University of South Carolina
UTS Main Data Center Fire Suppression System
FP00000096
Addendum Four
July 19, 2018

The following items add to, modify, clarify, or otherwise alter the Drawings and/or specifications and will become a part of the Contract Documents. Where a portion of the Drawings and/or specifications is added to, modified, clarified, or otherwise altered, the portion not so affected shall remain. Bidder shall include all effects that these items may have on his proposal.

General:

These questions were asked during the second site visit conducted on 7/17/18 at 10 am at 514 S Main Street.

1. Do we need an allowance for asbestos abatement in our bids?

   No – The university staff will handle any asbestos or lead abatement. There is known asbestos in the sheetrock joint compound and some tiles adhered to the cement floor. If you must drill through these items – contact the university staff.

2. Will the clean agent piping be exposed?

   Yes - The clean agent piping will be installed exposed in the data room.

3. Is the contractor allowed to bid the tanks in an alternate location to avoid core drilling the cement walls?

   No – contractors will bid what is shown on the engineer's drawings.

4. Will the "Liebert" units remain on after system activation?

   Yes – The system design shown on the plans were calculated with the units remaining on to assist with mixing of the clean agent gas in the enclosure.

5. Is the contractor responsible for shutting down any equipment in the data center?

   No.

6. Can we bid the project with locating the tanks in the data center to avoid core drilling the cement walls?

   No – Contractors will bid the project where the tanks are shown on the Engineered drawings.

Pre-Bid questions Received by 7/18/18:

A. If the old halon piping is not reused, are we still responsible for the demo and removal?

   This question was answered in Addendum # 2 Question # 5. I will provide the following clarification of the previous answer:

- The contractor is responsible for removal of all existing halon piping, nozzles, hangers, or other components of the old halon system within the data center.
- The contractor is not responsible for removing piping above the cement deck. There is piping below raised floors in office above the data center which will remain.
- The contractor may reuse existing halon piping in good conditions per the General Note F20 on sheet CA1.

B. If the area indicated on the referenced drawings does not pass the required integrity test, who is responsible for properly sealing the area so that it will pass the integrity test? Would the installing subcontractor be protected per General Conditions of the Contract for Construction, section 3.7.4?

The data center had an integrity test conducted 11/4/14 and the room passed. A copy of the test is attached to this addendum.

The owner stated since this test, they have been sealing up air leaks in the room and they feel another test of the room is not warranted.

The contractor is not responsible for the cost of sealing the room should the previous integrity tests not hold true in any future testing activities.

C. How many Room Integrity Tests should be included in the Bid?

None – see answer to question B.

D. Is annunciator panel required in the control room?

Yes - a remote annunciator is required in the control room per CA 2. The contractor will coordinate the exact location with USC's project manager.

E. Please confirm that we may re-use existing pipe where possible.

Yes - Please see the answer to Question B above.

F. Is FM-200 or other "agent" allowed, or only NOVEC-1230?

Contractors shall bid NOVEC-1250 (also known as Sapphire or FK-5-1-12) as the basis of their bids. Design calculations were not done for other agents.

Sheet CA 1 Rev 4

A typographical error was found on Sheet CA 1 and is corrected in Revision 4. The ceiling height was shown as 7' 5", in the volumetric calculations for the plan East side of the data center. The volume shown is correct because but 9' 10" was used for the calculation. Corrected CA 1 attached.

Enclosures – Sign In sheet from 7/17/18 site visit
Data Room Integrity Test
Sheet CA 1 Rev 4

END OF ADDENDUM FOUR

Second Site Visit Fire Suppression System PreBid - 4TS Data Center

Tuesday 7/17/18 10:00AM

Name	Company	Email
Thomas McCarty	JCI	thomas.mccarty@jci.com
Richard Rasshal	JCI	Richard.Rasshal@JCI.com
Andrew Bernstein	JCI	andrew.bernstein@jci.com
Ralph Foster	Foster Engineering	Ralph@FosterEngr.com
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Enclosure Integrity Test Report

In compliance with NFPA 2001 (2012 Edition) Annex C Enclosure Integrity Procedure and using FSSA peak pressure equations

Tested enclosure:	MUSC Data Center
Tested building:	MUSC Data Center
Building Address:	514 South Main Street Columbia, SC
Performed for:	University of SC c/o Foster Engineering
Performed by:	Tommy Middleton
Certification level	3
Test date:	2014-11-04
Associated Test report:	P:\Customer Job Files\FOSTER ENGINEERING\USC- Main Street Data Center\USC- Data Center NFPA-US 2014-11-04 0739- NOVEC.fxml

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Summary –

retrotec **FanTestic Integrity**	version: **5.6.0**	licensed to: **Columbia Fire and Safety**
Test date: **2014-11-04**	By: **Tommy Middleton**	Certification: **3**
Location: **514 South Main Street Columbia, SC**		Building: **MUSC Data Center**
Witness: **Ralph Foster, Foster Engineering**		**fosterengr@sc.rr.com**

Enclosure conditions prior to discharge	
Net protected volume, V [cu ft]	**104,958.8**
Max flooded height, H_o [ft]	**10.1**
Required protected height, H_p [ft]	**8.5**
Design temp, T [°F]	**72.0**
Enclosure pressure limit, [Pa]	**1,000**
Specified Hold Time, [min]	**10**
Elevation, [ft]	**300**
Minimum design humidity	**42%**
Maximum design humidity	**59%**

Extinguishing agent details	
Agent	**Novec 1230 [FK-5-1-12]**
Quantity [%]	**4.7**
Type	**Halocarbon**
Discharge time, [s]	**10**
Mixing during hold time	**Yes**
Initial concentration, c_i	**4.7%**
Design concentration, c	**4.7%**
Minimum concentration, c_{min}	**4%**
Bias during Hold, P_{bh} [Pa]	**1.4**

Test equipment	
Fan make/model	**Retrotec 3000SR**
Fan serial #	H02016
Fan calibration date	10/8/2013
Gauge make/model	**DM-2**
Gauge serial #	97913
Gauge calibration date	2/20/2014

Hold time results	
Leakage exponent, n	**0.608**
Leakage constant, k_1 [CFM/Pa^n]	**418.0**
Total Leakage Area, [sq in]	**500**
Predicted Hold Time, t [min]	**24**

Hold Time compliance based on Annex C of NFPA 2001 (2012 Edition)

Calculations predict that the extinguishing agent concentration will fall from the initial concentration of 4.7% to the minimum concentration of 4% in **24.2 minutes**. The enclosure **PASSES** this acceptance procedure because this hold time is greater than the specified minimum of 10 minutes.

Peak Pressure compliance using FSSA equations

Calculations predict a maximum positive peak pressure of **161 Pa**. This pressure is less than the specified maximum enclosure pressure limit of 1,000 Pa, therefore the enclosure **PASSES** this part of the procedure

Calculations predict a maximum negative peak pressure of **983 Pa**. This pressure is less than the specified maximum enclosure pressure limit of 1,000 Pa, therefore the enclosure **PASSES** this part of the procedure.

Assumptions and warnings

While FanTestic Integrity software may identify clean agent peak pressure and hold time risks, use of this software does not in any way guarantee the elimination of those risks.

