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COMPLIANCE IS MANDATORY

John C. Stennis Space Center
HVAC AND DOMESTIC HOT WATER DESIGN STANDARD

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Document History Log

Revision	Date	Originator/ Phone	Description
Basic		Donnie Thompson, x8-1641.	Initial release. Supersedes SSC Standard 50-001.
A	11/03/14	Donnie Thompson X8-1641	Five-year review. Updated references and acronyms.
B	11/03/19	Donnie Thompson X8-1641	Five-year review. Changed "NASA SSC Center Operations Design & Construction Project Management Division" to "NASA SSC Center Operations Facilities Engineering Test Complex Support" and "NASA SSC COD Operations and Maintenance Division" to "NASA SSC Center Operations Directorate Facility Services" throughout document, as necessary. Section 5.2-g: Deleted "only"; replaced "water tube, copper finned" with "high efficiency condensing"; and added "unless the LCCA proves this is not the most efficient and cost-effective option." Section 5.4.2-c: Added, "Alternately, the designer must provide written documentation as to why economizers are not being installed per current ASHRAE and other standards." Replaced temperature set point references throughout document with "per applicable ASHRAE standard." Updated references, acronyms, and minor formatting.
C	06/30/2020	Delton Rodriguez 8-2499 Matthew Ladner / 8-2386	Updated directorate titles on cover and header. Updated references. Subsection 5.5.7-k: Added SSTD-8070-0138-ELEC requirement. Appendix A.2: Added definitions.
C-1	09/15/2020	C. Wolfram 8/1620	Administrative update to make current the effective/review dates.

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1.0 PURPOSE

This standard establishes the requirements for design of heating, ventilation, and air conditioning (HVAC) systems as well as domestic hot water systems at the John C. Stennis Space Center (SSC).

The limits given conform to federally mandated energy conservation standards per National Aeronautics and Space Administration (NASA) Policy Directive (NPD) 8820.2, and to best known local factors.

2.0 APPLICABILITY

This SSC standard (SSTD) is applicable to NASA/SSC personnel, SSC contractors, and resident agencies.

This SSTD is applicable to all HVAC and domestic hot water projects in new construction as well as building, HVAC and domestic hot water renovations, regardless of size.

3.0 REFERENCES AND APPLICABLE DOCUMENTS

All references are assumed to be the latest version unless otherwise indicated.

ASHRAE Handbook of Fundamentals
ASHRAE Standard 55, *Thermal Environmental Conditions for Human Occupancy*
ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*
ASHRAE Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*
ASTM E917-17, *Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems*
ASTM E2204-15, *Standard Guide for Summarizing the Economic Impacts of Building-Related Projects*
Energy Independence and Security Act of 2007
EPAct 2005, Energy *Policy Act of 2005*
Executive Order 13834, *Efficient Federal Operations*
NPD 8820.2, *Design and Construction of Facilities*
NPR 8820.2, *Facility Project Requirements*
SPR 1440.1, *Records Management Program Requirements*
SSTD-8070-0005-CONFIG, *Preparation, Review, Approval, and Release of SSC Standards*
SSTD-8070-0138-ELEC, *SSC Arc Flash Standard*

4.0 RESPONSIBILITIES

a. NASA is required to construct new buildings and perform major renovations that meet or exceed current federal regulations, which specify energy efficiency levels. Since the

HVAC system, and to a certain extent the domestic hot water system, are significant energy users in most buildings, it is imperative that the designer utilize the most efficient equipment and systems that are currently available.

b. The designer shall coordinate with other design disciplines to incorporate design features that minimize energy consumption.

c. Users of this SSTD shall comply with its requirements, ensure use of the correct version of this standard and the documents it references, and inform the appropriate organization of needed changes in accordance with SSTD-8070-0005-CONFIG.

d. Responsibilities for the use and control of this SSTD and for the review and approval of revisions or cancellation of this standard shall be as specified in SSTD-8070-0005-CONFIG and the applicable documents referenced therein.

