



CODE CONSULTANTS
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The Fire Protection and
Life Safety Experts

- Code Consultation
- Alarm Systems Design
- Fire Sprinkler Design

TO: Ms. Tamara Saakian, P.E.
Bureau of Fire Prevention, FDNY

DATE: May 12, 2006

NYC DEPT. OF BUILDINGS
TECHNICAL AFFAIRS
RECEIVED 7206

CC: Chief Patrick McNally, FDNY
Fatma Amer, Department of Buildings, NYC
Carl Krebs, Davis Brody Bond, LLP
Richard Bikse, Lower Manhattan Development Corporation

FROM: Steven Wolin

2006 MAY 15 PM 5:25

RE: WORLD TRADE CENTER MEMORIAL & MEMORIAL MUSEUM
PROJECT NOS. 7383-4 & 7966-4

We are sending you ☒ Attached ☐ Under Separate Cover Via FedEx Priority

- ☐ Report ☐ Copy of Letter ☐ Plans ☐ Specifications
☐ Calculations ☐ Originals ☐ Shop Drawings ☐

Copies	Date	No.	Description
1	5-12-06		Letter Re: April 12, 2006 Meeting
1	5-12-06		Letter Re: Fire Simulation Studies

These are transmitted:

- ☐ For Approval ☐ For Your Use ☒ As Requested ☐ For Review and Comment

file

TRANSMITTAL

May 12, 2006



**CODE CONSULTANTS
PROFESSIONAL ENGINEERS, PC**

Ms. Tamara Saakian, P.E.
Director of Engineering
Bureau of Fire Prevention
9 Metrotech Center
Brooklyn, NY 11201-3857

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**RE: FIRE SIMULATION STUDIES
WTC MEMORIAL AND MEMORIAL MUSEUM
PROJECT NOS. 7383-4 & 7966-4**

**The Fire Protection &
Life Safety Experts**

■ Code Consultation
■ Alarm Systems Design
■ Fire Sprinkler Design

Dear Ms. Saakian:

We have prepared this letter and the attached documentation to provide additional information requested in your letter of April 28, 2006.

1. MEMORIAL HALL FIRE SIMULATION WITHOUT WATERFALL

The following table illustrates the temperature, carbon monoxide concentration, and visibility, respectively, at 6 feet above the 285'-6" level of the Memorial during a 30 MW flammable liquid fire in Memorial Hall. The figures compare the conditions (A) with the waterfall included in the simulation and (B) without the waterfall. In each case, the smoke control system design with a total exhaust rate of 64,000 cfm has been included in the model. The snapshots are taken at the end of the fire (30 seconds) and at the time of maximum smoke spread (1 minute 10 seconds).

