

**Functional & Operational Requirements  
and Design Guidance  
for the  
Advanced Manufacturing Collaborative**

**August 26, 2020**

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**Prepared for the  
U.S. Department of Energy  
Office of Environmental Management**

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## ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ATS	Acceptance Testing Specifications
CFR	Code of Federal Regulations
DCD	Design Criteria Document
DOE	Department of Energy
EIA	Electronic Industries Association
FM	Factory Mutual
GFCI	Ground Fault Circuit Interrupters
GSA	General Services Administration
HVAC	Heating, Ventilation, and Air Conditioning
IBC	International Building Code
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IESNA	Illumination Engineering Society of North America
IFC	International Fire Code
LA	Limited Area
LAN	Local Area Network
LCC	Life Cycle Cost
LED	Light Emitting Diode
LEED	Leadership in Energy & Environmental Design
M&O	Management & Operating Contractor
NACE	National Association of Corrosion Engineers
NEC	National Electric Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NPH	Natural Phenomena Hazard
PAS	Public Address System
PDR	Preliminary Design Requirements
PPA	Property Protection Area
PSTR	Project Subcontract Technical Representative
S&R	Shipping & Receiving
SC OSE	South Carolina – Office of State Engineer
SSC	Systems, Structures, and Components
TIA	Telephone Industries Association
UL	Underwriters Laboratories
UPC	Uniform Plumbing Code
UPS	Uninterruptible power supply
WB	Wet Bulb
WBDG	Whole Building Design Guide

## **1 PURPOSE**

This document describes the principal functional and operating requirements for the proposed Advanced Manufacturing Collaborative (AMC) Facility to establish the basis for the conceptual, preliminary and detailed space design.

The AMC space is a project sponsored by the U.S. Department of Energy (DOE). The Office of Environmental Management (EM) has an enduring need for safer, more cost effective nuclear chemical manufacturing technology, facilities, and expertise to:

- Complete the safe cleanup of radioactive and chemical waste from Cold War activities and nuclear research
- Comply with legally enforceable environmental regulatory requirements

The AMC space replaces functions that are housed in multiple aged facilities with a new facility, geographically located to support needed collaboration. As such, it will combine the functions of widely separated office and laboratory space into a single modern and flexible location.

## **2 OVERVIEW**

The magnitude of the EM mission is staggering; it includes managing over 1,000 metric tons of weapons-grade uranium and plutonium, over 90 million gallons of liquid waste, millions of cubic meters of contaminated soil, and billions of gallons of contaminated groundwater. Although DOE has made significant progress, the highest risk and most technically complex work lie ahead for these multi-decade nuclear chemical manufacturing challenges. The funding challenges are equally daunting. Projections of constrained funding lead to the untenable conclusion that some missions cannot predict an end date.

### **2.1 Mission Requirements**

Research, development, adaptation and utilization of mature, cutting edge technology are needed to establish manageable mission risk profiles and successfully execute long range plans. Current DOE nuclear chemical manufacturing operations rely upon chemical processes and facilities that were designed and built over the last 65 years. Conversely, the commercial chemical and manufacturing sector currently uses a range of proven, advanced technologies which deliver significant improvements in cost, worker and process safety, product quality, environmental stewardship, and workforce training. Adoption and utilization of these technologies are needed in the nuclear chemical manufacturing mission to better manage risk, improve program performance, and reduce life cycle costs and schedule.

The AMC will involve partnership and collaboration among the Savannah River National Laboratory (SRNL), Universities, Industry, and government entities at the local, state, and federal level. Synergy among these entities will foster a greater technical impact than would be possible through individual efforts. In addition to the anticipated domestic partner relationships, where appropriate, the AMC Facility could also promote and allow for the development of international relationships to foster the exchange of chemical manufacturing knowledge and personnel. The ability of the Collaborative to provide ease of access and exchange of knowledge and innovation amongst the variety of participants will be critical to realizing the maximum benefit of enhanced knowledge and technology transfer in support of Department missions.

## 2.2 Program Requirements

EM needs an AMC space in partnership with SRNL that will integrate and exploit the unique attributes of national laboratories, commercial entities, and educational institutions to stimulate innovative thinking and to adapt innovative technologies to accomplish DOE missions. The AMC would consist of a state-of-the-art facility for evaluation and translation of advanced manufacturing technologies to the DOE nuclear chemical manufacturing missions. The AMC space will bring together top-level talent from the national laboratories, academia, and industry in an environment that promotes cross-discipline interactions resulting in the fertilization of novel approaches to manufacturing technology adaptations to DOE missions.

**1. The AMC shall be a shared DOE-EM asset to support a significant EM multi-site user community in environmental management and monitoring.**

Access will be provided to scientists and engineers across and within the DOE complex. Work supports the DOE Strategic Objective to "Continue cleanup of radioactive and chemical waste resulting from the Manhattan Project and Cold War activities" and other acceptable programmatic requirements or needs.

**2. The AMC shall be a shared national resource to support a significant user community in advanced manufacturing external to EM.**

Access will be provided to the U.S. technical and scientific community. The facility will be a state-of-the-art, unique resource, which offers capabilities desired by users external to EM that can rapidly move advanced technology from industry to high hazard, high reliability manufacturing.

**3. The AMC shall support team-based research, applied science and engineering.**

Science and engineering functions best when supported by a design that facilitates both structured and informal interaction, flexible use of space, and sharing of resources.

**4. The AMC shall incorporate an optimal mix of open and closed laboratories and work spaces.**

Open laboratories support team-based work. Researchers share not only the space itself but also equipment, bench space, and support staff. The open laboratory format facilitates communication between scientists and makes the lab more easily adaptable for future needs.

**5. The AMC design shall maximize flexibility.**

Maximizing flexibility improves the ability to expand easily, to readily accommodate reconfigurations and other changes, and to permit a variety of uses.

**6. The AMC shall be designed to leverage the ubiquitous use of computing and communications technologies.**

Virtual laboratories are becoming commonplace. Embedded computing and communications are a crucial element of research from the benchtop to virtual design and tele-robotics.

**7. The AMC shall meet sustainable laboratory design standards.**

**8. The AMC will be located at the University of South Carolina at Aiken (USCA) to maximize collaboration between the public and private sectors.**

### 3 PRIMARY SPACE FUNCTIONAL DESCRIPTION

In order to meet mission and program needs, a state-of-the-art laboratory and office space is envisioned. The Functional and Operational Requirements (F&ORs) define the attributes the AMC space must have in order to meet the DOE mission need. The F&ORs consist of narrative descriptions and conceptual plans including site selection criteria that communicate the needs of the space. F&ORs were developed by a team of experts familiar with facility and commercial industry practices and the research and development (R&D) needs identified in the Mission Need Statement. The process to develop the requirements entailed data collection and validation as well as development of conceptual layouts.

Functional and operating considerations included:

- Codes and Standards
- Utility System Requirements
- Capital Equipment Needs
- Facility Relationship Lay-outs
- Conceptual Department Lay-outs
- Product Requirements
- Occupancy logistics requirements

The facility space will provide administrative, research and manufacturing space for the design and development of chemical engineering reactions, processes and materials; and the production of mechanical and electrical components. The facility includes the following critical functional spaces:

- Administration and Support
- Virtual Reality and Simulation Environments
- Computation Center
- Manufacturing Technology Environments and Stations
- Synthesis and Processing Labs
- Reaction and Electrical Engineering Areas, Scaling Test Bed Areas and Flexible High Bay
- Laboratory Support Facilities
- Training and Education Facilities
- Innovation and Incubation Areas and Office Space

### 3.1 Primary Space Functions

The primary functions of the AMC space are summarized in Table 1:

**Table 1. Functional Descriptions**

#### **Administration and Support**

Includes offices, conference rooms, restrooms, vending and break rooms, waste management facility, and printer/file/storage rooms.