5.0 REQUIREMENTS FOR HVAC DESIGN

5.1 GENERAL

a. The designer shall strictly adhere to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) requirements, accepted industry standards, and sound engineering practices in the design of all HVAC systems.

b. Each specific area of a building shall be carefully evaluated for its specific HVAC requirements.

c. HVAC systems shall be designed in accordance with ASHRAE 90.1 so that energy consumption is minimized.

d. Life-Cycle Cost Analysis (LCCA), as referenced, shall be conducted for HVAC systems.

e. The simultaneous operation of heating and cooling equipment for dehumidification purposes should not be allowed. However, if necessary, ASHRAE 90.1 shall be followed.

f. When the building is not continuously occupied, separate HVAC equipment shall be installed for areas that require uninterrupted conditioning.

g. Only refrigerants that meet or exceed the Environmental Protection Agency (EPA) requirements for ozone depletion and global warming shall be used.

h. Except for exhaust and ventilation fans, HVAC equipment shall not be installed on the roof of any building.

i. The HVAC design engineer shall use equipment with readily accessible published data.

j. The data shall be based on equipment in new condition, and cover full load, partial load, and standby conditions, as required, to enable determination of their compliance with this standard.

k. The designer shall specify only high efficiency or premium efficiency equipment.

l. The design of the HVAC system will be reviewed using a checklist that includes, but is not limited to, the following:
   1. Calculate exhaust and outside air requirements
   2. Cooling and heating load requirements
   3. Space/Zone air distribution
   4. Supply air (SA), return air (RA) and exhaust air (EA) ductwork layouts
   5. SA, RA and EA diffuser sizing
   6. Variable air volume (VAV) box, exhaust fan, and air handling unit (AHU) sizing
   7. Mechanical room layout including access clearances, and elevations showing equipment clearances
   8. Diffuser, exhaust fan, VAV box, unit heater and fan coil schedules
   9. Chillers, cooling towers and boiler sizes
   10. Layout of chilled water and hot water piping
   11. Expansion tank, 3-way/2-way valves, and air separator sizes
   12. Chiller, boiler and pump schedules
   13. Calculate expansion loops
   14. Central utility building layout

5.2 HEATING

a. For the purpose of sizing heating systems, heating design loads shall be determined in accordance with procedures described by ASHRAE.

b. Outdoor design temperature shall be per applicable ASHRAE standard.

c. Indoor design temperature shall be per applicable ASHRAE standard.

d. Electric resistance shall not be used to provide heating or reheating. The exception to this is if a LCCA proves that electric resistance heating is more cost effective than other heating systems.

e. All comfort heating equipment shall exceed ASHRAE efficiency requirements.

f. The designer shall select several potential heating systems, and conduct a LCAA to determine the most cost-effective system.

g. When a hydronic heating system is selected, the designer shall use high efficiency condensing boilers unless the LCCA proves this is not the most efficient and cost-effective option.

h. Boilers shall be located indoors and equipped with electronic pilot ignition.

i. Automatic vent dampers shall be used.

j. Boilers shall be sized to meet heating load requirements with water temperature set points no higher than 160°F.

k. Boilers shall be selected that are capable of automatically resetting temperature set points through the Energy Management Control System (EMCS).

5.3 VENTILATION

a. Provide sufficient outdoor air within the occupied spaces, in accordance with ASHRAE requirements.

b. Provide ventilation rates in sufficient quantity to ensure a positive pressure within the building relative to outside conditions.

c. Since the conditioning of outdoor air is energy intensive, the designer shall incorporate control strategies such as demand control ventilation as well as air flow measuring and energy recovery equipment.

5.4 COOLING

5.4.1 General

a. For the purpose of sizing air conditioning systems, cooling design loads shall be determined in accordance with procedures described by ASHRAE.

b. Outdoor design conditions for dry bulb and wet bulb temperatures shall be per applicable ASHRAE standard for the surrounding area.

c. Indoor design temperature shall be per applicable ASHRAE standard.

d. Indoor design relative humidity shall be per applicable ASHRAE standard.

e. The following areas shall not be mechanically cooled:
   1. Motor vehicle storage garages
   2. Maintenance shops

f. The following areas shall be conditioned to minimal levels as determined by ASHRAE 90.1:
   1. Boiler and chiller plants
   2. Building mechanical equipment rooms

g. Direct expansion (dx) systems shall have low ambient control by means of fan speed control, crank case heaters, and a five-year warranty on all compressors.

h. Chillers shall be selected that are capable of automatically resetting temperature set point through the EMCS.

i. Chillers shall be selected that are capable of operating with variable water flow rates.

