

PART 1 - GENERAL

1.01 SUMMARY

- A. This section specifies a completely integrated, digitally multiplexed, addressable, voice evacuation, selective signaling, manual and automatic Fire Alarm System and Campus Fire Alarm head end upgrade. Each building (G-wing and Adler Center) shall be provided with complete stand alone system. Each building shall be provided with Notifier NFS2 - 3030 D Voice type Fire Alarm Control Panel (FACP) and including but not limited to the following:
1. Combination Fire Alarm Control Center, Central Processing Unit (CPU) & Printer contained in multiple cabinets.
 2. Addressable Area Smoke Detectors
 3. Addressable Heat Detectors
 4. Addressable Fire Alarm Pull Stations
 5. Zone Adapter Modules
 6. Duct Smoke Detectors
 7. Audible (Speakers) and/or Visual (strobe) alarm indicating devices.
 8. Standby Battery Backup
 9. Connections to valve tamper switches and water flow switches for monitoring & alarm initiation.
 10. Equipment and wiring for automatic connection to the Campus head end over IP based network.
 11. All wiring, raceway, control devices and software for taking control of air handling equipment and fire smoke dampers.
 12. Remote Annunciator Panels.
 13. Remote Annunciator Panels with remote voice paging controls.
- B. Related Sections:
1. Division 23 - Installation of duct mounted smoke detectors.
 2. Section 26 05 33 - Raceway and Boxes for Electrical Systems.
 3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

1.02 SUBMITTALS

- A. Submit signed and sealed shop drawings by NJ State Professional Engineer, including product data, risers and all device lay-outs for the Fire Alarm System.

- B. The Contractor shall submit a list of all types of equipment and components provided. This shall be incorporated as part of a Table of Contents, which will also indicate the manufacturer's part number, the description of the part, and the part number of the manufacturer's product datasheet on which the information can be found.
- C. The Contractor shall submit a description of the operation of the system (Sequence of Operation). The sequence of operation shall be project specific, and shall provide individual sequences for every type of alarm, supervisory, or trouble condition, which may occur as part of the normal or off-normal system use.
- D. The Contractor shall submit the manufacturer's original printed product data, catalog cuts and the description of any special installation procedures. Photocopied and/or illegible product data sheets shall not be acceptable. All product datasheets shall be highlighted or stamped with arrows to indicate the specific components being submitted for review.
- E. The Contractor shall submit the manufacturer's installation instruction manual for the specified system.
- F. The Contractor shall submit samples of various items when requested.
- G. The Contractor shall submit a copy of its NJ License to perform fire alarm work.
- H. The Contractor shall submit copies of the NICET Level II Fire Alarm certifications for the technicians assigned to this project.
- I. The Contractor shall submit shop drawings as follows:
 - 1. Submit a coversheet with the project name, address and drawing index.
 - 2. Submit a general notes drawing with peripheral device backbox size information, part numbers, device mounting height information, and the names, addresses, point of contact, and telephone numbers of all contract project team members.
 - 3. The Contractor shall provide a riser diagram, which individually depicts all the control panels, annunciators, addressable devices, and notification appliances. It shall include a specific, proposed point descriptor above each addressable device. It shall further include a specific, discrete point address, which shall correspond to addresses depicted on the device layout floor plans. The drawing shall provide wire specifications, and tags shown on all conductors with conduit and wire sizes depicted on the riser diagram. All circuits shall have designations that shall correspond with those required on the control panel and floor plan drawings.
 - 4. The Contractor shall submit control panel termination drawing(s) depicting internal component placement and all internal and field termination points. The drawing shall provide a detail indicating where conduit penetrations shall be made, so as to avoid conflicts with the internally mounted batteries. For each additional data gathering panel, a separate control panel drawing shall be provided, which clearly indicates the designation, service and location of the control enclosure.
 - 5. See paragraph 3.05, DOCUMENTATION AND TRAINING, for other documents relating to this section.