#### **Virtual Reality and Simulation Laboratories**

- State-of-the Art Virtual Simulation Cave
- Semi-Immersion Virtual Reality Stations
- Individual Workstation Simulators
- Large-Area Simulation and Training Space

#### **Computational Center w/supercomputing connectivity**

- Process Modeling and Simulation—Smart Manufacturing
- Software Engineering for Process and Hardware Control
- Command and Control Capabilities—on-line access and control to Savannah River Site (SRS) Radiological Test-Bed Experiments

#### **Synthesis and Processing**

- Materials Chemistry and Processing
- Gaseous Systems and Processing
- Wasteform Development and Processing

#### **Manufacturing Technology**

- Additive Manufacturing-3D printing
- Advanced Robotics, Cobotics and Autonomous Platforms
- Advanced Material Joining and Inspection Technology
- Micro-Fabrication Technology for Principal Investigator Devices
- Non-Destructive Assay, Metrology and Evaluation

#### **Reaction Engineering**

- PI Device and System Testing and Evaluation
- Pilot Scale/Prototype Chemistry/Chemical Engineering High Bay
- External Source Effects: Microwave, Ultrasound, and Plasmas

#### **Electrical Engineering**

- Integrated Process Instrumentation, Sensors, and Controls
- Evaluation/Integration and Demonstration of Advanced Power Technologies

#### **Support Facilities**

- State-of-the Art Chemistry and Materials Characterization Laboratory
- Chemistry Preparatory Laboratories

#### **Training and Education Facilities**

- Modern Classroom, Conference Rooms and Collaborations Spaces
- Teaching/Training Laboratories
  - Advanced Manufacturing Operations and Maintenance Training

#### **Innovation, Entrepreneurship and Incubation Laboratory for Small Business Technology Development and Demonstration White Space (Office)**

Additionally, this space is available for expansion of the office and support areas.

#### **White Space (Manufacturing)**

This space is available for expansion for the manufacturing R&D areas or for new operations

## 3.2 Assumptions

The following assumptions provide the framework for the AMC space functions and requirements.

### 3.2.1 General Space Assumptions

- 3.2.1.1. The AMC space will be a government-owned, management and operating (M&O) contractor-operated facility. DOE and South Carolina will provide the necessary regulatory and safety oversight.
- 3.2.1.2. The AMC space will be located in proximity to SRNL, on the campus of USCA (host institution) to facilitate interaction among SRNL, Academic, and Industry staff.
- 3.2.1.3. Non-radiological work will be performed in the AMC space.
- 3.2.1.4. The AMC space will provide the capability to design, develop, test and demonstrate bench and engineering-scale chemical engineering reactions, processes and materials; and the production of mechanical and electrical components using advanced manufacturing processes and systems.
- 3.2.1.5. The AMC space will provide the capability to translate reactions, processes, materials and components to radioactive environments at all DOE EM sites, including the SRS.
- 3.2.1.6. The AMC space will be designed for the operational lifetime specified by the developer. The design lives of individual test equipment and engineering-scale demonstrations will be individually specified according to need.
- 3.2.1.7. The AMC space will provide the flexibility to support DOE-EM and allied missions at all DOE sites, other federal agency sites and other sites as required by DOE.
- 3.2.1.8. The AMC will provide an integrated operational capability for engineering-scale development and translation.
- 3.2.1.9. Fire protection and emergency medical response, electrical power, raw water and sanitation for the AMC space will be provided by local, community-based services because the site will be on State property.
- 3.2.1.10. The AMC space will be located on a single contiguous site at USCA.
- 3.2.1.11. Construction guidance contained in selected Whole Building Design Guides (WBDG) for research facilities and space types: dry laboratory, wet laboratory, light industrial and office has been followed. In addition, architectural guidelines of the host institution have been followed.

### 3.2.2 Functional Assumptions

- 3.2.2.1. The AMC space will provide the following key clusters of functional activities:
  - Wet Chemistry Areas.
  - Engineering Fabrication Laboratory or Areas for electro-mechanical fabrication and development.
  - High Bay Flexible space to support process system scale up testing and electrical component/system testing.
  - Office space for approximately 120 personnel including SRNL, Academia, and Industry partners.
  - Open collaborative spaces for inter-disciplinary work.
  - A limited number of private conference areas and single use phone booth areas for video teleconferencing capability (VTC), etc.
- 3.2.2.2. AMC venues and approaches will integrate technology development and teaching.
- 3.2.2.3. The AMC will provide collaborative learning and research spaces which join together multiple disciplines.

- 3.2.2.4. The AMC will have informal interaction places where information exchange is encouraged as a daily routine.
- 3.2.2.5. Laboratory and office arrangements will encourage interaction between technical disciplines and organizational components.
- 3.2.2.6. Common/similar functions could be co-located.
- 3.2.2.7. Administrative areas will be shared (coffee bars/refrigerators) and quantity may vary depending on final layout of facility (i.e. # of floors, length of each floor, etc.).
- 3.2.2.8. Laboratory, office, and storage areas must be lockable to meet minimum requirements of government Property Protection Areas (i.e. – for protection of government property and information when the facility is unoccupied).
- 3.2.2.9. Space will be provided for Academic, Industry, and Business outreach presence within the facility.
- 3.2.2.10. Conference areas will be shared among all occupants.
- 3.2.2.11. Video and “Smart Board” capability will be provided in all conference areas.
- 3.2.2.12. A limited staging area will be provided to support catering of public events in the facility.
- 3.2.2.13. Printers to be in designated, shared office areas.
- 3.2.2.14. Records/file space to be in common shared location.
- 3.2.2.15. General storage areas will be shared by all building occupants.
- 3.2.2.16. Diskless computing environment with no Central Processing Unit in the office areas.
- 3.2.2.17. LEED certification at the Gold (or higher) level will be achieved.
- 3.2.2.18. A full cafeteria will not be provided. Proximate availability of food service options is assumed.
- 3.2.2.19. An auditorium will not be provided for public briefings and colloquia. Proximate auditorium access is assumed.

#### 4 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

The primary space functions of the AMC space are described in Section 3. Functional and operational requirements are described in the following tables. Facility functions with the applicable requirements of each function are contained in Table 2. Individual requirements are listed in Table 3. Each identified requirement contains a detailed description, the basis for the requirement, the programmatic design requirement and the function that requires it. Each requirement is tied back to one of the functions listed in the function table.

##### 4.1 Functions

Facility functions with the applicable requirements of each function are contained in Table 2. Note: Any space allocations in the tables are listed as guides for the design. Final space allocations will be determined during design. All spaces should address functional requirements as specified in the tables.

**Table 2. Functions**

Function Number & Name	Description	Specified by
F.1 Provide AMC space	Provide for AMC space	R.1.1 LCC & Energy Conservation Reports R.1.2 Commissioning R.1.3 SC OSE Compliance R.1.4 Site Surveying R.1.5 No Asbestos R.1.6 Codes & Standards
F.1.1 Occupancy	Provide sufficient capacity to operate efficiently and effectively as an integrated laboratory, office, and collaborative technology development facility.	R.1.1.1 SRNL personnel in facility R.1.1.2 Conference/specialty rooms R.1.1.3 Property Protection Area criteria R.1.1.4 Up to 20 Academic, Industry, and Small Business support space R.1.1.5 Approximately 1,500 sq. ft. storage, supply R.1.1.6 Approximately 2,000 sq. ft. storage, files R.1.1.7 Up to 2500 sq. ft. for printers, plotters and visual arts items

Function Number & Name	Description	Specified by
F.1.2 Laboratory Space	Provide an open concept multi-function laboratory space suited to frequent adjustment to accommodate changing investigative purposes. Lab functions could be combined if the combination complies with safety, environmental and building standards.	R.1.2.1 Wet chemistry labs – approximately 5000 sq. ft. R.1.2.2 Engineering Fabrication labs – 5,000 – 10,000 sq. ft. R.1.2.3 High Bay Fab/Test Labs – approximately 5000 – 15,000 sq. ft. R.1.2.4 Fume hood exhaust as appropriate for non-radiological wet chemistry work R.1.2.5 Liquid waste collection/drain/treatment system to dispose of liquid lab wastes.
F.1.3 Office Space	Provide office space	R.1.3.1 Up to 20 private spaces at approximately 120 square feet R.1.3.2 Open office space supporting up to 30 senior scientists R.1.3.3 Open office space supporting up to 50 technicians and junior scientists. R.1.3.4 Up to 20 private spaces for Univ/ Ind.
F.1.4 Enhanced Collaborative Space	Provide two VTC conference rooms, and several small “open space” conference areas to support collaborative technology development. Provide one enclosed formal conference room.	R.1.4.1 Up to six open conference areas with SmartBoard and internet capability. R.1.4.2 Up to two private areas with video teleconference, SmartBoard, internet. R 1.4.3 One formal conference room with wireless SmartBoard and internet capability R.1.4.4 Up to Two private “phonebooth” areas with wireless teleconferencing capabilities

