Standard: **Facilities Design Standards, Rev. 10**

Process: Administer Facilities Process

Process Owner: Robert E Develle

Effective Date: January 29, 2009

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Document Change and Revision Log:

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Process Owner: Robert E Develle, Jr. - Division 2800
Document Owner: Susan Welch - Section 2810
Document Author: Bela Gutman – Section 2810

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N (New)	January 1, 1998	Total Revision and Re-publication of the Document.
1	January 1, 1999	Interim Administrative Revision of Part I only. No Change in Parts II and III.
2	January 1, 2000	Major Revision and Code Reference Updates. Removal and Replacement of Parts II and III.
3	January 1, 2001	Revision and Reorganization.
4	January 1, 2002	Review and Revision.
5	May 1, 2003	Review and Revision. Separating the CAD Guidelines into a distinct CAD Standard document.
6	November 19, 2004	Review and Revision.
7	July 31, 2006	Review and Revision. Reformat for 2004 MasterFormat
8	January 1, 2008	Review and General Revision. Update for the 2007 California Building Code
9	June 9, 2008	Removes the Exempt and Non-Exempt statement from the list of Job Families in the Table on p. 34.
10	January 1, 2009	Review and General Revision.

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JET PROPULSION LABORATORY **INTEROFFICE MEMORANDUM**

2810-2009-001/RED: btlg

TO: Distribution

FROM: Robert E Develle, Jr.

SUBJECT: **Facilities Design Standards** - Revision for 2009

Enclosed is the newly updated edition of the JPL Facilities Design Standards (FDS), dated January 1, 2009. This document fully replaces the previous edition. Please discard all previous editions.

All modifications and alterations of the physical infrastructure of the Laboratory, including the construction of new facilities, shall follow the dictates contained in the Facilities Design Standard. We appreciate the many contributors to this revision of the standards. Continued involvement of our stakeholders in the revision process assures JPL of a viable, relevant document to guide the facilities design process.

The Facilities Design Standard is scheduled for revision and update on an annual basis. Please direct all inquiries, suggestions, and requests for additional copies to Mr. Bela. T.L. Gutman, Mail Stop 200-213, phone (818) 354-7406.

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JPL FACILITY DESIGN STANDARD

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PREAMBLE

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The goal of the Facility Design Standards is to maintain coordinated and consistent facility systems throughout the JPL institutional environment.

This document is intended to:

- Facilitate the design and construction process through a uniform set of standards;
- Organize and maintain consistent materials, methods and equipment for construction projects;
- Expedite equipment maintenance, repair, or replacement associated with facilities at JPL.

The Standards are not intended to regulate or cover all areas of facility design and construction, but to address those institutional concerns important to JPL.

The most current version of this document is the only valid version. This can be found at "RULES" JPL internal web address: http://rules/cgi/doc-gw.pl?DocID=45413

STEWARDSHIP

Stewardship of three distinct categories of resources, in priority order, is the focus of the Facilities Design Standards.

People

Life safety, security, and environmental comfort (e.g. ventilation, temperature and lighting) baseline levels are established by referenced codes and regulations and enhanced by specific requirements. Appropriate individual and group workspace and support areas should enable rather than restrict staff members while respecting the need for institutional guidelines for space allocation. Aesthetic and other sensory design factors are highly desirable, but must be coordinated with, and balanced against, the pragmatic need for a manageable palette of options.

Property

Buildings, furniture, equipment, and infrastructure at JPL are paid for and owned by NASA. As users and caretakers of Government assets, best value considerations must include both initial and lifetime costs. Where economical, modernization by replacement is desired. Designs should accommodate current requirements within an environment of change, allowing flexibility for cost effective adaptation for future uses.

Place

Support of the JPL Strategic Business Plan and highest and best use of land are central elements of planning for new and remodel projects. Buildings and exterior landscape / hardscape should enhance the flow and interaction of people within the context of the campus-like JPL setting. Consideration of neighboring residents must include sensitivity to visual, audible and other sources of annoyance.

USE AND APPLICATION OF THE DESIGN STANDARDS

These Facilities Design Standards apply to all JPL construction projects, including new facilities, facility modifications, and re-arrangements. The standards are complimentary to, and do not supersede accessibility or life/property safety codes and regulations.

Who uses the Facility Design Standards?

The Facility Design Standards are to be used by JPL's project management teams in the development of construction projects, specification of materials and equipment and construction documents.

Facilities Engineering & Construction Project Management Teams, including:

- JPL Project Administrators
- JPL Project Engineers and Designers
- JPL Construction Administrators
- Project Consultants and Architectural / Engineering Firms
- JPL Facilities Quality Assurance

Maintenance Personnel
The Facility Design Standards are to be used by Maintenance Personnel in maintaining the facilities and in replacing or augmenting existing equipment.

General JPL Managers and Staff
General JPL managers and staff will reference the Facility Design Standards as they conceptualize projects and as a reference for establishing project standards and space allocation.

ORGANIZATION OF THE DESIGN STANDARDS
The JPL Facilities Standards consist of five documents. These documents are the basic elements of the facilities construction and maintenance, described in separate documents, and herein incorporated as mandatory requirements.

- Facilities Design Standard (FDS), (this document).
- Facilities Quality Assurance Standard (FQAS)
- Facilities Design Standard Details (FDSD)
- Facilities CAD Standards (FCS)
- Document Control Requirements (DCR)

DOCUMENT	***DISCIPLINE***	***OBJECTIVE***	***CONTENT***
Facilities Design Standard (FDS)	• Architects • Engineers • Project Managers	Provide institutional-wide consistency for facility design	Specific design requirements in addition to the minimum building code requirements
Facilities Quality Assurance Standard (FQAS)	• Architects • Engineers • Project Managers	Maintain consistent representation of design guidelines and criteria for the planning, design, and technical development of JPL facilities.	Submittal and Plan Check Requirements
Facilities Design Standard Details (FDSD)	• Architects • Engineers • Project Managers Drafters	Consistent details to ensure consistent facilities design	Preferred construction details and symbols conforming to JPL design standards

DOCUMENT	***DISCIPLINE***	***OBJECTIVE***	***CONTENT***
Facilities CAD Standards (FCS)	• Architects • Engineers Drafters	Electronic Conventions for all architectural, engineering and construction documents to ensure universal and efficient recognition and interpretation	Convention for drawing layers, paper-space, formatting conventions such as line weights, symbols used, standard title block, and dimensioning techniques, conforming to National CAD Standard (NCS) requirements
Document Control Requirements (DCR)	• Architects • Engineers • Project Managers Drafters	Archive and retrieval of documents	Conventions for electronic, paper, photographic formats; standardized archival system

The documents are available from the JPL Project Administrator or for additional copies contact Mr. Bela T.L. Gutman, Mail Stop 200-213, phone (818) 354-7406.

WAIVER PROCESS
To deviate from Facility Design Standards (FDS) a waiver must be obtained. A completed Facility Design Standards Waiver Request form is required. A copy and the process description are attached to the FDS in Appendix C. The form is also available from the JPL facilities Project/Task manager.

Submit the completed waiver request to the facilities Project Manager. The waiver shall include documentation and information adequate to make an informed decision, including a clearly stated justification. A review is conducted by the Facilities Engineering and Construction Section Manager for approval (The Approval Authority).

The approval authority is responsible for producing a written decision. A completed waiver package will be retained for inclusion in the permanent project files. The waiver package includes the waiver request, the information associated with granting or refusing the request and the rationale for the decision.

Disapproval by the “Approval Authority” can be appealed. The appeal shall be directed to the Facilities Division Manager. A complete waiver package and any additional circumstances and mitigating issues shall be submitted with the appeal to be considered. The decision by the Facilities Division Manager shall be final.

APPLICABLE STANDARDS, CODES, REGULATIONS AND REFERENCES:
All construction, modification, and rearrangements in JPL controlled property are governed by the codes listed as modified herein. Where dates are not indicated, the latest applicable distribution date, including amendments applies.

Bring conflicts between codes, regulations, references, and these Standards to JPL's attention early in the design process. Conflicts will be resolved in the following priority:

1. Increases occupant safety
2. Protects the property
3. Accommodates disabled occupants

General Construction: **2007 California Building Code (CBC)** California Code of Regulations, Title 24, Part 2
Accessibility Code: **2007 California Building Code (CBC)** California Code of Regulations, Title 24, Part 2
Electrical Work: **2007 California Electrical Code (CEC)** California Code of Regulations, Title 24, Part 3
Mechanical Work: **2007 California Mechanical Code (CMC)** California Code of Regulations, Title 24, Part 4
Plumbing Work: **2007 California Plumbing Code (CPC)** California Code of Regulations, Title 24, Part 5
2007 California Energy Code California Code of Regulations, Title 24, Part 6
2007 California Code of Regulations California Code of Regulations, Title 8
Fire Code: **2007 California Fire Code (CFC)** California Code of Regulations, Title 24, Part 9
2007 California Referenced Standards Code California Code of Regulations, Title 24, Part 12
Road System Design Standards: **Los Angeles, California County Code** – (Current Edition) **http://ordlink.com/codes/lacounty/index.htm**

South Coast Air Quality Management District Regulations, Including but not limited to Regulations II, IV, XI, XIII, XIV, XX, and XXX. – (Current Edition)

Additional Standards, Regulations, Codes and References are located in Appendix B:

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PROCUREMENT REQUIREMENTS SUBGROUP

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Division 00 Procurement and Contracting Requirements

00.01 USE OF IMPERIAL AND METRIC UNITS

JPL is in the process of converting from metric unit drawings to imperial unit drawings. During this process we will require that new buildings be designed and drawn in imperial units. Existing building minor renovation and modifications shall be performed in the same units of measure as that building's master drawings.

MINOR RENOVATION IN EXISTING BUILDINGS:

JPL's current facilities drawings and cad files are metric. All dimensional indications on these drawings shall utilize auto-dimensioning feature of the CAD program. This auto-dimensioning feature shall be used in dual metric and imperial (inch-pound / English) units. The primary unit of measurement is metric (SI), imperial with the secondary inch-pound unit indicated in parenthesis, i.e.: 1 067 mm (3'-6").

- All sheets/drawings shall have two graphic scales indicating both metric and imperial units respectively.
- Civil engineering site plans, drawings, and designs shall utilize metric units in meters only, with 3 decimal point accuracy.
- Written notes and documentation shall be in inch-pound / English units only.

NEW CONSTRUCTION AND BUILDINGS:

New JPL facilities drawings and cad files shall be in imperial measurements. All dimensional indications on these drawings shall utilize auto-dimensioning feature of the CAD program. All sheets/drawings shall have a graphic scale indicating imperial units.

00.02 USE OF RECYCLED MATERIALS

See EPA website for detailed listing of products, supplier and required percent recycled content:

http://www.epa.gov/epawaste/conserve/tools/cpg/products/index.htm

The following materials used in JPL construction must contain recycled content as specified by the Environmental Protection Agency:
Construction Products
Landscaping Products
Non-paper Office Products
Paper and Paper Products
Park and Recreation Products
Transportation Products
Vehicular Products
Miscellaneous Products

00.03 PURCHASES OF RECYCLED MATERIALS

Requestors making purchases that do not meet requirements for recycled content must submit a waiver request to the JPL Environmental Affairs Program Office for approval **before** the purchase is made.

The waiver must identify the reason(s) for purchasing items without the required recycled content as being one or more of the following:

1. Use of minimum content standards would result in inadequate competition.

2. Products meeting EPA guidelines are only available at an unreasonable price.
3. Products meeting EPA guidelines do not meet quality/performance specifications or standards.
4. Products meeting EPA guidelines are not available within a reasonable period.

GENERAL REQUIREMENTS SUBGROUP

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Division 01 General Requirements

01.01 GENERAL

01.02 PLAN AND DOCUMENT SUBMITTALS

JPL is located on Federal property and acts as its own building enforcement agency. JPL Facilities Quality Assurance Standard (FQAS) document is the submittal requirement. All designs for JPL buildings, other facilities and site construction shall be reviewed by JPL Facilities Quality Assurance and shall be designed and constructed to comply with the "permittable" standard of applicable regulations.

01.03 OTHER PERMIT REQUIREMENTS

Elevator construction permit and permit to operate is required by the State of California Division of Industrial Safety for elevators constructed at JPL.
JPL food service facilities require an approval of the Los Angeles County Department of Health.

01.04 PROJECT IMPLIMENTATION

Implementing JPL facility projects is multi-organizational task. Each of the organizations described below is part of the project flow at JPL.

01.05 JPL OCCUPATIONAL SAFETY REVIEW

JPL Occupational Safety Program Office (OSPO), will review and have oversight of occupational and facilities safety requirements.

01.06 JPL SYSTEMS SAFETY REVIEW

JPL Systems Safety Program Office (SSPO) will review and administer issues involving electrical, fire/life safety, flight hardware and flight projects requirements.

01.07 LIFTING DEVICES EQUIPMENT

The JPL LDEM (Lifting Devices Equipment Manager) shall be invited to all design review meetings including the project “kick off” meeting when lifting devices are part of the design. The LDEM shall review the implementation plan prior to the installation, and participate in equipment inspection and acceptance testing. The Use of installed lifting equipment are not be permitted at JPL unless above steps have been completed.

01.08 OFFICE OF PROTECTIVE SERVICES

JPL Facilities Section will consult with the Office of Protective Services to determine the need for security assessment and analysis on each project over $500,000.00 in construction cost. Projects with construction costs below $500,000.00 threshold will be considered only if the project warrants security considerations.

The security assessment will define security requirements for the design of new buildings or for the retrofit of existing facilities. This will determine the acceptable minimum level of security protection for a given facility. Items to be considered with the cooperation of Security and Protective services are:

- Asset analysis
- Threat analysis
- Vulnerability analysis
- Risk analysis

Security Assessments shall follow procedures set forth in “ISC SECURITY DESIGN CRITERIA

For New Federal Office Buildings and Major Modernization Projects" (September 29, 2007).

01.09 SPECIAL SECURITY SYSTEMS

JPL will supply project criteria for security systems. The systems require connection by telephone or through the video communication and fiber network to the Security Console located in Building 310.

01.10 JPL ENVIRONMENTAL REVIEW

JPL Environmental Affairs Program Office (EAPO) shall review and administer environmental requirements.

JPL review is required for all outdoor and certain indoor construction. Contact JPL Environmental Affairs Program Office (EAPO) during planning stages of a project to determine the level of review requirement.

01.11 ENVIRONMENTAL COMPLIANCE

The storage and handling of hazardous materials and waste discharges into the environment will conform to local, state, federal regulations and to specific JPL requirements.

01.12 JPL DIVERSITY PROGRAMS OFFICE (DPO)

JPL Diversity Programs Office (DPO) will review and administer disabled access requirements.

01.13 SUSTAINABLE BUILDING DESIGN AND OPERATIONS

'Sustainable' is the term used to describe the desire to sustain economic growth and environmental health for the long term. Sustainable development requires recognition that every design and operations choice has an impact on the natural and cultural resources of the local, regional, and global environments. Sustainable development seeks to manage natural, economic, and social systems in a fashion that enhances quality of life for current and future generations.

01.14 SUSTAINABLE BUILDING DESIGN

Apply sustainable design principles to the siting, design, and construction of new facilities, and where practical, to the rehabilitation and modification of existing facilities. To optimize life-cycle costs, prevent pollution and minimize energy usage throughout their useful life.

01.15 LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN GREEN BUILDING SYSTEM (LEED)

Develop structures according to the Leadership in Energy and Environmental Design Green Building Rating System (LEED). LEED, developed by the U.S. Green Building Council, evaluates the building's environmental performance over its life cycle, and assigns credits to the project for satisfying a list of criteria.

Project team members will strive for the highest possible LEED rating in their building design, and meet at least the minimum required score to achieve LEED Silver Rating. More information on LEEDS is available at http://www.usgbc.org/programs/LEED-RSv2.0.pdf

- Comply with NASA Policy Directive: "Facilities Sustainable Design".

Comply with NASA Policy Guide: "Reliability Centered Building And Equipment Acceptance Guide".

- Introduce sustainable strategies into the design process early. Incorporate and clearly state target requirements in the project construction documents;

- Use life-cycle cost analysis in the development process;
- Incorporate flexible design to reduce the waste generated from future remodeling;
- Provide consumer operating and maintenance information for best performance in this project through careful planning, specification, metering, job site management, and lab supervision.

01.16 ENERGY CONSERVATION

JPL is required to follow:

- The “Energy Policy Act of 2005” (Public Law 109-58). The text of the law can be found at http://energycommerce.house.gov/108/energy_pdfs_2.htm. Additional information can be found at:http://www.ferc.gov/legal/maj-ord-reg/fed-sta/ene-pol-act.asp.
- Executive Order 13423 (E.O.), “Strengthening Federal Environmental, Energy, and Transportation Management”
- Also, adapt to the latest Energy Conservation / Rebate programs available from Southern California Edison and The Gas Company (Sempra) into the construction project.

01.17 GENERAL PLANNING

JPL is a pedestrian oriented research and development facility exemplifying a "campus" environment. Design and landscape all projects to reflect and support this concept. Minimize lighting, noise intrusions, etc., into neighboring residential communities.

01.18 CONFORMITY TO MASTER PLAN

Generally conform to the Jet Propulsion Laboratory, Oak Grove Master Plan 2003-2013.

01.19 EXTERIOR

Design building exteriors to reflect a pedestrian oriented, technical, research and development, "campus" environment. Designs that "stand alone" and do not respect the scale, form, color and texture of existing adjacent buildings are not acceptable.

01.20 PRIMARY PEDESTRIAN ENTRIES

Incorporate disabled access into the primary pedestrian entry. Use freestanding entry canopies only as a connecting shelter to an adjacent building entry. Use of large skylights is discouraged.

01.21 EXTERIOR THERMAL TRANSMISSION CRITERIA

The exterior envelope shall meet State of California Energy Commission Energy Efficiency Standards.

01.22 INTERIOR DESIGN CONCEPTS

Accommodate current organizational requirements within a "flexible", generic space as opposed to "single use only" specific space.

Design partitions, ceilings, and utilities to standardized horizontal and vertical modules and to minimize future relocation costs. Consolidate office-technical areas into the largest practical suites for maximum future flexibility. Design laboratories in modular sizes. Consolidate shafts, elevators, stairs, corridors, and toilets and locate utility distribution systems to allow maximum flexibility. Size the chase and plenum areas for normal environmental needs and to accommodate large amounts of electronic equipment.

Design major raised access floors areas with a depressed structural sub-floor to establish a flush floor level eliminating ramps. Formal lobbies and receptionist areas are not allowed. A nominal display area is acceptable. Consider thermal and noise control vestibules at entries. Locate primary stairways, passenger elevators, lab-wide conference, satellite reproduction, and similar rooms near the main entry.

01.23 ERGONOMIC WORKSTATION DESIGN

The JPL furniture standards, which specify height-adjustable workstation components, foster Ergonomic workstation design. Ergonomics should also be primary consideration in the design of furniture arrangements. Standard office arrangements/layouts are available at the facilities website: http://construction/officedesignguide/index.html. Additionally, this information is also available in hard copy and electronic format upon request.

01.24 ACOUSTIC CRITERIA - SOUND TRANSMISSION CLASS (STC) & NOISE REDUCTION CLASS (NRC)

Areas considered:

ADJACENT AREAS	Conference Rooms	Meeting room, section manager, and higher offices.	General Office, open office area
Meeting rooms, Section Manager and higher office, general office, open office area, corridors. (Door gasket & sweeps at Sec Manager & higher office.)	STC 45 - 55	STC 35 - 45	STC 35 - 45
Restrooms, janitor, reproduction, computer centers, laboratories	STC 45 - 55	STC 45 - 55	STC 45 - 55
Maintenance shops	STC 55 - 65	STC 55 - 65	STC 55 - 65
Mechanical rooms	STC 55 - 65	STC 55 - 65	STC 45 - 55
Standard T-grid acoustic tile ceiling	NRC 60 in clean areas, NRC 70 and STC 35 in enclosed offices and laboratories, NRC 75 in open office areas and rooms with noisy equipment.		

To minimize sound transmission use floor-to-floor partitions or ceiling-high partitions and gypsum wallboard ceilings for conference, toilet, janitor and mechanical rooms.

01.25 SPACIAL PLANNING CONCEPTS

Building structural bays will be located and sized to achieve maximum flexibility of interior partition rearrangement, and to allow exterior addition expansion. Bays will be compatible with the building form and internal functions. Bays will be as similar as practical within a building to achieve standardized interior planning modules. Interior shear walls will be minimized and be located within fixed service element walls or permanent exit corridor walls.

01.26 PLANNING GRID

The only partitions that should be "off-grid" are exit corridor walls, exterior walls or service room or similar non-movable type partitions. The plan grid will be tied uniformly to the column grid within each major area of the building. At standard computer floors, the ceiling grid will be 2’-0” x 2’-0” and coincidental--on the same planning grid.

Allowable Planning Modules (Grids):

Standard Module	1’-0” x 1’-0” x 1’-0” cube; center to center of partitions; clear columns and ceiling height from concrete floor substrate
Sub Module	4” x 4”
Standard Floor Plan Module	2’-0” x 2’-0”; Minimum 1’-0” x 1’-0”
Standard Structural Column Bays	2’-0” modules
Standard Raised Floor	2’-0” x 2’-0” , or match adjacent units
Standard Ceiling Grid	2’-0” x 2’-0”; Typical field grid 2’-0” x 4’-0”, or if required, to match existing adjacent grid.
Standard Window Mullion or Vertical Joint Module	2’-0”

Standard Vertical Module (Ceiling Heights):

Office Areas	9’-0” is standard; 9’-3” , 9’-6” or 10’-0” is acceptable
General Tech. and Lab Areas	10’-0”
Exit Corridors	8’-0” in office areas; 9’-0” in laboratory areas - with recessed lights, sprinkler heads, etc.
Toilet and Janitor Rooms	8’-0”
Window Sill Height	3’-8” in office area. 4’-0” in tech/lab areas. 7’-0” in laboratory areas with anticipated "door height" equipment racks.

01.27 VALUE ENGINEERING

JPL employs Value Engineering techniques in the “Best Practices” methods. We urge all projects to adhere to the established Best Practices project management techniques in order to maintain a consistent approach to project executions.

Value Engineering explores for cost saving through value enhancement. Areas most commonly questioned are:

- Organizational boundaries
- Incorrect assumptions
- Changes in the state of the art
- Standard methods which are not the best in this case

01.28 ALLOWANCE FOR FUTURE BUILDINGS, BUILDING ADDITIONS

Site, utility systems and building development will allow for future adjacent buildings or additions if indicated in the project program or the master plan.

01.29 BUILDING MASSING AND SITING CRITERIA

Relate all new buildings to the character and scale of adjacent existing and proposed structures. Main pedestrian building entries will be by sidewalks or ramps. Space between buildings will be designed as an integrated single site.

01.30 EXISTING TOPOGRAPHY AND FLOOD PLAIN

Integrate building with existing topography to protect from flood conditions. The established flood plain elevation for buildings is 1080 feet above sea level.

01.31 BUILDING ORIENTATION

Orient buildings to maximize exterior views and to minimize blockage of views from existing or planned buildings. Massing and orientation of buildings shall maximize passive solar and thermal advantages.

01.32 MINIMUM BUILDING SEPARATION

The California Building Code according to the Types of Construction and Occupancy will determine the minimum distance required between buildings.

Minimum Building Setback:

Setback along "Ring Road" except at Surveyor and Arroyo Road:	20’-0” from curb face
Setback along "Ring Road" at Surveyor and Arroyo Road:	5’-0” from curb face
Setback from back edge of pedestrian mall:	10’-0”
Building overhangs with 15’-0” clearance above a walkway grade may encroach upon the required minimum building setback when approved by JPL.	

01.33 MAXIMUM BUILDING HEIGHT

The maximum allowable building height is elevation 1,276 feet above sea level, the approximate height of Building 264, unless approved by the Manager of the Facilities Division in writing for specific sites and projects.

Restrictions on new structure heights are based on the possible impact to existing adjacent building massing and heights from "off-site" views. Integration into the current building massing or "concealment" behind existing tall or massive buildings thereby minimizing skyline exposure is encouraged. Where possible, align floor levels with adjacent existing or planned buildings to accommodate future bridge or grade connections.

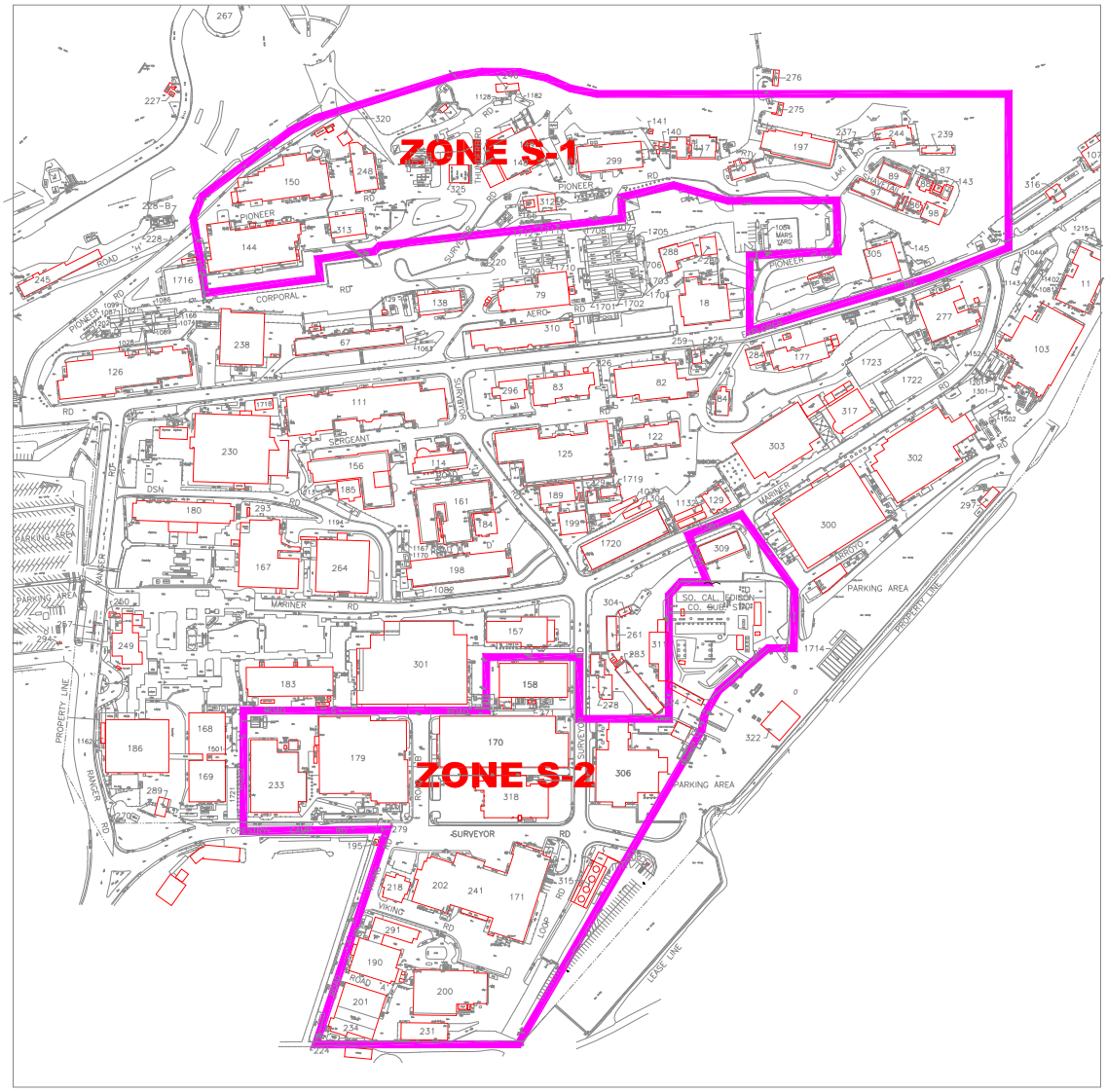

FIGURE 1. -- INDUSTRIAL CHARACTER ZONES

01.34 "INDUSTRIAL" CHARACTER ZONE

"Industrial" zone S-1 and S-2 is primarily for support services and special technical buildings [Figure 1].

ZONE S-1	The areas generally north of Pioneer Road adjacent to the foothills will be primarily used for warehousing and specialized test facilities.
ZONE S-2	The areas generally at the southern boundary will be primarily used for special technical, industrial, and service functions.

01.35 USE OF NON-COMBUSTIBLE MATERIALS

JPL will determine the applicability of NFPA 75 with specific tenants. Materials on new buildings and additions to buildings shall be non-combustible. Utility plants shall be of non-combustible materials. If non-combustible materials are not practical, use fire retardant treated combustible materials, for such items as wood roofing edge nailers and communication backboards.

01.36 EMERGENCY ACCESS
In buildings without elevators, one primary exit stairway and connected corridors, aisles and entry will accommodate the transport of a 2’-0” x 6’-3” ambulance gurney in a horizontal position. Identify the entry points with the "Star of Life" international medical symbol for emergency medical services.

01.37 MAIN EXIT CORRIDOR WIDTHS
The standard main corridor is minimum 5’-0” clear width. The primary exit corridor connecting exits will be 7’-6” minimum net width. A minimum 7’-6” net width corridor will directly connect the service delivery entry to the service elevator or service stairway.

01.38 FIRE RESISTIVE CORRIDORS
Design fire resistive corridors in a "tunnel" configuration to allow utilities to pass over without penetrating the fire rated construction.

01.39 FURNITURE / FILE CABINETS / BOOKCASES IN PATH OF EXIT
In order to prevent entrapment for occupants during earthquake and other emergencies, all furniture in paths of exit, with a height-to-depth ratio greater than 4 shall be anchored to the floor slab or adjacent walls.

