NASA Facilities Design Guide

August 2012

Photo Captions:

TOP ROW FROM LEFT: 1) LEED Office Facility for Transition, Building 20, Johnson Space Center. 2) Collaborative Support Facility, Building N232, Ames Research Center. 3) Transonic Tunnel, Langley Research Center.

BOTTOM ROW FROM LEFT: 1) Rocket Propulsion B Test Stand, Stennis Space Center. 2) Crew Vehicle Systems Research Facility, Ames Research Center. 3) Florida Power & Light Solar Array, Kennedy Space Center.

National Aeronautics and
Space Administration

Headquarters
Washington, DC 20546-0001

August 3, 2012

Reply to Attn of: Facilities Engineering Division

TO: Center Operations Points of Contact

FROM: Acting Director, Facilities Engineering Division

SUBJECT: NASA Facilities Design Guide

Enclosed is the newly developed NASA Facilities Design Guide. This document was a result of the collaborative efforts between Facilities Engineering Division, Center stakeholders, and the Engineering Construction Innovations Committee (ECIC). We thank all those who reviewed the document and contributed comments.

The Facilities Design Guide aims to communicate and describe the Agency's design philosophy and to provide a single document source that lists federally mandated laws, Executive Orders, codes and standards, as well as NASA directives relating to construction and maintenance of facilities. This Guide is intended to complement–not replace–existing Center best design practices and standards. It could be used as a reference by NASA facilities project managers when determining design requirements and writing statements of work, and by Architect-Engineer firms who might have limited experience working with NASA.

This Guide will be updated on a regular basis, and, as in the development of the first version, we are asking for the Centers' and ECIC's continued support by providing feedback to ensure the document is current, relevant, useful, and does not conflict with current Center design practices.

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Table of Contents

1. Introduction 1-1

2. National Codes & Standards, State & Local Codes 2-1
   - 2.1 Policy 2-1
   - 2.2 Definitions 2-1
   - 2.3 National Codes, Standards, & Guides 2-1
   - 2.4 State and Local Codes 2-5

3. Executive Orders, Federal Laws, Regulations, & Federal Guidance 3-1
   - 3.1 Policy 3-1
   - 3.2 Definitions 3-1
   - 3.3 Executive Orders 3-1
   - 3.4 Federal Laws 3-4
   - 3.5 Federal Regulations 3-7
   - 3.6 Other Federal Guidance 3-10

4. NASA Policy Directives (NPD), Procedural Requirements (NPR), Standards & Internal Documents 4-1
   - 4.1 Policy 4-1
   - 4.2 Definitions 4-1
   - 4.3 NASA Policy Directives 4-1
   - 4.4 NASA Procedural Requirements 4-3
   - 4.5 NASA Technical Standards 4-4
   - 4.6 NASA Internal Documents 4-5

5. Civil, Site, & Landscape Design 5-1
   - 5.1 Design Philosophy 5-1
     - 5.1.1 Goals and Objectives 5-1
     - 5.1.2 Site Planning and Analysis 5-1
     - 5.1.3 Grading 5-1
     - 5.1.4 Site Utilities 5-1
     - 5.1.5 Storm Drainage 5-1
     - 5.1.6 Pavement and Curbs 5-2
     - 5.1.7 Vehicle and Pedestrian Circulation 5-2
     - 5.1.8 Sustainable Landscaping 5-2
     - 5.1.9 Site Furniture, Signage and Lighting 5-2
   - 5.2 Key Civil, Site and Landscape Requirements, Regulations, Standards and Guidance 5-3

6. Architecture & Interior Design 6-1
   - 6.1 Design Philosophy 6-1
     - 6.1.1 Goals and Objectives 6-1
     - 6.1.2 Facility Planning 6-1

6.1.3 Exterior Facility Design 6-1
6.1.4 Interior Facility Design 6-2
6.1.5 Designing for Deconstruction 6-3
6.1.6 Alterations and Refurbishment of Existing Buildings and Historic Structures 6-3
6.2 Key Architectural and Interior Design Requirements, Regulations, Standards and Guidance 6-3

7. Structural Design 7-1
7.1 Design Philosophy 7-1
7.1.1 Goals and Objectives 7-1
7.1.2 Structural Considerations 7-1
7.1.3 Structural Requirements of New Buildings 7-1
7.1.4 Structural Upgrading of Existing Buildings 7-1
7.2 Key Structural Requirements, Regulations, Standards and Guidance 7-2

8. Mechanical & Plumbing Design 8-1
8.1 Design Philosophy 8-1
8.2 Key Mechanical and Plumbing Design Requirements, Regulations, Standards and Guidance 8-2

9. Electrical, Security, & Communication Design 9-1
9.1 Design Philosophy 9-1
9.1.1 Goals and Objectives – Electrical 9-1
9.1.2 Goals and Objectives – Security 9-2
9.1.3 Goals and Objectives – Communication 9-2
9.2 Key Electrical, Security and Communication Requirements, Regulations, Standards and Guidance 9-2

10. Fire Protection/Life Safety 10-1
10.1 Design Philosophy 10-1
10.2 Key Fire Protection/Life Safety Requirements, Regulations, Standards and Guidance 10-2

11. Sustainable Design/ Energy Conservation 11-1
11.1 Design Philosophy 11-1
11.1.1 Goals and Objectives 11-1
11.1.2 Sustainable Design 11-1
11.1.3 Employ Integrated Design Principles 11-2
11.1.4 Optimize Energy Performance 11-2
11.1.5 Protect and Conserve Water 11-3
11.1.6 Enhance Indoor Environmental Air Quality 11-3
11.1.7 Reduce Environmental Impact of Materials 11-3
11.2 Key Sustainable Design/Energy Conservation Requirements, Regulations, Standards and Guidance 11-4

12. Accessibility 12-1
12.1 Design Philosophy 12-1
12.2 Key Accessibility Requirements, Regulations, Standards and Guidance 12-1

13. Designing for Natural Disasters 13-1
13.1 Design Philosophy 13-1
13.1.1 Overview 13-1
13.2 Key Natural Disaster Requirements, Regulations, Standards and Guidance 13-1
14. Designing for Climate Change 14-1
14.1 Design Philosophy 14-1
14.2 Key Climate Change Requirements, Regulations, Standards and Guidance 14-2
15. Parking Requirements 15-1
15.1 Design Philosophy 15-1
15.2 Key Parking Requirements, Regulations, Standards and Guidance 15-1
16. Environmental Compliance 16-1
16.1 Design Philosophy 16-1
16.2 Key Environmental Requirements, Regulations, Standards and Guidance 16-3
17. Historic Preservation 17-1
17.1 Design Philosophy 17-1
17.1.1 Four Treatment Approaches 17-1
17.1.2 Historic Treatment Plan 17-2
17.1.3 Integrating Historic Preservation Concerns with Other Design Criteria 17-3
17.2 Key Historic Preservation Requirements, Regulations, Standards and Guidance 17-3
18. Designing for Maintainability 18-1
18.1 Design Philosophy 18-1
18.2 Key Maintainability Requirements, Regulations, Standards and Guidance 18-2

List of Tables

Table 2-1: National Codes, Standards & Guides 2-1
Table 3-1: Executive Orders 3-1
Table 3-2: Federal Laws 3-4
Table 3-3: Federal Regulations 3-8
Table 3-4: Other Federal Guidance Documents 3-11
Table 4-1: NASA Policy Directives (NPD) 4-2
Table 4-2: NASA Procedural Requirements (NPR) 4-3
Table 4-3: NASA Technical Standards 4-4
Table 4-4: NASA Internal Standards 4-5

1. Introduction

NASA is committed to building world-class and state of the art facilities that are also environmentally friendly, cost efficient and safe. 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.

NASA facility planning, design, construction and operation processes take place in accordance with the most current, efficient and cost-effective facility stewardship throughout a facility's life-cycle (design, construction, maintenance, renewal, and demolition). This requires an integrated and collaborative facility design approach in which all NASA stakeholders (facility engineers, designers, contractors, tenants, users, etc.) are encouraged to actively participate early and continuously in the planning process.

That approach and the laws, regulations, codes, standards, policies, and requirements that need to be considered in the development of a mature facility design are described in this document. The purpose of this NASA Facilities Design Guide is to communicate agency top-level design philosophy and to provide a document that will serve as a singular resource for all Agency-level planning, design, and construction requirements. These top-level requirements include:

- Current and applicable codes;
- Industry standards;
- Executive Orders (EOs), Federal Laws, Regulations, and Federal Guidance; and
- NASA Policy Directives (NPD's), NASA Procedural Requirements (NPR's), and NASA Standard

This Facilities Design Guide is intended to cover essentially all construction design activities done by NASA. Which means all tasks that involve the new construction, repair, alteration, upgrade, renovation, or demolition of buildings, structures, utilities, or building subsystems (fire protection, security, etc.). These include but are not limited to the following:

- Buildings used for offices or laboratory research;
- Specialized structures such as wind tunnels, arc jets, test stands, hangars, launch pads, etc.;
- Utility systems including electrical, communications, water, sewer, storm drains, natural gas, high pressure water distribution, and compressed air systems;
- Building subsystems including;
    - Fire protection systems including fire suppression systems and life safety alarm subsystems; and
    - Security access systems & Intrusion Detection Systems (IDS), closed circuit television (CCTV) systems, and physical security systems including security fences, physical security barriers, all doors, and other systems that impact the physical security of NASA assets

The Facilities Design Guide is to be used in conjunction with the specific building program for each project, which delineates all project information, such as number and sizes of building spaces, and requirements for mechanical, electrical and other operating systems. It is imperative that each facility be designed so that all components comprise an integrated solution, so that operation and maintenance of the facility, energy usage and other criteria may be maximized.

The Facilities Design Guide is intended to complement Center best practices and design standards. This document does not prohibit use of current management methods and systems currently used by the Centers and not specifically described in this Guide. While this Design Guide is intended primarily for the use of Architects/Engineers (A/E's), it does not relieve the A/E's of their responsibility to identify and determine other requirements not found in this document. This Design Guide contains design philosophy elements (and in some cases content largely incorporated) from NASA documents (NPD's, NPR's, Standards, and Guides), as well as the *Facilities Standards for the Public Buildings Service* (P-100), which establishes design standards and criteria for new buildings, major and minor alterations, and work in historic structures for the Public Buildings Service (PBS) of the General Services Administration (GSA), and the *Whole Building Design Guide (WBDG),* a web-based portal providing government and industry practitioners with one-stop access to up-to-date information on a wide range of building-related guidance, criteria and technology from a 'whole buildings' perspective.

2. National Codes & Standards, State & Local Codes

2.1 POLICY

In accordance with the Public Buildings Amendments of 1988, 40 U.S.C. 3312 (formerly section 21 of the Public Buildings Act of 1959, 40 U.S.C. 619), 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, fire and life safety codes, and plumbing codes, as the Administrator decides is appropriate.

2.2 DEFINITIONS

Codes - a collection of rules and regulations adopted by authorities having appropriate jurisdiction to control the design and construction, alteration, repair, quality or materials, use and occupancy, and related factors of facilities with their jurisdiction; 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.

2.3 NATIONAL CODES, STANDARDS, & GUIDES

Organizations that develop and publish national building codes, standards, and guides are outlined in Table 2-1.

TABLE 2-1: NATIONAL CODES, STANDARDS & GUIDES

CODE/STANDARD/GUIDE	DESCRIPTION
ABA Accessibility Standards for Federal Facilities (GSA)	Provides the standards for all facilities designed, constructed, altered, or leased with Federal funds under the Architectural Barriers Act (ABA) except for postal facilities, housing, and military facilities.
American Concrete Institute (ACI)	Develops technical information and documents for the concrete industry, which provide unbiased, consensus-based information that is widely acknowledged to be the standards of practice.

CODE/STANDARD/GUIDE	DESCRIPTION
American Institute of Steel Construction (AISC)	The leader in structural-steel-related technical activities, including specifications, codes, and standards development.
American Iron and Steel Institute (AISI)	Provides technical specification information for the use of steel.
American National Standards Institute (ANSI)	Oversees the creation, promulgation, and use of standards and guidelines that directly impact businesses in nearly every sector. Also provides accrediting programs that assess conformance to standards such as ISO 9000 and ISO 14000.
American Society of Civil Engineers (ASCE)	Provides technical guidelines and standards for promoting safety, reliability, productivity, and efficiency across all areas of civil engineering.
American Society of Mechanical Engineers (ASME)	Develops international codes and standards associated with the art, science, and practice of mechanical engineering; covering topics such as pressure technology, nuclear plants, elevators/escalators, construction, engineering design, standardization, and performance testing.
American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE)	Develops standards concerned with refrigeration processes and the design and maintenance of the indoor environment, providing methods of measurement or test, standard design, and standard practices.
American Society of Testing Materials (ASTM)	Establishes standards used around the world deliver the test methods, specifications, guides, and practices that support industry.
American Water Works Association (AWWA)	Develops vital guidelines and standards for all facets of the drinking water community, providing minimum requirements for the use of water-related products and chemicals
American Welding Society (AWS)	Provides the structural welding codes for steel, aluminum, sheet steel, stainless steel, reinforcing steel and also a bridge welding code.
Certified Ballast Manufacturers Association (CBMA)	The CBMA label indicates that the ballast has been tested and meets ANSI specifications.
FM Global (FM) *Formerly Factory Mutual Research Corp.*	Approval Standards illustrate the Approval criteria of various types of products and services. FM Approvals also provides third-party certification of products and services.

CODE/STANDARD/GUIDE	DESCRIPTION
FM Global Property Loss Prevention Data Sheets (FM Global)	Data Sheets are engineering guidelines written to help reduce the chance of property loss due to fire, weather conditions and failure of electrical or mechanical equipment, and incorporate loss experience, research results, input from consensus standards committees, equipment manufacturers and others.
Federal Emergency Management Agency (FEMA)	Manages a range of programs to reduce future losses to homes, businesses, schools, public buildings, and critical facilities from floods, earthquakes, tornadoes, and other natural disasters.
Illuminating Engineers Society of North America (IESNA)	Provides recommended practices and guidelines for a variety of specific lighting applications such as office, sports, outdoor, and healthcare facilities.
Institute of Electrical and Electronics Engineers (IEEE)	Provides a range of standards to make the exchange of technical knowledge and information possible, including: power and energy, information technology, information assurance, telecommunications, nanotechnology, transportation, etc.
Insulated Cable Engineers Association (ICEA)	Develops cable standards for the electric power, control, and telecommunications industries.
Interagency Security Committee (ISC)	Develops standards and best practices for the protection of nonmilitary federal facilities in the United States.
International Building Code (IBC)	Code establishing the minimum regulations for building systems using prescriptive and performance-related provisions
International Electrical Testing Association (NETA)	Establishes the standards for electrical system testing.
International Green Construction Code (IGCC)	Code providing a comprehensive set of requirements intended to reduce the negative impact of buildings on the natural environment.
International Mechanical Code (IMC)	Code establishing the minimum regulations for mechanical systems using prescriptive and performance-related provisions
International Plumbing Code (IPC)	Code establishing the minimum regulations for plumbing systems using prescriptive and performance-related provisions.
Manufacturers Standardization Society (MSS)	A non-profit technical association organized for development and improvement of industry, national and international codes and standards for: Valves, Valve Actuators, Pipe Fittings, Valve Modification, Flanges, Pipe Hangers, and Associated Seals

CODE/STANDARD/GUIDE	DESCRIPTION
National Design Specification (NDS) for Wood Construction	This specification is used to design wood structures and is dual formatted to include both allowable stress design (ASC) and load and resistance factor design (LRFD).
National Electrical Code (NEC, NFPA 70)	This code covers the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways.
National Electrical Manufacturers Association (NEMA)	Provides standards for products used in the generation, transmission, power distribution, control, and end use of electricity.
National Electrical Safety Code (NESC)	Consensus codes and standards intended to minimize the possibility and effects of fire and other related risks; includes but is not limited to the Life Safety Code, National Electrical Code, etc.
NETA (International Electrical Testing Association)	An accredited standards developer for the American National Standards Institute (ANSI) and defines the standards by which electrical equipment is deemed safe and reliable.
National Fire Protection Association (NFPA)	Consensus codes and standards intended to minimize the possibility and effects of fire and other related risks.
National Institute of Standards and Technology (NIST)	Establishes standards for measurements.
Nationally Recognized Testing Laboratories (NRTLs)	The Nationally Recognized Testing Laboratory (NRTL) Program is a part of OSHA's Directorate of Technical Support and Emergency Management. The Program recognizes private sector organizations as NRTLs, and recognition signifies that an organization has met the necessary qualifications specified in the regulations for the Program. The NRTL determines that specific equipment and materials ("products") meet consensus-based standards of safety to provide the assurance, required by OSHA, that these products are safe for use in the U.S. workplace.
Secretary of the Interior's Standards for the Treatment of Historic Properties	These standards are intended to promote responsible preservation practices that help protect our Nation's irreplaceable cultural resources.
Sheet Metal & Air Conditioning Contractors' National Association (SMACNA)	Guidelines for basic methods and procedures to design and attach HVAC air distribution systems, including ducts, piping, and conduits.
Steel Deck Institute (SDI) Specification and Commentaries for Steel Form Deck	Aide and general guide manual for the safe and proper erection of steel form deck.