Function Number & Name	Description	Specified by
F.2 Facility Access	Provide access to facility for employees, vehicles, and Fire Protection.	R.2.1 Facility Accessibility R.2.2 Access Roads R.2.3 Main Entrance/Access Road R.2.4 Access Road AASHTO & SC OSE Compliance R.2.5 Sidewalks R. 2.6 Cypher code personnel access controls to laboratory and storage areas.
F.2.1 Provide Handicap Accessible Facility	Provide a handicap accessible facility to accommodate for employees with physical handicaps	R.2.1.1 ANSI/ICC A 117.1 Compliance R.2.1.2 SC OSE Compliance & CFR
F.2.2 Provide Parking lots	Provide parking lots for employees per host institution guidelines.	R.2.2.1 Number of Employee Parking Spaces R.2.2.2 Parking Area Requirements R.2.2.3 Pave Parking Area R.2.2.4 Dumpster/Trash Allocation

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Function Number & Name	Description	Specified by
F.3 Provide Structure	Provide a structure for AMC activities following any host institution architectural guidelines.	R.3.1 Natural Phenomena Hazards (NPH) R.3.2 Occupancy Classification R.3.3 Type of Construction R.3.4 NFPA 101 R.3.5 UL & FM R.3.6 Interior Finishes-Flame Spread R.3.7 IBC 2012 R.3.8 Building Separation Distance R.3.9 Foundation R.3.10 Subsurface Testing R.3.11 Door Requirements R.3.12 Exterior Door Locks R.3.13 Roof Drainage R.3.14 Roof Access-if required R.3.15 Cool Roof Products R.3.16 Structure Height R.3.17 ASHRAE 90.1 R.3.18 LEED Certification R.3.19 Building Identification R.3.20 Interior Signs and Labeling R.3.21 Bollards R.3.22 Skylights
F.3.1 Provide Shipping & Receiving (S&R) Area	Provide an area for the receipt of AMC materials and supplies.	R.3.1.1 Fork Lift Access R.3.1.2 S&R Area Concrete Slab Strength R.3.1.3 Exterior Access to S&R Area R.3.1.4 Drainage
F.3.2 Provide Climate Control	Provide Climate Control for the HVAC in the facility.	R.3.2.1 Elevation R.3.2.2 Ventilation R.3.2.3 Indoor Design Conditions R.3.2.4 Outdoor Design Conditions R.3.2.5 HVAC Start-Up R.3.2.6 General HVAC Requirements R.3.2.7 HVAC System Filters R.3.2.8 Screens

Function Number & Name	Description	Specified by
F.3.3 Provide Floor	Provide adequate architectural floor covering appropriate for the intended uses of building spaces.	R.3.3.1 Floor Finish
F.3.4 Provide Lights	Provide lighting for both exterior and interior.	
F.3.4.1 Provide Emergency Lighting	Provide emergency lighting for facility.	R.3.4.1.1 Emergency Lighting Economic Analysis R.3.4.1.2 Emergency Lighting System Labeling
F.3.4.2 Provide Exit Marking	Provide exit marking for the facility to help employees to egress during an emergency.	R.3.4.2.1 Exit Sign-LED R.3.4.2.2 Exit Sign Test Switch
F.3.4.3 Provide Interior Lighting	Provide interior lighting for each area in the facility.	R.3.4.3.1 Interior Lighting-General Requirements.
F.3.4.4 Provide Exterior Lighting	Provide exterior lighting for the facility following any host institution guidelines.	R.3.4.4.1 Exterior Light Type R.3.4.4.2 Exterior Light Sensors R.3.4.4.3 Light Level Requirements R.3.4.4.4 Exterior Lighting Design Method
F.3.5 Provide Lightning Protection	Provide lightning protection for structure.	R.3.5.1 Lightning Protection R.3.5.2 Lightning Protection Compliance
F.3.6 Provide Offices	Provide suitable offices for employees to accomplish assigned/job related activities.	R.3.6.1 Occupants Offices
F.3.7.3 Provide Break Rooms	Provide adequate space and facilities for AMC personnel for storage and preparation of food	R.3.7.3.1 Provide Break Rooms
F.3.8 Provide Misc. Areas	Provide suitable space for mechanical, catering and janitorial and other miscellaneous storage.	
F.3.8.1 Provide Mechanical Room	Provide mechanical room for mechanical equipment.	R.3.8.1.1 Facility Mechanical room Design Requirements
F.3.8.2 Provide Staging area for catered events	Provide adequate space and services to support catering needs.	R.3.8.2.1 Staging area for catering
F.3.8.3 Provide Unclassified computing Router Hub Area	Provide unclassified router hubs for computers and unclassified datacenter space per industry guidelines.	R.3.8.3.1 Unclassified Data Center Design Requirements.

Function Number & Name	Description	Specified by
F.3.8.4 Men's restroom	Provide Men's restrooms for employees with either joint access for visitors/guests or separate facilities.	R.3.8.4.1 Men restroom room requirements
F.3.8.5 Women's Restroom	Provide Women's restrooms for employees with either joint access for visitors/guests or separate facilities.	R.3.8.5.1 Women restroom requirements
F.3.8.6 Provide Janitorial Supply Area	Provide janitorial supply area for the custodian to store cleaning supplies.	R.3.8.6.1 Janitorial supply area requirements
F.3.8.7 Provide Electrical Room	Provide an electrical room for electrical equipment.	R.3.8.7.1 Comply with NFPA 70E R.3.8.7.2 No water in electrical rooms
F.3.9 Provide Chemical and Supply Storage	Provide chemical and supply storage for the AMC	R.3.9.1 Organic Chemical storage R.3.9.2 Acid Chemical storage R.3.9.3 Dry Chemical storage R.3.9.4 Supply Storage
F.4 Provide Utilities	Provide utilities for the facility and process equipment.	R.4.1 Corrosion Control R.4.2 General Utility Requirements R.4.3 Utility Labeling R.4.4 Underground Utility Tracing R.4.5 Utility Road Crossing
F.4.1 Provide Natural Gas	Provide natural gas for the facility	R.4.1.1 Natural Gas Design Codes and Standards R.4.1.2 Natural Gas Design Requirements R.4.1.3 Natural Gas Meter R.4.1.4 Natural Gas Regulator Station
F.4.1.a Provide Compressed Gas Services	Provide compressed gas services to labs as needed.	R.4.1.a.1 Argon, Oxygen, Nitrogen, P10
F.4.2 Provide Communications	Provide communications systems for the facility that will support a minimum 100G Network capability.	R.4.2.1 Communications-General Requirements R.4.2.2 Communications-Joint Use R.4.2.3 Data System Structured Cable Type R.4.2.4 Cable Run Lengths & Communication Area R.4.2.5 Communications Backboards R.4.2.6 Communications Area

Function Number & Name	Description	Specified by
F.4.2.1 Provide Unclassified LAN	Provide unclassified LAN for unclassified computers and printers.	R.4.2.1.1 Local Area Network (LAN) Requirements R.4.2.1.2 Optical Fiber Requirements
F.4.2.1.1 Provide Drops for Printers and Computers	Provide drops for printers and computer to connect to the network.	R.4.2.1.1.1 Printers & Computers
F.4.2.3 Provide Telephone	Provide telephones for the facility.	R.4.2.3.1 Telephone Distribution Cable Type R.4.2.3.2 Telephone Distribution Cable Compliance R.4.2.3.3 Telecommunications Equipment Type R.4.2.3.4 Telephone System Components Compliance R.4.2.3.5 Telephone Drop R.4.2.3.6 Telephone Routing
F.4.2.4 Provide Public Address System (PAS)	Provide public address system (PAS) integrated with the host institution announcing system for the facility to send notifications to employees.	R.4.2.4.1 PAS-General Requirements R.4.2.4.2 PAS Testing
F.4.2.5 Provide fire alarm control panel	Provide fire alarm control panel to transmit emergency communications.	R.4.2.5.1 Communicate with emergency services dispatch center.
F.4.2.6 Communicate with Energy Management System	Provide energy management system to communicate with host institution energy management system.	R.4.2.6.1 Energy Management R.4.2.6.2 Energy Management & Metering R.4.2.6.3 Energy Management System Interface
F.4.3 Provide Fire Protection	Provide Fire protection for the facility.	
F.4.3.1 Provide Fire Detection	Fire detection for the complex.	R.4.3.1.1 Fire Alarm

