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NASA TECHNICAL STANDARD

NASA-STD-10002

NASA Headquarters Facilities Engineering and Real Estate Division

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Superseding NASA Facilities Design Guide, April 2018

NASA FACILITIES DESIGN STANDARD

DOCUMENT HISTORY LOG

Status	Document Revision	Change Number	Approval Date	Description
Baseline			2021-04-29	Initial Release—Converted from NASA Facilities Design Guide, April 2018. Key changes: Clarified requirements and guidance and reformatted the document to meet NASA Technical Standard requirements. Updated section 1, added new citations to section 2, added reference text to clarify requirements, and corrected grammar structure issues. Expanded Appendix B to include references from NASA Design Guide, April 2018.

FOREWORD

This NASA Technical Standard is published by the National Aeronautics and Space Administration (NASA) to provide uniform engineering and technical requirements for processes, procedures, practices, and methods that have been endorsed as standard for NASA programs and projects, including requirements for selection, application, and design criteria of an item.

This NASA Technical Standard is approved for use by NASA Headquarters and NASA Centers and Facilities, and applicable technical requirements may be cited in contract, program, and other Agency documents. It may also apply to the Jet Propulsion Laboratory (a Federally Funded Research and Development Center (FFRDC)), other contractors, recipients of grants and cooperative agreements, and parties to other agreements only to the extent specified or referenced in applicable contracts, grants, or agreements.

NASA is committed to building world-class, state-of-the-art facilities that are safe, cost efficient, and environmentally friendly. The purpose of this NASA Technical Standard is to communicate Agency top-level design requirements and to provide a standard to serve as a singular source for all Agency-level planning, design, and construction requirements.

Requests for information should be submitted via "Feedback" at https://standards.nasa.gov. Requests for changes to this NASA Technical Standard should be submitted via MSFC Form 4657, Change Request for a NASA Engineering Standard.

_____ _____

Erik Weiser
Director, Facilities and
Real Estate Division
Office of Strategic Infrastructure

Approval Date

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NASA FACILITIES DESIGN STANDARD

1. SCOPE

1.1 Purpose

NASA is committed to building world-class, state-of-the-art facilities that are safe, cost efficient, and environmentally friendly. NASA facilities should evoke a sense of permanence; be aesthetically pleasant, highly functional, robust, resilient, and sustainable; promote a conducive work environment; and enhance personal productivity to enable NASA to accomplish its mission.

The purpose of this NASA Technical Standard is to communicate Agency top-level design requirements and to provide a standard to serve as a singular source for all Agency-level planning, design, and construction requirements in compliance with NASA Procedural Requirements (NPR) 8800.15, Real Estate Management Program, including NID 8800.115, NASA Interim Directive: Real Estate Management Program Adding Decommission of Facilities. These top-level requirements include:

a. Applicable codes;
b. Industry standards;
c. Federal laws and regulations; and
d. NASA Policy Directives (NPD), NPR, guides, and standards.

This NASA Technical Standard is intended to cover essentially all construction design activities undertaken by NASA, encompassing all tasks that involve new construction, repair, alteration, upgrade, and renovation or demolition of buildings, structures, utilities, or building subsystems (e.g., fire protection and security). These include, but are not limited to, the following:

a. Buildings used for offices or laboratory research;

b. Specialized structures such as wind tunnels, arc jets, test stands, hangars, and launch pads;

c. Utility systems, including electrical, communications, water, sewer, storm drains, natural gas, high-pressure water distribution, steam, and compressed air systems;

d. Fire protection systems, including fire suppression systems and life safety alarm subsystems; and

e. Security access systems and Intrusion Detection Systems (IDS), closed-circuit television (CCTV) systems, data systems, and physical security systems, including security

fences, physical security barriers, all doors, and other systems that impact the physical security of NASA assets.

It is imperative that each facility be designed so that all components comprise an integrated solution, operations and maintenance of the facility are streamlined, energy use is minimized, and the use of other criteria is maximized.

This NASA Technical Standard complements Center best practices and design standards. It does not prohibit use of management methods and systems currently used by the Centers and those not specifically described in this NASA Technical Standard.

1.2 Applicability

This NASA Technical Standard is applicable primarily to Architects-Engineers (A-E). It, however, neither relieves the A-E of their responsibility to identify and determine other requirements not found in this NASA Technical Standard, nor supersedes specific project, NASA Center, and Authority Having Jurisdiction (AHJ) conditions. NASA facility planning, design, construction, maintenance, renewal, demolition, and cost-effective facility stewardship throughout a facility's life cycle (design, construction, maintenance, renewal, and demolition) require an integrated and collaborative facility design approach in which all NASA stakeholders (planners, facility engineers, designers, contractors, tenants, users, and operations and maintenance personnel) actively participate early and continuously in the planning process.

This NASA Technical Standard is approved for use by NASA Headquarters and NASA Centers and Facilities, and applicable technical requirements may be cited in contract, program, and other Agency documents. It may also apply to the Jet Propulsion Laboratory (a Federally Funded Research and Development Center [FFRDC]), other contractors, recipients of grants and cooperative agreements, and parties to other agreements only to the extent specified or referenced in applicable contracts, grants, or agreements.

1.3 Tailoring/Waiving of Requirements

See Section 17, Tailoring/Waiving of Specific Requirements.

1.4 Responsibilities

The Director of the Facilities Engineering and Real Property Division (FRED) is the Agency's functional leader and authority for design and construction of facilities as documented in NPD 7330.1, Approval Authorities for Facility Projects, and NPD 8820.2, Design and Construction of Facilities.

1.5 Legal Requirements, Codes, and Standards

1.5.1 Public Law 100-678, Public Buildings Amendments of 1988, 40 U.S.C. 3312

Section 21, Compliance with Nationally Recognized Codes of Public Law 100-678, states, "Each building constructed or altered by the General Services Administration or any other federal agency is to be constructed or altered, to the maximum extent feasible as determined by the Administrator or the head of the federal agency, in compliance with one of the nationally recognized model building codes and with other applicable nationally recognized codes, including electrical codes, plumbing codes, and fire and life safety codes, as the Administrator decides is appropriate."

1.5.2 Code of Federal Regulations (CFR)

NASA ensures that designs meet or exceed applicable CFR requirements.

1.5.3 State and Local Codes

NASA ensures that designs meet or exceed locally adopted, nationally recognized model building codes, including fire and life safety, seismic requirements, etc. Where federal requirements conflict with local requirements, the more stringent requirements apply.

1.5.4 NASA Requirements

NASA complies with NPR 8820.2, Facility Project Requirements, and individual NASA Center-unique requirements.

Compliance with this NASA Technical Standard is mandatory for all NASA owned/leased and/or occupied facilities, both new and existing. The individual NASA Centers are responsible for implementation and enforcement. This document establishes *minimum* requirements. NASA Centers should apply risk management to processes to assess their individual programs and adopt additional requirements as needed. The contracting officer and the responsible NASA Center construction program office evaluate the need for compliance with this NASA Technical Standard at NASA Centers by contractors performing NASA work and establish compliance as a contractual requirement where deemed necessary.

Verifiable requirement statements are designated by the acronym "FDSR" (Facilities Design Standard Requirement), numbered, and indicated by the word "shall"; this NASA Technical Standard contains 244 requirements. Explanatory or guidance text is indicated in italics beginning in section 4. To facilitate requirements selection by NASA programs and projects, a Requirements Compliance Matrix is provided in Appendix A.

2. APPLICABLE DOCUMENTS

2.1 General

The documents listed in this section contain provisions that constitute requirements of this NASA Technical Standard as cited in the text. Applicable NASA documents may be accessed at:

a. NASA Technical Standards, https://standards.nasa.gov.

b. NASA Directives and Procedural Requirements, https://nodis3.gsfc.nasa.gov/main_lib.cfm.

c. Unified Facilities Guide Specifications, www.wbdg.org.

Non-government standards of highest interest are cited in this document. Many more are cited in the Unified Facilities Guide Specifications.

2.1.1 The latest issuances of cited documents apply unless specific versions are designated.

2.1.2 Non-use of a specifically designated version shall be approved by the Director of FRED.

2.2 Government Documents

Department of Defense

UFGS 25 05 11, Cybersecurity of Facility-Related Control Systems

Department of Justice

ADA Standards for Accessible Design (https://www.ada.gov/2010ADAstandards_index.htm)

Federal

Public Law No. 90-480, 82 Stat. 718, Architectural Barriers Act (ABA)

Executive Order 12114, Environmental Effects Abroad of Major Federal Actions

Executive Order 13834, Efficient Federal Operations

10 CFR 433 – Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings

10 CFR 435 – Energy Efficiency Standards for the Design and Construction of New Federal Low-Rise Residential Buildings

10 CFR 436 - Federal Energy Management and Planning Programs

29 CFR 1910 – Occupational Safety and Health Standards
National Environmental Policy Act (NEPA) (https://ceq.doe.gov/)

FAR Subpart 23.1, Sustainable Acquisition Policy

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Federal Facilities

EPA's Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (https://www.epa.gov/vaporintrusion/technical-guide-assessing-and-mitigating-vapor-intrusion-pathway-subsurface-vapor)

The Risk Management Process for Federal Facilities: An Interagency Security Committee Standard (https://www.dhs.gov/publication/isc-risk-management-process)

Guiding Principles for Sustainable Federal Buildings and Associated Instructions, CEQ 2016 (https://www.sustainability.gov/pdfs/guiding_principles_for_sustainable_federal_buildings.pdf)

EPA-832-R-92-005, Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices
(https://nepis.epa.gov/Exe/ZyNET.exe/2000461J.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1991+Thru+1994&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C91thru94%5CTxt%5C00000003%5C2000461J.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL)

NIST GCR 11-917-12 Standards of Seismic Safety for Existing Federally Owned and Leased Buildings (https://www.wbdg.org/ffc/nist/criteria/nist-grc-11-917-12)

NASA

NASA Commissioning Guide for New and Existing Buildings (https://www.nasa.gov/sites/default/files/atoms/files/nasa_commissioning_guide_november_2015.pdf)

NASA Handbook for Master Planning (https://www.nasa.gov/offices/FRED/documents/master_planning)

Federal Leadership in High-Performance and Sustainable Buildings Memorandum of Understanding (MOU) (https://www.wbdg.org/FFC/FED/HPSB-MOU.pdf)

Guiding Principles for Federal Leadership in High Performance Sustainable Buildings, Memorandum of Understanding dated January 4, 2012 (https://fred.hq.nasa.gov/jxstaff_design.html)

NASA Reliability Centered Building and Equipment Acceptance Guide (https://www.nasa.gov/sites/default/files/atoms/files/rcbandeguidejul04.pdf)

NASA 2014 Strategic Sustainability Performance Plan (SSPP) (https://www.nasa.gov/content/strategic-sustainability-performance-plan-sspp)

NID 8800.115	NASA Interim Directive: Real Estate Management Program Adding Decommission of Facilities
NID 8000-104	NASA Interim Directive: Acquisition of Administrative Office Space
NPD 8500.1	NASA Environmental Management
NPD 8831.1	Maintenance and Operations of Institutional and Program Facilities and Related Equipment
NPR 8580.1	Implementing the National Environmental Policy Act and Executive Order 12114
NPR 8715.1	NASA Safety and Health Programs
NPR 8800.15	Real Estate Management Program

NPR 8810.1	Center Master Planning
NASA-STD-8719.12	Safety Standard for Explosives, Propellants, and Pyrotechnics
NASA-STD-8719.17	NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S)

2.3 Non-Government Documents

American Society of Civil Engineers (ASCE)

ASCE-7	Minimum Design Loads and Associated Criteria for Buildings and Other Structures

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 135	BACnet -- A Data Communication Protocol for Building Automation and Control Networks

American Society of Mechanical Engineers (ASME)

ASME Boiler and Pressure Vessel Code

International Code Council (ICC)

IBC	International Building Code® (IBC) (https://codes.iccsafe.org/public/document/IBC2018)
IMC	International Mechanical Code® (IMC) (https://codes.iccsafe.org/public/document/toc/549/)
IPC	International Plumbing Code® (IPC®) (http://shop.iccsafe.org/codes/2018-international-codes-and-references/2018-international-plumbing-code.html)

Illuminating Engineering Society (IES)

	IES Lighting Handbook
IES RP-8	Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting
IES RP-20	Lighting for Parking Facilities

National Institute of Building Sciences

	Whole Building Design Guide (https://www.wbdg.org/guides-specifications)

National Fire Protection Association

NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 101	Life Safety Code

Additional reference documents are cited in Appendix B.

2.4 Order of Precedence

2.4.1 The requirements and standard practices established in this NASA Technical Standard do not supersede or waive existing requirements and standard practices found in other Agency documentation, or in applicable laws and regulations unless a specific exemption has been obtained by the Director of FRED.

2.4.2 Conflicts between this NASA Technical Standard and other requirements documents are resolved by the Director of FRED.

3. ACRONYMS, ABBREVIATIONS, SYMBOLS, AND DEFINITIONS

3.1 Acronyms, Abbreviations, and Symbols

%	Percent
A-E	Architects-Engineers
ABA	Architectural Barriers Act
ABAAS	Architectural Barriers Act Accessibility Standard
ACI	American Concrete Institute
ADA	American with Disabilities Act
AHJ	Authority Having Jurisdiction

AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BAS	Building Automation System
CATEX	Categorical Exclusion
CBM	Condition-based maintenance
CCTV	Closed-Circuit Television
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFC	Chlorofluorocarbons
CFR	Code of Federal Regulations
DDC	direct digital controls
EIS	Environmental Impact Statement
EISA	Energy Independence and Security Act of 2007
EJ	Environmental Justice
EO	Executive Order
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FAR	Federal Acquisition Regulations
FDC	fire department connections
FDSR	Facilities Design Standard Requirement
FEMA	Federal Emergency Management Agency
FFRDC	Federally Funded Research and Development Center
FMEA	Failure Modes and Effects Analysis
FRED	Facilities and Real Estate Division
GSA	Government Services Administration
HCFC	Hydrochlorofluorocarbons
HPO	Historic Preservation Officer

HVAC	Heating, Ventilating, and Air-Conditioning
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
ICRMP	Integrated Cultural Resources Management Plans
ICSSC	Interagency Committee on Seismic Safety in Construction
IDS	Intrusion Detection System
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IESNA	Illuminating Engineering Society of North America
IgCC	International Green Construction Code
IMC	International Mechanical Code
IPC	International Plumbing Code
ISC	Interagency Security Committee
IT	Information Technology
ITSNA	Intertek Testing Services NA, Inc.
IWUIC	International Wildland-Urban Interface Code
LEED	Leadership in Energy and Environmental Design
MMPA	Marine Mammal Protection Act
MOU	Memorandum of Understanding
MSFC	Marshall Space Flight Center
MSS	Manufacturers Standardization Society
NACE	National Association of Corrosion Engineers
NAGPRA	Native American Graves Protection and Repatriation Act of 1990
NASA	National Aeronautics and Space Administration
NDAA	National Defense Authorization Act
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NHPA	National Historic Preservation Act
NID	NASA Interim Directive
NIST	National Institute of Standards and Technology
NPD	NASA Policy Directive

NPR	NASA Procedural Requirements
ODC	Ozone-Depleting Compounds
PUE	Power Usage Effectiveness
PVS	pressure vessels and pressurized systems
RCRA	Resource Conservation and Recovery Act
REC	Record of Environmental Consideration
ROD	Record of Decision
SDI	Steel Deck Institute
SDWA	Safe Water Drinking Act
SHPO	State Historic Preservation Office
SMACNA	Sheet Metal & Air Conditioning Contractors' National Association
SSPP	Strategic Sustainability Performance Plan
STD	Standard
UFGS	Unified Facilities Guide Specification
UL	Underwriters Laboratories Inc.
UPS	Uninterruptable Power Supply
U.S.C	United States Code
WBDG	Whole Building Design Guide

3.2 Definitions

Codes: A collection of enforceable standards, rules, and regulations adopted by authorities having jurisdiction to control the design and construction, alteration, repair, quality or materials, use and occupancy, and related factors of facilities; contains minimum architectural, structural, electrical, and mechanical standards for sanitation, public health, welfare, safety, and the provision of light and air.

Standards: Professionally prepared generic specifications and technical data compiled and published by competent organizations generally recognized and accepted by the construction industry. These standards are often used as criteria by which the acceptability and/or performance of a product, material, assembly, or piece of equipment can be judged.

Guides: Professionally prepared and published information intended to encourage enhanced performance.

