THE
UNIVERSITY
OF RHODE ISLAND
DIVISION OF
ADMINISTRATION
AND FINANCE

PURCHASING DEPARTMENT
10 Tootell Road, Suite 3, Kingston, RI 02881 USA p: 401.874.2171 f: 401.874.2306 uri.edu/purchasing

THINK BIG WE DO℠

BID/PROPOSAL

COMMODITY: **SMOKE EXHAUST PERFORMANCE TESTING** DATE: **5/30/2023**

FORMAL BID NO. _____ PUBLIC BID NO. **101280**

BIDS ARE TO BE RECEIVED IN URI PURCHASING DEPARTMENT BY: DATE: **6/20/2023** TIME: **2:00 PM** Eastern Time

BUYER: **KRISTEN BELLOTTI/rlc** Kristen Bellotti Digitally signed by Kristen Bellotti Date: 2023.06.09 14:40:01 -04'00' SURETY REQUIRED: YES: _____ NO: **X**

PRE-BID/PROPOSAL CONFERENCE: DATE: _____ TIME: _____

MANDATORY: YES: _____ NO: _____

LOCATION: _____

Questions concerning this solicitation must be received by: **DATE:** 6/9/2023 **TIME:** 12:00 PM

Questions are to be submitted in a *Microsoft Word* document to: **URIPurchasing@uri.edu**

Please reference the Bid Number on all correspondence. Questions received, if any, will be posted on the internet as an addendum to the bid. It is the responsibility of all intrested parties to download this information.

For Bid Solicitation Information visit: http://web.uri.edu/purchasing/bid-information/

STATEMENT REGARDING COVID-19

Effective immediately, we are suspending all in-person public bid openings until further notice.

Public Bid responses will be publicly read via Webex video conferencing. To participate in the bid opening, please visit the following site at the scheduled bid opening date and time:

*** URL: https://univofri.webex.com/meet/uripurchasing**

No offer will be considered that is not accompanied by the attached University of Rhode Island Bidder Certification Form/Contract Offer completed and signed by the offeror.

COMPANY NAME: _____

STREET AND NUMBER: _____

CITY, STATE & ZIP CODE: _____

_____ _____

Print Name and Title Telephone Number/Facsimile Number

_____ _____ _____

Signature Date E-mail address

THIS BID WILL NOT BE HONORED UNLESS SIGNED

University of Rhode Island Bidder Certification Form

ALL OFFERS ARE SUBJECT TO THE REQUIREMENTS, PROVISIONS AND PROCEDURES CONTAINED IN THIS CERTIFICATION FORM. Offerors are expected to read, sign and comply with all requirements. Failure to do so may be grounds for disqualification of the offer contained herein.

Rules for Submitting Offers

This Certification Form must be attached in its entirety to the front of the offer and shall be considered an integral part of each offer made by a vendor to enter into a contract with the University of Rhode Island. As such, submittal of the entire Bidder Certification Form, signed by a duly authorized representative of the offeror attesting that he/she (1) has read and agrees to comply with the requirements set forth herein and (2) to the accuracy of the information provided and the offer extended, is a mandatory part of any contract award.

To assure that offers are considered on time, each offer must be submitted with the specific Bid/RFP/LOI number, date and time of opening marked in the upper left hand corner of the envelope. Each bid/offer must be submitted in separate sealed envelopes.

A complete signed (in ink) offer package must be delivered to the University of Rhode Island Purchasing Office by the time and date specified for the opening of responses in a sealed envelope.

Bid responses must be submitted on the URI bid solicitation forms provided, indicating brand and part numbers of items offered, as appropriate. Bidders must submit detailed cuts and specs on items offered as equivalent to brands requested WITH THE OFFER. Bidders must be able to submit samples if requested.

Documents misdirected to other State or University locations or which are not present in the University of Rhode Island Purchasing Office at the time of opening for whatever cause will be deemed to be late and will not be considered. For the purposes of this requirement, the official time and date shall be that of the time clock in the reception area of the University of Rhode Island Purchasing Office. Postmarks shall not be considered proof of timely submission.

RIVIP SOLICITATIONS. To assure maximum access opportunities for users, public bid solicitations shall be posted on the RIVIP for a minimum of seven days and no amendments shall be made within the last five days before the date an offer is due. Except when access to the Web Site has been severely curtailed and it is determined by the Purchasing Agent that special circumstances preclude extending a solicitation due date, requests to mail or fax hard copies of solicitations will not be honored.