Function Number & Name	Description	Specified by
F.4.3.2 Provide above ground Fire Suppression system	Provide above ground fire suppression system for the facility.	R.4.3.2.1 Fire Suppression Type R.4.3.2.2 Fire Suppression Piping Requirements R.4.3.2.3 Fire Extinguishers R.4.3.2.4 Required Signs
F.4.3.3 Provide underground fire water distribution system	Provide underground fire water distribution system for the facility.	R.4.3.3.1 Service loop around facility R.4.3.3.2 Lead-in(s) R.4.3.3.3 Fire Hydrants
F.4.4 Provide Electricity	Provide electric power for the facility from the host institution electrical distribution system. Provide standby power to personnel protection systems and critical building functions. Provide independent utility power feed and high-bay drops for testbed as described in F.4.4.3 and F.4.4.4.	R.4.4.1 General Electrical Requirements R.4.4.2 Electrical System Labeling R.4.4.3 Electrical-Maintenance Considerations R.4.4.5 Electrical System Design Info and Drawings R.4.4.6 Electrical System Testing R.4.4.7 Electrical System Materials and Methods R.4.4.8 Exterior Electrical Utility Service R.4.4.9 Grounding-General Requirements R.4.4.10 Equipment Grounding R.4.4.11 Interior Electrical systems R.4.4.12 Receptacle Testing R.4.4.13 Electrical Panel Requirements R.4.4.14 Ground Fault Circuit Interrupters (GFCIs) R.4.4.15 Electrical System Design Aid R.4.4.16 Electrical Calculation Software R.4.4.17 NFPA 70 R.4.4.18 Electrical Metering R.4.4.19 Standby power for critical systems.
F.4.4.1 Provide Electrical Drops for Computers & Printers and equipment.	Provide electrical drops for the computer and printers and equipment in the facility.	R4.4.1.1 Provide electrical drops at computer equipment

Function Number & Name	Description	Specified by
F.4.4.2 Provide Surge Protection	Provide surge protection for the facility to protect equipment.	R.4.4.2.1 Provide Surge Protection
F.4.4.3 Provide Laboratory Electrical Drops Independent from Computer & printers and equipment	Provide electrical power for laboratory setting on sourced from a different feed from utility and has independent breaker paneling	R.4.4.3.1 Provide Lab Power
F.4.4.4 Provide Utility Power for Advanced Manufacturing Standards Testbed	Provide 1 - 2MVA of power from utility feed for supporting the advanced manufacturing standards testbed	R 4.4.3.1 Provide Testbed power
F.4.4.5 Provide Domestic water	Provide domestic water for the facility.	R.4.5.1 Plant Domestic Water Requirements R.4.5.2 Domestic Water Metering
F.4.4.6 Provide Sanitary Sewer	Provide sanitary sewer for the facility.	R.4.6.1 Plant Sanitary Sewer Requirements
F. 4.4.7 Emissions monitors	Provide effluent monitoring as required by SC OSE	R.4.7.1 Air Release Stack Monitors R.4.7.2 Liquid Effluent Monitors

## 4.2 Requirements

Individual requirements are listed in Table 3. All submissions must comply with the prescriptive requirement and baseline performance requirements of the General Services Administration (GSA) issued PBS-P100, “Facilities Standards for the Public Buildings Service” and the State of South Carolina, Office of the State Engineer (SC OSE) requirements.

**Table 3. Requirements**

Requirement Number & Name	Description	Basis	Functional and System Design Requirements Category	Function Specifies
R.1.1 LCC & Energy Conservation Reports	A Life Cycle Cost Analysis & Energy Conservation Report shall be completed.	Required per Executive Order 13834 and SC OSE	Nil (nothing)	F.1 Provide AMC

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.1.2 Commissioning	Facility shall be commissioned.	Guiding Principle referenced in Executive Order 13834. LEED requirement as well Required per SC OSE 0112 (Issue 2I, July 2011).	Nil	F.1 Provide AMC
R.1.3 SC OSE Compliance	Potentially state owned structures are assumed to be required to meet requirements of SC OSE.	State law.	Nil	F.1 Provide AMC
R.1.4 Site Surveying	The site shall be surveyed in accordance with SC OSE	Required per SC OSE	Civil and Site Work	F.1 Provide AMC
R.1.5 No Asbestos	Materials containing asbestos shall not be used for this project.	SC OSE	Nil	F.1 Provide AMC
R.1.6 Codes & Standards	Codes and Standards shall be as specified in Chapter 5 of SC OSE Manual for Planning and Execution of State Permanent Improvements – part II, 2015	Required by SC OSE	Nil	F.1 Provide AMC
R.1.1.1 Personnel in facility	Provide space for up to 100 SRNL personnel plus estimated 20 additional Academic and Industry residents.	Co-location of technology development efforts.	Nil	F.1.1 Provide Occupancy
R.1.1.2 Up to 8 conference/specialty rooms	Provide sufficient capacity to operate efficiently and effectively as an integrated laboratory, office, and collaborative technology development facility.	Collaborative work approach	Nil	F.1 Provide AMC
R.1.1.3 Offices, labs, and storage areas security.	All government property and information must be protected at the Property Protection Area level or above.	SRS M&O contract.	Nil	F.1.1 Provide Occupancy
R.1.1.4 Up to 20 Academic, Industry, and Small Business support space Industry	Academia and Industry will engage in co-location and partnership with SRNL.	Collaborative work approach.	Nil	F.1.1 Provide Occupancy

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.1.1.5 Approximately 1500 sq. ft. storage, supply	All building occupants will share storage space – to include hardware, chemicals, and office supply.	Maximize shared resources.	Nil	F.1.1 Provide Occupancy
R.1.1.6 Approximately 2000 sq. ft. storage, files	Common area storage for reference materials and working files not suitable for office storage.	Maximize shared resources.	Nil	F.1.1 Provide Occupancy
R.1.1.7 Up to 2500 sq. ft. for printers, plotters, and visual arts items	Common area for output devices driven from facility network and internet	Maximize shared resources.	Nil	F.1.1 Provide Occupancy
R.1.2.1 Wet Chemistry Laboratories	Up to four Wet Chemistry Labs of approx. 1200 sq. ft. each per WBDG.	SRNL Wet Chemistry space.	Nil	F.1.2 Laboratory Space
R.1.2.2 Engineering Fabrication Laboratories	Up to five Engineering Fabrication Labs of approx. 1800 sq. ft. each per WBDG.	SRNL Engineering Lab space	Nil	F.1.2 Laboratory Space
R.1.2.3 High Bay Space	One High Bay space of approx. 5000 –15,000 sq. ft. with a height of 100 ft. per WBDG. Including cranes and mezzanine platforms. This space should also include a high temperature steam and air lines capable of maintaining 800°C at 1 psig and additional electrical requirements described in R.4.4.3.1 and R.4.4.3.2.	SRNL process development and testing. Customer Requirement.	Nil	F.1.2 Laboratory Space
R.1.2.3.1 High Bay Grid Space	Within the high-bay area, approximately 1000 –2000 sq. ft. per WBDG for electrical testing per R.4.4.3.1 and R.4.4.3.2. The space should have a barrier surrounding the perimeter such as a chain link fence.	SRNL process development and testing. Customer Requirement.	Nil	F.1.2 Laboratory Space F.4.4 Provide Electricity
R.1.2.4 Exhaust System	Fume hood exhaust system for non-radiological wet chemistry labs and snorkels for engineering fab labs.	SRNL Wet Chemistry and Engineering Fab Labs	Nil	F.1.2 Laboratory Space

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.1.2.5 Liquid waste collection	Liquid waste collection/drain/treatment system for liquid effluent management	SRNL Wet Chemistry space.	Nil	F.1.2 Laboratory Space
R.1.3.1 Private office space	Approximately 20 offices of 120 sq. ft. for Fellow Scientists per WBDG. 2400 sq. ft. total	Management and senior leadership needs.	Nil	F.1.3 Office Space
R.1.3.2 Open office space	Open office space for 30 Senior Scientists per WBDG. Total of 3000 sq. feet. Maximum use of shared shelving and work tops.	Interdisciplinary collaborative environment.	Nil	F.1.3 Office Space
R.1.3.3 Open office space	Open office space for 50 Junior Scientists and Technicians per WBDG. Total of 4200 sq. ft. Maximum use of shared shelving and work	Interdisciplinary collaborative environment.	Nil	F.1.3 Office Space
R.1.3.4 Private office space	Approximately 20 offices of 120 sq. ft. each for Academia and Industry partners. Total of 2400 sq. ft.	Co-location of SRNL, Academia, and Industry groups.	Nil	F.1.3 Office Space
R.2.1 Facility Accessibility	Fire Department vehicles shall have access to within 150 feet of all parts of the facility via an all-weather service road	Required by IFC 2012 and SC OSE.	Civil and Site Work	F.2 Facility Access
R.2.2 Access Roads	Paved all weather access roads shall be provided per host institution guidelines.	Fire department requires access to the facility in the event of an emergency.	Civil and Site Work	F.2 Facility Access
R.2.3 Main Entrance/Access Road	A paved road connecting the nearest public highway with the planned employee parking lot for the facility shall be provided per host institution guidelines.	The main access road to the main entrance of the building shall be paved per SC OSE.	Civil and Site Work	F.2 Facility Access
R.2.4 Access Road AASHTO & SC OSE Compliance	All roads, including access roads, shall comply with AASHTO GDHS-5 and SC OSE.	Required by SC OSE	Civil and Site Work	F.2 Facility Access

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.2.5 Sidewalks	Provide sidewalks in design. Sidewalks shall be rigid pavement and comply with SC OSE. At a minimum, an ANSI/ICC A117.1 walkway shall be provided from the parking lot to the facility and from the facility to adjacent facility structures of the host institution per host institution guidelines.	Compliance is required by SC OSE	Civil and Site Work	F.2 Facility Access
R.2.6 Cypher code access	Provide cypher code system for personnel access to laboratories and storage areas	SRNS and DOE government equipment security	Civil and Site Work	F.2 Facility Access
R.2.1.1 ANSI/ICC A 117.1 Compliance	Facility shall comply with ANSI/ICC A 117.1-2003.	Required per SC OSE	Architectural	F.2.1 Provide Handicap Accessible Facility
R.2.1.2 SC OSE and CFR	Facility shall comply with SC OSE Standards and 28 CFR Part 36, Standards for Accessible Design.	Required per SC OSE	Architectural	F.2.1 Provide Handicap Accessible Facility
R.2.2.1 Number of Employee Parking Spaces	There shall be 100 general parking spaces (not including handicap).	Required Per SC OSE	Civil and Site Work	F.2.2 Provide Parking Lots
R.2.2.2 Parking Area Requirements	The parking area shall comply with SC OSE and follow any host institution guidelines.	Required by SC OSE	Civil and Site Work	F.2.2 Provide Parking Lots
R.2.2.3 Paved Parking Area	The employee parking area shall be paved per host institution guidelines.	Parking areas are typically paved on plant site. Also, helps meet requirement for surface requirements of ANS/ICC A117.1-2003 Section 302.	Civil and Site Work	F.2.2 Provide Parking Lots
R.2.2.4 Dumpster/Trash Allocation	Min of 3 Dumpsters: 1 Cardboard Recyclable and 2 standard dumpsters shall be located in the parking area on a concrete pad.	As required by host institution	Nil	F.2.2 Provide Parking Lots

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.1 Natural Phenomena Hazards	The SSCs shall be designed and analyzed in accordance with DOE-STD-1020-2012, IBC 2012, and AMC Building Criteria.	This requirement is determined by DOE STD-1020-2012,	Structural and Natural Phenomena	F.3 Provide Structure
R.3.2 Occupancy Classification	The occupancy classification shall be Determine thru IBC 2012 and NFPA 101.	IBC 2012, NFPA 101-2012.	Architectural	F.3 Provide Structure
R.3.3 Type of Construction	The structure shall be Type I or Type II construction, to be determined during design phase.	Required by SC OSE.	Architectural	F.3 Provide Structure
R.3.4 NFPA 101	The structure shall meet the egress, construction, compartmentalization, and hazard protection requirements of NFPA 101-2012.	Required by SC OSE.	Fire Protection	F.3 Provide Structure
R.3.5 UL & FM	Fire Rated wall, floor, ceiling, and roof assemblies shall be rated for their fire resistance by Underwriters Laboratories, Inc. (UL) or Factory Mutual (FM).	Required by SC OSE.	Fire Protection	F.3 Provide Structure
R.3.6 Interior Finishes-Flame Spread	Interior finishes shall have a UL-listed/FM-approved flame spread rating of 25 or less and a smoke developed rating of 50 or less, per American Society for Testing Materials (ASTM) E-84-2007.	Required by SC OSE.	Fire Protection	F.3 Provide Structure
R.3.7 IBC 2012	In addition to DOE-STD-1020-2012, the facility shall be designed under IBC 2012.	DOE-STD-2012 and IBC 2012.	Structural and Natural Phenomena	F.3 Provide Structure
R.3.8 Building Separation Distance	Building shall be placed such that there is adequate protection and separation from other structures. Building shall comply with NFPA 80A-2012.	Required by NFPA 80A-2012 and PFHA/FHA.	Fire Protection	F.3 Provide Structure
R.3.9 Foundation	The design of the structure's foundation shall consider soil conditions, load, settlement, and frost depth. Geotechnical investigation shall be developed in the early stage.	Required by SC OSE	Structural and Natural Phenomena	F.3 Provide Structure

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.10 Subsurface Testing	Soil borings shall be utilized to validate subsurface conditions for the facility site.	Required by SC OSE	Civil and Site Work	F.3 Provide Structure
R.3.11 Door Requirements	All doors shall meet the requirements in WBDG and SC OSE. Knock-down (KD) frames shall not be used.	Required by SC OSE	Architectural	F.3 Provide Structure
R.3.12 Exterior Door Locks	The exterior door lockable hardware shall suitable for the purpose.	Required by SC OSE	Architectural	F.3 Provide Structure
R.3.13 Roof Drainage	Roof drainage shall comply with SC OSE requirements for regional rainfall expectations.	Required by SC OSE	Structural and Natural Phenomena	F.3 Provide Structure
R.3.14 Roof Access-if required	If roof access is required (i.e. if rooftop HVAC units are used), roof access shall comply with IBC 2012 and OSHA 29 CFR 1910.27.	IBC 2012 & 29 CFR 1910.27	Structural and Natural Phenomena	F.3 Provide Structure
R.3.15 Cool Roof Products	The roof system for this facility shall comply with the definition of a “cool roof” under DOE’s Cool Roof Program in the roof design and it shall be provided with a minimum R30 insulation value. The cool roof program and products can be found at the following website: <a href="http://www1.eere.energy.gov/femp/pdfs/roof.pdf">http://www1.eere.energy.gov/femp/pdfs/roof.pdf</a> .	Requirement for energy efficiency. Executive Order E.O. 13834	Structural and Natural Phenomena	F.3 Provide Structure
R.3.16 Structure Height	The maximum structure height shall be determined in the design phase but should be consistent host institution requirement.	Value Engineering	Architectural	F.3 Provide Structure
R.3.17 ASHRAE 90.1	The structure shall be designed to be 30% more efficient than the ASHRAE 90.1-2010 base building	This building meeting ASHRAE 90.1 is a LEED requirement.	Mechanical	F.3 Provide Structure
R.3.18 LEED Certification	Buildings shall obtain LEED Gold certification, or higher.	Required by Executive Order 13834	Nil	F.3 Provide Structure