CODE/STANDARD/GUIDE	DESCRIPTION
Steel Joist Institute (SJI)	Covers the design, manufacture, application, and erection stability and handling of Open Web Steel Joists K-series in building or other structures.
Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA)	Set of three telecommunications standards addressing commercial building cabling for telecom products and services
Underwriter Laboratories Inc. (UL)	Provides world-class safety certifications, standards, and technical information on products regulated by these codes: contractor certification, exterior walls, fire protection, fire-resistance and smoke protection, interior finish materials, means of egress, plastic and foamed plastic materials, and roof assemblies.

2.4 STATE AND LOCAL CODES

NASA will ensure designs meet or exceed locally adopted, nationally recognized model building codes, including electrical, fire and life safety, and plumbing codes. Legally, buildings built on NASA (i.e. Federal) property are exempt from State and local building codes. In cases where local jurisdiction has adopted a code that is not nationally recognized, NASA will follow those codes to the maximum extent practicable, but in all cases will also ensure the design meets or exceeds the International Building Code from the International Code Council.

3. Executive Orders, Federal Laws, Regulations, & Federal Guidance

3.1 POLICY

It is NASA's policy to meet to the full extent all Executive Orders and Federal Laws and Regulations relevant to the construction of NASA facilities in order to meet NASA's primary core value of Safety. NASA is committed to protecting the safety and health of the public, our team members, and those assets that the Nation has entrusted to us.

3.2 DEFINITIONS

Executive Orders (EO) - used by the President to direct Executive Branch Federal agencies in their fulfillment of congressionally mandated actions (laws and/or policies). EOs do not require congressional approval to take effect, but are legally binding and have equal legal weight to laws passed by Congress. Presidential authority to issue EOs is established in Article II, Section 1 of the constitution (which grants the President "executive power") and Article II, Section 3 (which directs the President to "take care that the Laws be faithfully executed." Executive Orders in general provide guidance for expected actions, not quantitative requirements to be enforced.

Federal Laws and Regulations - those requirements imposed by the direct action of Congress, or by Federal Agencies acting at the direction of Congress.

3.3 EXECUTIVE ORDERS

Table 3-1 lists key Executive Orders. The status of these Executive Orders (if they have been amended or revoked) should be verified before they are used. That can be done by going to http://www.archives.gov/Federal-register/executive-orders/disposition.html and looking up the Executive Order Number of interest.

TABLE 3-1: EXECUTIVE ORDERS

EXECUTIVE ORDER	DESCRIPTION
11514 Protection and Enhancement of Environmental Quality	Administrative monitoring to assure construction doesn't adversely affect the environment

EXECUTIVE ORDER	DESCRIPTION
11593 Protection and Enhancement of the Cultural Environment	Federally owned sites, structures, and objects of historical, architectural or archaeological significance are to be preserved, restored, and maintained for the inspiration and benefit of the people
11988 Floodplain Management	Construction will avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains
11990 Protection of Wetlands	Construction will not adversely impact wetlands
11991 Environmental Impact Statements	Make the EIS process more useful to decision makers
12072 Federal Space Management	Federal facilities are to be attractive places to work and conserve urban resources
12114 Environmental Effects Abroad of Major Federal Facilities	Be concerned for the environmental impact of facilities built outside of the United States
12196 Occupational Safety and Health Programs for Federal Employees	Federal agencies are to furnish to employees places and conditions of employment that are free from recognized hazards, operate an occupational safety and health program, assure prompt abatement of unsafe or unhealthy working conditions, etc.
12699 Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction	Reduce risk to the lives of Federal building occupants from earthquakes
12893 Principles for Federal Infrastructure Investments	Systems analysis of expected benefits and cost of Federal infrastructure (water resources, energy, and environment) and efficient management of same
12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	Federal agencies are to conduct their programs, policies, and activities affect human health or the environment to ensure that they do not have the effect of excluding persons from participation or benefits or of discrimination.
12941 Seismic Safety of Existing Federally Owned or Leased Buildings	Adoption of "minimum standards" for existing Federal facilities and their upgrade to meet them.
12962 Recreational Fisheries	Federal Agencies are to foster sound aquatic conservation and restoration endeavors to benefit recreational fisheries
13006 Locating Federal Facilities on Historical Properties in our Nations Central Cities	Select location of Federal facilities to revitalize the central cities business areas
13007 Indian Sacred Sites	In selecting the location of Federal construction activity, adverse effects on the physical integrity of Indian sacred sites are to be avoided, and their confidentiality maintained
13045 Protection of Children from Environmental Health Risks and Safety Risks	Each Federal Agency will make certain that its policies, programs, and activities identify, assess, and address environmental health and safety risks that may disproportionately affect children

EXECUTIVE ORDER	DESCRIPTION
13112 Invasive Species	Federal agencies are to prevent the introduction of invasive species, to provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause
13132 Federalism	Federal agencies are to consider State Laws and to have an accountable process to ensure meaningful and timely input by State and local officials in the development and implementation of policies
13158 Marine Protected Areas	Federal agency actions are to avoid harm to the natural and cultural resources that have been designated a Marine Protected Area (MPA).
13175 Consultation and Coordination with Indian Tribal Governments	Federal Agencies are to consult with Federally recognized Tribal governments on programs, policies, and activities that may affect Tribal government interests, such as, building on or near a sacred site.
13186 Responsibilities of Federal Agencies to Protect Migratory Birds	In their land management and environmental quality planning, Agencies are to avoid/minimize adverse impacts on and to prevent/abate pollution or detrimental alteration of the environment of migratory bird resources.
13211 Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use	Agencies are to prepare a Statement of Energy Effects when undertaking an action that could have an adverse effect of energy supply, distribution, or use (including a shortfall in supply, pric3e increases, and increased use of foreign supplies), including reasonable alternatives to the action and the expected effects of such alternatives.
13212 Actions to Expedite Energy-Related Projects	For energy-related projects, agencies are to expedite their review of permits or take other actions as necessary to accelerate the completion of such projects.
13221 Energy Efficient Standby Power Devices	When purchasing commercially available, off-the-shelf products that use external standby power devices, or that contain an internal standby power function, purchase products that use no more than one watt in their standby power consuming mode
13231 Critical Infrastructure Protection in the Information Age	Continuous efforts are to be made to secure information systems for critical infrastructure, including emergency preparedness communications, and the physical assets that support such systems.
13287 Preserve America	Protection, enhancement, and use of Federally owned historical properties
13327 Federal Real Property Asset Management	Promote efficient and economical use of real property owned by the Federal Government

EXECUTIVE ORDER	DESCRIPTION
13347 Individuals with Disabilities in Emergency Preparedness	The unique needs of agency employees with disabilities and individuals with disabilities whom the agency serves are to be considered in emergency preparedness planning.
13352 Facilitation of Cooperative Conservation	Laws relating to the environment and natural resources are to be implemented in a manner that promotes cooperative conservation, with an emphasis on the appropriate inclusion of local participation in Federal decision-making.
13423 Strengthening Federal Environmental, Energy, and Transportation Management	New construction and major renovation projects are to comply with the Federal Leadership in High Performance and Sustainable Buildings MOU (2006)
13486 Strengthening Laboratory Biosecurity in the United States	Facilities that possess biological select agents and toxins are to have appropriate security and personnel assurance practices to protect against theft, misuse, or diversion to unlawful activity of such agents and toxins.
13514 Federal Leadership in Environmental, Energy, and Economic Performance	The Federal Government is to lead the creation of a clean energy economy through its construction activities
13547 Stewardship of the Ocean, Our Coasts, and the Great Lakes	Federal Agencies are to exercise stewardship of oceans, coasts, and the Great Lakes by protecting, maintaining, and restoring their health and biological diversity.

3.4 FEDERAL LAWS

Key applicable Federal laws are listed in Table 3-2.

TABLE 3-2: FEDERAL LAWS

FEDERAL LAW	DESCRIPTION
Americans with Disabilities Act of 1990	This Act was enacted by U.S. Congress in 1990 to provide a clear and comprehensive national mandate for the elimination of discrimination against individuals with disabilities, to provide clear, strong, consistent, enforceable standards addressing discrimination against individuals with disabilities, to ensure that the Federal Government plays a central role in enforcing the standards established on behalf of individuals with disabilities, and to invoke the sweep of congressional authority, including the power to enforce the Fourteenth Amendment and to regulate commerce, in order to address the major areas of discrimination faced day-to-day by people with disabilities.

FEDERAL LAW	DESCRIPTION
American Indian Religious Freedom Act	This Act was enacted August 11, 1978 to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiians, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.
Archaeological and Historic Protection Act	An Act to provide for the preservation of historic American sites, buildings, objects, and antiquities of national significance, and for other purposes, by specifically providing for the preservation of historical and archeological data (including relics and specimens) which might otherwise be irreparably lost or destroyed as the result of flooding, the building of access roads, the erection of workmen's communities, the relocation of railroads and highways, and other alterations of the terrain caused by the construction of a dam by any agency of the United States, or by any private person or corporation holding a license issued by any such agency or any alteration of the terrain caused as a result of any Federal construction project or federally licensed activity or program.
Archaeological Resources Protection Act	The purpose of this Act is to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands, and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals having collections of archaeological resources and data which were obtained before October 31, 1979 [the date of the enactment of this Act].
Architectural Barriers Act	The ABA (1968) addresses access to the built environment and requires facilities designed, built, altered, or leased with Federal funds to be accessible according to established standards. Under the ABA, the Access Board maintains accessibility guidelines upon which the ABA standards are based and enforces these standards through the investigation of complaints.
Bald and Golden Eagle Protection Act	The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs.
Comprehensive Environmental Response, Compensation and Liability Act	This Act created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.
Coastal Zone Management Act	This Act established a voluntary national program within the Department of Commerce to encourage coastal States to develop and implement coastal zone management plans and a system of criteria and standards for requiring that Federal actions be conducted in a manner consistent with the Federally approved plan.

FEDERAL LAW	DESCRIPTION
Emergency Planning and Community Right-To-Know Act (EPCRA)	The objective of the Emergency Planning and Community Right-To-Know Act (EPCRA) is to: allow state and local planning for chemical emergencies, provide for notification of emergency releases of chemicals, and address communities' right-to-know about toxic and hazardous chemicals.
Endangered Species Act	Through federal action and by encouraging the establishment of state programs, the 1973 Endangered Species Act provided for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.
Energy Independence and Security Act of 2007 (EISA 2007)	This Act includes the goal of moving the United States toward greater energy independence and security; increasing the production of clean renewable fuels; increasing efficiency of products, buildings, and vehicles; promoting research and development of greenhouse gas capture and storage options; and improving the energy performance of the Federal government. It requires greater tracking of green initiatives in Federal facilities and provides new oversight of Federal high performance and green building activities.
Energy Policy Act of 2005 (EPAct 2005)	Ensures jobs for the future with secure, affordable, and reliable energy and updates polices from EPAct 1992 by providing revised annual energy reduction goals for Federal facilities and revises renewable energy purchase goals. EPAct 2005 also reauthorizes the use of Energy Savings Performance Contracts (ESPC) through 2016. It requires procurement of energy efficient products and provides updated Federal green building standards with emphasis on energy efficiency and sustainable design principles.
Federal Facilities Compliance Act	This Act amends the Solid Waste Disposal Act to clarify provisions concerning the application of certain requirement and sanctions to Federal facilities.
Federal Water Pollution Control Act (Clean Water Act)	This Act established the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters.
Fish and Wildlife Coordination Act	The Act authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.
Historic Sites Act	This Act establishes a national policy to preserve for public use, historic sites, buildings, and objects of national significance for the inspiration and benefit of the American people. The Act authorizes the designation of national historic sites and landmarks, authorizes interagency efforts to preserve historic resources, and establishes a maximum fine of $500 for violations of the Act.

FEDERAL LAW	DESCRIPTION
Marine Mammal Protection Act (MMPA)	This Act calls specifically for an ecosystem approach to natural resource management and conservation. MMPA prohibits the taking of marine mammals, and enacts a moratorium on the import, export, and sale of any marine mammal, along with any marine mammal part or product within the United States.
Migratory Bird Treaty Act	Act for the protection of migratory birds.
National Defense Authorization Act (NDAA) for Fiscal Year 2007	This Act relates to the potential use of energy conservation measures and renewable energy systems, energy savings and renewable energy opportunities in the areas of facility infrastructure, energy supply and transmission systems, and vehicles at joint military bases.
National Environmental Policy Act (NEPA)	This Act established a national policy for the environment - establishing procedures for evaluating the potential environmental impacts of a proposed program, project, or activity; assuring public involvement and interagency/intergovernmental notice and comment before final agency action; and in the case of emergency, alternative procedures.
National Historic Preservation Act	An Act to establish a program for the preservation of historic properties and archaeological sites in the United States. Federal agencies are directed to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register.
Native American Graves Protection and Repatriation Act (NAGPRA)	This Act is to provide for the protection of Native American graves, establishing requirements for the treatment of Native American human remains and sacred or cultural objects found of federal lands.
Resource Conservation and Recovery Act (RCRA) 6002	This Act prohibits federal agencies from disposing of hazardous and non-hazardous solid waste, including construction and demolition debris except under specified conditions. Federal agencies are also required to handle hazardous materials, such as solvents and paints, in a specified manner.
Rivers and Harbors Act	This Act regulates placement of material or objects such as docks and bridges, in rivers and harbors.
Safe Drinking Water Act	This Act regulates drinking water systems.
Toxic Substances Control Act	This Act sets forth requirements for management of lead, asbestos, PCBs, and other toxic substances.

3.5 FEDERAL REGULATIONS

The Code of Federal Regulations (CFR) is the codification of the general and permanent rules published in the Federal Register by the departments and agencies of the Federal Government. Key applicable Federal regulations are listed in Table 3-3.

TABLE 3-3: FEDERAL REGULATIONS

FEDERAL REGULATION	DESCRIPTION
10 CFR 433 Energy Efficiency Standards for New Federal Commercial and Multi-Family High Rise Residential Buildings	This regulation establishes energy-efficiency performance standards for new Federal commercial and multi-family high-rise buildings, for which design for construction began on or after January 3, 2007.
10 CFR 434 Energy Code for New Federal Commercial and Multi-Family High-Rise Residential Buildings	This regulation is designed to achieve the maximum practicable improvements in energy efficiency and increases in the use of non-depletable sources of energy.
10 CFR 436 Federal Energy Management and Planning Programs	Sets forth the rules for Federal energy management and planning programs to reduce Federal energy consumption and to promote life cycle cost effective investments in building energy systems, water systems, and energy and water conservation measures.
14 CFR 1216.3 Procedures for Implementing NEPA (NASA Regulations)	NASA procedures implementing the provisions of section 102(2) of the National Environmental Policy Act (NEPA). The NASA procedures supplement the regulations of the Council on Environmental Quality (43 FR 55978) that establish uniform procedures for implementing those provisions of NEPA.
14 CFR 1251.302 Nondiscrimination on the Basis of Handicap	This regulation effectuates section 504 of the Rehabilitation Act of 1973, which is designed to eliminate discrimination on the basis of handicap in any program or activity receiving Federal financial assistance.
29 CFR 1910 Occupational Safety and Health Standards for General Industry	This regulation provides for occupational safety and health standards for general industry work places.
29 CFR 1926 Occupational Safety and Health Standards for Construction	This regulation provides for occupational safety and health standards for construction industry work places.
36 CFR 61 Procedures for State, Tribal, and Local Government Historic Preservation Programs	Requires the Secretary of the Interior (Secretary) to promulgate regulations for Approving and overseeing State historic preservation programs; certifying local governments to carry out the purposes of the Act; ensuring that applicable State Historic Preservation Officers (SHPOs) allocate to certified local governments (CLGs) a share of grants that the SHPOs receive under the Act; and assisting Indian tribes in preserving their particular ‘‘historic properties’’.
36 CFR 65 National Historic Landmarks Program	The purpose of the National Historic Landmarks Program is to identify and designate National Historic Landmarks, and encourage the long-range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States. These regulations set forth the criteria for establishing national significance and the procedures used by the Department of the Interior for conducting the National Historic Landmarks Program.