5.4.2 Cooling with Outdoor Air (Economizer Cycle)

a. Each fan system shall be designed to automatically use up to 100% of the fan system capacity for cooling with outdoor air while maintaining building pressure requirements.

b. Activation of economizer cycle shall be controlled by sensing indoor air enthalpy, outdoor air enthalpy, and dry bulb temperature jointly.

c. Cooling with outdoor air is not required if the fan system capacity is less than 4,000 ft^3/min or 120,000 BTU/h (35.2 kW) total cooling capacity. Alternately, the designer must provide written documentation as to why economizers are not being installed per current ASHRAE and other standards.

5.5 OTHER HVAC REQUIREMENTS

5.5.1 Controls

a. All HVAC equipment shall be connected to, as well as controlled and monitored by, the EMCS.

b. For each piece of equipment, the designer shall develop a sequence of operation that maintains comfort conditions, assures the proper operation of the equipment, and minimizes energy consumption.

c. Each HVAC system/zone shall be provided with a thermostat/temperature sensor for the regulation of each system/zone temperature.

d. At a minimum, each floor of a building shall be zoned to ensure thermal comfort of the occupants.

5.5.2 Insulation

a. All HVAC piping installed to a building and within the building shall be insulated according to ASHRAE 90.1.

b. Exposed condenser water piping shall not be insulated.

c. Insulation products shall be used for the purpose and in the manner recommended by the manufacturer, who should be consulted for detailed application instructions and regarding specific problems or unusual conditions involving the use of insulation.

d. Insulation installed exterior to the building shall be protected from physical damage.

e. Installation installed exterior to the building shall be weatherproof, waterproof, and ultraviolet (UV) protected.

f. Air handling unit (AHU) condensate line(s) shall be insulated to a point at which no moisture will form condensation on the outside of the line due to the line temperature being below the dew point temperature of the surrounding area.

g. Condensate lines passing over finished ceilings shall be insulated for the full length of the line over the ceiling.

h. All ducts, plenums, and enclosures installed in or on buildings shall be thermally insulated, unless the heat loss and/or gain of the duct system without insulation does not increase the energy requirements of the building or create problems due to condensation.

i. All duct insulation shall be installed on the exterior of the duct, and properly adhered and sealed to the duct.

j. Duct liner shall not be used.

5.5.3 Cooling Towers

a. All cooling towers shall have the following:
   1. Stainless steel basin with hinged access doors
   2. Gear box driven fans for motors 10 horsepower (hp) or greater
   3. Motor located outside the air stream
   4. Ladder access to the top
   5. Covered distribution deck with non-skid metal access panels
   6. Perforated pan for water distributors
   7. Three-way diverter valves on cooling tower piping
   8. Variable frequency drives on all cooling tower fan motors
   9. Reduced water usage per Executive Order 13834

b. Nozzles for distributors are not allowed.

5.5.4 Water Treatment

a. Water treatment will be provided on all chill, heating and condensed water systems.

b. An automated chemical injection system will be installed on all “open” systems, and a chemical pot feeder will be installed on all “closed” systems.

5.5.5 Filtration

a. All air filters shall fit in a 2-inch frame, and be sized for a maximum velocity of 500 FPM.

b. ANSI/ASHRAE 62.1 and other applicable requirements for filtration effectiveness shall be met.

5.5.6 Air Handling Units

a. All air-handling units shall be mounted on vibration isolators and have hinged access doors to the filter, drain pan, and fan sections.

b. The drain pan shall be configured to drain all water.

c. The unit shall be properly elevated to allow proper trapping of the condensate line.

d. All air handling units shall comply with ASHRAE 62.1

5.5.7 Electric Motors

a. Motors shall conform to American National Standards Institute (ANSI) / National Electrical Manufacturers Association (NEMA) standards.

b. One-half hp and smaller shall be operable on 115/208V, single-phase A.C. power.

c. Larger motors shall be three-phase with voltage rating to match the system voltage.

d. Larger motors shall have three-phase protection.

e. Operation of 230V motors on a 208V system shall not be permitted.

f. Dual rated 220/440V motors may be specified when suitable and available at no extra cost.

g. Totally enclosed fan cooled (TEFC) motors shall be used on all outdoor installations and in harsh environments.

h. Motor hp rating shall be matched as close as possible to load requirements under all conditions.

i. Variable frequency drives shall be installed on all motors that have varying loads.

j. Efficiency of all electric motors shall meet or exceed those levels in ASHRAE 90.1.

k. The motors shall comply with the requirements of SSTD-8070-0138-ELEC.

