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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA/KSC-28 31 33.00 98 (July 2020)

Preparing Activity: NASA

Superseding
NASA/KSC-28 31 33.00 98 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

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SECTION 28 31 33.00 98

AIR SAMPLING DETECTION SYSTEMS (ASDS)
07/20

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NOTE: This specification covers the requirements for air sampling detection systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Recommended changes to a NASAKSC Master Specification Section should be submitted as a Criteria Change Request (CCR) to the appropriate Technical Proponent (TP) through the SpecsIntact Help Desk.

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PART 1 GENERAL

Section 28 31 00.00 98 FIRE DETECTION AND ALARM applys to work specified in this section.

Provide all additional equipment, cabinets, conduit, and labor to meet the requirements and intent of this specification.

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1784	(2020) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2564	(2020) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM F438	(2017) Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F442/F442M	(2023) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)
ASTM F493	(2022) Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

COMPRESSED GAS ASSOCIATION (CGA)

KSC-STD-F-0004	(2016, Rev G) Standard for Fire Protection Design

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-STD 8719.11	(2020; Rev B) Safety Standard for Fire Protection

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 3	(2021) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 72	(2022; ERTA 22-1) National Fire Alarm and Signaling Code
NFPA 75	(2020) Standard for the Protection of Information Technology Equipment

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 497	(2001; Reprint Jul 2022) UL Standard for Safety Protectors for Paired Conductor Communication Circuits
UL 497B	(2004; Reprint Feb 2022) UL Standard for Safety Protectors for Data Communications and Fire Alarm Circuits
UL 1481	(2006) Standard for Power Supplies for Fire-Protective Signaling Systems
UL 2196	(2008) UL Standard for Tests for Fire Resistive Cables, 1st Edition
UL 1449	(2021; Reprint Dec 2022) UL Standard for Safety Surge Protective Devices
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory
UL Fire Resistance	(2014) Fire Resistance Directory

1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project.

A “G” following a submittal item indicates that the submittal requires Government approval. Some

submittals are already marked with a “G”. Only delete an existing “G” if the submittal item is not complex and can be reviewed through the Contractor’s Quality Control system. Only add a “G” if the submittal is sufficiently important or complex in context of the project.

An "S" following a submittal item indicates that the submittal is required for the Sustainability Notebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Contractor's Certifications[; G] to the Contracting Officer for approval, prior to any work being started on the ASDS, in accordance with paragraph titled "Qualifications".

KSC Transfer Of Responsibility[; G]

Quality Assurance Plan[; G]

SD-02 Shop Drawings

Connection Drawings[; G]

Record Drawings[; G]

Fire Service Floor Plans[; G]

Software Programs[; G]

Floor Plan Drawings[; G]

Module Schematics; {;G}

SD-03 Product Data

Submit Manufacturer's Product Data[; G] (Catalog Data) for the following items:

Pipe Hangers and Supports[; G]

Remote Display Module[; G]

Annunciator Cabinet And Interface Equipment[; G]

ASDS Detector Assembly[; G]

Pipe Network[; G]

Power Supply-Battery Charger[; G]

Filter[; G]

Fire Resistive Cables[; G]

Line Voltage Surge Suppressors[; G]

Low Voltage Surge Suppressors[; G]

Wiring (Wire And Multi-Conductor Cable)[; G]

SD-05 Design Data

ASDS Pipe Network Design Analysis[; G]

SD-06 Test Reports

ASDS Acceptance Test Procedures[; G] (For preliminary and final tests)

Continuity Test Report[; G]

Insulation Resistance Test Report[; G]

SD-07 Certificates

NFPA 72 Fire Alarm System Record Of Completion Form[; G]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals[; G]

Recommended Critical Spares List[; G]

1.3 GENERAL REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL[and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS] apply to work specified in this section.

1.3.1 Submittals Sequence

Submit submittals for approval in the following sequence with each approved prior to the next submittal.

1.3.1.1 Preconstruction Submittals

Submit the following submittals no later than [14] [_____] days after notice to proceed:

a. KSC Transfer of Responsibility form

b. Product Data (Catalog Data)

c. Contractor's Certifications

d. Quality Assurance Plan

1.3.1.2 Preliminary Test Submittals

Submit the following submittals no later than [14] [_____] days prior to the scheduled preliminary acceptance test:

a. ASDS Acceptance Test Procedures

b. Shop Drawings

Provide two completed sets minimum of the drawings and documentation and make available for reference at the preliminary test.

1.3.1.3 Final Test Submittals

Submit the following submittals no later than [14] [21] [_____] days prior to the scheduled final test:

a. Electronic Shop Drawings

b. NFPA 72 Fire Alarm System Record of Completion Form

Provide two completed sets minimum of the Shop Drawings and documentation and make available for reference at the final test.

1.3.1.4 Closeout Submittals

Submit the following submittals no later than 14 [21] [_____] days after the final acceptance test has been completed and approved:

a. Operation and Maintenance Manuals

b. Record Drawings

c. Completed final ASDS Acceptance Test Procedures

d. Recommended Critical Spares List

Include in this submittal two (2) sets of CD ROM digital media .DWG or .DGN format files of all the Record Drawings. Prepare and submit all drawings generated by computer aided design (CAD). Provide a complete copy of the Record Drawings in PDF format. Submit Recommended Critical Spares List in accordance with the paragraph entitled "Documentation Requirements" of this section. Submit these items electronically or using a government approved method.

1.3.2 Documentation Requirements

Installation shop drawings, record drawings, connection drawings, and design analysis must be signed and sealed by a Professional Engineer with qualifications as defined in paragraph titled "QUALIFICATIONS".

1.3.2.1 Shop Drawings

Include in Shop Drawings: Connection Drawings, Floor Plan Drawings, Air-sampling Smoke Detection System (ASDS), Sequence of Operations, ASDS Pipe Network Design Analysis, Module Schematics, and all other data required to fully document the completed system. After final testing is complete, provide Record Drawings including digital media and hard copies

of all new and revised softwares, drawings, and analysis/calculations incorporating approved comments and any changes.

1.3.2.1.1 Connection Drawings

Provide ASDS and Fire Alarm Control Panel (FACP) Connection Drawings consisting of point-to-point wiring diagrams of internal and external wiring including, but not limited to, detectors, modules, wiring type and AWG, and communication networking connections, where present, and battery connections. Point-to-point wiring is defined as wiring from device with integral terminal strip to next device with integral terminal strip, wiring between internal modules/devices in cabinet, circuit termination's on terminal strips in terminal boxes with integral terminal strips.

1.3.2.2 Record Drawings

Document final system configuration in Record Drawings (As-Built) including, but not limited to, all new and revised softwares, drawings, and analysis/calculations incorporating approved comments and any changes, including deviations from the amendments to the connections drawings, and field installation changes, concealed and visible.