6. The Contractor shall provide typical device wiring diagram drawings, which depict all system components, and their respective field wiring termination points. The wire type, gauge, and jacket shall also be indicated. When an addressable module is used in multiple configurations for monitoring or controlling various types of equipment, different device typical diagrams shall be provided.
7. The Contractor shall prepare layout floor plans for every area served by the fire alarm system. Floor plans shall be prepared in AutoCAD Version 2004 or later and shall indicate accurate locations for all control and peripheral devices. The drawings shall be no less than 1/8 inch scale. All addressable devices shall be depicted with a discrete address, which corresponds with that indicated on the riser diagram. All notification appliances shall also be provided with a circuit address, which corresponds to that depicted on the riser diagram. The Contractor shall indicate on the floor plans the location and routing of all riser conduits and all raceways that will be exposed to view. Indicate where the conduit will be concealed above the hung ceilings or in furred walls. If individual floors need to be segmented to accommodate the 1/8" scale requirements, key plans and break-lines shall be provided on the plans in an orderly and professional manner.
8. Contained in the title block of each drawing shall be symbol legends with device counts, wire tag legends, circuit schedules for all addressable and notification appliance circuits, the project name/address, and a drawing description which corresponds to that indicated in the drawing index on the coversheet drawing. A section of each drawing title block shall be reserved for revision numbers and notes. The initial submission shall be Revision 0, with Revision A, B, or C as the project modifications require.
- J. The Contractor shall submit battery calculations on a per power supply/charger basis. These calculations shall clearly indicate the quantity of devices, the device part numbers, the supervisory current draw, the alarm current draw, totals for all categories, and the calculated battery requirements. Battery calculations shall also reflect all control panel component, remote annunciator, and auxiliary relay current draws. Failure to provide these calculations shall be grounds for the complete rejection of the submittal package.
- K. The table of contents, product data sheets, sequences of operation, battery calculations, installation instructions, licenses, NICET certifications and B-Size (blackline) reduced shop drawings shall be submitted by the fire alarm vendor as part of a single, spiral bound submittal book. The submittal book shall have laminated covers indicating the project address, system type, and the Contractor. The book shall consist of labeled dividers, and shall not exceed 9 1/2" in width, and 12" in height. No less than four (4) sets of submittal booklets shall be provided to the Consulting Engineer for review and comment. Additional copies may be required at no additional cost to the Owner.
- L. The Contractor shall submit scale drawing sets along with the submittal booklets. These drawings may be either D-Size or E-Size Blue-line drawings and of a sufficient resolution to be completely read. The sets shall be bound and folded so as to not take up more than 100 square inches of space. No less than four (4) sets of scale drawing sets shall be submitted to the Consultant Engineer for review and comment.
- M. Maintenance data for the fire alarm systems shall be included in the operation and maintenance manual. The Contractor shall include data for each type of product, including all features and operating sequences, both automatic and manual. Include recommendations for spare parts to be stocked at the site. The Contractor shall

submit the names, address and telephone numbers of service organizations that carry a stock of repair parts for the system to be furnished.

- N. The building will be occupied in multiple phases and the existing fire alarm system will have to be modified to allow of occupancy of the 3rd and 4th floor of G-wing. Provide all required devices, wiring, programming, testing, signed and sealed shop drawings etc. as required to support initial occupancy. All devices on 3rd and 4th floor will ultimately be connected to the new fire alarm control panel. Provide all devices, wiring, programming, testing, signed and sealed shop drawings, etc. as required to support project phasing.
- O. Submission to authorities having jurisdiction: In addition to the routine submission of the above material, make an identical submission signed and sealed by Professional Engineer registered in the State of NJ to the authorities having jurisdiction. Include copies of annotated drawings as needed to depict component locations to facilitate the review. Upon receipt of comments from the authorities having jurisdiction, submit the comments to the Consultant Engineer for review. Resubmit if required to make clarifications or revisions in order to obtain an approval.
- P. The Contractor shall submit a record of all field tests of the system.

1.03 APPLICABLE CODES AND STANDARDS

- A. All equipment shall be UL listed for its intended use.
- B. NFPA 70 - The National Electric Code.
- C. NFPA 72 - The National Fire Alarm Code.
- D. NFPA 101 - Life Safety Code.
- E. 2009 International Building Code New Jersey Edition, 2009 Rehabilitation Subcode NJ 5:23-6 and applicable Fire Codes.
- F. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- G. Requirements of the local Authorities Having Jurisdiction.
- H. Underwriters Laboratories Inc.: The system and all components shall be listed by Underwriters Laboratories Inc. for use in a fire protective signaling system under the following standards as applicable:
 - 1. UL 38 Manually Activated Signaling Boxes.
 - 2. UL 217 Smoke Detectors Single Station.
 - 3. UL 228 Door Holders for Fire Protective Signaling Systems.
 - 4. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
 - 5. UL 268A Smoke Detectors for Duct Applications.
 - 6. UL 346 Waterflow Indicators for Fire Protective Signaling Systems.
 - 7. UL 464 Audible Signaling Appliances.

8. UL 521 Heat Detectors for Fire Protective Signaling Systems.
9. UL 864 Control Units for Fire Protective Signaling Systems.
10. UL 1481 Power Supplies for Fire Protective Signaling Systems.
11. UL 1638 Visual Signaling Appliances.
12. UL 1711 Amplifiers for Fire Protective Signaling Systems.
13. UL 1971 Standard for Signaling Devices for the Hearing Impaired.

I. Americans with Disabilities Act (ADA)

1.04 GUARANTEE

- A. Equipment manufacturer shall directly guarantee all fire alarm system components, parts and assemblies to be free from inherent mechanical or electrical defects and against defects in workmanship for period of one year from the date of final acceptance by the Owner. As required, repair service and replacement parts shall be performed and provided during normal working hours, at no cost to the Owner, for the one-year guarantee period, unless damage is caused by misuse, abuse or accident.
- B. Contractor shall guarantee all fire alarm system wiring and raceways to be free from inherent mechanical or electrical defects and against defects in workmanship for a period of one year from the date of final acceptance of the system by the Owner and Fire Department. As required, repair service and replacement parts shall be performed and provided during normal working hours, at no cost to the Owner, for the one-year guarantee period, unless damage is caused by misuse, abuse or accident.