PRICING. Offers are irrevocable for sixty (60) days from the opening date (or such other extended period set forth in the solicitation), and may not be withdrawn, except with the express permission of the University Purchasing Agent. All pricing will be considered to be firm and fixed unless otherwise indicated. The University of Rhode Island is exempt from Federal excise taxes and State Sales and Use Taxes. Such taxes shall not be included in the bid price.

PRICES QUOTED ARE FOB DESTINATION.

DELIVERY and PRODUCT QUALITY. All offers must define delivery dates for all items; if no delivery date is specified, it is assumed that immediate delivery from stock will be made. The contractor will be responsible for delivery of materials in first class condition. Rejected materials will be at the vendor's expense.

PREVAILING WAGE, OSHA SAFETY TRAINING and APPRENTICESHIP REQUIREMENTS. Bidders must comply with the provisions of the Rhode Island labor laws, including R.I. Gen. Laws §§ 37-13-1 et seq. and occupational safety laws, including R.I. Gen. Laws §§ 28-20-1 et seq. These laws mandate for public works construction projects the payment of prevailing wage rates, the implementation and maintenance of occupational safety standards, and for projects with a minimum value of $1 Million, the employment of apprentices. The successful Bidder must submit certifications of compliance with these laws from each of its subcontractors prior to their commencement of any work. Prevailing wage rates, apprenticeship requirements, and other workforce and safety regulations are accessible at www.dlt.ri.gov.

PUBLIC RECORDS. Offerors are advised that all materials submitted to the University for consideration in response to this solicitation will be considered without exception to be Public Records pursuant to Title 38 Chapter 2 of the Rhode Island General Laws, and will be released for inspection immediately upon request once an award has been made. Offerors are encouraged to attend public bid/RFP openings to obtain information; however, bid/RFP response summaries may be reviewed after award(s) have been made by visiting the Rhode Island Vendor Information Program (RIVIP) at www.purchasing.ri.gov > Solicitation Opportunities > Other Solicitation Opportunities. Telephone requests for results will not be honored. Written requests for results will only be honored if the information is not available on the RIVIP.

Award will be made the to the responsive and responsible offeror quoting the lowest net price in accordance with specifications, for any individual item(s), for major groupings of items, or for all items listed, at the University's sole option.

BID SURETY. Where bid surety is required, bidder must furnish a bid bond or certified check for 5% of the bid total with the bid, or for such other amount as may be specified. Bids submitted without a required bid surety will not be considered.

SPECIFICATIONS. Unless specified "no substitute", product offerings equivalent in quality and performance will be considered (at the sole option of the University) on the condition that the offer is accompanied by detailed product specifications. Offers which fail to include alternate specifications may be deemed nonresponsive.

VENDOR AUTHORIZATION TO PROCEED. When a purchase order, change order, contract/agreement or contract/agreement amendment is issued by the University of Rhode Island, no claim for payment for services rendered or goods delivered contrary to or in excess of the contract terms and scope shall be considered valid unless the vendor has obtained a written change order or contract amendment issued by the University of Rhode Island Purchasing Office PRIOR to delivery.

Any offer, whether in response to a solicitation for proposals or bids, or made without a solicitation, which is accepted in the form of an order OR pricing agreement made in writing by the University of Rhode Island Purchasing Office, shall be considered a binding contract.

REGULATIONS, GENERAL TERMS AND CONDITIONS GOVERNING STATE AND THE UNIVERSITY OF RHODE ISLAND CONTRACTS. This solicitation and any contract or purchase order arising from it are issued in accordance with the specific requirements described herein, and the State's Purchasing Laws and Regulations and other applicable State Laws and Regulations, including the Board of Governors for Higher Education Regulations and General Terms and Conditions of Purchase. The Regulations and General Terms and Conditions are incorporated into all University of Rhode Island contracts and can be viewed at: https://web.uri.edu/purchasing/files/BOGREG.pdf and www.ridop.ri.gov .

EQUAL EMPLOYMENT OPPORTUNITY. Compliance certificate and agreement procedures will apply to all awards for supplies or services valued at $10,000 or more. Minority Business Enterprise policies and procedures, including subcontracting opportunities as described in Title 37 Chapter 14.1 of the Rhode Island General Laws also apply.

PERFORMANCE BONDS. Where indicated, successful bidder must furnish a 100% performance bond and labor and payment bond for contracts subject to Title 37 Chapters 12 and 13 of the Rhode Island General Laws. All bonds must be furnished by a surety company authorized to conduct business in the State of Rhode Island. Performance bonds must be submitted within 21 calendar days of the issuance of a tentative notice of award.

DEFAULT and NON-COMPLIANCE Default and/or non-compliance with the requirements and any other aspects of the award may result in withholding of payment(s), contract termination, debarment, suspension, or any other remedy necessary that is in the best interest of the state/University of Rhode Island.