Enclosure Integrity (hold time)

The enclosure was tested in compliance with NFPA 2001 (2012 Edition) Annex C Enclosure Integrity Procedure. These tests only address potential failures in maintaining extinguishing agent concentration due to excessive enclosure leakage. The following assumptions were made:

- The initial extinguishing agent concentration as indicated in the test report will be achieved.
- Ductwork connected to air-handling systems that are outside this enclosure will be either isolated with dampers or will be shut down during the hold time.
- If air handlers are used to provide continuous mixing, they will be dedicated to this enclosure and will not create significant flows across the enclosure boundaries.
- An adequate return path for the air flow was provided during the enclosure integrity door fan tests.
- All intentional openings will be sealed during the enclosure leakage for hold time tests.
- The conditions in the enclosure are such that the air will be moving enough during the hold time to force the extinguishing agent and air to mix continuously and NOT form an agent/air interface.
- All other non-integrity tests, as outlined in the NFPA standard, will be satisfactorily completed.

Enclosure Integrity (peak pressure)

Enclosure integrity tests and calculations were performed to determine that the enclosure has adequate venting to provide peak pressure relief as required by NFPA 2001 (2012 Edition) section 5.

Calculations for peak pressure were performed using equations from the Fire Suppression Systems Association (FSSA) “Pressure Relief Vent Guide”.

The following assumptions were made:

- All intentional openings will be set to the operating condition expected during the agent discharge for positive peak pressure relief when enclosure leakage is tested for positive vent area.
- In addition, for halocarbons only, all intentional openings will be set to the operating condition expected during the agent discharge for negative peak pressure relief when enclosure leakage is tested for negative vent area.
- Adequate air flow was provided along a path leading to outdoors for the test fan but the doors surrounding the enclosure were set in the position that provide the lowest air flow required to establish the required test pressures.
- Design temperature inside the tested enclosure during discharge is 72.0 °F.
- Relative humidity in the enclosure will range between 42% and 59%.

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Background

Hold time prediction, Continuous Mixing Model

This procedure predicts the hold time for the extinguishing agent concentration to drop from the initial concentration to the minimum concentration, based on the variables shown in this report. It is assumed that the conditions in the enclosure are such that the air will be moving enough during the hold time to force the extinguishing agent and air to mix continuously and NOT form an extinguishing agent/air interface. Due to the conservative assumptions regarding leakage distribution, this prediction model usually predicts a shorter retention time as compared to an actual discharge, but not always.

A calculation for continuous mixing will yield the same results at all levels in the enclosure and is recommended for enclosures where protection must be held at high levels in the enclosure. This prediction only applies to conditions as found at the time of the test. Additional penetrations, weather, open doorways, HVAC modifications, malfunctions and the inherent assumptions in the enclosure integrity procedure could all combine to give very different results in a real discharge.

Leakage area defined for hold time

The Total Enclosure Leakage test measures all unintentional holes in the enclosure, the sub-floor and the above-ceiling space, whether or not extinguishing agent will leak out of these holes. All intentional openings (such as installed pressure relief vents) must be held in their closed position but not sealed. The measurement is performed over a range of pressures so that the exact leakage rate at lower pressures for agent loss will be known. The predicted hold time is worst case since it is assumed that half of the measured leakage is located in the ceiling and the other half is located in the floor.

Leakage area defined for Peak Pressure

Leakage for peak pressure does not depend on leak location, making the leakage area from the Total Enclosure Leakage test accurate for use in peak pressure prediction. All intentional openings (such as installed pressure relief vents) must held in the positions they are expected to be in during the positive peak pressure spike during discharge. For halocarbons, this test must be repeated where all intentional openings (such as installed pressure relief vents) must held in the positions they are expected to be in during the negative peak pressure spike during discharge. The measurement is performed over a range of induced test pressures so that the exact leakage rate at the higher reference pressure of 125 Pa for venting will be known. The predicted peak pressure will then be based on an enclosure leakage that accurately represents the free vent area faced by the agent discharge.

Discussion of Results –

Hold Time

Compliance with Annex C of NFPA 2001 (2012 Edition)

It is predicted that the leakage area **measurement** in this enclosure of 500 sq in would allow the extinguishing agent concentration to fall from the initial concentration of 4.7% to the minimum concentration of 4% in **24.2 minutes**. This hold time is greater than the specified minimum of 10 minutes, therefore the enclosure **PASSES** this acceptance procedure. The hold time is calculated based on a 'continuous mixing' model where NO interface is formed between extinguishing agent and air. Under mixing, all locations throughout the enclosure fall to the same percent concentrations at the same time.

Peak Pressure

Compliance with section 5 of NFPA 2001 (2012 Edition)

5.3.7: *The protected enclosure shall have the structural strength and integrity necessary to contain the agent discharge. If the developed pressures present a threat to the structural strength of the enclosure, venting shall be provided to prevent excessive pressures.*
And that the following shall be submitted for approval to the authority having jurisdiction:
5.1.2.2 (10): *maximum positive and the maximum negative pressure... expected to be developed upon the discharge of agent*
5.1.2.2 (28): *pressure relief vent area… to prevent development of a pressure difference across the enclosure boundary that exceeds a specified enclosure pressure limit.*

Calculations for peak pressure, based on leakage area of **Enclosure Only** at a standard reference condition of 125 Pa and using no pressure relief vent (PRV), determined:

- The enclosure would represent a free vent area during discharge of 852 sq in with the enclosure set up in the condition expected to occur during the positive pressure pulse caused by the agent discharge which is predicted to be **161 Pa**. This pressure is less than the specified maximum of 1,000 Pa, therefore the enclosure **PASSES** this part of the procedure
- The enclosure would represent a free vent area during discharge of 852 sq in with the enclosure set up in the condition expected to occur during the negative pressure pulse caused by the agent discharge which is predicted to be **983 Pa**. This pressure is less than the specified maximum of 1,000 Pa, therefore the enclosure **PASSES** this part of the procedure.

Vents should be installed high in the enclosure so that mostly air is exhausted, instead of the heavier extinguishing agent. Additionally, the vents should be rated to fully open between 80-130 Pa. Once a vent is installed or it is decided to use leakage of the enclosure only to relieve pressures during discharge, the chosen venting situation is used to calculate expected peak pressure, and the available free vent area must be enough

to relieve this peak pressure in order to pass. All leakage areas are extrapolated to a standard reference condition of 125 Pa which is representative of conditions where most of the peak pressure will be relieved

Peak pressure calculation detail

Using the leakage area of **Enclosure Only** and equations from the Fire Suppression Systems Association (**FSSA**) "Pressure Relief Vent Guide":

- At the highest humidity of 59%, a peak positive pressure of approximately **161 Pa** would form.
- At the lowest humidity of 42%, a peak negative pressure of approximately **–983 Pa** would form.

Free vent area required calculation detail

Assuming an Enclosure Pressure limit of ±1,000 Pa, this enclosure requires a total vent free area of **145 sq in** in the positive direction and **838 sq in** in the negative direction to maintain the enclosure's structural integrity.

Free vent area available calculation detail

The leakage area during discharge will be:

- **852 sq in** for the **Enclosure Only** with the enclosure set up in its Positive Discharge Period Condition, where any dampers or installed PRV were fixed in the position they would assume under +125 Pa.
- **852 sq in** for the **Enclosure Only** with the enclosure set up in its Negative Discharge Period Condition, where any dampers or installed PRV were fixed in the position they would assume under -125 Pa.