01.40 FURNITURE / FILE CABINETS / BOOKCASES IN MAIN EXIT CORRIDORS
Installation of file cabinets, bookcases and other furnishings in Main Exit Corridors is prohibited.

01.41 OFFICE SUITE HALLWAY WIDTH (NON MAIN EXIT CORRIDORS)
The standard suite corridor is minimum 4’-0” clear, including furniture.

01.42 OPEN OFFICE PARTITION AISLE WIDTH
The standard aisle width is minimum 4’-0”.

01.43 INTERIOR SPACE STANDARDS AND DESIGN CRITERIA
The target guidelines described below are not entitlements for either individuals or organizations. The space assigned to an individual will vary from target value depending on the room configuration and the total space assigned to the organization.

01.44 HARD WALL ENCLOSED OFFICE SPACE CRITERIA

EXECUTIVE Director, Deputy Director, Associate Director, Directors and Deputy Directors for; Chief Scientist, Chief Engineer, Chief Technologist	274 S.F.
MANAGEMENT 1. Manager III 2. Manager II 3. Manager I	170 S.F. 150 S.F. 130 S.F.

01.45 01.45 HARD WALL ENCLOSED OFFICE DESIGN CRITERIA
The minimum enclosed office size shall be 100 square feet, and the minimum clear dimension of any enclosed office shall be 9’-0”.

When multiple person workstations are installed inside hard wall offices, the partitions separating the workstations shall be no greater than 3’-4” high. The 5’-5” high partitions may be used only around the perimeter to support bookshelves or flipper cabinets, but shall not obstruct windows.

01.46 OPEN OFFICE WORK STATION AREA SPACE CRITERIA:

MEMBERS OF STAFF 1. Principal / Senior Research Scientist / Administrator IV 2. Senior / Research Scientist / Administrator III 3. Staff / Scientist / Administrator II 4. Associate / Administrator I	 130 S.F. 105 S.F. 95 S.F. 85 S.F.
MEMBERS OF SUPPORT STAFF 1. Senior 2. Staff 3. Associate 4. NASA Representative, Campus Personnel 5. Accountable Contractors 6. Employment Programs	 100 S.F. 90 S.F. 80 S.F. 120 S.F. 80 S.F. 80 S.F.
Multiple Person Office	Minimum 60 square feet per person.

01.47 01.46 OPEN OFFICE WORK STATION AREA DESIGN CRITERIA

The 5’-5” "open office" movable partition system is the standard. Enclose standard workstations on four sides and provide a 2’-6” minimum width entry.

Partitions separating workstations inside multiple person offices shall be no greater than 3’-4” high. The minimum dimension of any open office workspace shall be 7’-6”.

Stagger entries for privacy and acoustical control. Minimize exposure to through "public" traffic aisles. 5’-5” partial height, metal stud and gypsum board partitions may be utilized for "never to be relocated" major aisles.

01.48 CONFERENCE AND BRIEFING ROOMS (OFFICE AREAS)

Requirements for Division / Section / Group Complex	Minimum 1’-6” aisle behind seated conferees Minimum 3’-6” from table to wall Minimum 4’-6” from table to wall for whiteboard or display board access
Division Complex	16-0” x 24’-0” 384 S.F. or 14’-0” x 28’-0” 392 square feet for 20 to 24 people.
Section or Group Complex	12’-0” x 20’-0” 240 square feet for 12 persons. Maximum 12’-0” x 24’-0” 288 square feet for 14 persons.
Briefing Rooms	Consists of two Section or Division complex conference rooms "side-by-side" with a dividing moveable sound control partition.
Special Lecture Rooms	Criteria will be given by JPL for specific projects. A built-up, "movable", stepped floor configuration is preferred.

Meeting Rooms (Designated for use by specific group)	Locate within a group's office area. Standard size is 120 S.F. to 170 square feet with 10’-0” x 12’-0” minimum dimensions for six to ten persons. One meeting room will serve 70 persons. Size rooms to convert easily into future offices. No acoustical treatments allowed but provide 4’-0” x 8’-0” “whiteboard".
Medium Size ICIS Standard Conference Rooms Type “A”	Verify general requirements with JPL facilities Project Manager and ICIS Planning and Liaison Office (951) Institutional Computing and Information Service for equipment requirements.
Medium Size ICIS Standard Conference Rooms Type “B”	Verify general requirements with JPL facilities Project Manager and ICIS Planning and Liaison Office (951) Institutional Computing and Information Service for equipment requirements.
Small Standard ICIS Conference Rooms	Verify general requirements with JPL Facilities Project Manager and ICIS Planning and Liaison Office (951) Institutional Computing and Information Service for equipment requirements.

01.49 SPECIAL ROOMS OR AREAS (OFFICE AREAS)

Coffee Rooms	Provide one per floor per 100 +/- occupants, 48 S.F. minimum, to 65 S.F. maximum, near conference rooms. Provide 6'-0" wide sink cabinet and sink (No garbage disposal required). Provide 3'-0" wide wall cabinet and paper towel dispenser above sink cabinet. Provide floor standing trash receptacle and wall space for one 5'-0" + vending machine, including an 110V electrical outlet. A carpeted sitting area adjacent to the Coffee Room is allowed.
Vending Machine Area	When directed by JPL provide 3'-0" x 8'-0" minimum vending area adjacent to coffee room with two 110V duplex outlets, space for floor standing trash receptacle and money changing machine.
Mail Stations	One per floor for each 100 +/- occupants. Locate off the main corridor.

01.50 COPY-MACHINE ROOMS (OFFICE AREAS)

Locate copy machines in a separate room, located off main corridors central to area being served. Provide one per 100 +/- person office workstations with a minimum of one per floor over 5,000 S.F. Minimum 48 S.F. with a 6'-0" minimum room dimensions. Provide 120 V, 1 phase, 60 Hz, 20 A electrical service, tackable, sound absorbent wall panels on all walls and a 4'-0" wide x 1'-8" deep x 3'-0" high paper storage cabinet.

01.51 CLASSROOMS/TRAINING ROOMS

Tables with Chairs	Allow 20 S.F. – 24 S.F. per conferee. Length = 1.15 to 1.5 times width.
"U" Shaped Tables with Chairs	Allow 38 S.F. – 40 S.F. per conferee. Length = 1.15 to 1.3 times width.
Table Area per Conferee	2'-0" x 2'-8".
Aisles, Furnishing, Utilities and Sound Control	Refer to Conference and Briefing Rooms Office Area criteria.
Vision Area to Screens, TV Monitors, Main Displays	Plan: A maximum of 60° from display edge. Section: A max. of 25° from the horizontal to top of display.

01.52 SERVER ROOMS

Server rooms shall be provided only on special approval. If server room is provided it shall be mechanically and electrically engineered and locked, keyed.

01.53 COMMUNICATION ROOMS

Each floor will have at least one locked, keyed, dedicated, centrally located communication room to house HiNet telecommunications (hub room). The rooms will be 10'-0" x 11'-3" to serve up 10,000 square feet of floor space and will be stacked for ease of vertical access.

Design the room to accommodate HiNet terminal equipment and an 8'-0" x 8'-0" telephone terminal board. The maximum length of HiNet cable run from hub room is 300'-0". Provide ventilation 24 hrs/day and engineer mechanically and electrically for the designated intensity of use.

01.54 ELECTRICAL ROOMS

Each floor will have at least one locked, dedicated, centrally located electrical room. The rooms will provide adequate floor area for electrical equipment and required clearance with expansion possibilities. The electrical rooms will be stacked on each floor for ease of vertical access. No ceiling shall be in the electrical rooms.

01.55 STORAGE ROOMS (OFFICE AREAS)
Provide a minimum of one 50 S.F. to 60 S.F. room per 60 to 80 work stations. Provide 1'-0" deep shelving. (When the program allows, a "landlord's locked storage room" will be provided. The location and size will be determined by JPL.)

01.56 TOILET ROOMS
Locate men and women toilet complexes near main personnel entries and major conference rooms. Requirement for toilets in low occupancy areas shall be determined by JPL. The maximum travel distance to a toilet room for any occupant shall be 250 feet.

01.57 JANITOR ROOMS
Provide a locked, dedicated janitor room with service a floor mounted sink at each floor level, adjacent to each toilet complex. Provide a minimum 40 S.F. area free of door swing area. Mount a 3'-0" mop holder 5'-9" above the service sink. Provide a minimum of 24'-0" shelving, 1'-0" deep.

01.58 DRINKING FOUNTAINS
Provide code (ADA) compliant drinking fountains in corridors. Drinking fountains shall have water spigots. Cartridge type water filters shall be accessible for maintenance and repair.

01.59 SHOWER AND LOCKER ROOMS
JPL will determine when shower and locker rooms will be incorporated into the program. In new buildings or major remodels, provide separate men and women facilities. Locate at the ground floor adjacent to the toilets and near the building service entry.

Minimum for each room, unless modified by JPL are:

Shower Room	Two single showers with glass doors conforming disabled design requirements. Women's showers will have 3'-0" x 4'-0" separate dressing area screened from the toilet room.
Lockers	14-two tier high metal lockers and bench space for 4 persons.

01.60 TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS
All JPL Facilities Design Standards not altered by following "Specific Condition" will apply, unless otherwise directed by JPL. These standards are established for the following considerations:

- The site is on a remote location with one main accesses road.
- Typical site elevation is 7,500 feet above mean sea level (AMSL).
- The facility's proximity to the San Andreas Fault zone located approximately 3,000 feet south of the site.
- Seismic design shall be per the Structural Design Provisions of this document.

- The facility's snow conditions: Snowdrifts often extend above one story building roof ridge heights.
- Minimum design snow loads used in the structural design shall comply with the Structural Design Provisions of this document.
- The facility resides within a "Special Wind Region" as defined in the California Building Code, wind velocities up around 95 mph are common, with recent maximum gusts up to 125 mph. Minimum design wind loads used in the structural design shall comply with the Structural Design Provisions of this document.
- Frost can be concern for foundation design. Foundation design shall comply with Section 01.72.
- The facility's use of electric (Edison) power and propane gas (LPG) for heating, hot water, cooking and other equipment including the emergency generator.
- The facility's common exposure to lightning during electrical storms.
- The requirement to secure U.S. Forestry Department approval for major work on the site.
- The facilities are in use of by the scientific community during night hours.

01.61 “FAIR WEATHER" WORK

Work at Table Mountain Facility described as "Fair Weather" work must be completed during a five (5) month period: May through September.

"Fair Weather" work includes: AC paving, building shell caulked, painted and enclosed, including exterior doors and windows, roof shingles, vents and flues, lightning air protection terminals (including exterior ground grid connections). The heating system will be temporarily operational to provide heat to the interior of the shell. Provide temporary construction material staging and storage within the building or make other arrangements as approved by the JPL and the Site Facility Manager (SFM).

01.62 BUILDING ENTRANCES

For entry doors at Table Mountain Facility, provide a 4’-0” minimum roof overhang.

STRUCTURAL DESIGN PROVISIONS:

01.63 GENERAL

JPL and the Table Mountain Facilities are located in areas of very high seismicity. The impact of this is punctuated with the presence of the Bridge fault (a segment of the active Sierra Madre fault zone) which crosses the JPL Pasadena site (Figure 1) and the presence of the San Andreas Fault located less than 1-mile from the Table Mountain Facility. The California Department of Conservation has also mapped areas of potential of seismic hazards within the JPL site (Figure 2), including potentially liquefiable soils near the Arroyo Seco wash (defined as the area east of Surveyor Road and south of Mariner Road) and the potential for earthquake-induced landslides at the base of the Mesa (defined as the area north of Pioneer Road).

Where the evaluation of existing buildings for seismic loading is required, such evaluation shall be in accordance with ASCE/SEI 41-06 “Seismic Rehabilitation of Existing Buildings” as modified in section 01.60 of this document. Where conflicts in criteria are found, the more stringent criteria shall apply.

01.64 CLASSIFICATION OF JPL STRUCTURES

In addition to classification of building by occupancy (CBC Table 1604.5), JPL Buildings shall be classified as one of the following building types:

1. Mission Critical
2. Mission dependant- not critical
3. Support structures/other

Buildings with Mission Critical functions that occupy more than 30% of a building's usable space shall be classified as Mission Critical for the purpose of this document. Currently Mission Critical buildings are those identified in Figure 3.

01.65 BUILDING SEISMIC DESIGN AND EVALUATION MATRIX

As noted previously, JPL and the Table Mountain Facilities are located in areas of very high seismicity (Figure 3). Even so, the annual probability of a major earthquake affecting the JPL, Pasadena area is relatively small. However, the consequences of the occurrence of such an event could be significant and potentially catastrophic. A major earthquake has the potential to affect not only the safety of JPL personnel, but could jeopardize JPL's mission. Closure of earthquake damaged buildings can be much more costly in downtime and function loss than the cost of repairing actual physical damage induced by earthquake ground motion.

The consequences of major earthquake damage on the functionality and safety of a building and the occupants can be affected by a number of factors including:

- Building occupancy
- Criticality of the building function
- Site Seismicity and seismic hazards (including earthquake induced landslide, liquefaction, and fault rupture)
- Type of construction (i.e., concrete moment frame, concrete shear wall, wood, steel braced frame, etc.)
- Design building code (age of structure)

Identifying and classifying structures based upon the above factors is an important step in determining the seismic risks to JPL and ultimately be used to prioritize which buildings should be evaluated in detail and, if found to be deficient, upgraded or replaced.

Older buildings generally have a higher risk of damage during strong ground motion than newer buildings, as the understanding of earthquake effects on buildings and subsequent enactment of code requirements to address these effects was not begun until 1927. The damaging Santa Barbara earthquake in 1927, and more so the 1933 Long Beach earthquake were the for development of early seismic design codes. However, it was not until the 1976 Uniform Building Code (UBC), that significant improvements in seismic design codes, resulting from lessons learned in the 1971 San Fernando earthquake, were adopted as requirements for design and construction. Further improvements were made in later codes with significant changes occurring in 1988 UBC for steel framed buildings and additional improvements for all structures in the 2001 CBC.

FIGURE 2: MISSION CRITICAL BUILDINGS.

The JPL campus has over 150 permanent buildings and support structures, representing more than 2.5 million square feet of space. The buildings have been constructed from 1945 through the present, with the vast majority of structures being constructed in the 1960's (Figure Y). More than 70% of the building square footage comprising the JPL inventory was constructed prior to implementation of the 1976 UBC. In addition to the permanent structures, JPL utilizes approximately 40+ trailers for various space needs.

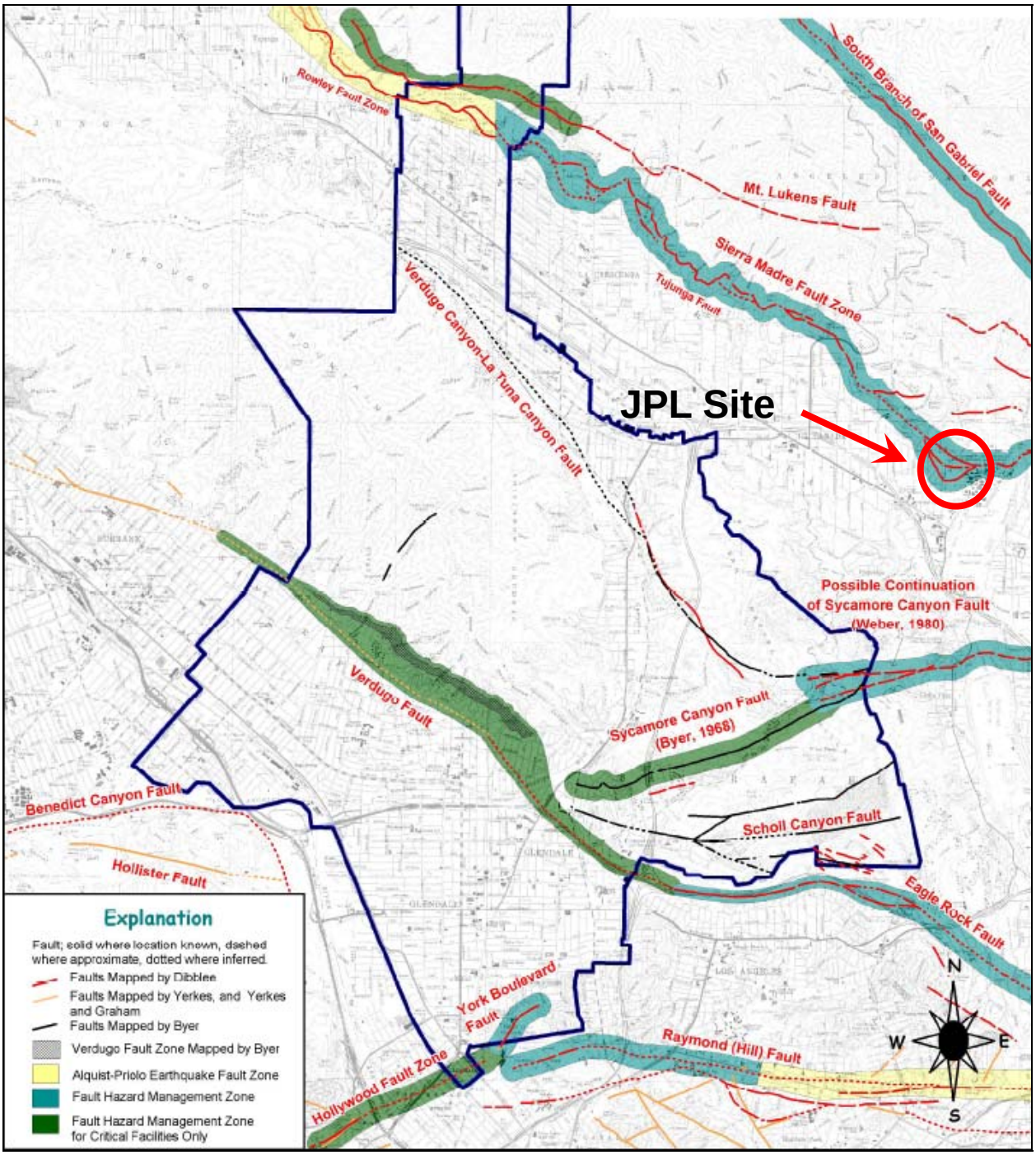

FIGURE 3: FAULT MAP (2003 SAFETY ELEMENT, CITY OF GLENDALE)

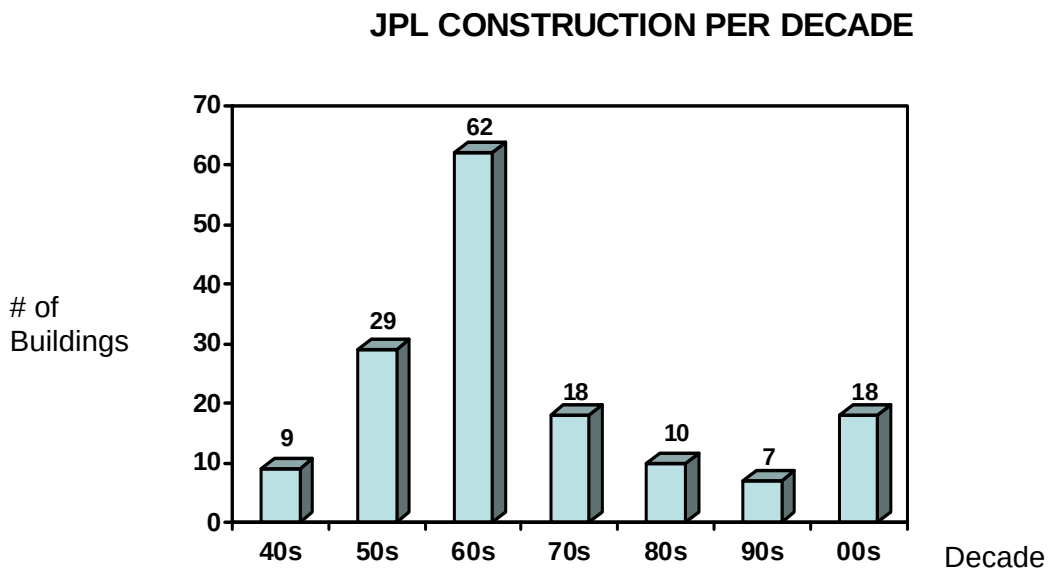

FIGURE 4: JPL BUILDING CONSTRUCTION PER DECADE

01.66 SEISMIC RISK SCREENING

To adequately address the campus-wide seismic risks and to determine the need for detailed seismic evaluation or seismic upgrade when changes in occupancy or tenant improvements are proposed, JPL buildings should have a screening assessment completed. The seismic risk screening assessment procedures used to determine earthquake risk to the JPL building inventory include a *seismic hazard evaluation* for the facility site, and a preliminary *structural classification* for each building. The results of these evaluations can be combined and used to classify each building into a relative risk category (using a 1-5 scale of relative risk), to allow seismic risk to be considered during Master Planning, identifying building function or occupancy, determining were to house Critical Mission functions, and determine when more detailed evaluations or strengthening should be required. To accomplish the screening and assign relative risk each structure should be classified within each of the following categories:

Building Occupancy

Occupancy Category (I – IV) per 2007 CBC Table 1604.5.

Mission Dependency

Building shall be classified, base upon the primary function of the structure, as Mission Critical, Mission Depend (not critical) or Support structures (other). Classification is based upon JPL definitions. Buildings with Mission Critical functions that occupy more than 30% of a building's usable space shall be classified as Mission Critical for the purpose of this document. (See Appendix "A")

Seismic Hazard

Site Seismic Hazards for the JPL campus can be broken into four distinct areas;

1) Hillside/Mesa area that has been identified by State of California as having the potential for earthquake induced landslide bounded by Pioneer on the south and the Mesa to the north,

2) Near fault area comprising those buildings that fall within 100 feet either side of the Bridge fault (Figure 5),

3) area near the Seco Wash east of Surveyor Road and south of Mariner Road where high water table and sandy soil may indicate liquefiable soils, and
4) areas not within those defined as 1, 2 or 3.

Type of Construction
Buildings shall be classified base upon the primary seismic resisting system of the structure. Classification is based upon ASCE 31 -03 Table 2-2.

Year of Construction
Year of record code for original construction or for major seismic strengthening, if applicable. (See Appendix “A”)

01.67 SEISMIC HAZARD EVALUATION
The seismic hazards identify earthquake effects at the site (e.g., ground shaking or ground failure) and quantify the likelihood of their occurrence, irrespective of buildings or other improvements on the site. Seismic hazards include strong ground shaking, ground rupture due to faulting, seismically-induced settlement, liquefaction, and slope failure.

As noted JPL has significant seismic hazards, due primarily to the presence of the Sierra Madre fault, including the Bridge fault segment that crosses the site, and other nearby faults, and also to the potential of liquefiable sandy soils combined with a high water table near the Arroyo Seco wash. Other earthquake faults could also cause strong ground shaking. Based on published geologic reports and maps, strong ground shaking may affect the JPL site as the result of earthquakes likely to occur on the following regional faults:

Table

Fault Name	Type	Limiting Magnitude	Distance (Km)
Sierra Madre	Thrust	7.2	0.7
Verdugo	Thrust	6.9	4.1
Raymond	Oblique	6.5	8.7
Hollywood	Oblique	6.4	10.1
Puente Hills Blind Thrust	Thrust	7.1	12.8
Upper Elysian Park	Thrust	6.4	13.3
Sierra Madre (San Fernando)	Thrust	6.7	14.1
Clamshell-Sawpit	Thrust	6.5	14.2
San Gabriel	Strike Slip	7.2	16.2
Northridge	Thrust	7.0	23.7
Newport-Inglewood	Strike Slip	7.1	26.5
Santa Monica	Oblique	6.6	26.8
Whittier	Strike Slip	6.8	27.5

In addition to strong ground shaking, which is the primary seismic hazard for the majority of buildings, there are numerous other seismic hazards which may affect the JPL site.

Fault Rupture and Near-Field Effects
California earthquake fault zones (EFZs), established by the State of California under the Alquist–Priolo Earthquake Fault Zoning Act (first enacted in 1973), are delineated

around known traces of active faults. In accordance with state law, cities and counties must withhold development permits for new construction within EFZs used for human occupancy until geologic investigations demonstrate that the proposed construction is not threatened by surface displacement from future faulting. If an active fault is found, a structure cannot be placed over the trace of the fault and must be set back from the fault (generally 50 feet). The effects of faulting are considered when assessing the potential for earthquake-related damage to existing facilities located within the fault or drag zone.

Although the segments of the Sierra Madre Fault east and west of the site are designated as Earthquake Fault Zones (EFZ) by the State of California, the Bridge fault segment is not. The fault is, however considered to be active and rupture of this fault could adversely affect the performance of adjacent structures.
Very high ground motions and increased damage to buildings have been observed within a few kilometers of historical earthquake ruptures. It has been reported that 90 percent of the buildings that collapsed or sustained severe damage in the 1995 Kobe, Japan earthquake were located within 5 kilometers of the fault rupture.

Liquefaction
Seismically-induced settlement and liquefaction may affect soils supporting foundations, causing the loss of bearing capacity and excessive settlement of foundations, resulting in increased seismic-related building damage. In California, Seismic Hazard Zone (SHZ) maps have been issued by the State Department of Conservation for many major urban areas showing areas prone to liquefaction and landslide. These maps show areas where investigations are required to identify actual liquefaction hazards before development and construction permits can be obtained. The California SHZ map for the JPL area indicates areas adjacent to the Seco wash are potentially prone to liquefaction (low-to-moderate risk).

Earthquake Induced Landslide
In addition to areas prone to liquefaction, California Seismic Hazard Zone (SHZ) maps show areas prone to earthquake induced landslides. These maps show areas where investigations are required for landslide hazards. As with the potential for liquefaction, California SHZ map for the JPL area indicates areas on campus that are potentially prone slope failure (landslides or local failures triggered by earthquakes). Identified is the area adjacent to the Mesa (north of Pioneer Road). Slope failures can affect soils supporting foundations and can lead to loss of bearing capacity and excessive settlement of foundations, resulting in increased seismic-related building damage and/or injury.

