), a level working platform extending 0.7 meter (2.5 feet) from the edge of the equipment on the control side and other sides requiring service access provided?			
12.4.	REFRIGERANT COMPRESSION EQUIPMENT:			
12.4.1.	General:			
12.4.1.1.	Compressors located in equipment rooms? (Do not locate compressors on roofs.)			
12.4.1.2.	Suction discharge and oil pressure gauges with isolation valves permanently mounted on equipment room walls or free-standing partitions? (Do not mount on equipment.)			
12.4.2.	Water-cooled compressors located in equipment rooms?			
12.4.3.	Air-cooled compressors located on ground-level concrete pads (except in desert environments)?			
12.5.	HEAT EXCHANGERS:			
12.5.1.	General:			
12.5.1.1.	Flanges or couplings and isolation valves located to allow piping removal directly in front of device (above, below, and or to the side)?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.5.1.2.	Devices sloped to allow for drainage?			
12.5.1.3.	Air bleeding adequately provided for in design?			
12.5.1.4.	Taps provided with hose bibs to allow chemical feeding for cleaning?			
12.5.1.5.	Space provided to pull tubes or coils?			
12.6.	SPECIALTIES:			
12.6.1.	Steam traps:			
12.6.1.1.	Traps mounted 0.3 meter to 0.4 meter below steam coil outlet to provide condensate head on the trap?			
12.6.1.2.	Minimum dirt leg of 152 millimeters (6 inches) provided before trap inlet?			
12.6.2.	Strainers:			
12.6.2.1.	Strainers provided upstream of steam traps, control valves, meters, and pumps?			
12.6.2.2.	Strainer housings equipped with drain valves?			
12.6.2.3.	Isolation valves provided for redundant parallel strainers in critical systems?			
12.6.3.	Meters are provided with bypass lines and isolation valves to allow removal of meters with no down time?			
12.6.4.	Ball valves specified, rather than gate or butterfly valves?			
12.7.	CONTROLS:			
12.7.1.	General:			
12.7.1.1.	Steel channel structural supports provided for actuators installed on less than 16 gauge sheet metal?			
12.7.1.2.	Over-current protection specified for input and output circuits of direct digital control (DDC) systems?			
12.7.1.3.	Dry-bulb economizer strategies specified instead of enthalpy controls?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.7.1.4.	Test point connections installed for determining control system pressure and voltages?			
12.8.	ELECTRICAL DEVICES. Motor starter contactors rated for cyclic loading specified? (Solid-state starters are preferred for cyclic loads.)			
12.9.	PUMPS. Horizontal split-case pumps specified (preferred), dependent upon application?			
12.10.	EQUIPMENT ROOMS:			
12.10.1.	Equipment rooms located along exterior walls with exterior access doors?			
12.10.2.	Large doors with easily removable panels designed to allow passage of largest piece of equipment?			
12.10.3.	Floors sloped to interior drain?			
12.10.4.	Room provided with domestic water, hose bib, and 115 volt power outlets?			
12.10.5.	Wall space or full standing partitions provided for mounting controls?			
12.10.6.	Space allowed for wire brushing of water-cooled condensers, chillers, and coils, filter removal, and access to control actuators?			
12.10.7.	Equipment item locations provide for maintenance safety space and safety clearance from electrical panels and switches?			
12.11.	IDENTIFICATION:			
12.11.1.	Structural. Small labels or other unobtrusive identification tapes specified for suspended ceiling grids (t-Bar) below components (e.g., static pressure sensors, VAV terminals, balancing dampers)? (Match the nomenclature with the mechanical construction drawings.)			

NO.	ITEM (Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)	YES	NO	N/A

12.11.2. Piping. Standard color-coded labels (ANSI A13.1) specified for piping, placed at 3-meter intervals? (Colored pipe labels will be printed to indicate the type of fluid carried [e.g., chilled water supply, hot water return]. Direction of fluid flow will be indicated by arrows. Color coding will be as shown in Table A1.)

Table A1. Label Color Codes

Fluid Type	Background Color	Color of Lettering
Boiler feed water	Yellow	Black
Chilled water	Green	White
Condensate return	Yellow	Black
Condenser water	Green	White
Hot water supply/return	Yellow	Black
Makeup water	Green	White
Steam supply	Yellow	White
Fuel	Yellow	Black

12.11.3. Valves and steam traps. Numbered brass tag specified to be connected to the valve with a brass jack chain? (Tags will be at least 50 millimeters round or square, with stamped black-filled lettering. In addition to numbers, tags will be lettered to indicate fluid carried through the valve [e.g., “cw”]. Numbers will be keyed to the mechanical construction drawings.)