Additional PRV area required detail

The Enclosure Only provides 852 sq in of positive venting area. Since this is less than the required total of 145 sq in, this enclosure **does not require any additional PRV area** to maintain structural integrity and pass the peak pressure procedure in the positive direction.

The Enclosure Only provides 852 sq in of negative venting area. Since this is less than the required total of 838 sq in, this enclosure does thus **not require any additional PRV area** to maintain structural integrity and pass the peak pressure procedure in the negative direction.

Enclosure Construction Data

The maximum flooded height used in the calculations is 10.1 ft. The equipment was installed in the room, and the top of the rack was measured to be 8.5 ft, so 8.5 ft was taken as the minimum height for protection. Net protected volume used is 104,958.8 cu ft. Building elevation used is 300 ft, and the elevation correction factor used in the calculations is 1.

Total Enclosure Leakage test data

Based on **measured** values, the enclosure alone has an equivalent leakage area of **500 sq inches** at a reference pressure of 10 Pa.

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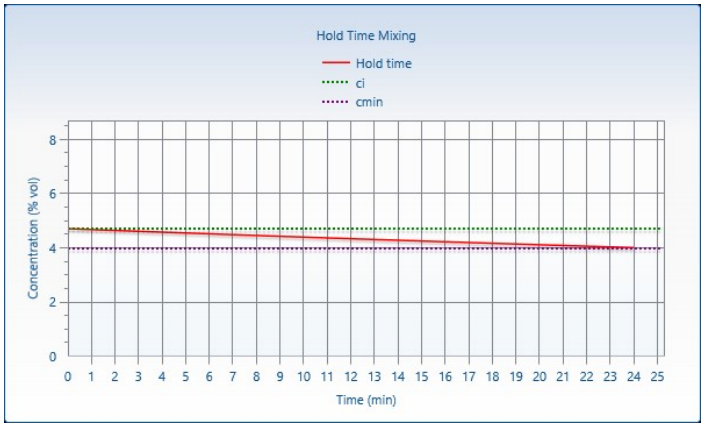
The following table represents the results from the enclosure integrity procedure carried out on the whole enclosure, with all intentional openings sealed.

Test conditions			
Test date	2014-11-04	Inside temperature, T_e [°F]	**68 °F**
Test time	08:24	Outside temperature, T_o [°F]	**68 °F**
Operator location	Inside	Bias pressure, P_{bt} [Pa]	**1.40**

		Depressurize Data		Pressurize Data		
Induced pressure [Pa]		-10.7	-50.6		10.6	50.4
Fan #1, Range C8	Fan Pressure [Pa]	373		Fan #1, Range C8	484.5	
	Flow [CFM]	1632			1899	
Fan #1, Range A	Fan Pressure [Pa]		288	Fan #1, Range A		274
	Flow [CFM]		4604			4492
Total Flow rate [CFM]		1632	4604		1899	4492
Leakage exponent, n		0.7114			0.5147	
Leakage characteristic, k_1 [CFM/Pa^n]		277.0			606.0	
Leakage area at 10 Pa [sq in]		418.93			582.8	
Correlation, r						



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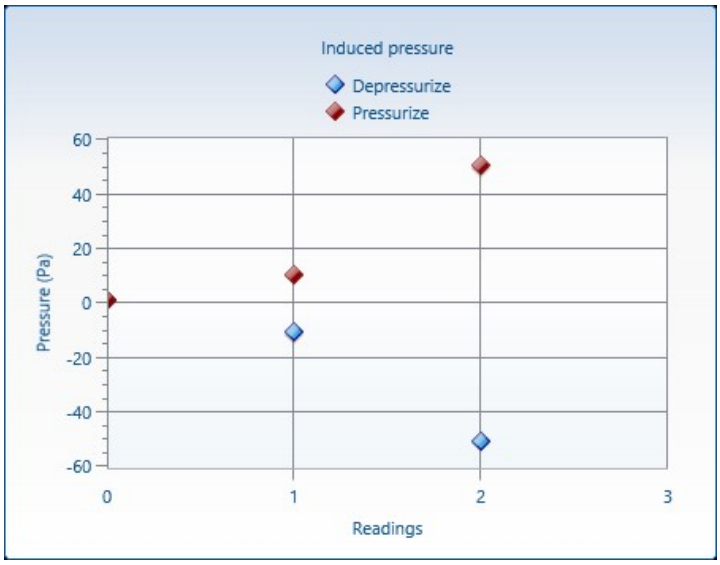

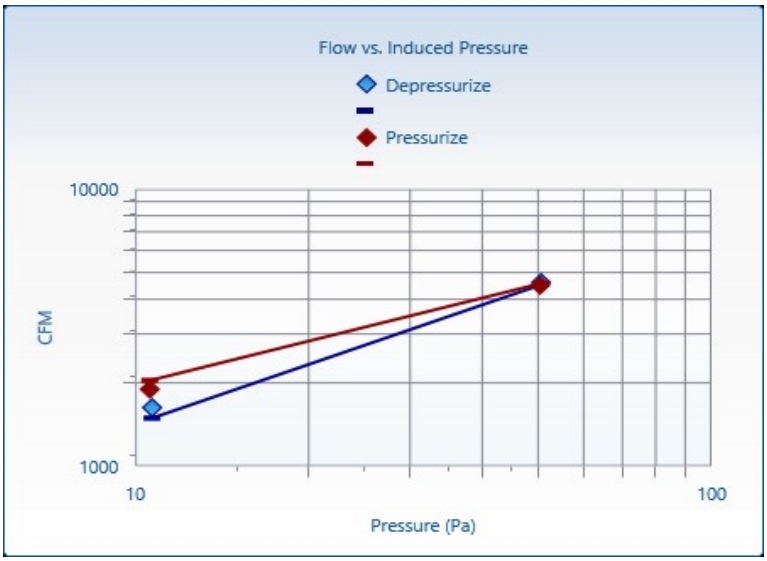

Venting data for Enclosure Only

There was no PRV installed for pressure relief so the Total Enclosure Leakage **measured** was extrapolated to the reference pressure of 125 Pa and used in further calculations as the only available leakage for peak pressure relief.

In the case where the leakage area of the PRV only was to be used for pressure relief, but leakage area for enclosure and vent was entered as the venting area dataset, to determine leakage area for pressure relief by PRV alone, the leakage of the enclosure would have been subtracted from the leakage of the venting dataset.

In the case where the leakage area of the enclosure and PRV was to be used for pressure relief, but leakage area for vent only was entered as the venting area dataset, to determine leakage area for pressure relief by the enclosure and PRV, the leakage of the enclosure would have been added to the leakage of the venting dataset.

Positive direction data

The positive free vent area provided by the Enclosure Only is **852 sq in**, for the enclosure set up in its Positive Discharge Period Condition, with all dampers or installed PRV fixed in the position they would assume under +125 Pa.

The leakage of the Enclosure Only in the positive direction was obtained by **measuring**, and this leakage was manipulated as necessary to determine the leakage area of the Enclosure Only required for positive pressure relief.

Negative direction data

The negative free vent area provided by the Enclosure Only is **852 sq in**, for the enclosure set up in its Negative Discharge Period Condition, with all dampers or installed PRV fixed in the position they would assume under -125 Pa.