4. CIVIL, SITE, AND LANDSCAPE DESIGN REQUIREMENTS

Civil, site, and landscape design should:

- *Incorporate balance among elements on-site and between the site and its surroundings in all projects.*
- *Ensure that site design is a direct extension of the building design to enable safe and efficient access to the building and support building functions.*
- *Ensure that the site design complements the surrounding urban landscape in terms of conservation and environmentally responsible practices.*
- *Use a "good neighbor" policy through collaboration with local officials and the implementation of local best design practices wherever possible.*

4.1 Site Planning and Analysis

4.1.1 [FDSR 1] Site planning **shall**:

a. Be integrated with the design of the buildings.

b. Respect the surrounding context.

c. Contribute to energy conservation, water conservation, and sustainability efforts.

d. Focus on accessibility compliance.

e. Require a thorough review and understanding of existing site conditions, opportunities, and constraints.

4.1.2 [FDSR 2] Prior to the start of design, a site inventory and analysis (e.g., site survey, geotechnical and groundwater investigations) and an environmental review as required by the National Environmental Policy Act (NEPA) **shall** be performed.

4.1.3 [FDSR 3] At all times, the A-E **shall** follow the requirements of the Record of Environmental Consideration (REC) or Record of Decision (ROD) that exist for the project site.

4.2 Grading

Site grading addresses the control of runoff, storm water management, and the manipulation of topography to improve the site and prevent watershed erosion.

[FDSR 4] Natural topography and existing vegetation **shall** be preserved to the maximum extent possible.

4.3 Site Utilities

4.3.1 [FDSR 5] The location of all new utilities **shall** be coordinated with site design features and existing utilities.

4.3.2 [FDSR 6] The designer **shall** be responsible for coordinating the utility design with local utility providers.

4.3.3 [FDSR 7] Utilities **shall** be located in unpaved areas where economically feasible.

4.3.4 [FDSR 8] NASA requirements on separation of all significant utilities **shall** be followed.

4.3.5 [FDSR 9] NASA and local water district authority requirements for water meters and backflow preventers **shall** be followed.

NASA's requirements for water metering and the installation of backflow preventers vary by location and are set by the Center that owns the project site.

4.3.6 [FDSR 10] Loop-fed systems with multiple water connections **shall** be considered on large buildings or campuses.

4.3.7 [FDSR 11] Dual-feed water systems **shall** be installed if required for the building occupancy.

4.3.8 [FDSR 12] The water supply system **shall** be designed to supply the required water flow for fire protection in accordance with NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

4.4 Storm Drainage

4.4.1 [FDSR 13] The storm water system's capacity for storm events **shall** be designed as directed by NASA and local requirements.

NASA requirements for storm water system capacity vary by location. These requirements are set by the Center with ownership of the project site.

4.4.2 [FDSR 14] Gravity flow **shall** be used for all storm drainage systems and not prevent the usage of mechanical sumps to assist with storm drains.

4.4.3 [FDSR 15] Storm drainage pipes **shall** be located in unpaved areas where economically feasible.

4.4.4 [FDSR 16] Rainwater from the building roof drainage system not collected for reuse **shall** be discharged into the storm drainage system.

4.4.5 [FDSR 17] Storm drainage systems **shall** be designed to reduce or eliminate offsite discharge of oils, greases, and debris.

4.4.6 [FDSR 18] Any required local approvals for a Storm Water Management Plan **shall** be prepared and obtained.

4.4.7 [FDSR 19] Site plans **shall** meet NASA, local, state, and Environmental Protection Agency (EPA) best management practices, including EPA-832-R-92-005, Storm Water Management for Construction Activities, Chapter 3.

NASA's best practices for site planning are Center specific and will vary by project. These requirements are set by the Center with ownership of the project site.

4.4.8 [FDSR 20] Storm water run-off **shall** meet NASA requirements, as well as state and local regulations.

NASA's regulations for handling storm water runoff are Center specific and will vary by project. These requirements are set by the Center with ownership of the project site.

4.4.9 [FDSR 21] Site design **shall** include measures to address both quantity and quality of storm water before entering into any storm water system.

4.4.10 [FDSR 22] Incorporation of low-impact development strategies **shall** be considered on a case-by-case basis.

4.5 Redevelopment Sites

[FDSR 23] The redevelopment of brownfield sites and infill development as a sustainable initiative **shall** be considered.

4.6 Landscape and Site Equipment

4.6.1 Landscaping

Landscape design should be an integral part of the design, and sustainability techniques should be utilized. Sustainable landscaping design techniques are addressed in section 13, Sustainable Design Practice.

4.6.2 Site Furniture, Signage, and Lighting

4.6.2.1 [FDSR 24] Site furnishings, signage, and lighting are included as part of the site design and **shall** be low maintenance and compatible in scale, style, and color with the surrounding architecture and landscape.

Wayfinding should be simple and clear.

4.6.2.2 [FDSR 25] Unobtrusive lighting and luminaire placement **shall** be used.

5. VEHICLE AND PEDESTRIAN CIRCULATION AND PARKING

5.1 Parking Accommodations

Providing parking for staff and visitors is vital to the mission and function of NASA Centers and facilities. Providing accommodations for parking areas is required in any facility design.

5.1.1 [FDSR 26] All parking area designs and construction **shall** meet NASA, federal, state, and local regulations.

NASA's goal is to minimize the impact of vehicular traffic at its Centers and facilities. NASA's regulations on the design and construction of parking facilities are set by the Center with ownership over the project site.

5.1.2 [FDSR 27] Pavements and curbs **shall** be designed using local NASA design standards and materials.

5.1.3 [FDSR 28] Chosen materials **shall** be suitable for the traffic volume, expected load, and anticipated use conditions.

5.1.4 [FDSR 29] Areas for truck maneuvering **shall** be paved with hard and durable materials.

5.1.5 [FDSR 30] Walkways **shall** be designed for compliance with American with Disabilities Act (ADA)/Architectural Barriers Act (ABA).

5.2 Circulation and Transportation

5.2.1 Efficient Layout and Circulation

[FDSR 31] Parking areas **shall** be sited and configured between facilities to encourage shared parking.

For facilities located in urban areas, parking levels under the facility should be designed when possible. To minimize automobile travel around NASA campuses, facilities and parking areas should be sited to encourage pedestrian and bicyclist circulation.

5.2.2 Vehicle and Pedestrian Circulation

Site circulation includes roadways, emergency accesses, driveways, building entries, parking, loading and service areas, sidewalks and pathways, and connections to the local public transit system.

5.2.2.1 [FDSR 32] Design of site circulation **shall** separate pedestrian access, vehicular access (including parking), and service vehicle access areas where practical.

5.2.2.2 [FDSR 33] Emergency vehicle access **shall** be incorporated and coordinated with the AHJ and the local fire department.

5.2.2.3 [FDSR 34] Consideration for access to public transportation **shall** occur early in the design process in coordination with the master plan and regional planners.

5.2.3 Alternative Transportation

NASA encourages the use of carpooling and alternative-fuel vehicles. Carpool and alternative-fuel vehicles should be provided the option of elevated privileges for parking. Charging stations and a charging plan should be provided for electric/hybrid vehicles.

5.2.3.1 [FDSR 35] Alternative means of transportation **shall** be considered part of any comprehensive parking strategy for Centers or facilities.

5.2.3.2 [FDSR 36] Access to mass transit stations **shall** be included in any master plan, if available.

Bicycle storage should be provided at all facilities.

Bicycle pathways and lanes should be incorporated on NASA-owned roads.

5.3 Security and Emergency Access

5.3.1 Anti-Terrorist/Force Protection Setbacks and Other Security Measures

[FDSR 37] Site design **shall** incorporate the setbacks and security measures as required in accordance with NASA requirements and The Risk Management Process for Federal Facilities: An Interagency Security Committee Standard.

According to the Homeland Security website (https://www.dhs.gov/interagency-security-committee, click on "Policies, Standards, and Best Practices"), this standard supersedes the previous guidance in the Facility Security Level Determinations for Federal Facilities: An Interagency Security Committee Standard published in March 2008, Physical Security Criteria for Federal Facilities: An Interagency Security Committee Standard published in April 2010, *Facility Security Committees: An Interagency Security Committee Standard, 2nd Edition* published in January 2012, and *Use of Physical Security Performance Measures published in June 2009. See https://www.dhs.gov/publication/isc-risk-management-process for the document and access to the "need to know" appendices.*

5.3.2 Emergency Vehicle Access

[FDSR 38] Local fire and emergency departments and AHJ **shall** be consulted on surface material, turning radius, weights, fire lane widths, and other relevant considerations.

6. PLANNING FOR NATURAL DISASTERS

Natural disasters come in many forms, both expected and unexpected such as floods, hurricanes, and earthquakes. Non-natural disasters or events include technological and man-made such as explosions and terror attacks. Each type of disaster threat has its own set of considerations; but

generally, data can be derived from flood maps and engineering models (including hurricanes, flooding, earthquakes, lessons learned reports, and other resources).

6.1 Planning, Design, and Construction

Disaster resilience has to be maximized in NASA facility planning, design, and construction efforts.

6.1.1 [FDSR 39] All NASA facilities **shall** be sited and designed to safeguard human life, minimize damage to properties, and allow for the immediate restoration of essential functions and services after a disaster.

6.1.2 [FDSR 40] The following actions **shall** be taken to enhance disaster resilience:

a. Pursue planning and siting that employs natural systems for disaster mitigation instead of engineered ones (e.g., natural wetlands and sufficient open space for flood protection versus concrete channels and levees).

b. Maximize the protective functions of natural systems within a macro-level master planning process approach to an entire facility or site rather than building-by-building.

c. Pursue strategies for disaster mitigation through both horizontal (e.g., land use, circulation, open space, infrastructure, and utilities) and vertical (e.g., structural engineering, architecture, and materials use) planning and design.

d. Identify emergency disaster response procedures, evacuation routes, and locations of critical facilities (e.g., command center, fire department, hospitals, emergency shelters, etc.) in the planning process.

7. STRUCTURAL DESIGN

During its life span, a typical building may undergo many minor and major alterations as NASA's missions change. Therefore, building system flexibility is necessary; and the capability to allow for future alterations should be incorporated from the start of any project.

7.1 Structural Systems

7.1.1 [FDSR 41] Structural systems **shall** be designed to provide room for future increases in loading.

7.1.2 [FDSR 42] Structural framing systems **shall** be selected to maximize bay sizes to take advantage of open floor plan capabilities.

7.1.3 [FDSR 43] Redundancy factors **shall** be included in the design of structures located in moderate-to-high seismic regions.

7.1.4 [FDSR 44] Recycled materials **shall** be incorporated for the most widely used building products so as not to negatively impact durability and structural performance.

7.2 Structural Considerations

Simplicity of structural framing and symmetry for economy are the main goals in the selection of vertical and lateral load-resisting systems.

7.2.1 [FDSR 45] Basic wind speeds based on special wind maps provided in ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, **shall** be used for structures located in hurricane-prone regions.

7.2.2 [FDSR 46] The structure **shall** be designed to aid in dampening mechanical equipment and external source noise.

7.2.3 [FDSR 47] Compliance with the EPA's Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air **shall** be ensured to remedy vapor intrusion from groundwater contamination and avoid creating new vapor intrusion pathways.

7.3 Structural Requirements of New Buildings

7.3.1 [FDSR 48] The structural design of new buildings, including wind and seismic design, **shall** be in full compliance with the latest edition of building codes and standards, including the International Building Code (IBC), ASCE 7, and NIST GCR 11-917-12, Standards of Seismic Safety for Existing Federally Owned and Leased Buildings.

7.3.2 [FDSR 49] Floor-framing members **shall** be designed with a combination of strength and stiffness that will not cause vibration beyond the "slightly perceptible" range of the Modified Reiher-Meister Scale.

7.3.3 [FDSR 50] All nonstructural elements, components, and equipment located within a building or on the site **shall** be anchored and/or braced to withstand gravity, wind, seismic, and other loads as required by the IBC, ASCE 7, and NIST GCR 11-917-12.

7.4 Structural Upgrading of Existing Buildings

If a waiver is granted in accordance with Section 17 of this document, the performance objective for seismic upgrades of existing buildings is life safety, which is defined as the safeguarding against partial or total building collapse and the prevention of falling objects during seismic events. Seismic upgrading is an expensive and often disruptive process, and it may be more

cost-effective to accept a marginally deficient building than to enforce full compliance with current code requirements.

[FDSR 51] Deficiencies in the attachment of elements of structures, nonstructural components, and equipment represent a life safety risk and **shall** be strengthened to meet current code requirements of the IBC, ASCE 7, and NIST GCR 11-917-12.

8. ARCHITECTURE AND INTERIOR DESIGN

Having high-performance buildings is a core principle of NASA. Due to the longevity of use of facilities, it is important for designers to integrate resiliency, robustness, flexibility, re-configurability, sustainability, maintainability, security, accessibility, consistent aesthetic and material palettes, and whole building design integration when designing new structures, or refurbishing existing structures, for NASA Facility Programming and Space Planning.

Facility planning is key to successfully meeting the goals of resiliency, robustness, flexibility, and re-configurability of functional spaces.

[FDSR 52] In conjunction with the design team, NASA **shall** conduct a visioning session and programming interviews with key stakeholders for the project.

8.1 General Public

[FDSR 53] Facilities that may receive regular visitors (e.g., tour groups) **shall** be designed to accommodate visitor accessibility, in addition to reasonable accommodation for employees.

8.1.1 Security

NASA is committed to providing a safe and secure working environment for its employees and protecting the vital research and development being performed. It is also important for visitors to be safe while visiting any NASA facility.

8.1.2 Functional Separation

[FDSR 54] Public access to parts of facilities that require separation **shall** be limited by integrating physical separation design elements such as entranceways, corridors, and lobbies.

8.1.3 Space Measurement and Building Efficiency

8.1.3.1 [FDSR 55] Area types **shall** be authorized in an approved prospectus.

8.1.3.2 [FDSR 56] Area types **shall** be delineated in a program of requirements, as measured in accordance with NASA space assignment requirements as described in NID 8000-104, NASA Interim Directive (NID): Acquisition of Administrative Office Space.

8.1.4 Circulation

[FDSR 57] Primary and secondary circulation **shall** be located and configured in an efficient and clear manner with delineation between service access, public access, and private accessways.

8.1.5 Wayfinding

8.1.5.1 [FDSR 58] Programmatic elements **shall** be connected.

8.1.5.2 [FDSR 59] The building **shall** be clearly organized horizontally and vertically.

8.1.5.3 [FDSR 60] Wayfinding **shall** not depend solely upon signage.

8.1.6 Vertical Transportation

[FDSR 61] A thorough vertical transportation traffic analysis of the facility **shall** be performed to assist in the selection of the type and quantity of conveying systems.

Vertical transportation systems include elevators, escalators, and wheelchair lifts.

8.1.7 Building Maintenance Access

8.1.7.1 [FDSR 62] An evaluation of access needs and requirements for facility equipment **shall** be performed early in the design process.

Facility equipment includes, but is not limited to, air handling units, switchgear, and telecommunication racks.

8.1.7.2 [FDSR 63] The parameters for corridors **shall** be considered to provide proper access for maintenance.

8.2 Exterior Facility Design

The exterior envelope of new and refurbished buildings plays an important role in the success of meeting each of NASA's high-performance goals.

8.2.1 Core and Shell

[FDSR 64] A standard module of the key core and shell elements **shall** be developed.

Key core and shell elements include the exterior envelope, equipment/building system rooms, specialized support systems, and common areas such as restrooms, pantries, and vertical circulation elements.

8.2.2 Modularity

[FDSR 65] A consistent module of materials, both in dimension and sequence, **shall** be created.

A consistent module of materials allows for ease of exterior expansion and maintainability and provides consideration for construction costs.

8.2.3 Construction Materials and Systems

Integrated materials and systems should:

a. Be appropriate to the individual NASA Center's context and mission;

b. Be lasting;

c. Provide enduring quality; and

d. Require minimal maintenance.

8.2.4 High Performance

[FDSR 66] A thorough commissioning of the envelope **shall** be performed to verify that the envelope meets or exceeds specified requirements.

8.3 Interior Facility Design

High-quality, high-performance, robust, and resilient facilities are the goal of NASA's design and construction process. Interior design plays a key role, and effective collaboration with the building A-E, landscape architects, facility managers, and tenants is essential to providing a high-quality workplace over the life of the facility. NASA supports an interior design program that creates superior workplace environments that meet the business goals of their tenant agencies and enhances employee health, satisfaction, and performance.

The interior facility design should:

a. Provide an effective workplace for NASA employees.
b. Reflect NASA's culture, mission, business strategy, and the nature of its work.

[FDSR 67] Effective adjacencies of functional spaces **shall** be considered.