1.3.2.3 Software Programs

Provide software programs, both hard copy and compact disc, for all new and/or existing programmable FACP(s) affected by the project. Provide system executable file and report file on the compact disc. FACP program documentation to include system point summary, addressable device switch settings, and descriptive check boxes for program functions listed on paragraphs titled "FACP Functions". FACP program documentation to clearly show interaction of system components in accordance with the Fire Alarm Input/Output Matrix and Sequence of Operations included in design. Programming documentation specifically programming check boxes to be reviewed and approved by government prior to Final Acceptance Testing.

1.3.2.4 ASDS Acceptance Test Procedures

Conduct tests in accordance with approved ASDS Acceptance Test Procedures, and in accordance with the paragraph entitled "Field Testing" in this specification. Prepare a test procedure and test record form for conducting complete tests on control panels, reporting systems, wiring systems, and field devices installed in accordance with the manufacturer's requirements and these specifications. Identify each device and circuit to be tested in the test procedure, describe the initial condition, each step or function in the test, required test result, and equipment to be employed.

Test procedures are to be written to minimally disrupt facility operations and reduce the time required to receive signals at the Ground Support Fire Alarm (GSFA) console for KSC testing by not routinely transmitting repetitive signals, for example on site inspectors may observe relay operations that cause radio zones to transmit. Test procedure to detail how to minimize activation of evacuation notification appliances, AHU shutdown, etc. in support of testing requirements. Ensure test forms have suitable space for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms with identified spaces for verification signatures of [KSC][CCAFS Fire & Emergency Services] Authority Having Jurisdiction and [_____] System Engineer witnesses and dates of the test.

1.3.2.5 Fire Service Floor Plans

Clearly indicate on Floor Plans geographic monitor zone boundaries, location of remote displays (ASDS Annunciator Cabinet), FACP, communication networking interface equipment, terminal cabinets, batteries, power source, pipe network (pipe segment dimensions), piping isometric views, operational calculations, detector performance criteria and sampling points (size and locations) and all other associated equipment that is required to provide a complete ASDS. Include program logic and/or ladder logic diagrams that show interaction of system components.

1.3.2.6 Design Analysis

Submit ASDS Pipe Network Design Analysis for approval for the Fire Alarm and Detection System modeled with manufacturer Windows-based software (ASPIRE), latest revision, consisting of fan speed, air flow pressures, transport times, sampling points diameter, and pipe segment dimensions.

1.3.2.7 Operation And Maintenance Manuals

Submit Operation and Maintenance Manuals. Bind information in manual format and group by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended test equipment, and safety precautions.

1.3.2.8 Recommended Critical Spares List

Submit Recommended Critical Spares List specific to the project. List to include critical spare parts and components recommended by the manufacturer to restore the system to operation in with minimal downtime.

1.4 SYSTEM REQUIREMENTS

Provide ASDS for smoke detection[of IT/Communication room(s)] conforming to the applicable requirements of NFPA 75, NFPA 72, KSC standards KSC-STD-F-0004, NASA requirements NASA-STD 8719.11 and manufacturer's application design guidelines, and requirements specified herein.

Provide all equipment, cabinets, modules, devices, programming, circuits, conduits, testing and labor to meet the requirements of this specification. Ensure all equipment and components provided are Underwriter Laboratory (UL) UL Fire Prot Dir listed or Factory Mutual (FM) FM APP GUIDE approved for their intended use and function.

Ensure manufacturer's Product Data identifies detector manufacturer's name and model number including any special tools for the maintenance and testing of the detector to operate and meet its UL or FM approval standards. Verify actual installed pipe network integrity meets or exceeds manufacturer pipe network modeling software (ASPIRE) and specifications herein.

1.4.1 ASDS Requirements

a. Consist of a highly sensitive, short wavelength LASER-based[, in conjunction with photodiodes and advanced imaging Flair detection technology].

b. Have a reset/disable/acknowledge button, LED indicator, and a [3.5" color touch screen] user interface Display to provide detector status information, including smoke level, smoke level bar graph, % airflow level, and fault categories.

c. Consist of a [four][_____] pipe model to transport air to the detection system, supported by calculations from a computer-based design modeling tool.

d. Be tested and approved for an area coverage of [21,520][_____] sq. ft with a [919][_____] ft pipe length (linear) and [1,837][_____] ft pipe length (branched).

e. Provide [four][_____] alarm levels (thresholds) corresponding to [Alert, Action, Fire 1 and Fire 2][_____] with a wide sensitivity range and two fault warning levels (maintenance and major fault).

f. Consist of alarm threshold sensitivity range of [0.0016%-6.25%][_____] obs/ft with a minimum Fire 1 threshold of [0.0031%][_____] obs/ft.

g. Incorporate an ultrasonic flow sensor in each pipe inlet and provide staged airflow faults against flow fault thresholds that may be determined and set for each pipe individually.

h. Consist of [seven][_____] configurable relay outputs, rated minimum 2A at 30 VDC, and [two][_____] programmable GPIs to report any alarm level, fault and disable indication on the detector.

i. Be a [two][_____]-stage filtration type and self-monitoring for filter dust count contamination and remaining filter life.

j. Have an AutoLearn Smoke/Flow internal button for rapid normalization function of detector.

k. Be modular type with field replaceable sub-assemblies.

l. Be configured, monitored, and maintained using a Windows application (Xtralis VSC/VSM) software running on a PC (or table/smart phone) via USB port, Ethernet, or WiFi. Software (VSC/VSM) to be provided for download.

m. Be provisioned for field upgrading the firmware in the system using a USB memory key connected directly to the detector, avoiding the need for a separate PC for this function.

n. Be capable of being protected (access) using a detector password specific to the detector with authentication protocol software security measures.

o. Support network connectivity which includes intelligent remote display module(s) and/or a high-level interface (HLI) with the building fire alarm system, or a dedicated graphics package (such as VSM4), for primary reporting, centralized configuration, control, maintenance and monitoring.

p. Be capable of storing up to [20,000][_____] events in on-board memory and report events via peer-to-peer communications networking.

1.5 QUALITY ASSURANCE PLAN

Provide manufactured UL listed or FM approved ASDS fire-alarm equipment which meets the requirements according to the paragraph titled "System Requirements" of this section. Use the latest standard design, and as listed by Underwriters' Laboratories (UL Fire Prot Dir) or approved by Factory Mutual FM APP GUIDE for its intended use. Ensure all installed devices are comparable, and function with the operation of the control panel and do not interfere.

Supplier and Installer should be factory-trained by the manufacturer to model, design, install, program, test, and commission the ASDS based on code requirements herein.

Installer should provide fully verified and dated electronic copies of all test data and results with a copy of the approved test procedure and any factory commissioning form.