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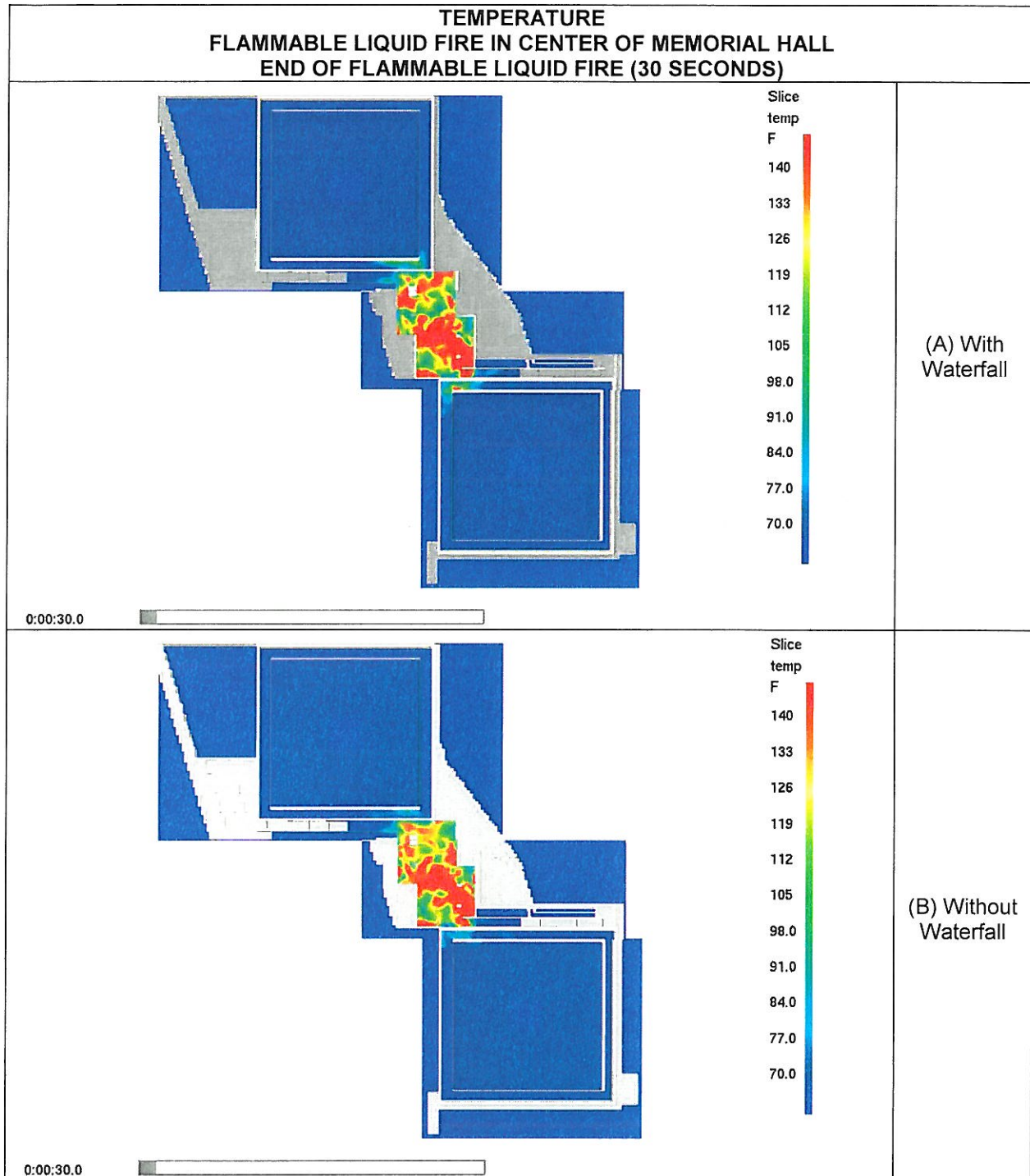
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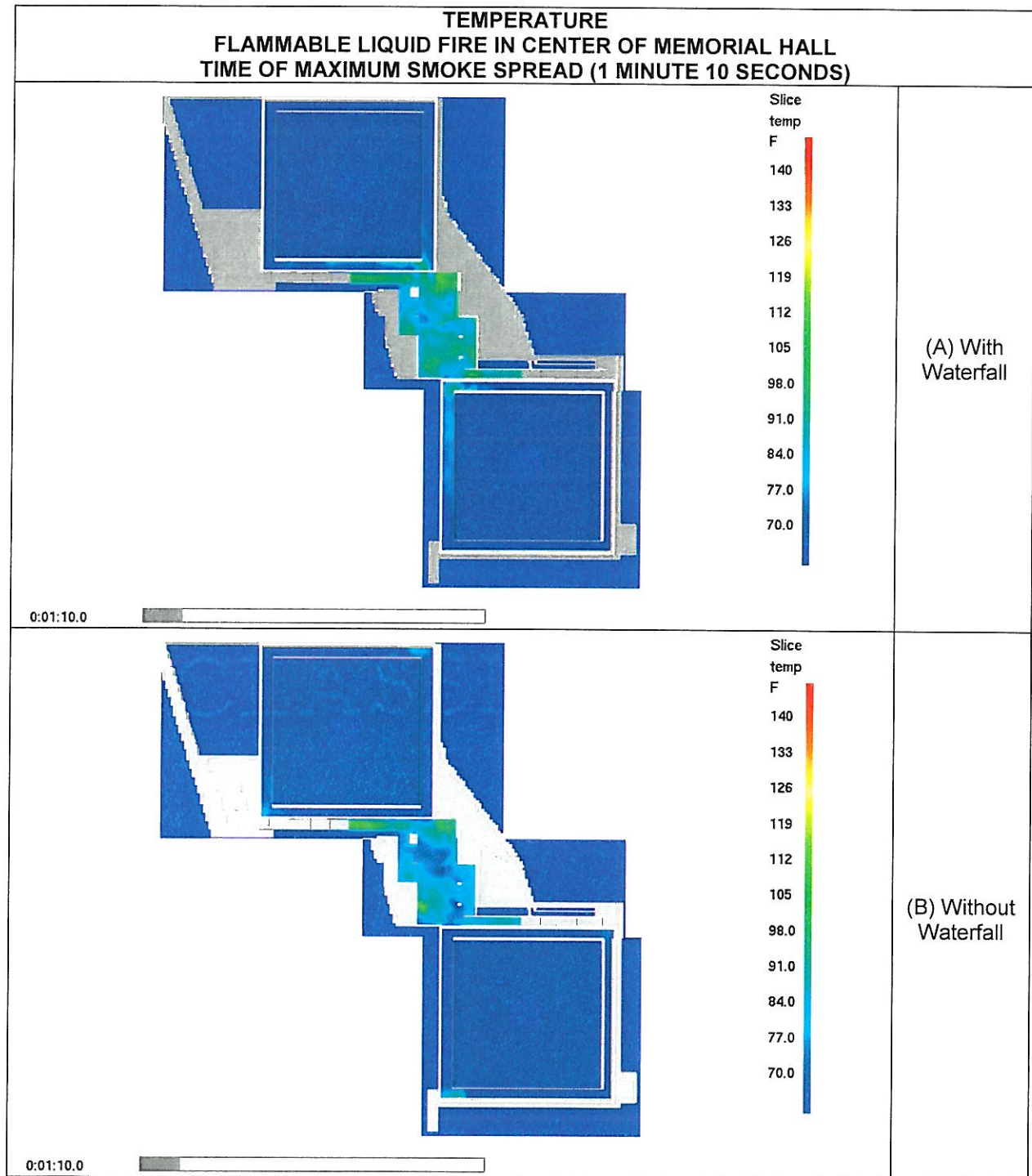
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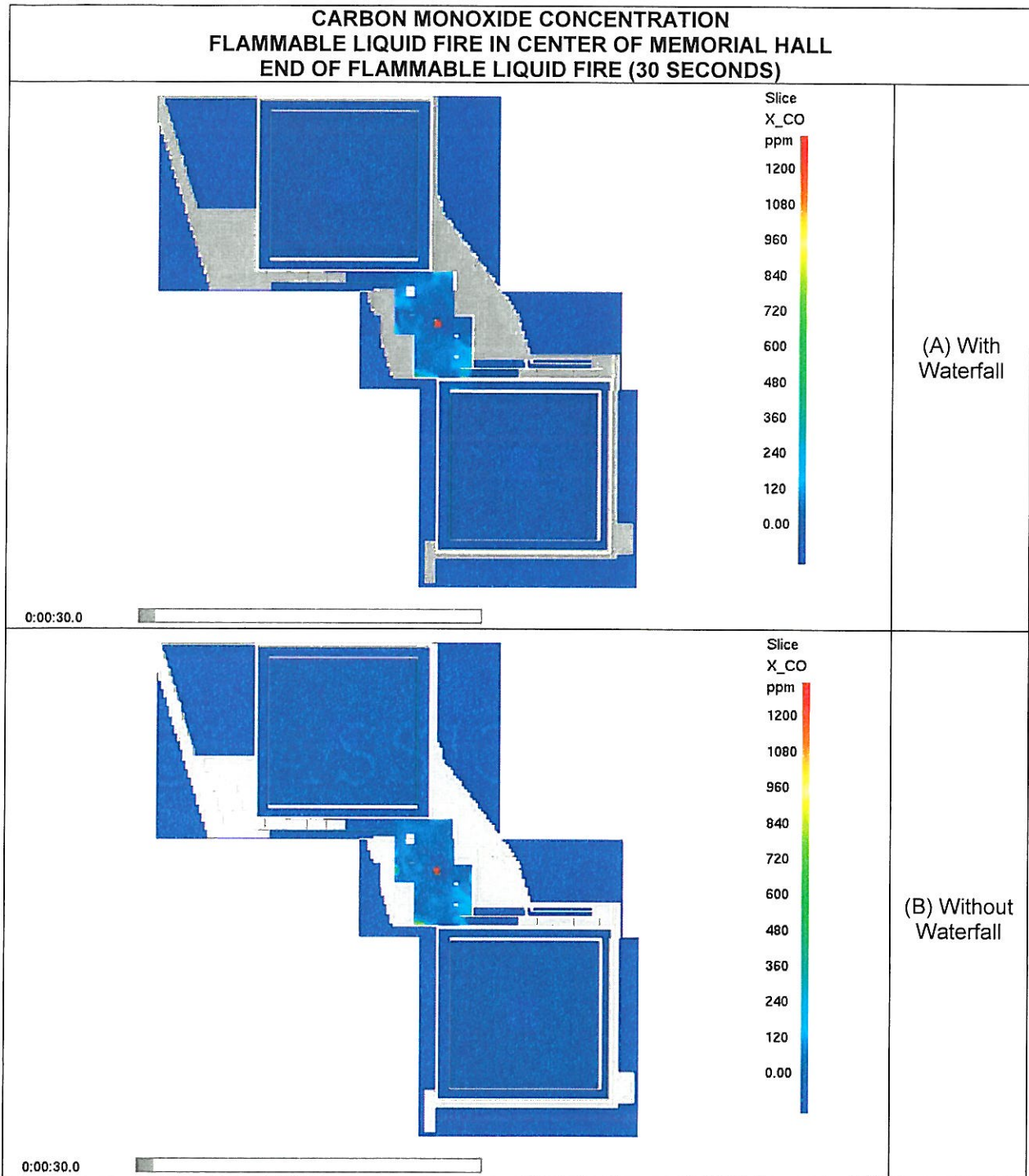
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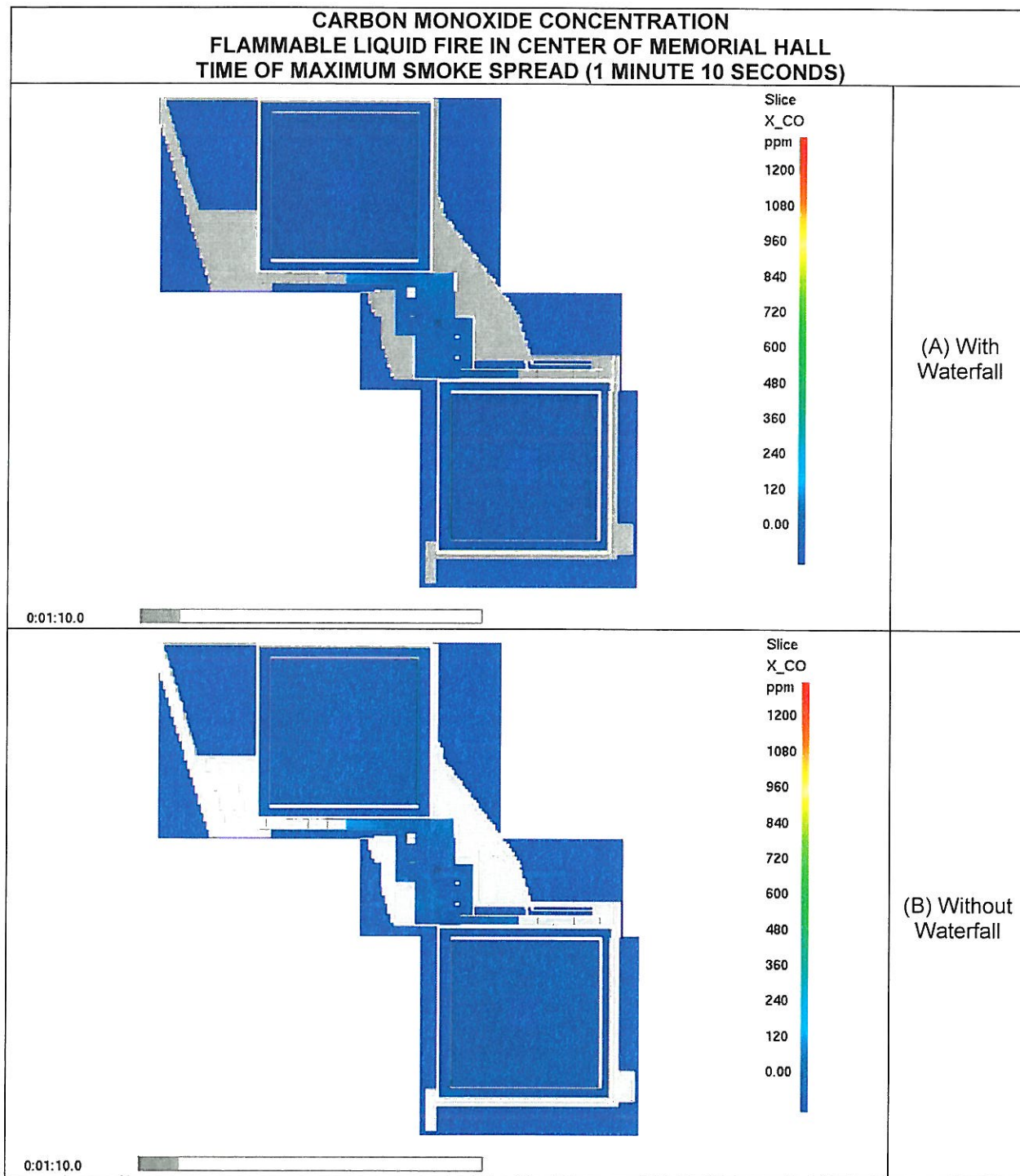
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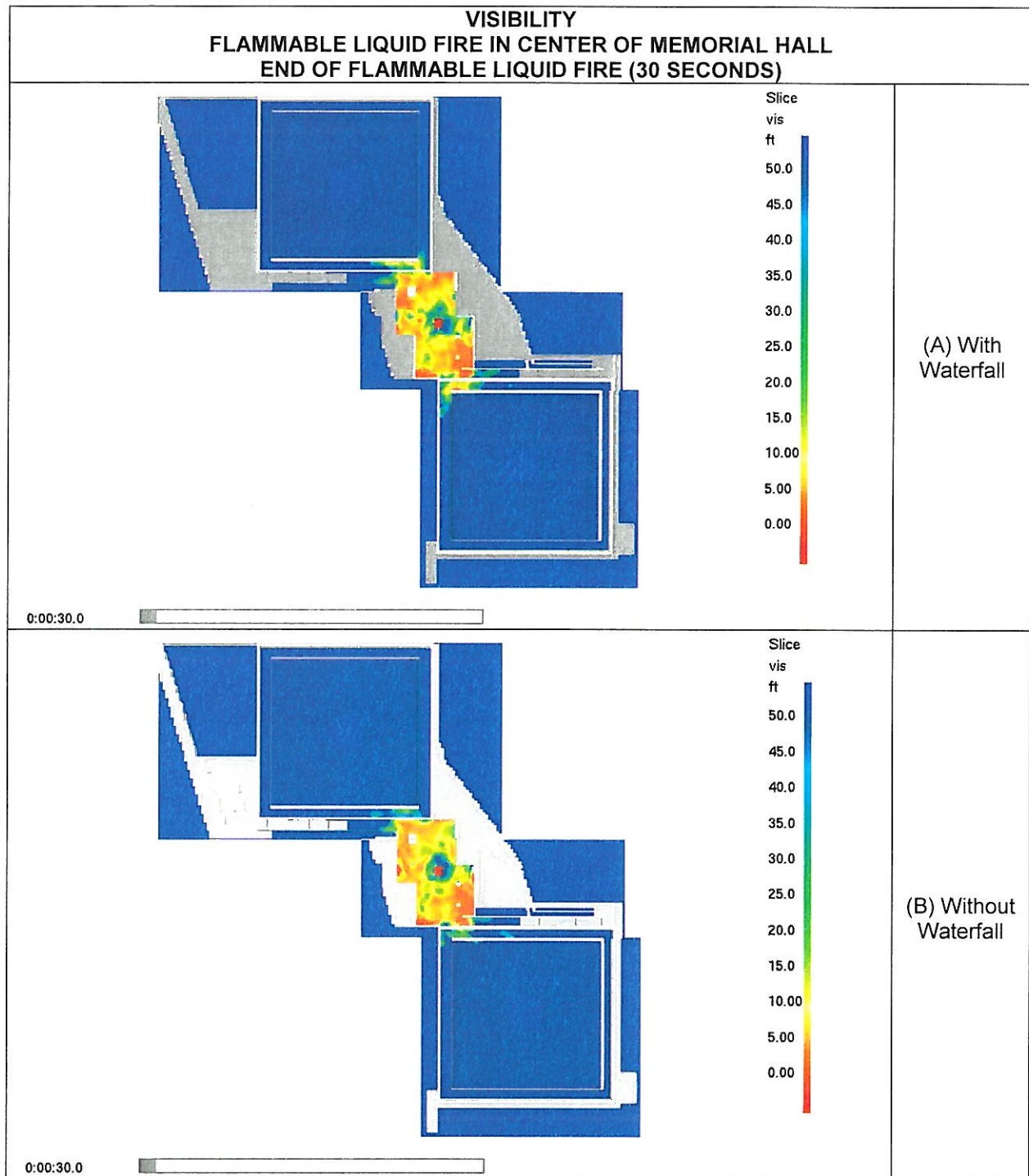