FEDERAL REGULATION	DESCRIPTION
36 CFR 79 Curation of Federally-Owned and Administered Archeological Collections	The regulations establish definitions, standards, procedures and guidelines to be followed by Federal agencies to preserve collections of prehistoric and historic material remains, and associated records, recovered under the authority of the Antiquities Act, the Reservoir Salvage Act, the National Historic Preservation Act or the Archaeological Resources Protection Act.
36 CFR 800 Protection of Historic Properties	The National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties and afford the Council a reasonable opportunity to comment on such undertakings. The procedures in this part define how Federal agencies meet these statutory responsibilities.
40 CFR 50 National Primary and Secondary Ambient Air Quality Standards	These standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health and protect the public welfare from any known or anticipated adverse effects of a pollutant.
40 CFR 51 Requirements for Preparation, Adoption and Submittal of Implementation Plans	Requires States to inventory emission sources located on nontribal lands and report this information to EPA.
40 CFR 60 Standards of Performance for New Stationary Sources	Defines standards of permanence for any building, structure, facility, or installation that emits or may emit any air pollutant.
40 CFR 61 National Emission Standards for Hazardous Air Pollutants	Building, structure, facility, or installation standards for hazardous air pollutants.
40 CFR 82 Protection of Stratospheric Ozone	Implement the Montreal Protocol on Substances that Deplete the Ozone Layer and sections 602, 603, 604, 605, 606, 607, 614 and 616 of the Clean Air Act Amendments of 1990, Public Law 101–549. The Protocol and section 604 impose limits on the production and consumption (defined as production plus imports minus exports, excluding transshipments and used controlled substances) of certain ozone-depleting substances, according to specified schedules.
40 CFR 93 Determining Conformity of Federal Actions to State or Federal Implementation Plans	Implement section 176(c) of the Clean Air Act (CAA), as amended (42 U.S.C. 7401 et seq.), and the related requirements of 23 U.S.C. 109(j), with respect to the conformity of transportation plans, programs, and projects which are developed, funded, or approved by the United States Department of Transportation (DOT), and by metropolitan planning organizations (MPOs) or other recipients of funds under title 23 U.S.C. or the Federal Transit Laws (49 U.S.C. Chapter 53).
40 CFR 260-299 Solid Wastes	Environmental Protection Agency regulations for hazardous and solid wastes

FEDERAL REGULATION	DESCRIPTION
40 CFR 300-399 Superfund, Emergency Planning and Community Right-to-Know Programs	The purpose of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) is to provide the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.
40 CFR 401-403 Effluent Guidelines and Standards	Prescribe effluent limitations guidelines for existing sources, standards of performance for new sources and pretreatment standards for new and existing sources pursuant to sections 301, 304 (b) and (c), 306 (b) and (c), 307 (b) and (c) and 316(b) of the Federal Water Pollution Control Act, as amended (the "Act"), 33 U.S.C. 1251, 1311, 1314 (b) and (c), 1316 (b) and (c), 1317 (b) and (c) and 1326(b); 86 Stat. 816; Pub. L. 92–500.
40 CFR 1500-1508 Council on Environmental Quality Regulations for Implementing NEPA	The National Environmental Policy Act (NEPA) is our basic national charter for protection of the environment. It establishes policy, sets goals (section 101), and provides means (section 102) for carrying out the policy. Section 102(2) contains "action-forcing" provisions to make sure that federal agencies act according to the letter and spirit of the Act. The regulations that follow implement section 102(2). Their purpose is to tell federal agencies what they are to do to comply with the procedures and achieve the goals of the Act. The President, the federal agencies, and the courts share responsibility for enforcing the Act so as to achieve the substantive requirements of section 101.
41 CFR 102-80 Safety and Environmental Management	Prescribes the basic safety and environmental management policies and responsibilities for real property that are intended to apply to GSA or those Federal agencies operating in GSA space pursuant to a GSA delegation of authority.
48 CFR 23 Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace	This regulation prescribes acquisition polices to support the government's program for protecting and improving the quality of the environment by controlling pollution; efficiently managing energy and water use in Federal facilities; using renewable energy and renewable energy technologies; and acquiring energy- and water-efficient products and services, environmentally preferable products, and products using recovered materials.

3.6 OTHER FEDERAL GUIDANCE

Additional key applicable Federal guidance documents are listed in Table 3-4.

TABLE 3-4: OTHER FEDERAL GUIDANCE DOCUMENTS

TITLE	DESCRIPTION
Contaminant Candidate List 3 -CCL	CCL 3 is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, that are known or anticipated to occur in public water systems, and which may require regulation under the Safe Drinking Water Act (SDWA).
Council on Environmental Quality Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts	The Council on Environmental Quality (CEQ) provides this draft guidance memorandum for public consideration and comment on the ways in which Federal agencies can improve their consideration of the effects of greenhouse gas (GHG) emissions1 and climate change in their evaluation of proposals for Federal actions under the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321 et seq.
Council on Environmental Quality Enhanced Public Tools for Reporting on NEPA Activities	CEQ continues to upgrade this site to include the status of reviews of agency NEPA guidance, Recovery Act NEPA reporting, and real-time NEPA review status. These upgrades are designed to improve public participation and the quality of Federal agency administration of NEPA.
Council on Environmental Quality Final Guidance Clarifying Use of Categorical Exclusions	The guidance recommends best practices for appropriate use of categorical exclusions and was developed as part of CEQ's effort to modernize and reinvigorate Federal agency implementation of NEPA. It was designed to ensure that agencies establish and use categorical exclusions appropriately and transparently. It also calls on agencies to review their existing categorical exclusions periodically to avoid the use of outdated NEPA procedures.
Council on Environmental Quality Final Guidance Clarifying Appropriateness of "Findings of No Significant Impact" and Specifying When There is a Need to Monitor Environmental Mitigation Commitments	The guidance clarifies that the environmental impacts of a proposed action may be mitigated to the point when the agency may make a FONSI determination. When the FONSI depends on successful mitigation, however, such mitigation requirements should be made public and be accompanied by monitoring and reporting.
Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)	Establishes energy-efficiency performance standards for new Federal commercial and multi-family high-rise buildings, for which design for construction began on or after January 3, 2007.
Groundwater Rule	The purpose of the rule is to provide for increased protection against microbial pathogens in public water systems that use ground water sources. EPA is particularly concerned about ground water systems that are susceptible to fecal contamination since disease-causing pathogens may be found in fecal contamination.

TITLE	DESCRIPTION
Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings	Provides direction to facility planners, designers, and managers regarding integrated design and maintenance, energy performance, water conservation, indoor environmental quality, as well as materials and resource use. This document is split into two sections: the Guiding Principles for Sustainable New Construction and Major Renovation and the Guiding Principles for Sustainable Existing Buildings.
ISC Security Design Criteria for New Federal Office and Major Projects	Ensures that security becomes an integral part of the planning, design, and construction of new Federal office buildings and major modernization projects. The criteria consider security in all building systems and elements.
Manual of Uniform Traffic Control Devices (USDOT/FHWA)	MUTCD defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic. The MUTCS is published by the Federal Highway Administration (FHWA) under 23 Code of Federal Regulations (CFR), Part 655, Subpart F.
Office of Management and Budget Scorecards	Introduced scorecards for Energy and Environmental Stewardship to track how well Agencies are executing targeted government-wide management initiatives. The Energy Scorecard tracks renewable energy projects, renewable energy purchase, energy-use reduction, energy auditing, ESPCs, and Utility Energy Services Contracts (UESC), sustainable design principles, and training for staff relating to energy efficiency. The Environmental Stewardship Scorecard tracks Agency progress on meeting EMS protocol, comprehensive green purchasing, green building, electronic stewardship, and compliance with management plan goals.
Radionuclide Rule	Rule requiring new monitoring provisions to ensure that all customers of community water systems will receive water that meets the Maximum Contaminant Levels for radionuclides in drinking water.
Radon Rule	Rule to reduce the public health risk from radon
Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation	These guidelines show how Federal agencies should address various requirements and guidelines; statutory authorities, regulations, or The Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation; in carrying out their responsibilities under the National Historic Preservation Act.
Statement of Federal Financial Accounting Standards 29, Heritage Assets and Stewardship Land .	This standard reclassifies all heritage assets and stewardship land information as basic except for condition information, which is reclassified as required supplementary information (RSI). This Standard requires that entities reference a note on the balance sheet that discloses information about heritage assets and stewardship land, but no asset dollar amount should be shown.

TITLE	DESCRIPTION
Storm water Management for Construction Activities, Document No. EPA-832-R-92-005, Chapter 3	The manual below provides detailed guidance on the identification of best management practices (BMPs) for construction activities and development of storm water pollution prevention plans (SWPPP).
Standards of Seismic Safety for Existing Federally Owned or Leased Buildings	These standards identify common minimum evaluation and mitigation measures for all Federal departments and agencies and ensure that all Federal entities have a balanced, agency-conceived and controlled seismic safety program for their existing owned or leased buildings.
Technical Guidance on Implementing the Storm water Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act	The purpose of this document is to provide technical guidance and background information to assist federal agencies in implementing EISA Section 438.
Whole Building Design Guide	The WBDG is the only web-based portal providing government and industry practitioners with one-stop access to up-to-date information on a wide range of building-related guidance, criteria and technology from a 'whole buildings' perspective.

4. NASA Policy Directives (NPD), Procedural Requirements (NPR), Standards & Internal Documents

4.1 POLICY

NASA Agency level directives take precedence over all other internal NASA published requirements whether Agency level or Center level. The order of precedence for NASA Directives and the definition of the types of NASA directives are established in NPD 1400.1 – Documentation and Promulgation of Internal NASA Requirements – as follows:

- NPD 1000.1 NASA Strategic Plan
- NPD 1000.2 NASA Strategic Management Handbook
- NPD 1000.3 NASA Organization

4.2 DEFINITIONS

NASA Policy Directives (NPDs) are defined as policy statements that describe what is required by NASA Management to achieve NASA's vision, mission, and external mandates and who is responsible for carrying out those requirements.

NASA Procedural Requirements (NPRs) are defined as Agency mandatory instructions and requirements to implement NASA Policy and delineated in an associated NPR.

NASA Technical Standards (NASA STD) are documents that contain common and repeated use rules, conditions, guidelines, or characteristics for products or related processes and production methods and related management systems practices. "Standard" may include: codes, guidebooks, handbooks, specifications, and standards.

NASA Internal Documents include, but are not limited to, NASA Technical Standards, Plans, Manuals, Work Instructions, and Agreements.

4.3 NASA POLICY DIRECTIVES

Table 4-1 lists the applicable NASA policy directives. The official versions of these directives are on NASA's Online Directives Information System – Document Management System (NODIS-DMS).

TABLE 4-1: NASA POLICY DIRECTIVES (NPD)

NPD	DESCRIPTION
NPD 1440.6 NASA Records Management	Managers are to ensure execution of NASA records management functions as described in NPR 1441.1.
NPD 1600.2 National Security Policy	Directs the use of facility construction standards and guidelines that adequately address physical security and antiterrorism
NPD 1800.2 NASA Occupational Health Program	Requires support of National Security Programs
NPD 2081.1 Nondiscrimination in Federally Assisted and conducted Programs of NASA	Federal employees who have disabilities are to have access comparable to the access of those who do not have disabilities
NPD 3713.8 Provision of Reasonable Accommodation for Individuals with Disabilities	Assure that individuals with disabilities enjoy full access to equal employment opportunity at NASA
NPD 7330.1 Approval Authorities for Facilities Projects	Establishes responsibilities for approving Facility projects
NPD 8500.1 NASA Environmental Management	Applies EO No. 13423
NPD 8700.1 NASA Policy for Safety and Mission Success	Protect the public, workforce, high-value equipment, and property
NPD 8710.5 Policy for Pressure Vessels and Pressurized Systems	Imposes NASA STD 8719.17 as a requirement
NPD 8800.14 Policy for Real Property Management	Management guidance
NPD 8810.2 Master Planning for Real Property	Planning guidance
NPD 8820.2 Design and Construction of Facilities	Use industry-best practices, applies physical security requirements which are post construction
NPD 8831.1 Maintenance and Operations of Institutional and Program Facilities and Related Equipment	Post construction, unless some practices impact the design and construction

4.4 NASA PROCEDURAL REQUIREMENTS

Table 4- 2 lists applicable NASA procedural requirements. The official versions of these requirements are on NASA's Online Directives Information System – Document Management System (NODIS-DMS).

TABLE 4-2: NASA PROCEDURAL REQUIREMENTS (NPR)

NPR	DESCRIPTION
NPR 1441.1 NASA Records Retention Schedules	Sets forth the retention periods of Federal records of the National Aeronautics and Space Administration (NASA).
NPR 1600.1 National Security Program Procedural	Requirements Chapter 7 delineates Physical Security requirements
NPR 1800.1 NASA Occupational Health Program Procedures	Chapter 4 addresses personal environmental health
NPR 2081.1 Nondiscrimination in Federally Assisted and Conducted Programs	Provides for complaint procedures
NPR 3713.1 Reasonable Accommodations Procedures	Establishes request and processing requirements for reasonable accommodations
NPR 4310.1 Identification and Disposition of NASA Artifacts	Provides procedures and guidance for the identification, reporting, transfer, or disposal of NASA articles, equipment and hardware of historical interest.
NPR 7120.5 NASA Space Flight Program and Project Management Requirements	Establishes the requirements by which NASA formulates and implements space flight programs and projects
NPR 7120.7 NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements	How to manage facility construction projects
NPR 8000.4 Agency Risk Management Procedural Requirements	Provides the requirements for risk management for the Agency, its institutions, and its programs and projects
NPR 8530.1 Affirmative Procurement Program and Plan for Environmental Preferable Products	Defines how the procurement of environmentally friendly products is to be done
NPR 8553.1 NASA Environmental Management System	General environmental management issues
NPR 8570.1 Energy Efficiency and Water Conservation	Directs implementation of cost-effective energy efficiency, renewable energy, and water conservation measures (not specifically stated)

NPR	DESCRIPTION
NPR 8580.1 Implementing The National Environmental Policy Act and Executive Order 12114	Meeting NEPA requirements and EO No. 12114 (which addresses facility requirements outside the United States)
NPR 8590.1 NASA Environmental Compliance and Restoration (ECR) Program	Requirements for managing an ECR program
NPR 8715.1 NASA Occupational Safety and Health Program	Provides details on how NASA is to implement Federal occupational safety and health regulations.
NPR 8715.3 NASA General Safety Program Requirements	Chapter 3 (operational), 5 (fire), and 8 (facility construction & activation)
NPR 8800.15 Real Estate Management Program	Chapter 4 (acquisition) and 5 (space)
NPR 8810.1 Master Planning Procedural Requirements	Master Plan development
NPR 8820.2 Facility Project Requirements	Minimum requirements for planning, design, construction, and activation of a facility
NPR 8831.2 Facilities Maintenance and Operations Management	Facility maintenance not construction, unless some maintenance issues affect the facility design and construction.