1.05 SERVICE AND MAINTENANCE

- A. Equipment manufacturer shall make available a fully equipped service organization, capable of guaranteeing an on-site service response time within eight hours to a service request call. Said service shall be available 24 hours per day and seven days per week.
- B. The Equipment manufacturer shall include in preventive maintenance make available, to the Owner, a price quotation for a one-year maintenance and testing agreement, to take effect on the date of final acceptance.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The Fire Alarm System shall be Notifier as manufactured by Honeywell and shall interface with existing Campus Fire Alarm monitoring system. Substitutions shall not be accepted.
- B. Contact Robert Farm, United Fire Protection Corp., tel.#908-688-0300 ext.245.

2.02 GENERAL

- A. Provide and install complete Fire Alarm System with all hardware and software as described herein and shown on the plans. The system shall be wired, connected,

programmed, verified and left in first class operating condition. System shall be connected to the existing campus monitoring system.

- B. The work covered by this section includes the furnishing of labor, equipment, and materials for the installation of a UL-864 Ninth Edition, fully addressable, manual and automatic, voice notification, fire alarm system as indicated on the drawings and specifications. The Fire Alarm System shall consist of all necessary hardware, equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations.
 - 2. Control and monitoring of fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.
- C. The system shall tie to the Notifier NFS2-3030 D Voice FACP and campus fire alarm monitoring and control network.
- D. The system shall be electrically supervised and monitor the integrity of all conductors.
- E. Circuit Loading:
 - 1. Notification Appliance Circuit loading shall provide for a minimum of 25% expansion. (Each NAC circuit shall not exceed its individual rated amperage capacity by more than 75%).
 - 2. Addressable device circuits shall allow for 25% expansion.
- F. Notification Appliance Circuit Device (Alarm Strobe) Synchronization shall be provided in accordance with NFPA 72, ANSI and ADA. Any room where two or more alarm strobes and/or the direct or indirect reflected visual flash can be seen, shall have such device's output synchronized.
- G. Each designated initiating and supervisory device shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Panels, the Intelligent Network Annunciator and remote Annunciators as indicated on drawings.
- H. The Fire Alarm Systems and Networking as described herein and as shown on the plans, shall be wired, connected, and left in first class operating condition. Include panels and devices as shown and noted on plans and risers and all low voltage wiring and installation of same, and terminations at all panels and devices. Conduit system, signaling cabling, and AC wiring shall be provided as part of this project.
- I. Provide all programming and modifications to the existing campus network monitoring control equipment as required for connection of G-Wing and Adler Center fire alarm control systems.
- ~~J. Provide wiring and devices required for monitoring position of fire smoke dampers.~~
- K. Network programming (a minimum of three) shall be included under this work to provide the full integration of all indicated buildings into the network. Each system shall be modular in construction to facilitate expansion and changes. Network architecture shall be peer to peer.
- L. The connection between network controls panels shall be NotifierNet based network communication scheme and shall be wired in a Class B, Style 4 fashion.
- M. Fire Alarm System shall provide the following integrated functions:

1. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download.
- N. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. Separate alarm and trouble logs shall be provided.
- O. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble), the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.
- P. Wiring/Signal Transmission:
1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
 2. Alarm and trouble signals from the FACP and other network nodes shall be digitally encoded by a listed electronic device onto a NFPA Style 4 looped multiplex communication system.
 3. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
 4. Initiation Device Circuits (IDC) shall be wired NFPA Style B (Class B).
 5. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y). Notification Appliance Circuits shall be loaded to no greater than 80% of their respective capacity. Voltage drop and loading calculations shall be provided as part of submittal package.
 6. Each building floor shall be provided with a dedicate signaling line circuit (SLC) for connection of addressable initiating and control devices.
 7. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.
 8. Supervisory Operations: Upon activation of a supervisory device such as a valve tamper switch, the system shall operate as follows:
 - a. Activate the system supervisory service audible signal and illuminate the LED at the control unit and the remote annunciator.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating an off-normal condition.
 - c. Record the event in the FACP historical log.

- d. Transmit the supervisory signal to the Campus Head End System.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
9. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation. Visual alarm indicating devices shall remain active until the "System Reset" button is pressed.
10. System Reset
- a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b. Should an alarm condition continue, the system will remain in an alarmed state.
11. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
12. The FACP shall automatically indicate when an individual sensor needs cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting shall be provided; "ALMOST DIRTY", "DIRTY SENSOR" and "EXCESSIVELY DIRTY SENSOR".
13. The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
14. Smoke Sensors: A maintenance and testing service providing the following shall be included with the base bid:
- a. Biannual sensitivity reading and logging for each smoke sensor.
 - b. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
 - c. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
 - d. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
 - e. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
 - f. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.