1.6 QUALIFICATIONS

1.6.1 Professional Engineer

Installations requiring completion of installation shop drawings and record drawings for ASDS and fire alarm systems require signing and sealing by a qualified engineer. For the purpose of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions:

a. A Registered Professional Engineer having a Bachelor of Science or Master of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of four years work experience in fire protection engineering.

b. A Registered Professional Engineer (P.E.) in fire protection engineering.

c. Registered Professional Engineer with verification of experience and minimum of five years of current experience in the design of fire alarm systems of similar complexity.

1.6.2 Installer

Installation of wire, cable, conduit, control cabinets, fire alarm terminal cabinets, and backboxes for fire alarm components must be performed by Fire Alarm Installers. Electricians are allowed to be Fire Alarm Installers. [Fire Alarm Installer to be assisted by a Fire Alarm Technician.]

1.6.3 Technician

Installation and termination of fire alarm control panels, releasing panels, notification appliances, initiating devices, cabinets and modules must be performed by [NICET Level II certified] Fire Alarm Technicians with a minimum of four years of experience. Fire Alarm Technicians must be trained by the manufacturer in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.4 Supervisor

Installation of the fire alarm control panels and releasing panels must be supervised by a [NICET Level III certified] Fire Alarm Technician with a minimum of 8 years of experience. The Fire Alarm Technicians must be trained by the manufacturer in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.5 Test Personnel

Testing and certification of fire alarm systems must be performed by a [NICET Level III certified] Fire Alarm Technician with a minimum of 8 years of experience. The Fire Alarm Technicians must be trained by the manufacturer in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.6.6 Manufacturer's Representative

The fire alarm control panel and releasing panel equipment Manufacturer's Representative must be present for the connection of wiring to the panel. The Manufacturer's Representative must be an employee of the manufacturer with necessary technical training [NICET Level III] on the system being installed.

1.6.7 Manufacturer

Components must be of current design and be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to the most current version of NFPA 72, except as otherwise or additionally specified herein.

PART 2 PRODUCTS

Provide an ASDS with performance conforming to the requirements of UL or FM approval standards. Ensure manufacturer's Product Data identifies detector manufacturer's name and model number including any special tools for the maintenance and testing of the detector to operate and meet its UL or FM approval standards. Verify actual installed pipe network integrity meets or exceeds manufacturer pipe network modeling software (ASPIRE) and specifications herein. Use components in the installation that are currently being produced and manufactured (not at 'End of Life') and are no more than two years old.

2.1 FRONT PANEL AND INTERNAL BUTTONS

Provide front panel and internal buttons in accordance of the paragraph titled "System Requirements" of this section.

Ensure the detector provides a LED button interface to control all operations of the ASDS to suit particular applications. Confirm that any alarm/fault condition causes the indicator lamps to flash and remain in this state until reset or acknowledged. Provide an isolate (disable) button or a separate maintenance by-pass switch to isolate each detector for testing purposes.

2.2 DETECTOR DISPLAY AND STATUS INDICATORS

Provide a [3.5" color] LCD touch-screen interface to allow scrolling

through status screens to show/look-up a range of status information, such as overall status, smoke level, flow levels, individual faults, trouble status, AutoLearn smoke/flow functions, alarm thresholds indicators, etc. Ensure that the color LCD touch-screen displays the detector's continuous output of smoke levels per active zone. Ensure that each detector contains a bar graph display feature with bar graph indicators being light-emitting-diodes (LED) or liquid crystal display (LCD).

Ensure the detector provides LED indicators to monitor all operations of the ASDS to suit particular applications. Detector provides an LED user interface with four LEDs to indicate Alert, Action, Fire 1, and Fire 2 alarm events, one fault LED, one disable/standby LED, and power On/Off indication. Ensure all alarm lamps, fault lamp, disable, and power On/Off indicators are visible on the detector front panel. Ensure LED indicators illuminate when their respective activation conditions are met.

Provide a separate detector LED indicator to show normal operating status when the ASDS is functioning as designed. Ensure detector status indicates a fault upon the loss of power, an open circuit or an electrical/electronic problem within the detector's circuitry or external wiring.

Ensure the detector [Alert, Action, Fire 1 and Fire 2][_____] indicators stay illuminated or flashes and a detector configurable relay or separate detector relay operates when the detected smoke is higher than the set alarm thresholds.

Ensure the detector fault indicator flashes and a trouble relay or separate detector failure relay operates when there is a failure/problem (fault categories: detector, chamber, filter, flow, aspirator, network, power, etc.) within the detector's circuitry and/or external wiring.

The detector should support generation and transmission of urgent and minor faults.

Adjust the time delay from zero (0) to sixty (60) seconds for each detector failure indicator lamp/relay. Set detector fault time delay to not more than ten (10) seconds.

[2.2.1 Remote Display Module

Provide a remote ASDS Annunciator Cabinet with LCD remote display module(s) to control, monitor, and report the status of the ASDS. Channel and distribute power and communication for the ASDS from the display module including referencing and chart recording. Ensure smoke level bar graph, alarm level threshold indicators for Alert, Action, and Fire 1, fault icons indicating specific individual faults such as detector, chamber, filter, air flow, aspirator, network, power, flow percentages levels per pipe sections, filter life, etc. are visible on each display module face. Protect all time delays, alarm level adjustments, and testing facilities for detector sensitivity within a secured enclosure to prevent tampering. Provide an override circuit per manufacturer's requirements for fail-safe operation in the event that the programmed alarm threshold is not set or is disabled, or that the fourth alarm threshold automatically defaults to the full-scale smoke level. Provide display module that contain all components necessary to maintain a smoke level history log and a historical event log. Ensure storage capacity for the smoke level history log is a minimum of [40,000] samples. Ensure historical event log is capable of a minimum storage capacity of [100]

events. Ensure display module is capable of retaining this information upon loss of both primary and secondary power sources.

Ensure display module is compatible with ASDS detector.

For single zone or multiple zone applications a unitized, self-contained, single enclosure detector/display can be utilized.

In multiple zone installations, where it is desirable to have a central control point monitoring and controlling the remote detector assembly panels, use a multi-zone display module(s). Provide a remote ASDS Annunciator Cabinet and Interface Equipment appropriately sized based on the number of remote display modules used, with a capacity of up to 200 devices, to report ASDS status to FACP. Obtain authorized network access by utilizing a minimum of two levels of password protection.

Communication Networking wiring should comply with manufacturer recommended wire type and size specifications to meet required communication baud rate. ASDS should detect communications networking interference, open, short circuit, and ground fault.

]2.3 ASDS CONFIGURATION AND PROGRAMMING

Provide latest software (VSC/VSM) revision to configure and program the ASDS.

2.3.1 Alarm Threshold Levels

Provide an ASDS with a minimum of four (4) alarm threshold levels for each zone:

Alarm Level 1 - ALERT

Alarm Level 2 - ACTION

Alarm Level 3 - FIRE 1

Alarm Level 4 - FIRE 2

Ensure programmed alarm thresholds are clearly visible on the face of the display and are adjustable through the full bar graph scale of the display. Provide a visual alarm level indicator that illuminates and/or flashes when the detector output signal reaches the programmed threshold level for the programmed time. Ensure that the visual alarm indicators on the display have circuitry arranged so that they can be manually reset through the reset feature. Ensure that alarm thresholds for each alarm level indicator are independently programmable across its sensitivity range and are set to meet the requirements herein. Setting of alarm threshold level Fire 1 should always appear as 100% on the bar graph scale. Program alarm thresholds to the following values unless the results of the System Acceptance Test procedures, indicate a clear need to change them. In the event that such a need is indicated, notify the Contracting Officer and provide complete documentation concerning the need to deviate from these values. Ensure initial threshold levels are approved prior to the final acceptance test.

Alarm Level 1: set ALERT at 0.0250 percent obs/ft

Alarm Level 2: set ACTION at 0.0500 percent obs/ft

Alarm Level 3: set FIRE 1 at 0.1000 percent obs/ft

Alarm Level 4: set FIRE 2 at 0.2000 percent obs/ft

Ensure the ASDS contains individual adjustable alarm time delays for each alarm threshold levels between 0 to 60 seconds. Program the alarm threshold time delays to 30 seconds for alarm levels 1 and 2, and 15 seconds for alarm level 3 and 4.

2.3.2 Air Flow Levels

Ensure the ASDS continuously monitors the air flow in each pipe. Ensure the color LCD touch-screen displays the flow level percentage for each of the flow sensors in each pipe inlet in use and shows an Air Flow malfunction as a separate fault indication from a trouble indication. Ensure display indicates a trouble condition when the air flow through the detector is insufficient to permit proper operation of the detection system. Use the detector air flow (% of normalized) factory default settings (Major and Minor Highs/Lows) and confirm the final settings based on design considerations and aspirator speed setting using manufacturer pipe network calculation software (ASPIRE).

Ensure the air flow fault threshold setting(s) are adjusted by the factory-trained representative on site and meet site specific conditions. Have a programmable time delay for the air flow fault alarm signal with a range of 0 to 60 seconds for each zone. Program the air flow fault time delay to 10 [_____] seconds unless the results of the system acceptance and commissioning tests, required in this specification, indicate a clear need to change them. In the event that such a need is indicated, provide the Contracting Officer with complete documentation concerning the need to deviate from these values.

2.4 ASDS AND FACP INTERFACE

Provide all contacts, addressable modules, cabinet, hardware, conduit, wire, and power circuits required for proper operation and interface between the ASDS and FACP per 28 31 00.00 98 section.

2.4.1 Alarm Level 1 (Alert)

Configure and program the ASDS so that when ALERT alarm threshold setting is reached for any detector, the alarm level indicator for that detector illuminates and an audible and a visual alarm sound at the display and remote display module, where present. Ensure a supervisory alarm activates at the [FACP][Releasing Control panel (RCP)] and is transmitted to the KSC Central Radio Monitoring Station (CRMS).

2.4.2 Alarm Level 2 (ACTION)

Configure and program the ASDS so that when ACTION alarm threshold setting is reached for any detector, the alarm level indicator for that detector illuminates and an audible and a visual alarm sound at the display and remote display module, where present. Ensure a supervisory alarm activates at the [FACP][RCP] and is transmitted to the KSC Central Radio Monitoring Station (CRMS).

2.4.3 Alarm Level 3 (Fire 1)

Configure and program the ASDS so that when FIRE 1 alarm threshold setting is reached for any detector, the alarm level indicator for that detector illuminates and an audible and a visual alarm sound at the display and remote display module, where present. Ensure a silent alarm activates at the [FACP][RCP], a visual notification appliance(s) and is transmitted to the KSC Central Radio Monitoring Station (CRMS). Activate visual notification appliance(s) in affected areas only

2.4.4 Alarm Level 4 (Fire 2)

Configure and program the ASDS so that when FIRE 2 alarm threshold setting is reached for any detector, the alarm level indicator for that detector illuminates and an audible and a visual alarm sound at the display and remote display module, where present. Ensure an alarm activates at the [FACP][RCP] and is transmitted to the KSC Central Radio Monitoring Station (CRMS). Activate general facility audio and visual notification appliances.

2.4.5 Isolate (disable) Indication

Confirm the ASDS is set-up so that in the event the isolate (disable) button is activated, the appropriate indicator illuminates. Ensure the ASDS activates an isolate alarm at the [FACP][RCP] and is transmitted to the KSC Central Radio Monitoring Station (CRMS).

2.4.6 Trouble Indications

Confirm the ASDS is set-up so that in the event of an air flow fault, or a detector fault; the appropriate air flow fault indicator or detector fault indicator illuminates. Ensure that the ASDS activates two separate trouble alarms at the [FACP][RCP] and transmits separate trouble alarms to the KSC Central Radio Monitoring Station (CRMS).

Coordinate audible trouble signal silencing with AHJ when FACP is located in occupied areas to minimize disturbance to occupants.

2.5 WIRING

Provide copper conductor wiring in accordance with NFPA 70 and NFPA 72. Connect all devices per NFPA 72, with the wire types specified in this section, unless specifically noted otherwise in the paragraph titled "Wiring (Wire and MultiConductor Cable)" of this section. For 120 VAC circuits, use 3.0 mm2 No. 12 AWG minimum.

Ensure all conductors installed on fire alarm systems are solid copper with an insulation rating of not less than 300 volts, permanently marked with the size, voltage rating and manufacturer's name on the conductor jacket at no less than 610 mm 2 feet intervals. Conductor sizes are listed below.

Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system. Conductor AWG diameter and Insulation Type are listed below. Required wire colors are listed in the paragraph titled "Wiring (Wire and Multi-Conductor Cable)" of this section.

Provide solid copper, shielded, twisted pairs, meeting UL 2196

requirements, for conductors in multiplexed communication circuits, signaling line circuits, speaker audio circuits, and remote reporting circuits. Ensure cable is listed as Type FPL, Power-Limited Fire Protective Signaling Cable, with conductor size less than 1.0 mm2 No. 16 AWG diameter for data circuits and 2.0 mm2 No. 14 AWG diameter for audio circuits.

Air sampling detection units are permitted to use 0.8 mm2 No. 18 AWG for connection to addressable modules with maximum conductor length not to exceed 25 feet.

Size power leads from the control panel for product-of-combustion detectors accordingly, but not less than 2.0 mm2 No. 14 AWG diameter, with insulation Type THHN/THWN for 2.0 mm2 No. 14 AWG diameter and larger.

[Ensure all underground circuit wiring meet UL Standards 444 and 13, and TIA 455-82B water infiltration tests.]

2.5.1 Fire Resistive Cables

Provide fire resistive cables for notification appliance circuits designed for use with automatic/manual systems in accordance with UL 2196.

Provide UL Fire Prot Dir listed Type FPL-CI fire alarm cable for use with power limited fire alarm notification appliance circuits. Ensure the CI cable has a minimum 2-hour fire resistance rating by having passed the applicable testing requirements of UL 2196. Install this cable in locations required to meet NFPA 72 survivability requirements.

2.6 ASDS DETECTOR ASSEMBLY

Air is drawn into the ASDS detector via the sampling pipe network by an aspirator, then passes through the filter and it is exposed to the short wavelength LASER light source [and Flair detection technology]within the detection chamber. Imaging and Light scattered smoke particles is measured by photodiodes and analyzed and converted to an electronic signal directly proportional to the obscuration level within the chamber. A signal corresponding to the obscuration level within the chamber is then transmitted to the ASDS display.

Provide a detector consisting of: cabling and pipe inlet and outlet ports, quick connector socket (screw terminals) interfacing, chamber assembly, filter, aspirator, flow sensing module, sensing module, and display. Detector should be modular type to allow field replacement of the filter, changer, and aspirator.

Provide a[VEP-A10-P model or approve equal] ASDS detector to contain all of the equipment, devices, and pipe network required for protection of [IT Communication room(s)],

When the floor area to be protected exceeds the maximum allowable coverage of that specific detector, use multiple detectors.

Submit manufacturer data indicating sensitivity range. The manufacturer recommends the detector sensitivity for the area to be protected by zone/application.

Provide a high-efficiency aspirator, electric centrifugal-flow impeller air pump designed for long life. Ensure the aspirator flow and pressure

ratings meet the maximum transport time for an air sample removed from the furthest sampling point (open or capillary tube holes) of each branch within the pipe network. Provide a detector equipped with a sensing device(s) which detects any change in the air flow through the detector which could impair the proper operation of the detector. Include four sample pipe inlets containing a flow sensor for each pipe inlet.

Ensure the detector is usable in environments with relatively high levels of airborne dust and other contaminants through the use of a filter or other approved method. Treatment of contaminants is by either an air filtration mechanism or by electronic discrimination of particle size. If a mechanical filtering system is used, provide a disposable filter cartridge to permit visual inspection of the filter without having to dismantle the detector. Ensure an indication is shown on display for replacement. Confirm the first stage filter has a maximum nominal pore size of 20 microns[with a second stage filter for ultra-fine 0.3 microns] or larger.

2.7 PIPE NETWORK

Design and install the sampling pipe network to monitor total room/zone concentration of smoke. Accomplish the design using a computer program based on sound fluid dynamic principles and is approved by Factory Mutual Engineering (FM) FM APP GUIDE or listed by Underwriters Laboratories (UL) UL Fire Prot Dir for its intended use. Pipe Network design, including sampling point size and quantity, should be developed and accepted by manufacturer Windows-based Pipe Network Design software (ASPIRE).

2.7.1 Sampling Pipe

Provide sampling pipe consisting of 19 millimeter smooth bore, 3/4-inch inside diameter, orange color, Chlorinated Poly(Vinyl Chloride) (CPVC) schedule 40. Pipe and fittings as defined in this section, are limited to thermoplastic materials meeting or exceeding the requirements of ASTM F442/F442M, ASTM F438, and ASTM D1784 or an approved equal. Ensure the CPVC pipe is the slip-joint solvent-weld type and fittings unthreaded solid CPVC. Joints should be bonded using appropriate solvent cement, ASTM F493, ASTM D2564. Use recommended manufacturer solvent cement. Accomplish directional changes in the pipe network by using bends and elbows. All sampling pipes should be fitted with end caps. Use socket fittings for final connection to the detector, and where pipe network removal is required for maintenance of equipment, glue is not permitted. Ensure pipe and fittings are air tight and installation conforms to NEMA TC 3.

[In areas subject to condensation build up within the sampling pipe, employ a water trap to prevent moisture from entering the detector.]

2.7.2 Sampling Points

The sampling pipe network is engineered for a maximum transport time of [60] [120] seconds, and has equal sensitivity throughout the entire system. Balance the air sampling pipe network so that the volume of air drawn from the last sampling point is not less than 70 percent of the volume from the first sampling point.

Ensure each sampling point has a maximum coverage of 23.2 square meter 250 sq ft of floor area for above ceiling, ceiling, and underfloor protection. Sampling points should not be separated by more than the

NFPA 72 maximum allowable distance of 30 feet. Comply with NFPA 75 sampling point maximum coverage for return grille applications.

2.7.2.1 Capillary Sampling Points

Capillary sampling points should terminate at an approved ceiling sampling point, approved by the manufacturer, connected by means of a capillary tube with 3/8" internal diameter and maximum length of 26 feet.

2.7.3 Labeling

Label all sampling pipe and sampling points as follows: "CAUTION SMOKE DETECTION SAMPLING PIPE DO NOT DISTURB" and "FIRE DETECTION SYSTEM" respectively.

2.8 PRIMARY POWER SUPPLY

The normal power for the ASDS detector is 120 V AC, 60 hertz. Ensure ASDS operates satisfactorily between 85 and 110 percent of normal voltage. Provide an ASDS disconnect/protective device as a fused switch with a red factory finish. Mount this disconnect switch adjacent to the ASDS. Mark as "AIR SAMPLING DETECTION SYSTEM # (indicate detector number) FED FROM (indicate supply circuit)" with a permanently affixed label that is plastic or phenolic type with a red background and white lettering using a minimum of 6 millimeter 0.25-inch block. Provide an installed switch capable of being locked in the "ON" or "OFF" position. This feature is not to interfere with the circuit protection capability of the device. Equip switch with surge suppression for all phase and neutral conductors. Install current limiting Class RK1 fuses properly sized to protect the ASDS equipment.

When power is supplied from a single 20-amp circuit breaker, provide an adjustable set screw type clamping device, red factory finish, over the circuit breaker handle to prevent handle operation.

2.9 SURGE SUPPRESSORS

Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel components.

Install surge suppression in accordance with UL 497B on each conductor of fire alarm circuits which extend beyond a building. Locate protection as close as practical to the point where the circuits leave the building. Install protectors in surge suppression cabinets of adequate size with terminal strips for all wiring connections plus 25 percent spare. Paint enclosures with a prime coat and one or more coats of red baked enamel finish to provide a smooth, hard, and durable finish. Where installed outdoors, provide stainless steel NEMA 4X rated cabinets. Provide a copper ground bus inside the cabinet and connect protectors to an earth ground electrode system in accordance with the manufacturer's requirements and NFPA 70. Ensure an etched metal or engraved laminated plastic identification plate labeled, "Fire Alarm Cabinet", is affixed to the cabinet door of the alarm control unit to identify the cabinet as a fire alarm cabinet. For cabinets painted black, ensure the identification plate has white letters on a black background, and for cabinets not painted red, the identification plate has white letters on a red background.

2.9.1 Line Voltage Surge Suppressors

Provide suppressor UL 1449 listed with a maximum 330-volt clamping level and a maximum response time of 5 nanoseconds, and also meets IEEE C62.41, category B tests for surge capacity. Ensure suppressor is a multi-stage construction type which includes inductors and silicon avalanche zener diodes. Provide suppressor which has a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components, with externally accessible fuses. Wire in series with the incoming power source to the protected equipment using screw terminations.

2.9.2 Low Voltage Surge Suppressors

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two or more buildings, provide suppressors at the circuit entrance to each building. Ensure suppressor is UL 497B listed, with a maximum 30-volt clamping level and a maximum response time of five nanoseconds, with multi-stage construction and both differential/common mode protection.

2.10 SECONDARY POWER SUPPLY

Provide a power supply-battery charger, UL 1481, as a means of automatically supplying the entire ASDS with backup power in the event the primary power system fails. In the event of AC power failure, the system switches to battery backup power and switches back to AC power upon return of primary power. If the backup batteries are removed for any reason, the ASDS detector continues operation. The system controls charging and floating level to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Use fused wiring to protect against battery over-current and polarity reversal. Primary power, battery, or charging equipment failure results in a trouble signal and visual indication at the ASDS display, transmitted to the FACP and the KSC Central Radio Monitoring System (CRMS).

Provide spill proof sealed battery modules, (no corrosive fumes). Use batteries that are listed for fire alarm service and suitable for high discharge currents required under alarm conditions. Size batteries to operate the ASDS in normal supervisory condition for 24 hours, minimum, then operate the system in the alarm mode for 10 minutes, minimum.

Provide a battery disconnect switch with DC rated contacts to allow testing for loss of secondary power supply.

2.10.1 Grounding

Design equipment allowing for low-impedance bond to the protective grounding system. Ensure equipment functions in an environment which supplies only a safety ground per NFPA 70. Isolate cabinet and equipment ground from battery return at the equipment and within the frame or cabinet.

PART 3 EXECUTION

3.1 INSTALLATION

Prior to performing any installation or modification work to existing ASDS, secure a Transfer of Responsibility Form completed by the COTR and signed by the Contractor and Institutional Services Contractor (ISC) Fire

Protective Systems designee. The completed form will be turned over to the Contracting Officer by the COTR. Permanently affix a copy of the completed "Transfer of Responsibility" Form to the affected FACP throughout the construction period.

Install all equipment in accordance with manufacturer's recommendations, and this document.

3.1.1 ASDS Detector

Securely mount the smoke detector to the building structure (i.e. column, permanent wall) using approved type anchors. Determine the mounted detector's orientation by the application (normal/inverted mounting). Maintain total access for servicing of the detector. Install equipment in accessible locations in such a manner as to prevent damage from vibration or jarring. Equipment requires a minimum of 914 millimeter 3 feet clearance directly in front of the detector for maintenance per NFPA 70. With multiple equipment, the three-foot clearance is required directly in front of the complete configuration. In addition, provide a 711 millimeter minimum 28-inch clear aisle way for access to the equipment. Provide cabinets with a hinged cover and an integral pin-tumbler cylinder lock (mortise or standard rim cylinder from Best Access Systems) with removable core that accepts the key presently in use with other control units existing in the area. Lock core will be provided by the government. Prior to installation, obtain approval from the Contracting Officer for mounting of the detector to other equipment/structure other than the building structure.

3.1.2 Sampling Pipe Network

Optional open or closed end system, per manufacturer's approved computer modeling design program can be used. Do not exceed 91.5 millimeter maximum single detector pipe length or maximum branch detector pipe total length for piping runs. Support all pipe network from the building structure only. Support all piping at approximately 5 feet maximum intervals on center with bracing for end of pipe run not to exceed 1 feet. Provide fasteners, pipe hangers and supports of appropriate dimensional size for supporting piping without distortion. Obtain Contracting Office approval for alternate means of support such as from cable trays, raceways, duct work, etc. prior to installation. Mount all piping which is adjacent to the detector tight against the wall or other structural elements which the detector is mounted on, and terminate within 457 millimeter 20 inches of the detector inlet ports. Connect piping to the detector by a socket union with a 457 millimeter 20-inch CPVC nipple of the same ID as the pipe network, to facilitate maintenance. Clean sampling pipe network inside and out. Join using manufacturer's approved solvent cement for air tight connections except at the detector enclosure connections for servicing. For safe handling of solvent cements used for joining thermoplastic pipe and fittings refer to ASTM F493, ASTM D2564. Ensure installation of pipe network is airtight.

3.1.2.1 Sampling Points

All sampling points should be identified. Ensure the size and spacing between sampling points is as per design calculations. Where sampling pipe is installed above suspended ceiling, center the sampling point fitting in the ceiling tiles and connect to the main sampling pipe using approved capillary tube. Locate sampling points so that they are clear of all supply air registers and/or air flows.

3.1.3 Spare Parts

Provide spare parts directly interchangeable with the corresponding components of the installed system. Ensure spare parts are suitably packaged and identified by nameplate, stamping, or tagging. Furnish the following:

a. Two filter assemblies

b. [_____]

3.1.4 Wiring (Wire and Multi-Conductor Cable)

Provide wiring conforming to the requirements of NFPA 70 and NFPA 72 and the following special requirements:

a. Install ASDS circuits in a separate raceway system. Route each circuit type (Initiating, Notification, Signaling, and Control) through a dedicated separate conduit or raceway system configured to comply with NFPA 72 Class A conduit system requirements. Do not allow 60-Hertz power circuits to enter enclosures containing fire alarm circuits except where required to connect to the ASDS.

b. Provide continuous conductors from a terminal point at one device to a terminal point at the next device and from a device to the FACP. Break wires at each terminal; do not loop wires over a terminal. Terminate approved explosion proof devices, provided with pigtail wiring connection leads, on a field installed terminal strip installed in the box on which the device is mounted. Install solderless ring tongue terminal lugs with manufacturer's required tooling on the device wiring connection leads. Use this ring type lug on stranded wire only. Terminate solid wire on compression or screw type terminals. When screw type terminals are used, capture the conductor under 80 percent of the screw head surface. Identify all circuit conductors within each enclosure where a tap, splice, or termination is made. Provide conductor identification by heat-shrink-type sleeves or other approved method. Use point destination type conductor labels to indicate cabinet, circuit board, terminal block and screw terminal location for each individual conductor.

c. Provide conductor colors as listed below and in accordance with FED-STD-595. Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system.

d. Mark conductors for multiplexed communication circuits, speaker audio circuits, and remote station signaling circuits with circuit designation, and maintain consistent color-coding for the positive and negative loops throughout the cable system.

e. Install direct current initiating device circuits (heat detectors, manual pull station) as Class A, parallel-wired circuits per NFPA 72. Ensure the positive loop conductor is colored blue, Color No. 15102, and the negative loop conductor is colored black, Color No. 17038.

f. Install power leads from the control panel for product-of-combustion detectors as Class A, parallel-wired circuits per NFPA 72. Ensure the positive conductor is be colored Red, Color No. 11105, and the

negative conductor is colored black, Color No. 17038.

g. Use approved manufacturer communications networking wiring, UL 497, UL 497B.

3.1.4.1 60-Hertz Power

Provide 120 volt, 60-hertz power to the ASDS. Provide one black phase conductor, one white solidly grounded neutral conductor and one green equipment grounding conductor. Provide conductor size as shown on the drawing with the minimum size No. 12 AWG copper. Install surge arresters in accordance with NFPA 70, UL 497B and UL 1449.

3.1.4.2 Installation In Cabinets and Boxes

Install wiring in control cabinets and boxes in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Provide continuous control wiring from device to device with no splices unless otherwise indicated. Permanently mark all wires entering or leaving control cabinets, boxes, and devices and terminate on screw terminals. Ensure marking is consistent throughout the fire alarm system and is the same as the identification shown on the connection drawings.

Ensure wire labels correspond to the approved connection drawings and use a method indicating the destination of the other end of the wire. Provide labels in control panel equipment or between fire alarm terminal cabinets which indicate the destination of the other end by cabinet designation-terminal strip designation-terminal number. Provide labels in fire alarm terminal cabinets indicating connection in control panel equipment by fire alarm cabinet designation-module identifier-module terminal strip identifier-terminal number. Provide conductor labels with legible machine-printed black lettering on white background using indelible ink. Ensure labels are heat shrink or wrap around type.

3.1.5 Conduit and Raceways

Minimum size for fire alarm system initiating, notification, signaling line and control circuit conduits and raceways is 12 mm 3/4-inch. Install in accordance with NFPA 70. Ensure all Class A initiating device, signaling line, notification appliance and control circuits use diverse routing in accordance with NFPA 72. Do not run outgoing and return redundant circuit conductors in the same cable assembly, enclosure or raceway except where permitted by NFPA 72.

Install rigid galvanized steel conduit in all hazardous (classified) locations, exterior locations where the conduit is exposed above grade, interior exposed locations from finished floor to 304 mm 1 foot above finished ceiling unless otherwise shown on the drawings. EMT with hexnut expansion gland-type fittings can be installed in all other locations. Use flexible metal conduit, maximum length 1828 mm 6 feet, as the final connecting raceway to a fire alarm device mounted on vibrating equipment or on a suspended ceiling.

Where devices, junction boxes, and cabinets are installed outdoors, arrange conduit systems to drain away from the box; ensure conduit enters the box side or bottom only and drain type fittings are installed.

Use schedule 80 PVC for conduit direct buried in earth. Ensure that

portions of underground raceway systems that penetrate above finished grade are rigid, galvanized, heavy-wall steel conduit with a 40-mil PVC coating or painted with a bitumastic compound.

Conceal all conduit in interior finished areas. Ensure conduit installed in a vertical position is parallel with walls and perpendicular with the floor and ceiling, and that conduit installed in a horizontal position is parallel with the floor and ceiling and perpendicular to the walls. Make changes in direction of runs with symmetrical bends. For bends of over 25 mm 1-inch in diameter, provide factory made elbows.

3.1.6 Firestopping

Seal all fire rated pipe network penetrations of floors, ceilings and walls. Fire-stop UL Fire Resistance all sampling pipe passing through fire-resistant rated walls, floors, ceilings, in a manner that maintains the integrity of the fire-resistant rating of the wall, floor or ceiling. Weather seal all pipe penetrations passing through non-fire rated wall/equipment enclosure.

3.1.7 Labeling

Provide red background with white lettering smoke detector labels that are plastic or phenolic type with a minimum of 6 millimeter 0.25-inch block lettering to indicate zone detector. For example: "ASDS No. 1".

Clearly label pipe network every 1.5 meter 5 feet to distinguish the pipe from other facility pipe work or protective cabling enclosures. For example: "CAUTION SMOKE DETECTION SAMPLING TUBE DO NOT REMOVE, PAINT, OR DISTURB."

Label all air sampling points with a round red label, each with a center hole to match the diameter of the drilled sampling point. For example: "FIRE DETECTION SYSTEM DO NOT PAINT". Indicate fractional dimensions in decimal format with a minimum of 3[_____] decimal places.

3.2 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, conduct tests to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. Perform the Tests covered in the following paragraphs in three parts:

a. Contractor Checkout - Perform this test to remove all troubles, ground faults, ensure all devices are fully functional and operational, and test the programming to ensure the installation meets the contract drawings and specifications, including reporting.

****
NOTE: Delete the following requirement if the installation is for a new fire alarm system
****

For modification and rehabilitation work, the Contractor is not responsible for existing troubles and ground faults that are not in contract scope. Clearly convey the existing troubles and ground faults that are not in contract scope in the Transfer of

Responsibility form. Submit a draft of NFPA 72 Fire Alarm System Record of Completion.

b. Preliminary - Perform this test using the approved test procedure and witnessed by the Government construction inspectors. Verify ASDS drawings against the system installed, annotate all red-lines, and summarize on a single set of drawings. Follow the test procedures as written and annotate all red-lines on a single Test Procedure. Secure the initials and date on the summarized set of drawings and test procedures from the construction inspector and the fire alarm vendor. The Preliminary test is not considered complete until all steps in the test procedure have been satisfactorily completed. This includes any additional steps required to complete 100 percent testing of the fire alarm system and its associated functionality.

c. Final Acceptance - After the successful completion of the preliminary test, schedule a Final Acceptance test. Incorporate the final acceptance test procedure and record drawings including all red lines from the preliminary test. Provide a copy of the consolidated redlines for the record drawings and preliminary test procedures from the preliminary test. Ensure the Contracting Officer, System Engineer, and the Authority Having Jurisdiction or their designee(s) witness the final acceptance test for the ASDS. Prior to test start, on-site, conduct a line by line review that proves all issues found during the preliminary test have been incorporated. During the Final Acceptance Test, provide five corrected as-built drawings and Final Acceptance Test Procedures for use in conducting the final acceptance test. Upon completion of the Final Acceptance Test, provide the following documentation to the Contracting Officer; a copy of the Final Acceptance Test procedure (with all steps annotated as complete), a corrected set of as-built drawings and a signed and completed NFPA 72 Fire Alarm System Record of Completion form.

3.2.1 External System Wiring

Perform the following tests on the external system wiring before connection to the control panel:

Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. Ensure that the tests are witnessed by the Contracting Officer and that test results are recorded for use at the Final Acceptance Test.

Megger Tests: After wiring has been installed, and connections to panels or devices, megger test wiring for insulation resistance, grounds, and/or shorts. Test conductors with 300 volt rated insulation at a minimum of 250 V dc. Ensure that the tests are witnessed by the Contracting Officer and that the test results are recorded for use at the Final Acceptance Test.