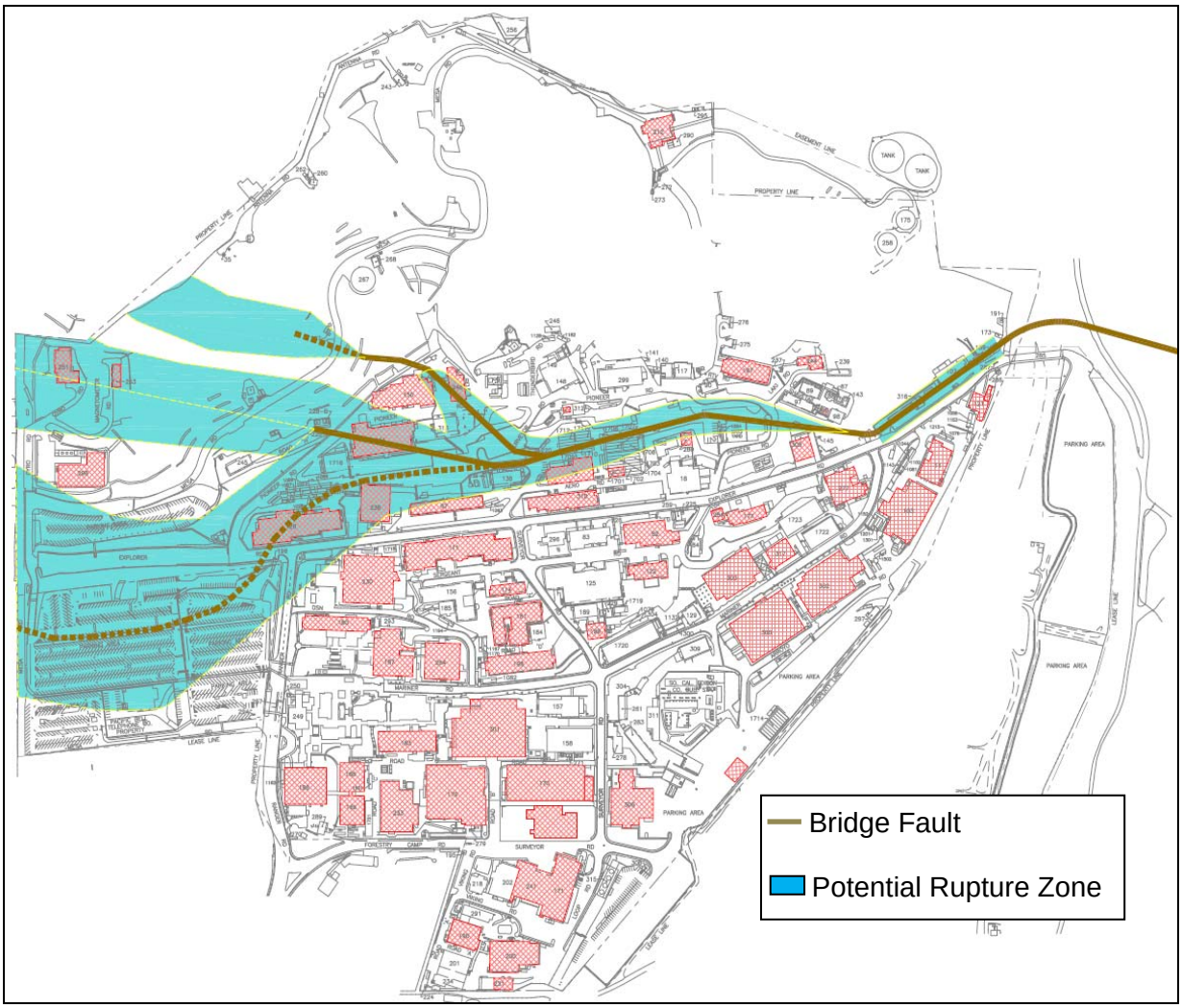

FIGURE 5: BRIDGE FAULT SEGMENT OF SIERRA MADRE FAULT ZONE

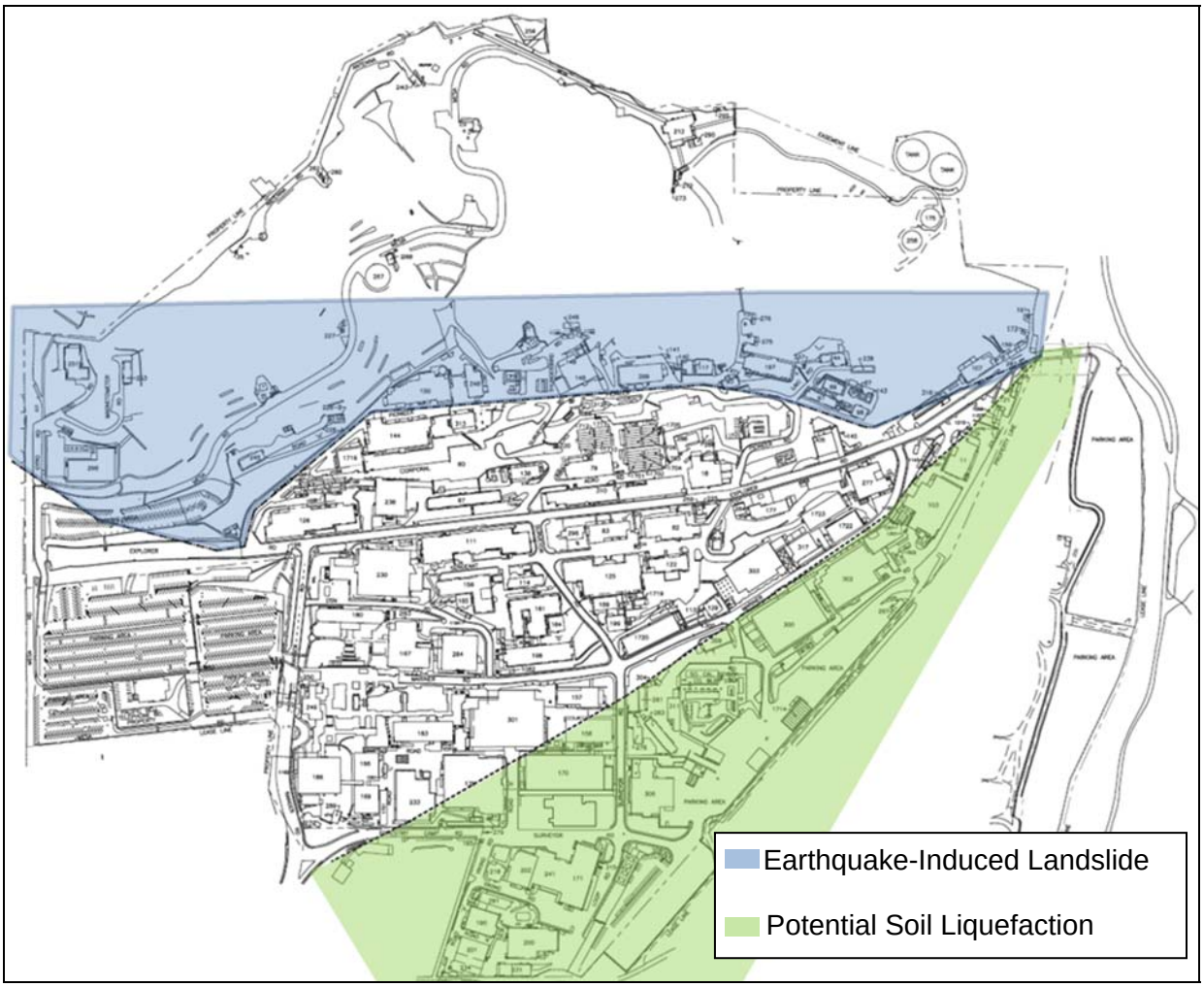

FIGURE 6: POTENTIAL SEISMIC HAZARDS AS IDENTIFIED BY STATE OF CALIFORNIA

01.68 STRUCTURAL EVALUATION

The *structural evaluation* provides basic knowledge of the occupancy, configuration, structural characteristics, and seismic deficiencies of the lateral force-resisting systems in each building. The type and configuration of primary vertical and lateral-force resisting systems are determined to the extent practical based on limited evaluation.

Based on the above scope, the year of original construction, type of vertical structural system, and type of lateral force-resisting system classified using the classification system from ASCE 31-03, “Seismic Evaluation of Existing Buildings”; a limited screening evaluation can be completed to determine relative performance of existing structure.

01.69 CLASSIFICATION OF RISK AND RETROFIT PRIORITY

For each building in the JPL inventory, the *seismic hazard evaluation* at the building site and the *structural evaluation* of the individual building can be combined to determine the overall seismic risk. Each building can be placed into a relative risk category (using the 1-5 scale below) based on the identified site hazards and the deficiencies in the building construction. The Risk categories are defined as follows:

RISK CATEGORY	DESCRIPTION OF RISK
1	**Building Appears to have a Significant Life-Safety Hazard or high consequences due to downtime**
2	**Building Likely has a Life-Safety Hazard**
3	**Building Possibly has a Life-Safety Hazard**
4	**Building is Unlikely to have a Life-Safety Hazard and low consequences due to downtime**
5	**Building is Very Unlikely to have a Life-Safety Hazard**

Buildings with higher relative risk (Risk Category 1 or 2) should not be used for Mission Critical functions without implementing a strengthening program.

For all buildings identified as Risk Category 1 or for Mission Critical buildings identified as Risk Category 1 or 2, detailed seismic evaluation per Section 01.67 should be completed to determine adequacy of the building, or if seismic strengthening is warranted.

For all buildings identified as Risk Category 2 or for Mission Critical buildings identified as Risk Category 3 or 4, detailed seismic evaluation per Section 01.67 should be completed if changes in occupancy or major capital expenditures are proposed.

For all buildings identified as Risk Category 5, detailed seismic evaluation per Section 01.67 need to be completed only if major modifications to the existing structural system are proposed.

01.70 APPLICABILITY

As noted above, detailed seismic evaluation of an existing building is required if the building is to be modified and any of the following apply:

1. Total construction cost, not including cost of furnishings, fixtures, and equipment, or normal maintenance, for the building exceeds 25% of the construction cost for the replacement of the existing building.
2. The changes are cumulative for past modifications to the building.
3. There are changes in the occupancy category that increase the consequences of seismic damage.
4. The modification to the structural components increases the seismic forces in or strength requirements of any structural component of the existing structure by more than 10% cumulative since the original construction or most recent seismic strengthening, unless the component has the capacity to resist the increased forces determined by Section 01.67.
5. Additions to the structure increases the live or dead load by more than 10% for any floor level.

Results of Detailed Evaluation

Where required, detailed seismic evaluation of an existing building shall be conducted in compliance with Section 01.57.03.5. The results of the evaluation shall determine the appropriate action.

1. Mission Critical buildings shall meet *Immediate Occupancy* (IO) level of performance. If the building does not meet an IO level but meets *Life Safety* (LS) level of performance, the Mission Critical functions shall be located to other structures meeting the IO performance level. Alternately the structure may be strengthened to meet the desired level of performance.

2. All other structures shall meet a minimum of LS level of performance. If the building does not meet an LS level of performance but meets *Collapse Prevention* (CP) level of performance, a program to strengthen the building shall be designed and implemented within 5 years.

3. Structures not meeting a minimum of a CP level of performance shall be not be occupied until strengthening is complete.

STRUCTURAL DESIGN STANDARDS:

01.71 FLOOR AND LIVE ROOF LOADS

Uniformly distributed and concentrated floor live loads shall be per Table 01-1. Live Loads from Table 01-1 are not reducible.

TABLE 01-1: FLOOR LIVE LOADS

Area	Minimum Live Load	Concentrated Load
Office and Light Electronic Labs	100 psf[1]	2,000 lbs
Labs With Heavy Equipment, Libraries, Tape Storage, Raised Floor Systems in Technical Areas	125 psf	1,500 lbs
Mechanical/Electrical Rooms	100 psf	2,500 lbs
All Occupancies, Slab On Grade	300 psf[1]	3,000 lbs
Storage Racks and Wall hung Cabinets[2]	--[2]	--[2]

[1] *This load includes an allowance of 20 psf for interior partition dead load.*

[2] *The minimum vertical design live load shall be as follows:*

Paper media:

12-inch deep shelf 33 pounds per lineal foot

15-inch deep shelf 41 pounds per lineal foot, or

33 pounds per cubic foot per total volume of the rack or cabinet, whichever is less.

Film media:

18-inch deep shelf 100 pounds per lineal foot, or

50 pounds per cubic foot per total volume of the rack or cabinet, whichever is less.

Other media:

20 pounds per cubic foot or 20 pounds per square foot, whichever is less, but not less than actual loads.

For floor area occupancies not identified in Table 01-1, floor live loads shall be determined per CBC Section 1603.11, Table 1607.1.

Roof live load shall be in accordance with CBC section 1607.11 and can be reduced in accordance with Section 1607.11.2.

In addition to roof live loads; roof snow loads shall be considered for Table Mountain Facility due to the facility's snow conditions: Snowdrifts often extend above one story building roof ridge heights. Design for snow loads shall be in accordance with Chapter 7 of ASCE 7. Utilize 75 psf (3.6 kPa) minimum design snow loads in the structural design.

Roof dead loads shall include weights of construction material and 150% of the actual operational weight of roof top equipment. In addition to dead loads noted previously, roof dead loads shall provide for the weight of at least one additional roofing, if new roofing can be applied over original without its removal.

01.72 WIND DESIGN

All JPL Buildings, structures and parts thereof shall be designed to resist the minimum wind loads prescribed in CBC Section 1609. Wind forces shall derived based upon an Exposure Category C, except for Mesa area (as defined in Section 01.1) and Table Mountain Facility area buildings, where an Exposure Category D shall be used for calculation of wind load. Wind importance factor, I_w, for Mission Critical structures shall be taken as I_w =1.25.

For wind design, the 3 second wind gust speed (V_{3S}) and fastest mile wind speed (V_{fm}) shall be taken as 100 mph and 85 mph, respectively. For wind design at Table Mountain Facility, the 3 second wind gust speed (V_{3S}) and fastest mile wind speed (V_{fm}) shall be taken as 125 mph and 109 mph, respectively.

Calculated story drift due to wind pressure shall not exceed 0.005 times the story height for buildings less than 65 feet in height or 0.004 times the story height for buildings greater than 65 feet in height.

01.73 SEISMIC DESIGN OF BUILDINGS

JPL Buildings, structures and parts thereof shall be designed to resist the minimum earthquake loads prescribed in CBC Section 1613. For buildings defined as Mission Critical, CBC section 1613A shall apply in addition to modifications to ASCE 07 provided in CBC Section 1614A.

Based upon site soil conditions, JPL campus is classified as Site Class D. The following Seismic coefficients shall be used for design:

S_s= 3.12g
S_1= 1.12g
S_{DS}= 2.08g
S_{D1}= 1.12g

Where a dynamic response spectrum analysis is required by CBC, the following response spectrum shall be used. (Table 01-2 and Figure 7)

TABLE 01-2:
JPL SITE RESPONSE SPECTRUM*5% DAMPING

Period (Seconds)	Spectral Accelerations (g)
0.0	0.71
0.01	0.882
0.1	1.54
0.15	1.946
0.2	2.086
0.3	2.058
0.4	1.932
0.5	1.778

TABLE 01-2: JPL SITE RESPONSE SPECTRUM*5% DAMPING	
0.6	1.638
0.7	1.498
0.8	1.372
0.9	1.246
1.0	1.12
1.3	0.826
1.6	0.63
2.0	0.462
3.0	0.3

*Modified from Report of Ground Motion Studies, Jet Propulsion Laboratory, August 1994.

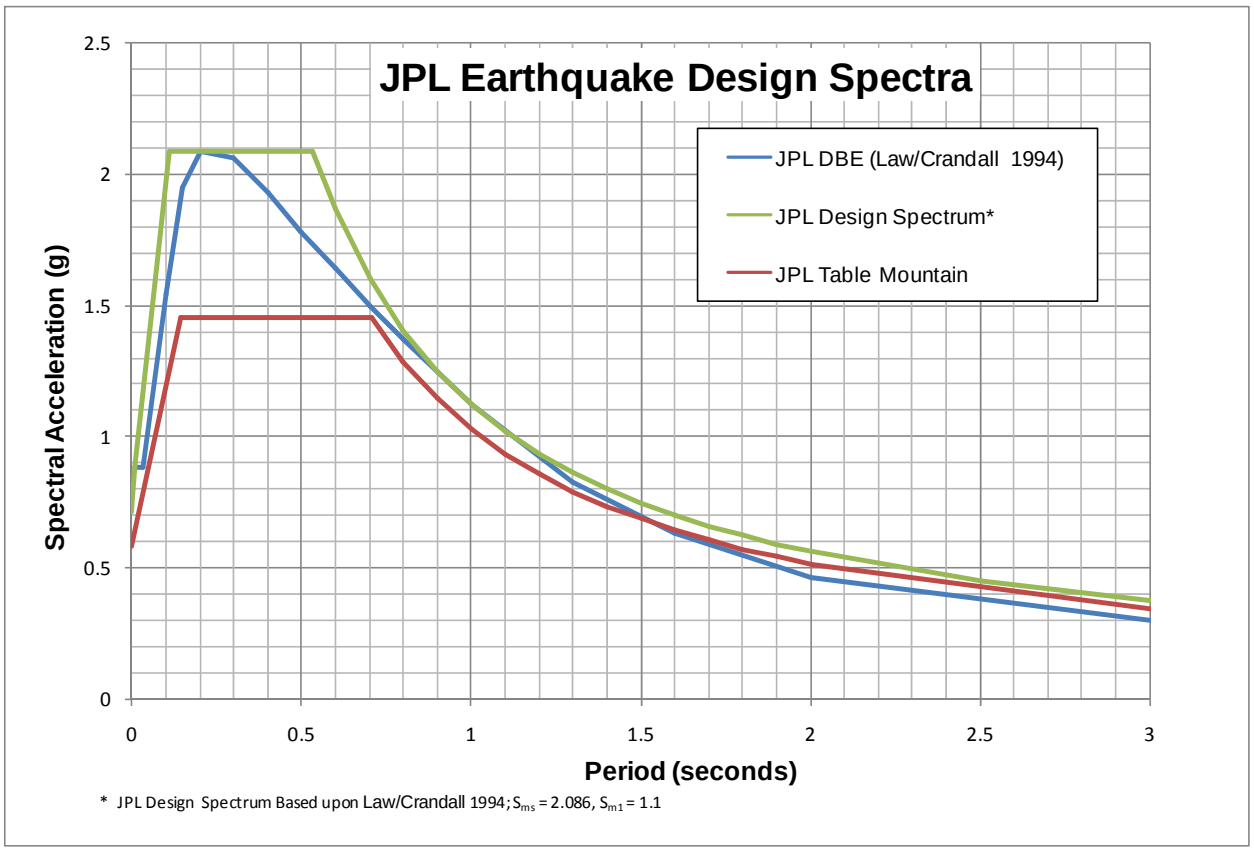

FIGURE 7: JPL EARTHQUAKE SPECTRUM

For Table Mountain Facility the Earthquake Hazard Level shall use the following seismic coefficients based upon a site class C and 2/3 MCE:

S_s= 2.19g
S_1= 1.20g
S_{DS}=1.453g
S_{D1}=1.028g

Where a dynamic response spectrum analysis is conducted for Table Mountain Facility, the following spectrum shall be used. (Table 01-3 and Figure 4)

TABLE 01-3: JPL TABLE MOUNTAIN FACILITY SITE RESPONSE SPECTRUM 5% DAMPING	
Period (Seconds)	Spectral Accelerations (g)
0.0	0.58
0.143	1.453
0.2	1.453
0.708	1.453
0.8	1.285
0.9	1.143
1.0	1.028
1.1	0.935
1.2	0.857
1.3	0.791
1.4	0.734
1.5	0.686
1.6	0.643
1.7	0.605
1.8	0.571
1.9	0.541
2.0	0.514
3.0	0.343

Buildings defined as Mission Critical shall be assigned a Seismic Design Category F and Importance Factor (I) = 1.5, all other buildings shall be assigned a Seismic Design Category E and Importance Factor = 1.0.

Material specific seismic requirements shall be per JPL FDS Divisions 03 through 06. For seismic requirements for Furniture and Mechanical Equipment design shall be per respective divisions.

For Table Mountain Facility the Earthquake Hazard Level shall use the following seismic coefficients based upon a site class C and 2/3 MCE:

01.74 SOIL AND FOUNDATIONS

Foundation design shall comply with CBC Chapter 18. Unless specified otherwise in a building specific soil investigation report, allowable load-bearing values shall be as follows:

Allowable Foundation Pressure	2500 psf
Lateral Bearing	300 psf/ft below natural grade
Lateral sliding/coefficient of friction	0.4

Increases in allowable lateral sliding resistance shall be per CBC section 1804.3.1.

Basement, foundation and retaining walls shall be designed, at a minimum, to resist design lateral soil load specified:

Active Pressure	40 psf/ft of depth
At rest	60 psf/ft of depth

In addition, provisions shall be made to increase lateral design pressure from surcharge loads as applicable.
Retaining walls higher than 12 feet shall be designed to resist the additional earth pressure from seismic ground shaking, in addition to lateral loads noted above.

For buildings in areas where soils have been identified as being potentially liquefiable, as near Arroyo Seco wash (Figure 2), pile foundations or mat foundations should be considered. Site soils investigation shall be completed for these areas and specific values and recommendations identified in the report shall be used for foundation design.

For buildings in areas where the potential for earthquake-induced landslides has been identified, as near the Mesa (Figure 2); site soils investigation shall be completed and specific values and recommendations identified in the report shall be used for foundation design.

For foundation design of Table Mountain Facility buildings, JPL will provide a geotechnical report. Unless otherwise specified in the geotechnical report, minimum design values shall as listed above. Spread footings are preferred and will generally extend through or bear on bedrock. Extend footings below frost line. For the purpose of design, the Frost line is assumed to extend to 24” below finish grade. Where fill exceeds 6’-0” utilize a one-sack concrete slurry mix under standard footings. Isolate foundation walls from interior slabs with 1” minimum rigid insulation board (R-5 minimum) extended below frost line.

01.75 EARTHQUAKE EVALUATION AND RETROFIT DESIGN OF EXISTING BUILDINGS

Seismic evaluation of existing JPL structures shall be in accordance with CBC sections 3414 - 3420 and per procedures defined in ASCE/SEI 41-06. Existing buildings shall be assessed for seismic performance based upon a prescribed Earthquake Hazard Level defined as 2/3 Maximum Considered Earthquake (MCE) using the following seismic coefficients (Site Class D):

S_{DS}=2.08g
S_{D1}=1.1g

Where a dynamic response spectrum analysis is conducted, the spectrum shall be used in Table 01-2 and Figure 7.

For Table Mountain Facility existing buildings, assessment for seismic performance shall be based upon a prescribed Earthquake Hazard Level defined as 2/3 Maximum Considered Earthquake (MCE) using the following seismic coefficients (Site Class C):

S_{DS}=1.453g
S_{D1}=1.028g

Where a dynamic response spectrum analysis is conducted for Table Mountain Facility, the spectrum shall be used in Table 01-3 and Figure 7.

Buildings classified as Mission Critical shall be evaluated for the ability of the earthquake load resisting system to meet an *Immediate Occupancy* level of performance. All other buildings shall be evaluated for the ability of the earthquake load resisting system to meet a *Life Safety* level of performance. (See Appendix “A”)

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FACILITY CONSTRUCTION SUBGROUP

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Division 02 Existing Conditions

02.01 REMOVAL OF ABANDONED EQUIPMENT
JPL's policy is to remove unused equipment in areas affected by the construction work, to eliminate possible hazards and future construction impedance. Abandoned electrical, mechanical equipment, conduits, lines, plumbing, ductwork, including underground installation, etc. shall be removed completely to the source. Where equipment also serves areas otherwise unaffected by the construction work, the designer / project engineer shall designate removal to the last active point in the system. JPL locks from doors and other items shall be safeguarded and returned to JPL Locks Section.

Division 03 Concrete

03.1 CONCRETE STRENGTH
Minimum concrete strength shall be 3,000 psi. Maximum water to concrete ratio for structural components shall be 0.5. Provide curb and gutter concrete design mix at 2,500 psi.

No calcium chloride or "De-Icer" chemicals allowed in concrete or mortar mix designs at Table Mountain Facility.

03.2 CONCRETE SLURRY
Provide concrete slurry for utility and other trench backfill. The concrete slurry shall be no more than one sack of cement per one yard of sand. When the slurry is pumped, two sacks of cement per one yard of sand is acceptable.

03.3 SITE WORK
Walks and landings will be non-slip, coarse, broom finish with texture perpendicular to pedestrian flow.

Division 04 Masonry

04.1 MASONRY DESIGN
Empirical design of masonry shall not be allowed.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS
For Table Mountain Facility colored slump stone; Angelus Block Company, Color "Tan", 4" nom high x 1'-4" nom long. Running bond pattern with colored mortar to match block. Apply clear silicone sealer over entire exterior.

Division 05 Metals

05.1 EXTERIOR METAL
Exterior site metals and railings shall be hot-dipped galvanized and unpainted or anodized aluminum.

05.2 STRUCTURAL PLANNING CONCEPTS

Structural bays will be located and sized to achieve maximum flexibility of interior partition rearrangement, and to allow exterior addition expansion. Bays will be compatible with the building form and internal functions. Bays will be as similar as practical within a building to achieve standardized interior planning modules. To maximize flexibility moment resisting frames should be considered.

05.3 SEISMIC DESIGN OF STEEL STRUCTURES

The design of steel structures to resist seismic forces shall be accordance with AISC 341-05 Part I.

05.4 BUILDING FRAME AND MOMENT-RESISTING FRAME SYSTEMS

For new construction the following systems are not permitted by JPL:

1. Ordinary steel concentric braced frames
2. Intermediate steel moment frames
3. Ordinary steel moment frames

Exception: *Single-story ordinary steel moment frames are permitted for non-Mission Critical buildings pursuant to ASCE 7-05 section 12.2.5.6.*

05.5 STEEL-MOMENT-RESISTING FRAME STRUCTURES AND CONNECTIONS

Design, construction and quality of steel moment frame structures shall meet requirements of AISC 341-05. Special steel moment frames shall meet design requirements of Chapter 9. Only steel frame beam-to-column connections that have been qualified through procedures in Appendix S and/or Appendix P shall be used in new construction.

Note: *Connections that have been independently reviewed and qualified by International Code Committee Evaluation Services (ICCES) to the requirements of ICCES - AC129 are deemed to meet requirements of this section.*

Division 06 Wood, Plastics, and Composites

06.1 EXTERIOR TREATED WOOD

Exterior painted eaves, fascia and trim and nailers and blocking shall be pressure treated wood.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

For Table Mountain Facility minimum roof slopes shall be one vertical to three horizontal (1:3). At exterior painted eaves, fascia and trim and nailers and blocking shall be pressure treated wood. Members shall be kiln dried vertical grain Douglas Fir, back kerfed and painted to minimize warpage with lapped scarf cuts at joints.

Division 07 Thermal and Moisture Protection

07.1 BUILDING ROOFS, ROOFING AND ROOF DRAINAGE CRITERIA

The minimum basic roof slope is 3%. Provide valleys and swales at minimum of 2% slope. Large built-up cant strips are not allowed. "Warp" the roof structure to minimize cants and crickets. Minimum rainfall design is 3” per hour. Maximum spacing between roof drains will be 60’-0”. Provide interior downspouts for buildings over two stories high outside of S-1 and S-2 zones [Figure 1] and insulate when sound is of concern. Provide through parapet scuppers

adjacent to roof drains. Connect downspouts to sub grade drainage system. Provide interior overflow drains on tall buildings above 3 stories.

07.2 ROOFING ASSEMBLY
Minimum 20-year "bondable", polymeric type (PVC) "single ply" mechanically attached to the roof or equivalent. Built-up/field applied bituminous roofing or major volatile/hydrocarbon emitting adhesives are not allowed. Provide 3/32" of poly-reinforced welded membrane with embossed surface walking pads for access to and around roof equipment. Provide expansion Joints at changes of substrate material or at structural expansion joints.

07.3 PARAPET CAP, ROOFING STOP
Use anodized aluminum parapet cap and roofing stops when visible from a major pedestrian way or plaza per JPL Standard Detail.

07.4 ROOF PENETRATIONS
Roof penetrations to be "boot" type closed with pipe clamps. No "unistrut "shall be used to penetrate the roof. No pitch pans allowed.

07.5 BELOW GRADE AND EXTERIOR WALL MOISTURE PROTECTION
Use single-ply, cold applied membrane with "geotextile" or similar filter and fabric drainage mat over the membrane with protection board. Provide a perforated plastic drainage pipe encased in filter fabric at the exterior wall footing.

07.5 THERMAL AND MOISTURE PROTECTION
Thermal Insulation will be foil faced (towards interior), minimum R-19 at exterior walls and minimum R-40 at roof.

Ice and snow shield membrane will be GAF, "Weather Watch" ice and water barrier, 0.5 lbs/s.f. minimum weight. Apply continuously around roof edge and over eaves and extend a minimum of 2'-0" into building line and a minimum width of 3'-0" at all valleys.

Shingle roofing will be GAF, "Royal Sovereign", color "Cedar Shake", installed for high wind application, hand tabbed during installation with a continuous ¼" bead of shingle roofing cement above and parallel to the sealing tabs for additional sealing of overlapping shingles. Apply shingles over a layer of 15 lbs/square asphalt saturated felt, nailed to the roof deck.

Division 08 Openings

08.1 MINIMUM OPEN OFFICE AREA EXTERIOR WINDOW VIEWS
70% of the linear dimension of exterior windows shall remain free for open office area exterior views and/or natural lighting. This required open window length shall not be blocked by fixed partition enclosed areas or with open office landscape partitions higher than 5'-5".

08.2 FENESTRATION
Windows in air conditioned buildings will not be operable, except for lockable windows for emergency or exhaust purposes as directed by JPL.

08.3 WINDOW WASHING CRITERIA

Use a roof-mounted, re-locatable, two-davit supported window-washing platform on buildings with major fenestration over 30’-0” from accessible grade.

08.4 WINDOWS AND GLASS

Guidelines on Glass Selection:

Insulated glass units (preferred),
Tinted glass without external solar screening,
Tinted reflective mirror glass with a maximum outdoor reflectance of 20%.
Clear glass, only if used with external solar control screening, within an atrium or facing north.
Opaque baked, porcelainized enamel metal or special plastic coated, aluminum panels, "spandrelite" or equivalent material with a 50-year projected life panels when incorporated within a window wall unit.

08.5 AUTOMATIC ELECTRIC OPERATED DOORS

Automatic Electric doors are desired for all primary public entrances. Gilgen Products , from EZ Systems, is the JPL preferred opener.

08.6 HINGED SERVICE DOORS AND EXIT DOORS

Standard is hollow metal doors, minimum 1/16” gage, with insulation type core in minimum 3/32” gage pressed metal frames.

08.7 LARGE SERVICE DOORS, OVER 6’-0” WIDE

Doors will be electrically operated, metal slat, roll-up door, insulated, weather and wind protected, with light colored exterior for solar reflectivity. For special doors, verify criteria with individual project.

08.8 INTERIOR DOORS CRITERIA

Interior doors will be solid wood core, natural finish stain or paint grade doors with wood (birch) veneer faces. Match existing doors when possible. Doorframes will be minimum 1/16” gage metal (hollow metal). Provide a strip window or 1/2 lite vision panel on doors into labs or rooms containing hazardous materials. Provide a coat hook on inside of office doors.

Standard Door Opening Sizes and Door Types:

Area	**Door Opening Width**
Office area less thn 3,000 S.F. to corridor. Second personnel opening to lab.	3'-0" x 7'-0" x 1 3/4". Use 3'-0" x 7'-0" door in new buildings and major remodels
Office area to corridor.	6'-0" x 7'-0" x 1 3/4" pair
Lab area less than 3,000 S.F. to corridor and lab to lab.	4'-0" x 7'-0"
Lab area greater than 3,000 S.F.	8'-0" x 7'-0" pair

08.9 FINISH DOOR HARDWARE

Exterior personnel exit doors will not have locking devices unless directed by JPL. Finish of all hardware, including hinges (except storefront doors). All hardware shall be 626 (26D) satin chrome plated.

Door Hardware Schedule:

Exterior Exit	Lever type latch sets, surface mounted closers.
Exterior and Interior Janitor, Mechanical, Electrical, Communication Rooms	Lever-type lock sets.
Offices, Storage, Conference Rooms, Repro. And Similar Rooms, Labs and Tech. Rooms	Lever-type lock sets.
Toilet Rooms	Push-pulls for non-fire rated doors; lever-type latch set for fire rated doors; surface mounted closers.