- g. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.
- 15. Audible Alarm Notification: By speakers in areas as indicated on drawings.
- 16. Fire Suppression Monitoring:
 - a. Water flow: Activation of a water flow switch shall initiate general alarm operations.
 - b. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
 - c. WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
 - d. The sprinkler water service shall be monitored for low water pressure on the supply side of the backflow prevention device. Should the water pressure drop below the normal low pressure, a supervisory alarm shall be generated.
- 17. Power Requirements:
 - a. The control unit shall receive AC power via a dedicated 120V, 20A circuit.
 - b. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 10 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
 - c. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
 - d. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
 - e. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
 - f. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control.
 - g. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.

- h. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

2.03 OPERATION

A. System Alarm Operation:

1. The FACP central processing unit (CPU) shall provide for the monitoring of addressable, "True Alarm" smoke sensors. The alarm threshold may be individually programmed for each smoke sensor as a sensitivity percentage (0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0%, and 3.7%) above its normal average value.
2. The FACP Central Processing Unit (CPU) shall be software programmed to provide alarm verification for any addressable area smoke detectors or any alarm initiating circuits serving area smoke detectors. The alarm verification sequence, as described in UL Standard 864, shall consist of three (3) periods, to total not more than the one-hundred twenty (120) seconds permitted by the Life Safety Code (NFPA 101):
 - a. Retard Period: Activation of any area smoke detector/sensor and its associated alarm initiating circuit shall cause the CPU to retard the activation of all control-by-event operation for a period of thirty (30) seconds. If any other alarm initiating device or alarm initiating circuit should go into alarm during this period, the first alarm will be confirmed and the appropriate control-by-event operation shall be carried out.
 - b. Detector Restart Period: If no alarm conditions, other than the first occur during the Retard Period, the CPU shall reset and repower the addressable area smoke sensor or the alarm initiating circuit and its associated smoke detectors during a reset period of no more than thirty (30) seconds.
 - c. Confirmation Period: Following the Reset Period, if any addressable alarm initiating device or alarm initiating circuit should go into alarm during a sixty (60) second period, all control-by-event operations for that device or circuit shall be carried out. If no alarms occur during the Confirmation Period, the CPU shall reset the system to normal operation.
 - d. The FACP shall have the capability to display the number of times (tally) a device, group of devices or alarm initiating circuit has gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.
3. System operation for Fire Alarm Condition for Voice:
 - a. Sound an pre-announce tone followed by a field programmable digitized custom evacuation message, on all floors. The visual signals shall operate in a similar pattern.
 - b. Evacuation message must be approved by the engineer and custom messages shall be provided as directed with no additional cost to the owner.

- c. A simultaneous message shall be delivered via all alarm speakers installed on the remaining floors indicating the requirement for occupants of these floors to remain alert for further instructions.
 - d. A simultaneous message shall be delivered via all alarm speakers installed in stairways and elevators informing occupants of the imminent shutdown of elevator circuits and the expected high traffic load in the stairwells.
 - e. An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences.
 - f. Status lights next to speaker selection switches on the control panel shall indicate speaker circuit selection.
 - g. Audible signals shall be silenced from the fire alarm control panel by an alarm silence switch. Visual signals shall be programmed to flash until system reset or alarm silencing, as required by the AHJ.
4. Operation of any manual fire alarm station shall automatically:
- a. Flash all alarm strobe lights throughout the building. The strobes should remain activated until the entire system is reset.
 - b. Sound evacuation tone via speakers throughout the building, followed by digitalized custom evacuation message.
 - c. Flash the general alarm LED indicator on the FACP. Pressing the alarm acknowledge key on the FACP shall continuously light the general alarm LED indicator during the alarm condition. Subsequent alarm conditions shall again flash the general alarm LED indicator.
 - d. Display a general indication and system status summary (numbers of alarm, supervisory and/or trouble conditions) on the FACP liquid crystal display (LCD). Pressing the alarm acknowledge key shall display, for thirty (30) seconds, the individual device or circuit display, to include the "alarm" status and custom label (up to forty characters and spaces) for the addressable device or circuit of alarm initiation on the liquid crystal display (LCD). At the end of the thirty (30) second period, the general alarm indication and system status summary shall be again displayed. The individual device/circuit display may be recalled at any time by repressing the alarm acknowledge key or until the alarm condition is reset to normal
5. Operation of any area smoke detector, heat detector or sprinkler waterflow switch shall automatically:
- a. Flash all alarm strobe lights throughout the building. The strobes should remain activated until the entire system is reset.
 - b. Sound evacuation tone via speaker throughout the building, followed by digitalized custom evacuation message.
 - c. Flash the general alarm LED indicator on the FACP. Pressing the alarm acknowledge key on the FACP shall continuously light the general

alarm LED indicator during the alarm condition. Subsequent alarm conditions shall again flash the general alarm LED indicator.