8.4 Workplace Components

8.4.1 Space Planning

8.4.1.1 [FDSR 68] Flexible space planning **shall** be facilitated with:

a. The minimization of fixed interior walls and partitions.

b. The selection of easily moveable and reconfigurable workplace components and furnishings.

Private offices for managers or senior personnel should be a standard size and designed to minimize reconstruction as office needs change.

8.4.1.2 [FDSR 69] Work settings **shall** be equipped to enable simultaneous voice, data, and video collaboration among distributed co-workers, both local and remote.

8.4.2 Daylighting and Artificial Lighting

8.4.2.1 [FDSR 70] Daylighting, occupant needs, and energy efficiency **shall** be balanced through the use of controls.

8.4.2.2 [FDSR 71] Interior spaces **shall** be designed to maximize the use of natural daylighting and provide daylighting and views for the occupants.

8.4.2.3 [FDSR 72] Natural light in open spaces **shall** be maximized.

8.4.2.4 [FDSR 73] The use of enclosed rooms along the perimeter at exterior windows **shall** be avoided.

8.4.2.5 [FDSR 74] Views of the exterior environment **shall** be maximized for building occupants.

8.4.3 Interior Finishes

The building's long-term design should ensure a cohesive, consistent, and streamlined approach.

[FDSR 75] Current building standards for finishes **shall** be used in case of facility rehabilitations.

8.4.4 Acoustics

8.4.4.1 [FDSR 76] Acoustic provisions and requirements within the design **shall** be developed and established with the concepts of:

a. Acoustic quality.
b. Speech privacy.
c. Background noise.
d. Equipment vibration and noise.
e. Exterior noise.

8.4.4.2 [FDSR 77] The architect **shall** differentiate between enclosed and open office environments to meet acoustic objectives.

Continuous background noise may have to be masked with additional electronically generated sound.

8.4.4.3 [FDSR 78] Office equipment noise levels **shall** meet acoustical standards at workstations using the Whole Building Design Guide.

8.4.4.4 [FDSR 79] Vibration and reverberation **shall** be controlled in auditoriums, conference rooms, team spaces, and training room spaces.

8.4.4.5 [FDSR 80] Facilities located near airports, highways, rail corridors, or other sources of significant environmental noise levels shall utilize building envelope assemblies that control noise intrusions within parameters of the required standards set in the Whole Building Design Guide.

8.5 Universal Accessibility

[FDSR 81] All NASA facilities **shall** be designed, constructed, and renovated in such a manner that the facility, or part of the facility, is readily accessible to and usable by all persons, including the general public, where applicable.

8.6 Designing for Deconstruction

Designing for deconstruction addresses the eventual disposal of a facility after its useful life.

8.6.1 [FDSR 82] The use of recyclable and recoverable materials for re-use **shall** be considered.

8.6.2 [FDSR 83] Building systems **shall** be simplified and separated to facilitate deconstruction.

8.6.3 [FDSR 84] The structural system **shall** be simplified to minimize the quantity of building materials used.

8.6.4 **[**FDSR 85] Structural fasteners, connectors, fittings, etc., that are simple to disassemble and are re-useable **shall** be considered.

8.7 Alterations and Refurbishment of Existing Buildings and Historic Structures

8.7.1 [FDSR 86] Renovation designs **shall** satisfy the immediate occupancy needs and anticipate additional future changes.

8.7.2 [FDSR 87] Building systems **shall** be remodeled to increase flexibility and adapt to changing occupancy needs.

Alteration projects can be defined as refurbishment of an area within a building (such as a floor or a suite), the major renovation of an entire structure, or the upgrade/restoration of historic structures. See section 15, Historic Preservation.

9. FIRE PROTECTION

9.1 Fire Protection Systems

9.1.1 [FDSR 88] The design **shall** incorporate efficient, cost-effective fire protection systems.

9.1.2 [FDSR 89] A registered fire protection engineer **shall** be part of the design team and serve as a full participant in the design, construction, and final acceptance phases of the project.

9.1.3 [FDSR 90] The AHJ **shall** be involved in all aspects of the system design.

9.1.4 [FDSR 91] The AHJ's approval or concurrence on system requirements **shall** be required for all projects.

9.1.5 [FDSR 92] Disruptions to fire alarm and sprinkler systems **shall** be kept to a minimum, or avoided if possible, for fire safety construction or renovation projects.

9.1.6 [FDSR 93] Construction phasing **shall** be defined to ensure:

a. Installations of new fire protection systems are expedited.
b. Existing systems are kept in service until the replacement system is operational.

9.1.7 [FDSR 94] A corrective impairment plan that maintains equivalent levels of fire protection that are acceptable to the AHJ **shall** be implemented if fire protection systems are to be disrupted.

9.1.8 [FDSR 95] All aspects of the fire protection system **shall** comply and be compatible with the existing fire alarm system at the respective Center and UFGS Division 21 Fire Suppression.

9.2 Fire Alarm Notification

[FDSR 96] Fire detection and notification system requirements **shall** address the following elements:

a. Detection.
b. Notification.
c. Survivability of systems.
d. Controls.

9.2.1 Site Fire Suppression Requirements

9.2.1.1 [FDSR 97] Site design **shall** integrate performance requirements associated with fire department access, fire suppression, and separation distances, in addition to the requirements of the building itself.

9.2.1.2 [FDSR 98] Site planning shall include fire department access, fire hydrants, supply lines, and water supply.

9.2.1.3 [FDSR 99] Buildings **shall** be designed with uncomplicated layouts and floor plans that enable firefighters to locate an area quickly.

9.2.1.4 [FDSR 100] Designs **shall** provide rapid access to features such as fire department connections (FDC), hose valves, annunciators, key boxes, elevators, and stairs.

9.2.1.5 [FDSR 101] The A-E **shall** coordinate with the Center's AHJ to accommodate the access of fire apparatus into and around the building site and coordinate access control point layout.

9.2.1.6 [FDSR 102] Supply lines **shall** be coordinated with the civil engineer and sized based on hydraulic calculations.

9.2.1.7 [FDSR 103] Large underground fire water additions and alterations **shall** be looped.

9.2.1.8 [FDSR 104] If available, grey water **shall** be used to meet fire protection requirements.

9.2.2 Interior Fire Suppression Requirements

9.2.2.1 [FDSR 105] Interior building fire suppression requirements **shall** include acquiring the latest-available water supply information.

9.2.2.2 [FDSR 106] Flow testing **shall** be performed if the latest-available water supply information is out of date.

9.2.2.3 [FDSR 107] Hydraulic calculations **shall** be provided by the designer to support the sizing of the fire suppression system.

9.2.2.4 [FDSR 108] The necessity of a fire pump **shall** be determined by the designer.

9.3 Life Safety

9.3.1 Life Safety Systems

9.3.1.1 [FDSR 109] The design **shall** incorporate efficient, cost-effective life safety systems.

9.3.1.2 [FDSR 110] The AHJ **shall** be involved in all aspects of the life safety system design.

9.3.1.3 [FDSR 111] The AHJ's approval or concurrence on system requirements **shall** be obtained by the A-E.

9.3.2 Design Standards and Criteria

[FDSR 112] Local building code(s), NFPA codes and standards, and UFGS Division 21 **shall** be utilized and the following addressed by the design team:

a. Construction and occupancy types.
b. Fire ratings.
c. Fireproofing.
d. Fire stopping.
e. Construction materials.
f. Vertical and horizontal exiting requirements.
g. Accessibility.
h. Building system controls.
i. Emergency lighting.
j. CEQ 2016 Guiding Principles for Sustainable Federal Buildings and Associated Instructions.

9.3.3 Site Requirements

[FDSR 113] Building design and layout **shall** integrate performance requirements associated with fire department access, suppression, separation distances, and other civil requirements.

9.3.4 Fire Department Access

[FDSR 114] Buildings **shall** be designed with uncomplicated layouts and floor plans that enable firefighters to locate an area quickly and provide rapid access to fire department access features.

10. MECHANICAL AND PLUMBING DESIGN

10.1 Mechanical and Plumbing Systems

10.1.1 [FDSR 115] Mechanical and plumbing systems **shall** be designed alongside one another.

10.1.2 [FDSR 116] Mechanical and plumbing materials **shall** be specified to be resistant to intrusion and damage by or to local wildlife species.

10.1.3 [FDSR 117] Systems **shall** be designed for ease of access and maintainability of the systems.

10.1.4 [FDSR 118] System design **shall** include a strategy for replacement of large pieces of equipment when a facility requires continuous operation.

10.1.5 [FDSR 119] All pipes, valves, and equipment in mechanical rooms, shafts, ceilings, and other spaces that are accessible to maintenance personnel **shall** be identified.

Identification can be in the form of labels, arrows, color-coated piping, color-coded bands, and permanent tags.

10.1.6 [FDSR 120] The identification of all pipes, valves, and equipment **shall** indicate the system type and direction of flow for piping systems or the type and number for equipment.

10.1.7 [FDSR 121] Chilled water, domestic water, and fire protection systems **shall** be designed and constructed with easy connect ports to allow for temporary water sources or chillers to quickly connect into the building in the event of a pipe or equipment failure so that occupancy can be maintained.

10.2 Mechanical

Mechanical systems are defined as heating, ventilating, and air conditioning (HVAC), including but not limited to, primary comfort heating and cooling, humidification, building automation, mechanical piping, HVAC pressurized systems, industrial ventilators, boilers, hot/tempered water generation tanks, water softener and refrigeration systems.

[FDSR 122] An integrated design procedure **shall** be incorporated to ensure that the mechanical systems and other building components function together and meet all performance objectives defined by the project's program requirements and the International Mechanical Code.

10.2.1 Energy Considerations

10.2.1.1 [FDSR 123] The mechanical system **shall** be designed to:

a. Meet the project's programmed sustainability rating;

b. Exceed the minimum performance requirements of ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, by at least 30%;

c. Meet the following applicable Code of Federal Regulations (CFR) standards:

(1) 10 CFR 433 – Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings,
(2) 10 CFR 435 – Energy Efficiency Standards for the Design and Construction of New Federal Low-Rise Residential Buildings,
(3) 10 CFR 436 - Federal Energy Management and Planning Programs, and
(4) 29 CFR 1910 – Occupational Safety and Health Standards;

d. Incorporate cost-effective energy conservation measures that do not compromise building performance or occupant comfort:

(1) Allow for the removal and replacement of major components such as boilers, chillers, cooling towers, pumps, and air-handling equipment; and

(2) Specifically design HVAC systems to meet all the defined performance objectives of the project, including any tenant-specific program requirements, at the full-load

and part-load conditions that are associated with the projected occupancies and modes of operations.

10.2.1.2 [FDSR 124] HVAC design **shall** comply with:

a. Division 23 in the Whole Building Design Guide.

b. The Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding.

10.3 Plumbing

Plumbing systems generally include domestic and process water, natural gas, sanitary, and other types of process liquids and gas.

10.3.1 [FDSR 125] Water conservation **shall** be a requirement of all plumbing systems.

10.3.2 [FDSR 126] Low-flow plumbing fixtures for Federal Acquisition Regulations (FAR) Subpart 23.1, Sustainable Acquisition Policy, compliance and sustainability concerns **shall** be specified.

10.3.3 [FDSR 127] Fixture counts that comply with the International Plumbing Code (IPC), UFGS Division 22, Plumbing, General Purpose, and local building codes **shall** be provided.

10.4 Process Systems

10.4.1 [FDSR 128] The safety policies in NPR 8715.1, NASA Safety and Health Programs, **shall** be used in pressure vessel design.

10.4.2 [FDSR 129] The technical requirements in NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS), **shall** be utilized in pressure vessel design.

10.4.3 [FDSR 130] All new ground-based conventional (i.e., non-flight) pressure vessel systems **shall** be designed, fabricated, assembled, erected, inspected, examined, and tested in accordance with the NASA Center's requirements, codes, and regulations, including NPR 8715.1, NASA-STD-8719.17, and the ASME Boiler and Pressure Vessel Code.

10.4.4 [FDSR 131] Specialty systems such as hydrogen gas, oxygen and oxygen systems, explosives, propellants, and hypergolic fluids **shall** comply with NASA safety standards, NASA-developed standards, NASA directives, various NASA Center requirements, and documents cited in NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.

10.5 Building System Controls

[FDSR 132] UFGS 25 05 11, Cybersecurity of Facility-Related Control Systems, **shall** be used as a template for cybersecurity design.

NPD 2810.1, NASA Information Security Policy, and NPR 2810.1, Security of Information Technology, apply.

10.5.1 [FDSR 133] Direct digital controls (DDC) for Building Automation Systems (BAS) **shall** be capable of the following:

a. Scheduling operations and maintenance;
b. Trending data history/storage retrieval; and
c. Adjusting building systems to optimize their performance.

10.5.2 [FDSR 134] ASHRAE 135, BACnet -- A Data Communication Protocol for Building Automation and Control Networks, open communication protocol **shall** be used to provide integration and interoperability between building systems and control vendors.

10.5.3 [FDSR 135] Approximately 20% spare capacity in the BAS **shall** be included for future expansion.

10.5.4 [FDSR 136] Metering **shall** be provided at the facility level for electricity, natural gas, steam, chilled water, and domestic water.

11. ELECTRICAL, SECURITY, AND COMMUNICATIONS DESIGN

11.1 General

11.1.1 [FDSR 137] Electrical, security, and communications (i.e., telecom/data) **shall** be designed and integrated into a building as required by the end users.

11.1.2 [FDSR 138] Power requirements **shall** meet current and potential future demand.

11.1.3 [FDSR 139] Security requirements, including wiring and communication back to security, **shall** meet the minimum standards for cameras, electronic locks, card readers, and other devices.

Security requirements vary by location and are set by the Center's Security Officer.

11.1.4 [FDSR 140] Additional user requirements **shall** be developed for telecom and data.

11.2 Electrical

The six primary objectives for the design of electric power system equipment for new and existing facilities are safety, reliability, maintainability, measurability, economy, and flexibility.

a. [FDSR 141] The lighting quality **shall** include luminance balance, color appearances, visibility of multiple visual tasks, visual comfort, daylight and views, control and finally, user acceptance.

b. [FDSR 142] The interior lighting requirements **shall** follow the recommended values of illuminance by the Illuminating Engineering Society (IES).

c. [FDSR 143] The exterior lighting design **shall** meet the IES Lighting Handbook recommendations.

d. [FDSR 144] Exterior luminaries and control system **shall** comply with all local zoning laws with lighting levels of exterior spaces not exceeding the IES Lighting Handbook's recommendations.

e. [FDSR 145] Illumination of exterior exit discharges **shall** be designed in accordance with the requirements in NFPA 101, Life Safety Code.

f. [FDSR 146] Parking lots and roadway lighting **shall** be designed per IES RP-8 and IES RP-20 in addition to International Dark Sky Association (IDA)/IES Model Lighting Ordinance (MLO) requirements.

g. [FDSR 147] Parking structure lighting **shall** be designed per IES RP-20 and meet ASHRAE 90.1 requirements for controls related to parking garage luminaires.

h. [FDSR 148] Illumination of means of egress **shall** be designed in accordance with the requirements in NFPA 101.

i. [FDSR 149] Enclosed stairway lighting **shall** be installed in accordance with the requirements in NFPA 101.

j. [FDSR 150] Emergency lighting for means of egress **shall** be designed in accordance with the requirements in NFPA 101, NASA, and any additional facility mission requirements with performance of emergency lighting in accordance with the requirements in NFPA 101.

11.2.1 Safety

11.2.1.1 [FDSR 151] Safety **shall** be incorporated in the design of all electric power systems.

[Rationale: Operations and maintenance staff should never be endangered by operating and maintaining any electrical equipment.]

11.2.1.2 [FDSR 152] Exposure to arc flash and shock hazards **shall** be mitigated by engineering controls designed into the electrical power systems.

11.2.2 Reliability

11.2.2.1 [FDSR 153] Unplanned outages **shall** be minimized by choosing the proper equipment type, protection schemes, distribution system configurations, equipment loading, and standby/backup measures or uninterruptible power supply (UPS) installations.

A careful balance should always be maintained between minimizing arc flash hazards and preventing nuisance tripping when selecting equipment, protection schemes, and trip settings.

11.2.2.2 [FDSR 154] Electrical system design and materials **shall** be specified to be resistant to local wildlife intrusion that may cause injury and electrical tripping.

11.2.3 Maintainability

11.2.3.1 [FDSR 155] Equipment **shall** be located in areas easily accessed by maintenance personnel.

11.2.3.2 [FDSR 156] Redundancy **shall** be considered for essential critical operations.

11.2.4 Measurability

11.2.4.1 [FDSR 157] Electrical equipment **shall** be energy efficient.