The leakage of the Enclosure Only in the negative direction was obtained by **measuring**, and this leakage was manipulated as necessary to determine the leakage area of the Enclosure Only required for negative pressure relief.

Minimum & maximum humidity levels are recommended levels provided by the ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers). ASHRAE recommends a dew point temperature range of 41.9 to 59% for proper operation in a server environment and to protect against static electricity. If the humidity levels in the room noted in this report are not within the ranges noted it is recommended that the proper adjustments are made to achieve these levels. If the humidity levels are outside of this range, retention time and peak pressures may not be accurate.

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Peak Pressure data

Peak pressure was calculated using the leakage of the Enclosure Only and equations from the Fire Suppression Systems Association (FSSA) "Pressure Relief Vent Guide". FSSA equations depend on experimentally derived curves for peak pressure based on a Leak to Volume ratio for the enclosure.

Design details	
Enclosure pressure limit, [Pa]:	**1,000**
Discharge time, [s]:	10
Pressure relief vent type:	no pressure relief vent (PRV)
Peak Pressure relief using:	Enclosure Only

Peak Positive Pressure	
Peak positive pressure, [Pa]	**161**
Leak to volume ratio, LVR_{pos} [sq in/cu ft]	8.1

Venting summary – Positive Direction	
Minimum required leakage, [sq in]	145
Venting area used, [sq in], (describes Enclosure Only)	852
Additional PRV area needed, [sq in]	**0**

Peak Negative Pressure	
Peak negative pressure, [Pa]	**983**
Leak to volume ratio, LVR_{neg} [sq in/cu ft]	8.1

Venting summary – Negative Direction	
Minimum required leakage, [sq in]	838
Venting area used, [sq in], (describes Enclosure Only)	852
Additional PRV area needed, [sq in]	**0**

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Test Equipment

The following test equipment was used in the performance of the enclosure integrity tests.

	Fan	Fan serial	Fan calibration	Gauge	Gauge serial	Gauge Calibration
#1	Retrotec 3000SR	H02016	10/8/2013	DM-2	97913	2/20/2014

Fan Calibration Certificate Retrotec 3000SR:

Retrotec 3000SR H02016						
Range	**n**	**K**	**K1**	**K2**	**K3**	**K4**
Open(22)	0.5214	519.618	-0.07	0.8	-0.115	1
A	0.503	264.996	-0.075	1	0	1
B	0.5	174.8824	0	0.3	0	1
C8	0.5	78.5	-0.02	0.5	0.016	1
C6	0.505	61.3	0.054	0.5	0.004	1
C4	0.5077	42	0.009	0.5	0.0009	1
C2	0.52	22	0.11	0.5	-0.001	1
C1	0.541	11.9239	0.13	0.4	-0.0014	1
L4	0.48	4.0995	0.003	1	0.0004	1
L2	0.502	2.0678	0	0.5	0.0001	1
L1	0.4925	1.1614	0.1	0.5	0.0001	1

Flow in CFM using the above calibration factors is calculated as follows:

$$flow = (FP - CR \times K1)^n \times (K + K3 \times FP) \times K4$$

FP = fan pressure, CR = corrected room pressure

GENERAL SYSTEMS NOTES–

F1. THIS IS A NOVEC 1230 "CLEAN AGENT" FIRE SUPPRESSION SYSTEM WITH A CONVENTIONAL DEDICATED FUNCTION LOCAL FIRE ALARM SYSTEM UL-LISTED FOR AGENT RELEASE. THE NEW SUPPRESSION SYSTEM WILL PROTECT THE SERVER ROOM #011 AND THE SERVER ROOM'S SUB-FLOOR. SEE NOTE F19.

F2. SYSTEM IS DESIGNED AND WILL BE MAINTAINED PER NFPA 72 (2013 EDITION), NFPA 2001 (2015 EDITION) & THE IFC (2015 EDITION).

F3. DESIGN CONCENTRATION SHALL BE MINIMUM REQUIRED FOR CLASS "C" HAZARDS PER NFPA 2001; FK 5-1-12 (Novec 1230)- 4.5%.

F4. CONTRACTOR TO PROVIDE FULL BATTERY & VOLTAGE DROP CALCULATIONS FOR SUBMITTAL & RECORD DOCUMENTS. THE SYSTEM SHALL BE PROVIDED WITH 24 HOURS OF STAND-BY WITH 5 MINUTES OF ALARM TIME.

F5. SHOP DRAWINGS, CALCULATIONS AND MANUFACTURER'S DATA SHEETS SHALL BE SUBMITTED FOR APPROVAL TO FOSTER ENGINEERING BEFORE SYSTEM INSTALLATION. THE CONTRACTOR SHALL SUBMIT ALL DOCUMENTS ELECTRONICALLY IN PDF FORMAT. DOCUMENT PROTECTION (IF USED) MUST ALLOW FOR MARKUPS BY FOSTER ENGINEERING.

F6. ALL SYSTEM DEVICES AND CIRCUITS WILL BE TESTED IN ACCORDANCE WITH NFPA 72 & THE IFC.

F7. A RECORD OF COMPLETION WITH THE APPROVED DRAWINGS AND SPECS WILL BE PROVIDED IN ACCORDANCE WITH NFPA 72 & THE IFC.

F8. INSTRUCTIONS FOR OPERATING, TESTING AND MAINTENANCE WITH THE RECORD DRAWINGS AND SPECIFICATIONS WILL BE PROVIDED AT AN APPROVED LOCATION PER THE IFC. UPON FINAL ACCEPTANCE OF THIS SYSTEM, THESE DRAWINGS, THE OWNER'S MANUAL, THE DEVICE DATA SHEETS AND ALL OTHER APPLICABLE DOCUMENTATION WILL BE DELIVERED TO THE FACILITY REPRESENTATIVE. THE CLOSEOUT DOCUMENTS SHALL INCLUDE ONE (1) ELECTRONIC COPY AND ONE (1) PRINTED COPY OF THE APPROVED SHOP DRAWINGS.

F9. THERE APPEAR TO BE NO KNOWN AREAS OF CONCERN FOR FALSE ALARM

F10. ABORT SWITCH MUST BE "DEAD MAN" STYLE, SHALL ONLY DELAY SYSTEM DISCHARGE AND SHALL NOT RESET COUNTDOWN.

F11. SEE PIPE INSTALLATION NOTES FOR PIPING INFORMATION.

F12. A ROOM INTEGRITY TEST WAS PERFORMED IN NOVEMBER OF 2014. AT THAT TIME THE ROOM WAS SATISFACTORY FOR RETENTION TIME AND PEAK POSITIVE PRESSURES. THE PEAK NEGATIVE PRESSURE RESULTS REQUIRED THAT AN ADDITIONAL 788 SQUARE INCHES OF VENTING BE PROVIDED. THE ROOM CONSTRUCTION HAS BEEN ALTERED SINCE THE ORIGINAL TEST. A FOLLOW UP FAN TEST SHALL BE PERFORMED BY THE CONTRACTOR TO RE-ESTABLISH THE ENCLOSURE INTEGRITY.