12.12. SPARE PARTS AND TOOLS:

12.12.1. Contractor will furnish difficult-to-obtain and manufacturer-unique spare parts upon contract completion?

12.12.2. Special tools required to service equipment will be supplied, with a lockable metal toolbox for security?

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
12.13.	DOCUMENTATION:			
12.13.1.	Documentation will be in English and host country language?			
12.13.2.	O&M equipment and operating manuals:			
12.13.2.1.	Requirements for O&M manuals are detailed and specified in an attachment to this checklist?			
12.13.2.2.	If required, are the provisions of the attachment included in the contract?			
12.13.3.	Contractor is required to provide 95% submittal of corrected contract drawings, indicating as-built conditions, 15 calendar days before scheduled O&M training? (Deficiencies discovered during the training session will be corrected by the contractor, and completed drawings submitted on Mylar® within 15 days of completion of the training session.)			
12.13.4.	Contract drawings:			
12.13.4.1.	Designer will provide a separate full-sheet drawing of mechanical equipment room, showing equipment layout with clearances for maintenance and repair?			
12.13.4.2.	Design provides for a separate piping diagram of all valves? (Valves will be numbered on the diagram and listed in the valve schedule. Valve numbers will correspond to valve tags.)			
12.13.4.3.	Design provides large-scale (small size) floor plan, showing zone boundaries with numerical identification of each zone?			
12.13.5.	Mechanical room documentation will be provided by the contractor in each mechanical room, sheets permanently mounted under clear Plexiglas®, including the duct work schematic, piping schematics and valve schedules, and control schematics with description of operation?			
12.14.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

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NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