11.2.4.2 [FDSR 158] Electrical equipment **shall** incorporate advanced metering capable of recording the seven major parameters of the electrical distribution system (amps, volts, power factor, volt-amps, watts, volt-amps reactive, and kilowatt hours), at a minimum.

11.2.4.3 [FDSR 159] Metering for clean power **shall** utilize measuring instruments capable of a faster data capture rate.

Meters capable of a faster data capture rate measure can more effectively manage harmonics and transients that can adversely impact data processing and sensitive experimental equipment and instruments.

11.2.4.4 [FDSR 160] Collaboration with end users **shall** be required to identify locations where clean power is required and alert them to the possible additional equipment costs.

11.2.4.5 [FDSR 161] Separate metering for data centers **shall** be required to facilitate the determination of power usage effectiveness (PUE).

11.2.5 Economy

11.2.5.1 [FDSR 162] Cost-effective solutions **shall** be incorporated into the design while providing the safest, most reliable, most maintainable, and most energy-efficient equipment for the use intended.

11.2.5.2 [FDSR 163] A life-cycle cost analysis **shall** be performed.

[Rationale: A life-cycle cost analysis will determine whether higher design and construction costs can be offset by the reduced lifetime cost of equipment due to significantly lower operation and maintenance costs.]

11.2.5.3 [FDSR 164] The criticality of a facility **shall** be determined with users during pre-design meetings.

[Rationale: Design and construction costs may be reduced if high reliability and maintainability are not required for the intended use of a facility.]

11.2.6 Flexibility

11.2.6.1 [FDSR 165] Flexibility **shall** be incorporated in the initial layout and sizing of the equipment so that future load additions will not require major modifications to the equipment.

Upscale electrical services such as electric vehicle charging stations, photovoltaics, and fuel cells can provide infrastructure for future needs.

11.2.6.2 [FDSR 166] Provisions **shall** be developed for independent metering at each electric vehicle charging station.

11.2.6.3 [FDSR 167] A plan **shall** be developed to charge users for electricity at electric vehicle charging stations.

11.2.6.4 [FDSR 168] Provisions for advanced lighting controls that are integrated with the daylighting features of the building **shall** be developed.

11.3 Security

11.3.1 [FDSR 169] Provisions for security systems in all buildings **shall** be included.

11.3.2 [FDSR 170] The type and level of security system **shall** be determined by local requirements.

11.3.3 [FDSR 171] The security requirements **shall** be integrated into the design for the project.

11.3.4 [FDSR 172] Security lighting during unoccupied hours **shall** be included at all facilities.

11.3.5 [FDSR 173] Additional security features such as cameras (CCTV), building access, motion sensing, or other more extensive security measures **shall** be developed at the discretion of the end user.

11.3.6 [FDSR 174] Security systems **shall** be integrated with emergency and standby power systems.

11.3.7 [FDSR 175] The following four types of communication systems **shall** be included at all buildings:

a. Emergency (part of the facility fire alarm mass notification system);
b. Building automation and energy management, including power monitoring devices;
c. Voice (e.g., conventional telephone service); and
d. Data (e.g., fiber optic/Ethernet).

11.3.8 [FDSR 176] Separate communication systems **shall** not be integrated with each other, except for voice and data (Voice over Internet Protocol) at the discretion of NASA Information Technology (IT) security.

12. ENERGY CONSERVATION

NASA's energy conservation objectives are to:

a. Increase energy efficiency;

b. Increase the use of renewable energy;

c. Measure, report, and reduce direct and indirect greenhouse gas emissions;

d. Conserve and protect water resources through efficiency, reuse, and storm water management;

e. Eliminate waste, prevent pollution, and increase recycling;

f. Leverage Agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services;

g. Design, construct, maintain, and operate high-performance sustainable buildings;

h. Utilize power management options and reduce the number of Agency data centers; and

i. Comply with internal NASA requirements, as well as agreements with other entities.

Increased energy costs lead to an increased risk to NASA's mission. This risk can be mitigated through a three-pronged approach to optimize energy performance:

a. Consider energy efficiency and cost in all aspects of facility operations;
b. Construct and renovate facilities with the overall life cycle in mind; and
c. Make wise purchasing decisions.

12.1 Energy Efficiency

12.1.1 [FDSR 177] Energy efficiency **shall** be considered throughout building design, selection of equipment and materials, and through broader efforts to improve operational processes.

12.1.2 [FDSR 178] Energy modeling **shall** be applied with the intent of reducing energy consumption to 30% below ASHRAE 90.1 baseline building.

12.2 Onsite Renewable Energy

[FDSR 179] Sources of onsite renewable energy **shall** be considered.

Increasing energy costs have underscored the need for facility managers to consider alternative energy in addition to reducing overall energy consumption. Some examples of renewable energy include, but are not limited to, photovoltaics, geothermal, wind, and biomass.

12.3 Measurement and Verification

12.3.1 [FDSR 180] Building systems and other facility equipment **shall** be periodically inspected to ensure optimum efficiency.

12.3.2 [FDSR 181] All new facilities **shall** be sub-metered to facilitate energy use, data collection, and evaluation of conservation measures.

12.4 Benchmarking

[FDSR 182] The design team **shall** set comprehensive and targeted energy goals.

These goals will challenge a design team to investigate innovative, cost-effective solutions that provide energy savings for new construction or retrofit projects.

12.5 Sustainable Design

Although energy conservation does not always include a sustainable design approach, they typically go together during the design process. See section 13, Sustainable Design Practice, for sustainable design practice requirements.

12.6 Zero-Net-Energy Building Initiative

[FDSR 183] Designs **shall** be in accordance with Executive Order 13834, Efficient Federal Operations, for existing federal buildings and leases.

A zero-net-energy building is defined as "an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the onsite renewable exported energy." A zero-net-energy building is comprised of a wide variety of energy conservation techniques, onsite energy generation, and sustainable design techniques that vary Center wide.

13. SUSTAINABLE DESIGN PRACTICE

NASA's sustainability objectives are to:

a. Support economic growth and livability of the communities where NASA conducts business;

b. Evaluate Agency climate change risks and vulnerabilities and develop mitigation measures to manage both the short- and long-term effects of climate change on the Agency's mission and operations;

c. Raise employee awareness and encourage everyone in the NASA community to apply the concepts of sustainability to every aspect of their daily work to achieve these objectives;

d. Maintain compliance with all applicable federal, state, local, and territorial laws and regulations related to energy security, a healthy environment, and environmentally sound operations;

e. Comply with internal NASA requirements and agreements with other entities; and

f. Address climate change concerns.

The NASA Memorandum of Understanding dated January 4, 2012, "Guiding Principles for Federal Leadership in High Performance Sustainable Buildings" reconciles the differences between Leadership in Energy and Environmental Design (LEED) requirements, and NPR 8820.2, which requires meeting all Guiding Principles. Focusing only on LEED requirements may not necessarily meet all the Guiding Principles, and the letter outlines which LEED credits could be applicable to specific Guiding Principles.

13.1 Climate Change

13.1.1 [FDSR 184] The following applicable regulations and guidance **shall** be used during building design:

a. Executive Order 13834,

b. NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment,

c. NPR 8810.1, Center Master Planning,

d. NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114,

e. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions,

f. The NASA Handbook for Master Planning, and

g. The Strategic Sustainability Performance Plan (SSPP).

13.1.2 [FDSR 185] The design team **shall** identify current and future climate hazards (e.g., sea-level rise, salt water intrusion, coastal flooding, overall increased temperature, increased number of high temperature days, precipitation changes, fire, wind, and air quality).

13.1.3 [FDSR 186] The design team **shall** conduct a vulnerability and risk assessment, generating a low-, medium-, and high-risk rating characterizing the risk of climate change on systems and assets.

13.1.4 [FDSR 187] The design team **shall** develop potential adaptation strategies.

Potential adaptation categories include:

a. Raising critical infrastructure set in basements or on ground floors;

b. Increasing cleaning of drains and gutters to reduce flooding;

c. Integrating green infrastructure to help reduce flood impacts;

d. Planting more heat and drought-/flood-tolerant trees, shrubs, and grasses;

e. Installing or increasing height-of-flood barriers such as revetments, levees, and sea walls;

f. Using construction materials that are resilient to increased temperatures, wind and fire risk, or periodic inundation;

g. Maintaining wildlife corridors;

h. Zoning changes;

i. Designing indoor environmental systems to handle new temperature extremes;

j. Identifying implementation approaches and funding for the adaptation strategies;

k. Identifying opportunities for partnership and coordination, particularly for sea-level rise impacts that can sometimes be more effectively dealt with at a sub-regional level.

13.2 Sustainability

[FDSR 188] Sustainability and sustainable, environmentally friendly design practices **shall** incorporate maintainable design elements, building commissioning processes, safety, health, and security features into facility planning, design, construction, activation, operation, maintenance, and decommissioning.

13.2.1 Integrated Design Principles

13.2.1.1 [FDSR 189] "Guiding Principles for Federal Leadership in High-Performance Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings" Memorandum of Understanding **shall** be used.

13.2.1.2 [FDSR 190] A collaborative, integrated planning and design process **shall** be used that

a. Initiates and maintains an integrated project team in all stages of a project's planning and delivery;

b. Establishes performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals and ensures incorporation of these goals throughout the design and life cycle of the building;

c. Considers all stages of the building's life cycle, including deconstruction.

13.2.1.3 [FDSR 191] Total building commissioning practices **shall** be used for new and renovation construction tailored to the size and complexity of the building and its system components.

13.2.1.4 [FDSR 192] Total building commissioning **shall** include a designated commissioning authority, commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.

13.2.1.5 [FDSR 193] Facilities design **shall** be future ready and flexible enough to accommodate future technologies, embrace innovative techniques, and adapt to climate change.

13.2.2 Optimize Energy Performance

See section 12, Energy Conservation, for information on energy performance.

13.2.3 Protect and Conserve Water

13.2.3.1 [FDSR 194] All new facilities **shall** be sub-metered to facilitate water use data collection and evaluation of conservation measures.

13.2.3.2 [FDSR 195] The water management approach, program goals, requirements, performance metrics, and building or system inventories **shall** be documented in a Water Management Plan or integrated into a water conservation program.

13.2.3.3 [FDSR 196] Regional, native plant materials and heat and drought-/flood-tolerant plants **shall** be used when selecting landscaping materials.

13.2.3.4 [FDSR 197] If available, non-potable water **shall** be used for irrigation with the aim to reduce irrigation water consumption.

13.2.3.5 [FDSR 198] Irrigation systems **shall** be designed to prevent unnecessary water usage.

13.2.3.6 [FDSR 199] Smart controllers that use evapotranspiration and weather data to adjust irrigation schedules **shall** be used.

13.2.4 Enhanced Indoor Environmental Quality

13.2.4.1 [FDSR 200] High-performance and sustainable buildings **shall** provide occupants with a well-ventilated and comfortable indoor environment.

13.2.4.2 [FDSR 201] Indoor moisture levels **shall** be controlled, as they contribute to mold growth, building damage, unhealthy building conditions, and poor indoor air quality.

13.2.4.3 [FDSR 202] Natural lighting or daylighting **shall** be used to reduce energy consumption by allowing sunlight into a building through openings such as windows and skylights.

13.2.4.4 [FDSR 203] Low-emitting materials **shall** be used.

13.2.4.5 [FDSR 204] Indoor air quality **shall** be controlled during construction or renovation projects.

13.2.4.6 [FDSR 205] Pest control **shall** be carefully considered, as pesticides can harm indoor air quality.

13.2.5 Reduced Environmental Impact of Materials

13.2.5.1 [FDSR 206] A cost-effective recycling and waste prevention program **shall** be developed in accordance with NPD 8500.1, NASA Environmental Management.

13.2.5.2 [FDSR 207] Sustainable facilities design **shall** include careful evaluation of material and equipment sources and consider recycled, salvaged, or otherwise environmentally friendly products when selecting building materials.

13.2.5.3 [FDSR 208] Ozone-depleting compounds (ODC), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and halons found in older building systems pose significant threats to the ozone layer, requiring extra effort to mitigate negative impacts, and **shall** not be used.

14. ENVIRONMENTAL COMPLIANCE

NASA is committed to being a responsible environmental steward through the consideration of the environment and compliance with environmental laws and regulations. The NEPA requires all federal agencies to integrate environmental resources into their decision-making processes by considering the potential environmental impacts of their proposed actions and the reasonable alternatives to those actions prior to making a decision.

The main objective of NEPA is to protect and enhance the quality of the human environment through four main initiatives:

a. Integrating environmental considerations into the planning of federal actions as early as possible;

b. Ensuring that environment, technical, and economic considerations are weighed during decision making and before any actions are taken;

c. Providing a meaningful opportunity for public comment and interagency/intergovernmental coordination; and

d. Ensuring that the decision maker is informed of the environmental consequences of proposed federal actions and available mitigation prior to making a decision.

The purpose of NASA's NEPA program is to ensure Agency compliance by integrating the NEPA process into facility planning.

The NEPA process often involves coordinating compliance with:

a. The Clean Air Act.

b. The Clean Water Act.

c. The National Historic Preservation Act.

d. The Endangered Species Act.

NASA's NEPA goals and objectives are to seek to avoid, minimize, and mitigate any adverse

effects of its proposed programs and projects that could hinder NASA in its efforts to implement its mission. Any mitigation measures needed are monitored during the implementation of the mission.

The White House Council on Environmental Quality (CEQ) sets the standard on NASA's NEPA process. NASA develops and implements Agency-specific regulations, policies, and procedures such as NPD 8500.1 to support its own mandate and meet other environmental requirements. NASA partners with other federal agencies; state, tribal and local governments; concerned public/private organizations; and individuals to act as responsible stewards of America's natural resources.

14.1 NASA'S NEPA Process

14.1.1 [FDSR 209] An environmental review of each project **shall** be conducted prior to the start of design as required by NEPA.

14.1.2 [FDSR 210] The environmental review **shall** be initiated by the NEPA proponent (the manager responsible for the proposed facility action) by completing an NEPA environmental checklist.

14.1.3 [FDSR 211] The Headquarters or Center NEPA Manager **shall** determine what level of documentation is needed to fulfill NEPA compliance.

14.1.4 [FDSR 212] If the environmental checklist reveals that the proposed facility project falls within one of NASA's 23 Categorical Exclusions (CATEXs), the NEPA Manager **shall** determine if development of an REC is needed.

14.1.5 [FDSR 213] If the environmental assessment identified potential environmental impacts that can be significant or cannot be mitigated, an Environmental Impact Statement (EIS) **shall** be completed and a Notice of Intent to Prepare an Environmental Impact Statement (EIS) is issued.

14.1.6 [FDSR 214] An EIS **shall** constitute the primary guideline for environmental design issues.

14.1.7 [FDSR 215] Designers **shall** ensure the EIS mitigation measures are implemented.

14.1.8 [FDSR 216] The policies and procedures developed through NASA's NEPA program **shall** be followed and integrated into the early planning stages of all programs and projects.

14.1.9 [FDSR 217] NASA's Environmental Justice (EJ) strategy **shall** be integrated into projects.

14.1.10 [FDSR 218] The cleanup of, reuse/construction on, and alternatives to reuse of Superfund or Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) sites **shall** be considered in an NEPA review to minimize cost, delay, and paperwork.

15. HISTORIC PRESERVATION

[FDSR 219] The local State Historic Preservation Office (SHPO) **shall** be involved early in any historic preservation project.

NASA is a committed steward of cultural resources, ensuring the preservation of the significance of NASA's mission, communities, and the history of our nation in accordance with the National Historic Preservation Act (NHPA) and the Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation.

Existing buildings can be energy efficient through the use of good ventilation, durable materials, and spatial relationships. Older buildings do not require new construction and have infrastructure already in place. Modifications can be made to adapt existing buildings to compatible new uses.

Historic properties, as identified by the NHPA, include any prehistoric or historic district, site, building structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. These same historic properties can include natural or man-made landscapes. NASA design projects may encompass any or all of these types of historic properties, and projects could be located in or on top of archeological remains or landscapes. Caution is advised whenever major physical intervention is required in an existing building or landscape, as demolition or bulldozing can irreparably damage a culturally significant landscape.

The Secretary of the Interior's Standards for the Treatment of Historic Properties seek to promote and guide the responsible treatment of historic structures and to protect irreplaceable cultural resources. These Standards are the guiding principles behind sensitive preservation design and practice at NASA.