COMPLIANCE Vendor must comply with all applicable federal, state and local laws, regulations and ordinances.

SPRINKLER IMPAIRMENT AND HOT WORK. The Contractor agrees to comply with the practices of the State's Insurance carrier for sprinkler impairment and hot work. Prior to performing any work, the Contractor shall obtain the necessary information for compliance from the Risk Management Office at the Department of Administration or the Risk Management Office at the University of Rhode Island.

Each bid proposal for a *public works project* must include a "public copy" to be available for public inspection upon the opening of bids. **Bid Proposals that do not include a copy for public inspection will be deemed nonresponsive.**

For further information on how to comply with this statutory requirement, see R.I. Gen. Laws §§ 37-2-18(b) and (j). Also see State of Rhode Island Procurement Regulation 5.11 at https://www.ridop.ri.gov/rules-regulations/

SECTION 2 - DISCLOSURES

ALL CONTRACT AWARDS ARE SUBJECT TO THE FOLLOWING DISCLOSURES & CERTIFICATIONS

Offerors must respond to every disclosure statement. A person authorized to enter into contracts must sign the offer and attest to the accuracy of all statements.

Indicate Yes (Y) or No (N):

____1 State whether your company, or any owner, stockholder, officer, director, member, partner, or principal thereof, or any subsidiary or affiliated company, has been subject to suspension or debarment by any federal, state, or municipal government agency, or the subject of criminal prosecution, or convicted of a criminal offense with the previous five (5) years. If Yes, then provide details below.

____2 State whether your company, or any owner, stockholder, officer, director, member, partner, or principal thereof, or any subsidiary or affiliated company, has had any contracts with a federal, state or municipal government agency terminated for any reason within the previous five (5) years. If Yes, then provide details below.

____3 State whether your company or any owner, stockholder, officer, director, member, partner, or principal thereof, or any subsidiary or affiliated company, has been fined more than $5000 for violation(s) of Rhode Island environmental laws by the Rhode Island Department of Environmental Management within the previous five (5) years. If Yes, then provide details below.

____4 State whether any officer, director, manager, stockholder, member, partner, or other owner or principal of the Bidder is serving or has served within the past two calendar years as either an appointed or elected official of any state governmental authority or quasi-public corporation, including without limitation, any entity created as a legislative body or public or state agency by the general assembly or constitution of this state. If Yes, then provide details below.

IF YOU HAVE ANSWERED "YES" TO QUESTIONS #1 – 4 PROVIDE DETAILS/EXPLANATION IN AN ATTACHED STATEMENT. INCOMPLETE CERTIFICATION FORMS SHALL BE GROUNDS FOR DISQUALIFICATION OF OFFER.

_____
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SECTION 3 - OWNERSHIP DISCLOSURE

Vendors must provide all relevant information. Bid proposals submitted without a complete response may be deemed nonresponsive.

If the company is publicly held, the vendor may provide owner information about only those stockholders, members, partners, or other owners that hold at least 10% of the record or beneficial equity interests of the vendor; otherwise, complete ownership disclosure is required.
List each officer, director, manager, stockholder, member, partner, or other owner or principle of the Bidder, and each intermediate parent company and the ultimate parent company of the Bidder. For each individual, provide his or her name, business address, principal occupation, position with the Vendor, and the percentage of ownership, if any, he or she holds in the Vendor, and each intermediate parent company and the ultimate parent company of the Vendor.

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SECTION 4 - CERTIFICATIONS

Bidders must respond to every statement. Bid proposals submitted without a complete response may be deemed nonresponsive.

Indicate "Y" (Yes) or "N" (No), and if "No," provide details below.

THE VENDOR CERTIFIES THAT:

____1 I/we certify that I/we will immediately disclose, in writing, to the University Purchasing Agent any potential conflict of interest which may occur during the course of the engagement authorized pursuant to this contract.

____2 I/we acknowledge that, in accordance with (1) Chapter §37-2-54(c) of the Rhode Island General Laws "no purchase or contract shall be binding on the state or any agency thereof unless approved by the Department [of Administration] or made under general regulations which the Chief Purchasing Officer may prescribe," and (2) RIGL section §37-2-7(16) which identifies the URI Board of Trustees as a public agency and gives binding contractual authority to the University Purchasing Agent, including change orders and other types of contracts and under State Purchasing Regulation 8.2.B any alleged oral agreement or arrangements made by a bidder or contractor with any agency or an employee of the University of Rhode Island may be disregarded and shall not be binding on the University of Rhode Island.

____3 I/we certify that I or my/our firm possesses all licenses required by Federal and State laws and regulations as they pertain to the requirements of the solicitation and offer made herein and shall maintain such required license(s) during the entire course of the contract resulting from the offer contained herein and, should my/our license lapse or be suspended, I/we shall immediately inform the University of Rhode Island Purchasing Agent in writing of such circumstance.

____4 I/we certify that I/we will maintain required insurance during the entire course of the contract resulting from the offer contained herein and, should my/our insurance lapse or be suspended, I/we shall immediately inform the University of Rhode Island Purchasing Agent in writing of such circumstance.

____5 I/we certify that I/we understand that falsification of any information herein or failure to notify the University of Rhode Island Purchasing Agent as certified herein may be grounds for suspension, debarment and/or prosecution for fraud.

____6 I/we acknowledge that the provisions and procedures set forth in this form apply to any contract arising from this offer.

____7 I/we acknowledge that I/we understand the State's Purchasing Laws (§37-2 of the General Laws of Rhode Island) and Purchasing Regulations and General Terms and Conditions available at the Rhode Island Division of Purchases Website (https://www.ridop.ri.gov/rules-regulations/) and the Board of Governors Regulations on the URI Purchasing Website (https://web.uri.edu/purchasing/files/BOGREG.pdf) apply as the governing conditions for any contract or purchase order I/we may receive from the University of Rhode Island, including the offer contained herein.

____8 I/we certify that the bidder: (i) is not identified on the General Treasurer's list, created pursuant to R.I. Gen. Laws § 37-2.5-3, as a person or entity engaging in investment activities in Iran described in § 37-2.5-2(b); and (ii) is not engaging in any such investment activities in Iran.

____9 If the product is subject to Department of Commerce Export Administration Regulations (EAR) or International Traffic in Arms Regulations (ITAR), please provide the Export Control Classification Number (ECCN) or the US Munitions List (USML) Category:_____

____10 I/we certify that the above information is correct and complete.

IF YOU ARE UNABLE TO CERTIFY YES TO QUESTIONS #1 – 8 and 10 OF THE FOREGOING, PROVIDE DETAILS/EXPLANATION IN AN ATTACHED STATEMENT. INCOMPLETE CERTIFICATION FORMS SHALL BE GROUNDS FOR DISQUALIFICATION OF OFFER.

Signature below commits vendor to the attached offer and certifies (1) that the offer has taken into account all solicitation amendments where applicable, (2) that the above statements and information are accurate and that vendor understands and has complied with the requirements set forth herein.

Vendor/Company Name;_____

Vendor's Signature:_____Bid Number:_____Date:_____
(Person Authorized to enter into contracts; signature must be in ink) (if applicable)

_____
Print Name and Title of Company official signing offer

COMMODITY: Smoke Exhaust Performance Testing
OPENING DATE & TIME: 6/20/23 2:00 PM

SHIP TO:
URI - Public Safety
44 Lower College Rd
Kingston, RI 02881

BIDDER (NAME OF FIRM)

BID NO: 101280

BIDDER (NAME OF FIRM)

BID NO: 101280

ATTACHMENT "A"

ITEM NO.	DESCRIPTION	QUANTITY	UOM	UNIT PRICE	EXTENDED PRICE	UNIT PRICE	EXTENDED PRICE	ITEM NO.

INSTRUCTIONS:

IF BIDDING ON ANY ITEM, THE ENTIRE BID MUST BE RETURNED. THE PRICE COLUMN ON THE RIGHT WILL BE DETACHED TO CREATE A BID TABULATION SPREAD SHEET FOR THE "OFFICIAL BID ANALYSIS", THEREFORE:

A. VENDOR NAME MUST APPEAR IN BOTH COLUMNS ON "EVERY" PAGE UNDER THE WORDS "BIDDER"

B. PRICE COLUMNS MUST CONTAIN "EXACTLY" THE SAME INFORMATION.

C. ANY SUPPLEMENTARY INFORMATION MUST BE REPEATED IN "BOTH" COLUMNS.

D. TO ASSURE THAT OFFERS ARE CONSIDERED ON TIME, EACH OFFER MUST BE SUBMITTED WITH SPECIFIC BID/RFP NUMBER (PROVIDED ABOVE), DATE AND TIME OF OPENING MARKED IN THE UPPER LEFT HAND CORNER OF ENVELOPE. EACH BID/ OFFER MUST BE SUBMITTED IN SEPARATE SEALED ENVELOPES:

MAIL TO:	COURIER:
UNIVERSITY OF RHODE ISLAND	UNIVERSITY OF RHODE ISLAND
P.O. BOX 1773	PURCHASING DEPARTMENT
PURCHASING DEPARTMENT	DINING SERVICES DISTRIBUTION CENTER
KINGSTON, RI 02881	10 TOOTELL ROAD
	KINGSTON, RI 02881-2010

DOCUMENTS MISDIRECTED TO OTHER STATE LOCATIONS OR WHICH ARE NOT PRESENT IN THE UNIVERSITY OF RHODE ISLAND PURCHASING DEPARTMENT AT THE TIME OF OPENING FOR WHATEVER CAUSE WILL BE DEEMED TO BE LATE AND WILL NOT BE CONSIDERED. FOR THE PURPOSE OF THIS REQUIREMENT, THE OFFICIAL TIME AND DATE SHALL BE THAT OF THE TIME CLOCK IN THE UNIVERSITY OF RHODE ISLAND PURCHASING DEPARTMENT. POSTMARKS SHALL NOT BE CONSIDERED PROOF OF TIMELY SUBMISSION.

FAILURE TO COMPLETE FORM AS INSTRUCTED MAY BE GROUNDS FOR "DISQUALIFICATION".

GROUP PURCHASING ORGANIZATIONS (GPO):
THE UNIVERSITY OF RHODE ISLAND IS A MEMBER OF THE FOLLOWING:
1) Educational & Institutional Cooperative Purchasing (E&I)
2) Provista

DELIVERY AS REQUESTED

DO NOT ATTACH QUOTES. QUOTATIONS SUBMITTED WITH BID RESPONSES WILL NOT BE CONSIDERED. ALL BID RESPONSES ARE IN ACCORDANCE WITH THE ATTACHED BID SPECIFICATIONS AND THE BOARD OF GOVERNORS FOR HIGHER EDUCATION PROCUREMENT REGULATIONS:
- http://www.ribghe.org/procurementregs113006.pdf

COMMODITY: Smoke Exhaust Performance Testing
OPENING DATE & TIME: 6/20/23 2:00 PM

SHIP TO:
URI - Public Safety
44 Lower College Rd
Kingston, RI 02881

BIDDER (NAME OF FIRM)

BID NO: 101280

BIDDER (NAME OF FIRM)

BID NO: 101280

ATTACHMENT "A"

ITEM NO.	DESCRIPTION	QUANTITY	UOM	UNIT PRICE	EXTENDED PRICE	UNIT PRICE	EXTENDED PRICE	ITEM NO.
	THE UNIVERSITY OF RHODE ISLAND IS SOLICITING PROPOSALS TO PROVIDE SMOKE EXHAUST SYSTEM PERFORMANCE TESTING, AS DESIGNED, OF THREE BUILDINGS ON URI'S KINGSTON CAMPUS PER THE ATTACHED SPECIFICATIONS IN "ATTACHMENT B". THE SERVICE SHALL INCLUDE, BUT IS NOT LIMITED TO, AIR FLOW SAMPLING/MEASURING, VISUAL INSPECTION OF ITEMS AS REQUIRED BY THE PREVIOUSLY APPROVED TESTING DOCUMENTS, AND PROVIDING A FINAL COMPLETE TEST REPORT OF EACH SYSTEM. THE WORK HOURS, FOR THIS PROJECT WILL BE M-F 8:30AM - 4:30PM NON STATE HOLIDAYS. THE UNIVERSITY WILL PROVIDE ONE FIRE ALARM TECHNICIAN TO ACTIVATE AND DISABLE THE FIRE ALARM AS NEEDED. THE WINNING BIDDER SHALL PROVIDE: 1. A TESTING PLAN IN ACCORDANCE WITH THE PREVIOUS APPROVED DESIGN FOR EACH BUILDING. THIS PLAN MUST BE PROVIDED PRIOR TO THE START OF WORK. 2. ALL TOOLS AND EQUIPMENT, INCLUDING STAGING, LADDERS NEEDED TO PERFORM THE TESTING. 3. A FINAL TESTING REPORT THAT INCLUDES DESIGN VALUES AND MEASURED VALUES. 4. A STAMPED COPY OF THE REPORT FROM A RI REGISTERED DESIGN PROFESSIONAL. Please provide a cost breakdown per building:							
1	Garrahy Hall (Building A)			$_____	$_____	$_____	$_____	1
2	Wiley Hall (Building B)			$_____	$_____	$_____	$_____	2
3	Eddy Hall (Building C)			$_____	$_____	$_____	$_____	3

AWARD

BIDDERS MUST BID ALL ITEMS TO BE CONSIDERED. AWARD WILL BE BASED ON TOTAL LOW.