Check continuity of circuits with an ohmmeter. Insert temporary jumpers in appropriate sockets of missing detectors and install the end-of line resistor when this test is performed. Verify resistance reading for each circuit is the value of the end-of-line resistor, plus or minus 10 percent.

Check each wire for grounds with 300-volt and 500-volt insulation resistance test set. Ensure resistance to ground is not less than 20

megohms. Isolate each wire tested from ground, with all other wires within the same conduit grounded. Verify that the conduit system is grounded prior to insulation resistance testing by verifying a short circuit between the conduit and earth ground.

Submit Continuity Test Report and Insulation Resistance Test Report.

3.2.2 ASDS Acceptance Test Procedures

Subject each zone of every ASDS to a full operational test in the presence of the Contracting Officer to demonstrate proper operation before any system is considered acceptable. Acceptance criteria for ASDS include the measurements and tests for each detector and its entire sampling pipe network. The approved operational test procedure submitted by the subcontractor for the ASDS includes the following tests:

3.2.2.1 Suction Pressure Test

Measure, record, and compare pressure at all sampling points, except the end cap port to APPROVED Design Calculations. Verify the suction pressure is within the manufacturer's specified range. Measure the pressure in inches of water or pascals.

3.2.2.2 Smoke Transport Time Test

Measure and record the time required for smoke to travel from the most remote sampling point in each air sampling piping network to the detector, and compared to APPROVED Design Calculations. Determine this TIME on each branch line individually by introducing a "gross" smoke source into the sampling point which is hydraulically most remote from the detector. The TIME from the beginning of smoke introduction until the bar-graph on the display reflects the presence of smoke in the detector is the Transport Time. The MAXIMUM ALLOWABLE Transport Time is [60] [120] seconds.

3.2.2.3 Deviations

If the measured and recorded results significantly differ from the measurement predicted by the APPROVED Design Calculations, determine and correct the cause of deviation. If the cause is a difference between the system as built and the system as designed, resubmit revised shop drawings and calculations for approval to the Contracting Officer. If the revised drawings and calculations agree with measured results, the system is considered acceptable provided that all other provisions of this specification have been met.

[3.2.2.4 Sensitivity Verification Test

This test is a month long (30 day minimum) test for all detection system installations. Each air sampling piping network by zone is subjected to this test before the system is considered acceptable. The purpose of this test is to ensure that the earliest possible alarm for smoke is rendered with the fewest number of false alarms. This is considered mandatory due to the fact that the ambient levels of dust or other air borne particulate which the detector senses as smoke varies from building to building or room to room within a given building or area.

a. Implement proper test procedures and data analysis to eliminate all false alarms from transient dust or smoke which can become airborne due to installation activity, cleaning and/or normal operations.

b. During the period while the sensitivity verification test is being conducted, ensure normal operations continue unaltered within the area being protected. Verify that the FACP monitors the ASDS. The FACP is to only transmit supervisory and trouble conditions to the KSC Central Radio Monitoring Station (CRMS). During this trial period, a successful test has the ASDS not activate any automatic suppression systems or cause a facility evacuation.

c. After the ASDS has been installed and all acceptance tests successfully conducted, maintain the event log and the smoke level history log for a period of not less than (30) calendar days.

d. Conduct data review and analysis after (7) calendar days of operation to identify any gross trends, and again at the end of (30) calendar days of operation. Additional interim analysis can be required depending on the results of the first week review.

e. During data review and analysis consider the normal base line, or ambient, pollutant level recorded, and all deviations from the established base line as recorded by the data logger from the detector.

(1) Compare the level of the ambient base line with the alarm threshold levels selected. Twenty percent is the minimum acceptable range between the ambient base line and the first alarm threshold of the detector's full-scale sensitivity calibration setting.

(2) Investigate each peak recorded to determine its cause. Analyze and consider whether the peak recurrence is at regular intervals, or whether it is a single event. Recurring peaks are usually related to activities within the protected area. Non-recurring peaks are generally the results of other types of activities, including fires. Consideration of normal activity within the fire zone, the time of day, and day of the week can be of assistance in determining the cause of a peak.

(3) Compare the magnitude and duration of the recorded peaks to the alarm threshold levels selected and initial time delay settings to determine the possible occurrence of a false alarm.

(4) Based on the data review, make adjustments to alarm levels and time delay settings, as required to eliminate false alarms.

(5) Peaks or alarms that are attributed to smoking in the protected area ARE NOT considered to be false alarms. Specifically configure the ASDS to alarm when smoking takes place within the protected area.

(6) Change detector sensitivity if data indicates that the adjustments to the alarm threshold levels and the time delay settings do not eliminate false alarms. If the false alarms cannot be eliminated, provide alternative solutions to the Contracting Officer for approval and implementation.

Fully document any change to the initial settings as prescribed by this specification with supportive analysis and review data and submitted by the manufacturers to the Contracting Officer for approval.

][3.2.2.5 Smoke Test

Provide all required testing tools, equipment, materials to complete all tests of the ASDS.

Introduce smoke at the furthest sampling point and demonstrate transport time meets requirements herein, and as specified by manufacturer pipe network design software (ASPIRE).

Perform smoke test in the vicinity of possible fires. For example: at equipment heights 1 to 1.5 meter 3 to 5 feet above the finished floor. Repeat the test in different locations within each protected zone under normal and abnormal operating conditions of the HVAC system. This ensures that the smoke source in both a high and still air flow environment have been addressed.

]3.3 Reacceptance System Tests

Perform reacceptance testing after system components are added or deleted; after any modification, repair, or adjustment to system hardware or wiring; or after any change to software. Test all components, circuits, systems operations, or site specific software functions known to be affected by the change or identified by a means that indicates the system operational changes are 100 percent tested. In addition, also test 10 percent of the initiating devices (maximum of 50 devices) that are not directly affected by the change and verify proper system operation.

Changes to all control units connected or controlled by the system executive software require a 10 percent functional test of the system, including a test of at least one device on each input and output circuit to verify proper system operation.

Upon completion of the modification, functionally test the existing devices that were reinstalled and test the devices that are on both sides of the point of connection of the new devices. Test all newly installed devices in accordance with the paragraph titled, "ASDS Acceptance Test Procedures" of this section.

After final acceptance testing has been successfully completed, submit test data under the terms of the "GENERAL REQUIREMENTS" clause of this contract.

3.4 PAINTING

Paint all ASDS conduit fittings, junction boxes, and junction box covers red, Color No. 11105 in accordance with FED-STD-595. Mark conduit with a minimum 2.54 cm 1-inch wide band every 6.1 m 20 feet. Alternative compliant method is to use red-colored EMT conduit that is hot-galvanized for durability with a red top coat. If the alternative method is selected, none of the conduit fittings, junction boxes, or junction box covers are required to be painted.

-- End of Section --