6.0 GENERAL REQUIREMENTS FOR DOMESTIC HOT WATER DESIGN

a. The designer shall strictly adhere to all applicable codes, accepted industry standards, and sound engineering practices in the design of all domestic hot water systems.

b. Each specific area shall be carefully evaluated for its specific requirements (i.e. VAV box minimum requirements, factory insulated heating coils, and maximum heat/reheat leaving air temperatures) as per ASHRAE 62.1. (This modification is not applicable to domestic hot water.)

c. Domestic hot water systems shall be designed so that energy consumption is minimized.

d. Hot water for domestic and sanitary purposes shall be generated and delivered in a manner conducive to saving energy.

e. As required by the Energy Independence and Security Act (EISA) of 2007, solar water heaters shall be used on all new construction.

f. Electric water heaters shall be controlled and monitored by EMCS.

g. Where life-cycle cost effective, localized water heaters shall be utilized in lieu of large centralized water heaters.

h. Where life-cycle cost effective, instantaneous water heaters shall be utilized in lieu of tank-type water heaters.

i. Domestic hot water systems shall be equipped with automatic temperature controls capable of adjustment to the lowest acceptable temperature setting for the intended use.

j. Domestic hot water temperature for restrooms, showers, and similar facilities shall be per applicable ASHRAE standard.

k. Where special functions, such as dishwashing, require hot water temperatures, the temperature required shall be per applicable local standard. Local booster heaters or chemical sterilization shall be utilized to meet the local requirements.

l. A separate shutoff valve shall be provided in the main line to the burner(s) of gas burning water heating systems.

m. Devices such as showerheads, faucets, and similar fixtures shall be specified such that hot water usage is minimized.

7.0 SAFETY

Exceptions to this standard may be required for the protection of or for the health and efficiency of employees. Such exceptions shall be submitted to the SSC Energy Resources Manager for review and authorization.

8.0 CONFORMANCE/COMPLIANCE

As required, system designs based on this standard shall include system balancing calculations and calculations that verify compliance with this standard for justification of any variance.

9.0 RECORDS AND FORMS

Records and forms required by the procedures of this standard shall be maintained in accordance with SPR 1440.1. All records and forms are assumed to be the latest edition unless otherwise indicated. Forms may be obtained from the SSC Electronic Forms repository or from the NASA SSC Forms Management Officer. Quality Records are identified in the SSC Master Records Index.

APPENDIX A - ACRONYMS, ABBREVIATIONS AND DEFINITIONS

Appendix A.1 Acronyms and Abbreviations

A.C.	alternating current
AHU	air handling unit
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BTU/h	British thermal unit per hour
dx	direct expansion
EA	exhaust air
EISA	Energy Independence and Security Act
EMCS	Energy Management Control System
EPA	Environmental Protection Agency
F	Fahrenheit
FPM	feet per minute
ft^3	feet cubed
hp	horse-power
HVAC	heating, ventilation, and air conditioning
LCCA	life cycle cost analysis
kW	kilowatt
min	minute
NASA	National Aeronautics and Space Administration
NEMA	National Electrical Manufacturers Association
NPD	NASA Policy Directive
NPR	NASA Procedural Requirement
RA	return air
SA	supply air
SPR	John C. Stennis Space Center Procedural Requirement
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Standard
TEFC	totally enclosed fan cooled
UV	ultraviolet
V	volt
VAV	variable air volume

Appendix A.2 Definitions

Arc Flash – An electrical short circuit through air when insulation or isolation between electrified conductors is breached or can no longer withstand the applied voltage. Temperatures can reach up to 35,000 ºF.

Circuit – A conductor or system of conductors through which electric current is intended to flow.

Conductor – A material, usually in the form of a wire, cable, or bus bar, suitable for carrying electric current.

Enclosure - The case or housing of apparatus — or the fence or walls surrounding an installation to prevent personnel from unintentionally contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage.