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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 F 402 (2005) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

ASTM F 442/F 442M (1999; R 2005e1) Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)

FM GLOBAL (FM)

FM P7825 (2009) Approval Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 3 (2004) Standard for Polyvinyl Chloride PVC Fittings for Use With Rigid PVC Conduit and Tubing

NEMA TC 13 (2005) Standard for Electrical Nonmetallic Tubing (ENT)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2009) Life Safety Code, 2009 Edition

NFPA 318 (2002) Protection of Cleanrooms

NFPA 70 (2008; AMD 1 2008) National Electrical Code - 2008 Edition

NFPA 72 (2006; Errata 2008; Errata 2009) National Fire Alarm Code

NFPA 75 (2009) Protection of Information Technology Equipment

NFPA 90A (2008; Errata 2009) Standard for the Installation of Air Conditioning and Ventilating Systems

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1016-2 (2007) Program Detail Manual Fire Alarm Systems, 8th Edition

UNDERWRITERS LABORATORIES (UL)

UL 1449 (2006; Rev thru Jun 2009) Surge Protective Devices

UL 497B	(2004; Rev thru Oct 2008) Protectors for Data Communication and Fire Alarm Circuits
UL 651	(2005; Rev thru May 2007) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings
UL Fire Prot Dir	(2009) Fire Protection Equipment 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 to reflect only the submittals required for the project. Keep submittals to the minimum required for adequate quality control.

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.

For submittals requiring Government approval on Army projects, use a code of up to three characters within the submittal tags following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

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

SD-01 Preconstruction Submittals

Submit evidence of the Contractor's State Certification to the Contracting Officer for approval prior to any work being started on the Fire Alarm System.

Submit fully verified and dated copies of all test data and results with a copy of the approved test procedure and any factory test information.

Provide two copies of the test procedures and recording forms for the preliminary tests. For the final acceptance tests, provide 10 copies of the test procedures and recording forms.

#### SD-02 Shop Drawings

Submit the following for air sampling detection systems in accordance with the paragraph entitled, "General Requirements," of this section.

##### Connection Drawings Schematics

Submit [As-Built Drawings](#) for approval 14 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "Field Testing" of this specification section. Provide magnetic media and hard copies of all new and revised software and drawings with the submittal. As-Built drawings must document final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

Provide intergraph compatible (DXF or DWG Format) computer generated floor plan layouts indicating location of monitoring facility fire alarm control panel [preaction control panel], air sampling piping (lengths of pipe) and sampling ports (sizes and locations). Floor plan must also indicate geographic monitor zone boundaries, location of display control panel and bar level annunciator panels if separate and all other associated equipment that is required to provide a complete operational system.

#### SD-03 Product Data

Submit manufacturer's catalog data and [Display Control Panel](#) for the following items:

- [Detector Assembly](#)
- [Aspirating Fan](#)
- [Power Supply](#)
- [Filter](#)
- [Piping Materials](#)
- [Pipe Hangers and Supports](#)
- [Batteries and Charger](#)
- [Software and Programming](#)
- [Interface Equipment for Reporting and Monitoring](#)

#### SD-05 Design Data

Submit Design Analysis and Calculations for the Air Sampling Detection Systems consisting of the battery capacity, loading calculations, and fan speed and air flow/transport calculations with schematic diagrams showing pipe segments, pipe diameters, lengths of pipe, node numbers, sample port diameters to verify the requirements are met.

Submit [List of Parts and Components](#) for air sampling detection systems in accordance with the paragraph entitled, "System Requirements," of this section.

List of parts and components for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

#### SD-07 Certificates

Submit Quality Assurance Plan consisting of the following:

Prepare a test procedure and test record forms for conducting and recording complete tests on control panels, wiring systems, and air sampling piping networks installed in accordance with the manufacturer's requirements and these specifications. Submit for approval the test procedure to the Contracting Officer at least 30 days prior to the preliminary system test described in the paragraph entitled "[Field Testing](#)" of this specification section. The test procedure must identify each device, circuit, piping network, and sampling port to be tested, describe the initial condition, each step or function in the test, required test results annotating acceptable ranges and actual values, and submit manufacturer's specifications for all test equipment to be used. Provide test forms with suitable spaces for recording test results on all equipment, devices, wiring and sampling ports. The test record forms also have identified spaces for verification signatures of official witnesses and dates of the tests.

Submit proof that all components are currently Underwriter Laboratory (UL) listed [UL Fire Prot Dir](#) or Factory Mutual (FM) [FM P7825](#) approved for their intended use and function.

#### SD-10 Operation and Maintenance Data

Submit [Operation and Maintenance Manuals](#) for Air Sampling Detection Systems. Information bound in manual format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to any acceptance tests being performed.

### 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.

Submit [Connection Drawings](#) for approval for Air Sampling Smoke Detection Systems.

Connection Drawings must consist of point-to-point wiring diagrams of internal and external wiring including, but not limited to, all smoke detection devices, and panel wiring. Point-to-point wiring is defined as wiring from device with integral terminal strip to next device with integral terminal strip, wiring between modules internal to control panels, circuit termination's on terminal strips in control panels, and terminal

boxes with integral terminal strips.

Submit intergraph compatible (DXF or DWG Format) computer generated Connection Drawings.

Submit [Schematics](#) for approval for each Air Sampling Smoke Detection Systems consisting of the following:

Module schematic drawings (minimum size 11 inches by 17 inches) to be provided prior to system acceptance testing.

Program logic and/or ladder logic diagrams that show interaction of system components.

Components used in the installation must be no more than two (2) years old.

Submit [As-built drawings](#) for approval 21 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "Formal Tests and Inspections," of this specification. Provide two (2) sets of magnetic media and hard copies of all new and revised software and drawings with the submittal. As-built drawings must document final system configuration including deviations from the amendments to the drawings, and field installation changes, concealed and visible.

#### 1.4 SYSTEM REQUIREMENTS

Submit [List of Parts and Components](#) for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

The air sampling detection system(s) must be a VESDA LaserPlus or equal containing all of the equipment, devices, [software and programming](#), and piping networks required for system operation in accordance with NFPA Codes and KSC requirements, including communication, [interface equipment for reporting and monitoring](#) to the Central Fire Monitoring Station (CFMS) via the facility fire alarm control panel (FACP), which monitors the Preaction Control Panel (PCP). The Air Sampling system(s) circuits must be [NFPA 72 Class A Style D](#) initiating device circuits and [NFPA 72 Class A Style 7](#) signaling line circuits. Initiating and signaling line circuits must be 24 Vdc. System must conform to all the applicable requirements of [NFPA 70](#), [NFPA 72](#), [NFPA 75](#), [NFPA 90A](#), [NFPA 101](#), and [NFPA 318](#).

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

#### 1.5 QUALITY ASSURANCE

Equipment to be provided under this specification must be that manufactured fire-alarm equipment which meets the requirements of the section entitled, "System Requirements." It must be the latest standard design, and must be listed by Underwriters' Laboratories ([UL Fire Prot Dir](#)) or approved by Factory Mutual [FM P7825](#) for its intended use. All devices installed must function with the display control panel and not interfere with the operation of the control panel.

#### 1.6 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

Services of a Certified Specialist thoroughly experienced in installation of Air sampling detection systems and fire alarm system work must be

provided on site to perform or directly supervise the installation, make all necessary adjustments, and perform all tests on the Air Sampling smoke detection system at the site.

The specialist is considered certified when the specialist holds a valid Fire Alarm System, Level III Certification from the National Institute for Certification in Engineering Technologies, or a valid Level III Fire Alarm Engineering Technician Certification from the International Municipal Signal Association (IMSA) or is licensed by the State of Florida as a Fire Alarm Contractor I in accordance with Florida State Statute, Chapter 489, Part II.

Submit evidence of the [Contractor's State Certification](#).

Certification of other recognized agencies with equivalent requirements will be considered. Provide evidence of the equivalent certification and the basis of certification to the Contracting Officer for approval by the Contracting Officer prior to any work being performed at Kennedy Space Center. Contractor submitted certification requirements must be in accordance with [NICET 1016-2](#).

## PART 2 PRODUCTS

### 2.1 DISPLAY CONTROL PANEL

The display control panel must be offered in various configurations to control and monitor all operations of the detector assembly and aspiration system to suit particular applications. All power and communication for the air sampling smoke detection system must be channeled and distributed from the display control panel including referencing and chart recording. All alarm lamps, trouble lamps, and alarm level threshold set-points, must be visible on the panel face. Protect all time delays, alarm level adjustments, and testing facilities for detector sensitivity within a secured enclosure to prevent tampering. An override circuit per manufacturer's requirements must provide fail-safe operation in the event that the programmed alarm threshold is not set or is disabled, the fourth alarm threshold automatically defaults to the full-scale smoke level. The display control panel must maintain a smoke level history log and a historical event log. The storage capacity for the smoke level history log must be a minimum of 40,000 samples. The historical event log must have a minimum storage capacity of 100 events. The display control panel must be capable of retaining this information upon loss of both primary and secondary power sources.

For single zone or multiple zone applications a unitized, self-contained, single enclosure detector/display control panel 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 control panel. The display control panel must be appropriately sized depending on the number of remote detectors used.

### 2.2 DISPLAY CONTROL PANEL STATUS INDICATIONS

The display control panel must display the detector's continuous output of smoke levels per active zone; in a minimum 10 percent increments of full scale. Each controller must include a bar graph display feature with bar graph indicators being light-emitting-diodes (LED) or liquid crystal

display(LCD) .

### 2.2.1 Alarm Threshold

Provide the display control panel 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

Programmed alarm thresholds must be clearly visible on the face of the display control panel, and must be adjustable through the full bar graph scale of the display control panel. The visual alarm level indicator must illuminate and/or flash when the detector output signal reaches the programmed threshold level for the programmed time. The visual alarm indicators on the display control panel must have circuitry arranged so that they must be manually reset through the display control panel reset feature. Program alarm thresholds to the following values unless the results of the System Acceptance Tests, required by this specification, indicate a clear need to change them. In the event that such a need is indicated, the Contracting Officer must be notified, and provided with complete documentation concerning the need to deviate from these values. The deviation documentation must include information that complies with the paragraph entitled, "Sensitivity Verification Test". The initial threshold levels must be approved prior to the final acceptance test.

Alarm Level 1: set ALERT at 0.0250 percent obsc./foot

Alarm Level 2: set ACTION at 0.0500 percent obsc./millimeter/ foot

Alarm Level 3: set FIRE 1 at 0.1000 percent obsc./foot

Alarm Level 4: set FIRE 2 at 0.2000 percent obsc./foot

The display control panel must contain individual adjustable alarm time delay features for each of the alarm threshold levels. The range of adjustment must be 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.

### 2.2.2 Air Flow Status Indicators

The display control panel must receive signals from the detector air flow sensor and must continuously display the status of the air flow through the detector. The display control panel must indicate a trouble condition when the air flow through the detector is insufficient to permit proper operation of the detection system. The initial setting must be set at the factory and the final setting must be selected based on the system configuration to be 10 percent reduction in air flow through the detector assembly. The display control panel must transmit a trouble signal to Central Fire Monitoring Station for KSC via the facility fire alarm system from the preaction control panel.

The air flow fault threshold setting(s) must be adjustable by the manufacturer's on site representative to meet site specific conditions. The air flow fault alarm signal must have a programmable time delay with a range of 0 to 60 seconds for each zone. Program the air flow fault time

delay to the following value 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, the Contracting Officer must be notified, and provided with complete documentation concerning the need to deviate from these values. Set the time delay at ten seconds.

### 2.3 DETECTOR STATUS INDICATORS

A separate detector lamp must indicate normal operating status when the system is functioning as designed. Detector status must indicate a fault upon the loss of power, an open circuit or an electrical/electronic problem within the detector's circuitry or external wiring and must transmit a Trouble signal to the Central Fire Monitoring Station for KSC via the facility fire alarm system from the preaction control panel.

Provide a fault indicator for each zone. The detector fault indicator must flash and a trouble relay or separate detector failure relay must operate when there is a failure/problem within the detector's circuitry or external wiring. The detector fault indicator setting must be per the manufacturer's recommendations.

Provide a detector fault time delay. The time delay must be adjustable from 0 to 60 seconds for each detector failure indicator lamp/relay.

Initial setting not more than 10 seconds.

The air flow fault and detector fault relay outputs must be connected/wired to cause a zone trouble and general trouble conditions to be annunciated at the preaction control panel and transmitted to the CFMS via the facility fire alarm system. These functions must be split as two separate trouble indications.

### 2.4 FRONT PANEL SWITCHES

Provide a reset switch for each zone. Any alarm/fault condition must cause the indicator lamps to flash and remain in this state until reset. Provide a disable switch or a separate maintenance by-pass switch to isolate each detector for testing purposes.

A detector bar graph sensitivity test switch must be provided for each zone and must be capable of testing the sensitivity of the detector from the front of the control panel. Detector sensitivity testing must be accomplished by pressing a switch on the control panel, and holding it until the bar graph indicates hundred 100 percent of full scale. Where remote sensitivity testing can be accomplished through data link to a remote computer or alarm panel, the display control panel must incorporate logic to disable the remote test and return the detection system to normal operation after 60 seconds.

Provide a detector fault test switch for each zone. The test switch simulates a detector head fault condition and verifies the integrity of the communication link between the controller and the detector.

Activating the detector fault test switch must cause the test relay to energize and the detector status indicator lamp to extinguish.

If the communication link between the controller and the detector is monitored automatically, a separate detector fault switch is not

required.

## 2.5 DISPLAY CONTROL PANEL AND DETECTOR INTERFACE

Provide all contacts, hardware, conduit and wire, and power required for proper operation and interface between the Display Control Panel and the Air Sampling Detector Assembly. The display control panel must have a minimum of four independently programmable ALARM LEVELS.

### 2.5.1 Alarm Level 1 (Alert)

Configure and program the display control panel so that when ALERT is reached for any detector, the alarm level lamp for that detector illuminates and an audible and a visual alarm sound at the display control panel. A SUPERVISORY ALARM must be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.2 Alarm Level 2 (ACTION)

Configure and program the display control panel so that when ACTION is reached for any detector, the alarm level lamp for that detector illuminates and an audible and a visual alarm sound at the display control panel. A SUPERVISORY ALARM must be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.3 Alarm Level 3 (Fire 1)

Configure and program the display control panel so that when FIRE 1 is reached for any detector, the alarm level lamp for that detector illuminates and an audible and a visual alarm sound at the display control panel. A SILENT ALARM must be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.4 Alarm Level 4 (Fire 2)

Configure and program the display control panel so that when FIRE 2 is reached for any detector, the alarm level lamp for that detector illuminates and an audible and a visual alarm sound and at the display control panel. An ALARM must be activated at the PCP and transmitted to the CFMS via the facility FACP.

### 2.5.5 Trouble Indications

The air sampling control panel must be set-up so in the event of an air flow fault, or a detector fault; the appropriate air flow fault lamp or detector fault lamp illuminates. The display control panel must activate a TROUBLE ALARM at the PCP and transmit it to the CFMS via the facility FACP.

## 2.6 DETECTOR ASSEMBLY

A single detector must be of type tested and approved, for a maximum coverage of 2,000 square meter 20,000 square feet. The detector must be usable in environments with relatively high levels of airborne dust and other contaminants through the use of a filter or other approved method.

### 2.6.1 Nuisance Alarm Avoidance

Treatment of contaminants must be 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 display control unit. The filter must have a maximum nominal pore size of 20 microns per manufacturer's requirement.

#### 2.6.2 Detector Head

The detector head must consist of inlet and outlet ports, quick connector type electrical receptacles for controller interfacing, a detection chamber with light source and optical components, and a signal processing electronic circuitry; all in a single assembly.

#### 2.6.3 Light Source

Air is drawn into the detector via the aspirating system, the air must be exposed to the light source within the detection chamber. Light scattered by smoke particles within the air stream must be converted to an electronic signal directly proportional to the obscuration level within the chamber. A signal corresponding to the obscuration level within the chamber must then be transmitted to the display control panel.

#### 2.6.4 Detector Sensitivity

The manufacturer must provide a minimum sensitivity range from 0.0015 to 7.0 percent obscuration per 0.005 to 20.0 percent (obs/m) foot (obs/ft). The manufacturer must recommend the detector sensitivity for the area to be protected by zone. This detector sensitivity must be approved by the contracting officer prior to installation of any equipment.

### 2.7 ASPIRATING FAN

The aspirating fan must be a high-efficiency, ball bearing, electric centrifugal-flow impeller pump designed for long life. The aspirator flow and pressure ratings must ensure that the maximum transport time for an air sample removed from the furthest sample point of each branch within the piping network must not exceed 60 seconds.

### 2.8 AIR FLOW SENSORS

The detector must be 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. The sensor(s) must be wired to the control panel, and must cause a TROUBLE condition to be initiated at the PCP and transmit it to the CFMS via the facility FACP.

### 2.9 AIR SAMPLING NETWORK

The air sampling network must be a closed-end system, and must be engineered for a maximum transport time of 60 seconds and have equal sensitivity throughout the entire system. The air sampling network must be balanced so that the volume of air drawn from the last sampling point must not be less than 60 percent of the volume from the first sampling point. Coverage of a single sampling pipe network must not exceed 929 square meter 10,000 square feet. When the area to be protected exceeds the maximum square footage criteria, install additional detectors. Each sampling point (hole) must have a maximum coverage of 23.2 square meter 250 square feet of floor area for above ceiling protection. Each underfloor sampling point must have a maximum coverage of 23.2 square meter 250 square feet.

### 2.9.1 Labeling

All pipe and sampling points must be labeled identifying "SMOKE DETECTION SAMPLING PIPE DO NOT DISTURB" and "AIR SAMPLING POINT" respectively.

### 2.9.2 Piping Materials

The sampling pipe must consist of 19 millimeter 3/4 inch inside diameter material. Tubing and fittings as defined in this section, are limited to thermoplastic materials meeting or exceeding the requirements of PVC or an approved equal. Rigid Plastic Conduit CPVC conduit must be not lighter than Schedule 40. Rigid CPVC must be the slip-joint solvent-weld type and fittings must be unthreaded solid CPVC. Conduit and fittings must be airtight and installation must conform to NEMA TC 3, TC 13, NFPA 70 and UL 651. The color must be orange. Accomplish directional changes in the piping network by long radius bends. The use of standard elbow joints must be approved by the Contracting Officer prior to installation. Final connection to the detector must not be glued, but must use a compression type fitting.

### 2.9.3 Design Layout

The air sampling network must be designed and installed to monitor total room/zone concentration of smoke. The design must be accomplished using a computer program which is based on sound fluid dynamic principles and is approved by Factory Mutual Engineering (FM) FM P7825 or listed by Underwriters Laboratories (UL) UL Fire Prot Dir for it's intended use. This type of design requires that air samples be continuously drawn from the areas being protected.

#### 2.9.3.1 Zone Coverage

When the floor area to be protected exceeds 929 square meter 10,000 square feet use multiple detectors. The maximum allowable coverage for any single detector must not exceed 10,000 square feet 929 square meter 10,000 square feet.

#### 2.9.3.2 Sample Port Coverage Area

Each high level above floor sampling port must have a maximum coverage of 23.2 square meter 250 square feet and underfloor area coverage must not exceed 23.2 square meter 250 square feet. The sampling piping must be installed above the suspended ceiling and supported from the building structure. Center the sampling point fitting(s) in the ceiling tiles and connected to the main air sampling pipe using 1 to 2 square meter 3 to 6 feet lengths of 5 to 6 millimeter 0.1875 to 0.25 inches ID flexible tubing. Size the sampling port as specified on the approved design drawings and confirmed by the computer generated design calculations.

### 2.10 PRIMARY POWER SUPPLY

The normal power for the detectors and the display air sampling control panel must be 120 volts AC, 60 hertz. All system components must operate satisfactorily between 85 and 110 percent of normal voltage. The air sampling detection system disconnect/protective device must be a fused switch with a red factory finish. Mount this disconnect switch adjacent to the air sampling detection system. In addition, mark it AIR SAMPLING DETECTION SYSTEM DISCONNECT with a label that is plastic or phenolic type red background with white lettering with a minimum of 6 millimeter 0.25 inch

block lettering. Permanently affix the label to the disconnect switch. Switch must be capable of being locked in the "on" or "off" position. This feature must not interfere with the circuit protection capability of the device. Switch must be equipped with surge suppression for all phase and neutral conductors. Install current limiting Class RK1 fuses properly sized to protect the Air Sampling detection system equipment.

## 2.11 SECONDARY POWER SUPPLY

**Batteries and charger**, and power transfer must provide a means of automatically supplying the entire smoke detection system with battery backup power in the event the primary power system fails. The system must switch to battery backup power in the event of AC power failure and switch back to AC power upon return of primary power. The air sampling control panel must operate if the backup batteries are removed for any reason. The system must control charging and floating level to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Wiring must be fused to protect against battery over-current and polarity reversal. Primary power, battery, or charging equipment failure must result in a trouble signal and visual indication at the display control panel, transmitted to the PCP and then to the CFMS via the facility FACP.

Battery modules must be sealed (no corrosive fumes) and spill proof. Batteries must be listed for fire alarm service and must be suitable for high discharge currents required under alarm conditions. Size batteries to operate the Air Sampling smoke detection system 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.

### 2.11.1 Grounding

The design of equipment must allow for low-impedance bond to the protective grounding system. Equipment must function in an environment which supplies only a safety ground per local electrical code requirements. Cabinet and equipment ground must be isolated from battery return at the equipment and within the frame or cabinet.

## 2.12 COMMUNICATION NETWORK

The network must utilize RS 232 or RS 485 using type TFN for No. 18 or No. 16 AWG twisted shielded pair cable for digital communication. Unauthorized access must be achieved by utilizing a minimum of two levels of password protection. Computer access must be achieved via an RJ 11 six conductor receptacle.

## PART 3 EXECUTION

### 3.1 SYSTEM SEQUENCE OF OPERATION

#### 3.1.1 Normal Operation

The display control panel must consist of an enclosure assembly, installation kit, and required number of display control cards, 1 to 4 zones as required and shown on drawings. Each display control panel must be powered from a 24 VDC source and monitored for alarm and trouble

conditions by the preaction control panel. The **display control panel** must have the following light indications:

Bar Graph Display	Alarm Level Lights
Air Flow Fault Light	Detector Fail Light
CPU Fail Light	Normal Operation Indicator
Power Supply Light	Isolate Light
Trouble Light	

Normal operation, air from the protected zone is drawn through a piping network to the detector unit by an aspirating fan in the detector assembly. The air is then illuminated by a light source. Smoke particles scatter this light to a sensitive, solid-state photo sensor. An analog signal is transmitted to the display control panel which displays smoke obscuration levels on a bar graph display. Each increment on the bar graph represents a percentage of the full scale sensitivity of the detector. Independently programmable alarm points provide additional visual indication on the display control panel and activate associated relays for additional annunciation and alarm.

### 3.2 INSTALLATION

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

#### 3.2.1 Display Control Panel

Equipment must be installed in each protected area, located where indicated on the approved drawings, and must be complete with all indicated accessories and devices. 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 display control panel and the detector unit for maintenance per **NFPA 70**. With multiple equipment, the three (3) foot clearance is required directly in front of the complete configuration. In addition, provide a **711 millimeter 28 inch** clear aisle way for access to the equipment. Cabinets must be provided with a pin-tumbler cylinder lock (Lock Cylinder No. Best Universal Lock Co. No. A8817-XUS26D-7KSC) with removable core that accepts the standardized key currently in use with all other fire alarm control panels at KSC; lock core will be provided by the government.

#### 3.2.2 Smoke 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 piping layout and application; while maintaining total access for servicing with a minimum clearance of **914 millimeter 3 feet** directly in front of the detector. Mounting of the detector to cable trays, movable walls and other equipment or frames must be approved by the Contracting Officer prior to installation.

#### 3.2.3 Air Sampling Network

The smoke detection system must be supplied with an air sampling network for air/smoke transport to the detector from the protected area. The piping network must be designed using a FM approved or UL listed air sampling system computer modeling program for design calculations. The air sampling network must consist of a balanced piping system including main branch piping with sampling points (holes) at pre-determined locations

with end caps. All piping network supports must be from the building structure only. Alternate means of support as from cable trays, raceways, duct work, etc. must be approved by the Contracting Officer prior to installation. All piping which is adjacent to the detector must be mounted tight against the wall or other structural elements which the detector is mounted on, and must terminate within 457 millimeter 18 inches of the detector inlet ports. Connect the air sampling piping to the detector by a union with an 457 millimeter 18 inch PVC nipple of the same ID as the air sampling network piping, to facilitate maintenance. Optional open or closed end system, per manufacturer's approved computer modeling design program can be used. Main piping runs must not exceed 91.5 millimeter 300 feet. Seal all fire rated penetrations of floors, ceilings and walls, per local building code requirement except use no silicone containing materials. The air sampling tubing must be cleaned inside and out, and joined using manufacturer's approved methods and materials for air-tight connections except at the detector enclosure connections for servicing. Locate sampling ports so that they are clear of all supply air registers and/or air flows.

#### 3.2.3.1 Non-Metallic Tubing

Refer to ASTM F 402 for safe handling of solvent cements, primers and cleaners used for joining thermoplastic pipe and fittings. All piping must be supported at approximately 1.5 meter 5 feet maximum intervals on center with bracing for end of pipe run not to exceed 31 meter 1 foot. Pipe hangers and supports and fasteners must be of appropriate dimensional size for supporting tubing without distortion. Refer to construction documents for additional and/or special attachment details. Conduit and fittings must be airtight and installation must conform to NEMA TC 3, NEMA TC 13, NFPA 70, UL 651 and ASTM F 442/F 442M.

#### 3.2.4 Spare Parts

Spare parts must be directly interchangeable with the corresponding components of the installed system. Spare parts must be suitably packaged and identified by nameplate, stamping, or tagging. Furnish the following:

Two (2) filter assemblies

#### 3.2.5 Wiring

Wiring must conform to the requirements of NFPA 70 and NFPA 72 and the following special requirements:

Install air sampling system circuits in a separate raceway or conduit system. Within the air sampling system, 60-hertz power circuits and air sampling initiating and signaling line circuits must be installed in separate raceway or conduit systems. 60-hertz power circuits must not enter enclosures containing 24 Vdc air sampling system circuits except where required to connect to the air sampling system.

Conductors must be continuous from a terminal point at the detector to a terminal point at the display control panel. Break wires at each terminal; wires must not be looped over a terminal. Install solderless ring tongue terminal lugs with manufacturer's required tooling on the device wiring connection leads. This ring type lug must be used on stranded wire only. Termination of solid wire conductors must be made on compression or screw type terminals. When screw type terminals are used the conductor must be captured under 80 percent of the screw head

surface.

Conductors must be solid copper with an insulation rating of not less than 300 volts. Conductors must be marked with the AWG size, voltage rating and manufacturer's name permanently marked on the conductor jacket at no less than 0.70 meter 2 feet intervals. Conductor size and color are listed below. Where modifications are made to existing systems, the new or added conductors must match the size and color coding of the existing system.

Conductors for network communication circuits must be solid copper, shielded, twisted pairs. Conductor size must be as indicated but not less than No. 16 AWG diameter for signaling circuits. Cables must be marked with circuit designation and consistent color coding for the positive and negative loops must be maintained throughout the cable system. Cable must be listed as type FPL, Power-Limited Fire Protective Signaling Cable.

Direct current initiating detector circuits must be a two loop circuit per NFPA 72, Style D with the positive loop conductor colored blue and the negative loop conductor colored black. Conductors size must be as indicated, but not less than No. 16 AWG diameter. Conductor insulation must be Type TFN for No. 16 AWG diameter, and Type THHN/THWN for 1.6 millimeter No. 14 AWG diameter and larger.

#### 3.2.6 60-Hertz Power

60-hertz power to the display control panel must be 120 volts. There must be one black phase conductor, one white solidly grounded neutral conductor and one green equipment grounding conductor. Conductor size must be 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.

#### 3.2.7 Installation In Cabinets and Boxes

Wiring in control cabinets and boxes must be installed in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Control wiring must be continuous from device to device with no splices [unless otherwise indicated]. All wires entering or leaving control cabinets, boxes, and devices must be permanently marked and terminated on screw terminals. Marking must be consistent throughout the Air Sampling smoke detection system and must be the same as the identification shown on the connection drawings.

#### 3.2.8 Conduit and Raceways

Minimum size for fire alarm system initiating, alarm and control circuit conduit and raceways must be 19 millimeter 3/4-inch minimum. Installation must be in accordance with NFPA 70.

Install rigid galvanized heavy wall steel conduit in all hazardous (classified) locations, exterior above grade, interior exposed, from floor to 1.5 meter 5 feet above finished floor unless shown on the drawings. EMT with hexnut expansion gland-type fittings can be installed in all other areas. Flexible metal conduit, maximum length 2 meters 6 feet, must be used as the final connecting raceway to a air sampling system mounted on vibrating equipment or on a suspended ceiling.

Conceal conduit in interior finished areas. Conduit penetrating fire-rated

construction i.e., walls, floors, ceilings, roofs, etc. must be fire-stopped with a UL listed or FM approved material commensurate with the fire resistance rating of the structure penetrated.

Conduit installed in a vertical position must be parallel with walls and perpendicular with the floor and ceiling. Conduit installed in a horizontal position must be parallel with the floor and ceiling and be perpendicular with the walls. Changes in direction of runs must be made with symmetrical bends. Bends of over one inch in diameter must be factory made elbows.

### 3.2.9 Labeling

Provide at the smoke detector labels that are plastic or phenolic type red background with white lettering with a minimum of 6 millimeter 0.25 inch block lettering to indicate detector and zone. Example: "AIR SAMPLING SMOKE DETECTOR No. 1-1 ZONE No. 5"

Provide at the display control panel labels that are plastic or phenolic type red background with white lettering with a minimum of 6 millimeter 0.25 inch block lettering to indicate the controller, the detectors controller served, and location example: "AIR SAMPLING SMOKE DETECTOR CONTROLLER No. 1 - SERVES DETECTOR No. 1-1 ROOM [\_\_\_\_], DETECTOR No. 1-2 ROOM [\_\_\_\_], DETECTOR No. 1-3 ROOM [\_\_\_\_], DETECTOR No. 1-4 ROOM [\_\_\_\_]" .

The pipe network must be clearly labeled every 1.5 meter 5 feet in open room areas, and within ceiling cavity; and every 0.61 meter 2 feet, centered in the floor panels, within the raised floor cavity. This is to distinguish the pipe from other facility pipe work or protective cabling enclosures. The labeling must read: "SMOKE DETECTION SAMPLING TUBE. DO NOT DISTURB".

Every air sampling point must be labeled with a round red label with a center hole to match the diameter of the drilled sampling point; and must read: "AIR SAMPLING POINT DIA [\_\_\_\_] millimeter [\_\_\_\_] inches". Fractional dimensions must be in decimal format indicating a minimum of four decimal places.

All electrical junction boxes and covers must be painted "red", and labeled with a plastic or phenolic label, red background with white lettering with block lettering sized as needed to read: "AIR SAMPLING SMOKE DETECTOR SYSTEM".

### 3.3 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. The tests covered in the following paragraphs must be done in two parts:

- a. Preliminary - This is an "in house" test to verify all the system(s) and components function in accordance with the approved contract drawings and specifications. Perform this functional test in the presence of government inspectors and repeat until performing one full test without device or system malfunction.
- b. Final Acceptance - After the successful completion of the

preliminary testing, the system(s) must be fully tested formally with full documentation (including As-Built Drawings) using the previously approved recording form. The Contracting Officer will witness this test and final acceptance of the system will be based upon his written approval of the test. On both preliminary and final tests, the approved testing procedures must be followed.

### 3.3.1 External System Wiring

Perform the following tests on the external system wiring before connection to the control panel: Check continuity of circuits with an ohmmeter. Temporary jumpers must be inserted in appropriate sockets of missing detectors and the end-of-line resistor must be installed when this test is performed. Resistance reading for each circuit must be the value of the end-of-line resistor, plus or minus 10 percent. Check each wire for grounds with a 500-volt insulation resistance test set. Resistance to ground must not be less than 20 megohms. All tests must be witnessed by the Contracting Officer or designee.

### 3.3.2 System Acceptance Testing

Each zone of every system must be subjected to a full operational test, in the presence of the contracting officer which must successfully pass before any system is considered acceptable. The approved operational test procedure submitted by the subcontractor for the air sampling system and display control panel must include the following tests:

#### 3.3.2.1 Acceptance Criteria

Acceptance criteria for air sampling piping network(s) and detector(s) must include the following measurements and tests for each detector and its air sampling piping network.

#### 3.3.2.2 Suction Pressure Test

Pressure at all sampling ports, except the end cap port, must be measured, recorded, and compared to APPROVED Design Calculations. The Suction Pressure must be within the manufacturer's specified range and be measured in inches of water or pascals.

#### 3.3.2.3 Smoke Transport Time Test

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

#### 3.3.2.4 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 must be considered acceptable provided that all other provisions of this specification have been met.

#### 3.3.2.5 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 must be 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. Proper test procedures and data analysis must 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, normal operations must continue unaltered within the area being protected. The preaction control panel (PCP) must monitor the air sampling detection system and the facility panel must monitor the PCP. The PCP must only transmit supervisory and trouble conditions to the CFMS. During this trial period the air sampling detection system must not activate any automatic suppression systems or cause a facility evacuation.
- c. After the air sampling detection system 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 could be required depending on the results of the first week review.
- e. Data review and analysis must 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 display control panel.

The level of the ambient base line must be compared with the alarm threshold levels selected. The minimum acceptable range between the ambient base line and the first alarm threshold must be minimum twenty percent of the detector's full scale sensitivity calibration setting.

Investigate each peak recorded to determine its cause. Analysis must 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.

The magnitude and duration of the recorded peaks must be compared

to the alarm threshold levels selected and initial time delay settings to determine the possible occurrence of a false alarm.

Based on the data review, adjustments must be made to alarm levels and time delay settings, as required to eliminate false alarms.

Peaks or alarms that are attributed to smoking in the protected area ARE NOT considered to be false alarms. Specifically configure the air sampling detection systems to alarm when smoking takes place within the protected area.

If data indicates that the adjustments to the alarm threshold levels and the time delay settings do not eliminate false alarms the detector sensitivity must be changed. If the false alarms can not be eliminated, provide alternative solutions to the Contracting Officer for approval and implementation.

Any change to the initial settings as prescribed by this specification must be fully documented with supportive analysis and review data and submitted by the manufacturers to the contracting officer for approval.

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**NOTE: Delete this paragraph unless a unique application requires the "Smoldering Smoke Test" to validate the operability for the installed air sampling detection system. Normal air sampling detection system installation do not require the "Smoldering Smoke Test."**  
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### 3.3.2.6 Smoldering Smoke Test

[Only use this test to establish the acceptance of the air sampling detection system for unique applications. Include in the test procedure a method similar to the British Wire overheat test using a set length of wire and a variac transformer to apply 120 VAC for a duration of 3 minutes, or use a predetermined length of wire coiled and laid on tin foil on a hot plate set at 371 - 482 degrees C 700 - 900 degrees F for 1 to 3 minutes to ensure that the installed system(s) performance complies with the approved contract drawings and specifications. The test must be carried out in the vicinity of possible fires (example: at equipment heights 1 to 1.5 meter 3 to 5 feet above the finished floor and under the raised 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.]

### 3.4 ACCEPTANCE TEST DOCUMENTATION

The results of the acceptance testing must be recorded by the installer. Submit at least six copies of the completed documentation to the Contracting Officer. Submit at least three copies of the "Operation and Maintenance Manuals" for the complete Air Sampling Detection System.

-- End of Section --