4.5 NASA TECHNICAL STANDARDS

Table 4-3 lists applicable NASA technical standards.

TABLE 4-3: NASA TECHNICAL STANDARDS

NASA STANDARD	DESCRIPTION
NASA STD 005 NASA Configuration Management (CM) Standard	Provides 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.
NASA STD 8719.7 Facility Systems Safety Guidebook	Guide for implementing a Facility system safety program
NASA STD 8719.9 Standard for Lifting Devices and Equipment	Establishes uniform design, testing, inspection, maintenance, operational, personnel certification, and marking requirements for lifting devices and associated equipment used in support of NASA operations.
NASA STD 8719.11 Safety Standards for Fire Protection	Planning, architecture, structure, mechanical, electrical, occupancy, service issues related to fire, Life Safety, Structural, Civil, Site Planning, Fire Operations, etc.

NASA STANDARD	DESCRIPTION
NASA STD 8719.12 Safety Standards for Explosives, Propellants, and Pyrotechnics	Safety standards/procedures for operations involving explosives handling and processing
NASA STD 8719.17 NASA Requirements for Ground Based Pressure Vessels and Pressurized Systems	All requirements related to pressure vessels and pressurized systems

4.6 NASA INTERNAL DOCUMENTS

Table 4-4 lists applicable NASA internal documents.

TABLE 4-4: NASA INTERNAL STANDARDS

INTERNAL DOCUMENT	DESCRIPTION
NASA Sustainable Policy Handbook for Facilities	Gives clarity to how High Performance and Sustainable Building (HPSB) principles can be uniformly applied throughout NASA's facility inventory and provides a collection of best practices within the NASA Centers through illustrative examples of concept strategies. The handbook is intentionally organized around the five guiding principles of HPSBs: ▪ Employ Integrated Principles ▪ Optimize Energy Performance ▪ Protect and Conserve Water ▪ Enhance Indoor Environmental Quality ▪ Reduce the Environmental Impact of Materials
NASA 2011 Strategic Sustainability Performance Plan	Outlines NASA 's climate change adaptation policy of applying NASA's scientific expertise and products by incorporating climate information into NASA's decision-making and planning, creating innovative, sustainable and flexible solutions, and sharing best practices. To implement this policy, NASA commits to: ▪ Undertake climate adaptation planning and apply the best science expertise and information available. ▪ Apply the "guiding principles" and planning "flexible framework" for climate change adaptation developed by the Interagency Climate Change Adaptation Task Force. ▪ Integrate climate adaptation planning and actions into agency programs, policies and operations. ▪ Consider potential climate impacts in long-term planning, setting priorities for scientific research and investigations, and making decisions affecting the agency resources, programs,

INTERNAL DOCUMENT	DESCRIPTION
	policies, and operations. ▪ Develop an agency-wide adaptation plan. ▪ Coordinate with other agencies and interagency efforts, nationally and internationally, on climate change adaptation issues, and share climate change adaptation planning information with the world
NASA Environmental Justice Strategy	This strategy provides a broad framework of the items to be accomplished by each Center to achieve Environmental Justice and ensures the integration of environmental justice into NASA's programs, policies, and activities. The strategy remains in effect and applies to NASA NEPA programs and actions.
NASA Non-Discrimination Regulations for Federally Assisted Programs	This Directive sets forth NASA's policy and establishes responsibilities to ensure nondiscrimination in Federally assisted and conducted programs of NASA, nondiscrimination in Federally conducted education and training programs, and access for individuals with disabilities to Federal electronic and information technology
NASA Partnering Guide	Provides principles and techniques which when used will help a project to apply Partnering effectively, thus achieving mutually beneficial goals.
NASA Reliability Centered Building & Equipment Acceptance (RCB&EA) Guide	Provides acceptance criteria guidelines for equipment associated with new construction, repair, or rehabilitation projects.

5. Civil, Site, & Landscape Design

5.1 DESIGN PHILOSOPHY

5.1.1 GOALS AND OBJECTIVES

All projects should incorporate harmony among elements on site and between the site and its surroundings. The quality of the site design should be a direct extension of the building design and should complement the surrounding urban landscape, in terms of conservation, and environmentally responsible practices. NASA adopts a "good neighbor" policy to collaborate with local officials and implements local best design practices wherever practicable.

5.1.2 SITE PLANNING AND ANALYSIS

Successful site planning and site design requires a thorough review and understanding of existing site conditions, opportunities, and constraints. Site planning should be integrated with the design of the buildings, respect the surrounding context, and contribute to energy conservation and sustainability efforts. Prior to the start of design, perform a site inventory and analysis (site survey, geotechnical & groundwater investigations, etc.) and environmental review as required by the National Environmental Policy Act (NEPA). Follow the requirements of the Record of Environmental Consideration (REC) or Record of Decision (ROD) at all times.

5.1.3 GRADING

Site grading addresses the control of runoff, storm water management, and the manipulation of topography to improve the site. Preserve natural topography and existing vegetation, particularly mature healthy trees and plant specimens to the maximum extent possible. Slope areas adjacent to buildings and ground cover toward the nearest inlet with appropriate grades to prevent erosion. Slopes of walkways and ramps are to meet the requirements of the Architectural Barriers Act Accessibility Standard (ABAAS).

5.1.4 SITE UTILITIES

Coordinate the location of all new utilities with site design features and existing utilities. The designer is responsible for coordinating the utility design with local utility companies and/or other service providers.

Wherever possible, locate all utilities in unpaved areas. Follow NASA requirements on separation of water, storm and sanitary sewer lines. Do not locate manholes in main pedestrian walkways, plazas, or entry courts.

Follow all NASA and local water district authority requirements for water meters and backflow preventers. Consider loop-fed systems with multiple water connections on large buildings or campuses. Install dual-feed systems if required for the building occupancy. Design the water supply system to supply the required water flow for fire protection in accordance with NFPA 24.

5.1.5 STORM DRAINAGE

Design the storm water system capacity for a storm event as directed by NASA and local requirements. Use gravity flow for all storm drainage systems. Wherever possible, locate storm drainage pipes in unpaved areas. Discharge rainwater not collected for reuse from the building roof drainage system into the storm drainage system and design system to reduce or eliminate oils, greases and debris from entering the storm drainage system. Obtain any required local approvals for the storm water management plan. Site plans are to meet NASA, local, State and EPA best management practices, including Storm Water Management for Construction Activities, EPA Document No. EPA-832-R-92-005, Chapter 3.

5.1.6 PAVEMENT AND CURBS

Design pavements and curbs using local NASA design standards and materials. Choose materials suitable for the traffic volume, expected load and anticipated use conditions. Pave areas for truck maneuvering with concrete. Pavement markings are to comply with the Manual of Uniform Traffic Control Devices (MUTCD). Design walkways to be stable, firm, and slip resistant and drain to avoid accumulation of water. Walking surfaces for accessible routes are to comply with Architectural Barriers Act Accessibility Standard (ABAAS).

5.1.7 VEHICLE AND PEDESTRIAN CIRCULATION

Site circulation includes roadways, emergency accesses, driveways, building entries, parking, loading and service areas, sidewalks and pathways, and connections to public transit system. Design site circulation to segregate pedestrian access, vehicular access (including parking), and service vehicle access areas. Incorporate and coordinate emergency vehicle access with the local fire department. NASA encourages the use of public transportation. Consider access to public transportation early in the design process in coordination with regional planners.

5.1.8 SUSTAINABLE LANDSCAPING

Landscape design should be an integral part of the design concept for the project. Use sustainable landscape design principles; select regional plant materials, plant more heat and drought/flood tolerant trees, shrubs, and grasses to replace less tolerant species as the latter deteriorate, minimize the need for chemical supplements, and use bio based landscaping materials. Use low maintenance landscape materials and noninvasive xeriscape. Select plants with their mature size and growth habit in mind to avoid overplanting that may potentially conflict with other plants, structures, or underground utility lines. Use approved standards, prepared by the American Nursery and Landscape Association (AN SI Z60.1), for the selection of plant materials. If available, use non-potable water for irrigation and aim to reduce irrigation water consumption by a minimum of 50 percent over that consumed by conventional means. Design the irrigation system to prevent unnecessary water usage. Install smart controllers that use evapotranspiration and weather data to adjust irrigation schedules where required.

5.1.9 SITE FURNITURE, SIGNAGE AND LIGHTING

Site furniture, signage & lighting are included as part of the site design. These fixtures should be low maintenance and compatible in scale, style and color with the surrounding architecture and landscape. Wayfinding should be simple and clear. Generally, unobtrusive lighting and luminaires placement is preferred. Place luminaires to reduce direct glare and light pollution.

5.2 KEY CIVIL, SITE AND LANDSCAPE REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key civil, site and landscape requirements, regulations, standards and guidance for civil, site and landscape design are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary
- American Nursery and Landscape Association (ANSI Z60.1)
- ANSI 117.1 Accessibility Code
- Architectural Barriers Act Accessibility Standard (ABAAS)
- IESNA RP-33, Recommended Practice Lighting for Exterior Environments
- ISC Security Design Criteria for New Federal Buildings and Major Projects
- International Building Code (IBC)
- Manual of Uniform Traffic Control Devices (UDOT/FHWA)
- NFPA 24, Fire Protection & Life Safety

Federal Laws

- Energy Independence and Security Act of 2007 (EISA 2007)
- EPA Stormwater Management for Construction Activities, Doc. No. EPA-832-R-92-005, Chapter 3
- Federal Water Pollution Control Act (Clean Water Act),
- National Environmental Policy Act (NEPA)
- National Historic Preservation Act (NHPA)

Federal Regulations

- 29 CFR 1910, Occupational Safety and Health Standards (General Industry)
- 29 CFR 1926, Occupational Safety and Health Standards (Construction Industry)

Executive Orders

- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

NASA Standards

- NASA-STD-8719.11, Safety Standard for Fire Protection

6. Architecture & Interior Design

6.1 DESIGN PHILOSOPHY

6.1.1 GOALS AND OBJECTIVES

Having high performance buildings is a core principle to NASA. Due to the longevity of use of facilities at NASA centers, as much as fifty years or more, it is important for both architects and engineers to integrate several key goals and objectives when designing new or refurbishing existing structures for NASA. These include resiliency, robustness, flexibility, re-configurability, sustainability, maintainability, security, consistent aesthetic and material palettes, and whole building design integration. The architects and engineers should maximize compliance with these goals and objectives to the greatest extent possible.

6.1.2 FACILITY PLANNING

Facility planning is key to successfully meeting the goals of resiliency, robustness, flexibility, and re-configurability as well as designing for effective adjacencies of functional spaces. It is recommended the following components be integrated during this critical phase.

Visioning and Programming: NASA along with the architect and engineers should conduct a visioning session and programming interviews with key stakeholders.

Space Measurement and Building Efficiency: Building designs are to adhere to area types authorized in an approved prospectus and delineated in a program of requirements. The areas will be measured in accordance with the NASA space assignment requirements.

Core and Shell: For efficiency during facility planning, a standard module should be developed of the key core and shell elements; exterior envelope, base building and support systems, and common areas such as restrooms, pantries, elevators and stairs. Placement of non-occupied spaces such as electrical, mechanical, and IT rooms should also be considered in the planning stage. Attention should be given to stacking core elements in multi-story facilities.

Circulation: Locate and configure both the primary circulation, connecting the building's exits and all public spaces and secondary circulation, leading off of primary circulation, usually inside the tenant's space. The efficiency factor of both primary and secondary circulation types will be determined by core placement, depth, planning modules, and plan configuration. Attention should be given to determining the need for service corridors for efficient flow and separation of circulation types.

Wayfinding: Connect programmatic elements and clearly organize the building both horizontally and vertically. Circulation patterns are to be efficient and minimize travel distances. Wayfinding should be intuitive and not solely dependent upon signage. Avoid mazes of hallways and hidden corners.

Vertical Transportation: Perform a thorough vertical transportation traffic analysis of the facility to assist in the selection of the type and quantity of conveying systems, such as elevators, escalators, and wheelchair lifts.

6.1.3 EXTERIOR FACILITY DESIGN

The exterior envelope of both new or refurbishment of existing buildings will play an important role in the success of meeting all of the high performance goals of NASA. Consideration should be given during design to potential future expansion and final demolition of the facility. The following are recommendations to be considered when designing the exterior envelope:

Modularity: Create a consistent module of materials both in dimension and sequence for ease of exterior expansion and maintainability as well as consideration for construction costs.

Construction Materials and Systems: Integrate materials and systems that are appropriate to the individual NASA Center context and mission, are lasting, provide enduring quality, and require minimal maintenance. Whenever possible to the design and construction, utilize shop fabricated building components and systems.

High Performance: It is recommended for the envelope to be commissioned for validation of high performance, robustness, and resiliency. The commissioning at minimum should consist of sustainability, performance of the envelope to the local climate and weather, security, and the impact of the aesthetic to the site context, including any historic and functional requirements. Attention should be given to thermal conductivity within the exterior envelope.

6.1.4 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 architects, engineers, landscape architects, facilities management and the tenant 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 design should provide an effective workplace for NASA employees reflecting their culture, mission, business strategy, and the nature of their work. Effective ardencies of functional spaces should also be considered. When designing and planning the interior of facilities whether new, renovation or refurbishment, the following are recommended standards to incorporate:

Workplace Components: To facilitate flexible space planning, minimize fixed interior walls and partitions by choosing easily moveable and reconfigurable workplace components and furnishings. Where fixed private offices are required for managers or senior personnel, the office should be one standard size and minimize reconstruction.

Daylighting and Artificial Lighting: Use appropriate controls to balance daylighting, occupant needs, and energy efficiency. Design interior spaces to provide daylighting and views for the occupants. Maximize natural light in open spaces and avoid placing enclosed rooms along the perimeter at exterior windows. Maximize views of the exterior environment giving building occupants visual comfort along with physiological and psychological benefits. Consideration should be given during the design of the facility systems layout to maximizing the use of natural daylighting.

Storage and Resource Centers: Provide ergonomic, efficient, and centrally located resource centers and file storage.

Communication Technology Integration: Equip work settings to enable simultaneous voice, data, and video collaboration among distributed co-workers, local and remote.

Interior Finishes: Develop and establish Building Design Standards for the purpose of creating guidelines for all future interventions and alterations. This will ensure a cohesive, consistent, and streamlined approach for the building's long-term design.

Acoustics: Develop and establish acoustic provisions and requirements within the design for the following four concepts of acoustic quality: speech privacy, background noise, equipment vibration and reverberation, and exterior noise. It is recommended to perform post-construction commissioning to confirm that the established acoustical standards have been met. Design should minimize noise intrusion from mechanical equipment and external sources.

Speech Privacy: The degree to which a conversation cannot be overheard in an adjacent space.

Background Sound: Continuous background sound may have to be supplemented with additional electronically generated sound to provide for masking of speech while private conversation is being conducted. The architect should differentiate between enclosed and open office environments to meet these objectives.

Equipment Vibration and Reverberation: Office equipment noise levels are to meet the standards at the workstations. Reverberation and echoes are to be controlled in auditoriums, and conference, team, and training room spaces and may require professional acoustical engineers to meet the standards. Inhibit sound transmission through building frames as much as possible.

Exterior Noise: Facilities located near airports, highways, rail corridors, or other sources of significant environmental noise levels will require building envelope assemblies controlling noise intrusions to the required standards.

Interior Facility Elements: Accessibility is not only limited to the accommodations of individual person's needs, but also the ability for facility personnel to service and maintain the facility. It is recommended the design team, both architect and engineers evaluate and integrate early in the design the access needs and requirements for facility equipment such as air handling units, switchgear, and telecommunication racks as well as the parameters for corridors to provide proper access for maintenance.

6.1.5 DESIGNING FOR DECONSTRUCTION

Designing for deconstruction addresses the eventual disposal of a facility after its useful life. Designers should consider the use of recyclable and recoverable materials for re-use.

6.1.6 ALTERATIONS AND REFURBISHMENT OF EXISTING BUILDINGS AND HISTORIC STRUCTURES

Renovation designs should satisfy the immediate occupancy needs and anticipate additional future changes. As they are remodeled, building systems should become more flexible and adaptable to changing occupancy needs.

Alteration projects are defined at three basic scales: refurbishment of an area within a building, such as a floor or a suite; major renovation of an entire structure; and upgrade/restoration of historic structures (see Chapter 17).

6.2 KEY ARCHITECTURAL AND INTERIOR DESIGN REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key architectural and interior design requirements, regulations, standards and guidance for accessibility are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ANSI 117.1 Accessibility Code
- ASME A17.1, Safety Code for Elevators and Escalators
- ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy
- ASHRAE Standard 62 Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1 Energy Standards for Buildings
- IESNA G-1-03, Guideline for Security lighting for People, Property, and Public Spaces
- IESNA RP-33, Recommended Practice Lighting for Exterior Environments
- ISC Security Design Criteria for New Federal Buildings and Major Projects
- NFPA 101, Life Safety Code

Executive Orders

- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, Sections 2(a), (b) and (c)

Federal Laws

- Energy Policy Act of 2005's (EPAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)

Federal Regulations

- 10 CFR 434, Energy Code for New Federal Commercial and Multi-Family High-Rise Residential Buildings
- 10 CFR 436, Federal Energy Management and Planning Programs
- 29 CFR 1910, Occupational Safety and Health Standards (General Industry)
- 29 CFR 1926, Occupational Safety and Health Standards (Construction Industry)

NASA Procedural Requirements (NPR)

- NPR 8820.2, Facility Project Requirements

NASA Standards

- NASA-STD-8719.11, Safety Standard for Fire Protection

7. STRUCTURAL DESIGN

7.1 DESIGN PHILOSOPHY

7.1.1 GOALS AND OBJECTIVES

During its life span a typical building undergo many minor and major alterations as the mission of NASA agencies and departments change. Therefore, building system flexibility is necessary and the capability to allow for future alterations should be incorporated from the start of project. Design structural systems to provide room for future increases in loading. Select structural framing systems to maximize bay sizes to take advantage of open floor plan capabilities. Include redundancy factors in the design of structures located in moderate to high seismic regions. Incorporate recycled materials for the most widely used building products so as not to impact durability and structural performance.

7.1.2 STRUCTURAL CONSIDERATIONS

The goals in the selection of vertical and lateral load resisting systems are simplicity of the structural framing and symmetry for economy. The selection should consider economy, aesthetics, function, and reliability. Both Load Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) are acceptable design methodologies for NASA buildings. Use basic wind speeds for structures located in hurricane-prone regions based on special wind maps provided in the code. Minimize noise intrusion from mechanical equipment and external sources when designing structural systems. Ensure compliance with U.S. Environmental Protection Agency requirements to remedy vapor intrusion from groundwater contamination and avoid creating new vapor intrusion pathways.

Designers should consider the following deconstruction design concepts to address the eventual disposal of a facility after its useful life:

- Simplify and separate building systems to facilitate phased de-construction;
- Simplify structural system to minimize the quantity of building materials used; and
- Use structural fasteners, connectors, fittings, etc. that are simple to disassemble and are re-useable

7.1.3 STRUCTURAL REQUIREMENTS OF NEW BUILDINGS

The structural design, including wind and seismic design of new buildings, is to be in full compliance with the latest edition of building codes and standards. All new buildings are classified as Category II according to the building code.

Design floor-framing members with a combination of strength and stiffness that will not cause vibration beyond the “slightly perceptible” range of the Modified Reiher-Meister Scale.

Anchor and/or brace all nonstructural elements, components and equipment located within a building or on the site to withstand gravity, wind, seismic, and other loads as required by code.

7.1.4 STRUCTURAL UPGRADING OF EXISTING BUILDINGS

Unless otherwise specified, 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. Where deficiencies in the attachment of elements of structures, nonstructural components and equipment pose a life safety risk, they should be strengthened to meet current code requirements.

7.2 KEY STRUCTURAL REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key structural requirements, regulations, standards and guidance for accessibility are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ASCE 7, Minimum Design Loads for Building and Other Structures.
- AISC 325, Steel Construction Manual
- AISC 341, Seismic Provisions for Structural Steel Buildings
- AISC 360, Specifications for Structural Steel Buildings
- AWS D1.1, Structural Welding Code - Steel
- AWS D1.3, Structural Welding Code – Sheet Steel
- AWS D1.4, Structural Welding Code – Reinforcing Steel
- AISI D100, Cold-Formed Steel Design Manual
- ACI 318, Building Code Requirements for Structural Concrete & Commentary
- ACI 530/530.1 Building Code Requirements and Specification for Masonry Structures and Commentaries
- ASCE 31, Seismic Evaluations of Existing Buildings
- ASCE 41, Seismic Rehabilitation of Existing Building
- ASME A17.1, Handbook and Safety Code for Elevators and Escalators
- ASME A17.3, Handbook and Safety Code for Existing Elevators and Escalators
- International Building Code (IBC)
- National Design Specification (NDS) for Wood Construction
- NISTIR 6762, Standards of Seismic Safety for Existing Owned or Leased Buildings
- Steel Deck Institute (SDI) specification and commentaries for roof deck

Executive Orders

- Executive Order 12699, Seismic safety of Federal and Federally assisted or regulated new building construction
- Executive Order 12941, Seismic safety of existing Federally owned and leased buildings

NASA Procedural Requirements (NPR)

- NPR 8715.1 NASA Occupational Safety and Health Programs (w/Change 3)
- NPR 8820.2, Facility Project Requirements

NASA Standards

- NASA-STD-8719.11, Safety Standard for Fire Protection

8. Mechanical & Plumbing Design

8.1 DESIGN PHILOSOPHY

Mechanical systems are defined as heating, ventilating, and air conditioning (HVAC), humidification and water treatment, primary heating and cooling, building automation, plumbing and pressurized systems. Incorporate an integrated design procedure to ensure that the mechanical systems and other building components function together that meets all performance objectives defined by the project's program requirements. Specify mechanical materials that are resistant to intrusion and damage by local wildlife species and that may attract wildlife that may be injured.

Design the mechanical system to meet the project's programmed sustainability rating (LEED rating), exceed the minimum performance requirements of ASHRAE Standard 90.1 by at least 30%, meet 10 CFR 434 standards and incorporate cost effective energy conservation measures that do not compromise building performance or occupant comfort. Consider maintainability and reliability requirements in the design and installation of all mechanical systems and equipment to allow for their removal and replacement, including major components such as boilers, chillers, cooling towers, pumps, and air-handling equipment. Specifically design the HVAC systems to meet all of 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.

Sustainability is integral to any HVAC design and should comply with federal sustainability guiding principles. Water conservation is a requirement of all plumbing systems. Specify low-flow plumbing fixtures that comply with the International Plumbing Code and local building codes.

Use direct digital controls (DDC) for Building Automation Systems (BAS) that are capable of scheduling operations and maintenance, and adjusting building systems to optimize their performance to minimize overall power and fuel consumption of the facility. BACnet or LonTalk open communication protocol is preferred to provide integration and interoperability between building systems and control vendors. For new buildings and major renovations, allow approximately 20 percent spare capacity in the BAS for future expansion.

Identify all pipes, valves, and equipment in mechanical rooms, shafts, ceilings, and other spaces accessible to maintenance personnel with color coated piping or color-coded bands, and permanent tags indicating the system type and direction of flow for piping systems or type and number for equipment.

Meter utilizes such as natural gas, district steam and hot water, district chilled water and domestic water if service is provided to a new or renovated facility.

Pressure systems safety policy and technical requirements are addressed in NPD 8710.5 and NASA STD-8719.17, respectively. Design, fabricate, assemble, erect, inspect, examine, and test all new, ground-based conventional (i.e., nonflight) pressure vessel systems in accordance with the appropriate NASA Center requirements, codes, and regulations. Specialty systems such as hydrogen gas, oxygen and oxygen systems, explosives, propellants, and hypergolic fluids are to comply with NASA Safety Standards, NASA Developed Standards, NASA Directives, and various NASA Center Requirements and Documents referenced in the NASA Technical Standards Program (NTSP).

8.2 KEY MECHANICAL AND PLUMBING DESIGN REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key mechanical and plumbing requirements, regulations, standards and guidance are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ASME A17.1, Safety Code for Elevators and Escalators
- ASME B31.1, Power Piping
- ASME B31.3, Process Piping
- ASME B31.5, Refrigeration Piping
- ASME B31.8, Gas Transportation & Distribution
- ASME B31.9, Building Services
- ASME Boiler and Pressure Vessel Code
- ASHRAE Standard 15, Safety Code for Mechanical Refrigeration
- ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy
- ASHRAE Standard 62, Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 90.1, Energy Standards for Buildings
- ASHRAE Standard 100, Energy Conservation in Existing Buildings,
- ASHRAE Standard 105, Standard Method of Measuring and Expressing Building Energy Performance
- ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC System
- ASHRAE Standard 135, BACnet: A Data Communication Protocol for Building Automation and Control Networks
- ASHRAE Guideline 12-2000, Minimizing the Risk of Legionellosis Associated with Building Water Systems
- ASTM Standards, American Society for Testing and Materials
- AWS D1.1, American Welding Society Structural Welding Code- Steel
- AWWA Standards, American Water Works Association
- FM P7825, Factory Mutual Research Approval Guide
- International Building Code (IBC)
- International Mechanical Code
- International Plumbing Code
- Manufacturers Standardization Society (MSS)
- SMACNA-91, Seismic Restraint Manual, Guidelines for Mechanical Systems

Federal Laws

- Energy Policy Act of 2005 (EPAct 2005)

Federal Regulations

- 10 CFR 434, Energy Code for New Federal Commercial and Multi-Family High-Rise Residential Buildings

- 10 CFR 436, Federal Energy Management and Planning Programs
- 29 CFR 1910, Occupational Safety and Health Standards (General Industry)

Federal Guidance

- Federal Leadership in High Performance and Sustainable Building Memorandum of Understanding (MOU)
- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings

NASA Policy Directives (NPD)

- NPD 8710.5, Policy for Pressure Vessels and Pressurized Systems
- NPD 8820.2, Design and Construction of Facilities
- NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment

NASA Procedural Requirements (NPR)

- NPR 8715.3, General Safety Program Requirements
- NPR 8820.2, Facility Project Requirements

NASA Standards

- NASA STD 8719.7, Facility Systems Safety Guidebook
- NASA STD 8719.17, NASA Requirements for Ground Based Pressure Vessels and Pressurized Systems
- NASA STD 8719.12 Safety Standard for Explosives, Propellants, and Pyrotechnics

9. Electrical, Security, & Communication Design

9.1 DESIGN PHILOSOPHY

9.1.1 GOALS AND OBJECTIVES – ELECTRICAL

The six primary objectives for the design of electric power system equipment for new and existing facilities are:

Safety – Incorporate safety in the design of all electric power systems. Operations and maintenance staff should never be endangered by operating and maintaining any electrical equipment. Exposure to arc flash and shock hazards should always be mitigated first by engineering controls designed into the electrical power systems.

Reliability – Minimize unplanned outages 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. Specify electrical system design and materials that are resistant to local wildlife intrusion that may cause injury and electrical tripping.

Maintainability – Ensure maintainability by locating equipment that eliminates the danger to staff. Consider redundancy for essential critical operations.

Measurability - Utilize electrical equipment with the highest energy efficiency and incorporate advanced metering (microprocessor-based) 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) as a minimum. Where clean power is a viable option, it will be necessary to use measuring instruments capable of a faster data capture rate in order to measure and more effectively manage harmonics and transients that can adversely impact data processing and sensitive experimental equipment and instruments. Collaborate with end users to identify those locations where clean power is required and alert them to the possible additional equipment costs. Consider separate metering for data centers to facilitate the determination of “power usage effectiveness” or PUE.

Economy - Incorporate cost effective solutions while providing the safest, most reliable, most maintainable, and most energy efficient equipment for the use intended. In general, the more safe, reliable and maintainable a facility is, the greater the design and construction costs will be. A life cycle cost analysis can show that the higher design and construction costs can be offset by the reduced lifetime cost of the equipment due to significantly lower operation and maintenance costs. Carefully defining the criticality of a facility with the users during pre-design meetings can help reduce design and construction costs if high reliability and maintainability are not required for the intended use of a particular facility.

Resiliency/Flexibility - Incorporate flexibility in the initial layout and sizing of the equipment as much as possible so that future load additions will not require major modifications to the equipment. Upscale electrical services to provide infrastructure for future needs such as electric vehicle charging stations, photovoltaics and fuel cells even though they will not be provided as part of the project initially. Include provisions for independent metering at each electric vehicle charging station and develop a plan to charge users for electricity. Include provisions for advanced lighting controls integrated with the day lighting features of the building and provide fixtures that use compact fluorescent lamps, light emitting diode lamps, and T-8 or T-5 fluorescent lamps wherever possible.

9.1.2 GOALS AND OBJECTIVES – SECURITY

Include provisions for security systems in all government buildings, new or existing, large or small, recent vintage or historic. The type and level of security system should be determined by local NASA Center requirements. The security requirements should be integrated into the design for the project. Include security lighting during unoccupied hours at all facilities, as a minimum. Some facilities may require additional security features such as cameras (CCTV), building access, motion sensing or other more extensive security measures at the discretion of the end user. The security systems should be integrated with the emergency and standby power systems.

9.1.3 GOALS AND OBJECTIVES – COMMUNICATION

Include the following four types of communication systems at all government buildings as a minimum:

- Emergency (part of the facility fire alarm mass notification system);
- Building automation and energy management (may include power monitoring devices);
- Voice (conventional telephone service); and
- Data (fiber optic/Ethernet). Separate communication systems may not be integrated with each other with the exception of voice and data (VoIP) at the discretion of NASA IT Security.

9.2 KEY ELECTRICAL, SECURITY AND COMMUNICATION REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key electrical, security and communication requirements, regulations, standards and guidance are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ANSI: American National Standards Institute
- ASHRAE: Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings
- ASTM: American Society for Testing and Materials
- CBM: Certified Ballast Manufacturers
- FM: FM Approvals LLC (formerly Factory Mutual)
- ICEA: Insulated Cable Engineers Association
- IEEE: Institute of Electrical and Electronics Engineers
- IESNA: Illuminating Engineering Society of North America

- ITSNA: Intertek Testing Services NA, Inc. (formerly Electrical Testing Laboratories – ETL)
- NEC (NFPA 70): National Electrical Code
- NFPA: National Fire Protection Association
- NFPA 70E: Standard for Electrical Safety in the Workplace
- NEMA: National Electrical Manufacturers Association
- NESC: National Electrical Safety Code
- NETA: International Electrical Testing Association
- UL: Underwriters' Laboratories

Executive Orders

- Executive Order 12196, Occupational Safety and Health Programs for Federal Employees
- Executive Order 13211, Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use
- Executive Order 13212, Actions to Expedite Energy-Related Projects
- Executive Order 13221, Energy Efficient Standby Power Devices
- Executive Order 13231, Critical Infrastructure Protection in the Information Age
- Executive Order 13486, Strengthening laboratory Biosecurity in the United States

Federal Laws

- Resource Conservation and Recovery Act (RCRA) 6002
- Energy Policy Act of 2005 (EPAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)

Federal Regulations

- 10 CFR 433, Energy Efficiency Standards for New Federal Commercial and Multi-Family High Rise Residential Buildings
- 10 CFR 434, Energy Code for New Federal Commercial and Multi-Family High-Rise Residential Buildings
- 10 CFR 436, Federal Energy Management and Planning Programs
- 29 CFR 1910, Occupational Safety and Health Standards (General Industry)
- 29 CFR 1926, Occupational Safety and Health Standards (Construction Industry)
- 48 CFR 23, Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace

Federal Guidance

- Federal Leadership in High Performance and Sustainable Building Memorandum of Understanding
- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
- Office of Management and Budget Scorecards

NASA Policy Directives (NPD)

- NPD 8820.2, Design and Construction of Facilities
- NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment

NASA Procedural Requirements (NPR)

- NPR 7120.7, NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements

NASA Standards

- NASA STD 005, NASA Configuration Management (CM) Standard

Internal NASA Documents

- NASA Sustainability Policy Handbook for Facilities

10. Fire Protection/Life Safety

10.1 DESIGN PHILOSOPHY

The majority of the fire protection and life safety requirements are contained in national codes and standards and NASA technical standards. The design incorporates efficient, cost-effective fire protection and life safety systems. A registered fire protection engineer is to be part of the design team and a full participant in the design, construction and final acceptance phases of the project. Involve the Authority Having Jurisdiction (AHJ) in all aspects of the system design and obtain his/her approval or concurrence on system requirements. For fire safety construction or renovation projects, disruptions to fire alarm and sprinkler systems are to be kept to a minimum or avoided. Delineate phasing of construction to ensure that installations of new fire protection systems are expedited and existing systems are kept in service until the replacement system is operational. Incorporate a corrective impairment plan if fire protection systems are to be disrupted to maintain equivalent levels of fire protection that are acceptable to the AHJ.