INSURANCE

IN ACCORDANCE WITH THE BOARD OF GOVERNORS (BOG) FOR HIGHER EDUCATION GENERAL CONDITIONS OF PURCHASE, INSURANCE CERTIFICATES ARE REQUIRED FOR WORKERS COMPENSATION, GENERAL LIABILITY, PROPERTY DAMAGE AND AUTO INSURANCE. UPON NOTICE OF TENTATIVE AWARD, THE SUCCESSFUL BIDDER(S) WILL BE REQUIRED TO SUBMIT THE ABOVE NAMING THE UNIVERSITY OF RHODE ISLAND, THE URI BOARD OF TRUSTEES, AND THE STATE OF RHODE ISLAND AS ADDITIONAL INSURED, BY A FIRM AUTHORIZED TO DO BUSINESS IN THE STATE OF RHODE ISLAND.

Gilbane
University of Rhode Island
c/o Postal Services
6 Garage Road
Kingston, RI 02881

Gilbane

BUILDING A & B

Garrahy & Wiley

SMOKE EXHAUST SYSTEM

TESTING PROTOCOL

UNIVERSITY OF
Rhode Island

University of Rhode Island
New Student Housing

Testing Protocol
Atrium Smoke Exhaust System
North Woods Residence-Building A & B

Construction Manager
Gilbane Building Company

Electrical Contractor
R. F. Audet

Fire Alarm Contractor
Simplex/Grinnell

Mechanical Contractor
Delta Mechanical

Sheet Metal Contractor
Unique Metal Works

Balancing Contractor
R. K. Baker and Associates, Inc.

Atrium Smoke Control
Proposed Testing Protocol

URI-New Student Housing

Prior to testing the Atrium Smoke Control System, verify the completion of the building system, including the following features:

1. Integrity of partitions and floor penetrations
2. Firestopping
3. Doors and closers related to the Smoke Exhaust area
4. Glazing at Atrium area

Testing is to include the following sub-systems to the extent that they affect or are affected by the operation of the Smoke Exhaust system:

1. Fire Alarm System
2. Building Management System
3. HVAC System and Equipment
4. Electrical Equipment
5. Temperature Control System
6. Normal and Emergency Power sources
7. Automatic Fire Suppression System
8. Automatic operating doors and closers
9. Emergency Elevator operation

The following parameters are to be measured during acceptance testing:[1]

1. Total volumetric flow rate.
2. Airflow velocities.[2]
3. Airflow direction
4. Door opening forces[3]
5. Pressure differentials
6. Ambient temperature

The following equipment will be needed to perform acceptance testing:

1. Differential pressure gauges, inclined water manometers or electric manometer [instrument ranges 0-0.25 in. w.g. (0-62.5 Pa) and 0-0.50 in. w.g. (0-125 Pa) with 50 ft of tubing]
2. Scale suitable for measuring door opening force (30 lbs to start door, 15 lbs to full open)
3. Anemometer, including traversing equipment.
4. Ammeter
5. Door wedges
6. Tissue paper roll or other convenient device for indicating direction of airflow
7. Signs indicating that a test of the smoke evacuation system is in progress and that doors are not to be opened.

Instruments for testing shall have been calibrated within one month prior to test. Calibration shall be traceable to NBS Standards. Calibration certificates for test equipment used must be provided.

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[1] NFPA 92B-8.3.2
[2] NFPA 92B-4.6
[3] NFPA 92B-4.6.3

Sequence of Operation

The following sequence applies to Smoke Exhaust Fans SEF-1 & SEF-2, and Makeup Air Fans SMAU-1 through SMAU-4:[4]

1. The system shall be available 24 hours per day, 7 days a week; all equipment and controls shall be on legally required standby power.
2. Upon activation of any Atrium associated smoke detection device the Fire Alarm System shall perform the following functions:
    a. Send a signal to the Automatic Control Dampers (via the DDC System) to allow Smoke Exhaust Make-up Air to enter the Atrium.
    b. Send a signal to the Building Automation System to activate the Atrium Smoke Control Dampers and Exhaust Fans.
3. The following shall occur when the Atrium Smoke Control System is activated:
    a. Automatic Control Dampers shall open.
    b. Magnetic hold-open devices on Doors 113, 125 and 137 shall be de-energized.
    c. When the Automatic Control Dampers are proven 60% open, the Smoke Make-up Air Fans (SMAU-1 through SMAU-4) and Smoke Exhaust Fans (SEF-1 & SEF-2) shall be energized and run continuously until the Fire Alarm System terminates the signal via the Fire Alarm Control Panel.
    d. The Fans will then be de-energized and the Automatic Control Dampers shall close.