Requirement Number & Name	Description	Basis	Functional and System Design Requirements Category	Function Specifies
R.3.19 Building Identification	Building identification shall be provided on all sides of the exterior of the building. Signs shall be large enough for viewing from adjacent roads and resistant to the environment (e.g. UV radiation, thermal cycling, rain, hail, and wind). Signage shall be consistent with SRNL branding and host institution requirements	SRNL and host institution requirements.	Architectural	F.3 Provide Structure
R.3.20 Interior Signs and Labeling	Interior signs and labeling shall comply with the SC OSE and host institution requirements.	Required by SC OSE and host institution.	Architectural	F.3 Provide Structure
R.3.21 Bollards	Bollards shall be installed to protect the facility, equipment and components associated with this project in areas where vehicle damage could occur (e.g. hydrants, HVAC equipment, PIVs, Cathodic test stations, etc.). Bollards shall be provided at locations for both on- road and off-road vehicles (e.g. mowers, etc.). Bollards to be consistent with SC OSE requirements and host institution practices.	This is required to prevent damage to the facility and equipment.	Civil and Site Work	F.3 Provide Structure
R.3.22 Skylights	Skylights shall be determined in design phase. Maximum use of natural lighting is encouraged.	LEED principles.	Architectural	F.3 Provide Structure
R.3.1.1 Fork Lift Access	Provide Shipping & Receiving Area to allow a fork lift access to allow the loading and unloading of flatbed trailers and smaller box trucks. The area will also have an adjacent charging area for the forklift in the ramp	Customer Requirements	Civil and Site Work	F.3.1 Provide Shipping & Receiving (S&R) Area
R.3.1.2 S&R Area Concrete Strength	The concrete in the S&R area shall support a 4,000 lb. capacity loaded forklift as well as meet the requirements for the trucking where applicable	Customer Requirements	Civil and Site Work	F.3.1 Provide Shipping & Receiving (S&R) Area

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.1.3 Exterior Access to S&R Area	Access to the facility S&R area shall consist of an asphalt paved road designed to support loaded semi-trucks.	Customer Requirements	Civil and Site Work	F.3.1 Provide Shipping & Receiving (S&R) Area
R.3.1.4 Drainage	Provide drainage in the S&R area to prevent the accumulation of storm water in the low points of the S&R area.	The S&R area cannot collect water.	Civil and Site Work	F.3.1 Provide Shipping & Receiving (S&R) Area
R.3.2.1 Elevation	All mechanical equipment shall be capable of meeting specified performance at the host institution elevation above sea level.	Required by SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.2 Ventilation	Ventilation shall be provided per ASHRAE Standard	Required by SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.3 Indoor Design Conditions	Design temperature for heating shall be 68°F dry bulb. Cooling is 72 °F in lab. Cooling is 75°F in office.	Customer Requirements and SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.4 Outdoor Design Conditions	Laboratory areas shall be designed with an outdoor temperature of 96°F DB/67°F WB in the summer and 6°F in the winter. Design for administrative and service areas shall be in accordance with the 2.5% temperature in the current edition of the ASHRAE Handbook - Fundamentals	Required by SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.5 HVAC Start-Up	Manufacturer's start-up services shall be provided for all mechanical equipment. This includes testing the equipment for proper operation.	Required by SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.6 General HVAC Requirements	HVAC system shall meet the requirements of SC OSE	Required by SC OSE	Mechanical	F.3.2 Provide Climate Control
R.3.2.7 HVAC System Filters	Filters shall be required in all outside air and return air systems prior to air handling and/or distribution equipment	Filters help maintain acceptable indoor air quality. ASHRAE 62.1	Mechanical	F.3.2 Provide Climate Control
R.3.2.8 Screens	Bird screens shall be provided for fresh air and exhaust ducts.	Required to maintain an operational HVAC system. Refer to SC OSE.	Mechanical	F.3.2 Provide Climate Control

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.3.1 Floor Finish	Areas for general access and equipment rooms shall be non-carpeted. Areas such as office and conference room may be carpet or tile. Laboratories shall be tile or concrete as appropriate.	Required by SC OSE	Architectural	F.3.3 Provide Floor
R.3.4.1.1 Emergency Lighting Economic Analysis	An economic analysis shall be completed to determine which emergency lighting system would best serve the facility with maintenance costs included.	Required by SC OSE	Electrical	F.3.4.1 Provide Emergency Lighting
R.3.4.1.2 Emergency Lighting System Labeling	Emergency light fixtures shall be labeled in accordance with practices of the host institution guidelines.	Required by SC OSE	Electrical	F.3.4.1 Provide Emergency Lighting
R.3.4.2.1 Exit Sign-LED	Exit signs shall be illuminated with an LED source.	Required by SC OSE	Electrical	F.3.4.2 Provide Exit Marking
R.3.4.2.4 Exit Sign Test Switch	Exit Marking signs shall have a push-button test switch located on the exterior of the fixture.	Required by SC OSE	Fire Protection	F.3.4.2 Provide Exit Marking
R.3.4.3.1 Interior Lighting- General Requirements	Interior lighting shall comply with SC OSE and host institution design requirements. Maximize use of natural lighting.	Required by SC OSE	Electrical	F.3.4.3 Provide Interior Lighting
R.3.4.4.1 Exterior Light Type	LED Lighting shall be primarily used for exterior lighting and also consider host institutions guidelines.	Required by SC OSE	Electrical	F.3.4.4 Provide Exterior Lighting
R.3.4.4.2 Exterior Light Sensors	Photo sensors that acknowledge daylight shall be included on exterior lighting.	Required by SC OSE	Electrical	F.3.4.4 Provide Exterior Lighting
R.3.4.4.3 Light Level Requirements	Lights shall provide a minimum of 0.2 foot-candle illumination for building roof top and 150 feet in all directions of building and limited fence.	Required by SC OSE	Electrical	F.3.4.4 Provide Exterior Lighting

Requirement Number & Name	Description	Basis	Functional and System Design Requirements Category	Function Specifies
R.3.4.4.4 Exterior Lighting Design Method	Exterior lighting shall be designed per IESNA Lighting Handbook Reference and Application by Illuminating Engineering Society of North America (IESNA) Chapter 10 & 11 current edition.	Required by SC OSE	Electrical	F.3.4.4 Provide Exterior Lighting
R.3.5.1 Lightning Protection	Lightning protection systems shall be provided.	Required by SC OSE	Electrical	F.3.5 Provide Lightning Protection
R.3.5.2 Lightning Protection Compliance	Lightning protection systems shall comply with ANSI/NFPA 70 (2011 Edition), ANSI/NFPA 780 (2011 Edition), UL 96-2005, and UL 96A-2007. System shall have lightning arresters and surge protective devices in accordance with NFPA 70, NFPA 780 and UL listing	Required by SC OSE	Electrical	F.3.5 Provide Lightning Protection
R.3.6.1 Occupants Offices	Offices shall comply with WBDG, host institution, and SC OSE requirements.	Efficiency.	Nil	F.3.6 Provide Offices
R.3.7.3.1 Provide Break Room(s)	Provide a lunch/break room(s) or areas with a total capacity of 40 people. Lunch room(s) will include refrigerators, microwave ovens, sink and ice maker. Multiple areas may be dispersed within the facility	Shared space concept.	Nil	F.3.7.3 Provide Break Room(s)
R.3.8.1.1 Facility Mechanical Room Design Requirements	Mechanical Room(s) shall be used to house facility mechanical equipment. All mechanical rooms must be mechanically ventilated to maintain room space conditions as indicated in ASHRAE 62 and ASHRAE 15. Water lines shall not be located above motor control centers or disconnect switches and shall comply with requirements of NEC. Mechanical rooms shall have floor drains in proximity to the equipment they serve to reduce water streaks or drain lines extending into aisles.	Required by ASHRAE, GSA, and SC OSE	Nil	F.3.8.1 Provide Mechanical Room

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.8.2.1 Staging area for catering	Provide adequate space and services for catered events. Include limited amount of refrigeration and warming ovens for food service.	SRNL and host institution program needs.	Nil	F.3.8.2 Provide staging area for catered events.
R.3.8.3.1 Unclassified Data Center Design Requirements.	Provide Data Center space for router and server connections for the building that supports 100G network capability per industry guidelines. Wireless Access Points will be located throughout the areas to provide Wi-Fi coverage for portable devices.	Required by occupants.	Nil	F.3.8.3 Unclassified Data Center Design Requirements.
R.3.8.4.1 Men's restrooms requirement	Provide Men's restrooms in accordance with the applicable codes.	Required by IBC and UPC.	Mechanical	F.3.8.4 Men's restroom
R.3.8.5.1 Women's restrooms requirement	Provide women's restrooms in accordance with the applicable codes.	Required by IBC and UPC.	Mechanical	F.3.8.5 Women's Restroom
R.3.8.6.1 Janitorial supply area requirements	Janitorial supply area is room that is required for the custodian to take care of the facility. This room requires a hard surface floor, a mop sink at floor level, a faucet for the mop sink, chemical storage, cabinets and/or shelves, and a floor drain.	Customer requirement.	Utilities and Maintenance	F.3.8.6 Provide Janitorial supply area
R.3.8.7.1 Comply with NFPA 70E	Electrical installations shall comply with NFPA 70E, Standard for Electrical Safety in the Workplace	Required by SC OSE.	Electrical	F.3.8.7 Provide Electrical Room
R.3.8.7.2 No water in electrical rooms	No water lines are permitted in electrical rooms, except for fire sprinkler piping. Sprinkler piping lines must not be located directly above any electrical equipment	Required by SC OSE.	Electrical	F.3.8.7 Provide Electrical Room
R.3.9.1 Organic Chemical storage	The facility will require organic chemical storage.	Required by building occupants.	Nil	F.3.9 Provide Chemical and Supply Storage
R.3.9.2 Acid Chemical storage	The facility will require acid chemical storage.	Required by building occupants.	Nil	F.3.9 Provide Chemical and Supply Storage

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.3.9.3 Dry Chemical storage	The facility will require Dry chemical storage.	Required by building occupants.	Nil	F.3.9 Provide Chemical and Supply Storage
R.3.9.4 Supply Storage	The facility will require general supply storage.	Required by building occupants.	Nil	F.3.9 Provide Chemical and Supply Storage.
R.4.1 Corrosion Control	All underground metal utility piping and components shall be cathodically protected per NACE Standard RPO-0169-96 and SC OSE	Required per SC OSE	Civil and Site Work	F.4 Provide Utilities
R.4.2 General Utility Requirements	Plant Utility Piping buried under concrete slab shall be welded and not threaded. Unions and flanges shall be installed in utility piping systems to allow the maintenance or replacement of equipment.	Required per SC OSE	Civil and Site Work	F.4 Provide Utilities
R.4.3 Utility Labeling	Label all utilities per SC OSE and host institution requirements.	Required per SC OSE	Civil and Site Work	F.4 Provide Utilities
R.4.4 Underground Utility Tracing	All underground utility lines (metallic and non-metallic) shall be installed with a trace wire and marking tape per SC OSE	Required per SC OSE	Civil and Site Work	F.4 Provide Utilities
R.4.5 Utility Road Crossing	If it is necessary for an above ground utility to cross a road or other vehicle traffic area, the required height shall be evaluated by the contractor. The vertical Clearance shall not be less than 16.5 ft.	Required per SC OSE	Civil and Site Work	F.4 Provide Utilities
R.4.1.1 Natural Gas Design Codes and Standards	Natural gas systems shall be designed in accordance with the UPC, ASME B31.8, and NFPA 54-2012/ANSI /AGA Z223.1.	Required per SC OSE	Civil and Site Work	F.4.1 Provide Natural Gas
R.4.1.2 Natural Gas Design Requirements	Natural gas distribution piping shall meet all requirements of SC OSE	Required per SC OSE	Civil and Site Work	F.4.1 Provide Natural Gas

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.1.3 Natural Gas Meter	Natural gas metering shall be provided at the facility gas service connection. Meters shall be provided with totalizer and report to the energy management system of the host institution if appropriate.	Required per SC OSE	Civil and Site Work	F.4.1 Provide Natural Gas
R.4.1.4 Natural Gas Regulator Station	Natural gas regulator station shall be designed and installed per SC OSE and host institution requirements.	Required per SC OSE	Civil and Site Work	F.4.1 Provide Natural Gas
R.4.1.a.1 – Argon, Oxygen, Nitrogen, P10	Provide compressed gas services to all laboratory spaces. Details to be resolved in design phase.	Required for laboratories	Mechanical	F.4.1.a – Provide Compress Gas Services
R.4.2.1 Communications- General Requirements	Communication and alarm systems shall comply with SC OSE	Required per SC OSE	Electrical	F.4.2 Provide Communications
R.4.2.2 Communications- Joint Use	Telephone circuits shall be used for other telecommunications and alarm services to the maximum extent practicable.	Required per SC OSE	Electrical	F.4.2 Provide Communications
R.4.2.3 Data System Structured Cable Type	The Data System Structured Cabling shall be an ANSI/TIA/EIA-568-B compliant system using Category 6 or better cable.	Requirement to be confirmed in conceptual design phase.	Electrical	F.4.2 Provide Communications
R.4.2.4 Cable Run Lengths & Comm. Area	Where any structured cabling station cable run's total length, including coming down walls and service loops, exceeds 90 meters (295 ft.), an additional communications area shall be established in that area of the building.	Requirement to be confirmed in conceptual design phase.	Electrical	F.4.2 Provide Communications

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.2.5 Communications Backboards	Backboards shall be installed on the walls in the communications area of the facility. Backboards shall be made from 3/4" AC Grade plywood. All surfaces of the plywood, including at cut outs for electrical outlets (etc.), shall be painted with fire retardant paint, electrical gray in color, before it is mounted to the wall.	Required by SC OSE	Electrical	F.4.2 Provide Communications
R.4.2.6 Communications Area	Room(s) for all communication equipment including telephone and network backboards and components shall be located in the new facility. The number of rooms shall be minimized	Required by SC OSE	Electrical	F.4.2 Provide Communications
R.4.2.1.1 Local Area Network (LAN) Requirements	Installation and performance requirements for LAN shall comply with SC OSE that will also support a minimum 100G network capability.	Required per SC OSE	Electrical	F.4.2.1 Provide Unclassified LAN
R.4.2.1.2 Optical Fiber Requirements	Installation and performance requirements for optical fiber systems shall comply with SC OSE that will also support a minimum 100G network capability.	Required per SC OSE Sections	Electrical	F.4.2.1 Provide Unclassified LAN
R.4.2.1.1.1 Printers and Computers	Provide LAN connections for both unclassified printers and computers.	The customer requires this equipment.	Architectural	F.4.2.1.1 Provide Drops for Printers and computers.
R.4.2.3.1 Telephone Distribution Cable Type	The Telephone System (Voice) Structured Cabling shall be an ANSI/TIA/EIA-568-B compliant system using Category 6 or better cable.	Requirement to be confirmed in conceptual design phase.	Electrical	F.4.2.3 Provide Telephone
R.4.2.3.2 Telephone Distribution Cable Compliance	Cable shall comply with Insulated Cable Engineers Association (ICEA) S-80-576 (2002).	Required by SC OSE	Electrical	F.4.2.3 Provide Telephone

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.2.3.3 Telecommunications Equipment Type	All telecommunications equipment's shall be a four- position modular, latching, plug type, jack-in flush mounting wall plate.	Required by SC OSE	Electrical	F.4.2.3 Provide Telephone
R.4.2.3.4 Telephone System Components Compliance	All telephone system components shall comply with Electronic Industries Association/Telephone Industries Association (EIA/TIA) 568.	Required by SC OSE	Electrical	F.4.2.3 Provide Telephone
R.4.2.3.5 Telephone Drop	Provide one telephone drop for facility. (Extra drops will be required for the Fire Alarm System)	Customer Requirements	Electrical	F.4.2.3 Provide Telephone
R.4.2.3.6 Telephone Routing	Telephone service to the new facility. Exterior telephone system shall comply with SC OSE and host institution system.	Required by SC OSE	Electrical	F.4.2.3 Provide Telephone
R.4.2.4.1 PAS-General Requirements	PAS shall comply with requirements of SC OSE and be compatible with host institution system.	Required by SC OSE	Electrical	F.4.2.4 Provide Public Address System (PAS)
R.4.2.4.2 PAS Testing	PAS shall be tested. Sound level shall be at least 15 dB above ambient noise level, but not exceed 90 db.	Building occupants need to be able to hear announcements, but sound level must remain below OSHA limits.	Electrical	F.4.2.4 Provide Public Address System (PAS)
R.4.2.5.1 Communicate with emergency services dispatch	Communicate with emergency services thru automatic notification of fire alarm signals.	Required by SC OSE	Fire Protection	F.4.2.5 Provide DACT on fire alarm control panel
R.4.2.6.1 Energy Management	The facility's energy management system shall be compatible with the host institution system.	Required per SC OSE	Mechanical	F.4.2.6 Communicate with Energy Management System
R.4.2.6.2 Energy Management & Metering	All meters (for electricity and natural gas) shall include provisions for monitoring by the host institution energy management system.	Required per SC OSE	Mechanical	F.4.2.6 Communicate with Energy Management System
R.4.2.6.3 Energy Management System Interface	The energy management system shall be designed and installed such that it can be operated and monitored by the host institution	Required per SC OSE	Mechanical	F.4.2.6 Communicate with Energy Management System