The following are four distinct approaches to the treatment of historic properties:

a. Preservation focuses on the maintenance, stabilization, and repair of existing historic materials and retention of a property's form as it has evolved over time;

b. Rehabilitation acknowledges the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character;

c. Restoration depicts a property at a particular period of time in its history while removing evidence of other periods;

d. Reconstruction re-creates vanished or non-surviving portions of a property for interpretive purposes.

Most NASA projects that reuse existing historic structures or buildings will likely fall under Rehabilitation. To operate these structures efficiently, NASA recognizes the need to modernize these facilities to keep up with scientific advancement while respecting the history and historic

events associated with the advancement of science and technology that these specialized facilities may represent.

15.1 Historic Treatment Plan

15.1.1 [FDSR 220] The key compliance milestones of the Historic Treatment Plan **shall** be met to keep the project schedule on track.

15.1.2 [FDSR 221] The Center's Integrated Cultural Resources Management Plans (ICRMP) **shall** be followed.

15.1.3 [FDSR 222] The Center Historic Preservation Officer (HPO) **shall** identify the compliance process and reviews associated with various laws and regulations.

15.1.4 [FDSR 223] Projects involving historic properties **shall** be coordinated with the HPO.

15.1.5 [FDSR 224] The appropriate treatment for a historic property **shall** be selected at project initiation, before the design begins.

15.1.6 [FDSR 225] Prior to commencing the design of a project, the design team **shall** create a planning document outlining the following design parameters:

a. The historical significance of the historic building or district;

b. The qualities and elements that contribute to the historic character of the resource;

c. Historic preservation priorities; and

d. The appropriate treatment standard for the project (e.g., preservation, rehabilitation, restoration, or reconstruction).

15.1.7 [FDSR 226] The design team **shall** prepare a separate Historic Treatment Plan in consultation with the HPO for rehabilitation or adaptive reuse projects involving historic properties.

15.1.8 [FDSR 227] Projects in the viewshed of a historic property **shall** consider the design qualities of the historic property or historic district and ensure that the new design does not adversely impact those qualities.

15.1.9 [FDSR 228] New construction **shall** not detract from the key characteristics that contribute to a historic property's significance.

If a building was historically the tallest building in the area, then constructing a new "tallest" building adjacent to the historic building would not be appropriate.

For more guidance on treatment plans or other tools recommended for working with historic properties, refer to the Whole Building Design Guide.

15.2 Integrating Historic Preservation Concerns with Other Criteria

15.2.1 [FDSR 229] Preservation and design professionals **shall** consider the cumulative effect of minor changes that can greatly diminish the integrity of a historic building over time.

15.2.2 [FDSR 230] Major preservation designs **shall** include the following:

a. Update building systems appropriately to strike a balance between retaining original building features and accommodating new technologies and equipment;

b. Address life safety, seismic, and security issues in ways that preserve historic sites, spaces, and features;

c. Design access for persons with disabilities while meeting preservation goals; and

d. Accommodate energy efficiency requirements and improvements.

16. DESIGNING FOR OPERATIONS AND MAINTENANCE

16.1 Design Philosophy

16.1.1 [FDSR 231] Designing for maintainability **shall** require collaboration among designers, maintenance personnel, users, and construction managers during the facility design and construction phases to identify equipment and facility maintenance requirements aimed at reducing or eliminating maintenance costs and downtime and improving safety.

16.1.2 [FDSR 232] Maintenance personnel **shall** be active participants during the entire design and construction phases, as well as maintaining a lessons learned file on each project.

16.1.3 [FDSR 233] Outfitting for condition-based maintenance (CBM) **shall** be a requirement on all new construction and major renovations, where feasible, to achieve testability and diagnostics.

16.1.4 [FDSR 234] The NASA Maintenance Manager, with assistance from others, **shall** be required to determine the level of criticality for the facility and the facility's related equipment.

16.1.5 [FDSR 235] NASA **shall** provide the designer with the CBM requirements based on criticality so they can be designed into the project.

16.1.6 [FDSR 236] Critical systems **shall** have backup or redundant systems.

16.1.7 [FDSR 237] Equipment **shall** be specified that is easy to install, operate, troubleshoot, and maintain.

This includes equipment with features such as permanently lubricated and sealed parts, designed for quick disassembly, minimal alignment, adjustment and calibration in the field, built-in

provisions for handling heavy parts, use of standardized fasteners and parts so no specialized tools are required, and the use of parts that will only install one way.

16.1.8 [FDSR 238] Equipment **shall** come with a manufacturer-provided Failure Modes and Effects Analysis (FMEA).

16.1.9 [FDSR 239] The guidelines set forth in the NASA Commissioning Guide for New and Existing Buildings **shall** be followed for all new construction and major renovations.

16.1.10 [FDSR 240] The procedures outlined in the NASA Reliability Centered Building and Equipment Acceptance Guide **shall** be specified to accept building equipment.

16.1.11 [FDSR 241] Lessons learned, including feedback from maintenance to design on equipment performance, maintainability, and reliability, **shall** be tracked.

16.1.12 [FDSR 242] Based on the current design procedure for a project, section 16 **shall** incorporate the following items:

a. Review and approval of the Facility Requirements Document by all stakeholders.

b. Review and approval of the Facility Hazard Analysis by the safety engineer and project manager.

c. Develop the Project Management Plan throughout the project design and construction period.

d. Establish design schedule and work breakdown.

e. Apply the latest edition of NFPA, ANSI, IEEE, NETA, and all applicable standards and codes.

f. Include preliminary and critical design reviews (30, 60, 90, and 100%) by Design.

g. Prepare and review drawings and specifications.

h. Prepare independent cost estimate.

i. Prepare and review testing and commissioning procedure.

j. Review verification and tracking procedure.

k. Consider equipment nameplate and rating.

l. Consider monitoring, metering, and protection systems.

m. Establish configuration management.

n. Review and obtain approval of as-built drawings.

17. TAILORING/WAIVING OF SPECIFIC REQUIREMENTS

It is NASA policy that all prescribed requirements (requirements levied on a lower organizational level by a higher organizational level) are complied with unless relief is formally granted. If a requirement contained in this NASA Technical Standard cannot be achieved or cannot be achieved at a cost commensurate with the value of the requirement, the A-E (via the requisite Center Facilities office) may request, in writing, to the NASA Headquarters Facilities Engineering and Real Estate Division that the requirement be tailored or waived.

17.1 [FDSR 243] The tailoring/waiver request shall:

a. Certify that the A-E has diligently attempted to meet the requirement, the requirement cannot reasonably be met, and alternative approaches meet the intent of the requirement.

b. Be supported by evidence of the A-E's research and documentation that the alternative approach meets the function and interoperability requirements of this NASA Technical Standard.

17.2 [FDSR 244] Waivers from the requirements in this NASA Technical Standard shall require the concurrence of the Director of FRED**.**

NASA Headquarters Facilities Engineering and Real Estate Division, in its sole discretion, may waive or approve tailoring of requirements found to be currently unachievable or not commercially practicable.

APPENDIX A

REQUIREMENTS COMPLIANCE MATRIX

A.1 Purpose/Scope

The Requirements Compliance Matrix below contains this NASA Technical Standard's requirements and may be used by programs and projects to indicate requirements that are applicable or not applicable to help minimize costs. Enter "Yes" in the "Applicable" column if the requirement is applicable to the program or project or "No" if the requirement is not applicable to the program or project. The "Comments" column may be used to provide specific instructions on how to apply the requirement or to specify proposed tailoring.

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
4.1.1	Site Planning and Analysis	[FDSR 1] Site planning shall: a. Be integrated with the design of the buildings; b. Respect the surrounding context; c. Contribute to energy conservation, water conservation, and sustainability efforts; d. Focus on accessibility compliance. e. Require a thorough review and understanding of existing site conditions, opportunities, and constraints.		
4.1.2	Site Planning and Analysis	[FDSR 2] Prior to the start of design, a site inventory and analysis (e.g., site survey, geotechnical and groundwater investigations) and an environmental review as required by the National Environmental Policy Act (NEPA) shall be performed.		
4.1.3	Site Planning and Analysis	[FDSR 3] At all times, the A-E shall follow the requirements of the Record of Environmental Consideration (REC) or Record of Decision (ROD) that exist for the project site.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
4.2	Grading	[FDSR 4] Natural topography and existing vegetation shall be preserved to the maximum extent possible.		
4.3.1	Site Utilities	[FDSR 5] The location of all new utilities shall be coordinated with site design features and existing utilities.		
4.3.2	Site Utilities	[FDSR 6] The designer shall be responsible for coordinating the utility design with local utility providers.		
4.3.3	Site Utilities	[FDSR 7] Utilities shall be located in unpaved areas where economically feasible.		
4.3.4	Site Utilities	[FDSR 8] NASA requirements on separation of all significant utilities shall be followed.		
4.3.5	Site Utilities	[FDSR 9] NASA and local water district authority requirements for water meters and backflow preventers shall be followed.		
4.3.6	Site Utilities	[FDSR 10] Loop-fed systems with multiple water connections shall be considered on large buildings or campuses.		
4.3.7	Site Utilities	[FDSR 11] Dual-feed water systems shall be installed if required for the building occupancy.		
4.3.8	Site Utilities	[FDSR 12] The water supply system shall be designed to supply the required water flow for fire protection in accordance with NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.		
4.4.1	Storm Drainage	[FDSR 13] The storm water system’s capacity for storm events shall be designed as directed by NASA and local requirements.		
4.4.2	Storm Drainage	[FDSR 14] Gravity flow shall be used for all storm drainage systems and not prevent the usage of mechanical sumps to assist with storm drains.		
4.4.3	Storm Drainage	[FDSR 15] Storm drainage pipes shall be located in unpaved areas where economically feasible.		
4.4.4	Storm Drainage	[FDSR 16] Rainwater from the building roof drainage system not collected for reuse shall be discharged into the storm drainage system.		
4.4.5	Storm Drainage	[FDSR 17] Storm drainage systems shall be designed to reduce or eliminate offsite discharge of oils, greases, and debris.		
4.4.6	Storm Drainage	[FDSR 18] Any required local approvals for a Storm Water Management Plan shall be prepared and obtained.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
4.4.7	Storm Drainage	[FDSR 19] Site plans shall meet NASA, local, state, and Environmental Protection Agency (EPA) best management practices, including EPA-832-R-92-005, Storm Water Management for Construction Activities, Chapter 3.		
4.4.8	Storm Drainage	[FDSR 20] Storm water run-off shall meet NASA requirements, as well as state and local regulations.		
4.4.9	Storm Drainage	[FDSR 21] Site design shall include measures to address both quantity and quality of storm water before entering into any storm water system.		
4.4.10	Storm Drainage	[FDSR 22] Incorporation of low-impact development strategies shall be considered on a case-by-case basis.		
4.5	Redevelopment Sites	[FDSR 23] The redevelopment of brownfield sites and infill development as a sustainable initiative shall be considered.		
4.6.2.1	Site Furniture, Signage, and Lighting	[FDSR 24] Site furnishings, signage, and lighting are included as part of the site design and shall be low maintenance and compatible in scale, style, and color with the surrounding architecture and landscape.		
4.6.2.2	Site Furniture, Signage, and Lighting	[FDSR 25] Unobtrusive lighting and luminaire placement shall be used.		
5.1.1	Parking Accommodations	[FDSR 26] All parking area designs and construction shall meet NASA, federal, state, and local regulations.		
5.1.2	Parking Accommodations	[FDSR 27] Pavements and curbs shall be designed using local NASA design standards and materials.		
5.1.3	Parking Accommodations	[FDSR 28] Chosen materials shall be suitable for the traffic volume, expected load, and anticipated use conditions.		
5.1.4	Parking Accommodations	[FDSR 29] Areas for truck maneuvering shall be paved with hard and durable materials.		
5.1.5	Parking Accommodations	[FDSR 30] Walkways shall be designed for compliance with American with Disabilities Act (ADA)/Architectural Barriers Act (ABA).		
5.2.1	Efficient Layout and Circulation	[FDSR 31] Parking areas shall be sited and configured between facilities to encourage shared parking.		
5.2.2.1	Vehicle and Pedestrian Circulation	[FDSR 32] Design of site circulation shall separate pedestrian access, vehicular access (including parking), and service vehicle access areas where practical.		
5.2.2.2	Vehicle and Pedestrian Circulation	[FDSR 33] Emergency vehicle access shall be incorporated and coordinated with the AHJ and the local fire department.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
5.2.2.3	Vehicle and Pedestrian Circulation	[FDSR 34] Consideration for access to public transportation shall occur early in the design process in coordination with the master plan and regional planners.		
5.2.3.1	Alternative Transportation	[FDSR 35] Alternative means of transportation shall be considered part of any comprehensive parking strategy for Centers or facilities.		
5.2.3.2	Alternative Transportation	[FDSR 36] Access to mass transit stations shall be included in any master plan, if available.		
5.3.1	Anti-Terrorist/Force Protection Setbacks and Other Security Measures	[FDSR 37] Site design shall incorporate the setbacks and security measures as required in accordance with NASA requirements and The Risk Management Process for Federal Facilities: An Interagency Security Committee Standard.		
5.3.2	Emergency Vehicle Access	[FDSR 38] Local fire and emergency departments and AHJ shall be consulted on surface material, turning radius, weights, fire lane widths, and other relevant considerations.		
6.1.1	Planning, Design, and Construction	[FDSR 39] All NASA facilities shall be sited and designed to safeguard human life, minimize damage to properties, and allow for the immediate restoration of essential functions and services after a disaster.		
6.1.2	Planning, Design, and Construction	[FDSR 40] The following actions shall be taken to enhance disaster resilience: a. Pursue planning and siting that employs natural systems for disaster mitigation instead of engineered ones (e.g., natural wetlands and sufficient open space for flood protection versus concrete channels and levies). b. Maximize the protective functions of natural systems within a macro-level master planning process approach to an entire facility or site rather than building-by-building. c. Pursue strategies for disaster mitigation through both horizontal (e.g., land use, circulation, open space, infrastructure, and utilities) and vertical (e.g., structural engineering, architecture, and materials use) planning and design. d. Identify emergency disaster response procedures, evacuation routes, and locations of critical facilities (e.g., command center, fire department, hospitals, emergency shelters, etc.) in the planning process.		
7.1.1	Structural Systems	[FDSR 41] Structural systems shall be designed to provide room for future increases in loading.		
7.1.2	Structural Systems	[FDSR 42] Structural framing systems shall be selected to maximize bay sizes to take advantage of open floor plan capabilities.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
7.1.3	Structural Systems	[FDSR 43] Redundancy factors shall be included in the design of structures located in moderate-to-high seismic regions.		
7.1.4	Structural Systems	[FDSR 44] Recycled materials shall be incorporated for the most widely used building products so as not to negatively impact durability and structural performance.		
7.2.1	Structural Considerations	[FDSR 45] Basic wind speeds based on special wind maps provided in ASCE 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, shall be used for structures located in hurricane-prone regions.		
7.2.2	Structural Considerations	[FDSR 46] The structure shall be designed to aid in dampening mechanical equipment and external source noise.		
7.2.3	Structural Considerations	[FDSR 47] Compliance with the EPA's Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air shall be ensured to remedy vapor intrusion from groundwater contamination and avoid creating new vapor intrusion pathways.		
7.3.1	Structural Requirements of New Buildings	[FDSR 48] The structural design of new buildings, including wind and seismic design, shall be in full compliance with the latest edition of building codes and standards, including the International Building Code (IBC), ASCE 7, and NIST GCR 11-917-12, Standards of Seismic Safety for Existing Federally Owned and Leased Buildings.		
7.3.2	Structural Requirements of New Buildings	[FDSR 49] Floor-framing members shall be designed with a combination of strength and stiffness that will not cause vibration beyond the "slightly perceptible" range of the Modified Reiher-Meister Scale.		
7.3.3	Structural Requirements of New Buildings	[FDSR 50] All nonstructural elements, components, and equipment located within a building or on the site shall be anchored and/or braced to withstand gravity, wind, seismic, and other loads as required by the IBC, ASCE 7, and NIST GCR 11-917-12.		
7.4	Structural Upgrading of Existing Buildings	[FDSR 51] Deficiencies in the attachment of elements of structures, nonstructural components, and equipment represent a life safety risk and shall be strengthened to meet current code requirements of the IBC, ASCE 7, and NIST GCR 11-917-12.		
8.	Architecture and Interior Design	[FDSR 52] In conjunction with the design team, NASA shall conduct a visioning session and programming interviews with key stakeholders for the project.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
8.1	General Public	[FDSR 53] Facilities that may receive regular visitors (e.g., tour groups) shall be designed to accommodate visitor accessibility, in addition to reasonable accommodation for employees.		
8.1.2	Functional Separation	[FDSR 54] Public access to parts of facilities that require separation shall be limited by integrating physical separation design elements such as entranceways, corridors, and lobbies.		
8.1.3.1	Space Measurement and Building Efficiency	[FDSR 55] Area types shall be authorized in an approved prospectus.		
8.1.3.2	Space Measurement and Building Efficiency	[FDSR 56] Area types shall be delineated in a program of requirements, as measured in accordance with NASA space assignment requirements as described in NID 8000-104, NASA Interim Directive (NID): Acquisition of Administrative Office Space.		
8.1.4	Circulation	[FDSR 57] Primary and secondary circulation shall be located and configured in an efficient and clear manner with delineation between service access, public access, and private accessways.		
8.1.5.1	Wayfinding	[FDSR 58] Programmatic elements shall be connected.		
8.1.5.2	Wayfinding	[FDSR 59] The building shall be clearly organized horizontally and vertically.		
8.1.5.3	Wayfinding	[FDSR 60] Wayfinding shall not depend solely upon signage.		
8.1.6	Vertical Transportation	[FDSR 61] A thorough vertical transportation traffic analysis of the facility shall be performed to assist in the selection of the type and quantity of conveying systems.		
8.1.7.1	Building Maintenance Access	**[**FDSR 62] An evaluation of access needs and requirements for facility equipment shall be performed early in the design process.		
8.1.7.2	Building Maintenance Access	[FDSR 63] The parameters for corridors shall be considered to provide proper access for maintenance.		
8.2.1	Core and Shell	[FDSR 64] A standard module of the key core and shell elements shall be developed.		
8.2.2	Modularity	[FDSR 65] A consistent module of materials, both in dimension and sequence, shall be created.		
8.2.4	High Performance	[FDSR 66] A thorough commissioning of the envelope shall be performed to verify that the envelope meets or exceeds specified requirements.		
8.3	Interior Facility Design	[FDSR 67] Effective adjacencies of functional spaces shall be considered.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
8.4.1.1	Space Planning	[FDSR 68] Flexible space planning shall be facilitated with: a. The minimization of fixed interior walls and partitions. b. The selection of easily moveable and reconfigurable workplace components and furnishings.		
8.4.1.2	Space Planning	[FDSR 69] Work settings shall be equipped to enable simultaneous voice, data, and video collaboration among distributed co-workers, both local and remote.		
8.4.2.1	Daylighting and Artificial Lighting	[FDSR 70] Daylighting, occupant needs, and energy efficiency shall be balanced through the use of controls.		
8.4.2.2	Daylighting and Artificial Lighting	[FDSR 71] Interior spaces shall be designed to maximize the use of natural daylighting and provide daylighting and views for the occupants.		
8.4.2.3	Daylighting and Artificial Lighting	[FDSR 72] Natural light in open spaces shall be maximized.		
8.4.2.4	Daylighting and Artificial Lighting	[FDSR 73] The use of enclosed rooms along the perimeter at exterior windows shall be avoided.		
8.4.2.5	Daylighting and Artificial Lighting	[FDSR 74] Views of the exterior environment shall be maximized for building occupants.		
8.4.3	Interior Finishes	[FDSR 75] Current building standards for finishes shall be used in case of facility rehabilitations.		
8.4.4.1	Acoustics	[FDSR 76] Acoustic provisions and requirements within the design shall be developed and established with the concepts of: a. Acoustic quality. b. Speech privacy. c. Background noise. d. Equipment vibration and noise. e. Exterior noise.		
8.4.4.2	Acoustics	[FDSR 77] The architect shall differentiate between enclosed and open office environments to meet acoustic objectives.		
8.4.4.3	Acoustics	[FDSR 78] Office equipment noise levels shall meet acoustical standards at workstations using the Whole Building Design Guide.		
8.4.4.4	Acoustics	[FDSR 79] Vibration and reverberation shall be controlled in auditoriums, conference rooms, team spaces, and training room spaces.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
8.4.4.5	Acoustics	[FDSR 80] Facilities located near airports, highways, rail corridors, or other sources of significant environmental noise levels shall utilize building envelope assemblies that control noise intrusions within parameters of the required standards set in the Whole Building Design Guide.		
8.5	Universal Accessibility	[FDSR 81] All NASA facilities shall be designed, constructed, and renovated in such a manner that the facility, or part of the facility, is readily accessible to and usable by all persons, including the general public, where applicable.		
8.6.1	Designing for Deconstruction	[FDSR 82] The use of recyclable and recoverable materials for re-use shall be considered.		
8.6.2	Designing for Deconstruction	[FDSR 83] Building systems shall be simplified and separated to facilitate de-construction.		
8.6.3	Designing for Deconstruction	[FDSR 84] The structural system shall be simplified to minimize the quantity of building materials used.		
8.6.4	Designing for Deconstruction	**[**FDSR 85] Structural fasteners, connectors, fittings, etc., that are simple to disassemble and are re-useable shall be considered.		
8.7.1	Alterations and Refurbishment of Existing Buildings and Historic Structures	[FDSR 86] Renovation designs shall satisfy the immediate occupancy needs and anticipate additional future changes.		
8.7.2	Alterations and Refurbishment of Existing Buildings and Historic Structures	[FDSR 87] Building systems shall be remodeled to increase flexibility and adapt to changing occupancy needs.		
9.1.1	Fire Protection Systems	[FDSR 88] The design shall incorporate efficient, cost-effective fire protection systems.		
9.1.2	Fire Protection Systems	[FDSR 89] A registered fire protection engineer shall be part of the design team and serve as a full participant in the design, construction, and final acceptance phases of the project.		
9.1.3	Fire Protection Systems	[FDSR 90] The AHJ shall be involved in all aspects of the system design.		
9.1.4	Fire Protection Systems	[FDSR 91] The AHJ’s approval or concurrence on system requirements shall be required for all projects.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
9.1.5	Fire Protection Systems	[FDSR 92] Disruptions to fire alarm and sprinkler systems shall be kept to a minimum, or avoided if possible, for fire safety construction or renovation projects.		
9.1.6	Fire Protection Systems	[FDSR 93] Construction phasing shall be defined to ensure: a. Installations of new fire protection systems are expedited. b. Existing systems are kept in service until the replacement system is operational.		
9.1.7	Fire Protection Systems	[FDSR 94] A corrective impairment plan that maintains equivalent levels of fire protection that are acceptable to the AHJ shall be implemented if fire protection systems are to be disrupted.		
9.1.8	Fire Protection Systems	[FDSR 95] All aspects of the fire protection system shall comply and be compatible with the existing fire alarm system at the respective Center and UFGS Division 21 Fire Suppression.		
9.2	Fire Alarm Notification	[FDSR 96] Fire detection and notification system requirements shall address the following elements: a. Detection. b. Notification. c. Survivability of systems. d. Controls.		
9.2.1.1	Site Fire Suppression Requirements	[FDSR 97] Site design shall integrate performance requirements associated with fire department access, fire suppression, and separation distances, in addition to the requirements of the building itself.		
9.2.1.2	Site Fire Suppression Requirements	[FDSR 98] Site planning shall include fire department access, fire hydrants, supply lines, and water supply.		
9.2.1.3	Site Fire Suppression Requirements	[FDSR 99] Buildings shall be designed with uncomplicated layouts and floor plans that enable firefighters to locate an area quickly.		
9.2.1.4	Site Fire Suppression Requirements	[FDSR 100] Designs shall provide rapid access to features such as fire department connections (FDC), hose valves, annunciators, key boxes, elevators, and stairs.		
9.2.1.5	Site Fire Suppression Requirements	[FDSR 101] The A-E shall coordinate with the Center's AHJ to accommodate the access of fire apparatus into and around the building site and coordinate access control point layout.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
9.2.1.6	Site Fire Suppression Requirements	[FDSR 102] Supply lines shall be coordinated with the civil engineer and sized based on hydraulic calculations.		
9.2.1.7	Site Fire Suppression Requirements	[FDSR 103] Large underground fire water additions and alterations shall be looped.		
9.2.1.8	Site Fire Suppression Requirements	[FDSR 104] If available, grey water shall be used to meet fire protection requirements.		
9.2.2.1	Interior Fire Suppression Requirements	[FDSR 105] Interior building fire suppression requirements shall include acquiring the latest-available water supply information.		
9.2.2.2	Interior Fire Suppression Requirements	[FDSR 106] Flow testing shall be performed if the latest-available water supply information is out of date.		
9.2.2.3	Interior Fire Suppression Requirements	[FDSR 107] Hydraulic calculations shall be provided by the designer to support the sizing of the fire suppression system.		
9.2.2.4	Interior Fire Suppression Requirements	[FDSR 108**]** The necessity of a fire pump shall be determined by the designer.		
9.3.1.1	Life Safety Systems	[FDSR 109] The design shall incorporate efficient, cost-effective life safety systems.		
9.3.1.2	Life Safety Systems	[FDSR 110] The AHJ shall be involved in all aspects of the life safety system design.		
9.3.1.3	Life Safety Systems	[FDSR 111] The AHJ's approval or concurrence on system requirements shall be obtained by the A-E.		
9.3.2	Design Standards and Criteria	[FDSR 112] Local building code(s), NFPA codes and standards, and UFGS Division 21 shall be utilized and the following addressed by the design team: a. Construction and occupancy types. b. Fire ratings. c. Fireproofing. d. Fire stopping. e. Construction materials. f. Vertical and horizontal exiting requirements. g. Accessibility. h. Building system controls. i. Emergency lighting.		

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		j. CEQ 2016 Guiding Principles for Sustainable Federal Buildings and Associated Instructions.		
9.3.3	Site Requirements	[FDSR 113] Building design and layout shall integrate performance requirements associated with fire department access, suppression, separation distances, and other civil requirements.		
9.3.4	Fire Department Access	[FDSR 114] Buildings shall be designed with uncomplicated layouts and floor plans that enable firefighters to locate an area quickly and provide rapid access to fire department access features.		
10.1.1	Mechanical and Plumbing Systems	[FDSR 115] Mechanical and plumbing systems shall be designed alongside one another.		
10.1.2	Mechanical and Plumbing Systems	[FDSR 116] Mechanical and plumbing materials shall be specified to be resistant to intrusion and damage by or to local wildlife species.		
10.1.3	Mechanical and Plumbing Systems	[FDSR 117] Systems shall be designed for ease of access and maintainability of the systems.		
10.1.4	Mechanical and Plumbing Systems	[FDSR 118] System design shall include a strategy for replacement of large pieces of equipment when a facility requires continuous operation.		
10.1.5	Mechanical and Plumbing Systems	[FDSR 119] All pipes, valves, and equipment in mechanical rooms, shafts, ceilings, and other spaces that are accessible to maintenance personnel shall be identified.		
10.1.6	Mechanical and Plumbing Systems	[FDSR 120] The identification of all pipes, valves, and equipment shall indicate the system type and direction of flow for piping systems or the type and number for equipment.		
10.1.7	Mechanical and Plumbing Systems	[FDSR 121] Chilled water, domestic water, and fire protection systems shall be designed and constructed with easy connect ports to allow for temporary water sources or chillers to quickly connect into the building in the event of a pipe or equipment failure so that occupancy can be maintained.		
10.2	Mechanical	[FDSR 122] An integrated design procedure shall be incorporated to ensure that the mechanical systems and other building components function together and meet all performance objectives defined by the project's program requirements and the International Mechanical Code.		
10.2.1.1	Energy Considerations	[FDSR 123] The mechanical system shall be designed to:		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
		a. Meet the project's programmed sustainability rating. b. Exceed the minimum performance requirements of ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, by at least 30%; c. Meet the following applicable Code of Federal Regulations (CFR) standards: (1) 10 CRF 433 – Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings, (2) 10 CFR 435 – Energy Efficiency Standards for the Design and Construction of New Federal Low-Rise Residential Buildings, (3) 10 CFR 436 - Federal Energy Management and Planning Programs, and (4) 29 CFR 1910 – Occupational Safety and Health Standards; d. Incorporate cost-effective energy conservation measures that do not compromise building performance or occupant comfort: (1) Allow for the removal and replacement of major components such as boilers, chillers, cooling towers, pumps, and air-handling equipment; and (2) Specifically design HVAC systems to meet all the defined performance objectives of the project, including any tenant-specific program requirements, at the full-load and part-load conditions that are associated with the projected occupancies and modes of operations.		
10.2.1.2	Energy Considerations	[FDSR 124] HVAC design shall comply with: a. Division 23 in the Whole Building Design Guide. b. The Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding.		
10.3.1	Plumbing	**[**FDSR 125] Water conservation shall be a requirement of all plumbing systems.		

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10.3.2	Plumbing	**[**FDSR 126] Low-flow plumbing fixtures for Federal Acquisition Regulations (FAR) Subpart 23.1, Sustainable Acquisition Policy, compliance and sustainability concerns shall be specified.		
10.3.3	Plumbing	[FDSR 127] Fixture counts that comply with the International Plumbing Code (IPC), UFGS Division 22, Plumbing, General Purpose, and local building codes shall be provided.		
10.4.1	Process Systems	[FDSR 128] The safety policies in NPR 8715.1, NASA Safety and Health Programs, shall be used in pressure vessel design.		
10.4.2	Process Systems	[FDSR 129] The technical requirements in NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PVS), shall be utilized in pressure vessel design.		
10.4.3	Process Systems	[FDSR 130] All new ground-based conventional (i.e., non-flight) pressure vessel systems shall be designed, fabricated, assembled, erected, inspected, examined, and tested in accordance with the NASA Center's requirements, codes, and regulations, including NPR 8715.1, NASA-STD-8719.17, and the ASME Boiler and Pressure Vessel Code.		
10.4.4	Process Systems	[FDSR 131] Specialty systems such as hydrogen gas, oxygen and oxygen systems, explosives, propellants, and hypergolic fluids shall comply with NASA safety standards, NASA-developed standards, NASA directives, various NASA Center requirements, and documents cited in NASA-STD-8719.12, Safety Standard for Explosives, Propellants, and Pyrotechnics.		
10.5	Building System Controls	[FDSR 132] UFGS 25 05 11, Cybersecurity of Facility-Related Control Systems, shall be used as a template for cybersecurity design.		
10.5.1	Building System Controls	[FDSR 133] Direct digital controls (DDC) for Building Automation Systems (BAS) shall be capable of the following: a. Scheduling operations and maintenance; b. Trending data history/storage retrieval; and c. Adjusting building systems to optimize their performance.		
10.5.2	Building System Controls	[FDSR 134] ASHRAE 135, BACnet -- A Data Communication Protocol for Building Automation and Control Networks, open communication protocol shall be used to provide integration and interoperability between building systems and control vendors.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
10.5.3	Building System Controls	[FDSR 135] Approximately 20% spare capacity in the BAS shall be included for future expansion.		
10.5.4	Building System Controls	[FDSR 136] Metering shall be provided at the facility level for electricity, natural gas, steam, chilled water, and domestic water.		
11.1.1	General	[FDSR 137] Electrical, security, and communications (i.e., telecom/data) shall be designed and integrated into a building as required by the end users.		
11.1.2	General	[FDSR 138] Power requirements shall meet current and potential future demand.		
11.1.3	General	[FDSR 139] Security requirements, including wiring and communication back to security, shall meet the minimum standards for cameras, electronic locks, card readers, and other devices.		
11.1.4	General	[FDSR 140] Additional user requirements shall be developed for telecom and data.		
11.2a	Electrical	[FDSR 141] The lighting quality shall include luminance balance, color appearances, visibility of multiple visual tasks, visual comfort, daylight and views, control and finally, user acceptance.		
11.2b	Electrical	[FDSR 142] The interior lighting requirements shall follow the recommended values of illuminance by the Illuminating Engineering Society (IES).		
11.2c	Electrical	FDSR 143] The exterior lighting design shall meet the IES Lighting Handbook recommendations.		
11.2d	Electrical	[FDSR 144] Exterior luminaries and control system shall comply with all local zoning laws with lighting levels of exterior spaces not exceeding the IES Lighting Handbook's recommendations.		
11.2e	Electrical	[FDSR 145] Illumination of exterior exit discharges shall be designed in accordance with the requirements in NFPA 101, Life Safety Code.		
11.2f	Electrical	[FDSR 146] Parking lots and roadway lighting shall be designed per IES RP-8 and IES RP-20 in addition to International Dark Sky Association (IDA)/IES Model Lighting Ordinance (MLO) requirements.		
11.2g	Electrical	[FDSR 147] Parking structure lighting shall be designed per IES RP-20 and meet ASHRAE 90.1 requirements for controls related to parking garage luminaires.		
11.2h	Electrical	[FDSR 148] Illumination of means of egress shall be designed in accordance with the requirements in NFPA 101.		

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11.2.i	Electrical	[FDSR 149] Enclosed stairway lighting shall be installed in accordance with the requirements in NFPA 101.		
11.2j	Electrical	[FDSR 150] Emergency lighting for means of egress shall be designed in accordance with the requirements in NFPA 101, NASA, and any additional facility mission requirements with performance of emergency lighting in accordance with the requirements in NFPA 101.		
11.2.1.1	Safety	[FDSR 151] Safety shall be incorporated in the design of all electric power systems.		
11.2.1.2	Safety	[FDSR 152] Exposure to arc flash and shock hazards shall be mitigated by engineering controls designed into the electrical power systems.		
11.2.2.1	Reliability	[FDSR 153] Unplanned outages shall be minimized by choosing the proper equipment type, protection schemes, distribution system configurations, equipment loading, and standby/backup measures or uninterruptible power supply (UPS) installations.		
11.2.2.2	Reliability	[FDSR 154] Electrical system design and materials shall be specified to be resistant to local wildlife intrusion that may cause injury and electrical tripping.		
11.2.3.1	Maintainability	[FDSR 155] Equipment shall be located in areas easily accessed by maintenance personnel.		
11.2.3.2	Maintainability	[FDSR 156] Redundancy shall be considered for essential critical operations.		
11.2.4.1	Measurability	[FDSR 157] Electrical equipment shall be energy efficient.		
11.2.4.2	Measurability	[FDSR 158] Electrical equipment shall incorporate advanced metering capable of recording the seven major parameters of the electrical distribution system (amps, volts, power factor, volt-amps, watts, volt-amps reactive, and kilowatt hours), at a minimum.		
11.2.4.3	Measurability	[FDSR 159] Metering for clean power shall utilize measuring instruments capable of a faster data capture rate.		
11.2.4.4	Measurability	[FDSR 160] Collaboration with end users shall be required to identify locations where clean power is required and alert them to the possible additional equipment costs.		
11.2.4.5	Measurability	[FDSR 161] Separate metering for data centers shall be required to facilitate the determination of power usage effectiveness (PUE).		

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11.2.5.1	Economy	[FDSR 162] Cost-effective solutions shall be incorporated into the design while providing the safest, most reliable, most maintainable, and most energy-efficient equipment for the use intended.		
11.2.5.2	Economy	[FDSR 163] A life-cycle cost analysis shall be performed.		
11.2.5.3	Economy	[FDSR 164] The criticality of a facility shall be determined with users during pre-design meetings.		
11.2.6.1	Flexibility	[FDSR 165] Flexibility shall be incorporated in the initial layout and sizing of the equipment so that future load additions will not require major modifications to the equipment.		
11.2.6.2	Flexibility	[FDSR 166] Provisions shall be developed for independent metering at each electric vehicle charging station.		
11.2.6.3	Flexibility	[FDSR 167] A plan shall be developed to charge users for electricity at electric vehicle charging stations.		
11.2.6.4	Flexibility	[FDSR 168] Provisions for advanced lighting controls that are integrated with the daylighting features of the building shall be developed.		
11.3.1	Security	[FDSR 169] Provisions for security systems in all buildings shall be included.		
11.3.2	Security	[FDSR 170] The type and level of security system shall be determined by local requirements.		
11.3.3	Security	[FDSR 171] The security requirements shall be integrated into the design for the project.		
11.3.4	Security	[FDSR 172] Security lighting during unoccupied hours shall be included at all facilities.		
11.3.5	Security	[FDSR 173] Additional security features such as cameras (CCTV), building access, motion sensing, or other more extensive security measures shall be developed at the discretion of the end user.		
11.3.6	Security	[FDSR 174] Security systems shall be integrated with emergency and standby power systems.		
11.3.7	Security	[FDSR 175] The following four types of communication systems shall be included at all buildings: a. Emergency (part of the facility fire alarm mass notification system); b. Building automation and energy management, including power monitoring devices;		

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		c. Voice (e.g., conventional telephone service); and d. Data (e.g., fiber optic/Ethernet).		
11.3.8	Security	[FDSR 176] Separate communication systems shall not be integrated with each other, except for voice and data (Voice over Internet Protocol) at the discretion of NASA Information Technology (IT) security.		
12.1.1	Energy Efficiency	[FDSR 177] Energy efficiency shall be considered throughout building design, selection of equipment and materials, and through broader efforts to improve operational processes.		
12.1.2	Energy Efficiency	[FDSR 178] Energy modeling shall be applied with the intent of reducing energy consumption to 30% below ASHRAE 90.1 baseline building.		
12.2	Onsite Renewable Energy	[FDSR 179] Sources of onsite renewable energy shall be considered.		
12.3.1	Measurement and Verification	[FDSR 180] Building systems and other facility equipment shall be periodically inspected to ensure optimum efficiency.		
12.3.2	Measurement and Verification	[FDSR 181] All new facilities shall be sub-metered to facilitate energy use, data collection, and evaluation of conservation measures.		
12.4	Benchmarking	[FDSR 182] The design team shall set comprehensive and targeted energy goals.		
12.6	Zero-Net-Energy Building Initiative	[FDSR 183] Designs shall be in accordance with Executive Order 13834, Efficient Federal Operations, for existing federal buildings and leases.		
13.1.1	Climate Change	[FDSR 184] The following applicable regulations and guidance shall be used during building design: a. Executive Order 13834, b. NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment, c. NPR 8810.1, Center Master Planning, d. NPR 8580.1, Implementing the National Environmental Policy Act and Executive Order 12114, e. Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, f. The NASA Handbook for Master Planning, and g. The Strategic Sustainability Performance Plan (SSPP).		
13.1.2	Climate Change	[FDSR 185] The design team shall identify current and future climate hazards (e.g., sea-level rise, salt water intrusion, coastal flooding, overall increased		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
		temperature, increased number of high temperature days, precipitation changes, fire, wind, and air quality).		
13.1.3	Climate Change	**[**FDSR 186] The design team shall conduct a vulnerability and risk assessment, generating a low-, medium-, and high-risk rating characterizing the risk of climate change on systems and assets.		
13.1.4	Climate Change	[FDSR 187] The design team shall develop potential adaptation strategies.		
13.2	Sustainability	[FDSR 188] Sustainability and sustainable, environmentally friendly design practices shall incorporate maintainable design elements, building commissioning processes, safety, health, and security features into facility planning, design, construction, activation, operation, maintenance, and decommissioning.		
13.2.1.1	Integrated Design Principles	[FDSR 189] "Guiding Principles for Federal Leadership in High-Performance Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings" Memorandum of Understanding shall be used.		
13.2.1.2	Integrated Design Principles	[FDSR 190] A collaborative, integrated planning and design process shall be used that a. Initiates and maintains an integrated project team in all stages of a project's planning and delivery; b. Establishes performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals and ensures incorporation of these goals throughout the design and life cycle of the building; c. Considers all stages of the building's life cycle, including deconstruction.		
13.2.1.3	Integrated Design Principles	[FDSR 191] Total building commissioning practices shall be used for new and renovation construction tailored to the size and complexity of the building and its system components.		
13.2.1.4	Integrated Design Principles	[FDSR 192] Total building commissioning shall include a designated commissioning authority, commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.		
13.2.1.5	Integrated Design Principles	[FDSR 193] Facilities design shall be future ready and flexible enough to accommodate future technologies, embrace innovative techniques, and adapt to climate change.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
13.2.3.1	Protect and Conserve Water	[FDSR 194] All new facilities shall be sub-metered to facilitate water use data collection and evaluation of conservation measures.		
13.2.3.2	Protect and Conserve Water	[FDSR 195] The water management approach, program goals, requirements, performance metrics, and building or system inventories shall be documented in a Water Management Plan or integrated into a water conservation program.		
13.2.3.3	Protect and Conserve Water	[FDSR 196] Regional, native plant materials and heat and drought-/flood-tolerant plants shall be used when selecting landscaping materials.		
13.2.3.4	Protect and Conserve Water	[FDSR 197] If available, non-potable water shall be used for irrigation with the aim to reduce irrigation water consumption.		
13.2.3.5	Protect and Conserve Water	[FDSR 198] Irrigation systems shall be designed to prevent unnecessary water usage.		
13.2.3.6	Protect and Conserve Water	[FDSR 199] Smart controllers that use evapotranspiration and weather data to adjust irrigation schedules shall be used.		
13.2.4.1	Enhanced Indoor Environmental Quality	[FDSR 200] High-performance and sustainable buildings shall provide occupants with a well-ventilated and comfortable indoor environment.		
13.2.4.2	Enhanced Indoor Environmental Air Quality	[FDSR 201] Indoor moisture levels shall be controlled, as they contribute to mold growth, building damage, unhealthy building conditions, and poor indoor air quality.		
13.2.4.3	Enhanced Indoor Environmental Quality	[FDSR 202] Natural lighting or daylighting shall be used to reduce energy consumption by allowing sunlight into a building through openings such as windows and skylights.		
13.2.4.4	Enhanced Indoor Environmental Air Quality	[FDSR 203] Low-emitting materials shall be used.		
13.2.4.5	Enhanced Indoor Environmental Air Quality	[FDSR 204] Indoor air quality shall be controlled during construction or renovation projects.		
13.2.4.6	Enhanced Indoor Environmental Air Quality	[FDSR 205] Pest control shall be carefully considered, as pesticides can harm indoor air quality.		
13.2.5.1	Reduced Environmental Impact of Materials	[FDSR 206] A cost-effective recycling and waste prevention program shall be developed in accordance with NPD 8500.1, NASA Environmental Management.		
13.2.5.2	Reduced Environmental Impact of Materials	[FDSR 207] Sustainable facilities design shall include careful evaluation of material and equipment sources and consider recycled, salvaged, or otherwise environmentally friendly products when selecting building materials.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
13.2.5.3	Reduced Environmental Impact of Materials	[FDSR 208] Ozone-depleting compounds (ODC), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and halons found in older building systems pose significant threats to the ozone layer, requiring extra effort to mitigate negative impacts, and shall not be used.		
14.1.1	NASA's NEPA Process	[FDSR 209] An environmental review of each project shall be conducted prior to the start of design as required by NEPA.		
14.1.2	NASA's NEPA Process	[FDSR 210] The environmental review shall be initiated by the NEPA proponent (the manager responsible for the proposed facility action) by completing an NEPA environmental checklist.		
14.1.3	NASA's NEPA Process	[FDSR 211] The Headquarters or Center NEPA Manager shall determine what level of documentation is needed to fulfill NEPA compliance.		
14.1.4	NASA's NEPA Process	[FDSR 212] If the environmental checklist reveals that the proposed facility project falls within one of NASA's 23 Categorical Exclusions (CATEXs), the NEPA Manager shall determine if development of an REC is needed.		
14.1.5	NASA's NEPA Process	[FDSR 213] If the environmental assessment identified potential environmental impacts that can be significant or cannot be mitigated, an Environmental Impact Statement (EIS) shall be completed and a Notice of Intent to Prepare an Environmental Impact Statement (EIS) is issued.		
14.1.6	NASA's NEPA Process	[FDSR 214] An EIS shall constitute the primary guideline for environmental design issues.		
14.1.7	NASA's NEPA Process	[FDSR 215] Designers shall ensure the EIS mitigation measures are implemented.		
14.1.8	NASA's NEPA Process	[FDSR 216] The policies and procedures developed through NASA's NEPA program shall be followed and integrated into the early planning stages of all programs and projects.		
14.1.9	NASA's NEPA Process	[FDSR 217] NASA's Environmental Justice (EJ) strategy shall be integrated into projects.		
14.1.10	NASA's NEPA Process	[FDSR 218] The cleanup of, reuse/construction on, and alternatives to reuse of Superfund or Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) sites shall be considered in an NEPA review to minimize cost, delay, and paperwork.		
15.	Historical Preservation	[FDSR 219] The local State Historic Preservation Office (SHPO) shall be involved early in any historic preservation project.		

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Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
15.1.1	Historic Treatment Plan	[FDSR 220] The key compliance milestones of the Historic Treatment Plan shall be met to keep the project schedule on track.		
15.1.2	Historic Treatment Plan	[FDSR 221] The Center's Integrated Cultural Resources Management Plans (ICRMP) shall be followed.		
15.1.3	Historic Treatment Plan	[FDSR 222] The Center Historic Preservation Officer (HPO) shall identify the compliance process and reviews associated with various laws and regulations.		
15.1.4	Historic Treatment Plan	[FDSR 223] Projects involving historic properties shall be coordinated with the HPO.		
15.1.5	Historic Treatment Plan	[FDSR 224] The appropriate treatment for a historic property shall be selected at project initiation, before the design begins.		
15.1.6	Historic Treatment Plan	[FDSR 225] Prior to commencing the design of a project, the design team shall create a planning document outlining the following design parameters: a. The historical significance of the historic building or district; b. The qualities and elements that contribute to the historic character of the resource; c. Historic preservation priorities; and d. The appropriate treatment standard for the project (e.g., preservation, rehabilitation, restoration, or reconstruction).		
15.1.7	Historic Treatment Plan	[FDSR 226] The design team shall prepare a separate Historic Treatment Plan in consultation with the HPO for rehabilitation or adaptive reuse projects involving historic properties.		
15.1.8	Historic Treatment Plan	[FDSR 227] Projects in the viewshed of a historic property shall consider the design qualities of the historic property or historic district and ensure that the new design does not adversely impact those qualities.		
15.1.9	Historic Treatment Plan	[FDSR 228] New construction shall not detract from the key characteristics that contribute to a historic property's significance.		
15.2.1	Integrating Historic Preservation Concerns with Other Criteria	[FDSR 229] Preservation and design professionals shall consider the cumulative effect of minor changes that can greatly diminish the integrity of a historic building over time.		
15.2.2	Integrating Historic Preservation Concerns with Other Criteria	[FDSR 230] Major preservation designs shall include the following:		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
		a. Update building systems appropriately to strike a balance betweem retaining original building features and accommodating new technologies and equipment; b. Address life safety, seismic, and security issues in ways that preserve historic sites, spaces, and features; c. Design access for persons with disabilities while meeting preservation goals; and d. Accommodate energy efficiency requirements and improvements.		
16.1.1	Design Philosophy	[FDSR 231] Designing for maintainability shall require collaboration among designers, maintenance personnel, users, and construction managers during the facility design and construction phases to identify equipment and facility maintenance requirements aimed at reducing or eliminating maintenance costs and downtime and improving safety.		
16.1.2	Design Philosophy	[FDSR 232] Maintenance personnel shall be active participants during the entire design and construction phases, as well as maintaining a lessons learned file on each project.		
16.1.3	Design Philosophy	[FDSR 233] Outfitting for condition-based maintenance (CBM) shall be a requirement on all new construction and major renovations, where feasible, to achieve testability and diagnostics.		
16.1.4	Design Philosophy	[FDSR 234] The NASA Maintenance Manager, with assistance from others, shall be required to determine the level of criticality for the facility and the facility's related equipment.		
16.1.5	Design Philosophy	[FDSR 235] NASA shall provide the designer with the CBM requirements based on criticality so they can be designed into the project.		
16.1.6	Design Philosophy	[FDSR 236] Critical systems shall have backup or redundant systems.		
16.1.7	Design Philosophy	[FDSR 237] Equipment shall be specified that is easy to install, operate, troubleshoot, and maintain.		
16.1.8	Design Philosophy	[FDSR 238] Equipment shall come with a manufacturer-provided Failure Modes and Effects Analysis (FMEA).		
16.1.9	Design Philosophy	[FDSR 239] The guidelines set forth in the NASA Commissioning Guide for New and Existing Buildings shall be followed for all new construction and major renovations.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
16.1.10	Design Philosophy	[FDSR 240] The procedures outlined in the NASA Reliability Centered Building and Equipment Acceptance Guide shall be specified to accept building equipment.		
16.1.11	Design Philosophy	[FDSR 241] Lessons learned, including feedback from maintenance to design on equipment performance, maintainability, and reliability, shall be tracked.		
16.1.12	Design Philosophy	[FDSR 242] Based on the current design procedure for a project, section 16 shall incorporate the following items: a. Review and approval of the Facility Requirements Document by all stakeholders. b. Review and approval of the Facility Hazard Analysis by the safety engineer and project manager. c. Develop the Project Management Plan throughout the project design and construction period. d. Establish design schedule and work breakdown. e. Apply the latest edition of NFPA, ANSI, IEEE, NETA, and all applicable standards and codes. f. Include preliminary and critical design reviews (30, 60, 90, and 100%) by Design. g. Prepare and review drawings and specifications. h. Prepare independent cost estimate. i. Prepare and review testing and commissioning procedure. j. Review verification and tracking procedure. k. Consider equipment nameplate and rating. l. Consider monitoring, metering, and protection systems. m. Establish configuration management. n. Review and obtain approval of as-built drawings.		
17.1	Tailoring/Waiving of Specific Requirements	[FDSR 243] The tailoring/waiver request shall: a. Certify that the A-E has diligently attempted to meet the requirement, the requirement cannot reasonably be met, and alternative approaches meet the intent of the requirement. b. Be supported by evidence of the A-E's research and documentation that the alternative approach meets the function and interoperability requirements of this NASA Technical Standard.		

NASA-STD-10002				
Section	**Description**	**Requirement in this Standard**	**Applicable (Enter Yes or No)**	**Comments**
17.2	Tailoring/Waiving of Specific Requirements	[FDSR 244] Waivers from the requirements in this NASA Technical Standard shall require the concurrence of the Director of FRED**.**		

APPENDIX B

REFERENCES

B.1 Purpose/Scope

This Appendix provides reference information to the user.

B.2 Reference Documents

B.2.1 Government Documents

NASA

NPD 1440.6	NASA Records Management
NPD 1600.2	NASA Security Policy
NPD 2081.1	Nondiscrimination in Federally Assisted and Conducted Programs of NASA
NPD 2810.1	NASA Information Security Policy
NPD 3713.8	Provision of Reasonable Accommodation for Individuals with Disabilities
NPD 7330.1	Approval Authorities for Facility Projects
NPD 8700.1	NASA Policy for Safety and Mission Success
NPD 8800.14	Policy for Real Estate Management
NPD 8810.2	Master Planning for Real Property
NPD 8820.2	Design and Construction of Facilities
NPR 1441.1	NASA Records Management Program Requirements
NPR 1600.1	NASA Security Program Procedural Requirements
NPR 1800.1	NASA Occupational Health Program Procedures
NPR 2081.1	Nondiscrimination in Federally Assisted and Conducted Programs

NPR 2810.1	Security of Information Technology
NPR 3713.3	Anti-Harassment Procedures
NPR 4310.1	Artifact Identification and Disposition
NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7120.7	NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements
NPR 8000.4	Agency Risk Management Procedural Requirements
NPR 8510.1	NASA Cultural Resources Management
NPR 8530.1	NASA Sustainable Acquisition
NPR 8553.1	NASA Environmental Management System
NPR 8570.1	NASA Energy Management Program
NPR 8590.1	Environmental Compliance and Restoration Program
NPR 8715.1	NASA Occupational Safety and Health Programs
NPR 8715.3	NASA General Safety Program Requirements
NPR 8820.2	Facility Project Requirements
NPR 8831.2	Facilities Maintenance and Operations Management
SAE EIA-649	Configuration Management Standard
NASA-STD-5008	Protective Coating of Carbon Steel, Stainless Steel, and Aluminum on Launch Structures, Facilities, and Ground Support Equipment
NASA-STD-8719.11	Safety Standard for Fire Protection
NASA-STD-8719.7	Facility System Safety Guidebook
NASA Form 4657	Change Request for a NASA Engineering Standard

NASA Environmental Justice Strategy
(https://www.nasa.gov/agency/nepa/ej.html)

NASA Reliability Centered Maintenance Guide
(https://fred.hq.nasa.gov/Assets/Docs/2015/NASA_RCMGuide.pdf)

NASA Sustainable Policy Handbook for Facilities)
(www.hq.nasa.gov/office/codej/codejx/Assets/Docs/SustainableHandbookforFacilities.pdf)

NASA Post-Occupancy Evaluations

Reliability-Centered Maintenance Guide
(https://fred.hq.nasa.gov/Assets/Docs/2015/NASA_RCMGuide.pdf)

Executive Orders (EO)

EO 11514	Protection and Enhancement of Environmental Quality
EO 11593	Protection and Enhancement of the Cultural Environment
EO 11988	Floodplain Management
EO 11990	Protection of Wetlands
EO 11991	Environmental Impact Statements
EO 12072	Federal Space Management
EO 12196	Occupational Safety and Health Programs for Federal Employees
EO 12699	Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction
EO 12893	Principles for Federal Infrastructure Investments
EO 12898	Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
EO 12941	Seismic Safety of Existing Federally Owned or Leased Buildings
EO 13006	Locating Federal Facilities on Historical Properties in our Nations Central Cities
EO 13007	Indian Sacred Sites

EO 13045	Protection of Children from Environmental Health Risks and Safety Risks
EO 13112	Invasive Species
EO 13158	Marine Protected Areas
EO 13175	Consultation and Coordination with Indian Tribal Governments
EO 13186	Responsibilities of Federal Agencies to Protect Migratory Birds
EO 13221	Energy-Efficient Standby Power Devices
EO 13231	Critical Infrastructure Protection in the Information Age
EO 13287	Preserve America
EO 13327	Federal Real Property Asset Management
EO 13347	Individuals with Disabilities in Emergency Preparedness
EO 13352	Facilitation of Cooperative Conservation
EO 13486	Strengthening Laboratory Biosecurity in the United States
EO 13547	Stewardship of the Ocean, Our Coasts and the Great Lakes
EO 13717	Establishing a Federal Earthquake Risk Management Standard
EO 13728	Wildland-Urban Interface Federal Risk Mitigation

Federal Laws

15 U.S.C. § 2227	Fire Safety Systems in Federally Assisted Buildings
16 U.S.C. § 661-666c	Fish and Wildlife Coordination Act
16 U.S.C. § 703-712	Migratory Bird Treaty Act of 1918
33 U.S.C. § 403; Chapter 425, March 3, 1899; 30 Stat. 1151	Rivers and Harbors Appropriation Act of 1899
NDAA	National Defense Authorization Act (NDAA)
Public Law No. 100-678	Public Buildings Amendments of 1988, 40 U.S.C. 3312

Public Law No. 101-601, 104 Stat. 3048	Native American Graves Protection and Repatriation Act (NAGPRA)
Public Law No. 109-58, 119 Stat. 594	Energy Policy Act of 2005 (EPAct 2005)
Public Law No. 110-140, 121 Stat. 1492	Energy Independence and Security Act of 2007 (EISA 2007)
Public Law No. 72-428, 47 Stat. 1489	Buy American Act
Public Law No. 88-206, 77 Stat. 392	Clean Air Act
Public Law No. 89-665, 80 Stat. 915	National Historic Preservation Act (NHPA)
Public Law No. 91-190, 83 Stat. 852	National Environmental Policy Act (NEPA)
Public Law No. 92-500, 86 Stat. 816	Clean Water Act
Public Law No. 92-522, 86 Stat. 1027	Marine Mammal Protection Act (MMPA)
Public Law No. 93-205, 87 Stat. 884	Endangered Species Act of 1973
Public Law No. 93-523, 88 Stat. 1660	Safe Drinking Water Act (SDWA)
Public Law No. 94-469, 90 Stat. 2003	Toxic Substances Control Act
Public Law No. 94-580, 90 Stat. 2795	Resource Conservation and Recovery Act (RCRA)
Public Law No. 95-341, 92 Stat. 469	American Indian Religious Freedom Act
Public Law No. 95-619, 92 Stat. 3206	National Energy Conservation Policy Act (1978)

Public Law No. 96-510, 94 Stat. 2767	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)
Public Law No. 96–95 as amended, 93 Stat. 721	Archaeological Resources Protection Act of 1979
Public Law No. 99-499, 100 Stat. 1728	Emergency Planning and Community Right-To-Know Act (EPCRA)

Code of Federal Regulations

10 CFR 133	Energy Efficiency Standards for the Design and Construction of New Federal Commercial and Multi-Family High-Rise Residential Buildings
14 CFR 1216.3	Procedures for Implementing the National Environmental Policy Act (NASA Regulations)
14 CFR 1251	Nondiscrimination on Basis of Disability
23 CFR 655	Traffic Control Devices on Federal-Aid and Other Streets and Highways
29 CFR 1926	Safety and Health Regulations for Construction
36 CFR 67	Historic Preservation Certification under the Internal Revenue Code
36 CFR 800	Protection of Historic Properties
36 CFR 61	Procedures for Approved State and Local Government Historic Preservation Programs
36 CFR 65	National Historic Landmarks Program.
36 CFR 79	Curation of Federally Owned and Administered Archeological Collections.
40 CFR 122	EPA Administered Permit Programs: The National Pollutant Discharge Elimination System
40 CFR 1500-1508	Council of Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA
40 CFR 260-299	Solid Wastes

40 CFR 300-399	Superfund, Emergency Planning and Community Right-to-Know Programs
40 CFR 401-403	Effluent Guidelines and Standards
40 CFR 50	National Primary and Secondary Ambient Air Quality Standards
40 CFR 51	Requirements for Preparation, Adoption, and Submittal of Implementation Plans
40 CFR 60	Standards of Performance for New Stationary Sources
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 82	Protection of Stratospheric Ozone
40 CFR 93	Determining Conformity of Federal Actions to State or Federal Implementation Plans,
41 CFR 102-80	Safety and Environmental Management
43 CFR 10	Native American Graves Protection and Repatriation Regulations
48 CFR 23	Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety, and Drug-Free Workplace

Council on Environmental Quality (CEQ)

	Final Guidance Clarifying Use of Categorical Exclusions (https://ceq.doe.gov/docs/ceq-regulations-and-guidance/NEPA_CE_Guidance_Nov232010.pdf)
CEQ 2016	Guiding Principles for Sustainable Federal Buildings and Associated Instructions

Department of the Interior

	Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation (https://www.nps.gov/tps/standards.htm)

Environmental Protection Agency (EPA)

EPA 841-B-09-001	Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects *under Section 438)
	Contaminant Candidate List 3 (CCL 3)

(https://www.epa.gov/ccl/contaminant-candidate-list-3-ccl-3)

EPA Groundwater Rule
(https://www.epa.gov/dwreginfo/ground-water-rule)

EPA Radionuclide Rule
(https://www.epa.gov/dwreginfo/radionuclides-rule)

EPA Radon Rule
(https://www.epa.gov/radon)

Federal Emergency Management Agency (FEMA)

FEMA 350	Recommended Seismic Design Criteria for New Steel Moment-Frame Building
FEMA 351	Recommended Seismic Evaluation and Upgrade Criteria for Existing Welded Steel Moment-Frame Buildings
FEMA 352	Recommended Post-Earthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings
FEMA 353	Recommended Specifications and Quality Assurance Guidelines for Steel Moment-Frame Construction for Seismic Applications

General Services Administration (GSA)

ABAAS	Architectural Barriers Act Accessibility Standard (https://www.gsa.gov/real-estate/design-construction/accessible-facility-design)
P-100	Facilities Standards for the Public Buildings Service (https://www.gsa.gov/cdnstatic/2018%20P100%20Final%20Updated%207-26-18.pdf)

Interagency Committee on Seismic Safety in Construction (ICSSC)

Standards of Seismic Safety for Existing Federally Owned or Leased Buildings
(https://www.gsa.gov/cdnstatic/ICSSC_RP8_December_2011_508c.pdf)

Interagency Security Council (ISC)

ISC Security Design Criteria for New Federal Office and Major Projects
(https://www.nap.edu/catalog/10678/isc-security-design-criteria-for-new-federal-office-buildings-and-major-modernization-projects)

National Institute of Standards and Technology (NIST)

NISTIR 6762	Standards of Seismic Safety for Existing Federally Owned and Leased Buildings (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.204.1912&rep=rep1&type=p

Office of Management and Budget

	Scorecard on Sustainability and Energy (https://www.epa.gov/greeningepa/office-management-and-budget-scorecards-sustainability-and-energy)

United States Access Board

ABA Standards	Accessibility Standards for Federal Facilities (https://www.access-board.gov/guidelines-and-standards)

B.2.2 Non-Government Documents

American Concrete Institute (ACI)

ACI 318	Building Code Requirements for Structural Concrete and Commentary
TMS 402/602	Building Code Requirements and Specifications for Masonry Structures

American Institute of Steel Construction (AISC)

AISC 325	Steel Construction Manual
AISC 341	Seismic Provisions for Structural Steel Buildings
AISC 360	Specification for Structural Steel Buildings

American Iron and Steel Institute (AISI)

AISI D100	Cold-Formed Steel Design Manual

American National Standards Institute (ANSI)

ANSI 117.1	Accessibility Code
ANSI ICC 117.1	Accessible and Usable Buildings and Facilities
ANSI Z60.1	American Standard for Nursery Stock

American Society of Civil Engineers (ASCE)

ASCE 41	Seismic Evaluation and Retrofit of Existing Buildings

American Society of Mechanical Engineers (ASME)

ASME A17.1	Safety Code for Elevators and Escalators
ASME A17.3	Safety Code for Existing Elevators and Escalators
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME B31.5	Refrigeration Piping and Heat Transfer Components
ASME B31.8	Gas Transmission and Distribution Piping Systems
ASME B31.9	Building Services Piping

American Society for Testing and Materials (ASTM)

Annual Book of ASTM Standards
(https://www.astm.org/BOOKSTORE/BOS/index.html)

American Welding Society (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.2	Structural Welding Code – Aluminum
AWS D1.3	Structural Welding Code – Sheet Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel

American Water Works Association (AWWA)

AWWA Standards
(https://www.awwa.org/publications/standards.aspx)

Construction Industry Institute

RT-142	Design for Maintainability

Factory Mutual

Factory Mutual Approval Guide
(https://www.fmapprovals.com/approval-guide)

Factory Mutual (FM) Global Property Loss Prevention Data Sheets (https://www.fmglobal.com/research-and-resources/fm-global-data-sheets)

International Code Council

IgCC — International Green Construction Code (https://www.iccsafe.org/codes-tech-support/international-green-construction-code-igcc/international-green-construction-code/)

IWUIC — International Wildland-Urban Interface Code (http://shop.iccsafe.org/codes/2018-international-codes-and-references/2018-international-wildland-urban-interface-code.html)

Insulated Cable Engineers Association (ICEA)

ICEA Standards (https://www.icea.net/documents)

International Electrical Testing Association (NETA)

NETA Standards (https://www.netaworld.org/standards)

Institute of Electronics and Electrical Engineers (IEEE)

IEEE Standards (https://www.ieee.org/standards/index.html)

NESC — The National Electrical Safety Code®

Illuminating Engineering Society of North America (IESNA)

IESNA G-1-03 — Guideline for Security Lighting for People, Property, and Public Spaces

IESNA RP-33 — Lighting for Exterior Environments

Intertek Testing Services NA, Inc. (ITSNA)

ITSNA Standards (http://www.intertek.com/testing/)

Manufacturers Standardization Society (MSS)

MSS Standards

(http://msshq.org/Store/index.cfm)

National Association of Corrosion Engineers (NACE)

NACE Standards
(https://www.nace.org/resources/industry-standards/)

National Wood Council

National Design Specification for Wood Construction
(https://www.awc.org/codes-standards/publications)

National Electrical Manufacturers Association (NEMA)

NEMA Standards
(https://www.nema.org/Standards/pages/default.aspx)

National Fire Protection Association (NFPA)

NFPA 1	Fire Code
NFPA 101	Life Safety Code
NFPA 110	Standard for Emergency and Standby Power Systems
NFPA 13	Standard for the Installation of Sprinkler Systems
NFPA 14	Standard for the Installation of Standpipe and Hose Systems
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 25	Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
NFPA 30	Flammable and Combustible Liquids Code
NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 45	Standard on Fire Protection for Laboratories Using Chemicals
NFPA 51	Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes
NFPA 54	National Fuel Gas Code

NFPA 70	National Electrical Code
NFPA 70E	Standard for Electrical Safety in the Workplace
NFPA 72	National Fire Alarm and Signaling Code
NFPA 75	Standard for the Fire Protection of Information Technology Equipment
NFPA 90A	Standard for the Installation of Air-Conditioning and Ventilating Systems

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

ANSI/SMACNA 001-2008	Seismic Restraint Manual, Guidelines for Mechanical Systems

Steel Deck Institute (SDI)

SDI Standards
(https://www.sdi.org/publications-2/standards/)

The Aluminum Association

Aluminum Design Manual
(http://www.aluminum.org/all-new-aluminum-design-manual)

Underwriters Laboratories Inc. (UL)

UL 1	UL Standard for Safety Flexible Metal Conduit
UL 1480	UL Standard for Safety Speakers for Fire Alarm ,and Signaling Systems, Including Accessories
UL 1971	UL Standard for Safety Signaling Devices for the Hearing Impaired
UL 464	UL Standard for Safety Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories

Fire Protection Equipment Directory
(https://www.ul.com/code-authorities/building-code/fire-protection-systems/)