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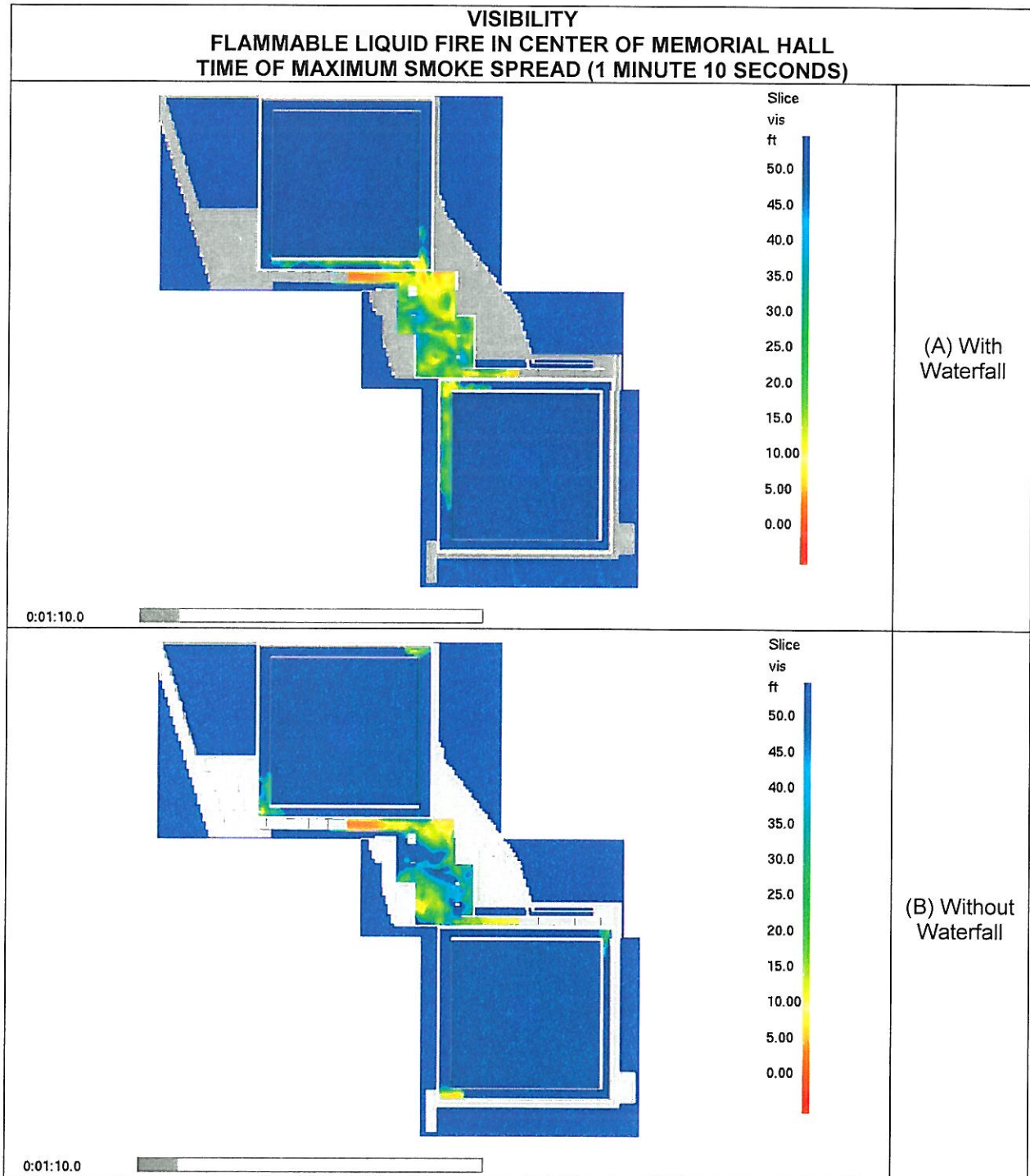
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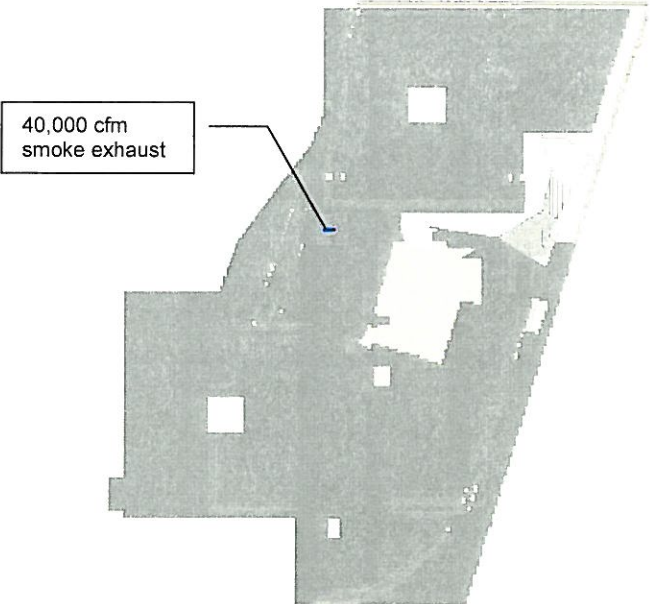
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At the end of the flammable liquid fire, the conditions in the Memorial Hall are the same with or without including the effects of the waterfall. At the time of maximum smoke spread in the galleries, minor differences can be seen between the conditions with and without the waterfall. Reduced visibility occurs over a larger area with the waterfall operational than when the waterfall is shut down. The conditions inside the Memorial Hall improve more quickly when the waterfall is shut down, versus when the waterfall remains in operation. Thus, the waterfall is proposed to be shutdown upon activation of the fire alarm system.