F13. SEISMIC NOTES–
- A FLEXIBLE CONNECTION MUST BE USED TO CONNECT THE AGENT CYLINDER TO THE DISCHARGE PIPING.
- THE AGENT CYLINDER MUST BE RESTRAINED USING TWO (2) STRAPS THAT MUST BE ATTACHED TO A MINIMUM OF THREE (3) WALL STUDS.
- MAINTAIN A MAXIMUM DISTANCE OF 12" FROM THE POINT OF ATTACHMENT TO THE STRUCTURE AND THE TOP OF ALL HORIZONTAL OVERHEAD PIPING.

F14. PER NFPA 2001-4.3.1.3 ALL INITIATING AND RELEASING CIRCUITS SHALL BE INSTALLED IN RACEWAYS.

F15. CONTRACTOR SHALL PROVIDE TWO (2) SIXTY MINUTE TRAINING SESSIONS FOR STAFF. USC WILL SET THE TIME AND DATE FOR TRAINING SESSIONS.

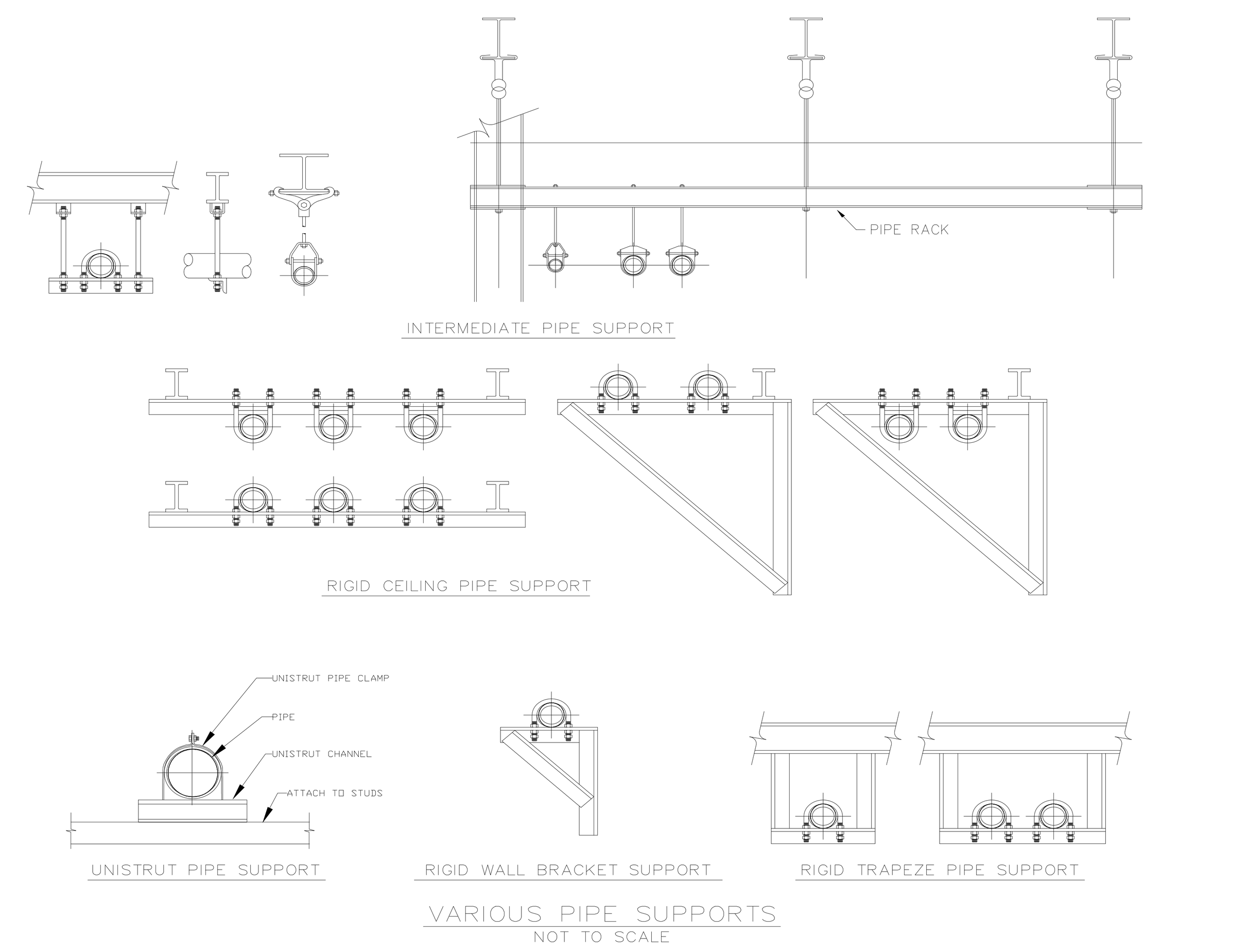
F16. CONTRACTOR TO INCLUDE SYSTEMS FIRST YEAR'S SERVICE AND MAINTENANCE IN THEIR BASE BID.

F17. CONTRACTOR TO PROVIDE USC WITH AN OPTION FOR THE FOR SYSTEMS 2ND YEAR SERVICE AND MAINTENANCE.

F18. CONTRACTOR TO REUSE EXISTING PIPING WHICH IS SERVICEABLE. SEE OWNER'S NOTE # 1.

F19. THIS PROJECT SHALL INCLUDE THE INSTALLATION OF A NEW CONVENTIONAL RELEASING PANEL CONTROL UNIT COMPATIBLE WITH THE NEW CLEAN AGENT SUPPRESSION SYSTEM. THE NEW RELEASING PANEL SHALL FUNCTION AS A SUB-PANEL TO THE EXISTING EDWARDS EST3 BUILDING FIRE ALARM CONTROL UNIT. THE INSTALLING CONTRACTOR SHALL BE RESPONSIBLE FOR CONTRACTING A LICENSED EST DISTRIBUTOR TO COMPLETE THE FOLLOWING–
- THE EXISTING EST3 CONTROL UNIT SHALL BE REPROGRAMMED TO "CORRELATE" THE EXISTING SMOKE DETECTION IN THE SERVER ROOM 011 & SUBFLOOR APPROPRIATELY FOR "CROSS-ZONED" DETECTION.
  -- ONE HALF OF THE EXISTING SMOKE DETECTORS (EVERY OTHER DETECTOR) IN THE SERVER ROOM 011 AND ITS SUB-FLOOR SHALL BE CORRELATED TO "CLEAN AGENT DETECTION ZONE 1".
  -- THE REMAINING SMOKE DETECTORS IN THE SERVER ROOM 011 AND ITS SUB-FLOOR SHALL BE CORRELATED TO "CLEAN AGENT DETECTION ZONE 2".
- TWO (2) NEW EST ADDRESSABLE RELAYS SHALL BE INSTALLED AND PROGRAMMED AS A PART OF THIS PROJECT. THEY SHALL BE INSTALLED IMMEDIATELY ABOVE THE NEW RELEASING CONTROL PANEL (SEE THE PARTIAL RISER DIAGRAM FOR ADDITIONAL INFORMATION..
  -- ONE RELAY SHALL BE CORRELATED TO SWITCH STATE UPON ACTIVATION OF ANY DETECTOR IN "CLEAN AGENT DETECTION ZONE 1". THE NEW RELEASING CONTROL UNIT'S DETECTION ON-BOARD DETECTION ZONE 1 SHALL SUPERVISE THE NORMALLY OPEN SIDE OF THE ADDRESSABLE RELAY CORRELATED WITH THE EST "CLEAN AGENT DETECTION ZONE 1".
  -- ONE RELAY SHALL BE CORRELATED TO SWITCH STATE UPON ACTIVATION OF ANY DETECTOR IN "CLEAN AGENT DETECTION ZONE 2". THE NEW RELEASING CONTROL UNIT'S ON-BOARD DETECTION ZONE 2 SHALL SUPERVISE THE NORMALLY OPEN SIDE OF THE ADDRESSABLE RELAY CORRELATED WITH EST "CLEAN AGENT DETECTION ZONE 2".