Hardware Manufacturers and Product Model Numbers:

Lock and Latch Sets	Schlage Lock Company; 2 ¾" backset
Lever-type lock sets	Schlage D53PD X RHO X 626, Rhodes design lever lockset Utility/Janitor = D80S X RHO X 626, Rhodes design lever lockset
Lever-type latch sets	Passage Non-locking = D1OS Rhodes
Keyway	0 bitted C Keyway. (No IC Core)
Automatic Door Operators	EZ Systems Dor-O-matic Horton Automatics
Closer - Surface Mounted	LCN 1460, full rack and pinion, heavy duty (cast iron) with full covers.
Door Holder	Cast Bronze Lever style door holder / McMaster-Carr catalogue# 1415A7, dull chrome finish

Closer - Floor Mounted	Rixon 27PH-105 degree S (with hold open selector)
Top pivot and Mid Pivot	Rixon #180AC, Rixon #M19
Panic Hardware	Von Duprin series 99 touch bar with concealed vertical rod with LHR outside trim #372L.
Fire Alarm Panel Lock	Corbin Camlock keyed to "CAT 15" or verify with JPL.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

08.10 DOORS *(TABLE MOUNTAIN FACILITY)*

Where the building code requires out swinging exit doors, provide two (2) doors, side by side, one swinging-out to meet code and one swinging-in to accommodate exiting during heavy snow conditions. Exterior doors will be insulated hollow metal with tempered glass view windows, weather-stripped with metal drip; door bottoms sweep seal or neoprene seal in aluminum threshold.

Division 09 Finishes

09.1 MATERIALS COMPOSITION CHARACTERISTICS

Select finish materials, caulking and adhesives that provide low out gassing characteristics for human comfort in offices and for potential damage to "system", "flight" or similar technological hardware in laboratories.

09.2 SPECIAL PURPOSE LABORATORIES AND CLEAN ROOMS

Approval of System Safety Program Office shall be required for all materials in use in special purpose laboratories and clean rooms.

09.3 LABORATORIES, CLEANROOMS

Classifications Of Clean Rooms:

ISO -14644–1 CLEAN ROOM STANDARD							FEDERAL STANDARD 209E
particle/m³							English
Class	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm	Class
ISO 1	10	2					
ISO 2	100	24	10	4			
ISO 3	1,000	237	102	35	8		1
ISO 4	10,000	2,370	1,020	352	83		10
ISO 5	100,000	23,700	10,200	3,520	832	29	100
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	1,000
ISO 7				352,000	83,200	2,930	10,000
ISO 8				3,520,000	832,000	29,300	100,000
ISO 9				35,200,000	8,320,000	293,000	

Provide smooth surface walls and gypsum board ceilings, cabinets and surfaces in contact with the air supply, i.e. plenums.

Smooth surfaces including support grid structure and utilities shall be painted with a coating equivalent to Ameron-Amerlock 400. All paint used in clean rooms shall be non-out gassing.

09.4 STANDARD FINISHES FOR BUILDINGS 180, 230, 264, AND 301

BUILDINGS LISTED HERE USE SPECIALLY SELECTED FINISHES.

SPACES	MATERIAL	BUILDING 180	BUILDING 230	BUILDING 264	BUILDING 301
Office and conference rooms and general areas	Carpet	Design Weave, Centrepoint "Aspen Z0935-00793"	Design Weave, Caravan "Sahara 984-353"	Design Weave, Caravan "Tortoise Shell 984-259"	Design Weave, Caravan "Northern Light 984-793"
	Carpet base	Burke "True Blue 505"	Burke "Black 523"	Burke "Black 523"	Burke "True Blue 505"
Corridor and elevator / lobby area	Carpet	Design Weave, Centrepoint "Aspen Z0935-	Design Weave, Caravan "Sahara 984-353"	Design Weave, Caravan "Tortoise Shell 984-	Design Weave, Caravan "Midnight Sun 984-757"

SPACES	MATERIAL	BUILDING 180	BUILDING 230	BUILDING 264	BUILDING 301
		00793"		259"	
	Carpet base	Burke "True Blue 505"	Burke "Dark Brown 598"	Burke "Dark Brown 598"	Burke "True Blue 505"
Walls	Paint color	Dunn Edwards " 6274" Frostbite	Dunn Edwards " 6274" Frostbite	Dunn Edwards "DE 6274" Frostbite	Dunn Edwards "DE 6274" Frostbite
Doors and frames	Paint color	Dunn Edwards "G120"	Dunn Edwards "G115"	Dunn Edwards "G115"	Dunn Edwards "DE331"
Generals areas	Ceiling	"Capaul-Capcore" or "Armstrong" ARM/3102 2 ft. x 4 ft. Composite Medium density Fiberglass	"Capaul-Capcore" or "Armstrong" ARM/3102 2 ft. x 4 ft. Composite Medium density Fiberglass	"Capaul-Capcore" or "Armstrong" ARM/3102 2 ft. x 4 ft. Composite Medium density Fiberglass	"Capaul-Capcore" or "Armstrong" ARM/3102 2 ft. x 4 ft. Composite Medium density Fiberglass
Office and conference rooms	Ceiling	"Capaul-Capcore" or "LBI Boyd" (ACP) 2 ft. x 4 ft. Mineral Backed Medium. Density Fiberglass	"Capaul-Capcore" or "LBI Boyd" (ACP) 2 ft. x 4 ft. Mineral Backed Medium Density Fiberglass	"Capaul-Capcore" or "LBI Boyd" (ACP) 2 ft. x 4 ft. Mineral Backed Medium Density Fiberglass	"Capaul-Capcore" or "LBI Boyd" (ACP) 2 ft. x 4 ft. Mineral Backed Medium Density Fiberglass
Concentration of hard wall offices / rooms		Along Windows	Along Exterior Walls	Along Windows	Along Interior Walls

NOTES:

1. In Building 301, whenever Westinghouse workstations are changed they shall be replaced with Knoll Systems.
2. Whenever possible, consider replacing old and worn out carpet flooring and dirty or stained ceiling tiles within the vicinity of the project area.

09.5 EXPOSED T-GRID ACOUSTIC TILE CEILING

Standard grid members are exposed 15/16” heavy-duty components in white color. (Armstrong 7301 Prelude, or equal). Standard grid configuration is a 2’-0” x 4’-0” bay with square edge lay in acoustical panel.

09.6 ACOUSTIC CEILING TILE

Offices, open office areas and laboratories:

- Capaul Open Plan
  Medium density fiberglass, NRC rating of .85 minimum, square edge, lay-in, and fine textured finish
- Celotex Softone Cashmere:
  3/4” mineral board, NRC .50 -.60, CAC 30 – 40
- Armstrong Optima Open Plan
  Fiberglass with painted white face, NRC .95, CAC 37
- Capaul Capcore 44
  5/8” mineral board, NRC 55 – 65, CAC 40 – 44

Hard wall offices: with suspended ceiling:

- Capaul Capcore
  Medium density fiberglass and mineral board composite, NRC .75 to .85, CAC 35 to 39

09.7 CHAIR RAIL

Natural finish solid hardwood or painted medium density fiberboard.

09.8 RESILIENT FINISH FLOORING

The standard resilient flooring is commercial grade laminate, sheet vinyl, or a comparable resilient composition material. The vinyl material and adhesive will produce non-volatile residue (NVR) and out gassing of not greater than 8 mg/m^2. Conductive flooring shall be required to comply with JPL's flight hardware handling and storage requirements.

09.9 LABORATORY FLOORING WITH ELECTROSTATIC DISCHARGE CONTROL (ESD)

ESD flooring shall be grounded and tested to conform to NFPA-99 (12-4.1.3.8) with a minimum resistance of 250,000 ohms and a maximum of 5 Megaohms between two test locations on the floor, with the same resistance to ground. The average of five different readings will not exceed 2 Megaohms.

Polymer top coating is required; wax is not allowed. Include an integral floor plaque of the same floor material near the main entry door stating "Conductive Floor -Do Not Wax".

09.10 LABORATORY VINYL FLOORING COMPARISON

Contact JPL Contamination Control Engineering and Cleanroom Engineering for approved and tested materials. All candidate materials shall be tested by the JPL Chemical Analysis group and approved by JPL Contamination Control Engineering and Clean room Engineering prior to specifying such material.

09.11 VINYL COMPOSITION TILE

Standard for all ordinary applications shall be Armstrong, “Standard EXCELON Imperial Texture” with preferred base color “Shelter White”.

09.12 RESILIENT WALL BASE

Standard for top set base color will be Burke 664P, "Mist" with the Cool Color Palette and Burke 674P, "Warm Grey" with the Warm Color Palette for carpet and non-lab vinyl floors.

09.13 STAIRWAYS

The finish material for treads and risers will be a hard, noncombustible, non-slip material. All floor finish will have a slip-resistance coefficient of greater than 0.50 when tested in accordance with ASTM C1028.

Secondary and service stairway will be nonskid concrete with galvanized steel nosing guards. Nonskid perforated, galvanized, steel treads may be use for service stairways.

09.14 CARPET AND CARPET TILES

Select carpet from the JPL standard carpet palette. Use carpet tile when possible. Carpet tile is not allowed where ESD is a concern. Broadloom carpet and carpet tile may be used on raised floor systems when directed by JPL.

Prefer carpet tile for open office areas, high traffic zones and where liquid and food spills are a concern. Carpet tile shall be 2'-0" x 2'-0" applied with releasable adhesive.

All carpet will have a slip-resistance coefficient of greater than 0.50 when tested in accordance with ASTM C1028. Verify with JPL for allowable locations when considering carpet tiles.

09.15 STANDARD CARPET TILE PALETTE

Shaw Industries, Inc.	**Madrid III sq** - (26oz., Solution Dyed) 57412 All I Can Do / Q 57411 I Wish / Q	**Parallels II** - (26oz., Solution Dyed) 66333 Correlate / Q 66431 Match 66531 Correspondent / Q 66532 Uniform / Q
C&A Floorcoverings	**Offers 18"x18", 36"x36"** - (75% Solution Dyed, 25% Yarn Dyed) 05141 –Rio, Color 38409 - Brazilia 01957 – Crayon, Color 48002 – Tidal Wave 06141 – Rio, Color 38411 - Samba 01433 – Sail Away, Color 31512 – Outer Mark 01433 – Sail Away, Color 31504 – Spinnaker	

09.16 STANDARD BROADLOOM CARPET PALETTE

Shaw Industries, Inc.	**Illusions II** (26oz., Solution Dyed) 45440 Show & Tell 45520 Kite Day 45530 Jungle Gym 45540 Mural
C&A Floorcoverings	**Offers 6' wide rolls** - (75% Solution Dyed, 25% Yarn Dyed) 05141 –Rio, Color 38409 - Brazilia 01957 – Crayon, Color 48002 – Tidal Wave 06141 – Rio, Color 38411 - Samba 01433 – Sail Away, Color 31512 – Outer Mark 01433 – Sail Away, Color 31504 – Spinnaker

09.17 GENERAL PAINTING

Use flat vinyl acrylic or similar paints in Offices, Meeting and Conference Rooms. Use semi-gloss enamel in Corridors, Toilets, Service Rooms and Laboratories. Paint chips for listed colors are available from JPL.

09.18 STANDARD INTERIOR FINISH MATERIAL SCHEDULE

Area	Flooring	Base	Walls	Ceiling	Comments
Entry	QT, CT	Match Floor	GWB SV	ACT	
Office/Corridor	CPT	VB	GWB	GWB, ACT	
Special Tech Corridor	VT	VB	GWB	GWB, ACT	
Office	CPT	VB	GWB	ACT	
Conference	CPT	VB	GWB	GWB	Tackable acoustic panels. "Sound Soak" above chair rail
Meeting Room	CPT	VB	GWB	ACT	
Technical	CPT, VT,	VB	GWB	ACT	
Laboratory	SV, RFP				
Coffee Area	VT,	VB	GWB	GWB	
Repro, Copy Machine	VT	VB	GWB	GWB	Tackable acoustic panels "Sound Soak" above chair rail
Toilet	TER, CT,	Match Floor	CT	GWB	Natural gray colored, grout
Janitor	VT	VB	GWB		C/T Wainscot at service sink
Service-Shop Area	CONC	VB	GWB	EXP, GWB	

Legend (Abbreviations, Descriptions) for Interior Finish Schedule:

ACT	Acoustic Tile or Panels	QT	Quarry tile
CONC	Concrete-exposed steel trawled surface with hardener	RFP	Raised floor panels
CPT	Carpet; glue down type	SV	Sheet vinyl
CT	Ceramic tile, glazed tile on walls. Unglazed floor tile, min.	TER	Terrazzo
EXP	Exposed construction	VT	Vinyl tile
GWB	Gypsum wall board	VB	Vinyl base, 4” standard.

09.19 ARCHITECTURAL COATINGS

All exterior and interior paints (i.e., coating materials), including those listed below, must not exceed VOC limits as specified in SCAQMD Rule 1113 (Architectural Coatings) Table of Standards.

09.20 STANDARD EXTERIOR PAINT COLORS

Walls:	Dunn Edwards - DE 6213 Fine Grain Dunn Edwards - DE 6172 Bungalow Taupe Dunn Edwards - DE 6208 Tuscan Mosaic
Accent:	Dunn Edwards - DEA 156 Arabian Red Dunn Edwards - DE 5796 Before the Storm Dunn Edwards - DE 6361 Baby Seal Dunn Edwards - DEC 756 Weathered Brown

09.21 STANDARD INTERIOR PAINT COLORS:

Dunn-Edwards Colors:	**Warm Color Palette**	**Cool Color Palette**
Basic Wall Color:	Dunn Edwards DE 6274 "Frostbite"	Dunn Edwards DE 6274 "Frostbite"
Trim:	Dunn Edwards DE 6391 "Black Russian"	Dunn Edwards DE 6370 "Charcoal Smudge"
Trim or Door:	Dunn Edwards DE 6389 "Fallen Rock"	Dunn Edwards DE 6376 "Looking Glass"
Trim, Door or Wall Accent:	Dunn Edwards DEC 770 "Drifting"	Dunn Edwards DE 6375 " Caslerock "

NOTE:
With the exception of the Basic Wall Color, the colors within a Color Palette may be used in any combination, but colors from the cool or warm palette will not be intermixed.

09.22 CUSTOM COLORS

May be used in the following offices only:
Managers II and III, Associate Director, Deputy Director and Director, others of equivalent level.

09.23 MATCHING EXISTING COLORS

Where conditions require the use of JPL's earlier color palette or when working with existing factory finished materials, coordinate colors with JPL before the final selection.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS
All JPL Facilities Design Standards not altered by following "Specific Condition" will apply, unless otherwise directed by JPL.

09.24 STANDARD PAINT COLORS *(TABLE MOUNTAIN FACILITY)*
U.S. Forestry Service approved exterior colors are Plochere Color System Nos. 180, 181 and 184. Buildings involving infrared optical science use Plochere No. 182, cut down to 25% color level with a 37% titanium dioxide mixture. Interior colors are Plochere Nos. 180, 181 and 184 with 274 for darker interior color.

Division 10 Specialties

10.1 TOILET ROOM / SIMILAR ACCESSORIES

- Key all locks used in toilet room accessories to JPL standards

Mirrors	Locate over lavatories. Locate a 2'-6" high by 5'-6" mirror in toilets with more than one water closet.
Briefcase Shelf	Minimum 1'-4" x 3'-0" stainless steel; located 3'-0" from floor.
Toilet Tissue Dispenser	Scott #9600 Contin-U-Matic automatic refill. (Standard 112 mm wide x 136 mm diameter tissue rolls) JPL uses 1,500 sheet toilet tissue rolls.
Paper Towel Dispenser and Disposal	Continental #630W Surface Mounted Dispenser in small Toilet and Coffee Rooms or Boric B-3907 recessed-mounted for dispensing single fold 9 3/8" x 10 ¾" single fold paper towels. Wall mounted 16 Gallon waste container.
Toilet Seat Cover Dispensers	Bobrick, B-221 Type 304 stainless steel and shall be surface mounted. Dispenser shall have a minimum capacity of 250 seat covers.
Hand Soap Dispenser	Bobrick, Model B-4112 Contura Series Soap Dispenser. Locate over lavatories.
Hand Soap Dispenser (shops)	Boraxo Model 36, for special heavy-duty powdered soap, all metal finished in white enamel. Chrome plated, vandal proof cover, 3-1/2 oz capacity.

Sanitary Napkin Dispenser	Bobrick, Model B-2800 -25 Surface–Mounted Napkin/Tampon Vendor. $0.25 single coin operation.
Sanitary Napkin Disposal	Bobrick, Model B-270 Contura Surface–Mounted Sanitary Napkin Disposal
Paper Cup Dispenser	Solo #1335 – 3 1/2 oz (100 g) capacity. No locks will be provided.
Lavatory Hot Water and Drain Shields	Vinyl covered foam similar to Plumerex Specialty Products, Cathedral City, CA, conforming to ADA.

10.2 TOILET PARTITIONS AND URINAL SCREENS

Provide baked enamel or porcelainized metal, floor mounted, overhead braced partitions and wall-mounted urinal screens. Urinal screens will be porcelainized metal.

10.3 TACKBOARD

Locate a tack board in a well-illuminated main corridor area. (I.e.: Over the mail station or adjacent to the drinking fountain.)

10.4 CORNER GUARDS

Provide clear/transparent corner guards at external gypsum wallboard corners at main exit ways, height 3’-6” to 4’-0”.

10.5 RAISED ACCESS FLOORS

Wood core or lightweight concrete, metal covered panels 1” solid thickness, 2’-0” x 2’-0” panels, 1’-0” high is standard. Stringers are preferred to provide an electrical-zero signal reference grid.

10.6 EXTERIOR BUILDING IDENTIFICATION

Building names are not allowed unless specifically directed by JPL. Locate a dark, anodized solid aluminum, Helvetica medium, building number on the building or site wall adjacent to the major pedestrian and service entries. Provide 8” minimum height numbers and locate to be readily observable to pedestrians using normal building approaches.

10.7 INTERIOR GRAPHICS

Provide Helvetica medium, building code and ADA required signs and symbols. JPL will furnish and install room numbers, room identification (i.e. Clean Room class M4.5), name plaques, directional signage, directories, and informational tack boards. Design a location for a building directory 4’-0” x 6’-0” at each primary entry and/or elevator lobby. Illuminate displays and feature walls when instructed. Minimum signing-symbols:

- Building Code signs including "Star of Life: elevator medical emergency,
- Fire Equipment: Fire Department signs and symbols.
- JPL Safety, Warning Signs, Symbols, and signing as directed by JPL.

Division 11 Equipment

11.1 SEISMIC DESIGN OF NON-STRUCTURAL COMPONENTS

Per CBC Section 1614A and ASCE 7-05 Chapter 13, except the seismic coefficients shall be the following: S_{DS} = 2.08, I_P = 1.5 for Mission Critical and I_P = 1.0 elsewhere. The minimum lateral seismic design load (F_P) for equipment shall be 0.75 times its weight.

11.2 ROOF MOUNTED EQUIPMENT

Screen major equipment from pedestrian and other building views. Screening in Zones S-1 and S-2 [Figure 1] will be as directed by JPL.

For seismic design of roof mounted equipment and for attachment of the equipment to the rooftop structure, 150% of the operational weight shall be used for calculating lateral design loads per section 11.1.

Provide a guardrail or parapet for roof mounted equipment where required by CAL-OSHA, or if the work program requires a personnel safety guard. Do not locate equipment requiring periodic servicing within 10’-0” of a roof edge not equipped with parapet or guardrail. Provide roof openings, hatches and skylights with fall protection.

Provide minimum 3’-0” wide service access aisle between equipment. When equipment is installed less than 3’-0” apart, the combined equipment width will be considered as one unit. Install equipment on minimum 6” high non-combustible raised pads or elevated framed platforms to allow roofing repairs.

Minimize roof-mounted piping and conduit. To allow roofing repairs, conduit and piping will clear the roof by a minimum 1’-0”. Provide non-combustible stiles or platforms over groups of pipes or conduits over 1’-6” wide when intersecting a roof walkway.

Provide elevated equipment platform as follows:

MINIMUM HEIGHT OF ELEVATED PLATFORMS:

WIDTH OF EQUIPMENT	***MINIMUM HEIGHT OF LEGS***
Up to 2’-0”	1’-0”
2’-0” to 3’-0"	1’-6”
3’-0” to 4’-0”	2’-0”
4’-0” to 5’-0”	2’-6”

11.3 FLOOR MOUNTED EQUIPMENT

Mechanical, Electrical or other machinery will be mounted on 4” interior installation and 6” exterior installation, high, concrete "housekeeping pads".

Floor mounted equipment weighing more than 400lbs, anchorage shall be designed by structural engineer for lateral design loads per section 11.1 to resist overturning and sliding.

11.4 CEILING MOUNTED EQUIPMENT
For ceiling supported Mechanical, Electrical or other equipment weighing more than 40lbs, anchorage shall be designed by structural engineer for lateral design loads per section 11.1.

11.5 MACHINERY DESIGN LOADS
For the purpose of design, the weight of machinery with moving loads will be increased as follows to allow for impact:

Elevator machinery	100%
Light machinery shaft- or motor-driven	20%
Reciprocating machinery or power driven units	100%
Hangers for floors or balconies	50%

All percentages will be increased if so recommended by the equipment manufacturer.

11.6 PERSONNEL VIBRATION DESIGN CRITERIA
The floor will be designed to be in the "slightly perceptible" or less range of vibration per the "Engineering Journal/American Institute of Steel Construction, 3rd Quarter, 1975".

11.7 MACHINERY RESONANCE
Structures will be designed to overcome resonance resulting from the harmony between the natural frequency of the structure and the imposed dynamic frequency of reciprocating or rotating mechanical equipment. The use of vibration isolation pads should be considered for major reciprocating engine and other similar resonance producing equipment.

11.8 VENTILATION FOR LABORATORY CHEMICAL FUME HOODS
Operations for hazardous substance that possible of being explosive, flammable, poisonous, an irritant, or otherwise harmful is likely to cause injury or illness, shall provide an exhaust of average face velocity of at least 100 feet per minute with a minimum of 70 fpm at any point. Regulated carcinogens shall average linear face velocity be 150 feet per minute with a minimum of 125 feet per minute at any point.

11.9 CHEMICAL FUME HOODS MONITORING
Hoods shall be equipped with a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation. The quantitative airflow monitor shall measure either the exact rate of inward airflow or the relative amount of inward airflow. Examples of acceptable devices that measure the relative amount of inward airflow include diaphragm pressure gauges, inclined manometers, and vane gauges.

11.10 CHEMICAL FUME HOOD ALARMS
The requirement for a quantitative airflow monitor may also be met by an airflow alarm system if the system provides an audible or visual alarm when the airflow decreases to less than 80% of the airflow required.

11.11 DUCTLESS FUME HOODS
Ductless fume hoods are not allowed.

Division 12 Furnishings

12.1 WINDOW COVERINGS:

Mini-Blinds:

COOL PALETTE:

LEVOLOR RIVIERA 1":	GRABER CLASSICS SUPREME 1"
#34 Brushed Aluminum	#095 U.N. Gray
#113 White Cap	#121 Brushed Aluminum
#820 Squirrel Gray	#771 Mercury
#867 Slate	#963 Gray Haze
#821 Star Dust	

WARM PALETTE

LEVOLOR: RIVIERA 1"	GRABER CLASSICS OR SUPREME: 1"
#317 Warm Feather	#062 Charbrown
#818 Misty	#122 Grelge
#863 Wood Ash	#329 Granite Pearl
#887 Raw Umber	#386 Snow Cap White
#1387 Lady's Lace	

12.2 DRAPERY

MARHARAM, #2 Natural Crete.

12.3 OPEN OFFICE FURNITURE SYSTEM

Knoll Furniture Systems "EQUITY Group". Verify standard heights, widths and accessories with JPL. 80" partitions are not allowed.

12.4 FINISH AND COLORS FOR KNOLL OPEN OFFICE PARTITIONS

Fabric:	**Metal and Plastic Trim**	**Work Surfaces, Cabinets Shelves and Drawers**
Knoll S812 "Opal"	Knoll "Soft Gray."	Knoll M42 "Soft Gray"

12.5 ENCLOSED OFFICE FURNITURE SYSTEM (MANAGER):

Supervisor (Manager I) in hard wall office:

- Knoll Equity Freestanding furniture with plastic laminate work surfaces (M42 / soft gray color) mounted on "L" and "T" shaped plastic laminate desk height panels.
- Overhead cabinets mounted on the hard wall or panel with a task light mounted beneath.
- Two mobile pedestals for storage (moves with user).

Section Manager (Manager II) executive furniture in hard wall office:

- Knoll Reff freestanding furniture work surfaces and cabinet finish, closed pore techwood veneer (V1) with cherry (SWT-KC) finish.
- Fabric cover for back acoustical panel W432/3 "Versatility".
- Cabinets with "J" pulls, metal interiors, hinge doors.
- Work surface top edge 1 ¼" 5 ply V1, 1 1/8" radius back and front, "L" lock hole drilled.
- Provide overhead light with variable intensity.
- Grommets R (recessed grommet location), F (standard corner location), LG (black color).

12.6 OFFICE FURNITURE
Floor standing load bearing furniture shall be used whenever possible.

12.7 FILE CABINETS
File cabinets with a greater than 4:1 height-to-depth (the narrowest dimension) ratio, arranged in groups shall be attached to one another and shall be anchored to the structure. Anchorage shall prevent sliding and overturning of equipment when subjected to earthquake loads.

12.8 BOOKCASES / SHELVES
Only pre-manufactured units shall be allowed. No bookcases or shelves shall be mounted on demountable partitions. Freestanding bookcases with a height-to-depth (the narrowest dimension) ratio, greater than 4:1 shall be anchored to a permanent stud wall and directly attached to studs or shall be designed with floor attachment to prevent overturning of the unit in the event of strong ground motion. Design of the unit and anchorage to resist lateral loads shall be per section 11.1. Minimum vertical live load for wall mounted units shall be per Table 01-1. No thru bolting (i.e.: securing through the wall into the next room), toggle bolting or mounting to wall splines is allowed.

12.9 RECESSED EXTERIOR ENTRY MAT
Provide a 3’-0” x 4’-0” vinyl, open link mat at primary personnel and service doors. Steel frame FM 3B, 3/8”. Provide water drainage from recessed area. Locate at exterior if under cover a minimum of 8’-0”.

Division 13 Special Construction

13.1 TRAILERS
The use of trailers is permitted only by written approval from the Facilities Division Manager. When trailers are permitted, occupied trailers will conform to State of California requirements. Trailers shall be structurally anchored to a designed foundation system,, conforming the CBC Chapter 18 for lateral earthquake loads per section 1613A. Temporary supports such as “Jack Stands” shall not be used. Trailers will be fully fire sprinkled in occupied spaces, including covered entry balconies and in crawl spaces below trailers and balconies. Full fire draft curtains will block off the perimeter around trailer crawl spaces.

13.2 ELECTROSTATIC DISCHARGE AND CONTAMINATION CONTROL
Provide special facilities in areas involved in research, production testing, handling and operation of electrostatic discharge and contamination sensitive equipment and devices including electronic flight and ground support equipment.

13.3 RADIATION CONTROL
Design, construction, or modification of facilities for the storage or use of radioactive materials or development / use of ionizing radiation-producing machines/devices shall be coordinated with the Radiation Safety Officer/Radiation Safety Committee during the pre-project review phase of development.

13.4 EXPLOSIVES CONTROL
Design, construction, or modification of facilities for the storage or use of explosives, propellants, or pyrotechnics shall be coordinated with the Explosives Safety Officer during the pre-project review phase of development.

JPL will determine if a built-in air ionizer system is required. The JPL Facilities shall review and approve pertinent facility materials, design and installation specifications.

13.5 SPECIAL SECURITY SYSTEMS

JPL will supply project criteria for security systems. The systems require a minimum of a 25 pair cable connection into the telephone and video communications network to the Guard Console in building 310.

Division 14 Conveying Equipment

14.1 PASSENGER ELEVATOR

Provide a minimum of one passenger elevator for buildings two stories or more above or below a grade level entry. The standard elevator is hydraulic to three levels and electric traction for four stories and above. Design elevators assuming the majority of laboratory/technical areas will be converted to offices during the life of the building. Elevator shall conform to "C2" load rating.

14.2 SERVICE ELEVATOR

Provide a minimum of one service elevator, capacity 7,000 lbs, for all new buildings two stories or more and over 10,000 S.F total gross in areas without grade level access to each floor. Identify this elevator by the "Star of Life" symbol for emergency medical services. Design the elevator to accommodate passengers and accessible requirements if it is the only building elevator.

The elevator shall serve the roof level when major equipment is located there. The elevator may open to the exterior at the grade level loading area. Provide a minimum 4’-0” overhang protection beyond the door to control wind, water, and debris.

Elevator Speed Requirements:

Elevator Type	Minimum Speed	Maximum Speed
Hydraulic Passenger	150 feet/minute	200 feet/minute
Hydraulic Freight/Service	100 feet/minute	125 feet/minute
Traction Passenger	-	500 feet/minute
Traction Freight/Service	-	350 feet/minute

14.3 SEISMIC DESIGN FOR ALL ELEVATORS

Elevators, elevator support rails and attachments to the building shall be designed to conform to the seismic design requirements of ASCE 7 section 13.6.10 and CBC section 1613A, and sections 1614A.1.15 and 1614A.1.16.

14.4 DESIGN/INSTALLATION FEATURES FOR ALL ELEVATORS

For hydraulic elevators specify PVC lining inside outer cylinder casing and oil scavenger pumps. Solid-state controllers may be used with JPL approval. Specify 2-year operational warrantee.

Provide ventilation or cooling in equipment rooms to accommodate the equipment manufacturer's requirements. Do not locate non-elevator equipment, valves etc., in the room.

Size elevators as indicated and to conform to disabled and medical emergency building code requirements.