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.3.1.1 Fire Alarm	Facility shall be provided with a fire alarm system designed and installed in accordance with NFPA 72- 2013 and SC OSE.	Required per SC OSE	Fire Protection	F.4.3.1 Provide Fire Detection
R.4.3.2.1 Fire Suppression Type	Provided a complete automatic fire suppression system designed and installed in accordance with NFPA 13-2013. Fire Suppression systems includes wet pipe, deluge, and/or dry pipe.	Required per SC OSE	Fire Protection	F.4.3.2 Provide Above ground fire suppression system
R.4.3.2.2 Fire Suppression Piping Requirements	Fire suppression piping shall comply with NFPA 13	Required per SC OSE	Fire Protection	F.4.3.2 Provide Above ground fire suppression system
R.4.3.2.3 Fire Extinguishers	Fire extinguishers shall be supplied throughout the facility.	Required per SC OSE	Fire Protection	F.4.3.2 Provide Above ground fire suppression system
R.4.3.2.4 Required Signs	Signage shall be as required by SC OSE and the host institution.	Required per SC OSE	Architectural	F.4.3.2 Provide Above ground fire suppression system
R.4.3.3.1 Service loop around facility	Loop configuration is required around all facilities.	Required per SC OSE	Fire Protection	F.4.3.3 Provide underground fire water distribution system
R.4.3.3.2 Lead-in(s)	Lead-in piping off the main loop shall have a lead-in PIV that is located at a minimum of 40feet from the building.	Required per SC OSE	Fire Protection	F.4.3.3 Provide underground distribution system
R.4.3.3.3 Fire Hydrants	Provide exterior fire hydrants to provide coverage to all facility location.	Required per SC OSE	Fire Protection	F.4.3.3 Provide underground distribution system
R.4.4.1 General Electrical Requirements	Electrical system shall comply with applicable codes and standards.	Required per SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.2 Electrical System Labeling	Electrical system shall be labeled per SC OSE and NFPA 70-2011. All conduits shall be labeled per host institution practices.	Required per SC OSE	Electrical	F.4.4 Provide Electricity

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.4.3 Electrical-Maintenance Considerations	Electrical system shall be designed and installed to accommodate maintenance per SC OSE	Required per SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.5 Electrical System Design Info and Drawings	Detailed design drawings and information shall be created per Electrical SC OSE	Required per SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.6 Electrical System Testing	Electrical system shall be tested per SC OSE and International Electrical Testing Association, Inc.-Acceptance Testing Specifications (NETA-ATS).	Required per SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.7 Electrical System Materials and Methods	Electrical system shall comply with SC OSE design requirements.	Required per SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.8 Exterior Electrical Utility Service	Exterior electrical system shall comply with SC OSE requirements.	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.9 Grounding-General Requirements	Electrical system shall comply with grounding requirements in NEC and SC OSE	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.10 Equipment Grounding	All equipment grounding shall comply with NEC and SC OSE	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.11 Interior Electrical Systems	Interior electrical system shall comply with NEC and SC OSE	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.12 Receptacle Testing	All receptacles shall be checked for correct polarity	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.13 Electrical Panel Requirements	All electrical panels shall comply with NEC and SC OSE requirements.	Required by SC OSE	Electrical	F.4.4 Provide Electricity

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R.4.4.14 Ground Fault Circuit Interrupters (GFCIs)	GFCI receptacles shall be installed where required by NFPA 70-2011.	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.15 Electrical System Design Aid	Contractor shall use Electrical Design aids as specified by SC OSE and host institution.	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.16 Electrical Calculation Software	Calculations shall be documented per SC OSE and host institution requirements.	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.17 NFPA 70	Installation shall comply with NFPA 70, The National Electric Code (NEC)	Required by law.	Electrical	F.4.4 Provide Electricity
R.4.4.18 Electrical Metering	Provide electrical meters at the building level for each building. Individual electrical metering shall be as required by host institution energy management practices. .	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R 4.4.19 Standby Power	Provide standby power for personnel protection systems and critical building functions (e.g. fume hood exhaust)	Required by SC OSE	Electrical	F.4.4 Provide Electricity
R.4.4.1.1 Provide electrical drops at computer equipment	Provide an electrical drop at each computer and printer	Customer Requirement	Electrical	F.4.4.1 Provide Electrical Drops for Computers and Printers & equipment
R.4.4.2.1 Provide Surge Protection	Provide surge suppression	Required by SC OSE and host institution.	Electrical	F.4.4.2 Provide Surge Protection
R.4.4.3.1 Provide High-bay additional power	Provide an independent electric system for high-bay. Provide 120VAC and 480VAC three phase connections on this independent electrical system.	Customer Requirement	Electrical	F.4.4.3 Provide Laboratory Electrical Drops Independent from Computer & printers and equipment

<b>Requirement Number &amp; Name</b>	<b>Description</b>	<b>Basis</b>	<b>Functional and System Design Requirements Category</b>	<b>Function Specifies</b>
R 4.4.3.2 Provide High-bay Testbed power	Provide a utility feed and switch gear of 1-2MVA at distribution voltage for the independent electrical system in R.4.4.3.1. Customer will provide distribution transformer. Provide circuit connections for a range from 120VAC to 4160VAC	Customer Requirement	Electrical	F.4.4.4 Provide Utility Power for Advanced Manufacturing Standards Testbed
R.4.5.1 Plant Domestic Water Requirements	Domestic water shall be provided in accordance with the requirements of the Uniform Plumbing Code and NSF 61	Required by SC OSE and host institution.	Utilities	F.4.5 Provide Domestic Water
R.4.5.2 Domestic Water Metering	Domestic water meter shall be installed at the service entrance of each building. Meter shall be provided with a totalizer and report to the host institution energy management and metering system if required.	Required by SC OSE and host institution.	Utilities	F.4.5 Provide Domestic Water
R.4.6.1 Plant Sanitary Sewer Requirements	Sanitary sewer shall be designed and installed in accordance with the UPC and SC OSE.	Required by SC OSE and host institution.	Utilities	F.4.6 Provide Sanitary Sewer
R 4.7.1 Air emissions monitoring	Air Release Stack monitoring as required by state and federal law	Required by SC OSE, SCDHEC, and EPA	Utilities	F 4.7 Provide Emissions Monitoring
R 4.7.2 Liquid effluent monitoring	Liquid effluent monitoring as required by state and federal law	Required by SC OSE, SCDHEC, and EPA	Utilities	F 4.7 Provide Emissions Monitoring

### 4.3 Design Guidance

For conceptual design purposes, AMC space referenced the Design Guidance contained in selected Whole Building Design Guides for research facilities and space types: dry laboratory, wet laboratory, light industrial and office.

The WBDG is a program of the National Institute of Building Sciences. This source brings together regulatory information and market trends to provide the user with a path to the design and operation of sustainable buildings.

Individual requirements for research facilities and identified space types are available at

<http://www.wbdg.org/design/>.

Sustainable design and LEED certification is an assumed requirement for the AMC space. LEED stands for Leadership in Energy and Environmental Design and certification is provided through the U. S. Green Building Council. The object of attaining LEED certification is to embrace the “reduce, reuse, recycle” approach for building construction and operation to reduce the energy and water usage for the building.