F20. ANY EXISTING DISCHARGE PIPING THAT WILL BE REUSED IN THE NEW SYSTEM SHALL BE PRESSURE TESTED PER NFPA 2001 (7.7.2.2.12.1) PRIOR TO THE BEGINNING OF THE INSTALLATION OF THE FIRE SUPPRESSION SYSTEM. USC SHALL BE NOTIFIED IF ANY PART OF THE DISCHARGE PIPE FAILS THE PRESSURE TEST.



VARIOUS PIPE SUPPORTS
NOT TO SCALE

INSTALLATION NOTES FOR CLEAN AGENT SYSTEM

THESE SPECIFICATIONS ARE TO APPLY TO ALL INSTALLATIONS OF CLEAN AGENT FIRE EXTINGUISHER SYSTEMS.

1. ALL PIPE SHALL CONFORM WITH NFPA 2001 SECTION 4.2.1.
2. JOINTS & FITTINGS SHALL COMPLY WITH NFPA 2001 SECTIONS 4.2.2 & 4.2.3.
3. PIPE GRADES MUST BE SUITABLE FOR THE PRESSURES CALCULATED BY MANUFACTURER'S FM-200 FLOW CALCULATION PROGRAM. CONSULT THE CHART IN THE MANUFACTURER'S DESIGN MANUAL OR NFPA 2001, FOR MAXIMUM PIPE PRESSURES FOR THE DIFFERENT PIPE GRADES.
4. SEE NOTE F-13 IN GENERAL NOTES.
5. ALL FITTINGS USED TO CONSTRUCT THE MANIFOLD, INCLUDING FITTINGS BEFORE THE ORIFICE UNION TO BE BLACK FORGED STEEL 2000 lb. OR 3000 lb. ANSI B-16.11.
6. PIPE LENGTHS GIVEN ARE FROM CENTER TO CENTER OF FITTINGS.
7. ANY DEVIATIONS FROM THE ARRANGEMENT SHOWN ON THE SHOP DRAWINGS WILL REQUIRE A COMPLETE REVIEW OF THE FLOW CALCULATIONS BY THE CONTRACTOR.
8. REAM AND CLEAN EACH PIPE SECTION INTERNALLY AFTER PREPARATION AND BEFORE ASSEMBLY BY MEANS OF SWABBING, UTILIZING A SUITABLE NON-FLAMMABLE CLEANER. THE PIPING NETWORK SHALL BE FREE OF PARTICULATE MATTER AND OIL RESIDUE BEFORE INSTALLATION OF NOZZLES OR DISCHARGE DEVICES.
9. ALL DEAD END PIPE LINES TO BE PROVIDED WITH A DIRT TRAP.

Table & Maximum Distance Between Pipework Supports

Pipe Size (in.)	Maximum Distance Between Supports (feet)
3/8	5.0
3/4	6.0
1	7.0
1 1/4	8.0
1 1/2	9.0
2	11.0
3	12.0
4	14.0
6	17.0

PIPING INFORMATION

OWNER'S NOTES

1. *ALL BIDDING CONTRACTOR'S SHOULD SURVEY THE SITE TO FAMILIARIZE THEMSELVES WITH THE EXISTING DISCHARGE PIPE. THE BIDDERS CAN UTILIZE THE DRAWINGS PREPARED IN 2009 BY DWG CONSULTING ENGINEERS. THE CONTRACTOR SHALL SHOW THEIR BASE BID WITH A DEDUCT FOR REUSING THE EXISTING PIPE.*
2. *LOCATE THE REMOTE ANNUNCIATOR IN THE OPERATIONS COMMAND CENTER ON THE WALL NEXT TO THE OPERATOR'S STATION.*

SEQUENCE OF EVENTS

1. Activation of an existing EST smoke detector correlated with "Clean Agent Detection Zone 1" shall:
   a. Illuminate the "ALARM" lamp on the EST3 control panel face.
   b. Cause the new addressable relay correlated with "Clean Agent Detection Zone 1" to switch state triggering the clean agent on-board detection zone 1.
   c. Energize the clean agent control panel alarm bell.
   d. Transfer the on-board alarm relay contact on the new clean agent control unit.

2. Activation of an existing EST smoke detector correlated with "Clean Agent Detection Zone 2" shall:
   a. Cause the new addressable relay correlated with "Clean Agent Detection Zone 2" to switch state triggering the clean agent on-board detection zone 2.
   b. Illuminate the "PRE-DISCHARGE" lamp on the control panel face.
   c. Energize horn/strobe device, pre-discharge.
   d. Start time-delay sequence (30 seconds).
   e. Transfer pre-discharge relay contact.

3. After the 30 Second Time Delay Reaches Zero the following shall occur:
   a. Discharge Agent into protected space.
   b. Illuminate "DISCHARGE" lamp on the control panel face.
   c. Activate Pre-discharge Horn-strobe on steady.
   d. Energize discharge warning strobe outside the hazard.

4. Abort Switch Operation: Countdown will continue during the abort activation. Release of agent will occur when both the countdown is complete and the abort switch is deactivated (UL requires a 10 second countdown after the abort has been released).

5. Manual Pull Operation:
   a. Agent is discharged immediately.Horn/Strobe is activated on steady.
   b. Illuminate "DISCHARGE" lamp on the control panel face.
   c. Transfer the on-board alarm relay contact on the new clean agent control unit.
   d. Energize discharge warning strobe outside the hazard.

SEQUENCE OF OPERATION MATRIX

OUTPUTS — CONTROL UNIT ANNUNCIATION (AT PANEL) / NOTIFICATION / REQUIRED FIRE SAFETY CONTROL

A. DISPLAY EVENT INFORMATION ON CONTROL PANEL L.C.D. SCREEN
B. ALARM L.E.D. (RED) ILLUMINATED
C. ALARM PIEZO (AUDIBLE) ACTIVATED (ON STEADY)
D. TROUBLE L.E.D. (YELLOW) ILLUMINATED
E. TROUBLE PIEZO (AUDIBLE) ACTIVATED (30 PPM)
F. SUPERVISORY L.E.D. (YELLOW) ILLUMINATED
G. SUPERVISORY PIEZO (AUDIBLE) ACTIVATED (60 PPM)
H. ACTIVATE INTERIOR HORN STROBE "GENERAL ALARM" (30 PPM)
I. ACTIVATE INTERIOR HORN STROBE "DISCHARGE" (ON STEADY)
J. ACTIVATE INTERIOR BELL "DISCHARGE" (ON STEADY)
K. ACTIVATE EXTERIOR STROBE "DISCHARGE" (ON STEADY)
L. ALARM SIGNAL SENT TO BLDG. F.A.C.U.
M. TROUBLE SIGNAL SENT TO BLDG. F.A.C.U.
N. SUPERVISORY SIGNAL SENT TO BLDG. F.A.C.U.
O. IF NECESSARY, SHUTDOWN ROOM HVAC AND/OR CLOSE MOTORIZED DAMPERS
P. ACTIVATE 30 SECOND DISCHARGE TIME DELAY
Q. AGENT RELEASE ABORTED UNTIL ABORT SWITCH RELEASED
R. AGENT RELEASE
S.