Pressurization of stairs and corridors was not modeled because the stair and corridor pressurization systems would only improve conditions during egress by providing a flow of fresh air low into the space and, thereby, helping to maintain tenable conditions at the level of the occupants. The analysis investigated worst case scenarios.

2. VENT LOCATIONS IN SMOKEVIEW

The following table illustrates the smoke exhaust vents locations in the World Trade Center Memorial Museum using the Smokeview renderings of the model. The figures are similar to a reflected ceiling plan and show the ceiling of each floor level viewed from below. Enclosed with this letter is the input file for the simulation with smoke exhaust locations highlighted (Enclosure A).

Smoke Exhaust Vent Locations	
	264'-270' Level 40,000 cfm Smoke Exhaust

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Smoke Exhaust Vent Locations	
 <p>A 3D architectural rendering of a building's interior space on the 284' level. A single smoke exhaust vent is indicated by a blue dot on a wall. A callout box points to this vent with the text "40,000 cfm smoke exhaust".</p>	<p>284' Level</p> <p>40,000 cfm Smoke Exhaust</p>
 <p>A 3D architectural rendering of a building's interior space on the 294' level. Three smoke exhaust vents are indicated by blue dots. Callout boxes point to each vent with the following text: "50,000 cfm smoke exhaust" (top left), "50,000 cfm smoke exhaust" (top right), "40,000 cfm smoke exhaust" (middle right), and "20,000 cfm smoke exhaust" (bottom right).</p>	<p>294' Level</p> <p>160,000 cfm Smoke Exhaust</p>

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3. EGRESS MODELING RESULTS

The egress modeling results were provided in Section VI and Appendix E of the January 27, 2006 Fire & Egress Modeling Studies report. If additional information is needed please contact us, so we can provide the requested documentation.

4. FLAMMABLE AND COMBUSTIBLE LIQUID STORAGE

The intent of the arson studies was to investigate an intentional destructive event that is not otherwise addressed by the prescriptive requirements of the Building Code or Fire Prevention Code. The Security Performance Criteria for the site identified that 5 gallons of liquid could be brought into the Memorial or Museum if security screening was not present. The fire modeling is intended to evaluate the performance of the fire protection systems during events that are not recognized by the applicable codes.

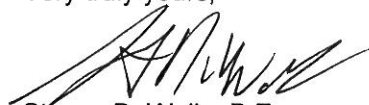
The 5 gallon flammable liquid fire scenario was not intended to account for flammable or combustible liquid storage in the building, because flammable and combustible liquid storage in the building is required to be located in a fire resistance rated enclosure that is secure from the remainder of the building. Fire scenarios investigated as part of the fire modeling studies simulate a fire condition where a flammable liquid fire is ignited in an occupied, unsecured area of the building, if screening procedures are not undertaken at normal entry points into the facility.

Nonetheless, flammable and combustible liquid storage exceeding 5 gallons is not proposed in the building, with the exception of fuel oil storage for the emergency generator. The fuel oil storage tank will be installed and protected in accordance with SubChapter 14 of the Building Code. The fuel oil storage tank for the emergency generator will be enclosed in 3-hour fire resistance rated construction and will be located on the lowest floor of the building (242' level). To provide power for required emergency loads, the fuel oil storage tank for the emergency generator will be approximately 8,000 gallons. The design specifications for the fuel oil storage tank are enclosed with this letter (Enclosure B).