- d. Display a general indication and system status summary (numbers of alarm, supervisory and/or trouble conditions) on the FACP liquid crystal display (LCD). Pressing the alarm acknowledge key shall display, for thirty (30) seconds, the individual device or circuit display, to include the "alarm" status and custom label (up to forty characters and spaces) for the addressable device or circuit of alarm initiation on the liquid crystal display (LCD). At the end of the thirty (30) second period, the general alarm indication and system status summary shall be again displayed. The individual device/circuit display may be recalled at any time by repressing the alarm acknowledge key or until the alarm condition is reset to normal.
 - e. Operate control relay contacts to release door holders.
 - f. Operate control relay contacts to shutdown all air handling units, AC units and return fans that serve the building. Fans shall not be permitted to restart from the simple operation of the system reset switch. A separate fan restart switch shall be provided on the fire alarm control panel to enable fan systems to be restarted after the system has been reset to normal.
 - g. Operate control relays contacts to close all fire smoke dampers.
 - h. Enter the alarm condition custom label with time and date of occurrence into the FACP historical alarm log for future recall.
 - i. Initiate the transmission of an alarm indication to the Campus Head End Monitoring System.
 - j. Sound an audible signal at the remote annunciator panel. The audible signal may be silenced during the alarm condition.
6. Operation of any HVAC duct smoke detector shall automatically:
- a. Flash all alarm strobe lights throughout the building. The strobes should remain activated until the entire system is reset.
 - b. Sound evacuation tone via speakers throughout the building, followed by digitalized custom evacuation message.
 - c. Flash the general alarm LED indicator on the FACP. Pressing the alarm acknowledge key on the FACP shall continuously light the general alarm LED indicator during the alarm condition. Subsequent alarm conditions shall again flash the general alarm LED indicator.
 - d. Display a general indication and system status summary (numbers of alarm, supervisory and/or trouble conditions) on the FACP liquid crystal display (LCD). Pressing the alarm acknowledge key shall display, for thirty (30) seconds, the individual device or circuit display, to include the "alarm" status and custom label (up to forty characters and spaces) for the addressable device or circuit of alarm initiation on the liquid crystal display (LCD). At the end of the thirty (30) second period, the general alarm indication and system status summary shall be again displayed. The individual device/circuit display may be

recalled at any time by repressing the alarm acknowledge key or until the alarm condition is reset to normal.

- e. Operate control relay contacts to shutdown related air handling unit, AC unit or return fan only and close associated FSD's only.
- f. Enter the alarm condition custom label with time and date of occurrence into the FACP historical alarm log for future recall.
- g. Initiate the transmission of an alarm indication to the Campus Head End Monitoring System.
- h. Sound an audible signal at the remote annunciator panel. The audible signal may be silenced during the alarm condition.

7. Activation of a sprinkler valve tamper switch, shall automatically:

- a. Sound an audible signal at the FACP and at any remote trouble signals (bells). Pressing the supervisory acknowledge key on the FACP shall silence the audible signal(s) during the off-normal condition. Subsequent off-normal conditions shall resound the audible signal.
- b. Flash the general supervisory service LED indicator on the FACP. Pressing the supervisory acknowledge key on the FACP shall continuously light the general supervisory service LED indicator during the off-normal condition. Subsequent off-normal conditions shall again flash the general supervisory LED indicator.
- c. Display a general supervisory indication and system status summary (number of alarm, supervisory and/or trouble conditions) on the FACP liquid crystal display (LCD). Pressing the supervisory acknowledge key shall display, for thirty (30) seconds, the individual device or circuit display, to include the "off-normal" status and custom label (up to forty characters and spaces) for the addressable device or circuit of supervisory, off-normal initiation on the liquid crystal display (LCD). At the end of the thirty (30) second period, the general supervisory indication and system status summary shall again be displayed. The individual device/circuit display may be recalled at any time by repressing the supervisory acknowledge key or until the off-normal condition is restored to normal.
- d. Visually annunciate the individual addressable device in off-normal or the software defined group of addressable devices, which includes the addressable device in off-normal, at the FACP, via an individual off-normal LED indicator. The visual indication shall remain on until the off-normal condition is restored to normal.
- e. Enter the off-normal circuit/device custom label with time and date of occurrence into the FACP historical trouble log for future recall.
- f. Activate the system printer to printout a hard copy record of the off-normal condition to include the time and date and custom label for the device/circuit in off-normal condition.
- g. Initiate the transmission of a supervisory indication to the Campus Head End Monitoring System.

- h. Sound an audible signal at the remote annunciator panel. The audible signal may be silenced during the off-normal condition.
- i. Visually indicate a general supervisory, off-normal condition at the remote annunciator panel(s), via one (1) general supervisory, off-normal LED indicator. The visual indication shall remain on until the off-normal condition is restored to normal.

B. System Supervision:

- 1. The fire alarm system wiring (except control wiring to fans, dampers, etc.) shall be electrically supervised to automatically detect and report trouble conditions to the FACP.
- 2. Any opens or grounds on alarm initiating or supervisory circuit wiring and any opens, grounds or shorts across alarm signal, alarm gongs or alarm light wiring shall initiate a system trouble condition.
- 3. System addressable devices shall be supervised for placement and normal operation. Removal of an addressable device or the failure of its internal electronic circuitry shall initiate a system trouble condition.
- 4. Operation of any manual control commands that alter the system from its normal programmed standby configuration shall initiate a trouble condition.

2.04 SYSTEM COMPONENTS

A. Fire Alarm Control Panel (FACP)

- 1. Notifier Model NFS2-3030 D Voice Series Fire Alarm Control Panel.
- 2. The main FACP shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.
- 3. FACP shall be equipped with IP network gateways and UL864 listed Ethernet switching hubs.
- 4. FACP shall be provided with ONYX Works color screen. All graphics programming and software shall be provided.
- 5. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 - a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
 - c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary

devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

- d. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
6. Acknowledge Switch:
- a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
 - b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
7. Signal Silence Switch: Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
8. Drill Switch: Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
9. System Reset Switch: Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.
10. Lamp Test: The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.
11. System Capacity and General Operation:
- a. The control panel shall be capable of expansion via up to 10 SLC circuits.
 - b. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640 -character liquid crystal display, individual, color coded system

status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system.

- c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

12. Power Supply:

- a. Model: AMPS-24.
- b. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
- c. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
- d. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.
- e. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
- f. The Addressable Main Power Supply shall be power-limited per UL864 requirements.
- g. Power supply and batteries shall provide for 120% of system required capacity.

13. Audio Amplifiers:

- a. Model: DAA2-5025/5070.
- b. The Audio Amplifiers will provide Audio Power (@25 Volts RMS) for distribution to speaker circuits.
- c. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
- d. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the data received, data transmitted, ground fault, audio detected, short circuit, board failure and power supply conditions.
- e. The audio amplifier shall provide the following built-in controls: Amplifier Address Selection Switches, Signal Silence of communication loss annunciation Reset, Level adjustment for background music, Enable/Disable for Earth Fault detection on DAP A, Switch for 2-wire/4-wire FFT riser.

- f. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
- g. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
- h. System shall be capable of backing up digital amplifiers.

14. Audio Message Generator (Prerecorded Voice)/Speaker Control:

- a. Model: DVC-EM with DVC-KD.
- b. System shall be configured at minimum to allow selective automatic and voice messaging and paging by building and floor and be multi-channel to allow for providing different messages simultaneously to different buildings and floors.
- c. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
- d. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.
- e. A built-in microphone shall be provided to allow paging through speaker circuits.
- f. System paging from emergency telephone circuits shall be supported .

B. Remote Annunciator/Audio Command Station

- 1. Provide Notifier Model LCD-160 series annunciator and remote control. Annunciator shall be equipped with 640 character LCD display. Panel shall provide system control and display capabilities for all or for selected network devices and components.
- 2. Where indicated on the drawings provide remote annunciator (LCD-160) and remote paging station model DVC-RPU in single enclosure.

C. Addressable Circuit Interface Adapter Modules

- 1. Interface modules shall allow for the monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices and for control of AHU systems.
- 2. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
- 3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure

that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

4. Provide the following modules:

- a. Notifier Model FMM-1(A) or FDM series Monitor Module
- b. Notifier Model FCM-1(A) or FCR series Control Module

D. Manual Pull Stations

- 1. Provide Notifier Model NBG-12LX, double action (pull alarm lever), addressable type manual station.
- 2. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- 3. The station shall be furnished for semi-flush mounting or surface mounting with matching back box, where shown on the Drawings.

E. Area Smoke Detector

- 1. Provide Notifier Model FSP-851 photoelectric, two-wire, 24 VDC smoke sensor.
- 2. The detectors shall use the photoelectric principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
- 3. Sensors shall be provided with Notifier Model B710LP, surface mount, addressable base assembly with a power-on/alarm/trouble LED indicator, remote alarm LED output and screw terminals for all connections.

F. Heat Detector

- 1. Provide Notifier Model FST-851R combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- 2. Sensors shall be provided with Notifier Model B210LP, surface mount, addressable base assembly with a power-on/alarm/trouble LED indicator, remote alarm LED output and screw terminals for all connections.
- 3. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

G. Duct Mounted Smoke Detector Housing

- 1. Provide Notifier Model NDR, 2-wire type duct mounted smoke sensor housing with FSP-851R detector.
- 2. Intelligent photoelectric duct smoke detectors shall be equipped with visual alarm indicator and test switch. Each detector shall be installed upon the supply/return air ducts(s), with properly sized air sampling tubes. Duct smoke

detectors shall be equipped with remote test station where not readily accessible.

H. Visual Alarm Indicating Device (Strobe)

1. Provide Notifier Model SR-P visual alarm indicator shall consist of a xenon flash tube and associated lens/reflector system. The enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.
2. Visual appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visual Only appliance.
3. Visual appliances shall be synchronized.

I. Audible Alarm Device (Speaker)

1. Provide Notifier Model SPR audio alarm indicator.
2. Speakers shall operate on 25 VRMS and with field selectable taps from 0.5 to 2.0 watts.
3. Speakers shall produce a nominal sound output of 84 dba at 10 ft.

J. Audible/Visual Alarm Combination Device (Speaker/Strobe)

1. Provide Notifier Model SPSR-P combination audio/visual alarm indicator shall consist of a xenon flash tube and associated lens/reflector and multi-tapped speaker. The enclosure shall mount directly to standard 4" square electrical box with extension ring.
2. Combination device shall be provided with multi-candela synchronized strobe, strobe intensity selectable as 15, 30, 75 or 110 candela and a multi-tapped speaker.

K. ONYX Works Campus System Head End Upgrade

1. Provide three (3) Notifier ONYX Works computer each with 19" listed monitor, IP protocol gateway, UL 864 listed Ethernet hub.
2. Primary ONYX Works computer shall be located in Anisfield Building, Fire Control Room 133A. Refer to contract drawings for additional information.
3. Two other ONYX Works computers and system printer shall be located in Academic Building, Core 3, Public Safety Office. Refer to contract drawings for additional information.
4. Each location shall be provided with UL 1481 listed UPS to operate the system for 4 hours during primary power loss. UPS system shall be as indicated on the drawings.
5. Provide all required components, devices, wiring for fully functional system.
6. Provide Bosch D6600 Digital Alarm Communicator Receiver in Anisfield Building, Fire Control Room 133A, fire alarm system equipment rack. Provide integration of receiver with ONYX Works system.

2.05 FIRE ALARM WIRING

- A. Provide and install in accordance with applicable National, State and local codes, the manufacturer's recommendations, and the plans and specifications; all equipment, wiring in conduit and outlet boxes required for the erection of a complete and properly operating system.
- B. All wiring shall be in a completely separate conduit system and in accordance with these specifications and the manufacturer's recommendations. Wires specified below are minimum sizes and shall be increased to meet proper system operation and field conditions.
 - 1. Comnet Wiring: Fire code (Teflon rated, red, twisted, shielded, 2 conductor #18 AWG fire alarm cable). The system shall transmit all data, voice and emergency telephone signals between the CPU and CDT's using the required number of the specified cables.
 - 2. Mapnet Wiring (Teflon rated red fire alarm cable) shall be as follows:
 - a. Data for all Addressable Devices - 2#18
 - b. Power to ZAM's - 2#14
 - c. Fire Alarm Speakers - 2#16 Twisted and shielded
 - d. Between ZAM's and duct smoke detectors - 2#16
 - e. Between ZAM's and waterflow and tamper switches - 2#16
 - f. Fire Alarm Strobes - 2#14
 - 3. Other wiring and power circuits: THHN, size as required.
 - 4. Control wiring for handling system and dampers #12 type THHN.
- C. Speaker circuiting and system amplification requirements:
 - 1. A minimum of two (2) speaker circuits shall be provided for each floor. Alternately wire speaker so that adjacent speakers are on different circuits.
 - 2. Each speaker circuit shall have a minimum of 20 percent spare power above that required to satisfy the minimum sound pressure levels specified herein.
 - 3. No limitation of component, power supply or other consideration shall cause the sound output level to deteriorate from those specified in any mode of the system operation including "all call".

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall receive and store all material and equipment necessary to complete the Project.
- B. Store fire alarm equipment in a clean, dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

- C. Handle fire alarm equipment carefully to prevent damage. Do not install any damaged equipment or components; replace with new.

3.02 INSTALLATION

- A. The entire system shall be installed in a workmanlike manner, in accordance with approved manufacturer's wiring diagrams. The Contractor shall furnish all conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for the complete installation.
- B. Smoke Detectors:
 - 1. The Contractor shall furnish and install smoke sensors at locations where shown on the Drawings or called for in the Specifications.
 - 2. The smoke sensors shall be surface or semi-flush mounted.
 - 3. Detectors shall be mounted on ceilings. Contractor shall furnish and install a suitable flush backbox to which the sensor will be mounted.
 - 4. Smoke detectors shall be installed no closer than five feet from air registers.
 - 5. Do not install smoke sensor heads until the Work (including cleaning) of all trades in the area has been completed. Protect installed smoke sensor heads from airborne dust and debris. Any detector-cleaning cost, necessitated by failure to protect the smoke detector heads, shall be the responsibility of the Contractor.
- C. Duct Smoke Detectors:
 - 1. Contractor shall furnish duct mounted smoke sensors, where shown on the Drawings or called for in the Specifications. Coordinate number of detectors with the mechanical drawings.
 - 2. Contractor shall coordinate the installation of the duct smoke detector housings.
 - 3. All sampling and reference tubes shall be cut to fit the interior dimensions of the ductwork being penetrated and in a manner that meets the manufacturer's criteria for an acceptable working arrangement.
 - 4. Contractor shall consult the HVAC Drawings for locations of the duct smoke detectors, in order to provide adequate conduit, wiring and connections.
 - 5. Do not install duct smoke sensor heads until the Work (including cleaning) of all trades in the building has been completed and the air handling systems have been run for a minimum of four hours. Protect all installed duct smoke sensor heads from airborne dust and debris. Any sensor cleaning costs, necessitated by failure to protect the duct smoke sensor heads, shall be the responsibility of the Contractor.
- D. Visual Alarm Indicating Devices (Alarm Strobe Lights and Combination Assemblies):
 - 1. Contractor shall furnish and install visual alarm indicating devices, where shown on the Drawings.

2. The bottom of an alarm strobe light and/or the bottom of the alarm strobe light component of an audio/visual combination assembly shall be mounted 80 to 96 inches above the finished floor (to the bottom of the device), whichever is higher. Where low ceiling exist (less than 9 feet clear), the device shall be located 6 inches below the ceiling.
- E. The following items shall be provided with an engraved phenolic sign white letters (1 inch high) on a red background identifying its functions and mounted as indicated:
1. "Fire Alarm Transponder" (On panel).
 2. "Supervisory Bell" (on wall above the bell).
- F. Wiring: As defined in Part 2.
- G. Conduit and Raceways:
1. All wiring shall be installed in dedicated conduit system throughout the building. Conduit system shall be concealed in walls or above ceilings in finished spaces.
 2. Conduit shall be 3/4" minimum.
 3. All outlet boxes shall be galvanized steel. Surface mounted boxes, where used shall be manufacturer red surface type boxes for use on fire alarm systems.
 4. Where exposed in mechanical and electrical rooms, and damp or wet location, wiring shall be installed in threaded rigid galvanized steel (RGS) conduit (3/4" minimum). Where conduits are run exposed above 8ft in finished spaces, use EMT (3/4" minimum) and install conduit following building structure, exposed concrete roof baffles so visual effect is minimum. Conduit straps shall be secured to the wall with metallic anchors. Outlet boxes shall be weather-tight in damp and wet locations.
 5. Where concealed in stud walls or above hung ceilings, wiring shall be installed in electrical metallic tubing (EMT) with steel compression fittings.
 6. All penetrations of floor slabs and firewalls shall be fire stopped in accordance with all local fire codes.
 7. Fire alarm system terminal and junction locations shall be identified as indicated above. Terminal and junction boxes shall be painted red.
 8. Conduits serving the FACP shall only enter the sides or bottom of the cabinets. Conduits shall not enter the top of the FACP cabinets.
 9. All junction box covers associated with the fire alarm system shall be painted red.
- H. End of line devices (resistors, diodes, capacitors, etc.) shall be furnished as required for mounting as directed by the manufacturer.
- I. The manufacturer's technical representative shall provide the following field services:
1. Provide to the Contractor a list of addressable device address numbers, for each addressable circuit, for setting by Contractor.

2. Supervise all final connections between system control equipment and the field peripheral equipment circuit wiring.
3. Prepare, adjust and start system prior to testing.

3.03 CLEAN UP

- A. Upon completion of the installation, all debris created by the installation shall be removed from the premises.

3.04 TESTS

- A. Prior to the final acceptance test, the Contractor and a trained manufacturer's technical representative shall test the completed system for proper operation. The system shall be demonstrated to perform all of the functions as below listed in 3.04 C. Any system, equipment or wiring failures discovered during said test shall be repaired or replaced before requesting scheduling of the final acceptance test.
- B. The system shall be tested for final acceptance in the presence of the Owner's representative, Architect's representative, Engineer's representative, the Local Code enforcement official, Contractor's representative and the Manufacturer's representative.
- C. During the final acceptance test:
 1. Every manual fire alarm station shall be tested.
 2. Every smoke sensor shall be tested using canned smoke.
 3. The sprinkler system water-flow alarm switches shall be tested by flowing water. Valve tamper switches and low water pressure switches shall be tested.
 4. All other alarm initiating devices/connected panels shall be activated to their alarm state.
 5. All other supervised devices shall be activated to their off-normal position or state.
 6. Every audible alarm-signaling device shall be sounded.
 7. Every visual alarm-signaling device shall be flashed.
 8. Every system control function shall be tested for its proper operation.
 9. Every controllable fan system, fire shutter and damper shall be tested for proper operation.
 10. All supervised circuits shall be opened at two locations to test for proper supervision.
- D. Upon successful completion of all final acceptance tests, Contractor and Manufacturer's representatives shall each author and sign a Fire Alarm System Record of Completion form, following the format indicated in Section 4 of NFPA 72. The form shall be complete and contain all information on the system installed. Copies of

the forms shall be distributed to the Owner, the Architect's representative, the Engineer's representative and the local Code enforcement official.

- E. All final acceptance testing shall be done at a time convenient to the local Code enforcement official and the Owner's representatives and all testing costs shall be borne by the Contractor as part of this Contract.

3.05 DOCUMENTATION AND TRAINING

- A. Contractor shall, with the assistance of the equipment manufacturer, compile and provide to the Owner, six complete manuals on the finished system to include:
 - 1. Operating instructions for this specific system.
 - 2. Preventive and required maintenance schedules.
 - 3. Manufacturers catalog pages of all equipment and components provided.
 - 4. All as-built wiring and conduit diagrams, both floor plan and riser types, including one set of reproducible masters and drawings on compact discs (CD) in a format suitable for use with AutoCAD.
 - 5. In addition to the above manuals, Contractor shall provide the services of a trained manufacturer's employee for three periods of eight hours each, during normal business hours, to instruct the Owner's designated personnel on the operation and maintenance of the entire system.

END OF SECTION