	INPUTS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	MANUAL PULL STATION ACTIVATION	●	●	●							●	●	●			●			●	
2	MANUAL TANK ACTUATOR ACTIVATION	●	●	●							●	●	●			●			●	
3	1ST DETECTOR IN ALARM: EITHER ZONE 1 OR 2	●	●	●					●				●							
4	2ND DETECTOR IN ALARM: BOTH ZONE 1 AND 2	●	●	●					●		●		●			●	●			
5	30 SECOND TIME DELAY REACHES ZERO	●	●	●						●		●	●						●	
6	ABORT BUTTON DEPRESSED DURING COUNTDOWN**	●			●	●								●				●		
7	NOTIFICATION APPLIANCE CIRCUIT SHORT	●			●	●								●						
8	D.F.C.U. A.C. POWER FAILURE	●			●	●								●						
9	D.F.C.U. SYSTEM LOW BATTERY	●			●	●								●						
10	OPEN CIRCUIT	●			●	●								●						
11	GROUND FAULT	●			●	●								●						
12	RELEASING CIRCUIT DISABLE SWITCH DISABLED	●					●	●							●					

** SUPPRESSION CONTROL PANEL MUST BE RESET DURING ABORT SWITCH OPERATION. RELEASE OF ABORT SWITCH DURING THE 30 SECOND TIME DELAY WILL ALLOW THE COUNTDOWN TO CONTINUE COUNTING DOWN TO ZERO THEN HOLD. THE AGENT DISCHARGE OCCURS WHEN COUNTDOWN REACHES ZERO.

SYSTEM SYMBOLS
SEE "DEVICE MOUNTING HEIGHT" DETAIL

Symbol	Description
DFCU	AGENT RELEASE CONTROL UNIT
FAA	REMOTE ANNUNCIATOR
F	FM-200 MANUAL RELEASE STATION
A	FM-200 DISCHARGE ABORT
cd (horn strobe)	FIRE ALARM HORN STROBE- CLEAN AGENT NOTIFICATION DEVICES SHALL BE MARKED "AGENT" AND PROVIDED WITH A RED LENS COVER. ("C" INDICATES A CEILING MOUNT DEVICE.)
cd (strobe)	FIRE ALARM STROBE- CLEAN AGENT NOTIFICATION DEVICES SHALL BE MARKED "AGENT" AND PROVIDED WITH A RED LENS COVER ("C" INDICATES A CEILING MOUNT DEVICE.)
AB	6" ALARM BELL
S	EXISTING ADDRESSABLE PHOTOELECTRIC SMOKE DETECTOR.
RM	ADDRESSABLE PHOTOELECTRIC SMOKE DETECTOR (BUILDING FIRE ALARM CONTROL UNIT)
KS	KEYED MAINTENANCE SWITCH
	ELECTRIC ACTUTATOR
	360 DEGREE, FM-200 DISCHARGE NOZZLE

VOLUMETRIC & AGENT QTY CALCULATIONS

CALC NOTES

1. HAND CALCULATIONS FOR THE MINIMUM AGENT QTY FOR NOVEC 1230 ARE SHOWN AS AN EXAMPLE OF HOW TO PROPERLY DETERMINE THE MINIMUM AMOUNT OF AGENT NEEDED. OTHER AGENTS THAT MEET THIS PROJECT'S SPECIFICATIONS MAY BE UTILIZED.
2. THE MINIMUM CLEAN AGENT REQUIRED IS BASED ON AGENT CONCENTRATIONS LISTED IN GENERAL NOTE "F3". THE TOTAL MINIMUM AGENT REQUIRED IS BASED ON THE ROOM VOLUME ONLY. SEE THE CONTRACTOR'S HYDRAULIC CALCULATION RESULTS FOR ACTUAL AGENT AMOUNT REQUIRED.

ABOVE RAISED FLOOR VOLUME & AGENT QTY CALCULATION (Novec 1230)

ABOVE RAISED FLOOR, PLAN WEST OF SOFFIT- 6,340 sq ft x 10'-3"h = 64,985 cu ft
ABOVE RAISED FLOOR, PLAN EAST OF SOFFIT- 3,803 sq ft x 9'-10"h = 37,397 cu ft — REV.4
TOTAL VOLUME ABOVE RAISED FLOOR= 102,382 cu ft

Above Raised Floor Minimum Agent Calculation
4.5% @ 70F
W = ((V/S)*(c/ (100-c))
= (102,382 / (0.9856 + 0.002441t)) * (% / (100-%))
= (102,382 / (0.9856 + (0.00244 * 70)) * (4.5 / (100-4.5))
= (102,382 / 1.15647) * (0.04712))
= (88,530) * (0.04712) = 4,171.5336 => 4,172 Lbs

MINIMUM NOVEC 1230 REQUIRED ABOVE THE RAISED FLOOR- 4,172 Lbs.

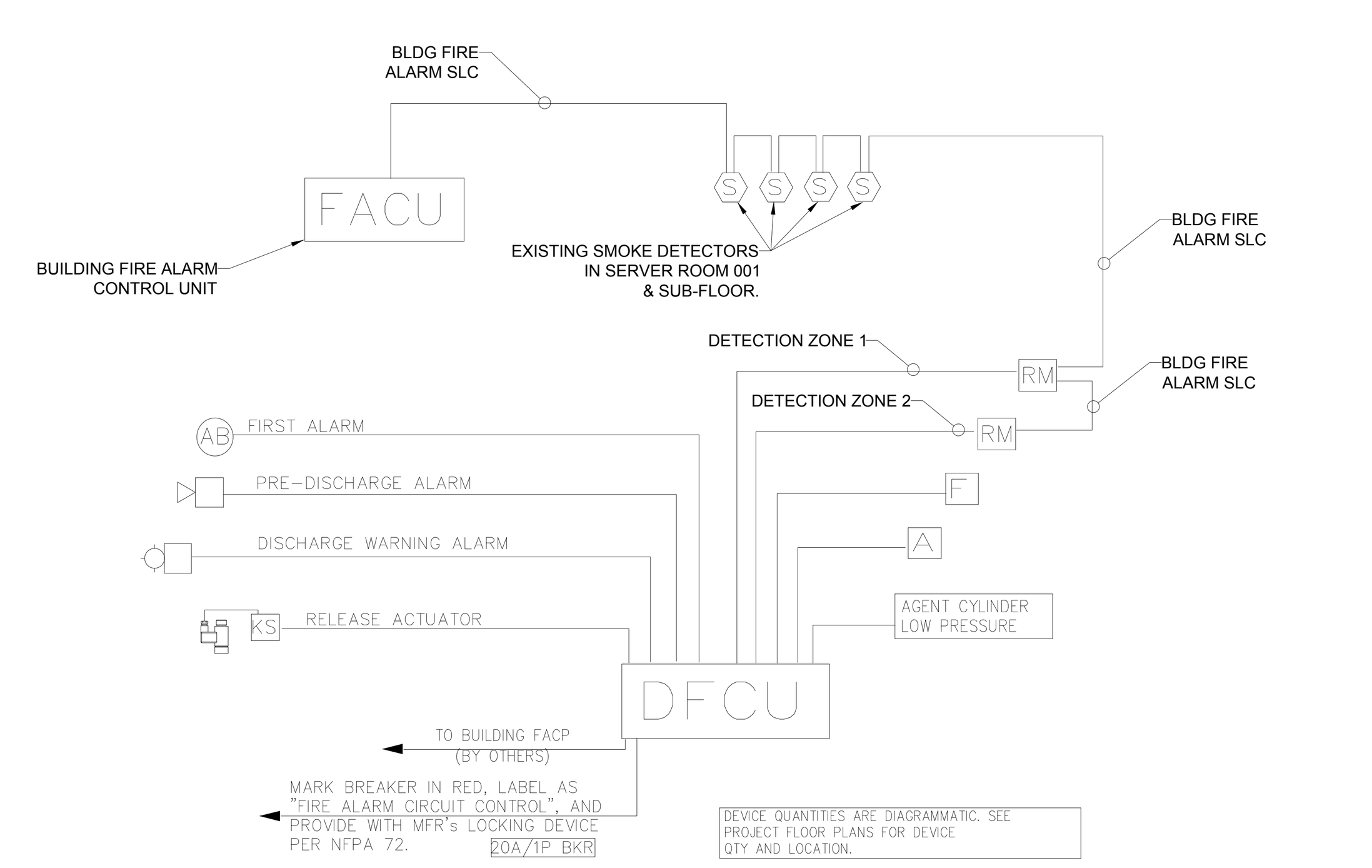
BELOW RAISED FLOOR VOLUME & AGENT QTY CALCULATION (Novec 1230)