Prior to acceptance testing, all building equipment must be placed in normal operating mode, including equipment that is not used to implement smoke exhaust, such as elevator shaft vents and machine room fans and vents, general exhaust and supply air through Atrium Supply Diffusers .

Weather data shall be recorded, including wind speed, direction and outside temperature. Extreme changes in conditions during the test shall be recorded.[5]
Testing on Stand-by Power to all Smoke Exhaust System components must be conducted while on both Normal and Emergency Power. Disconnect Normal Power at the Main Service disconnect to simulate the true operating conditions in this mode.

The acceptance testing must demonstrate that the correct outputs are produced for a given input for each control sequence specified. The following sequences are to be followed and documented:[6]

1. Normal mode
2. Automatic Smoke Exhaust mode for Fire Alarm
3. Manual override of normal and automatic exhaust modes
4. Return to normal

With the HVAC System in normal mode, measure pressure differences across all door barriers and airflow velocities at interfaces with open areas.
Activate the Smoke Exhaust System. Verify and record the operation of all fans, dampers, doors and related components. Measure fan exhaust capacities and air velocities at Exhaust Fans and at First Floor Atrium supply grilles.
Using a scale, measure the force required to open the First Floor Atrium doors to ensure that the force required to set the doors in motion does not exceed 30 lbs, and the force to bring the door to full open does not exceed 15 lbs.
Measure and record the pressure differences across all doors that separate the Smoke Exhaust area from adjacent spaces and the velocities at interfaces with open spaces.

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[4] Contract Document H608, Detail for Smoke Control System Diagram as amended by Sketch SKH3.21.
[5] NFPA 92B-4.8
[6] NFPA 92B-8.3.4.4

Appendix

International Building Code 2003

Section 909, "Smoke Control Systems"

NFPA 92B 2005 Edition

Standard for Smoke Management Systems in Malls, Atria and Large Spaces
Chapter 4-paragraphs 4.6, 4.6.3 and 4.8
Chapter 8-paragraphs 8.3.2 and 8.3.4.4

Rhode Island Fire Safety Code

Rules and Regulations
Promulgated by the Board of Appeal and Review
Chapter 13-paragraphs (Add) 13.8.10.4.3.3.5 and (Add) 13.8.10.5.10

University of Rhode Island New Student Housing

Construction documents prepared by The S/L/A/M Collaborative and R.G. Vanderweil Engineers, specifically Drawing H608 as amended by Addendum 3, Sketch SKH3.21

System Summary Report

Provided by Vanderweil Engineers

Seimens Building Technologies

Submittal for Building Controls, Sheets 105, 105A and 105B

4.5.2 System Startup.

4.5.2.1 The smoke management system shall achieve full operation prior to conditions in the space reaching the design smoke conditions.

4.5.2.2 The determination of the time it takes for the system to become operational shall consider the following events (as appropriate to the specific design objectives):

(1) Time for detection of the fire incident

(2) HVAC system activation time including shut-down and start-up of air handling equipment, opening and closing of dampers, and opening and closing of natural ventilation devices

4.5.3 Duration.

4.5.3.1 When the design of the smoke management system is based on occupants exiting a space before being exposed to smoke or before tenability thresholds are reached, the system shall remain operational for the duration required.

4.5.3.2 Smoke management systems designed to maintain tenable conditions shall not be required to prevent the descent of a smoke layer in spaces where tenable conditions are demonstrated.

4.5.3.3 When the design of the smoke management system is based on occupants' exiting a space before being exposed to smoke or before tenability thresholds are reached, a timed egress analysis shall be conducted.

4.5.4 Manual Override.

4.5.4.1 A means of manually starting and stopping the smoke management system shall be provided at an approved location accessible to the fire department.

4.5.4.2 Manual controls shall be able to override automatic system operation.

4.6* Makeup Air.

Makeup air shall be provided by fans or by openings to the outside.

4.6.1 The supply points for the makeup air shall be located beneath the smoke layer interface.

4.6.2 Mechanical makeup air shall be less than the mass flow rate of the mechanical smoke exhaust.

4.6.3 The makeup air shall not cause door-opening force to exceed allowable limits.

4.6.4* The makeup air velocity shall not exceed 200 ft/min (1.02 m/sec) where the makeup air could come into contact with the plume unless a higher makeup air velocity is supported by engineering analysis.

4.7 Operating Conditions.

The smoke management system components shall be capable of continuous use at the maximum temperatures expected over the design interval time.

4.8* Weather Data.

Designs shall incorporate the effect of outdoor temperature and wind on the performance of the smoke management system.

4.9* Stratification of Smoke.