14.5 INTERIOR CAB FINISHES AND CRITERIA

	Walls	**Doors**	**Floor**
Passenger Elevator:	Laminated Plastic	Textured Stainless Steel	Rubber Flooring or Carpet
Service Elevator: Key: Barrel Key - EPCO-17	Textured stainless steel protective pads and hangers	Heavily textured stainless steel	Vinyl tile

Acceptable Elevator Manufacturers:	**Traction:**	**Hydraulic:**
Alternate manufacturers may be specified with the approval of JPL	Armor, Dover, Otis, Schindler.	Delta, Dover, Amtech Reliable.

Division 15 Reserved
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FACILITY SERVICES SUBGROUP

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Division 20 Reserved

Division 21 Fire Suppression

21.1 FIRE SUPPRESSION - GENERAL REQUIREMENTS

Materials and equipment utilized in the fire protection systems shall be installed per JPL Facilities Design Standard. The JPL Fire Protection Engineer and Fire Department shall determine the location and spacing of hydrants.

21.2 FIRE HYDRANTS

Wet-barrel U.L. listed fire hydrants with one 4” and two 2 ½” hose connections shall be utilized.

21.3 SPRINKLER AND FIRE HYDRANT FEEDS

Underground pipe serving as lateral feeds to no more than two hydrants from looped underground pipe shall be minimum diameter of 6” Underground pipe serving feeds to sprinkler risers from looped underground piping shall be a minimum diameter of 8”.

21.4 SPRINKLER SYSTEMS SUPPLIED BY CONNECTIONS

New sprinkler systems shall have a U.L listed back-flow prevention assembly standard fire department pumper connection provided as part of the installation. Any major revision or remodel of an existing building/sprinkler system shall incorporate new U.L. listed back-flow prevention devices in the sprinkler risers.

21.5 HYDRAULIC DESIGN CRITERIA

Hydraulic calculations shall include velocity pressures and the hydraulic calculations shall be based on a minimum operating area of 3,000 S.F.

Hydraulic calculations shall be based on the most current water test data provided by the JPL fire dept. and shall further be based on the utilization of 90% of that supply.

Hydraulic calculations when grid systems are utilized shall be based on a rectangular area having a dimension parallel to the branch line at least 1.4 times the square root of the area of sprinkler operation 3,000 square feet.

Hydraulic calculations shall be within 0.1 psi at all junction points within the system and carried to the point of connection.

21.6 ABOVE GROUND SPRINKLER SYSTEM COMPONENTS

Sprinkler system components utilizing steel pipe shall consist of not less than schedule 10 pipe. Sprinkler system components utilizing copper pipe with soldered joints or CPVC-Polybutylene pipe shall comply with applicable standards noted in 1.3.1. Sprinkler heads shall be quick response or standard response per direction of JPL, rated at 165° F and have a minimum orifice of ½”. Earthquake bracing on sprinkler piping shall comply with the most current code.

21.7 RECESSED METAL FIRE CABINETS

Provide full recessed metal cabinets with full vision panels to house a 2 ½” gate valve and fire extinguisher in office buildings. Surface-mounted extinguishers shall be installed in labs, clean rooms where applicable, service and mechanical rooms.

21.8 INSIDE HAND HOSE STATIONS
Inside hand hose stations shall not be installed in JPL buildings.

21.9 SUPPRESSION SYSTEMS
Ordinary hazard classed office areas featuring light to moderate combustible loading shall be protected by wet-pipe sprinkler systems designed to provide 0.2 Gallons/minute per S.F. over the most remote 3,000 square feet.

21.10 FIRE PROTECTION IN CLEAN ROOMS OR LABS
Clean rooms or labs housing flight hardware in an unfinished condition shall be protected by wet-pipe sprinkler systems except as deemed otherwise by the JPL Fire Protection Engineer.

21.11 FIRE PROTECTION IN CLEAN ROOMS OR LABS WITH CEILING HEIGHT LESS THAN 30’-0”
Clean rooms or labs housing flight hardware in flight ready state shall be protected by one of the following means when the ceiling height is less than 30’-0”.

- Automatic, total-flood, clean-agent gas system.
- Automatic pre-action, double-interlocked sprinkler system.

21.12 FIRE PROTECTION IN CLEAN ROOMS OR LABS WITH CEILING HEIGHT MORE THAN 30’-0”
Clean rooms or assembly areas housing flight hardware in a flight ready state shall be protected when the ceiling height is in excess of 30’-0”. The design of protection shall be provided by a registered fire protection engineer, using computer fire modeling tools, and shall determine the method deemed most effective in minimizing the damage to flight hardware.

21.13 BUILDING FIRE PROTECTION
Buildings shall be provided with a smoke detection systems or a fire alarm system.

21.14 FIRE SPRINKLERS
The JPL System Safety Program Office will determine hazard rating for the building for the purposes of sprinkler protection. Systems will be monitored by the existing fire alarm system.

Use flexible head connections when modifying or installing fire sprinklers. Flexible head connectors shall not exceed 6’ in length.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

21.15 FIRE SPRINKLERS *(TABLE MOUNTAIN FACILITY)*
Buildings, including attics and under floor spaces, will be fire sprinklered by a dry pipe system. The JPL System Safety Program Office will determine hazard rating for the purposes of sprinkler protection. Systems will be monitored by the existing fire alarm system.

Division 22 Plumbing

22.1 BUILDING POTABLE WATER DISTRIBUTION

Potable water piping within building will be copper; type L. Provide shock absorbers in accessible locations. Polybutylene pipe shall not be used in the domestic water system.

28.1 UNDERGROUND PIPING

Underground water distribution piping shall be class 200 rated, schedule 80 consisting of ductile iron or PVC pipe. Underground pipe determined to be part of the “looped” system shall be minimum 10”.

22.2 WASTE SYSTEMS

Waste and vent piping 2” and larger will be service weight cast iron with no-hub fittings. Smaller piping, when above grade may be schedule 40 galvanized steel with cast iron drainage fittings.

22.3 METERS

Provide a gas meter for each new building with a digital reading consumption output to the JPL EMS system. Provide a water meter for each new building. Provide a cooling tower(s) make-up water meter.

22.4 VALVES

Provide an accessible shut-off valve upstream of fixtures and at branches of all piping systems.

22.5 GAS PRESSURE REGULATORS

Incorporate low-pressure cut-off, which stops the inlet gas supply if the outlet pressure drops below a certain point. Regulator shall be equipped with low-pressure cut-off.

22.6 LABORATORY GAS SYSTEMS

Will be designed in accordance with the "Compressed Air and Gas Handbook" by the Compressed Air and Gas Institute. All gas valves shall be accessible.

22.7 HAZARDOUS WASTE SYSTEM

For piping and disposal design direction, contact JPL Environmental Office and Project Administrator.

22.8 PIPING SYSTEMS IDENTIFICATION

Identification marking systems will be per ASME(The American Society of Mechanical Engineers) A13.1. Use snap on acrylic labels. Identify underground piping per Paragraph 33.3.

22.9 EMERGENCY EYEWASH AND SHOWER EQUIPMENT

Provide as required by the California Building Code, CAL-OSHA, and as directed by JPL. Eyewash and shower equipment locations should be designed so they can be accessed with impaired vision. Provide clear path to exits within room or area.

The units will deliver potable water and not be connected to the fire suppression system. Identify each eyewash and shower with a sign posted behind the unit.

Provide insulation on pipes for showers and eyewashes if they are located outdoors.

22.10 PRESSURE VESSELS AND SYSTEMS

JPL Pressure Vessels and Systems Document (RULES-42472) cover the code and regulatory requirements for the design of pressure vessels and pressurized systems including liquid nitrogen distribution, laboratory gas systems, heating boilers, and other pressurized systems with the following exceptions:

1. Utility and fire water systems
2. Fire extinguishing systems, including portable fire extinguishers
3. Low pressure natural gas supply and distribution systems
4. Commercially manufactured packaged refrigerators and freezers
5. Commercially available and packaged hydraulic systems

22.11 HOSE BIBBS

Locate keyless hose bibbs adjacent to building exterior perimeter areas at a maximum 100 feet apart. Provide hose bibbs at mechanical rooms and adjacent mechanical equipment on roofs.

22.12 WATER HEATERS

Provide potable, thermostatically controlled water heating by direct-fired commercial type, gas water heaters. Provide a pump forced circulation system. Small or remotely located lavatories may be use instantaneous electrical water heaters with demand and flow control.

22.13 PLUMBING FIXTURE AND EQUIPMENT SELECTION

Pipe, fittings, and valves will be identified by a specification followed by the ASME, AWWA, ASTM or ASA standard specification number. Manufacturer names required only for valves.

Plumbing	
Butterfly Valves (Lug type)	Norris R-3000 angle discs, or Nibco – High Performance Keystone - AR2 lug type Keystone - Super Seat - Series S92
Ball Valves	Nibco or Tyco
Gate Valves	Nibco or Keystone
Plug Valves	Nibco or Tyco
Gate Valves	Nibco or Keystone
Drainage Specialties	Acorn, Josam, Smith, Wade, Zurn
Water Hammer Absorbers	Josam, Smith, Zurn
Backflow Preventors	Beeco, Febco, Watts
Drinking Fountains, Elect Wall Mounted.	Haws, Sunroc (with filtered water)
Plumbing Fixtures	Crane, American-Standard, Kohler. Fixtures will be compatible with valves.
Toilets	Wall-mounted with exposed "low-flush" valves. White open front seats. (Use extra thick seats.)
Urinals	Wall-mounted "waterless" urinals. Falcon Waterfree Technologies, L.L.C. / Model F-1000.
Urinals *(Selected Installation Only)*	Wall-mounted Barrier Free urinals. Lynbrook model. American Standard Inc.
Urinal Flushometer *(Selected Installation Only)*	Sensor Operated Urinal Flushometer Sloan 186 ESS for ¾" top spud urinals.
Lavatories	Wall-mounted with back splash, cast iron. 200 faucet centers.
Lavatory Faucets	Sloan EAF 275 Faucet. (Solar / Battery operated)

Plumbing	
Floor Drains	Required in toilet, mechanical and janitor rooms. Floor sinks/drains will have automatic trap primers.
Shower Heads	Low-flow type
Service Sink	Corner, floor-mounted cast iron
Flush Valves/Toilet *(For Retrofit Installation Only)*.	Sloan, SMO Unitl ES-S with Manual Override *(For Retrofit Installation Only)*.
Flush Valves/Urinal *(For Retrofit Installation Only)*.	Sloan, SMO Unitl ES-S with Manual Override *(For Retrofit Installation Only)*.
Flush Valves/Toilet *(New Installation Only)*.	Sloan, Crown Series Model ES-S with Manual Override *(New Installation Only).*
Flush Valves/Urinal *(New Installation Only)*.	Sloan, Crown Series Model ES-S with Manual Override *(New Installation Only)*.
Water Heating	
Domestic Water Heaters	General, Day & Night, Mission, Holly, Rheem, A.O. Smith
Gas Pressure Regulators	Equimeter 143-80 (Outlet side "under pressure" shut-off)
Pumps and Accessories	
Pumps	Bell and Gossett, Peerless, Weinman, Paco, Aurora
Circulators	Grundfos
Expansion Tanks	Taco, Amtrol-Extrol sealed cushion type
Insulation	
Insulation	Certain-Teed, Owens-Corning, Mansville, Armstrong, Pittsburgh Corning

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

All JPL Facilities Design Standards not altered by following “Specific Condition” will apply, unless otherwise directed by JPL.

22.14 DOMESTIC WATER SUPPLY TO HEATED BUILDINGS (*TABLE MOUNTAIN FACILITY)*

Bury water supplies a minimum 3’-0” below finish grades and locate the main shut off valve inside the building in a utility room. Locate at 4’-0” above finish floor in a recessed box identified as "water main shut-off". Provide manual drains at all low points in system.

22.15 DOMESTIC WATER PRESSURE REGULATOR *(TABLE MOUNTAIN FACILITY)*

Located in the same utility room as the inside main shut off valve, on the output "down stream" side, prior to domestic in house plumbing.

22.16 DOMESTIC HOT WATER SYSTEMS *(TABLE MOUNTAIN FACILITY)*

The system will be looped with a manual drain at the low point. The hot water heater will be propane (LPG) with a continuous running circulating pump and manual disconnect (standard switch type). No temperature sensing/automation on-off control features on the pump are required. Provide a floor sink below the tank drain valve.

User-scientific requirements are often incompatible with heater exhausts therefore building occupancy and use will determine when LPG or electric water heating is required. Verify with JPL and the State Fire Marshall (SFM).

22.17 WATER HEATER FLUE *(TABLE MOUNTAIN FACILITY)*

Extend flues a minimum of 3’-0” above the roof and secure with a minimum of 3 - #10 diagonal galvanized wire braces.

Division 23 Heating, Ventilating, and Air Conditioning

23.1 GENERAL DESIGN CONCEPTS

Distribute HVAC and utility systems in a regularized, modular pattern to allow for future low cost rearrangements. Allow for a high degree of use of electronic-type equipment.

The HVAC system will consider future space use with higher heat loads, additional lighting and electrical load requirements. Evaluate additional capacity and costs for future space uses on a building-by-building basis. At a minimum allow for one 500 W personal computer per office occupant.

23.2 SOUND AND VIBRATION CONTROL

Use "NASA Reliability Centered Maintenance Guide for Facilities and Collateral Equipment" for sound and vibration control management. The NC (Noise Criteria) and RC (Room Criteria) range to be in accordance with the latest published ASHRAE “Systems Curves for HVAC Sound Control.”

Locate machinery, cooling towers and high-velocity exhausts to minimize aerial transmission of noise to office and technical occupancies. Locate machinery with reciprocating or similar equipment capable of transmitting unacceptable vibration to the building on inertia-type concrete pads. Machinery will be provided with vibration isolators, flexible duct, electric and piping connectors.

All diffusers, grilles, fans, fan coil units, induction units, mixing boxes, heating and ventilating units and other equipment will have noise-level ratings consistent with the noise criteria for the area affected by the noise.

Minimize excessive velocities and turbulence in duct and piping systems to avoid noise transmission. Where required to prevent noise transmission through the ventilating ductwork, acoustical attenuators shall be provided in the ducts. Provide vibration isolators for ducts in enclosed shafts and exposed and plenum areas with adjacent vibration sensitive rooms.

23.3 WATER LEAK PREVENTION IN CRITICAL AREAS

Provide means to prevent inadvertent leaks and water discharge. This includes protection from fire sprinkler, steam lines, HVAC, condensate water and potable and other water systems. Provide protection for flight and other critical hardware including clean rooms, and data centers.

23.4 STANDBY AND EMERGENCY UTILITY

Provide standby and emergency utilities where loss of service would result in danger to life, in damage to mission critical equipment, or in loss of essential data as established by JPL.

Design heating, ventilating and air conditioning equipment with sufficient peak demand capacity and with sufficient equipment unit redundancy (i.e., multiple units) to handle essential loads, even if the largest refrigeration unit or other major unit of utility equipment goes out of service.

23.5 EQUIPMENT AND UTILITY DISTRIBUTION SYSTEMS ACCESS

Provide service personnel access to above ceiling equipment. Locate equipment requiring servicing a minimum of 10’-0” from a roof edge not equipped with parapet or guardrail.

Piping and conduits will be grouped and run parallel to exposed structural and architectural elements. Maintain headroom for maintenance personnel in all normally traveled access ways. Make provision for the servicing and removal of installed equipment.

Design openings to allow for removal of the largest component of disassembled equipment without major modifications to the building. Access panels to environmental systems equipment will be as standardized in size and location as practical.

23.6 HVAC SYSTEMS (GENERAL DESIGN AND COMPONENT SELECTION CRITERIA)

Follow design procedures recommended in the ASHRAE Handbook series, latest edition.

Air Conditioning Design Conditions:

General Technical or Office Type Facilities			
Outside Design Conditions	DB (Summer) = 97° F	WB = 75° F	DB Winter = 30° F
Indoor Design Conditions	Summer = 73° F, 50% RH.	Winter = 73° F	
Technical Facilities (Involving Special Design Conditions as Required by JPL)			
Outdoor Design Conditions	DB (Summer) = 100 ^{o} F	WB = 75 ^{o} F	DB Winter = 30 ^{o} F
Indoor Design Conditions	Summer = 73 ^{o} F	Winter = 73 ^{o} F	

Ranges of relative humidity and temperature may be dictated by individual project requirements as directed by JPL.

23.7 AIR DISTRIBUTION SYSTEMS

No "high velocity" air distribution will be utilized. Use lower air velocities to minimize noise or vibration in all areas, offices, technical spaces and sensitive laboratories. Do not extend exterior or perimeter zones more than 12’-0” into the building.

Provide zones for fan systems to allow an operating areas of the building can be shut down without affecting other areas. Standard ceiling supply air diffusers in office-technical and similar rooms with suspended T-bar ceiling grid will be flush within a drop-in metal pan fitting within the grid. Diffusers will have re-arrangeable multiple cores. Ducted returns preferred. Use of plenum ceilings requires JPL approval.

23.8 AIR DISTRIBUTION DUCTWORK

Ducts shall use externally wrapped insulation, when required, internal duct lining shall be of non-fibrous type is allowed upon JPL approval. Internally insulated ducts with fibrous type. Use connection of flexible trunk duct to the suspended ceiling only. The supply diffuser shall allow it to be relocated maximum 5’-0” in the ceiling plane from the initial location. Hard ceiling installations shall use sheet metal duct to the supply diffusers and return grilles.

Air returns or air supply diffusers shall not be located in areas that can disrupt the capture velocity of chemical fume hoods

23.9 AIR CONDITIONING / REFRIGERATION SYSTEMS

Evaluate air or water cooled direct expansion or chilled water systems to determine what combination of equipment best suits the project.

Centrifugal Chillers shall be provided with automated tube cleaners. Chillers will be equipped with microprocessor control with the capability of having the chilled water temperature reset by the energy management system.

Equipment shall utilize “Green Refrigerants” Do not use R-22 refrigerant.

All main chilled water and condenser water lines shall be provided with suitable connect stub valves to allow for connecting trailer mounted portable rental chillers located outside of a building. Consider aesthetics for termination of ventilation and refrigerant relief discharges.

Monitor and ventilate refrigeration machinery rooms in accordance with ANSI/ASHRAE Standard 15. Refrigerant R123 monitor will be equal to "Chillgard IR" with internally mounted alarm horn. Set 1st stage alarm at 10 ppm of the test refrigerant to flash amber indicator on panel. 2nd stage alarm will flash orange indicator at 30 ppm.

Configure 3rd stage as rate-of-rise alarm set at 300 ppm/min. to flash red panel indicator and sound alarm horn to indicate a major refrigerant leak. A 4-20 milliampere analog output will be connected to the energy management system computer and calibrated to read out in parts per million. The EMS will be programmed to start the emergency ventilation system. Locate the monitor outside the principal entrance to the machinery room.

23.10 HEATING SYSTEMS

Un-interruptible natural gas service is distributed on Lab at 5 psi. Unless heat pumps are justified, gas fired hydronic heating and gas fired heating will be utilized. Avoid fire tube boilers and no provisions for dual fuel firing will be provided.

All boilers, 500,000 BTU or above, shall be provided with metering and monitored by EMS. Hot water boilers will be water tube with electronic ignition, high-low fire capability, and setback control initiated by the EMS. Where the heating requirement is small, consider the use of high efficiency, sealed combustion chamber boilers. This type of boiler can be used in multiples and in local installations to eliminate the need for a central boiler room and flue.

23.11 CONTROL SYSTEMS

Temperature control systems will be electronic with pre-wired panels with capacity for 25% expansion. In hydronic systems install gauges and thermometer, as well as combination pressure/temperature taps. Refer to Energy Management Systems (EMS), Paragraph 2.15.9.

23.12 ZONE CONTROLS

Provide individual zone control for areas of dissimilar thermal loads. Rooms dedicated to information management and computer equipment will each have separate zone sized to handle heat generated by anticipated equipment.

23.13 HUMIDIFICATION

Consider in-room units with self contained blowers when humidification may be required during the cooling cycle when cold air ducts have low moisture carrying capacity. Where humidification is required for an entire building or major portions thereof a spray evaporative humidifier shall be considered. Entering air to the humidifiers will be pre-heated to maintain a constant enthalpy to optimize control and energy consumption. Humidification systems shall cycle off when corresponding air handler cycles off to avoid moisture in duct systems. Humidification shall have high limit safety control.

23.14 VARIABLE FLOW PUMP AND FAN CONTROL

Use electronic variable speed controls for pumps and fans with varying flows at motor sizes 10 HP and above.

23.15 CENTRIFUGAL PUMPS

Centrifugal pumps 2.5 HP and larger will be flexible coupled (space permitting) mechanical seal type with high efficiency motors mounted on heavy duty cast iron or fabricated steel base. Pump shafts will be stainless steel if available. Mount pumps in a horizontal position, when possible.

23.16 VALVES

Use plug valves, gate valves or butterfly valves on boilers, chilled water systems, use full bore plug valves for condenser water service shut-off. Use butterfly valves for flow balancing for lines 2 ½” and larger; use ball valves for lines 2” and smaller.

23.17 COOLING TOWERS

Construct cooling towers of non-combustible materials. All hot water basin parts, columns projecting into the basin, assembly and attaching hardware, and all basic options including sumps, will be stainless steel. Other components may be galvanized.

Where multiple towers are used, provision will be made for basin equalizer piping. Basin drain and overflow will be side outlet. Provide fan deck handrails and ladders. Tower manufactures shall warrant performance of the tower. Do not specify field test by Cooling Tower Institute. Warrant tower mechanical equipment for a minimum of five years.

Utilize induced draft towers when size, weight, and configuration permit. Tower fans 10 HP and greater will be gear driven. Cooling tower water valves over 2” will be butterfly valves for balancing flows and lube type plug valves (Wallworth) for service shut-off.

23.18 WATER TREATMENT SYSTEMS

Chemical treatment products will comply with the Los Angeles County Sanitation District regulations. All water treatment programs shall control scale, corrosion, and organisms and shall be approved by JPL. Install emergency eyewash and shower near the chemical dispensing area.

For water treatment of cooling towers (condenser water system), provide a Lakewood 21-412-63 DTA Controller or equivalent system with pH, conductivity, and inhibitor chemical controls and instrumentation.

Provide a separate LED type meter display for pH and for conductivity, dual auto-biocide delay. Unit shall have an interface to make-up the water meter. House monitor in a NEMA 4X weatherproof enclosure, epoxy coated inside and out for corrosion protection. Provide corrosion coupon racks on each tower to monitor system corrosion.

Each cooling tower, water treatment system will include controls for four chemical pumps. Injection will be via manifold located in the proximity of the cooling tower. It shall include CPVC chemical injection fittings for each chemical pump, 3/8” brass ball cock sample valve, ¼” PVC ball cock pressure relief valve to facilitate chemical pump priming, ¾” PVC double union shut-off valve and ¾” brass inlet shut-off valve.

Fail-safe features will include an integral combination flow switch, flow sight, and back check valve, and will disconnect all outputs at sample stream flows below 1.6 GPM.

For cooling tower water treatment, provide L.M.I. model A-111-92t or Pulsafeeder model LB64-SA-KTZ1 chemical feed pumps with PVC heads, capable of pumping 0.5 Gallons/day to 24 Gallons/day at 90 psi, 115V, 60 Hz, I phase. Provide a bleed line solenoid valve, normally closed, 115V, ¾” size. Valves will be slow closing, with manual flow rate and closing speed adjustment.

Cooling tower water treatment system will maintain pH at 7.2 to 8.1, organic (phosphonate) inhibitor residual at 10 to 16 ppm, 1 ½ cycles for the first 48 hours and then 3-4 cycles of concentration and algae control. Treatment chemicals and application will comply with the Lab-wide treatment program being conducted by the Facilities Maintenance and Operations Section at the time. Commence treatment when water is introduced into the system and continue until accepted by JPL.

For water treatment of closed systems, install a 12 Gallons capacity chemical pot feeder on a bypass across circulating pumps. Closed loop treatment chemicals will be indicated by JPL.

Chemically clean new systems. Flush systems, refill, and add cleaning compound. Circulate for a minimum of eight hours. Drain and flush until water is clear and all traces of cleaning compound are removed. Clean all strainers. After cleaning, certify that "M" alkalinity is same as City water. Add initial charge of concentrated corrosion inhibitor to maintain 1000 to 2000 ppm total alkalinity above City water and adjust nitrite levels to 500-1000 ppm.

23.19 MECHANICAL FIXTURE AND EQUIPMENT SELECTION

Air Movement-Fan-Ducts-Condensers	
Grilles, Registers and Diffusers	ADP, Anemostat, Krueger, Metalaire, Titus.
Ductwork	Per ASHRAE/SMACNA Standards.
Fans	Barry, Breidert, Buffalo, Carrier, Central, Cook, Greenheck, Joy, New York Blower, Penn, Trane, Twin Cities.
Air Handling Units, Condensers, Coils, Etc.	Carrier, Energy Labs, Huntair, Magic Air, McQuay, Temtrol, Thermal, Trane, York, Liebert, Data Aire.
Mixing Terminals	Anemostat, Krueger, Titus.
Refrigeration Equipment and Cooling Towers	
Reciprocating Refrigerant Compressors and Chillers	Carrier, Trane, McQuay.
Centrifugal Water Chillers	McQuay,Trane Centravac using refrigerant 123.
Cooling Towers	Baltimore Air Coil, Marley.
Specialties and Controls	
Vibration Isolation	California Dynamics, Korfund, Mason, Sausse.
Filters	AAF, Air Guard, Farr, Globe, HEPA Corp, Tridem.
Temperature Control Systems	STAEFA Talon-AX Electronic Controls compatible with EMS system.
Refrigerant Specialties	Alco, Henry, Ranco, Penn, Sporlan.
Humidifier	Dri-Steem, Nortec, Aerofil.
De-humidifier	Bryaire, Cargocaire, Desert Aire, Dryomatic.
Motor/Speed Controllers	
Motors	Motors will be high efficiency motors tested in accordance with IEEE Standard 112, Test Method B, using accuracy improvement as specified in ANSI/NEMA Standard MG1-12.53a.
Motor Speed Control	Asea Brown Boveri, Westinghouse with manual bypass on drivers.
Heating Boilers	
Boilers	A.O. Smith, Ajax, Bryan, Cleaver-Brooks, Parker, Rite.
Condensate Return Systems	Parker.
Insulation	
	Armstrong, Certain-Teed, Mansville, Owens-Corning, Pittsburgh Corning.

23.20 CLEAN ROOMS

Laboratories developing flight hardware and other products that would be harmfully affected by NVRs (non-volatile residues) will have a charcoal or comparable filtration system or accommodations for a future system.

HEPA Filters will not be tested with or exposed to DOP (Dioctyl-phthalate) because of its deleterious effect on certain laboratory instrumentation, equipment, and products. All sealant will be G.E. - RTV-162. Clean room fan bearing grease will be non out-gassing Type: Texaco Premium R.B. Lubricant or Krytox Low Vapor Pressure Lubricant or equivalent.

Base HEPA filter selection on life cycle cost, comparing the operating energy cost of initially more expensive filters that have the lowest pressure drop versus higher pressure drop filters, and considering the longer service life of "mini-pleat" type filters.

For rooms not served by a dedicated air-handling unit consider fan-powered HEPA terminals with variable speed motors, serviceable from the room side of the unit. Maintain clean rooms at 15Pa (0.05” WG) positive pressure above rooms of lower cleanliness levels. Provide fan units that operate within acceptable sound levels under installed conditions.

Air locks and gowning rooms are not required for ISO Class 8 clean rooms but are recommended for ISO Class 7 and better clean rooms. Air showers with ionizers are recommended for ISO Class 5 and better clean rooms.

Evaluate standard manufactured central vacuum cleaning systems for inclusion into ISO Class 8 clean rooms and better projects. Piping will be thin-wall steel tubing with fittings. For ISO Class 7 and better clean rooms provide a 3’-0” x 4’-0” closet or metal cabinet for cleaning supplies. Also, provide a portable HEPA vacuum cleaner in the entry air lock.

(See Classifications Of Clean Rooms – Page 59)

23.21 ENERGY MANAGEMENT SYSTEMS (EMS)

The mechanical operation of all buildings will be controlled by the Energy Management System (EMS). All Building Automation System (BAS) controls will interface and communicate with the existing system through JACE or Staefa Talon AX network managers. All control devices shall be LonMark certified or shall be compatible with LonMark standards, which utilize the LonTalk communication protocol. Systems capable of this interface shall operate through the existing EMS without additional computer hardware or software located at the EMS central station.

23.22 EMS REQUIREMENTS

All pertinent mechanical equipment installed will be monitored and controlled by the EMS. The fire/smoke signal system will override the EMS system and directly control the HVAC air movement system. The equipment will be installed with a "Hand/Off/Automatic" switch at the motor control center. The "Automatic" position will indicate control by the EMS and the "Hand" position will indicate the EMS control is bypassed. Retrofit existing pneumatic actuators with EMS compatible electro-pneumatic controls.

The following equipment will be designed for both digital and analog control and status indication:

- Boilers
- Chillers
- Pumps: Chilled water (primary and secondary), condenser water, hot water
- Cooling tower fans
- Air handlers, supply and return fans, exhaust fans
- VAV's and fan coils (zone control)
- Variable speed drives (VSD)
- Air conditioning units (package units, etc.)
- Dampers and valves.
- Humidifiers

The following equipment will be designed to accommodate points for monitoring by the EMS:

- Chilled water supply and return temperatures for each chiller
- Condenser water supply and return temperatures for each chiller
- Hot water supply and return temperatures for each boiler
- Air handler supply temperatures (hot and cold)
- Air handler return temperature
- Air handler static pressure
- Space temperatures of appropriate areas
- Appropriate relative humidity points
- Building static pressure
- Building electrical consumption
- Building natural gas consumption

23.23 EMS TEMPERATURE SENSORS

All temperature sensors will be compatible with the EMS. Each air conditioning zone will be monitored by a minimum of one temperature sensor. Temperature sensors will be installed in the supply and return air stream of each air handler.