Because the Building Code specifically permits fuel oil to be located within the building and requires fuel oil storage to be on the lowest floor of the building, the present location and quantity of fuel oil is proposed to remain on the 242' Level.

If there are any further questions or more information is needed, please contact us at your convenience.

Very truly yours,



Steven D. Wolin, P.E.
Technical Director

CODE CONSULTANTS



Kevin D. Morin, P.E.
Project Manager

Enclosure

c: Chief Patrick McNally, Bureau of Fire Prevention, FDNY
Fatma Amer, Department of Buildings, City of New York
Carl Krebs, Davis Brody Bond, LLP
Richard Vikse, Lower Manhattan Development Corporation

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ENCLOSURE A

FIRE DYNAMICS SIMULATOR INPUT FILE FOR FLAMMABLE LIQUID FIRE ON MUSEUM 242' LEVEL

NOTE: Obstruction lines for the architecture of the building have been omitted.

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ENCLOSURE B

SECTION 15560AC

WORK IN CONNECTION WITH THE EMERGENCY GENERATOR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of the General Conditions, Supplementary Conditions, and the following specification sections apply to all Work herein:

1. Section 15010AC - General.
2. Section 15020AC - Scope of Work.
3. Section 15245AC - Vibration Isolation.
4. Section 15500AC - Pipes, Valves, and Fittings.
5. Section 15540AC - Pumps.
6. Section 15990AC - Testing, Balancing, and Adjusting.

1.2 SUMMARY

- A. Furnish and install the tanks and vessels for various fuel oil systems herein specified and as indicated on the Drawings.

1.3 REFERENCE STANDARDS

- A. All tanks and vessels shall be designed, manufactured, and tested in accordance with the latest applicable standards including the following:

1. ASME.
2. Underwriters Laboratories.
3. American Welding Society.
4. NFPA.
5. UL.

1.4 QUALITY ASSURANCE

- A. After completion of installation, but prior to Substantial completion, Subcontractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB's), in a format acceptable to the Owner. In the event no product or material is available that does not contain asbestos, PCB or hazardous materials as determined by the Owner, a "Materials Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.

- B. In the event that materials, products, and/or processes being proposed for this Project contain, or may emit, any volatile organic compounds (VOC), formaldehyde formulations, or hazardous out-gassing, as determined by the manufacturer, a "Materials Safety Data Sheet", as described above, shall be submitted as part of the shop drawing process for review by the Engineer and/or Owner.
- C. All equipment and material to be furnished and installed on this Project shall be UL or ETL listed, in accordance with the requirements of the City of New York or any other Authority having jurisdiction, and suitable for its intended use on this Project.

1.5 SUBMITTALS

- A. The following submittal data will be furnished by the oil storage tank supplier and the emergency generator supplier according to the Conditions of the Construction Contract, Division 1 Specifications, and Section 15010AC and shall include but not be limited to:
 - 1. Fuel oil tanks, complete with physical dimensions, materials, capacity data, foundation and installation requirements, connection details, etc., and all accessories furnished with the fuel oil storage tanks.
 - 2. Emergency generator, complete with physical dimensions and all details on the material furnished with the generators.
 - 3. Fuel oil tank gauging and leak detection system.
- B. The following submittal data will be furnished by this Subcontractor according to the Conditions of the Construction Contract, Division 1 Specifications, and Section 15010AC and shall include but not be limited to:
 - 1. Installed tank arrangement, complete with controls, gauges, accessories, etc.
 - 2. Fuel oil tank gauging and leak detection system.
 - 3. Fuel oil filtration system.
 - 4. Fuel oil pumping system.

1.6 WARRANTY

- A. Comply with the requirements of the General Conditions, Section 15010AC, and this specification Section.

PART 2 PRODUCTS

2.1 UNAUTHORIZED MATERIALS

- A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB's) or other hazardous materials identified by the Owner.

2.2 ACCEPTABLE MANUFACTURERS

- A. If it complies with these Specifications, fuel oil specialties and equipment manufactured by OCP, Preferred Utilities Manufacturing Corp., Pneumercator, or Veeder-Root will be acceptable.

2.3 WORK IN CONNECTION WITH EMERGENCY GENERATOR AND FUEL OIL SYSTEMS

- A. Emergency generator, flexible connectors and silencers will be provided under Division 16 of the Specifications. The work to be performed under this Section shall include all work associated with the installation of the monoxide exhaust system, flexible connectors, generator silencers, the fuel oil system, including all piping, valves and pipe specialties, tank, and tank accessories, tank gauge and leak detection system, fuel oil filtration and pumping system, etc., as shown on drawings and specified whether furnished by the fuel oil storage tank supplier or not.
- B. Exhaust flue piping shall be attached to the building structure in such a manner as to prevent any vibrations from the generator being transmitted to the building and to allow for the thermal growth of the generator silencer and the flue pipe without exerting any forces due to such thermal movement on the building structure. Submit method of supporting the silencer and flue piping which shall be as recommended by the generator manufacturer. Vibration isolation shall be detailed in Section 15245AC. Submit weights and reactions of the silencers and flue piping for review by the Structural Engineers.
- C. The exhaust flexible connection(s), exhaust silencer(s), and exhaust piping arrangement shall be installed in accordance with the successful engine-generator manufacturer's installation drawings. The engine-generator manufacturer will furnish a detailed piping installation drawing. If, as a result of a different arrangement of pipe sizes, equipment, sizes and/or quantities of engine-generator sets made by the successful engine-generator manufacturer, there are any additional costs incurred, all changes required will be at no additional cost to the Owner.
- D. Engine exhaust piping and silencers shall be insulated in their entirety and protected from the weather in accordance with Article 15260AC entitled "Thermal Insulation".
- E. Subcontractor shall provide sufficient fuel oil for the initial testing and starting up of the emergency generator.