Issues to address in developing a successful fire protection design usually include:

Design Standards and Criteria (i.e., Building Code, etc.)—to be utilized by the design team, including statutory requirements and voluntary requirements addressing owner's performance needs.

Site Requirements — a quality site design will integrate performance requirements associated with fire department access, suppression, and separation distances.

- Fire department access
    - Design buildings with uncomplicated layouts and floor plans that enable firefighters to locate an area quickly, and provide rapid access to various features such as fire department connections (FDCs), hose valves, elevators and stairs, annunciators, key boxes, etc.
    - Coordinate with Center AHJ to accommodate the access of fire apparatus into and around the building site and to coordinate access control point layout.
- Fire hydrants
- Coordinate with security measures

Building Construction Requirements - will address the following elements:

- Construction type, allowable height, and area
- Exposures/separation requirements
- Fire ratings, materials, and systems
- Occupancy types
- Interior finish
- Exit stairway enclosure

Egress Requirements - will address the following elements:

- Exit stairway remoteness

- Exit discharge
- Areas of refuge
- Accessible exits
- Door locking arrangements (security interface)

Fire Detection and Notification System Requirements - will address the following elements:

- Detection
- Notification
- Survivability of systems

Fire Suppression Requirements - will address the following elements:

- Water supply
- Type of automatic fire extinguishing system
    - Water-based fire extinguishing system
    - Non-water-based fire extinguishing system
- Standpipes and fire department hose outlets

Emergency Power, Lighting, and Exit Signage - will address the following elements:

- Survivability of systems
- Electrical Safety
- Distributed Energy Resources

Special Fire Protection Requirements - will address the following elements:

- Engineered smoke control systems
- Fireproofing and firestopping
- Atrium spaces
- Mission critical facility needs

10.2 KEY FIRE PROTECTION/LIFE SAFETY REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key fire protection/life safety requirements, regulations, standards and guidance are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- Factory Mutual, Loss Prevention Sheets
- International Building Code (IBC)
- NFPA 1, Fire Prevention Code
- NFPA 13, Standard on Installation of Sprinkler Systems
- NFPA 14, Standard on Standpipe Systems

- NFPA 20, Stationary Fire Pumps
- NFPA 24, Private Fire Service Mains
- NFPA 25, Water-Based Fire Protection Systems
- NFPA 30, Flammable and Combustible Liquids Code
- NFPA 37, Stationary Combustion Engines & Gas Turbines
- NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals
- NFPA 51B, Standard on Welding, Cutting, and Hot Work
- NFPA 54, National Fuel Gas Code
- NFPA 70, National Electrical Code
- NFPA 72, National Fire Alarm Code
- NFPA 75, Computer / Data Processing Equipment
- NFPA 90A, Installation of Air-Conditioning and Ventilating Systems
- NFPA 101, Life Safety Code
- NFPA 110, Emergency and Standby Power Systems
- Underwriters Laboratories Inc. (UL), Fire Protection Equipment Directory
- UL 1, Standard for Safety Flexible Metal Conduit
- UL 2, Fire Resistive Directory
- UL 464, Standard for Audible Signal Appliances
- UL 1480, Standard for Speakers for Fire Alarm, Emergency and Commercial and Professional Use
- UL 1971, Signaling for the Hearing Impaired

Federal Regulations

- USC Title 15, Section 272 Utilization of Consensus Technical Standards by Federal Agencies
- USC Title 15, Section 2227 *Fire Administration Authorization Act* (also referred to as the Fire Safety Act)
- 29 CFR 1910, Occupational Safety and Health Standards (General Industry)

NASA Policy Directives (NPD)

- NPD 1800.2, NASA Occupational Health Program
- NPD 8820.2, Design and Construction of Facilities

NASA Procedural Requirements (NPR)

- NPR 1800.1, NASA Occupational Health Program Procedures
- NPR 8715.1, NASA Occupational Safety and Health Programs w/Change 3
- NPR 8715.3, General Safety Program Requirements
- NPR 8820.2, Facility Project Requirements

NASA Standards

- NASA STD 8719.7, Facility Systems Safety Guidebook
- NASA-STD-8719.11, Safety Standard for Fire Protection

11. Sustainable Design/ Energy Conservation

11.1 DESIGN PHILOSOPHY

11.1.1 GOALS AND OBJECTIVES

In executing its mission, NASA's sustainability objectives are to:

- Increase energy efficiency;
- Increase the use of renewable energy;
- Measure, report, and reduce NASA's direct and indirect greenhouse gas emissions;
- Conserve and protect water resources through efficiency, reuse, and stormwater management;
- Eliminate waste, prevent pollution, and increase recycling;
- Leverage Agency acquisitions to foster markets for sustainable technologies and environmentally preferable materials, products, and services;
- Design, construct, maintain, and operate high-performance sustainable buildings;
- Utilize power management options and reduce the number of Agency data centers;
- Support economic growth and livability of the communities where NASA conducts business;
- 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;
- Raise employee awareness and encourage each individual in the NASA community to apply the concepts of sustainability to every aspect of their daily work to achieve these goals;
- Maintain compliance with all applicable Federal, state, local or territorial law and regulations related to energy security, a healthy environment, and environmentally-sound operations; and
- Comply with internal NASA requirements and agreements with other entities.

11.1.2 SUSTAINABLE DESIGN

This guide sets out the specific sustainability requirements for NASA facilities (new construction, existing building, etc.). At NASA, sustainability means incorporating appropriate sustainable design practices, maintainable design elements, building commissioning processes, safety, health and security features into facility planning, design, construction, activation, operation and maintenance, and decommissioning to enhance and balance facility life-cycle cost, environmental impact, occupant health, safety, security, and productivity.

As referenced in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (2006), the Federal Government's guiding principles for sustainable design are:

- Employ Integrated Design Principles
- Optimize Energy Performance
- Protect and Conserve Water
- Enhance Indoor Environmental Air Quality
- Reduce Environmental Impact of Materials

11.1.3 EMPLOY INTEGRATED DESIGN PRINCIPLES

Guidance for integrated design and commissioning can be found in the Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings set forth in the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding, which is mandated by Executive Order 13423.

Integrated Design. Use a collaborative, integrated planning and design process that (1) initiates and maintains an integrated project team in all stages of a project's planning and delivery; (2) 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 lifecycle of the building; and, (3) Considers all stages of the building's lifecycle, including deconstruction.

Commissioning. Employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This should include a designated commissioning authority, inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report.

Future Proofing. Facilities design should be future ready and flexible enough to accommodate future technologies, embrace innovative techniques and be adaptable to climate change.

11.1.4 OPTIMIZE ENERGY PERFORMANCE

Increased energy costs lead to an increased risk to NASA's mission. This risk can be mitigated through a three-pronged approach: consider energy efficiency and cost in all aspects of facility operations; construct and renovate facilities with the overall life cycle in mind; and make wise purchasing decisions.

Energy Efficiency. Improving energy efficiency can reduce operating costs, maintain air quality, and reduce the need to expand the electric power distribution system. Energy efficiency can be improved through building design and selection of equipment and materials, as well as through broader efforts to improve operational processes.

On-Site Renewable Energy. Since 2000, increasing energy costs have emphasized the need for facility managers to consider alternative energy, in addition to focusing on reduction of overall energy consumption.

Measurement and Verification. Once building systems and other facility equipment have been installed and calibrated to proper specifications, they are to be periodically checked to ensure optimum efficiency. All new facilities should be sub-metered to facilitate energy use data collection and evaluation of conservation measures.

Benchmarking. Comprehensive and targeted energy goals challenge the design team to investigate innovative, cost-effective solutions that provide energy savings for new construction or retrofit projects.

11.1.5 PROTECT AND CONSERVE WATER

Measurement of Water Use. Reduction in potable water use is a goal. All new facilities should be sub-metered to facilitate water use data collection and evaluation of conservation measures. The water management approach, program goals, requirements, performance metrics, and building or system inventories are documented in a Water Management Plan or are integrated into a water conservation program,

Indoor Water. Changes in occupant behavior and modifications to fixtures and fittings can lead to significant reductions of potable water use.

Outdoor Water. Water management practices are not restricted to applications inside buildings. Sustainable site design can reduce demands on water supplies as well as reduce the polluted discharges resulting from rainfall.

Process Water. Process water includes water used to make a product or affect a procedure or action. Implementing changes to building system equipment or to industrial operations and process can achieve reductions in potable water use.

11.1.6 ENHANCE INDOOR ENVIRONMENTAL AIR QUALITY

Ventilation and Thermal Comfort. High-performance and sustainable buildings provide occupants with a well-ventilated and comfortable indoor environment.

Moisture Control. Excess indoor moisture levels contribute to mold growth, building damage, unhealthy building conditions, and poor indoor air quality.

Daylighting. Natural lighting, or daylighting, can reduce energy consumption by allowing sunlight into a building through openings such as windows and skylights and thus eliminating the need for some artificial lighting.

Low-Emitting Materials. Materials used inside a building can have a significant impact on indoor air quality.

Protect Indoor Air Quality During Construction. Construction or renovation of a building can generate dust, mud, paint, moisture, and other contaminants that often remain once work is complete.

Integrated Pest Management. Indoor pest control and the use of pesticides can also harm air quality.

11.1.7 REDUCE ENVIRONMENTAL IMPACT OF MATERIALS

Waste and Materials Management. Federal facilities are required to develop and implement cost effective recycling and waste prevention programs.

Building Materials Selection. Long before construction begins, the process of bringing building materials to market can cause pollution, harm habitats, and drain natural resources. Sustainable facilities design requires careful evaluation of material and equipment sources, and managers should consider recycled, salvaged, or otherwise environmentally-friendly products when selecting building materials.

Ongoing and Durable Products. After construction is complete, sustainable purchasing should continue with ongoing and durable product purchasing.

Ozone-Depleting Compounds. Ozone-depleting compounds (ODC), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and halons found in older building systems pose significant threats to the ozone layer.

11.2 KEY SUSTAINABLE DESIGN/ENERGY CONSERVATION REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key sustainable design/energy conservation requirements, regulations, standards and guidance are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

Executive Orders

- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, Sections 2(a), (b) and (c)
- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Federal Laws

- Resource Conservation and Recovery Act (RCRA), Section 6002
- Energy Policy Act of 2005 (EPAct 2005) Section 102, 103, 109 and 203
- Energy National Defense Authorization Act (NDAA) of 2007 Subtitle E, Energy Security, Section 2852
- Energy Independence and Security Act of 2007 (EISA 2007) Sections 431-434, 523

Federal Regulations

- 10 CFR 433, Energy Efficiency Standards for New Federal Commercial and Multi-Family High Rise Residential Buildings
- 10 CFR 436, Federal Energy Management and Planning Programs
- 29 CFR 1926, Occupational Safety and Health Standards (Construction Industry)
- 48 CFR 23, Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace

Federal Guidance

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)
- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
- Office of Management and Budget Scorecards

NASA Policy Directives (NPD)

- NPD 7330.1, Approval Authorities for Facilities Projects
- NPD 8500.1, NASA Environmental Management
- NPD 8800.14, Policy for Real Property Management
- NPD 8810.2, Master Planning for Real Property
- NPD 8820.2, Design and Construction of Facilities
- NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment

NASA Procedural Requirements (NPR)

- NPR 7120.5, Program and Project Management Processes and Requirements
- NPR 8530.1, Affirmative Procurement Program and Plan for Environmentally Preferable Products
- NPR 8553.1, NASA Environmental Management System
- NPR 8570.1, Energy Efficiency and Water Conservation
- NPR 8580.1, Implementing the National Environmental Policy Act and EO 12114
- NPR 8800.15, Real Estate Management Program
- NPR 8810.1, Master Planning Procedural Requirements
- NPR 8820.2, Facility Project Requirements
- NPR 8831.2, Facilities Maintenance and Operations Management

Internal NASA Documents

- NASA Sustainable Policy Handbook for Facilities
- NASA 2011 Strategic Sustainability Performance Plan

12. ACCESSIBILITY

12.1 DESIGN PHILOSOPHY

It is NASA's commitment to provide accessible facilities to the maximum practicable extent not only required by law, but also in alignment with the mission and function of each NASA Center. This would include the general public where applicable, NASA employees, and meeting the specific accessible regulations defined by 14CFR 1251.302. Designing appropriate access for NASA personnel and visitors to NASA facilities will also require consideration of the occupant capacity, security and functional separation within these facilities.

14 CFR 1251.302: Mandates that all NASA facilities are to be designed and constructed in such manner that the facility or part of the facility is readily accessible to and usable by handicapped persons and to the maximum extent feasible, be altered in such manner that the altered portion of the facility is readily accessible to and usable by handicapped persons. This is to be accomplished by incorporating the accessibility design guidelines required by the GSA Architectural Barriers Act Accessibility Standard (ABAAS).

General Public: Visitors are a common part of NASA business and facilities that may receive regular visitors (tour groups) need to be designed to accommodate visitor accessibility in addition to reasonable accommodation for employees. It is recommended an analysis of public access requirements be performed during the planning and programming phase of design and the following requirements be developed as necessary.

Occupant Capacity: Since occupant counts are drivers for determining life-safety measures, HVAC loads and the amount of plumbing fixtures required, it is recommended during programming for the design team in conjunction with NASA to analyze and evaluate the extent of visitors to the facility as well as the frequency and duration.

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. Thus, attention should be paid in any design to security where visitors to NASA may be allowed to access facilities.

Functional Separation: The interaction of visitors with NASA staff is a major part of the culture, mission and function of NASA. This interaction does require a degree of scrutiny with the sensitive nature of the work being performed. Limiting access to facilities or parts of facilities to the public may be required. During the programming phase, a public access study is recommended for any facility project. Integration of required physical separation design elements for visitors from staff, such as entrances, corridors, and lobbies should be considered.

12.2 KEY ACCESSIBILITY REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key accessibility requirements, regulations, standards and guidance are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ABA Accessibility Standards for Federal Facilities (GSA)

Federal Regulations

- 14 CFR 1251.302, Nondiscrimination on the basis of handicap.

NASA Policy Directives (NPD)

- NPD 2081.1, Nondiscrimination in Federally Assisted and Conducted Programs of NASA
- NPD 3713.8, Provision of Reasonable Accommodation for Individuals with Disabilities

NASA Procedural Requirements (NPR)

- NPR 2081.1, Nondiscrimination in Federally Assisted and Conducted Programs
- NPR 3713.1, Reasonable Accommodations Procedures

Internal NASA Documents

- NASA Non-Discrimination Regulations for Federally Assisted Programs

13. Designing for Natural Disasters

13.1 DESIGN PHILOSOPHY

13.1.1 OVERVIEW

Natural disasters come in many forms, both expected and not, such as floods, hurricanes, and earthquakes. Each type of disaster threat has its own set of considerations, but in general, data may be derived from flood maps, engineering models (hurricanes, flooding, earthquakes, lessons learned reports, et al).

As a general tenet, all NASA facility planning, design and construction efforts should consider disaster resilience as a major goal. The overarching philosophy is that all NASA facilities will be sited and designed to safeguard human life, minimize damages to properties and allow for the immediate restoration of essential functions and services after a disaster. More specifically, disaster resilience may be enhanced by the following actions:

- 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);
- 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;
- Pursue strategies for disaster mitigation through both horizontal (land use, circulation, open space, infrastructure, and utilities) and vertical (structural engineering, architecture, materials use) planning and design. For example, disaster mitigation in flood-prone areas is dependent on a comprehensive strategy that would (1) pursue proper facilities siting (such as in the LEED Site Selection Credit) that avoids flood prone areas instead of berming or over-grading land to mitigate flood plains and (2) use best-practice building engineering techniques and technologies for structures that naturally flex and respond to rising waters, such as floating building pads that rise and fall with flood waters instead of stilts that can only accommodate a fixed level of water rise; and
- Identify emergency disaster response procedures, evacuation routes, and locations of critical facilities (command center, fire department, hospitals, emergency shelters, etc.) in the planning process

13.2 KEY NATURAL DISASTER REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Successful disaster planning is dependent on a robust and comprehensive set of regulations and codes that help reduce / mitigate the risk and impacts of disasters when they occur. The implementation of items mentioned below (summarized in Chapters 2 thru 4), although insufficient alone, would together and in combination with the planning and design approach discussed above, support a more disaster resilient development / facility.

National Codes and Standards

- ACI 318, Building Code Requirements for Reinforced Concrete and Commentary
- ASCE 7, Minimum Design Loads for Buildings and Other Structures
- ASME A17.1, Safety Code for Elevators and Escalators
- 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
- International Building Code (IBC)

Executive Orders

- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 12072, Federal Space Management
- Executive Order 12114, Environmental Effects Abroad of Major Federal Facilities
- Executive Order 12196, Occupational Safety and Health Programs for Federal Employees
- Executive Order 12699, Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction
- Executive Order 12893, Principles for Federal Infrastructure Investments
- Executive Order 12941, Seismic Safety of Existing Federally Owned or Leased Buildings
- Executive Order 13231, Critical Infrastructure Protection in the Information Age
- Executive Order 13347, Individuals with Disabilities in Emergency Preparedness
- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management
- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Federal Laws

- Energy Policy Act of 2005 (EPAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)

Federal Regulations

- 10 CFR 436, Federal Energy Management and Planning Programs
- 29 CFR 1910, Occupational Safety and Health Standards
- 48 CFR 23, Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace

Federal Guidance

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)

- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
- ISC Security Design Criteria for New Federal Office and Major Projects
- Standards of Seismic Safety for Existing Federally Owned or Leased Buildings

NASA Policy Directives (NPD)

- NPD 1600.2, National Security Policy
- NPD 8700.1, NASA Policy for Safety and Mission Success
- NPD 8710.5, Policy for Pressure Vessels and Pressurized Systems
- NPD 8810.2, Master Planning for Real Property
- NPD 8820.2, Design and Construction of Facilities

NASA Procedural Requirements (NPR)

- NPR 1600.1, National Security Program Procedural
- NPR 7120.7, NASA Information Technology and Institutional Infrastructure Program and Project Management Requirements
- NPR 8553.1, NASA Environmental Management System
- NPR 8570.1, Energy Efficiency and Water Conservation
- NPR 8580.1, Implementing The National Environmental Policy Act and Executive Order 12114
- NPR 8715.1, NASA Occupational Safety and Health Programs w/Change 3
- NPR 8715.3, NASA General Safety Program Requirements
- NPR 8810.1, Master Planning Procedural Requirements
- NPR 8820.2, Facility Project Requirements

NASA Standards

- NASA STD 8719.7, Facility Systems Safety Guidebook
- NASA STD 8719.11, Safety Standards for Fire Protection
- NASA STD 8719.12, Standard for Explosives, Propellants, and Pyrotechnics
- NASA STD 8719.17, NASA Requirements for Ground Based Pressure Vessels and Pressurized Systems

14. Designing for Climate Change

14.1 DESIGN PHILOSOPHY

Scientists have collected weather and climate data and indicators of longer-term climate patterns from the entire globe. Based on analyses of these data, sophisticated models have been developed that project future climate changes. Climate models consistently project that climate change will accelerate this century. NASA climate scientists are an important part of the international research effort, particularly in climate modeling and collection of both earth-based and space-based data used to develop and validate climate models and identify climate impacts. As a research organization tasked with expanding knowledge of the Earth and its systems, NASA is applying its preeminent expertise in climate science to help manage the risks to NASA mission success posed by climate change impacts. A key element in managing these risks is making appropriate adaptations to institutional systems.

As outlined in NASA's Strategic Sustainability Performance Plan (SSPP), climate change impacts are of concern because NASA's assets are located along America's coasts, where sea level rise and increased frequency of intense storms is predicted, and in areas where changes in precipitation are expected to impact potable water supplies, fire risk, air quality, transportation, and energy supply and demand. While climate change is a global phenomenon, impacts are being and will be felt at all scales. NASA recognizes that integrating climate change adaptation into installation planning is a local activity. A changing climate will impact facility operations (e.g., water management, energy demands), natural resources (e.g., tidal marsh habitat, increase in invasive species, increase in pest species), infrastructure that is vital to mission success (e.g., flooded buildings and launch assets, buildings too hot to work in), quality of life in the community (e.g., increased number of hot days) and the region's economy (e.g., increased percentage of public funds for utility costs, firefighting, and flood control).

Executive Order 13514 directs Federal agencies to assess and manage the effects of climate variables on their operations and mission in both the short and long term. In addition to EO 13514, a number of NASA Policy Procedures and Directives require that NASA's facilities and equipment are to "be maintained in the most cost effective fashion to minimize risk to processes and products, protect the safety and health of personnel and the environment, protect and preserve capabilities and capital investments" (NPD 8831.1) and have the "flexibility to respond to changing future conditions and needs" and that "… proposed plans are to reflect the best current thinking about facilities engineering, life-cycle cost, sustainability, as well as aesthetics" (NPR 8810.1). The National Environmental Policy Act, discussed in Chapter 16, also directs Federal agencies, such as NASA, to consider reasonably foreseeable changes in circumstances that could affect or be affected by a proposed action (NPR 8580.1). Given the impact of climatic changes, in order to comply with these directives when designing and planning new facilities it is necessary to carry out a number of steps in order to provide a resilient, productive and safe work environment. This process has been carried out during NASA Center-specific workshops, titled Resilience and Adaptation to Climate Change Risks, at three NASA bases (Florida's Space Coast, Ames Research Center, Langley Research Center) as of December 2011. It should also be noted that the NASA master-planning handbook (available 2012) will contain more specific language relating to sustainable development, and ensuring that facilities are resilience to future climatic changes. The SSPP Section 1.5.5 Climate Change Risk and Vulnerability, outlines both NASA activity to date and plans for the future.

In order to achieve the climate resiliency described above, it is recommended that the following activities be carried out for design and planning projects:

- Identify current and future climate hazards (such as sea level rise, salt water intrusion, coastal flooding, overall increased temperature, increased number of high temperature days, precipitation changes, fire, wind, and air quality);
- Characterize risk of climate change on systems and assets (to result in a low, medium, high risk rating through a vulnerability and risk assessment) to identify facilities and locations at most risk;
- Develop potential adaptation strategies, such as:
    - Raising critical infrastructure which sits in basements or on ground floors;
    - Increasing cleaning of drains and gutters to reduce flooding;
    - Integrating green infrastructure to help reducing flood impacts;
    - Planting more heat and drought/flood tolerant trees, shrubs, and grasses to replace less tolerant species as the latter deteriorate;
    - Installing or increasing height of flood barriers such as revetments, levees and sea walls;
    - Using construction materials resilient to increased temperatures, wind and fire risk or periodic inundation;
    - Maintaining wildlife corridors; and
    - Zoning changes
- Identify implementation approaches and funding for the adaptation strategies;
- Identify opportunities for partnership and coordination, particularly for sea level rise impacts which can sometimes be more effectively dealt with at a subregional level;
- Integrate into management and planning; and
- Monitor and reassess

Note that many climate-related design policies have been focused to date on climate mitigation – activities that will decrease greenhouse gas (GHG) emissions. These are covered in this Guide in the related chapter on Sustainable Design, outlining energy and water efficiency improvements and use of renewable energy generating technologies that reduce GHG emissions associated with new build and refurbishment projects. Many of these also have adaptation benefits. For example, a more energy and water efficient building will be more resilient in drought and heat wave scenarios.

14.2 KEY CLIMATE CHANGE REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key climate change requirements, regulations, standards and guidance for climate change design considerations are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ASHRAE Standard 90.1, Energy Standards for Buildings
- International Green Construction Code

Executive Orders

- Executive Order 11514, Protection and enhancement of environmental quality
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 12893, Principles for Federal Infrastructure Investments
- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Federal Laws

- Energy Policy Act of 2005 (EPAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)
- National Environmental Policy Act

Federal Regulations

- 10 CFR 433, Energy Efficiency Standards for New Federal Commercial and Multi-Family High Rise Residential Buildings
- 10 CFR 434, Energy Code for New Federal Commercial and Multi-Family High-Rise Residential Buildings
- 10 CFR 436, Federal Energy Management and Planning Programs
- 14 CFR 1216.3 – Procedures for Implementing NEPA (NASA regulations)
- 29 CFR 1926, Occupational Safety and Health Standards (Construction Industry)
- 40 CFR 1500-1508 – Council of Environmental Quality (CEQ) Regulations for Implementing NEPA
- 48 CFR 23, Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace

Federal Guidance

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)
- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
- Office of Management and Budget Scorecards

NASA Policy Directives (NPD)

- NPD 8810.2, Master Planning for Real Property
- NPD 8831.1, Maintenance and Operations of Institutional and Program Facilities and Related Equipment

NASA Procedural Requirements (NPR)

- NPR 8570.1, Energy Efficiency and Water Conservation
- NPR 8810.1, Master Planning Procedural Requirements
- NPR 8820.2, Facility Project Requirements

Internal NASA Documents

- NASA Sustainable Policy Handbook for Facilities
- NASA Strategic Sustainability Performance Plan

15. Parking Requirements

15.1 DESIGN PHILOSOPHY

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. Any parking area designs and construction are to meet NASA, Federal, State and Local regulations.

With the necessity for parking, NASA's goal is to minimize the impact of parking at its centers and facilities. The following considerations should be incorporated into both campus planning and facility designs:

Efficient Layout & Circulation: Parking areas should be sited and configured between facilities to encourage shared parking; for facilities located in urban areas, parking levels under the facility should be designed; and to minimize the use automobiles travel around NASA campuses, facilities and parking areas should be sited to encourage pedestrian and bicyclist circulation.

Alternative Transportation: NASA encourages the use of carpooling and alternative-fueled vehicles. Designated parking spaces should be set aside in parking areas for these types of vehicles through pavement stripping and signage. To minimize the amount of parking being utilized alternative means of transportation should be part of any comprehensive parking strategy for centers or facilities. Mass transit, bicycles and public transportation are three alternatives to automobiles:

Mass transit: If applicable, access to mass transit stations should be part of any master plan;

Bicycles: It is recommended to provide bicycle storage at all facilities and incorporate bicycle pathways and lanes on NASA Centers; and

Buses: Where NASA Centers and facilities are in areas with public buses, any master plan should incorporate and encourage the use of buses.

Emergency Vehicle Access: Local fire departments should be consulted on surface material, turning radius weights, fire lane widths, etc.

Run-offs: Storm water run-off from parking areas is required to meet NASA, as well as State and local, regulations. Design of parking areas should include measures to handle both quantity and quality of storm water before entering into any storm water system. Incorporation of strategies such as installation of pervious paving should be considered on a case-by-case basis for each Center.

15.2 KEY PARKING REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key parking requirements, regulations, standards and guidance are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- ASCE 7, Minimum Design Loads for Building and Other Structures.
- IESNA G-1-03, Guideline for Security lighting for People, Property, and Public Spaces

- IESNA RP-33, Recommended Practice Lighting for Exterior Environments
- ISC – The Design –Basis Threat Report (U)
- ISC – Physical Security Criteria for Federal Facilities

Executive Orders

- Executive Order 11514, Protection and enhancement of environmental quality
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 11991, Environmental Impact Statements
- Executive Order 12072, Federal Space Management
- Executive Order 12114, Environmental Effects Abroad of Major Federal Facilities
- Executive Order 13006, Locating Federal Facilities on Historical Properties in our Nations Central Cities
- Executive Order 13007, Indian Sacred Sites
- Executive Order 13287, Preserve America
- Executive Order 13352, Facilitation of Cooperative Conservation

Federal Laws

- National Historic Preservation Act

Federal Regulations

- 48 CFR 23, Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety and Drug-Free Workplace

Federal Guidance

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)
- Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings

NASA Policy Directives (NPD)

- NPD 8810.2, Master Planning for Real Property

NASA Procedural Requirements (NPR)

- NPR 8810.1, Master Planning Procedural Requirements

Internal NASA Documents

- NASA Sustainable Policy Handbook for Facilities

16. Environmental Compliance

16.1 DESIGN PHILOSOPHY

NASA is committed to being a responsible environmental steward through the consideration of the environment and compliance with environmental laws and regulations.

The National Environmental Policy Act (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 purpose of NASA's NEPA program is to ensure agency compliance by integrating the NEPA process into facility planning. This supports mission success and minimizes environmental liability while meeting the federal stewardship expectation of the general public.

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

- Integrating environmental considerations into the planning of federal actions as early as possible;
- Ensuring that environment, technical, and economic considerations are weighed during decision making and before any actions are taken;
- Providing a meaningful opportunity for public comment and interagency/intergovernmental coordination; and
- Ensuring the decision maker is informed of the environmental consequences of proposed federal actions and available mitigation prior to making a decision.

NEPA is a largely procedural law; however, because it requires federal agencies to look at the entire spectrum of environmental impacts, make certain disclosures/findings, and allow for public and other agency comment, it is often referred to as "umbrella" legislation. The NEPA process often involves coordinating compliance with the following laws:

- Clean Air Act (discussed below and in Chapter 14)
- Clean Water Act
- National Historic Preservation Act (discussed in Chapter 17)
- Endangered Species Act

NASA's NEPA goal and objectives are to seek to avoid, minimize, and mitigate the adverse effect of its proposed programs and projects that enable NASA to implement its mission. Any mitigation measures needed are monitored during the implementation of the mission. NASA sees NEPA as much more than a compliance responsibility:

- **NASA-NEPA Program:** NASA strives to achieve productive harmony between people and nature in carrying out NASA mission needs and goals when planning programs and projects.
- **NASA-NEPA Process:** The White House Council on Environmental Quality (CEQ) sets the standard, and NASA develops and implements agency-specific regulations, policies and procedures to support its own mandate and also meet other environmental requirements.

- **NEPA Environmental Stewardship**: NASA partners with other Federal agencies, State, and Tribal and local governments, concerned public / private organizations, and individuals to act as responsible stewards of America's vast natural resources. NEPA seeks to protect human health and the environment.

NASA conducts an environmental review of each project prior to the start of design as required by the National Environmental Policy Act (NEPA). The review is initiated by the NEPA Proponent (manager responsible for the proposed facility action) by completing a NEPA environmental checklist. This is then presented to the Headquarter or Center NEPA Manager to determine what level of documentation is needed to fulfill NEPA compliance; the review identifies environmental impacts and alternative courses of action that may have less impact. The review can result in:

A. A Categorical Exclusion (CATEX) with decision document being a Record of Environmental Consideration (REC)

If the environmental checklist reveals that the proposed facility project falls within one of NASA's 23 CATEXs, the NEPA Manager will determine if development of a Record of Environmental Consideration (REC) is needed.

B. Environmental Assessment (EA) with decision document being a FONSI or a Notice of Intent to Prepare an Environmental Impact Statement (EIS)

If the proposed action (planned program or project) has the potential for environmental effect, an Environmental Assessment is prepared. The preparation of an EA typically results in a Finding of No Significant Impact (FONSI). However, if the EA identified potential environmental impacts that can be significant or cannot be mitigated, then preparation of an EIS is triggered and a Notice of Intent to Prepare an Environmental Impact Statement (EIS) is issued.