23.24 EMS CONTROL DEVICES

EMS control devices shall be compatible and programmable through the “Tridium Niagra AX Work Bench”. Each control device will be labeled with the appropriate corresponding board and channel address. Each controller will be labeled to indicate what equipment is being controlled. New EMS net controller cabinets, control board cabinets, or field interface panels (FIPs) will be keyed the same as the other EMS cabinets (key C413A). These cabinets or panels will contain only components and controls directly related to the EMS and will provide a dust free environment. New control board cabinets and FIPs shall be similar in size and construction to the Seimens Datamux 2’-0” wide x 4’-0” high x 9” deep. The control board cabinets will be provided with a minimum of one spare control board-wiring base for future expansion.

23.25 EMS CABINETS AND FIPS

All EMS cabinets and FIPs will have provisions to maintain their interior within maximum temperature limits recommended by the manufacturer. A rated 125V electrical outlet will be provided in close proximity to the control board cabinets to provide optional power for the necessary diagnostic tools. All cabling, wires, or wire looms will be contained in either cable trays or conduit. High and low voltage wiring will be clearly labeled and will not be allowed to occupy the same cable tray or conduit.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

All JPL Facilities Design Standards not altered by following “Specific Condition” will apply, unless otherwise directed by JPL.

23.26 PROTECTION OF HVAC EQUIPMENT *(TABLE MOUNTAIN FACILITY)*

All HVAC equipment will be protected for the weather. Locate equipment and piping indoors wherever possible. Those parts of HVAC equipment, which need some exterior exposure, will be protected from above by a roof or canopy and from the sides by walls of sufficient height and construction to keep the adjacent areas free of snow. HVAC equipment and piping will be protected from freezing. Maintain ventilation requirements of equipment manufacturer’s.

23.27 DUAL ENERGY COMFORT HEATING *(TABLE MOUNTAIN FACILITY)*

The primary system for the main central forced air unit is propane (LPG) with individually zoned electric strip heaters as the back-up system (If LPG delivery is not available). Provide individual

local zoned thermostats with a maximum allowable setting of 68° F for heating control. Where possible, provide two (2) smaller F.A.U. heaters instead of one (1) larger unit to provide minimal heating, should one fail.

User-scientific requirements are often incompatible with heater exhausts therefore building occupancy and use will determine when LPG or electric heating is utilized.

23.28 HVAC CONTROLS FOR BEDROOMS AND OFFICES *(TABLE MOUNTAIN FACILITY)*
The main thermostat will be connected to the high-low air temperature sensors located in the return air duct, before the outside make-up air, in the fan room adjacent to the unit. The main thermostat will have settings for heat cooling. Locate an individual on-off wall switch next to the main thermostat. In bedrooms, provide individual local thermostats for heating only. The unit fan will run continuously to provide airflow for electric strip heater protection.

23.29 ROOF VENTS *(TABLE MOUNTAIN FACILITY)*
Minimize roof vents and penetrations due to snow cover. Locate all exterior wall air, exhaust, vents, etc., as high as possible under overhangs for snowdrift protection.

Division 24 Reserved
Division 25 Integrated Automation – Not Used

Division 26 Electrical

26.1 DESIGN CONCEPTS
Design new facilities and modifications to existing facilities with energy efficient systems and equipment to minimize maintenance and to permit economical and quick remodeling of interior spaces.

Designs will provide a safe environment for occupants and for the Facilities maintenance and operation personnel. The JPL Facilities Electrical Safety Advisory Board (FESAB) will answer site/building questions and assist in the application and interpretation of these Standards.

26.2 PANEL SCHEDULES
When installing or modifying an electrical panel board, the "panel schedule" shall be updated to reflect an accurate and current description of the newly added load(s). This shall be in the form of a JPL furnished template, “Excel” computer spreadsheet titled, “Panel Schedule”, a copy of which shall be affixed to the inside of the panel board door, clearly indicating area (room number) and type of new load(s).

Existing loads (if any) will be documented on the new spread sheet as it appears on the existing paper panel schedule with an annotation stating “Unverified Circuit”. Electrical panel schedules shall be completely verified when work on any given panel in a building affects or modifies 33% (1/3) of the panels’ distribution system. The newly generated panel schedule(s) shall be entered into the “AutoManager Meridian” file and drawing retrieval system.

This file shall be accessible through the standard facility file management system for use by the designers and outside engineers. The information shall be dated, identified, maintained and posted for each appropriate panel it affects.

Use the JPL template of this Excel" computer generated spreadsheet titled, "panel schedule". The file can be obtained from "Facilities Design Standard Details" (FDSD)..

26.3 EXTERIOR LIGHTING

New streetlights shall match existing per JPL Standard Drawing and Details. Use silhouette lighting on building and structures for night security in areas where no parking or service areas are located.

Luminaries will consist of exposed standard and lightweight housing with cut-off lens. Mount fixtures on buildings where possible. Use dark bronze anodized aluminum fixtures for building-mounted fixtures. Use round, 3'-0" high, concrete pedestal bases in roadway, parking, service or areas subject to auto/truck damage.

The standard, clear height of light fixtures will be 20'-0" above the finished grade. Provide cut off lenses to minimize light source visibility from off-site residences. Roadway lighting will be fed from the existing 480V roadway lighting system circuits.

Mall and plaza areas lighting will be dark bronze anodized aluminum, 20'-0" high, with a square shaped aluminum or steel standard and a high pressure sodium lamps.

Supplemental fixture for areas adjacent to building entries or along pedestrian walkways and stairs will be Kim Type LLF recessed step light; cast aluminum luminaries with exposed dark bronze anodized trim luminaries cast into concrete or masonry walls or bollards. Lamp will be high-pressure sodium. Relay, photocell, or both shall control all outdoor luminaries.

26.4 LOW VOLTAGE CONDUCTORS

All low voltage conductors shall be copper, stranded, and rated 600 volts. Minimum conductor size shall be #10 AWG for branch circuits and #12 AWG for lighting circuits. Conductors shall be rated for 140° F (60° C) insulation class, when the load is 100 AMPS or less. Insulation class shall be 194° F (90° C) (THHN/THWN) when the load is greater than 100 AMPS.

26.5 COLOR CODE FOR CONDUCTORS

Conductors shall be manufactured with colored insulation. This chart is applicable for all voltages.

Phase A: Red
Phase B: Orange
Phase C: Black
Neutral: White
Ground: Green
Isolated grounds: Green with yellow stripes
DC Positive: Blue
DC Negative: White

26.6 PHASE ROTATION

Phase rotation shall be A-B-C (Red, Orange, Black) clockwise at all new panels.

26.7 RACEWAYS AND CONDUITS

Arrange wiring installed in electrical closets, shafts and between areas to retain the fire integrity of the floor or area. Install conduits in concealed areas, when practical. Conduits in walls shall be installed vertically. Horizontal runs of a raceway inside walls shall not exceed 1'-4" and not penetrate studs.

Minimum size conduit will be ¾". Interior conduits may be electrical metallic tubing with compression type connections or where exposed to possible damage galvanized rigid steel conduit with threaded connections. Compression fittings are not allowed on rigid steel conduits. Install flexible conduit with equipment susceptible to vibration, not to exceed 3'-0".

1" conduits and larger shall have grounding bushings on both ends when installed in concentric and eccentric knock-outs.

Provide for feeder conduits grounding bushings at each end of conduits and at any interruptions and changes in the conduits. All feeder conduits 2" and above shall be made of rigid metal.

26.8 CIRCUIT DENSITY

Provide minimum of one circuit per gross building area of 90 square feet. This is a required circuit density independent of building use.

26.9 ELECTRICAL REQUIRENTS FOR KNOLL PARTITIONS

Cubicle partitions are equipped with raceway. The standard Knoll partitions have the capability of 6 circuits; two sets of 3 circuits, each set having a shared #10 AWG neutral and grounding conductor.

26.10 POWER REQUIREMENTS FOR KNOLL PARTITIONS IN OPEN LANDSCAPE:

Provide a minimum of one dedicated circuit per cubicle, and a minimum of one duplex receptacle on each wall of Knoll partition or two duplex receptacles per each workstation. Provide one spare dedicated circuit in the distribution J-box for each cluster of 6 cubicles.

26.11 POWER REQUIREMENTS FOR HARD WALL OFFICES

Provide one dedicated 20A/120V circuit per office. Provide one receptacle per wall at maximum 12'-0" spacing, in addition a minimum of two receptacles per individual workstations.

26.12 POWER REQUIREMENTS LABORATORIES AND SHOPS

Use “Wiremold” G4000 and/or G6000 surface metal raceways in laboratories and shops. These raceways shall be dedicated to either power or communications cables only. In new laboratories, provide a panel for minimum of 500 S.F. to 1,000 S.F. of floor space.

26.13 POWER REQUIREMENTS DEDICATED COMPUTER EQUIPMENT ROOMS

Electrical power service to computer rooms will come from dedicated electrical panel located within same room or down-line from an un-interruptible power source (UPS).

26.14 BUILDING POWER DISTRIBUTION SYSTEMS

Circuit breaker types and interrupting capacities, (KAIC) ratings, hall be selected based on the results of a short circuit study. Circuit breakers, panel boards, transformers and feeders shall be selected based on load calculation and coordinated study. The short circuit and voltage drop values shall be on the “Single Lines” drawing.

26.15 GROUNDING

Provide a ground ring with ground well for all new buildings and structures per JPL Standard Drawings.

Building grounding systems shall comply with the latest codes referenced in these standards (see Applicable Codes in the Preamble Section). The grounding system for automatic data processing equipment (ADP) will conform to the latest NEC and the IEEE 142 for ADP Installations.

26.16 LIGHTNING PROTECTION

Provide lightning protection on facilities as directed by JPL’s Project Administrator.

26.17 BUILDING LIGHTING

The lighting design of new and existing buildings will conform to the California Energy Code. Exceptions may be necessary for certain critical research facilities. Working areas will be adequately and economically illuminated. The use of daylight, with controlled direct sunlight is encouraged.

26.18 LIGHTING LEVELS

Lighting levels shown for various tasks illustrate established design levels and are acceptable provided they also meet the current California Energy Code (CEC) requirements.

Administration/ Office/ Open Workstations	35 F.C. average at the work level
Circulation/ Lounges/ Corridors and Restrooms	15 F.C. average
Storage/ Support Rooms	15 F.C. average
High Bays	75 F.C. to 102 F.C.
Laboratories/ Lab Equipment Rooms/ Benches and Table Tops	50 F.C. average at the work level
Mechanical/ Plumbing/ Electrical Equipment Rooms	20-30 F.C. average
Exterior	1-5 F.C. average

Use task lighting for specific areas requiring a higher light level. The lighting fixtures and locations should minimize “veiling glare” and “computer screen” light reflectance.

26.19 SWITCHING

Three lamp fixtures will have the inner and outer lamps switched separately after the occupancy sensor. All occupied spaces will have switches located within site of the areas controlled. Provide a dedicated programmable lighting controller with custodian and occupant over-ride capability for open office areas and exterior lighting as required.

26.20 OCCUPANCY SENSORS

Provide ceiling mounted occupancy sensors with wall mounted over-ride toggle. Sensors shall be dual technology type manufactured by “UNENCO”, “NOVITAS”, “WATTSTOPPER” or JPL approved equal.

26.21 FLUORESCENT LIGHTS

4’-0” T8 and /or T5, 4100 Kelvin lamps or better and electronic ballasts with no more than 10% total harmonic distortion. Down light fixtures shall have type PL 4100 Kelvin compact fluorescent lamps and high power factor ballasts.

26.22 LIGHTING FOR OFFICES

Provide 2’-0” x 4’-0”, recessed fluorescent fixtures with parabolic louvers silver finish. The quantity and wattage of the lamp will be determined by the designer.

26.23 LIGHTING FOR CONFERENCE ROOMS

Provide 2’-0” x 4’-0”, linear direct/indirect, extruded aluminum fluorescent fixtures with for ceilings 9’-6” or higher. The quantity and wattage of the lamp will be determined by the designer.

26.24 LIGHTING FOR LABORATORIES

Provide 2’-0” x 4’-0” fluorescent fixtures with prismatic lens. Incandescent fixtures required for RFI shielded enclosures may be used and separately switched but must be supplemented with fluorescent lighting. The quantity and wattage of the lamp will be determined by the designer.

26.25 CLEAN ROOM LIGHTING

Provide 2’-0” x 4’-0”, fluorescent fixtures with prismatic lens. Clean room fixtures shall be steel body with all internal corner joints sealed. Extruded doorframe will be sealed to fixture body with continuous neoprene gasketing and held in place by minimum 6 captive screws. Lens will be sealed in frame with clear silicone. The quantity and wattage of the lamp will be determined by the designer.

26.26 LIGHTING FOR HIGH BAY AREAS

Use industrial fixtures with metal halide lamps, or fluorescent T5 lamps, when color rendition is critical.

26.27 LIGHTING FOR REST ROOMS, STORAGE, JANITOR AND SIMILAR ROOMS

Provide 1’-0” x 4’-0”, fluorescent fixtures. The quantity and wattage of the lamp will be determined by the designer.

26.28 NIGHT LIGHTING

To be provided at corridors, mechanical, communication, electrical rooms, rooms with hazardous material or devices, and rooms of 400 square feet and larger.

26.29 EMERGENCY LIGHTING

Provide emergency lighting as required by the Building Code and in non windowed office areas, large electrical, mechanical rooms, technical areas, and hazardous areas. Provide integral

battery power for emergency lighting where no existing or new emergency power distribution system exists. Use high temperature, maintenance free, nickel-cadmium. Batteries shall have minimum 10 year warranty. Use night light fixtures for emergency lighting when applicable.

26.30 EMERGENCY BATTERY BACKUP FOR LIGHTING

Emergency battery backup shall be capable of providing normal fixture operation in a switched fixture. Include "TEST" switch and "AC ON" indicator light. Power supply shall have self-test diagnostic feature.

26.31 EXIT SIGNS

Exit signs shall be internally illuminated. Required signs shall have green light emitting diode (L.E.D.) type lamps and have nickel cadmium battery backup power. The exit signs shall be equipped with self diagnostic feature. No Tritium (Radiation) exit signs are permitted.

Replace Tritium (Radiation) exit signs when the scope of work is within the area of existing Tritium (Radiation) signs.

26.32 STAIRWAY LIGHTS

Provide lights easily accessible for maintenance above landing areas without special equipment. Do not exceed 10 feet reach.

26.33 MOTOR STARTERS

Motor starters shall be solid state controller, provided with a control transformer fused on the primary and secondary, 2 normally open/closed auxiliary contacts and hand-off auto switch. Motor overload protection shall be provided for each motor phase.

26.34 MOTORS

Shall be high power factor and energy efficient. Motors 1 HP and over will be 480 V three phase. Motors below 1 HP may be 120/208 V single phase.

26.35 DRY TYPE DISTRIBUTION TRANSFORMERS

General-purpose dry type transformer (600 V and below) shall have copper windings, and be K rated, with the exception when used for pure mechanical load.

26.36 PRIMARY SWITCHGEAR

Switchgear for use at 16.5 kV will be rated 25 kV class, metal-clad interrupter switchgear with manually operated fused disconnects, shall be three pole single throw gang operated. Fuses will be standard, speed “E” rated. Switchgear shall be metal enclosed ABB, CUTLER-HAMMER, GE, or Kinney, switchgear.

26.37 SECONDARY PROTECTIVE DEVICES

Main switchboards at 1,000 A, or above shall have circuit breakers with solid-state electronic trip units and adjustable trip characteristics. Provide accessible main building disconnect.

26.38 POWER AND LIGHTING DISTRIBUTION PANELBOARDS

Shall be hinged door-in-door type construction by Square D, GE Spectra, or Cutler-Hammer.

Panel boards shall be 120/208V, 3-phase 4 Wire, 225 A, 42 spaces, or 480/277V, 3-phase 4 Wire, 225 A (minimum) by Square D, GE Spectra, or Cutler-Hammer.

26.39 VARIABLE FREQUENCY SPEED DRIVES (VFD)

Variable frequency speed controllers shall be ABB, CUTLER-HAMMER, SIEMENS or JPL accepted equal. Variable frequency speed drives shall be within 200 feet of its motor and shall be in a sealed, gasketed enclosure with a bypass system. Disconnects and motors shall be labeled stating source and load information.

26.40 WIRING DEVICES

125 V receptacles shall be rated 20 A minimum and conform to JPL Standard Drawing and Details. General use receptacles shall be specification grade or better for use on alternating current only. Device plates will be high-impact thermoplastic such as Nylon or Teflon.

26.41 MAINTENANCE OUTLETS

Provide 125 V maintenance outlets spaced less than 100 feet apart on exterior walls and roofs. Outlets shall be spaced less than 12 feet apart in all other areas including hallways and aisles at “hard” walls. Provide outlets in toilet areas, electrical, mechanical rooms, laboratories, and communication rooms.

26.42 MOUNTING HEIGHTS FOR RECEPTACLES AND SWITCHES

Receptacles in Offices and Corridors	1’-3”
Receptacles in Shops & Labs	4’-0”
Receptacles in Restrooms	3’-3”
Light Switches	4’-0”

26.43 EQUIPMENT IDENTIFICATION PLATE

Provide engraved laminated plastic identification plate on all panels, switchgears; motor control centers and disconnects switches. Identification plates shall be 3-layers; BLACK-WHITE-BLACK, engraved to show uppercase white letters on a black background for normal power and RED-WHITE-RED, engraved to show white uppercase letters on a red background for emergency power. Identification plate shall be affixed to the front of electrical equipment indicating panel or equipment designation, voltage, amperage and source panel. Identification plates shall be fastened by means of corrosion resistant steel or nonferrous metal screws. Hand lettering, marking or self adhesive tapes are not acceptable.

Identification plates shall be descriptive of the load and source (Voltage, Current, Phase, # of wires). See standard plate design in the JPL “Facilities Design Standard Details” (FDSD).

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

All JPL Facilities Design Standards not altered by following “Specific Condition” will apply, unless otherwise directed by JPL.

26.44 LIGHTING *(TABLE MOUNTAIN FACILITY)*
Use incandescent lamps at exterior and in occupied rooms instead of fluorescent lighting because of the night use of facility by astronomers (Night blindness caused by the fluorescent lighting may take as much as 15 to 20 minutes for the human eye to recover.)

Emergency lighting will be 12V battery, minimum 90-minute capacity, trickle charged, with adjustable headlamps. Locate units for easy checking of battery condition.

26.45 LIGHTNING AND GROUNDING PROTECTION *(TABLE MOUNTAIN FACILITY)*
Per NFPA 70, Article 250; NEMA LA1; NFPA 780, Standard for the Installation of Lightning Protection System, 2000; and UL 96. System will be installed by or under the direct supervision of a Certified Master Installer certified by the Lightning Protection Institute. The entire system will be tested and certified by a licensed, independent testing company and include a copy of the certified test report. System will have a resistance of 25 ohms or less.

Division 27 Communications

27.1 EMERGENCY PAGING SYSTEMS
Provide an emergency paging system with speakers and cabling to each speaker, and an emergency PA system amplifier, at a maximum of 20’-0” spacing in corridors and in open office and technical areas.

The system input shall connect to the LAB paging system through a telephone line at a level of 8 dB, at 600-ohm impedance. The system will feed speakers in sound masking systems.

27.2 TELECOMMUNICATIONS SYSTEMS
Cables for the telecommunications systems shall be plenum rated cables. In finished spaces, cables shall to be distributed in cable trays installed in the above ceiling space or below access floors. Provide a system of cable trays in the above ceiling space for the distribution of cables to all communication outlets on each floor. The JPL Network Engineering Section will review telecommunications systems.

27.3 CABLE TELEVISION SYSTEM (CATV)
Provide a minimum of one 125 V outlet and cable conduit/J-box for a television receiver in every conference room, dining, and assembly areas.

27.4 TELEPHONE SYSTEM
Per JPL Standard Drawing and Details. Provide a telephone outlet for every workstation, laboratory, shop, electrical and mechanical room.

Provide one LAB phone outlet accessible to the handicapped located near the main personnel entry and elevator lobby area.

Provide a minimum 8’-0” x 8’-0” terminal board in the communications room at each floor with two dedicated 125 V outlets. The maximum cable length from terminal board to outlet will be 150 feet.

Provide floor penetration, conduit sleeves, and minimum 4” diameter to interconnect communication rooms.

Division 28 Electronic Safety and Security

28.2 FIRE DETECTION

All automatic extinguishing systems shall be provided with proprietary alarm supervision including but not limited to water-flow, valves, smoke detection, manual pull station, agent discharge, low air pressure supervision.

28.3 ALARM EQUIPMENT

All alarm equipment shall be U.L. listed or approved by a similarly recognized testing agency acceptable to JPL. All alarm equipment shall comply with this standard.

28.4 FIRE ALARM SYSTEMS

Analysis shall be reviewed for design and final approval by the JPL “Authority Having Jurisdiction” and Facilities Design Section.

28.5 NOTIFIER SYSTEM

Analog Notifier Intelligent Fire Alarm system for all new buildings with provisions to connect to a NION-RS232 module, which shall be connected to the nearest UNINET Hub. Include required equipment including NION's, Routers and Repeaters.

28.6 DESIGN SUBMITTAL

Design submittal shall include the following:

- Location of all devices including panel on drawings
- Battery capacity and loading calculations
- Conduit Requirements
- Calculations to verify the requirements of the alarm control panel.
- Voltage drop calculation for signaling line circuits.

28.7 ALARM PANELS

Alarm panel shall be located at building main entrance.

28.8 FIRE ALARM WIRING

All fire alarm wiring shall be in conduit.

- Wiring Colors and Sizing for fire alarm systems shall be maintained as follows:
- S.L.C. Loop – 16ga., 2 conductor FPL.
- Annunciator – 18ga., 2 conductors shielded FPL (2 each).
- Power – Pink/Purple, 14ga. THHN.
- Horn/Strobe – Yellow/Blue, 12ga. THHN
- Speakers – Red/Black, 14ga. THHN
- Door Holders & Misc. Circuits – Orange/Brown, 14ga. THHN

28.9 OXYGEN AND CARBON MONOXIDE MONITORING SYSTEM

Provide in all areas where the potential for an oxygen-deficient atmosphere or excessive carbon monoxide exists. The system will have visual and audible alarms, an alarm signal to the Security Console in Building 310 via UNINET 2000.

28.10 OXYGEN MONITORING SYSTEMS

Shall be MSA (Mine Safety Appliances) ULTIMA PLUS for multi-point systems and AMI Model 221 for single point systems, or alternates as approved by JPL. Verify instrument selection and sensor locations with JPL Occupational Safety Program Office (OSPO) and JPL Instrument Service Group prior to installation.

28.11 SPECIAL SENSOR ALARM SYSTEMS

Special sensor/alarm systems will be provided at all areas containing toxic or hazardous chemicals, liquids, gases, explosives, radioactive materials, lasers, electromagnetic radiation as required by the JPL Occupational Safety Program Office. Refer to table in paragraph 28.13.

28.12 MISCELLANEOUS ALARMS

The only exceptions to the following alarms are when the sounds are unique to specific equipment and do not infringe on any other standard alarm sounds and are localized enough that operating personnel are familiar with them such as: Machinery room refrigerant R123 sensor, portable oxygen depletion alarms, cranes and computer/ electronic equipment.

Alarm Functions:

Alarm Situation Location	Significance	Audible Alarm [1]	Visual Alarm [2]	Signage [3]
Fire and Smoke detection, water-flow, etc.	Emergency evacuation.	California March Time (3-tones)	Synchronized Strobes (and/or flashing exit signs where applicable)	"EVACUATION ALARM"
O_2/CO_2/CO	Emergency evacuation.	Temporal Tone [1]	Strobe [2] light (and/or flashing exit signs where applicable)	Specific sign indicating type of hazard
Radiation Machine	Warning of unsafe parameter		Flashing red light	Specific sign indicating type of hazard
Laser Operation	Hazardous operation being performed. Test area closed.		Amber light, flashing or rotary	"DANGER - LASER ON WHEN LIT"
Operation or Test Facility	No test in progress. Proceed to control or shop area only. Do not enter test area unescorted.		Green light, flashing or rotary	"AUTHORIZED PERSONNEL ONLY" "OPERATING PERSONNEL ONLY"

Alarm Situation Location	Significance	Audible Alarm [1]	Visual Alarm [2]	Signage [3]
	Hazardous operation being performed. Test area open to operating personnel only unless special permission granted by supervisor.		Amber light, flashing or rotary	"TEST IN PROGRESS DO NOT ENTER Without approval from supervisor in charge."
	Hazardous test in progress. Test area is closed. No admittance to any personnel.		Red light, flashing or rotary	"TEST IN PROGRESS DO NOT ENTER"
(Test cell propellant facility. Red light condition)	Extreme danger. Explosive or toxic hazard. Evacuate the area at once. All personnel MUST stay out of the test area. Follow directions of the person in charge.	Air horn, high pitched, pulsating		
(Test cell propellant facility. Red or amber light condition)	Test to start in 10 seconds. Stay clear of test cell.	Air horn low pitched, steady (15 seconds duration)		
Equipment or machinery (central panels)	Equipment malfunction. Notify person in charge.	Small horns, adaptahorns or buzzers	Red indicator light, flashing or steady	Sign required
	Equipment or machinery stopped. No action necessary.		Amber indicator light, steady	Sign required
	Equipment or machinery on and operating properly. No action necessary.		Green indicator light steady	Sign required
Water Gong and or Electric Bell		Repetitive bell closely spaced.		Sign required.
Walk-in refrigerator	Indicates light is on within the unit.		Blue indicator light, steady.	Sign required

Alarm Situation Location	Significance	Audible Alarm [1]	Visual Alarm [2]	Signage [3]
	Equipment malfunction. Notify person in charge.	Small horns, adaptahorns or buzzers	Red indicator light, flashing or steady	Sign Required
Elevator		Continuous bell		Sign required
Security Door		Raucous bell		Sign required
Motorized Moving Door		Continuous bell		Sign required
Motorized Fire Door	Door malfunction	Buzzer		Sign Required
Emergency Eyewash/Shower, Cranes, Computer, Electronic Equipment		Unique to each		Sign required

1. (Max. 120 dB A. Min. exceeds prevailing equivalent sound level by 15 dB A or exceeds max. sound level lasting 60 seconds by 5 dB A.)
2. Xenon strobe or equivalent. Color: Clear. Pulse: Max. 2 second with max. duty cycle 40%. Intensity minimum 75 cd. Flash Rate: Min. 1 Hz to max. 3 Hz.
3. 1” letters visible from 25’-0”.

28.13 ANCILLARY ALARM FUNCTION

The following Fire Alarm Matrix is provided to detail the devices and systems needed for individual occupancies relative to JPL's environment.

Ancillary Alarm Function MATRIX

Occupancy Group	MFA Manual Pull Stations	Water Flow	Automatic Heat/Smoke	Audible	Visual	Voice Evacuation	Smoke Detector Release	Duct Detector		Fire/Smoke Dampers	Smoke Control	Elevator Recall	Electrical Supervision	Monitoring (CSS)
A1	X	X		X	X	X	X	X	*	X		X	X	X
A2	X	X		X	X	X	X	X	*	X		X	X	X
A2.1	X	X		X	X	X	X	X	*	X		X	X	X
A3	X	X		X	X		X	X	*	X		X	X	X
B	X	X	X	X	X		X	X	*	X		X	X	X
F1	X	X		X	X		X	X	*	X		X	X	X
F2	X	X		X	X		X	X	*	X		X	X	X
H	X	X	X	X	X		X	X	*	X		X	X	X
H5	X	X	X	X	X	X	X	X	*	X		X	X	X
S	X	X		X	X							X	X	X
B Hi-Rise	X	X	X	X	X	X	X	X	*	X	X	X		X

TABLE LEGEND:

X Required devices/systems.

***** Ceilings of the occupied space are provided with smoke detectors and sprinkler protection, duct detectors are not needed.

OCCUPANCY GROUPS:

A1	Building with an assembly room able to hold up to 1000 people and has a legal stage.
A2	Building with an assembly room able to hold less than 1000 people and has a legal stage.
A2.1	Building with an assembly room able to hold less than 300 people and does not have a stage.
A3	Building with an assembly room able to hold less than 300 people and does not have a stage.
B	Buildings with an occupant load of less than 50 people.
F1	Buildings housing moderate hazard factory and industrial operations.
F2	Buildings housing low hazard factory and industrial operations.
H	Buildings housing high fire, explosive or health hazard occupancies such as laboratories.
H5	Buildings housing semi-conductor facilities, utilizing high hazard chemicals in large quantities.
S	Buildings utilized for storage.
B Hi-Rise	Buildings utilized as offices over 75 feet in height above the lowest level of fire department vehicle access.

28.14 SPECIAL SECURITY SYSTEMS

JPL will supply project criteria for security systems. The systems require connection by telephone or through the video communication and fiber network to the Security Console located in Building 310.

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS

All JPL Facilities Design Standards not altered by following “Specific Condition” will apply, unless otherwise directed by JPL.

28.15 FIRE ALARM SYSTEM *(TABLE MOUNTAIN FACILITY)*

Fire alarm equipment installed in TMF buildings shall be compatible with Notifier panels in order to facilitate monitoring by the JPL Proprietary Station monitoring system. All installations shall utilize Notifier equipment including but not limited to fire alarm panels, smoke detectors, tamper switches, low air pressure switches, manual pull stations, water flow switches. Smoke detectors shall be addressable. Where smoke detection is provided in open occupied areas, smoke detection need not be provided in return air ducting.