AF FORM 2519, 19911101 ***(EF-V4) (REVERSE)***

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 13. ELECTRICAL GENERATORS			
13.1.	GENERAL:			
13.1.1.	Overhead crane, or overhead clearance for portable crane, provided in power plant for removing and replacing heavy generator parts?			
13.1.2.	Maintenance space provided around generators, switchgear, and auxiliary equipment?			
13.1.3.	Split bus specified for redundancy and reliability?			
13.1.4.	Solid-state exciter (radio frequency interference [RFI] free) and voltage regulator specified?			
13.1.5.	Generator compatible with solid-state uninterruptible power supply [SSUPS] installation (e.g., harmonics)? (Harmonics from SSUPS may interfere with generator controls. Generator must be sized to handle SSUPS in rush current.)			
13.1.6.	Automatic transfer switch has bypass capability for easy maintenance?			
13.1.7.	Design has been reviewed by electrical superintendent, and relevant comments incorporated?			
13.1.8.	Generators smaller than 750 kW skid-mounted?			
13.1.9.	Prime power generators grounded in accordance with IEEE Standard 142, *IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems*, and the *National Electrical Code*?			
13.1.10.	Computerized short circuit analysis and coordination study provided for prime power plants?			
13.1.11.	Backup generators have capability to have oil checked and be refueled without shutdown?			
13.1.12.	Backup generators have bypass capability with cannon plug-type receptacle for quick connection of mobile electric power (MEP) unit in case of failure?			
13.1.13.	Auto-start equipment of backup generators capable of being locked out during maintenance?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
13.1.14.	Backup generator prime mover shutdown limited to low oil pressure, high temperature, and overspeed? (Alarm will be connected to status panel, but consider remote alarm to central status location, such as the energy management and control system [EMCS].)			
13.1.15.	Alternator has maintenance-free, sealed, 50,000-hour bearing? (Consider multitap leads.)			
13.1.16.	Class C generator regulator has automatic and manual capability, and is easily accessible for maintenance or repair?			
13.1.17.	Louvers are thermostatically controlled?			
13.1.18.	Roads adequate for service vehicle access?			
13.1.19.	Prime power facilities have oil storage structures and storage containers for used oil?			
13.1.20.	Fuel systems provide for dipstick water detection, and vent and fill pipes are above the highest water level? (Fuel piping should be in troughs for easy access.)			
13.1.21.	Battery chargers are float-charge type, adjustable down to 0.1 ampere, and batteries are sealed, maintenance-free type?			
13.1.22.	Air start systems are redundant with diesel engines (instead of gasoline), and have redundant air receivers?			
13.1.23.	Radiators in multi-unit facilities capable of being manifolded? (This allows a generator to continue running if the radiator is out of service. Treated coolant storage should also be provided. Similar requirement for fuel systems.)			
13.1.24.	Large generator units have automatic temperature regulator (instead of thermostat), and automatic coolant/crankcase heater with isolation valves?			
13.1.25.	Standby units that cannot tolerate reapplying power without cycling have dropout/lockout relays?			
13.1.26.	Exhaust outlets located to avoid intakes of adjacent buildings?			
13.1.27.	Spare parts are provided?			
13.1.28.	Audible alarms provided to alert operators of abnormal conditions?			
13.1.29.	Generator switchgear breakers are drawout type?			
13.1.30.	Voltage generated at distribution level, when possible?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
13.1.31.	Control unit soundproofed for larger multi-unit plant?			
13.1.32.	Auxiliary fuel tanks placed below grade for emergency generators located within the airfield environment?			
13.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 14. CORROSION PREVENTION AND CONTROL			
14.1.	GENERAL:			
14.1.1.	Buried or submerged metallic piping, tanks, and related facilities have cathodic protection or protective coating system? (Cathodic protection or protective coatings are functional requirements for virtually all projects.)			
14.1.2.	The following were considered in the design and selection of the corrosion prevention and control methods:			
14.1.2.1.	Meteorological conditions?			
14.1.2.2.	Soil resistivity and hydrogen-ion concentration (pH)?			
14.1.2.3.	Chemical content of soil?			
14.1.2.4.	Presence of airborne pollutants?			
14.1.3.	All review comments have been complied with to ensure minimal impact on reliability and maintainability of the system?			
14.2.	CATHODIC PROTECTION:			
14.2.1.	Metallic construction members, either buried or submerged in an electrolyte, have been considered for possible cathodic protection?			
14.2.2.	Method of cathodic protection specified is the most suitable for the situation?			
14.2.3.	Cathodic protection design system was based on, and took account of, the following:			
14.2.3.1.	Soil resistivity?			
14.2.3.2.	Soil chemical content?			
14.2.3.3.	Liquid electrolyte velocity?			
14.2.3.4.	Type of metal?			
14.2.3.5.	Design life?			
14.2.3.6.	Source and availability of power?			
14.2.3.7.	Electrolyte pH?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
14.2.4.	Electrical isolation (if required):			
14.2.4.1.	Insulating flanges and unions are located as close as possible to the structure being isolated?			
14.2.4.2.	Location of each insulating fitting is shown on drawings?			
14.2.4.3.	Detail sketch has been included showing the components and construction of each type of insulating fitting?			
14.2.4.4.	If buried insulating flanges are used, details are included showing installation of flange field test stations, and connections with the stations?			
14.2.4.5.	Insulating fittings installed on auxiliary connections to the electrically isolated structure are held to a minimum?			
14.2.4.6.	Metal jacketing applied over thermal insulation on piping does not short out insulating flanges or fittings?			
14.2.5.	Underground metallic pipe, partially encased in concrete:			
14.2.5.1.	Protection provided where pipe emerges from encasement?			
14.2.5.2.	Pipe properly coated and has cathodic protection?			
14.2.6.	Design identifies existing cathodic protection systems in the vicinity of construction (i.e., location, type, level of protection)?			
14.2.7.	System capable of withstanding high-voltage power surges in areas with overhead power lines?			
14.2.8.	Sacrificial anode systems:			
14.2.8.1.	Anode locations shown on drawings?			
14.2.8.2.	Anode installations detailed, including spacing from pipes, burial depths, and connections of anodes to pipes?			
14.2.8.3.	Wire sizes and connection methods indicated on each installation detail?			
14.2.9.	Impressed current systems:			
14.2.9.1.	Impressed current anode locations shown on drawings?			
14.2.9.2.	Enough anodes to conduct estimated required protective current?			
14.2.9.3.	Rectifier, terminal box, and junction box locations shown on drawings?			
14.2.9.4.	Cable route associated with system shown on drawings?			
14.2.9.5.	Installation details shown on drawings?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
14.2.9.6.	Wire sizes and termination methods shown on drawings?			
14.2.9.7.	Wiring diagram for each rectifier includes alternating current (AC) power terminals, circuit number for AC power leads, number and size of conductors connected to rectified output terminals, and description of where each lead from rectifier terminates?			
14.2.10.	Proper system maintainability:			
14.2.10.1.	Test stations provided?			
14.2.10.2.	Test stations shown on drawings?			
14.2.10.3.	Test station installations detailed?			
14.2.10.4.	Test procedures ensure system will provide an acceptable level of protection under anticipated operating conditions?			
14.2.11.	Cathodic protection (CP) design performed by corrosion specialist accredited by National Association of Corrosion Engineers (NACE)?			
14.3.	MATERIALS:			
14.3.1.	Plastics exposed to direct sunlight are UV-resistant?			
14.3.2.	Corrosion resistance was considered when specifying metals?			
14.3.3.	Components (e.g., valves) will not exhibit galvanic action? (This may require non-standard nuts, handwheels, and levers.)			
14.3.4.	Piping accessory materials (e.g., thermowells, pressure taps, flow switch bushings) have been carefully considered? (Early installation may be useful where internal coatings will be applied.)			
14.4.	COATING SELECTION:			
14.4.1.	Shop-applied coatings appropriate for anticipated corrosive conditions?			
14.4.2.	Shop-applied prime coatings compatible with field-applied top-coatings?			
14.4.3.	Proper surface preparation specified for field-applied coatings?			
14.4.4.	Appropriate application and curing methods specified for field-applied coatings?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
14.4.5.	Field-applied coatings can be applied and cured in anticipated environmental conditions?			
14.4.6.	Procedures specified will ensure proper coverage and thickness of field-applied coatings?			
14.4.7.	Coating selections based on thorough analysis of surfaces to be coated, and anticipated environmental conditions?			
14.5.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 15. PAVEMENTS			
15.1.	CRITERIA:			
15.1.1.	Construction phasing plan and scope of work coordinated with flight operations regarding types of aircraft, aircraft clearances, and operations proposed for the facility?			
15.1.2.	Pavement type specified meets requirements of UFC 3-260-02, *Pavement Design for Airfields*?			
15.1.3.	Airfield pavement design meets criteria specified in AFI 32-1024, *Standard Facility Requirements*, AFH 32-1084, *Facility Requirements Handbook*, AFMAN 32-1123 (I), and UFC 3-260-02?			
15.1.4.	Airfield thickness design, materials, and compaction requirements comply with UFC 3-260-02?			
15.1.5.	Computer aided design program (CADP) used to establish design parameters?			
15.1.6.	Airfield markings shown in design drawings, and comply with AFI 32-1042, *Standards for Marking Airfields*?			
15.1.7.	Roads designed in accordance with UFC 3-260-02, Technical Manual (TM) 5-826-1, *Airfield Pavement Evaluation Concepts,* TM 5-826-2, *Engineering and Design: Airfield Flexible Pavement Evaluation,* TM 5-826-3, *Airfield Rigid Pavement Evaluation,* TM 5-826-4, *Army Airfield-Heliport Pavement Reports*, and TM 5-826-6, *Procedures For U.S. Army and U.S. Air Force Airfield Pavement Condition Surveys*?			
15.1.8.	Drainage grates, hand hole and manhole covers located within the shoulder and overrun area of airfield pavements designed to support a 34,000-kilogram (75-kip) wheel load?			