C. Environmental Impact Statement (EIS) with decision document being a Record of Environmental Decision (ROD)

If an Environmental Assessment or EIS has been prepared, it will constitute the primary guideline for environmental design issues. In those instances where NASA has committed to implementing specific mitigation measures, designers are to ensure that those measures are carried out in the design. The National Environmental Policy Act (NEPA) levies procedural requirements on NASA. To ensure proper implementation of NEPA, NASA has established a program within the Environmental Management Division to have oversight of the NEPA process and requirements at NASA. Following the NEPA procedural requirements, NASA's NEPA program has developed NASA-specific policies and procedures for the Agency. The requirements in the policies and procedures proscribe how to develop the analyses and documents that are central to the NEPA process. Non-compliance with NEPA can pose a critical risk to mission schedules and costs. It is critical that NEPA be integrated into the early planning stages of all programs and projects.

In July 1992, EPA published a report, entitled "Reducing Risk for All Communities," which noted that minorities and low-income communities experience higher than average exposures to selected air pollutants, hazardous waste facilities, and other forms of environmental pollution. The EPA's Administrator Browner reaffirmed the EPA's commitment to Environmental Justice (EJ) in 1993. President Clinton signed Executive Order (EO) 12898 on February 11, 1994 to establish Environmental Justice as a national priority. The EO directs federal agencies to address human health and environmental issues in low-income and/or minority communities with the goal of achieving environmental protection for all communities. Section 2-2 of the EO directed Federal agencies to develop Environmental Justice strategies by March 24, 1995 to promote non-discrimination in federal programs substantially affecting human health and environment, and to provide

minority and low-income communities access to public information on, and an opportunity for public participation in, matters relating to human health or the environment.

NASA has its own Environmental Justice Strategy to ensure the integration of environmental justice into NASA's programs, policies, and activities. The strategy provides a broad framework of the items to be accomplished by each Center to achieve Environmental Justice. The strategy remains in effect and applies to NASA NEPA programs and actions.

Some construction projects may implement Superfund (CERCLA) clean up requirements or follow closely after the cleanup, in which case, if the reuse is reasonably foreseeable, the cleanup and proposed reuse/construction and its alternatives may be considered in a NEPA review to minimize cost, delay, and paperwork.

16.2 KEY ENVIRONMENTAL REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key environmental requirements, regulations, standards and guidance are listed below and summarized in Chapters 2 thru 4.

Executive Orders

- Executive Order 11514, Protection and enhancement of environmental quality
- Executive Order 11988, Floodplain Management
- Executive Order 11990, Protection of Wetlands
- Executive Order 12114, Environmental Effects Abroad of Major Federal Facilities
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- Executive Order 12962, Recreational Fisheries
- Executive Order 13045, Protection of Children From Environmental Health Risks and Safety Risks
- Executive Order 13112, Invasive Species
- Executive Order 13158, Marine Protected Areas
- Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management
- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance
- Executive Order 13547, Stewardship of the Ocean, Our Coasts, and the Great Lakes

Federal Laws

- Clean Air Act, 42 U.S.C. 7401 et seq.
- Clean Water Act, 33 U.S.C. 1251 et seq., Sections 401, 402, and 404
- Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601
- Emergency Planning and Right to Know Act, 42 U.S.C. 11001 et seq.
- Endangered Species Act, 16 U.S.C. §1531 et seq., Section 7
- Fish and Wildlife Coordination Act, 16 U.S.C. 661 et seq.
- Marine Mammal Protection Act, 16 U.S.C. 1361

- Migratory Bird Treaty Act, 16 U.S.C. 703-712
- National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321-4347
- Rivers and Harbors Act, Section 10
- Resource Conservation and Recovery Act, 42 U.S.C. 6901
- Safe Drinking Water Act, 42 U.S.C. 300f et seq.
- Toxic Substances Control Act, 15 U.S.C. 2601 et seq.

Federal Regulations

- 14 CFR 1216.3 – Procedures for Implementing NEPA (NASA regulations)
- 40 CFR 50, National Primary and Secondary Ambient Air Quality Standards
- 40 CFR, parts 51 and 93 – EPA General Conformity Rule
- 40 CFR 60, New Source Performance Standards
- 40 CFR 61, National Emission Standards for Hazardous Air Pollutants
- 40 CFR 82, Protection of Stratospheric Ozone
- 40 CFR 102-80, Safety and Environmental Management
- 40 CFR, part 122 and scattered sections, National Pollutant Discharge Elimination System
- 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 1500-1508 – Council of Environmental Quality (CEQ) Regulations for Implementing NEPA
- 48 CFR, subpart 23.9 Contractor Compliance with Environmental Management Systems
- Drinking Water Candidate Contaminant List
- Groundwater Rule
- National Ambient Air Quality Standards
- National Emissions Standards for Hazardous Air Pollutants
- Radionuclide Rule
- Radon Regulation

Federal Guidance

- Council of Environmental Guidance (CEQ) - Final Guidance Clarifying Use of Categorical Exclusions
- Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act (EPA 841-B-09-001)

NASA Policy Directives (NPD)

- NPD 8500.1, NASA Environmental Management

NASA Procedural Requirements (NPR)

- NPR 8580.1, Implementing The National Environmental Policy Act and Executive Order 12114
- NPR 8590.1, NASA Environmental Compliance and Restoration (ECR) Program
- NPR 8000.4, Agency Risk Management Procedural Requirements
- NPR 8553.1, NASA Environmental Management System

Internal NASA Documents

- NASA Environmental Justice Strategy

17. Historic Preservation

17.1 DESIGN PHILOSOPHY

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.

Preserving historic buildings is essential to understanding our nation's heritage. In addition, it is an environmentally responsible practice. Reusing existing historic buildings is essentially a recycling program that also respects and preserves the legacy of our built heritage. Contrary to popular belief, existing buildings can often be energy efficient through their use of good ventilation, durable materials, and spatial relationships. An immediate advantage of older buildings is that a building already exists; therefore energy is not necessary to create new building materials and the infrastructure is already in place. Modifications can be made to adapt existing buildings to compatible new uses. This not only makes good economic sense, but also preserves our legacy and is an inherently sustainable practice.

Historic Properties, as identified by the National Historic Preservation Act of 1966, 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 manmade 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 extant building or landscape as demolition or bulldozing can irreparably damage a culturally significant landscape.

17.1.1 FOUR TREATMENT APPROACHES

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:

- **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.
- **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.
- **Restoration** depicts a property at a particular period of time in its history, while removing evidence of other periods.
- **Reconstruction** re-creates vanished or non-surviving portions of a property for interpretive purposes.

The majority of 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.

17.1.2 HISTORIC TREATMENT PLAN

Work on historic buildings, landscapes, archaeological sites, or other cultural resources, requires knowledge of a unique process of compliance and review. Since the review process can affect project schedules, it is important that key compliance milestones are met in order to keep the project schedule on track. For example, projects involving rehabilitation or demolition of historic properties, new construction involving in historic buildings or districts, or new construction within historic districts or their viewsheds may have need extra time to get through the compliance review process.

Centers are required to develop Integrated Cultural Resources Management Plans (ICRMP) that are key tools in identifying management approaches to historic properties and cultural resources at the Center. The Center Historic Preservation Officer (HPO) is responsible for the development of the ICRMP and for identifying the compliance process and reviews associated with various laws and regulations such as Section 106 of the NHPA or the Archeological Resources Protection Act. Projects involving historic properties – including historic buildings, historic districts, archeological sites, and historic landscapes - should be coordinated with the HPO.

It is imperative to determine the appropriate treatment for a historic property at project initiation, before design begins. This includes making sure that the proposed function for the historic property is compatible with the existing conditions in order to minimize destruction of the historic fabric. Project designers must be aware of the character defining features of a historic property. Generally, the least amount of change to the building's historic design and original architectural fabric is the preferred approach. However, a well thought out approach to the rehabilitation or adaptive reuse of a historic building can include distinguishing the character defining features that should be retained versus other fabric that may be removed without adversely affecting the historic character of the building.

Prior to commencing the design of a project, it is essential for the design team to create a planning document outlining the following design parameters:

- The historical significance of the historic building or district;
- The qualities and elements that contribute to the historic character of the resource;
- Historic preservation priorities; and
- The appropriate treatment standard for the project (preservation, rehabilitation, restoration, or reconstruction)

For rehabilitation or adaptive reuse projects involving historic properties, the design team should prepare a separate Historic Treatment Plan in consultation with the HPO to ensure the project is designed to minimize impacts to historic properties. For example, if a historic building is known for its innovative vertical siding and special windows, the Historic Treatment Plan would identify ways to repair these features without replacing them, and would identify appropriate replacement materials that would retain the character of the building if repair is infeasible. .

Project designers should also be aware if a new construction project is in the viewshed of a historic property (building or district) or within the boundaries of a historic district. New construction in these locations should take into account the design qualities of a historic property or historic district and ensure that the new design does not adversely impact those qualities. For instance, if a particular historic district is known for key views from different public viewpoints, new construction should not obstruct those views. Additionally, new construction should not detract from the key characteristics that contribute to the historic property's

significance. For example, if a building was historically the tallest building in the area, then constructing a new "tallest" building adjacent to the historic building may not be appropriate.

For more guidance on treatment plans or other tools recommended for working with historic properties, go to http://www.wbdg.org/design/apply_process.php.

17.1.3 INTEGRATING HISTORIC PRESERVATION CONCERNS WITH OTHER DESIGN CRITERIA

Preservation and design professionals should consider the cumulative effect of seemingly minor changes over time, which can greatly diminish the integrity of a historic building. Major preservation design goals include:

- **Update Building Systems Appropriately:** Updating building systems in historic structures requires striking a balance between retaining original building features and accommodating new technologies and equipment. Building system updates require creativity to respect the original design and materials while meeting applicable codes and tenant needs.
- **Accommodate Life Safety and Security Needs:** Accommodation of new functions, changes in technology and improved standards of protection provide challenges to the reuse of historic buildings and sites. Designers must address life safety, seismic, and security issues in innovative ways that preserve historic sites, spaces, and features.
- **Comply with Accessibility Requirements**: Accessibility and historic preservation strategies sometimes conflict with each other. Designers must provide access for persons with disabilities while meeting preservation goals.
- **Accommodate energy efficiency requirements and improvements:** Integrating energy efficiency and performance in historic buildings is a large task that needs to be properly evaluated through analysis or energy audit before deciding quick fixes that may not provide the best return on investment or which may permanently affect historic features of a building. For example, repairing and retrofitting historic windows often does a better job of achieving energy efficiency goals, and should be thoroughly evaluated before planning for a quick fix of replacement windows.

17.2 KEY HISTORIC PRESERVATION REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key historic preservation requirements, regulations, standards and guidance are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

National Codes and Standards

- Secretary of the Interior's Standards for the Treatment of Historic Properties.

Executive Orders

- Executive Order 11593, Protection and Enhancement of the Cultural Environment
- Executive Order 12114, January 4, 1979, Environmental Effects Abroad of Major Federal Actions
- Executive Order 13007, May 24, 1996, Indian Sacred Sites
- Executive Order 13175, Nov 6, 2000, Consultation and Coordination with Indian Tribal Governments

- Executive Order 13287, March 3, 2003, Preserve America
- Executive Order 13327, February 6, 2004, Federal Real Property Asset Management
- Executive Order 13423, January 24, 2007, Strengthening Federal Environmental, Energy, and Transportation Management

Federal Laws

- National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq.
- Archaeological Resources Protection Act of 1979, 16 U.S.C. § 470aa-mm.
- Federally Recognized Indian Tribe List Act of 1994, 25 U.S.C. 479a.
- Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3001 et seq.
- American Indian Religious Freedom Act, 42 U.S.C. 1996.
- National Environmental Policy Act, 42 U.S.C. § 4321 and §§ 4331– 4335.

Federal Regulations

- 36 CFR Part 800, Protection of Historic Properties (The Advisory Council on Historic Preservation's Regulations for Implementing Section 106 of NHPA).
- 36 CFR Part 61, Procedures for State, Tribal, and Local Government Historic Preservation Programs.
- 36 CFR Part 65, National Historic Landmarks Program.
- 36 CFR Part 79, Curation of Federally Owned and Administered Archeological Collections.

Federal Guidance

- Secretary of the Interior's Standards and Guidelines for Federal Agency Historic Preservation, Federal Register: April 24, 1998 (Volume 63, Number 79), Pg. 20495
- Statement of Federal Financial Accounting Standards 29, Heritage Assets and Stewardship Land, July 7, 2005.
- Whole Building Design Guide

NASA Policy Directives (NPD)

- NPD 1440.6, NASA Records Management
- NPD 8500.1, NASA Environmental Management
- NPD 8800.14, Policy for Real Estate Management
- NPD 8820.2, Design and Construction of Facilities

NASA Procedural Requirements (NPR)

- NPR 1441.1, NASA Records Retention Schedules
- NPR 4310.1, Identification and Disposition of NASA Artifacts
- NPR 7120.5, NASA Space Flight Program and Project Management Requirements
- NPR 8553.1, NASA Environmental Management System
- NPR 8800.15, Real Estate Management Program
- NPR 8820.2, Facility Project Requirements

18. Designing for Maintainability

18.1 DESIGN PHILOSOPHY

MIL-HDBK-470A, Department of Defense Handbook Designing and Developing Maintainable Products and Systems, defines **Maintainability** as:

> "The relative ease and economy of time and resources with which an item can be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair. In this context, it is a function of design."

As NASA buildings and equipment systems become more complex and expensive, maintainability and long-term reliability become important factors in facility planning. An effective maintenance program requires setting objectives, proactive planning and training, disciplined design implementation, and continuous feedback from maintenance personnel and facility users. Designing for maintainability is the first step of such maintenance program. It is the collaboration between 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 & downtime, and improving safety. NASA strongly encourages the active participation of maintenance personnel during the entire design and construction phases as well as maintaining a lessons learned file on each project.

Designing for maintainability attempts to address the following considerations:

- **Testability and Diagnostics.** A design element that allows the detection and isolation of faults within the system in a timely and efficient manner;
- **Environmental Factors**. A design element that determines the physical operational environment such as clearances, locations, access, optimum operating temperature, etc.;
- **Human Factors**. A design element that addresses human considerations such as safety, comfort, and ease of operation. This also addresses operator skill level and training requirements;
- **Life Cycle Cost**. Design data that address the overall cost acquiring, owning, and disposing of building and equipment systems over the systems' expected life.
- **Redundancy.** Ensure critical systems have backup or redundant systems.
- **Equipment Specification.** Specifying equipment that is easy to install, operate, troubleshoot and maintain. This would include 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.
- **Acceptance.** Specifying the procedures outlined in the NASA Reliability Centered Building and Equipment Acceptance Guide to accept building equipment.

- **Tracking Lessons Learned.** Such as a feed back mechanism from maintenance to design on equipment performance, maintainability and reliability.

Designing for maintainability also addresses the manner by how operations and maintenance documents & data are gathered and submitted to the facility owner. These data include equipment lists, make, model, & serial numbers of installed equipment, product data sheets, installation & assembly instructions, warranties, replacement parts, preventive maintenance schedules, submittal & approval registers during the construction phase, safety, emergency & troubleshooting information, start-up & shut-down procedures, etc. To standardize the electronic format and simplify the collection & turnover of these data in a way that can be automatically uploaded into the Computerized Maintenance Management System (CMMS).

18.2 KEY MAINTAINABILITY REQUIREMENTS, REGULATIONS, STANDARDS AND GUIDANCE

Key requirements, regulations, standards and guidance for Designing for Maintainability are summarized below. Requirements for each are listed below and summarized in Chapters 2 thru 4.

Executive Orders

- Executive Order 13327, February 6, 2004, Federal Real Property Asset Management
- Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, Sections 2(a), (b) and (c)
- Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Federal Laws

- Energy Policy Act of 2005's (EPAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)

ASA Policy Directives (NPD)

- NPD 8810.2, Master Planning for Real Property

NASA Procedural Requirements (NPR)

- NPR 8810.1, Master Planning Procedural Requirements
- NPR 8820.2, Facility Project Requirements
- NPR 8831.2, Facilities Maintenance and Operations

Internal NASA Documents

- NASA Reliability Centered Building and Equipment Acceptance Guide
- NASA Sustainable Policy Handbook for Facilities