Division 29 Reserved

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SITE AND INFRASTRUCTURE SUBGROUP

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Division 30 Reserved

Division 31 Earthwork

TABLE MOUNTAIN FACILITY SPECIFIC CONDITIONS
All JPL Facilities Design Standards not altered by following “Specific Condition” will apply, unless otherwise directed by JPL.

31.1 SITE GRADING *(TABLE MOUNTAIN FACILITY)*
Minimum slope is 2%. Maximum slope is 1 vertical to 2 horizontal (2:1). All fill minimum 95% relative compaction. Slope all grades away from buildings. Maximum driveway slope is 8% (5% preferred) with no obstructions, which could be buried under snow.

31.2 SITE PAVING *(TABLE MOUNTAIN FACILITY)*
Minimum slope for AC paved areas is 1%. For landscaped areas the minimum slope is 2%. Do not exceed 12% for roads and not more 15% slope for short access roads up to 50 feet. The minimum slope is 0.5% for concrete paving.

Division 32 Exterior Improvements

32.1 SITE WALKWAYS AND WALLS
Malls, walks, stairways, and patio paving will be natural color concrete. Concrete finishes; textures and patterns at Mariner Mall will match existing. Provide tree well grates in pedestrian areas and site walls for seating, screening service elements, security, and other functional purposes

Site Wall Materials:

Walls at malls, plazas, and other pedestrian areas.	Poured in place natural gray concrete or split face concrete block (Tan). Chain link is not allowed.
Slope retaining walls (other than malls/plazas)	Natural gray concrete or split face concrete block (Tan).
Service element walls not adjacent to malls or major building "views". (Service elements include transformers, mechanical items, trash containers, etc.)	Natural gray concrete, gray concrete block or chain link.

32.2 GENERAL ROADWAY DESIGN STANDARDS
Road system design will be per Los Angeles County (LACO) standards. Provide vertical curve transitions at grade transitions. Base minimum turning radius for truck access on a WB-50 design vehicle, 45’-6” radius for a 55’-0” large semi-trailer combination. Provide 15’-0” minimum overhead clearance at roadways and fire lanes.

Segments of the road systems may require additional clearance and must be verified with JPL for each project. Provide accessible curb ramps at intersections of pedestrian walkways and street curbs.

Design Loads	
Roads and Service Areas:	H-20 (Los Angeles County (LACO) Standards
Parking Areas:	H-15 (Los Angeles County (LACO) Standards
Ring Road System [Figure 2]	
Curb to curb width	36'-0" standard, two 12'-0" driving lanes and 6'-0" left turn and two parking lanes.
Interior curve radius	35'-0" minimum
Combination curb and gutter is required on both sides of Explorer Road, Ranger Road and east-west segment of Surveyor Road. Curb and gutter, and cross gutters required at intersections. Provide curb ramps for disabled access.	
Secondary Road System	(All other roads)
Two way streets	24'-0" minimum with two 12'-0" driving lanes. 6'-0" minimum required for each on-street parking lane.
One way streets	16'-0" minimum when no on-street parking is allowed.
Interior curve radius	25'-0" minimum
Combination curb and gutter required when roadway is adjacent to a major walkway or mall.	
Fire and Emergency Lanes	
Primary fire lane	24'-6" minimum vehicle access to all sides of major buildings, including mall access and along Mariner Mall.
Exterior curve radius	50'-0" minimum from entry roads and a driveway. Removable pipe barrier required at pedestrian ways.

32.3 GRADIENT CRITERIA

Site Grades:

Grade for roads	Maximum 12%
Grade for short access roads not longer than 50 feet.	Maximum 15%. Provide vertical curve transitions at grade transitions
Grade for parking and service area	Maximum 5% cross grade
Slope at landscaped areas	Minimum 2%. Maximum 1 vertical to 2 horizontal (1:2)
Slope at A.C. paving	Minimum 1%
Slope at concrete paving	Minimum 0.5%
Slope at concrete gutters	Minimum 0.5%
Slope at turf	Minimum 2%
Slope at Mall Walkway	Maximum 5%, minimum 1%. The standard slope is 2%.

32.4 TRASH AREAS

Provide space for a minimum of one 25 S.F. trash bin per 12,000 S.F. office area served, verify requirements for other areas. Multiple building groups may be provided with a single trash bin area. Provide a 12'-0" x 35'-0" pick-up stall in front of the bin for a 30'-0" front loading truck with 45'-0" outside wheel turning radius. A 13'-9" minimum height clearance is required. Trash pick-

up stall may be combined with a service vehicle stall. Confirm requirements with JPL Environmental Affairs Office.

Maximum slope from a trash area to a service door at grade level and to trash truck accessibility will be 8 %. Building walls within 10'-0" of a trash area will be rated not less than 1 hour, with 45 minute protected openings. Provide bumpers around the trash container to prevent damage to wall structure by the trash container. Screen all trash areas from building or pedestrian view.

32.5 STORM DRAINAGE

Site drainage calculations will be per the Los Angles County Flood control District "Hydrology Manual". Use the Modified Rational Method for a recurrence interval of 25 years for rainfall intensity and a runoff coefficient of 0.90 and as determined by JPL. For small areas, the designer may use a rainfall intensity of 5 ¼" per hour instead of reference to the "Hydrology Manual".

When a combined storm drain pipe and surface flow system is designed, the pipe may be designed for 10 year rainfall intensity, but the surface flow will be designed for full 25 year rainfall intensity with catch basin sump areas designed so water levels never reach within 6" of an adjacent facility floor elevation.

Conduct storm drainage from small paved areas and buildings, less than 3,000 S.F. via surface paving to a roadway curb face. Surface flow shall not flow over a pedestrian walkway. Mall area drains to be 6" – 9 ¾" wide trench drains with cast iron traffic grating. They shall be integrated into the paving pattern.

Storm drain pipe will be minimum 6" diameter. Corrugated metal pipe is not allowed. Locate surface clean-outs or accessible catch basins at a reasonable interval. Use water inlet type catch basins with access covers for clean-out maintenance. Prevent storm flow from backing into foundation drains. Use Los Angeles County (LACO) Standards details.

32.6 SUSTAINABLE LANDSCAPE DESIGN

Where cost-effective and to the extent practicable, do the following (Reference: The Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds directs agencies and EO 13148 Section 207)

- Use regionally native plants for landscaping;
- Design, use, or promote construction practices that minimize adverse effects on the natural habitat;
- Seek to prevent pollution by, among other things, reducing fertilizer and pesticide use, using integrated pest management techniques, recycling green waste, and minimizing runoff. Landscaping practices that reduce the use of toxic chemicals.
- Implement water-efficient practices, such as the use of mulches, efficient irrigation systems, audits to determine exact landscaping water-use needs, and recycled or reclaimed water and the selecting and siting of plants in a manner that conserves water and controls soil erosion. Landscaping practices, such as planting regionally native shade trees around buildings to reduce air conditioning demands, can also provide innovative means to meet energy consumption goals; and
- Create outdoor demonstrations incorporating native plants, as well as pollution prevention and water conservation techniques, to promote awareness of the environmental and economic benefits of implementing this directive.

32.7 LANDSCAPE

Present an overall unified appearance, appropriate to the terrain, buildings, and open areas. The design of major use areas should create its own distinctive character.

Trees, shrubs, and ground cover will consist of massing of similar materials and the plant material palette minimal in the number of species in one area. The design shall be simple, clean and blend both with neighboring landscaping and the entire JPL site.

32.8 LANDSCAPE CONCEPTS

Utilize landscaping, earth embankments or berm walls, organic and "hardscape" materials to achieve the following primary functions:

- Provide public entry focus, enhancement and screening at the site boundaries.
- Provide park-like pedestrian walkways and seating areas.
- Enhance and define, provide climatic modification, dust and noise control for buildings and outdoor use areas.
- Frame and accentuate vistas.
- Screen parking, service and other utilitarian structures from off and on-site view.
- Prevent soil erosion.

Areas covered with 2” to 5” rounded stones are encouraged (Xeriscape) in appropriate drainage courses or other areas. Provide a minimum 1’-6” wide x 6” deep with 2-#13 re-bars, concrete drainage control and mow strip or minimum 4’-0 wide walkway paving next to building perimeter abutting turf or landscaping planting. Provide 6” x 6” concrete mow strip with 1-#13 re-bar, between turf and shrubbery or similar planting area.

32.9 ENVIRONMENTAL ZONES

The JPL site is divided into three environmental zones. These zones are described below. Please note that every effort should be made to appropriately integrate landscape, hardscape and streetscape design elements throughout these zones. The goal is to promote a seamless pedestrian experience on the JPL campus.

32.10 PERIMETER ZONES

Perimeter includes all boundary zones, parking areas and points of entry. Blend the planting design with the natural chaparral where appropriate and provide screening of adjoining residential views. Use predominately evergreen trees for residential view screening.

32.11 PEDESTRIAN ZONES

Includes all primary pedestrian routes and plazas where people socialize. Provide shade tree patterns of similar and unified species.

Bus waiting and seating areas shall present a common architectural theme. Define plazas with a simple and unified organic and "hardscape" palette. Provide shade trees, vine covered trellises and umbrella-covered seats for summer shade at major seating and eating areas. Designated trees are established for key roadway/sidewalks.

32.12 GENERAL ZONES

The areas include the remainder of the landscaped spaces, between buildings, slopes, and along drives and roads. Blend materials with adjacent areas and sites. Properly scale shrubs and trees with the buildings and spaces. Design planting to emphasize major building entries.

32.13 PLANT SELECTION AND LOCATION CRITERIA

Maintain native mature chaparral and mature trees where possible. Plants below 1,100 feet elevation adjacent to the Arroyo "cold-sink" are subject to sporadic freezing in the19° F to 30° F range. An agronomy report indicating the acceptability and required soil amendments is required for all plantings unless indicated otherwise by JPL.

Do not use plants that are not tolerant of alkaline and high calcium soils except where uniquely and aesthetically appropriate such as in restricted spaces and areas where the soil can be treated to provide suitable conditions.

All plants within the zone controlled by a remote control irrigation valve will have similar irrigation requirements, with emphasis on drought resistant varieties.

Keep trees and shrubs with weak or brittle branches and trunks to a minimum and locate in wind-protected areas. Design irrigation systems that promote deep rooting of trees and shrubs without adversely affecting construction and paving.

Do not specify plants subject to browsing by deer, verify with JPL Maintaince for plant species not desired. Select trees that do not have vigorous surface willow-rooting characteristics to minimize breaking and upheaval of paving, curbs and foundations.

Do not plant trees under power or communication lines, and do not plant large trees in small planters, and do not “crowd” trees. Space trees according mature size.

Use tree root barriers where proximity to paved areas is less than 5’-0”. JPL desires to eliminate shearing of shrubs, therefore select plants that fit the space when mature. Vines will not climb on building walls but may be planted to climb fences and masonry screen walls.

New planting areas less than 4’-0” wide at parkways, between buildings, walls or fences and paving/lawns are unacceptable.

Planting or berms shall not obstruct sight lines for drivers at road intersections or driveways. Planting setbacks from buildings at hillside brush areas will conform to CFC and LACO requirements.

32.14 MINIMUM PLANT SIZE AND PLANTING CRITERIA

Shrubbery	5 Gallon
Trees	36” box is the minimum size.
Trees at malls, street trees, major walkways and plazas	36”” + box is the minimum size. Brace trees up to 2’-0” + box with two 2” diameter poles. Brace trees in boxes over 2’-0” + with a triangular guy wire brace, or with a bolted "tree guard" when a grating is used within a mall / sidewalk / pedestrian way.
Ground Cover Plants	Planting pattern - triangular or staggered. Distance from tree or shrub – 1’-6” minimum. Distance from edge of bed – 9” minimum.
Lawns	Lawns will be sodded.

32.15 PLANT MATERIAL PALETTE

Perimeter zone plants are selected to conserve water and subsist with little irrigation.
Plants that tolerate shady areas are marked with (sh).

Plants that are native within 250 miles of JPL site are marked with (n). Water conserving or drought tolerant plants are marked with an asterisk (*). Plants listed in more than one zone are considered worthy of use throughout JPL.

Perimeter Zones

Trees	
Calocedrus decurrens - Incense cedar* (n) Cedrus deodara - Deodar cedar* Geijera parviflora- Australian willow Koelreuteria bipinnata - Chinese flame tree* Quercus Agrifolia - Coast live oak* (n)	Quercus coccinea- Scarlet oak Quercus ilex- Holly oak Quercus lobata- Valley oak Platanus Acerifolia – London Plane tree Bloodgood* Tristania conferta - Brisbane box*
Shrubs	
Anisodontea- Cape mallow Arctostaphylos densiflora var. - Vine hill manzanita* Bougainvillea spp. Cercis occidentalis - Western redbud* (n) Cistus sp. - Rock rose* Echium fastuosm - Pride of Madeira* Suryops pectinatus- Euryops daisy Heteromeles arbutifolia - Toyon* (n) Knipbofia uvaria- Red hot poker	Lavadula sp. - Lavender Leptospermum laevigatum- Tea Tree Ligustrum spp.- Privet Photinia fraseri * Plumbago auriculata -- Cape plumbago* Podocarpus macrophyllus - Yew podocarpus* Purshia Tridentata – Antelope Bitterbrush* Salvia sp.- Sage (n) Tecomaria capensis -- Cape honeysuckle*

Ground Cover

Acacia redolens* Aptenia cordifolia- Red apple Carpobrotus edulis -- Iceplant* Cotoneaster dammeri “low fast”- Bearberry Drosanthemum floribundum - Rosea iceplant* Drosanthemum hispidum Delosperma sp.	Hypericum calycinum- St. Johnswort Osteospermum fruitcosum Rosmarinus officinalis "Lockwood de Forest"
Lawns	
Blend of turf-type tall fescues, i.e., "Marathon II," or "Water Saver 2"	

General Zones

Trees	
Acer palmatum var. -- Japanese maple* Brachychiton acerifolia - Australian flame tree* Chorisa speciosa -- Floss silk tree Cupaneiopsis anacardioiodes – Carrotwood Ginkgo Biloba – Maidenhair Tree Jacaranda acutifolia – Jacaranda Koelreuteria bipinnata -- Chinese flame tree* Lagerstroemia indica var. -- Crapemyrtle*	Melaleuca quinquenerva -- Cajeput tree* Parkinsonia aculeata -- Jerusalem thorn, Palo Platanus acerifolia - London plane tree* Podocarpus elatior -- Fern pine Podocorpus henkelii -- Yellow wood Podocarpus macrophyllus - Yew podocarpus Quercus lobata Torulosa – Hollywood Juniper
Shrubs	
Abelia grandiflora -- Glossy abelia Abelia grandiflora "Edward Goucher" Agave sp. Anigozanthos Arbutus unedo compacta -- Strawberry tree Aucuba japonica - Japanese aucuba(sh) Brunfelsia pauciflora floribunda - Yesterday Today & Tomorrow(sh) Calliandra tweedii - Trinidad flame bush*	Calliandra haematocephala - Pink powder puff* Chaenomeles japonica - Flowering quince Chamalaucium uncinatum - Geralton wax flower* Cistus sp. – Rock rose Eleagnus pungens - Silverberry* Grevillea noelli* Lavandula sp. - Lavender Phormium sp. – New Zealand Flax Salvia sp. – Sage (n) Tupidanthus calyptratus – Schefflera Yucca - Gloriosa recurvifolia
Ground Covers	
Achillea sp. – Yarrow Aptenia cordifolia* Delosperma sp.* Drosanthemum floribundum - Rosea iceplant* Drosanthemum hispidum Hyparricum calycinum – Aaron’s beard	Polygonum Capitatum Rosemarinus officinalis "Lockwood de Forest" - Sarcococca hookeriana humilis –Himalayan sweetbox(sh) Vinca major - Periwinkle*
Vines	
Distictis buccinatorius - Scarlet trumpet vine Clytostoma callistegioides - Lavender trumpet vine	Parthenocissus tricuspidata - Boston ivy

Lawns
Blend of turf-type tall fescues, i.e., "Marathon II," or "Water Saver 2

Pedestrian Zones

Trees	
Acer palmatum var. - Japanese maple Albizia julibrissin - Silk tree Bauhinia blakeana - Hong Kong orchid tree Bauhinia forficata Cassia leptophylla - Gold medallion tree Cupaniopsis anacardioiodes – Carrotwood Ginkgo Biloba – Maidenhair tree Koelreuteria bipinnata - Chinese flame tree* Lagerstroemia indica var. - Crapemyrtle*	Nyssa sylvatica - Pepperidge tree Platanus acerifolia - London plane tree Podocarpus elatior - Fern pine Pyrus kawakamii - Everygreen pear Stenocarpus sinuatus - Firewheel tree Sophora japonica - Japanese pagoda tree Tabebuia avellanedae Tabebuia chrysotricha - Golden trumpet tree Tristania conferta - Brisbane box*
Shrubs	
Anisodontea – Cane Mallow Abelia grandiflora var. - Glossy abelia	Mahonia aquifolium compacta - Compact Oregon grape Nandina domestica compacta - Nandina Osmanthus fragrans - Sweet osmanthus* Calliandra tweedii - Trinidad flame bush* Calliandra haematocephala - Pink powder puff*
Ground Covers	
Archillea sp. Campanula poscharskyana - Serbian bell flower Campanula elatines garganica Drosanthemum hispidum	Hypericum calyeinum – Aarons beard Vinca minor - Dwarf Periwinkle(sh)
Vines	
Combretum fruiticosum Clytostoma callistegiodes - Lavender trumpet vine	Disticitis buccinatorius - Scarlet trumpet vine
Lawns	
Blend of turf-type tall fescues, i.e., "Marathon II," or "Water Saver 2"	

Designated Road-Side Trees

Mariner Road (Mariner Mall): Cupaneiopsis anacardioides – Carrotwood Sargent Road: Tristania conferta - Brisbane box Explorer Road: Cupaniopsis anacardioides - Carrotwood, east from Building 18. Tristania conferta - Brisbane box, east from Building 18 to the East gate.	Corporal Road: Pyrus calleryana "Capital" - Capital pear Pioneer Road: Tristania conferta – Brisbane box Ranger Road: Cupaniopsis anacardiodes Surveyor Road and Loop Road: Prunus cerafisera atropurpurea - Purple leaf plum.

Herbaceous Perennials - All Zones

Agave Aloe Astilbe Chasmanthe Cordyline Dietes Dietes bicolor*	Dietes iridiodes - Fortnight lily* Euryops* Euphorbiacae – Euphorbia family of plants Hesperaloe parviflora -* Heuchera "Santa Ana Cardinal" - Coral bells Geraniaceae – geranium family of plants Limonium perizii - Sea lavender* Kniphofia uvaria* Yucca

32.16 IRRIGATION STANDARDS

Provide irrigation design and operation standards that provides an easily maintained and interchangeable system of components. This system of components shall be compatible with existing irrigation components and capable of providing sufficient, controlled watering to support proper plant health with proper water conservation. Provide drip irrigation when possible. In landscaped areas, locate keyless hose bibbs or quick coupler, Rain Bird 330, a maximum of 100 feet apart adjacent to walks and patios.

Install remote control irrigation valves in plastic valve box in no traffic areas. For dimensions and configuration, see JPL Standard Drawings.

32.17 DRIP IRRIGATION

Provide pressure regulator at P.O.C. to operate drip irrigation system at prescribed water pressure. Provide debris filter inline after the pressure regulator and downstream of the gate valve. Provide 6" metal stakes to secure drip system tubing to soil to prevent movement if placed above ground.

32.18 PIPE

All pipes shall be schedule 40 PVC. Standard installation: In a trench, minimum 1’-0” earth cover. Thrust blocks at change of direction of pressure pipe, DN 50 and larger. All exposed pipe above grade shall be UV rated, including laterals and mainlines.

32.19 VALVES

Superior automatic valve - #950 with flow control stem.

32.20 SPRINKLER HEADS
"Toro" 570 Series, 150 and 300 pop-ups; or "Hunter" PGP adjustable heads for large areas. Stream rotors are not acceptable. Provide check valve in each irrigation head.

32.21 CONTROLLERS
Controllers shall be of the same configuration and model as existing of the centrally controlled, computerized landscape irrigation system. Provide surge protection and 110 V power switch ahead of controller. Existing controllers may be utilized with JPL concurrence. 110 V Outlet is required. Controllers shall be enclosed in a waterproof stainless steel lockable unit and be accessible from the top of the enclosure.

32.22 BATTERY CONTROLLERS
When required, battery irrigation controller shall be (7) day programmable with (3) start times minimum.

Division 33 Utilities

33.1 SITE UTILITIES
Locate main utility distribution lines within streets, designated "rights-of-ways" or "corridors". Install site utility lines at a minimum depth of 2’-0” below grade. When within roadways or parking areas with less than 2’-0” earth cover, encase piping systems in concrete slurry fill and cover with a 6” concrete cap.

33.2 SANITARY SEWER
Locate sanitary sewer lines below water lines.

33.3 UNDERGROUND UTILITIES IDENTIFICATION
Identify underground pipes, cables and conduits with color coded, utility name imprinted, continuous, 2” or 3” wide polyethylene tape installed 1’-0” directly above the utility. Identify non-metallic cables and pipelines with a conductive tape. Identify utilities crossing utility company lines according to utility company requirements.

Additional utility colors: Valve box covers will have the utility name cast or welded and painted per the standard JPL color code: Water = green; gas = yellow; air = white. Provide Los Angeles County (LACO) standard traffic covers on hand-holes and manholes.

33.4 SPECIAL GASEOUS SYSTEMS
Provide location monuments at curb identifying special gaseous systems.

33.5 NATURAL GAS DISTRIBUTION
Gas is distributed at 5 psi, 10 psi and 30 psi, Verify pressure with JPL.

33.6 SITE UTILITY PLANT CONCEPTS

Utilize existing centralized utility plants (heating, cooling, condensing water, etc.) for building services. If not available or economically feasible, consider a utility plant or utility system serving a cluster of contiguous buildings to provide energy savings and equipment redundancy.

33.7 ON-SITE POWER SOURCE

JPL maintains and operates an underground 16.5 kV power distribution system. New buildings shall be fed from the 16.5 kV distribution systems.. JPL FESAB (Facilities Electrical Safety Advisory Board) will direct where to connect new facilities to the distribution system.

33.8 ELECTRICAL BANKS AND SUBSTATIONS

Laboratory and office buildings shall have a transformer bank with two transformers with primary fuse protection and a manually operated primary selector switch fed from two 16.5 kV feeders circuits.

Each transformer secondary will have a single main circuit breaker feeding a switchboard bus connected with a tie circuit breaker. One transformer / switchboard will feed mechanical loads most likely to create disturbances, such as voltage transients, sags. The other transformers / switchboards will feed critical type loads such as computers, lighting and laboratories. Either transformer will be capable of supplying the total building load, but will not be rated less than the total demand load. JPL FESAB (Facilities Electrical Safety Advisory Board) will direct how and where to feed new buildings.

33.9 POWER TRANSFORMERS

Power transformers to be fed at 16.5 kV lab wide power system. They shall be oil filled, insulated type unit substation type with standard impedance. Windings shall be copper. Verify with JPL prior to the transformer selection.\

33.10 MEDIUM VOLTAGE CONDUCTORS

Conductors shall be stranded copper shielded ethylene-propylene rubber insulation (EPR). “MV-105” with 133% insulation level. Conductors shall be 25kV or 35kV class minimum.

33.11 AUXILIARY POWER SOURCES

Provide standby, redundant and/or emergency utilities only when the loss of utility service would result in danger to life, damage to equipment of high monetary value or loss of essential data. JPL will direct when an un-interruptible power system (UPS) is required for a project.

33.12 SITE ELECTRICAL AND COMMUNICATION DUCT BANKS

Install all exterior electrical and communication services in underground duct banks or conduits. Duct banks shall be provided with a No. 4/0 AWG bare copper ground conductor. Underground conduit will be PVC Schedule 40 for power and PVC Schedule 80 for communications.

Duct banks for electrical feeders 480V and above shall be encased in red concrete with #4 rebar at corners of the duct bank line and with #4 rebar spiral at minimum 2’-0” on center.

33.13 MANHOLE AND HAND-HOLE COVERS

Manholes will be 9’-0” long by 7’-0” wide by 7’-0” deep with 3’-0” diameter opening and provided with a permanent ladder. All manhole and hand-hole covers shall be permanently engraved with numbers. Electrical shall be even and all communications numbers shall be odd numbers. JPL Quality Assurance assigns the specific numbers used.

Division 34 Transportation

34.1 SERVICE VEHICLE PARKING AND LOADING AREAS

Provide minimum one stall for each building, and utility facility. Provide one stall per 30,000 S.F. of gross building served. Provide a dock height loading area for buildings over 30,000 square feet.

34.2 BICYCLE PARKING

Unless directed otherwise provide a minimum of 4 lockable, sheltered bike racks per building or 6 for the first 100 occupants and 4 per each additional 100 persons. Bicycle parking / racks should be located near the pedestrian / service entrance to building.

34.3 PARKING AREA STANDARDS

For dimensions and configuration see JPL Standard Drawings. Increase end stall sizes as necessary to accommodate adjacent obstructions such as curbs, walls and other structures.

34.4 STRIPING, WHEEL STOPS AND APPURTENANCES

Striping, traffic paint and colors, wheel stops, hall be standard CalTrans design

Provide concrete curbs and gutters for drainage with minimum 1’-6” radii at corners adjacent to landscaped areas. Use wheel stops only to protect structures or to prevent vehicles from rolling. Do not use within general parking areas where the stops present a tripping hazard.

A blue roadway reflector shall be adhered to the centerline of the roadway to indicate the location of a fire hydrant near the adjacent curb. Paint curbs in front of hydrants red (no stopping).

34.5 PEDESTRIAN RAMPS AND STAIRS

Utilize ramps wherever possible for grade transitions.

34.6 TRAFFIC INTERFERENCE

Minimize vehicle traffic interference with pedestrian malls and plazas and only allow emergency and restricted service vehicle (forklifts) access to these areas.

34.7 PEDESTRIAN MALLS, WALKWAYS, PATIOS AND BUS WAITING AREAS

Integrate pedestrian malls, walkways, patios and bus waiting areas as a cohesive network. Furnish bus-waiting areas with benches, appropriate graphics, posted routes, and schedules.

34.8 GENERAL TRAFFIC SIGNS

General and informational road and traffic signs hall be standard CalTrans signs design.

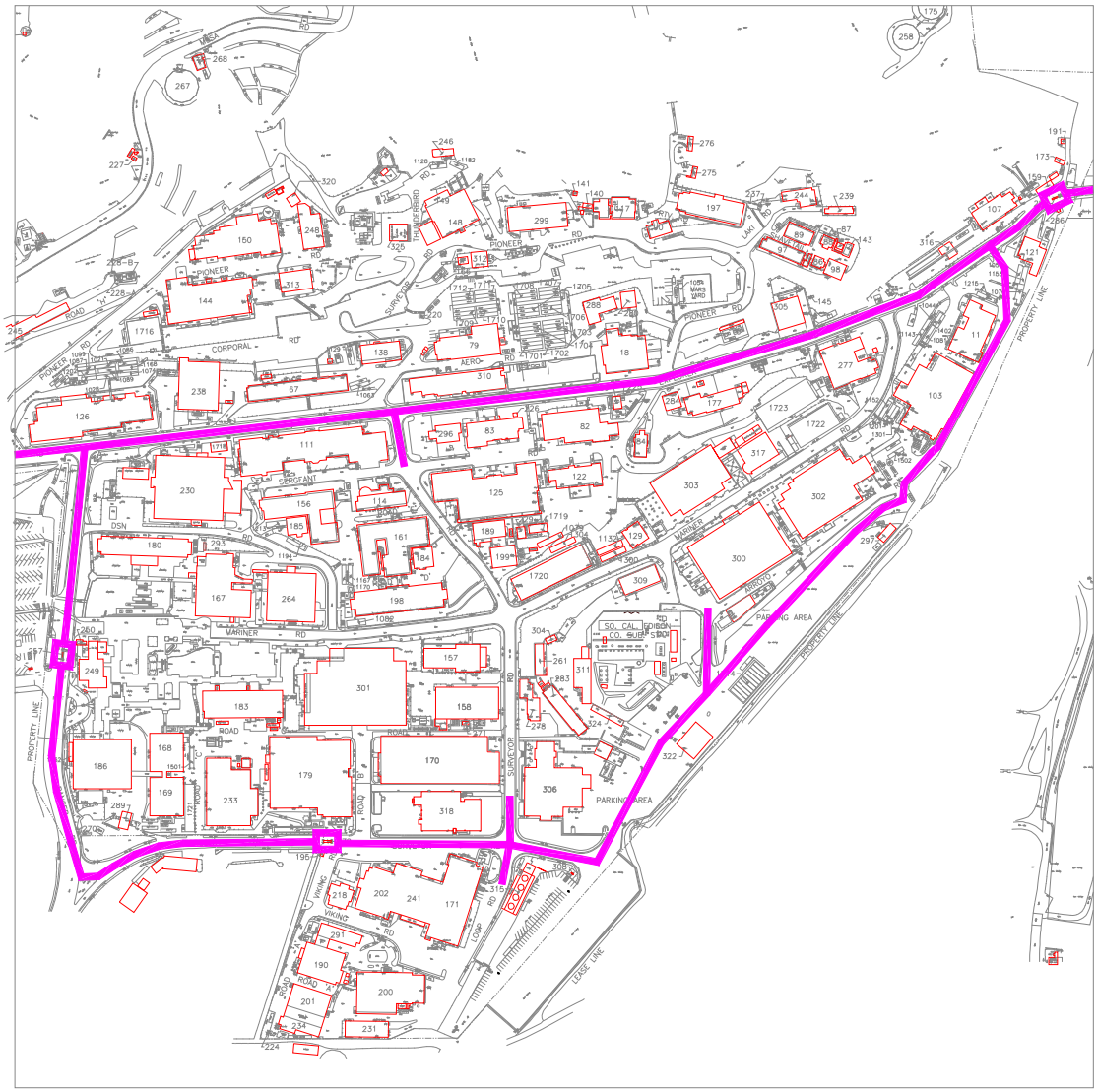

FIGURE 8. -- RING ROAD

34.9 AUTO, BUS, SERVICE AND PARKING CONCEPTS

The primary auto and service road network is the "Ring Road" [Figure 8]. Employee parking areas will be located in proximity to and accessed as directly as possible from the "Ring Road." Service access to facilities and buildings will also be as direct as possible from the "Ring Road".