- F. Fuel oil storage tanks will be furnished and installed by this Subcontractor. This Subcontractor shall receive and store these units as they are received from the manufacturer's plant. He shall bring them to the project site, rig, and install them to provide a complete installation.
- G. This Subcontractor shall provide all required piping, valves, fittings, and any accessories as required to make a complete installation as specified and shown on the Contract Drawings. He shall install all accessories furnished by the fuel oil tank supplier or the Division 17 Subcontractor.
- H. Fuel Oil Storage Tanks
 - 1. Provide New York City approved all welded horizontal fuel oil storage tanks, having a capacity of one of 8,000 gallons, suitable for installation inside the building. Tank shall be constructed of not less than 1/4 inch thick Class A steel, in strict accordance with Underwriters Laboratories specification. All heads and shell rings shall be of 5/16 inch thick one-plate construction. Tanks 73 inches to 120 inches in diameter shall have 5/16 inch thick shell rings and 3/8 inch thick heads. Plates shall be gauged and inspected by a UL representative before fabrication.
 - 2. Each tank shall be lap welded continuously on the outside, and may be tack welded on the inside in accordance with UL specifications for same. Prior to painting, tank shall be pressure tested against leakage of not less than 5 nor more than 7 psig.
 - 3. Each tank shall be furnished with suitable saddles welded to the tank designed to continuously support the tank along the full length of the saddle base.
 - 4. Both the interior and exterior surfaces of tank(s) shall be sand blasted after fabrication to remove rust and scale to a near white blast in accordance with Specification SSPC-SP10 prior to factory applying paint. Tank(s) shall be internally coated with one coat of Koppers 654 epoxy primer to a dry film thickness of 1.5 mils with two top coats of Koppers 201 epoxy to a dry film thickness of 2.0 mils per coat, cured under controlled conditions, and be suitable for use with No. 2 fuel oil as intended. Paint exterior of tank(s) and the supporting frame(s) with two coats of red oxide paint, and suitably prepare for final field finish painting.
 - 5. Provide tank(s) with 24 inch diameter gasketed combination hinged manhole cover and emergency vent, integral internal ladder (painted in accordance with the above) and exterior ladder extending from the top of the tank down to the floor. Furnish each above ground tank with an exterior ladder with OSHA approved safety cage. The exterior ladder shall terminate at the top of tank to a continuous platform at the top of the tank. The platform shall be constructed of galvanized grating and be completely enclosed with OSHA approved safety railing. Platform shall be such that all tappings into the top of the tank are completely accessible from within the railed area. All piping connection fittings, manways and covers

and structural accessories, including ladders, saddles, platforms, railings, support frames, etc., shall be furnished complete by the tank manufacturer.

6. Provide a competent, factory service representative for final inspection of the fuel oil storage tank after installation is complete to perform a thorough inspection of the fuel oil storage tank(s), including all piping connections. Report deficiencies in writing to the Owner's Representative and the Consultant.
- I. Tank Gauging System: Provide remote reading fully automatic electronic fuel oil tank gauging system with optional leak/theft alarm for each fuel oil tank to provide continuous simultaneous indication of each tank's oil level. System shall utilize an intrinsically safe vertical lift type tank level float requiring less than 3 feet above the tank for insertion and removal to provide a continuous digital remote indication directly in gallons. The indicator shall have a die cast aluminum housing containing all of the electronics and adjustments, 0.8 inch digital display, flashing and audible alarm with silencing switch (display will continue to flash even if silencing switch is utilized) for tank high level, tank low level and extreme low level. System shall also be capable of electronic transmission to the building automatic temperature control system.
- J. Water Detection: Provide and install a single point capacitance level switch in each fuel oil tank to detect presence of water. The assembly shall consist of an integral mounting between a weighted TFE coated flexible probe and a NEMA 4X enclosure. Probe furnished shall be 6 feet in length, field adjusted to alarm at a level of water 6 inches above the bottom of the fuel oil tank. Unit shall operate on a 120 VAC input.
- K. Fuel Oil Tank Accessories: Provide for each of the fuel oil tanks, a 4 inch lock type fill box, 2-1/2 inch vent hood and 2 inch stick gauge box of approved type, see drawings for locations.
- L. All horizontal fuel oil piping between the main storage tank and the day tank shall be run within welded black steel outer piping and the entire installation covered with a two-hour fire rated enclosure.
- M. The day tank will be an integral part of generator set furnished under Electrical Section.
- N. Fuel Oil Transfer Pumps
 1. The pumps shall be duplex, rotary screw type, positive displacement type. Pump set shall be resiliently mounted on a substantial steel base, prepiped with individual suction lines (flanged) and common discharge line (flanged), and shall include but not be limited to the following: Suction and discharge pressure gauges, relief valve on each pump discharge piped back to pump suction, gate valves on each pump suction and discharge piping and discharge check valve for each pump. Provide flanged duplex canister suction strainers as shown on the Contract Drawings, with compound gauges. In addition to the above, the pump set shall be furnished completely prewired with an electrical control system with all components including all required starters, indicator lights, control transformers,

pressure interlocks, lead/lag alternator and surface mounted switch, etc., installed within an approved type NEMA enclosure mounted on the base.

2. Pumps to be complete with all equipment hereinafter specified, mounted, piped and wired by Subcontractor in field on a steel stand ready for oil suction, discharge and electrical connections. The unit shall be complete with the following equipment:
 - a. Two (2) fuel oil pumps, each with a rated capacity of not less than 450 gph and not less than 12 inch Hg. suction capability and 100 psig discharge pressure when operating with Commercial Grade No. 2 fuel oil (35 ssu.). Pumps shall be positive displacement gear type units similar to Viking No. GG195D for No. 2 pumping. Shop drawings must make a statement to this fact. Fuel oil pump motors shall be 1-1/2 hp, 460 volt, 3 phase, 60 hertz, and shall operate at a maximum speed of 1800 rpm.
 - b. One (1) screwed duplex strainer for the suction side of pump. Strainers shall be similar to Preferred Instruments No. 50 standard cast iron body, or as approved. Strainer shall have one-piece cast iron body ASTM A-48-58, Class 30, hydrostatically tested at 300 psi, and suitable for 200 psi service.
 - c. Subcontractor shall provide two (2) fuel oil pump relief valves. Each valve shall be similar to Bailey No. 118, or as approved, with an adjustable range of 75 to 200 psi, set at 100 psi.
 - d. Subcontractor shall provide two (2) 1-1/2 inch dial compound gauges to be placed on suction and discharge sides of suction strainer (see drawings). Each gauge shall be similar to Ashcroft, 0-30 psi and 0-30 inch vacuum, or as approved.
 - e. Subcontractor shall provide one (1) dial pressure gauge to be placed on discharge side of pumps (see drawings). Gauge shall be similar to Ashcroft, 0-300 psi, or as approved.
 - f. Subcontractor shall provide one flow diverting valve to interlock fuel oil flow to boilers and/or emergency generator day tank.
3. Motor Starters
 - a. Provide motor starters and control packages for each duplex fuel oil pump set, in NEMA enclosures. The control package shall include control transformer, pressure interlocks, automatic alternator, lead/lag controls, selector switches, auxilliary contacts for remote start stop and all indicator lights.
 - b. Provide On/Off switches and Hand-Off-Automatic switch for each oil pump.

- c. A wiring diagram shall be mounted on the Generator Room and Fuel Oil Pump Room walls.
 - d. Subcontractor shall perform necessary wiring and provide necessary components to interlock operation of fuel oil pump with package boiler(s) and/or emergency generator day tank contacts.
4. Piping
- a. All fuel oil piping shall be of the sizes noted on the drawings and as scheduled elsewhere. All oil side gate valves, as noted, shall be similar to Jenkins, or as approved. Globe valves shall be similar to Jenkins, or as approved. Vertical ball check valves for discharge side of each fuel oil pump shall be constructed of bronze with steel ball and shall be similar to Lunkenheimer, or as approved.
 - b. All piping, valves and fittings shall be in accordance with the drawings and shall be field fabricated.

O. Oil System Indication and Alarm Cabinet

- 1. Provide a master fuel oil system control cabinet in the Fuel Oil Room. The cabinet shall be installed in a location approved by the Engineer.
- 2. The cabinet shall incorporate all of the points of indication and alarm detailed hereinbelow.
- 3. A repeater panel shall be provided in the Generator Room at the entrance pavilion roof that shall provide all of the information from the cabinet in the Fuel Oil Room.
- 4. An auxiliary contact shall be provided to annunciate a common alarm for all points in the control cabinet. This common alarm shall be for the Division 17 Subcontractor and the Building Management System.
- 5. The cabinet shall provided continuous indication of fuel oil level in each fuel oil tank, manual fuel oil transfer pump control, fuel oil system alarm monitoring, water level alarm and tank status. The fuel oil control cabinet shall be free standing, constructed of 11 gauge steel continuous seam welded construction. The cabinet shall have two (2) full length, fully gasketed rear doors constructed of 14 gauge steel with 3 point latch and locking handle and three (3) lifting eyebolts. All internal components shall be mounted on removable perforated subplates. Cabinet finish shall be prime coated and painted as follows: exterior: Chemical resistant textured gray enamel; interior: white baked enamel; subplates: white baked enamel. The cabinet shall be factory wired and tested. All cabinet mounted devices shall be prewired to terminal strips for connection to field mounted devices. Cabinet mounted devices and field mounted devices shall include, but not be limited to the following:

a. Cabinet Mounted Devices

- 1) Indication of fuel oil tank levels through the tank gauging and leak detection system detailed in Paragraph I.
- 2) One (1) programmable logic controller (PLC) to transfer the information in the cabinet to the Generator Room repeater panel.
- 3) Two (2) pump-hand-off-auto selector switches.
- 4) One (1) lead pump selector switch.
- 5) All necessary alarm lights, alarm horn, lamp test pushbutton, alarm silence pushbutton, 0-30 minute (adjustable timer) to reenergize the alarm horn after actuation of the silence pushbutton, including circulation alarm beacon light, indicating status lights, circuit breakers, relays, motor starters, etc. to provide all required control status and alarm functions as indicated in Table "A".

b. Field Mounted Devices

- 1) Provide one (1) leak sensor for each tank vault, and one (1) leak sensor for the fuel oil transfer Pump Room.
 - 2) Provide four (4) leak sensors for outer pipe containment.
 - 3) All leak sensors shall be intrinsically safe, have continuous electronic checking, fail-safe to an alarm condition and have indicating transmitters with test switches to exercise the sensors and check the instrument response. Test systems that bypass the sensors or relay only on electric simulation are unacceptable.
6. The cabinet front panels shall have pilot lights indicating each alarm status. The indicating lights shall be activated from PLC digital outputs. This information shall also be capable of being displayed at the BMS system network computer via digital outputs from the PLC. Provide cabinet cut-outs with blank control plates for all alarms indicated as "future", plus a cut-out and blank coverplate for one (1) future tank status light.
7. Provide a separate remote audible and visual alarm at an approved location adjacent to the fill connection to alarm for each fill box spill sump and each tank high level condition. Panel shall provide flashing and audible alarm with silencing switch (display will continue to flash even if silencing switch is utilized).

PART 3 EXECUTION

3.1 GENERAL

- A. All tanks and specialties shall be installed in accordance with the latest industry standards, per the manufacturer's recommendations, and as indicated on the Drawings.
- B. See Section 15500AC titled "Pipes, Valves and Fittings" and Section 15510AC titled "Piping Accessories" for all piping requirements for standby generating system. This Subcontractor shall install all piping as necessary from the storage tanks to the fuel transfer pumps and from the fuel transfer pumps to the day tanks, including accessories and bypass pump and valves.
- C. Division 16 will install all control wiring interlocks required for the standby generating system fuel transfer pumps to be controlled automatically by the demand for fuel at the day tanks for the emergency generators. See Division 16 Specification Section 16620 titled "Electric Generating System" for requirements.
- D. All standby generating system fuel tanks shall be installed in accordance with the manufacturer's instructions, EPA Standards, and the requirements of the City of New York and all other national, state, and/or local Codes where applicable for the type of installation indicated.

3.2 FACTORY TESTING

- A. All tanks and vessels shall be tested in accordance with the latest applicable industry standards.

3.3 FIELD TESTING

- A. Refer to Section 15990AC for additional testing requirements for tanks and vessels.

END OF SECTION 15560AC