15.2.	GENERAL:			
15.2.1.	CADP or applicable design curve used for thickness design? (Design should include printout showing inputs and thickness, or have curve attached.)			
15.2.2.	Contract provides for full-time inspection on large projects?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
15.2.3.	Air Force-developed standard design details, or any deviations, incorporated in design?			
15.2.4.	Current project data included in pavement improvement plan (PIP)? (This applies to M&R projects only.)			
15.2.5.	Project scope sufficient to ensure critical facilities (e.g., runways) will not require project work within 3 to 5 years?			
15.3.	RIGID PAVEMENTS. Neoprene compression materials are initially more expensive than field-poured sealants, but have a longer performance life. The MAJCOM will specify the sealer type to be used on new, reconstruction, or reseal projects, based on life cycle costs and operational considerations. Disagreements between user and design agency regarding design options will be resolved by HQ AFCESA/CES.			
15.3.1.	Design provides for joint spacing not greater than 6 meters?			
15.3.2.	Joint width is at least 12 millimeters, regardless of joint seal type (i.e., preformed or field-poured)?			
15.3.3.	Design provides for runway and taxiway centerline joints? (Crowning of the centerline should be avoided since uncontrolled cracking occurs.)			
15.3.4.	New joints and resealing of joints and cracks meet requirements of TM 5-822-11, *Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements*?			
15.3.5.	Joint resealing project design provides for complete removal of old joint seal material?			
15.3.6.	Metal joint inserts not specified? (These are prohibited on Air Force pavements.)			
15.3.7.	Joint sealants tested by Air Force-approved laboratory to ensure compliance with applicable Federal or American Society for Testing and Materials (ASTM) standards?			
15.3.8.	Joints and cracks within 7.6 meters (25 feet) of liquid oxygen (LOX) production and storage areas sealed with LOX-compatible sealants? (If LOX sealants are unavailable, joints and cracks must be kept clean and unsealed.)			
15.3.9.	Continuously reinforced concrete pavement (CRCP) specified for all new pavements in LOX areas?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
15.4.	FLEXIBLE PAVEMENTS. Technical guidance for improving the quality of asphaltic concrete pavements is provided in UFC 3-250-03, *Standard Practice Manual for Flexible Pavements*.			
15.4.1.	"Double-string line" method required to ensure close control of longitudinal and transverse grade of paving?			
15.4.2.	Pavement recycling design conforms to TM 5-822-10, *Standard Practice for Pavement Recycling,* and UFC 3-250-03?			
15.4.3.	Specification provides that contractor will receive reduced payment if correct quality is not provided?			
15.5.	PAVEMENT GROOVING:			
15.5.1.	Spacing and groove types are specified for AC and PCC pavements?			
15.5.2.	Grooving eliminated within 91.4 meters of aircraft arresting barriers?			
15.6.	SEAL COATS AND REJUVENATORS FOR FLEXIBLE PAVEMENTS:			
15.6.1.	Rejuvenators not specified for runway surfaces? (Rejuvenators may make pavement extremely slippery.)			
15.6.2.	Test strips required to ensure specified rejuvenators are correctly applied?			
15.6.3.	Pavement to be rejuvenated contains at least 5% voids?			
15.6.4.	Pavements subject to heavy traffic or high tire pressures not slurry-sealed, due to foreign object damage (FOD) potential?			
15.7.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 16. FIRE PROTECTION			
16.1.	GENERAL. Applicable manuals, codes, and standards represent minimum acceptable requirements, and are not considered design goals. They will typically be exceeded to achieve desired R&M.			
16.1.1.	Exterior and interior fire protection systems (e.g., standpipes, sprinklers, hoses, accessories, extinguishers) are completely described, drawn, and conform to appropriate technical manuals and National Fire Protection Agency (NFPA) codes?			
16.1.2.	Fire alarm is coordinated with electrical central alarm system?			
16.1.3.	Sprinkler system piping ensures free draining to riser drain valves?			
16.1.4.	Non-potable water storage allows secondary use so continual changing is provided?			
16.1.5.	Fire alarm and detection system compatible with existing on-base system? (System standardization is desired.)			
16.1.6.	Design identifies required fire protection and life safety features, such as protection of vertical openings, interior finishes, signaling systems, extinguishing systems, segregation or protection of hazardous conditions, fire doors, and building service equipment?			
16.1.7.	Design provides outside fire protection, including water supply/storage and fire department access?			
16.1.8.	Electrical and mechanical drawings show location of fire alarm system appurtenances and automatic fire doors, fire and or smoke dampers, ceiling dampers, and similar means of fire protection for air duct systems?			
16.1.9.	System provided for containment and collection of expended dry/wet chemical extinguishing agents?			
16.1.10.	Suffocating extinguishing agents, such as CO_2, are not specified with munitions or materials containing own oxygen supply?			
16.1.11.	Fire extinguishing systems, smoke evacuation systems, and related systems and equipment are designed so operation does not depend upon high maintenance? (The design objective is a highly reliable, easily maintainable, and cost-effective system.)			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
16.2.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
	SECTION 17. CENTRAL HEAT PLANTS			
17.1.	COAL HANDLING AND STORAGE AREA:			
17.1.1.	Outside storage area is adequate size to maintain required coal at limited pile height?			
17.1.2.	Storage area designed for rubber-tired vehicles to manage stockpile?			
17.1.3.	Rail receiving area provided (if base rail system is available)?			
17.1.4.	Truck receiving and handling area provided, if applicable?			
17.1.5.	Capacity of each item of conveying equipment installed in series limited to the capacity of the following item of equipment?			
17.1.6.	Conveying rate of coal handling system capable of transporting maximum daily requirement to live storage in 8 hours?			
17.1.7.	Inclined conveyors (e.g., belt, flight, en masse) kept at a minimum incline to prevent capacity decrease?			
17.1.8.	Hopper angles as steep as practicable, with an absolute minimum angle of 55 degrees from horizontal? (For a square hopper, the valley angle must be a minimum of 55 degrees.			
17.1.9.	Potential dead areas in bunkers are avoided to prevent spontaneous combustion?			
17.1.10.	Fire prevention and extinguishing equipment specified?			
17.1.11.	Bunkers and silos provide the capability for evacuation in case of fire?			
17.1.12.	Construction material for storage and handling equipment able to withstand corrosive effects of coal?			
17.1.13.	Screw-type conveyors not specified? (This type tends to change coal size.)			
17.2.	OIL HANDLING AND STORAGE:			
17.2.1.	Heating system will maintain oil at viscosity suitable for handling?			
17.2.2.	Storage and handling equipment material will not corrode?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
17.3.	GAS HANDLING AND STORAGE. Safety valves installed at each boiler to limit gas pressure (one for high limit, one for low limit)?			
17.4.	ASH HANDLING:			
17.4.1.	Ash hopper valves are zero-leak style, designed to open after ash line vacuum is turned on, and close after ash line vacuum is turned off?			
17.4.2.	Separate silos are provided for storage of fly ash and bottom ash?			
17.4.3.	Fly ash handling system is dilute phase pneumatic type?			
17.4.4.	Ash handling system provides that bottom ash is cool before handling?			
17.5.	FANS AND DAMPERS:			
17.5.1.	Control of forced draft and induced draft fans by variable speed motors considered instead of mechanical damper positions? (This achieves more stable control of furnace draft pressure.)			
17.5.2.	If common ducting is used between boilers, zero-leak dampers are specified to isolate each boiler?			
17.5.3.	Dampers motorized and controlled from inside heat plant?			
17.6.	EQUIPMENT:			
17.6.1.	Oxygen monitors specified for each boiler outlet to determine operations and combustion efficiencies?			
17.6.2.	For oil and coal fuels, opacity and oxygen monitors at each boiler outlet specified?			
17.6.3.	Wiring for monitors of shielded type?			
17.6.4.	Monitors are self-calibrating and self-cleaning?			
17.6.5.	Displays and chart devices located on operating level for easy viewing and maintenance access?			
17.6.6.	Water treatment system is continuous-feed type with each chemical metered separately?			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A
17.7.	AIR POLLUTION CONTROL:			
17.7.1.	Mechanical collectors provided as pre-cleaning devices upstream from baghouses and electrostatic precipitators (ESP)?			
17.7.2.	Mechanical collectors designed with manhole access for the collector inlet/outlet and hopper?			
17.7.3.	Electrical charging and rappers section on the roof of ESPs enclosed and heated to prevent corrosion?			
17.7.4.	Baghouse and ESP hoppers heated to prevent clinkering, and hopper areas enclosed?			
17.7.5.	Baghouses designed in modules to allow being taken off-line for maintenance while the boiler is still on-line?			
17.7.6.	ESPs designed with three fields in series aspect ratio no less than 1.5?			
17.7.7.	Heat recovery devices of proper size to avoid acid corrosion? (The minimum temperature entering air pollution control devices should be 177 °C [350 °F].)			
17.8.	LIST ANY ADDITIONAL LOCALLY-UNIQUE R&M DESIGN FEATURES TO BE CONSIDERED:			

NO.	ITEM *(Assign a paragraph number to each item. Draw a horizontal line between each major paragraph.)*	YES	NO	N/A

AF FORM 2519, 19911101 ***(EF-V4) (REVERSE)***

REPLY TO
ATTN OF:

SUBJ: Reliability and Maintainability (R&M) Program – Lessons Learned

TO: HQ AFCESA/CES
Tyndall AFB FL 32403-6001

1. To enhance the quality and performance of facilities and supporting systems, the following "lessons learned," supporting the principles of the Air Force R&M program, is provided for information and appropriate action.

   a. Facility/System Data.

      (1) Location (AFB) _____

      (2) Building Number _____

      (3) Project Title _____

      (4) Construction Program (MCP, O&M, etc.) _____

      (5) Fiscal Year Programmed _____

      (6) Year Constructed _____

   b. Description of Problem/Success: _____
_____
_____
_____
_____
_____

   c. Recommended Action: _____
_____
_____
_____
_____
_____

2. Name, Address and Phone Number of Originator: _____
_____
_____
_____

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