BELOW RAISED FLOOR- 10,143 sq ft x 18"h = 15,215 cu ft

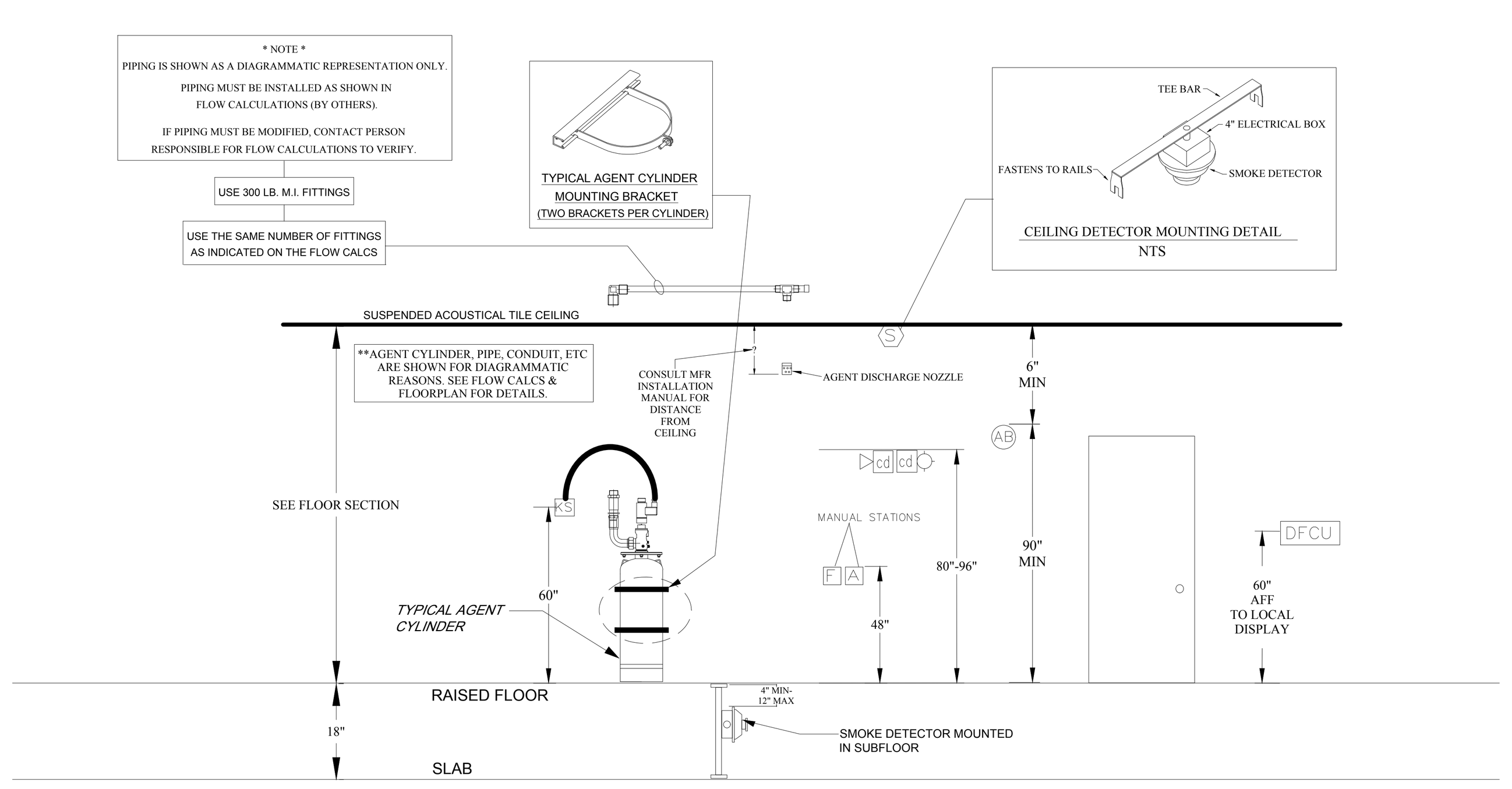
Below Raised Floor Minimum Agent Calculation
4.5% @ 70F
W = ((V/S)*(c/ (100-c))
= (15,215 / (0.9856 + 0.002441t)) * (% / (100-%))
= (15,215 / (0.9856 + (0.00244 * 70)) * (4.5 / (100-4.5))
= (15,215 / 1.15647) * (0.04712))
= (13,157) * (0.04712) = 619.95784 => 620 Lbs

MINIMUM NOVEC 1230 REQUIRED BELOW THE RAISED FLOOR- 620 Lbs.

TOTAL PROTECTED VOLUME= 117,597 cu ft
TOTAL MINIMUM AGENT REQUIRED- 4,792 Lbs.



PARTIAL FIRE SYSTEM RISER DIAGRAM
SCALE: NTS



DEVICE MOUNTING HEIGHT
SCALE: NTS

NO.	REVISION	DATE
1	NOTES (OWNER'S MEETING)	12/8/14
2	ROOM CHANGES	4/16/18
3	SYSTEM CHANGES	6/13/18
4	CORRECTED EAST SOFFIT AFF DIM.	7/19/18

FEC
FIRE PROTECTION ENGINEERING
Foster Engineering & Consulting, LLC

UNIVERSITY OF SOUTH CAROLINA
COMPUTER CENTER ANNEX BUILDING
514 SOUTH MAIN STREET
COLUMBIA, SOUTH CAROLINA
CLEAN AGENT FIRE SUPPRESSION SYSTEM

DATE
DECEMBER 5, 2014

SHEET SIZE- 30 x 42

CA1
DRAWING