Division 35 Waterway and Marine Construction – Not Used

Division 36 Reserved
Division 37 Reserved
Division 38 Reserved
Division 39 Reserved

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PROCESS EQUIPMENT SUBGROUP

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Division 40 Process Integration – Not Used

Division 41 Material Processing and Handling Equipment

41.1 CRANEWAY DESIGN LOAD AND CRANEWAY DESIGN

All overhead and gantry cranes, including top running monorail, under hung and jib cranes, hoist and winches shall be designed to be in compliance with NASA-STD 8719.9, "Standard for Lifting Devices and Equipment" (2007).

Crane designers shall verify with JPL Lifting Devices Equipment Manager (LDEM), the JPL "Critical Lift" designation. Cranes designated by JPL to handle loads that are rated "Flight", "Flight-Critical" and "Project Vital" shall be designed to comply with the operational requirements of the latest published version of "JPL Standard for Systems Safety", JPL Document D-560.

Division 42 Process Heating, Cooling, and Drying Equipment – Not Used

Division 43 Process Gas and Liquid Handling, Purification, and Storage Equipment

43.01 LIQUID NITROGEN (LN2) DISTRIBUTION

Distribute LN^2 through a building in a vacuum insulated piping system.

Where complete elimination of two-phase flow is critical, VBC "Semiflex/Triax" will be considered. Consider applied insulation such as urethane or Foamglas only for short distribution runs.

Provide pressure relief valves between any two shut-offs in LN^2 lines. Install "keep full" devices (phase separators) at the end of distribution lines. Gas vents will be copper, piped to the exterior, and insulated to prevent sweating. Configure LN^2 vents to minimize condensation of frost and to prevent accumulated or breakaway frost from damaging property or harming people.

Division 44 Pollution Control Equipment – Not Used
Division 45 Industry-Specific Manufacturing Equipment – Not Used
Division 46 Reserved
Division 47 Reserved
Division 48 Electrical Power Generation – Not Used
Division 49 Reserved

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Appendix A.
CATAGORIES OF BUILDINGS AT JPL

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Building Number	Building Name	Status	Physical Size (SF)	Year 1st Built	Dependency Mission
011	SPACE SCIENCES LABORATORY	Active	9,043	1958	Mission Critical
018	STRUCTURAL TEST LABORATORY	Active	14,731	1945	Mission Dependent, Not Critical
035	Secrurity Radio Equipment	Active	160	2003	Mission Dependent, Not Critical
035A	Radio/Repeater Complex	Active	160	2002	Not Mission Dependent
067	MATERIAL RESEARCH	Active	14,523	1945	Mission Critical
079	LOW -TEMP LABORATORY	Active	21,527	1958	Mission Critical
082	HIGH VACUUM LABORATORY	Active	11,407	1958	Mission Critical
083	QUALITY ASSURANCE	Active	10,302	1948	Mission Dependent, Not Critical
084	CHEMICAL MATERIALS LABORATORY	Active	1,415	1948	Mission Dependent, Not Critical
086	SOLID OXIDIZER LABORATORY	Active	534	1948	Mission Critical
087	PROPELLANT CONDITIONING LABORATORY	Active	182	1948	Mission Dependent, Not Critical
088	Bio-Chemical Cold Room	Active	624	1966	Not Mission Dependent
089	LASER LABORATORY	Active	2,011	1948	Mission Dependent, Not Critical
090	PYROTECHNICS LABORATORY	Active	797	1948	Mission Dependent, Not Critical
098	SOLID FUEL LABORATORY	Active	1,773	1951	Mission Dependent, Not Critical
103	ELECTRONIC FABRICATION SHOP	Active	23,861	1951	Mission Critical
107	LASER RESEARCH LABORATORY	Active	5,461	1947	Mission Dependent, Not Critical
111	TECHNICAL INFORMATION	Active	44,390	1950	Mission Critical
114	ADMINISTRATION	Active	9,317	1951	Mission Critical
114A	Coffee Cart Shelter	Active	240	2005	Not Mission Dependent
117	LIQUID AND SOLID PROPELLANT LAB.	Active	4,148	1954	Mission Dependent, Not Critical
121	ANALYTICAL INSTRUMENTS LABORATORY	Active	3,543	1956	Mission Critical
122	ENERGY CONVERSION SYSTEMS	Active	7,373	1951	Mission Critical
125	COMBINED ENGINEERING SUPPORT	Active	66,114	1958	Mission Dependent, Not Critical
126	INFORMATION SYSTEMS DEVELOPMENT	Active	52,584	1953	Mission Critical
129	COMBUSTION RESEARCH LABORATORY	Active	2,499	1953	Mission Dependent, Not Critical
138	MISSION OPERATIONS	Active	11,385	1958	Mission Dependent, Not Critical
140	PROPULSION MATERIALS STORAGE	Active	203	1954	Mission Dependent, Not Critical
141	PROPULSION MATERIALS STORAGE	Active	127	1954	Not Mission Dependent
143	SOLID ROCKET DOCK	Active	420	1955	Mission Dependent, Not Critical
144	ENVIROMENTAT LABORATORY	Active	35,019	1966	Mission Critical
145	MAGIZINE - PROPELLANT	Active	58	1953	Mission Dependent, Not Critical
148	ENERGY CONVERSION LABORATORY	Active	6,611	1956	Mission Dependent, Not Critical
149	ENERGY CONVERSION DEVELOPMENT	Active	5,494	1975	Mission Dependent, Not Critical
150	SPACE SIMULATOR FACILITY	Active/Heritage	26,809	1962	Mission Critical
156	COMPUTER PROGRAM OFFICES	Active	23,995	1957	Mission Dependent, Not Critical
157	APPLIED MECHANICS	Active	29,918	1966	Mission Dependent, Not Critical
158	MATERIALS RESEARCH PROCESSING LAB.	Active	29,707	1963	Mission Dependent, Not Critical
159	PUMP HOUSE (WATER)	Active	606	1959	Mission Dependent, Not Critical
161	TELECOMMUNICATIONS LABORATORY	Active	37,273	1958	Mission Critical
166	Cooling Tower	Active	0	1958	Mission Critical
167	CAFETERIA	Active	37,006	1964	Mission Critical
168	INSTRUMENTS SYSTEMS	Active	42,132	1963	Mission Critical
169	EARTH SPACE SCIENCE	Active	42,500	1965	Mission Critical
170	FABRICATION SHOP	Active	35,533	1963	Mission Critical
171	MATERIAL SERVICES	Active	74,028	1967	Mission Critical
173	TEST SHELTER	Active	278	1958	Not Mission Dependent
175	WATER RESERVOIR	Active	0	1959	Mission Dependent, Not Critical
177	TRANSPORTATION	Active	5,081	1958	Mission Critical
179	SPACECRAFT ASSEMBLY FACILITY	Active	64,723	1961	Mission Critical
180	ADMINISTRATION	Active	105,568	1964	Mission Critical
183	PHYSICAL SCIENCES LABORATORY	Active	96,483	1965	Mission Critical
184	TELECOMMUNICATIONS	Active	2,066	1959	Mission Dependent, Not Critical
185	PROGRAMMING OFFICE	Active	1,978	1959	Mission Dependent, Not Critical

Building Number	Building Name	Status	Physical Size (SF)	Year 1st Built	Dependency Mission
186	PUBLIC OUTREACH ADMINISTRATION	Active	23,745	1963	Mission Critical
189	ELECTRONIC LABORATORY ANNEX	Active	3,232	1959	Mission Dependent, Not Critical
190	PROCUREMENT OFFICES	Active	16,451	1960	Mission Critical
191	MATERIALS COMPATIBILITY LABORATORY	Active	120	1960	Mission Dependent, Not Critical
195	GUARD SHELTER	Active	56	1960	Mission Dependent, Not Critical
196	GUARD SHELTER	Active	49	1960	Not Mission Dependent
197	SOLID PROPELLANT ENGINEERING LAB.	Active	7,987	1962	Mission Critical
198	CONTROL SYSTEMS LABORATORY	Active	67,172	1961	Mission Critical
199	CELESTRIAL SIMULATOR	Active	3,366	1961	Mission Critical
200	FACILITIES ENGINEERING & SERVICE	Active	29,491	1961	Mission Critical
201	ADMINISTRATIVE SUPPORT SYSTEMS	Active	12,000	1963	Mission Dependent, Not Critical
202	PROCUR. & COMMUNICATIONS SUPPORT	Active	17,416	1961	Mission Dependent, Not Critical
212	ANTENNA LABORATORY	Active	10,562	1961	Mission Critical
218	CREDIT UNION	Active	2,621	1964	Not Mission Dependent
220	ICS TERMINAL	Active	38	1964	Mission Dependent, Not Critical
224	SEWER STATION	Active	0	1961	Mission Dependent, Not Critical
225	GUARD SHELTER	Active	53	1961	Mission Dependent, Not Critical
226	SOLVENT STORAGE	Active	74	1962	Not Mission Dependent
227	PISTOL RANGE STORAGE	Active	13,000	1961	Not Mission Dependent
228	COOLING TOWER (A & B)	Active	0	1961	Mission Critical
229	SHIELDED ROOM BUILDING	Active	371	1962	Mission Dependent, Not Critical
230	SPACE FLIGHT OPERATIONS COMMAND FAC	Active/Heritage	134,779	1963	Mission Critical
231	MICROWAVE TECHNOLOGY SUPPORT	Active	8,353	1964	Mission Critical
233	SYSTEMS DEVELOPMENT	Active	43,313	1964	Mission Critical
234	LUMBER STORAGE	Active	2,133	1963	Mission Dependent, Not Critical
237	COOLING TOWER	Active	0	1962	Mission Dependent, Not Critical
238	TELECOMMUNICATIONS	Active	84,174	1965	Mission Critical
239	PROPELLANT CONDITIONING LAB	Active	860	1964	Mission Dependent, Not Critical
241	RECEIVING & SHIPPING & ADMIN	Active	26,752	1963	Mission Critical
243	REMOTE ANTENNA RANGE CONTROL	Active	1,298	1965	Mission Dependent, Not Critical
244	CHEMICAL ENGINEERING	Active	3,680	1964	Mission Critical
245	SPECTROSCOPY LABORATORY	Active	4,159	1965	Mission Dependent, Not Critical
246	SOILS TEST LABORATORY	Active	750	1964	Mission Dependent, Not Critical
248	TEN-FOOT SPACE SIMULATOR	Active	13,469	1965	Mission Critical
249	VISITORS RECEPTION	Active	4,873	1966	Mission Dependent, Not Critical
250	MAIN GUARD SHELTER	Active	210	1966	Mission Dependent, Not Critical
251	GYRO LABORATORY	Active	6,280	1965	Mission Critical
252	GUARD SHELTER	Active	205	1963	Not Mission Dependent
253	MAGNETIC LABORATORY	Active	1,552	1965	Mission Critical
256	MODEL RANGE CONTROL	Active	597	1965	Mission Dependent, Not Critical
257	MAIN GUARD SHELTER	Active	36	1966	Mission Dependent, Not Critical
258	WATER RESERVOIR	Active	0	1965	Mission Dependent, Not Critical
259	LIQUID NITROGEN BOTTLING STORAGE	Active	567	1966	Mission Dependent, Not Critical
260	ILLUMINATOR EQUIPMENT	Active	479	1968	Mission Dependent, Not Critical
262	RADIOMETER	Active	49	1968	Mission Dependent, Not Critical
264	SPACE FLIGHT SUPPORT	Active	126,504	1971	Mission Critical
267	WATER RESERVOIR	Active	0	1969	Mission Dependent, Not Critical
268	PUMP HOUSE	Active	640	1969	Mission Dependent, Not Critical
270	SEWAGE METERING STATION	Active	0	1966	Mission Dependent, Not Critical
271	OIL STORAGE	Active	162	1968	Mission Dependent, Not Critical
272	EAST ILLUMINATOR	Active	106	1970	Mission Dependent, Not Critical
273	ANTENNA TOWER	Active	110	1969	Mission Critical
275	PYROTECHNIC STORAGE	Active	328	1970	Mission Dependent, Not Critical
276	PROPELLANT STORAGE	Active	352	1970	Mission Dependent, Not Critical
277	ISOTOPE THERMOELECTRIC SYS. LAB.	Active	23,782	1972	Mission Critical

Building Number	Building Name	Status	Physical Size (SF)	Year 1st Built	Dependency Mission
279	GUARD SHELTER	Active	27	1970	Mission Dependent, Not Critical
280	STATIC TEST FACILITY	Active	1,440	1972	Mission Critical
284	TRANSPORTATION FACILITY OFFICE	Active	1,225	1973	Mission Critical
285	ARROYO BRIDGE	Active		1971	Not Mission Dependent
286	GUARD STATION	Active	120	1972	Mission Dependent, Not Critical
287	GUARD ISLAND	Active	36	1972	Mission Dependent, Not Critical
288	PROJECT EQUIPMENT STORAGE	Active	3,444	1973	Mission Dependent, Not Critical
289	MAIN SEWAGE LIFT STATION	Active	0	1976	Mission Dependent, Not Critical
290	ANTENNA INSPECTION	Active	596	1972	Mission Dependent, Not Critical
291	ACQUISTIONS ADMN SUPPORT	Active	7,492	1974	Mission Dependent, Not Critical
293	INSTRUMENTATION CABLE AMPLIFIER	Active	333	1975	Mission Dependent, Not Critical
294	GUARD SHELTER (VISITORS LOT)	Active	24	1976	Not Mission Dependent
295	ANTENNA TEST FACILITY	Active	181	1980	Mission Dependent, Not Critical
296	CENTRAL COOLING TOWER	Active	0	1983	Mission Dependent, Not Critical
298	FREQUENCY STANDARDS LAB	Active	18,772	1986	Mission Critical
299	ASSEMBLY HANDLING & SHIPPING EQUIP.	Active	10,860	1986	Mission Dependent, Not Critical
300	EARTH & SPACE SCIENCE LABORATORY	Active	103,904	1985	Mission Critical
301	CENTRAL ENGINEERING	Active	201,856	1986	Mission Critical
302	MICRODEVICES LABORATORY	Active	74,567	1986	Mission Critical
303	ENGINEERING SUPPORT BUILDING	Active	82,855	1989	Mission Critical
305	HAZARDOUS WASTE/CRYOGENIC STORAGE	Active	0	1989	Mission Critical
306	OBSERVATIONAL INSTRUMENTS LAB	Active	79,444	1989	Mission Critical
308	SEWAGE PUMP STATION	Active	0	1993	Mission Dependent, Not Critical
309	MAINTENANCE STORAGE FACILITY	Active	4,000	1995	Mission Dependent, Not Critical
310	Emergency Services Facility - Bldg. 310	Active	21,495	1999	Mission Critical
312	SHELTER MAINTENANCE FACILITY	Active	1,678	1996	Not Mission Dependent
313	ENVIRONMENTAL TESTING	Active	3,988	1996	Not Mission Dependent
315	COOLING TOWER SOUTHERN SECTOR	Active	6,235	1997	Mission Dependent, Not Critical
316	HAZARDOUS MATERIALS STORAGE FACILITY	Active	3,835	1996	Not Mission Dependent
317	In-Situ Instruments Lab	Active	18,309	2001	Mission Critical
318	Optical Interferometry Development Laboratory (OID	Active	16,050	2002	Mission Critical
320	Environmental Test Laboratory Support Facility	Active	1,225	2002	Mission Dependent, Not Critical
322	General Storage Facility	Active	4,354	2003	Mission Critical
323	Monolithic Microwave Intergrated Circuit Assembly	Active	3,120	2005	Mission Dependent, Not Critical
324	Recycling Facility	Active	1,350	2003	Mission Dependent, Not Critical
325	Flight Hardware Logistics Program Bldg 325	Active	6,794	2003	Mission Dependent, Not Critical
328	West Pre-Inspection Guard Station	Active	36	2004	Not Mission Dependent
329	East Pre-Inspection Guard Station	Active	36	2004	Not Mission Dependent
333	Compressed Natural Gas Station	Active	0	2005	Not Mission Dependent
336	Mars Yard	Active	23,500	2005	Mission Dependent, Not Critical
337	12 M Antenna Site	Active	484	2005	Not Mission Dependent
600	Woodbury Building II	Active	35,600	2005	Mission Dependent, Not Critical
601	Woodbury Complex	Active	55,000	2000	Not Mission Dependent
602	Woodbury Technical Building	Active	35,062	2005	Not Mission Dependent
606	Lincoln Palms Building	Active	5,000	2004	Mission Dependent, Not Critical
JC-125	COMMUNICATION SYSTEM	Active	0	1958	Mission Dependent, Not Critical
JE-101	ELECTRICAL SYSTEM	Active	0	1963	Mission Dependent, Not Critical
JG-104	GAS TRANSMISSION	Active	0	1958	Mission Dependent, Not Critical
JI-127	Other Ground Improvements	Active	0	1958	Mission Dependent, Not Critical
JR-126	ROADS	Active	0	1958	Mission Dependent, Not Critical
JS-103	Sewage & Industrial Waste	Active	0	1958	Mission Dependent, Not Critical

Building Number	Building Name	Status	Physical Size (SF)	Year 1st Built	Dependency Mission
JW-102	WATER DISTRIBUTION SYSTEM	Active	0	1958	Mission Dependent, Not Critical
LP-1	LAND PARCEL NO. 1 (ARMY)	Active		1966	Mission Dependent, Not Critical
LP-2	LAND PARCEL NO.2 (VALDEZ)	Active		1966	Mission Dependent, Not Critical
LP-3	LAND PARCEL NO.3 (LOGAN)	Active		1966	Mission Dependent, Not Critical
LP-4	LAND PARCEL NO. 4 (GODBEY)	Active		1966	Mission Dependent, Not Critical
LP-5	LAND PARCEL NO.5 (CITY OF PASADENA)	Active		1977	Mission Dependent, Not Critical
T1058	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1063	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1079	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1128	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1129	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1132	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1153	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1167	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1170	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1182	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1194	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1213	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1300	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1304	Trailer	Active	500	1970	Mission Dependent, Not Critical
T1701	Trailer	Active	1,650	1997	Mission Critical
T1702	Trailer	Active	1,650	1997	Mission Dependent, Not Critical
T1703	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1704	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1705	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1706	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1707	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1708	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1709	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1710	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1711	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1712	Trailer	Active	1,650	1996	Mission Dependent, Not Critical
T1713	Trailer	Active	550	1996	Not Mission Dependent
T1714	Trailer	Active	5,200	1997	Mission Dependent, Not Critical
T1715	Trailer	Active	550	1997	Not Mission Dependent
T1716	Trailer - Modular Office	Active	5,040	1998	Mission Dependent, Not Critical
T1717	Trailer - Rest Room	Active	720	1998	Not Mission Dependent
T1718	Trailer - Modular Office	Active	2,160	1998	Mission Dependent, Not Critical
T1719	Trailer	Active	1,440	2000	Mission Dependent, Not Critical
T1720	Trailer	Active	12,240	2000	Mission Dependent, Not Critical
T1721	Two Story Modular	Active	6,528	2001	Mission Dependent, Not Critical
T1722	Mars Exploration I	Active	7,200	2001	Mission Dependent, Not Critical
T1723	Mars Exploration II	Active	9,360	2001	Mission Dependent, Not Critical
T1724	Mars Modular 1722 Restroom	Active	720	2001	Not Mission Dependent
T1725	Mars Modular 1723 Restroom	Active	720	2001	Not Mission Dependent
Tank #15A	Liquid Nitrogen Tank	Active	0	2006	
Tank #16A	Liquid Nitrogen Tank	Active	0	2007	Not Mission Dependent

Appendix B.
ADDITIONAL CODES, STANDARDS AND REFERENCES

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This list is only a representation of applicable codes and regulations. For the users' convenience we outlined the most used, but not all. It is the responsibility of the designer and engineer to verify and obtain the codes, standards and other documents referenced.

While diligent effort is made to provide accurate and up-to-date information, we hereby disclaim any responsibility or liability in connection of any data or links contained herein.

Source:	Title of the Document:
ANSI	ANSI Z358.1-2004, **Emergency Eye Wash and Shower Equipment**.
ANSI	ANSI / AIHA Z9.2-2007, **American National Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems.**
ANSI	ANSI-Z 136.1-2007, **Lasers**
ANSI	ANSI/ESD S7.1-2005 **Resistive Characterization of Materials–Floor Material**
APWA	**Standard Plans for Public Works Construction** -. APWA 2002
APWA	**Standard Specifications for Public Works Construction** - APWA / 2006
ASHRAE	**"Handbooks - ASHRE"** latest distribution dates
Cal/OSHA	**State of California Construction Safety Orders** (CAL-OSHA) – (Current Edition)
Cal/OSHA	**California Code of Regulations**, Title 8. Occupational Safety
Executive Order	**Greening the Government Through Efficient Energy Management** - Presidential Executive Order 13123.
FIPS	**Electrical Power for ADP installations** - FIPS Publication 94**.**
GSA	**M2 Metric Design Guide** (Third Edition), October 1993 General Services Administration (GSA), GSA Region 3 Headquarters, Design and Construction Division, Philadelphia, PA 19107. To obtain a copy, write the Publications Department, National Institute of Building Science (NIBS) at 1201 L Street, N.W., Suite 400, Washington, D.C. 20005 or call 202-289-7800.
ISO	**Cleanrooms and Associated Controlled Environments - Part 1, - Classification of Airborne Particulates -**. - ISO 14644-1-2004
ISO	**Cleanrooms and Associated Controlled Environments - Part 2, - Specifications for Testing and Monitoring to Prove Continued Compliance with ISO 14644-1 -** ISO 14644-2-2004
ISO	**Cleanrooms and Associated Controlled Environments - Part 4, - Design and Construction and Start-up of Cleanroom Facilities -** ISO 14644-4-2004
JPL	**Asbestos Data Management Program (ADAM) Database,** September 4, 1997JPL Occupational Safety Program Office
JPL	**JPL Safety Policies, Procedures and Requirements**: (JPL Occupational Safety Program Office) documents and descriptions located at: http://rules.jpl.nasa.gov

Source:	Title of the Document:
JPL	**RULES** JPL's Official Resource for Institutional and Governing Documents: JPL document and process descriptions located at: http://rules.jpl.nasa.gov/
JPL	**Safety Manual for Explosives at JPL Oak Grove and Table Mountain -** DOD 4145.26-M
JPL	**Standards for System Safety -** JPL Systems Safety Program Office - JPL Rules Document Number: D-560
Los Angeles County	**Guidelines for Underground Storage of Hazardous Materials** (1984), Los Angeles Sanitation Districts of Los Angeles County (Wastewater Ordinance)
NASA	**Design and Construction of Facilities -** NPR: 8820.2 – NASA Procedural Requirements
NASA	**Facilities Maintenance Management -** NPR 8831.2- NASA Procedural Requirements
NASA	**Policy for Safety and Mission Success** - NASA - NPD 8700.1
NASA	**Implementing The National Environmental Policy Act And Executive Order 12114 -** NPR 8580.1 - NASA Procedural Requirements
NASA	**Affirmative Procurement Plan for Environmentally Preferable Products -** NPR 8530.1 - NASA Procedural Requirements
NASA	**Facilities Maintenance Management w/ Change 1 (4/21/04) -** NPR 8831.2 - NASA Procedural Requirements
NASA	**Safety Standard for Fire Protection -** NASA -STD-8719.11 – Revalidated April 6, 2006
NASA	**Safety Standard for Lifting Devices and Equipment -** NASA - STD-8719.9 Revalidated: October 1, 2007
NASA	**SPECSINTACT** - JPL / NASA Specifications Production System, Including NASA and Local JPL Masters. Obtain the program and the text free of charge at: http://si.ksc.nasa.gov/
NASA	**Use of the Metric System of Measurements in NASA Programs** – NASA NPD -8010.2E - NASA Policy Directive
NFPA	**101 Life Safety Code** -- NFPA 2006. Edition
NFPA	**Flammable and Combustible Liquids Code -** NFPA 30 - 2008 Edition**.**
NFPA	**Standard on Fire Protection for Laboratories Using Chemicals** - NFPA 45 - 2004 Edition.
NFPA	**Standard for the Protection of Electronic Computer/Data Processing Equipment** - NFPA 75 - 2003 Edition**.**
NFPA	**Standard for the Installation of Lightning Protection Systems** - NFPA 780 - 2008 Edition.
NFPA	**Recommended Practice on Static Electricity** - NFPA 77 - 2007 Edition**.**

Source:	Title of the Document:
NIBS	**Metric Guide for Federal Construction -** First Edition Published by: The National Institute of Building Services (NIBS), 1201 L Street N.W., Washington D.C. 20005, Telephone: (202) 289-7800. This document is the base document explaining the basics of SI application to construction
SMACNA	**Guideline for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems,** SMACNA, Addendum #1 (September 2000)
State of California	**State of California Rules for Overhead Line Construction** - General Order No. 95
U.S. Federal Register	**Savings in Construction Act of 1996** (Cox Bill) - U.S. Federal Register
U.S. Government	**Resource Conservation Recovery Act and Applicable Regulation (40 CFR Part 260 et. al)**
U.S. Government	**Biohazard Cabinetry and Biosafety in Microbiological Laboratories - National Sanitation Foundation International Standard #49 -** U.S. Department of Health and Human Services (Publication - CDC 93-8395)
U.S. Government	**Department of Energy, Federal Energy Management Program**
U.S. Government	**Federal Energy Standards -** 10 CFR PART 435 (In support of Title 24, Energy Code)
UL	**2002 Fire Resistance -** Volumes. 1, 2, and 3 - UNDERWRITERS LABORATORIES INC. (UL)

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Appendix C.
FDS WAIVER FORM AND PROCESS DESCRIPTION

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FACILITY DESIGN STANDARDS WAIVER REQUEST

ATTACH SUPPLEMENTAL SHEETS AS NECESSARY

PAGE # OF # PAGES

NAME OF PROJECT, TASK: PROJECT ID, NUMBER OR SERVICE REQUEST NUMBER.:	DATE OF REQUEST:
NAME OF REQUESTOR: MAIL STOP OF REQUESTOR:	BADGE #: PHONE # OF REQUESTOR:
ORIGINAL REQUIREMENT (Cite Specific Requirement, Applicable Sections and Text from Facilities Design Standards, Include FDS Revision Number:	
WAIVER REQUESTED:	
REASON / JUSTIFICATION:	
EFFECT ON PERFORMANCE (Describe benefit if waiver approved; and describe impact if not approved):	

		APPROVED	DISAPPROVED	SIGNATURE:	NAME (PRINT):	DATE
	PROJECT/TASK MANAGER	☒	☐			
APPROVALS	FACILITIES ENGINEERING AND CONSTRUCTION SECTION MANAGER	☐	☐			
APPROVALS	FACILITIES DIVISION MANAGER *(ON APPEAL ONLY*	☐	☐			

DISPOSITION COMMENTS:	WAIVER ID NO.: WAIVER TO: ☐ POLICY ☐ DESIGN STANDARDS ☐ CODE

Facility Design Standards Waiver Request Procedure:

Step	Actor	Action
1	Requester	• Identify need for Waiver. Identify specific requirements(s) affected by Waiver. • Complete the Waiver Request Form following instructions on the form. • Attach any pertinent impact/justification information. • Submit signed request form with all attachments to the facilities Project/Task Manager.
2	Project/Task Manager	• Submit signed request form with all attachments to the Approval Authority (Facilities Engineering and Construction Section Manager) for approval.
3	Approval Authority	• Review content to determine merit of the request, consulting with Requester as necessary. Document the results of any consulting as an augmentation to the supplied risk assessment. • If additional information for action or risk assessment is required, assign action to Requester. • Return form and all attachments to the Requester, if applicable. • If no additional information is needed, proceed to Step 5.
4	Requester	• Perform any additional assigned actions as directed by the Approval Authority. • Return completed form and all attachments to the Approval Authority, if applicable.
5	Approval Authority	• Review submission for completeness. • Assign a Waiver identification number to the form. • Review the data on the request form and any attachments. Consult with necessary subject matter experts to solicit a recommendation. • Determine approval or disapproval of request. • Record decision on the request form, including any applicable disposition comments. • Notify Requester and Project Manager (if applicable) of decision. Send copies of approved or disapproved Waiver to all signatories. Archive signed copy.
6	Requester	If the request is not approved, you may appeal to the Facilities Division Manager.
7	Facilities Division Manager	If appealed: • Review all documentation supporting both request and disapproval. • Consult with necessary subject matter experts to determine the merit of the Waiver request and document the results of any consulting as an augmentation to the supplied risk assessment. • If Waiver request is approved on appeal, notify the Approval Authority of override of disapproval and sign the Waiver request form. • If Waiver request is disapproved on appeal, notify the Approval Authority
8	Approval Authority	• Notify Requester and Project Manager (if applicable) of appeal decision. If decision was approved, send copies of Waiver to all signatories and archive signed copy.