For large spaces where smoke stratification can occur, one of the following detection schemes shall be used:

(1)* An upward beam to detect the smoke layer

(2)* Detection of the smoke layer at various levels

(3)* Horizontal beams to detect the smoke

Chapter 8 Testing

8.1 General.

8.1.1* Each system shall be tested against its specific design criteria using component system testing, acceptance testing, and periodic testing and maintenance.

8.1.2 Construction documents shall include all acceptance testing procedures and pass/fail criteria.

8.2 Component System Testing.

8.2.1* Responsibility for testing shall be defined clearly prior to component system testing.

8.2.2 Prior to testing, the party responsible for testing shall verify completeness of building construction, including the following architectural features:

(1) Smoke barriers including joints therein
(2) Firestopping
(3) Doors and closers related to smoke control
(4) Glazing that encloses a large-volume space

8.2.3* Operational testing of each individual system component shall be performed.

8.2.4* Testing shall include all subsystems to the extent that they affect or are affected by the operation of the smoke management system.

8.2.5 All documentation from component system testing shall be available for inspection.

8.3 Acceptance Testing.

8.3.1* **General.** Acceptance testing shall demonstrate that the final integrated system installation complies with the specific design and is functioning properly.

8.3.2 Test Parameters. Where appropriate to the design, the following parameters shall be measured during acceptance testing:

(1) Total volumetric flow rate
(2) Airflow velocities
(3) Airflow direction
(4) Door-opening forces
(5) Pressure differences
(6) Ambient indoor and outdoor temperatures
(7) Wind speed and direction

8.3.3 Measurement Locations. The locations for measurement of the parameters identified in 8.3.2 shall be in accordance with nationally recognized methods.

8.3.4 Testing Procedures. The acceptance testing shall include the procedures described in 8.3.4.1 through 8.3.4.5.

8.3.4.1* Prior to beginning acceptance testing, all building equipment shall be placed in the normal operating mode, including equipment that is not used to implement smoke management.

8.3.4.2* If standby power has been provided for the operation of the smoke management system, the acceptance testing shall be conducted while on both normal and standby power.

8.3.4.3 The acceptance testing shall include demonstrating that the correct outputs are produced for a given input for each control sequence specified.

8.3.4.4 The complete smoke management sequence shall be demonstrated for the following:

(1) Normal mode

(2) Automatic smoke management mode for first alarm

(3) Manual override of normal and automatic smoke management modes

(4) Return to normal

8.3.4.5* Acceptance tests for the fire protective signaling system in conjunction with the smoke management system shall be permitted.

8.3.5* System Testing.

8.3.5.1 Specific smoke management performance criteria shall be developed by the system designer and described in the construction documents.

8.3.5.2 Acceptance testing to verify system performance shall include the following:

(1) Prior to performance testing, verify the exact location of the perimeter of each large-volume space smoke management system, identify any door openings into that space, and identify all adjacent areas that are to remain open and that are to be protected by airflow alone. For larger openings, measure the velocity by making appropriate traverses of the opening.

(2) Activate the smoke management system. Verify and record the operation of all fans, dampers, doors, and related equipment. Measure fan exhaust capacities and air velocities through inlet doors and grilles or at supply grilles if there is a mechanical makeup air system. Measure the force to open exit doors.

(3) Where appropriate to the design, measure and record the pressure difference across all doors that separate the smoke management system area from adjacent spaces and the velocities at interfaces with open areas.

8.3.6 Testing Documentation.

8.3.6.1 Upon completion of acceptance testing, a copy of all operational testing documentation shall be provided to the owner.

8.3.6.2 This documentation shall be available for reference for periodic testing and maintenance.

8.3.7 Owner's Manuals and Instruction. Information shall be provided to the owner that defines the operation and maintenance of the system.

8.3.8 Modifications.

8.3.8.1 All operation and acceptance tests shall be performed on the applicable part of the system wherever there are system changes and modifications.

8.3.8.2 Documentation shall be updated to reflect these changes or modifications.

8.4 Periodic Testing.

8.4.1* Proper maintenance of the system shall, as a minimum, include the periodic testing of all equipment, such as initiating devices, fans, dampers, controls, doors, and windows.

8.4.2* The equipment shall be maintained in accordance with the manufacturer's recommendations.

8.4.3 The periodic tests shall determine the airflow quantities and the pressure differences at the following locations:

(1) Across smoke barrier openings

(2) At the air makeup supplies

(3) At smoke exhaust equipment

8.4.4 All data points shall coincide with the acceptance test location to facilitate comparison measurements.

Stories used exclusively for mechanical equipment rooms, elevator penthouses and similar spaces are not occupiable stories.

(Add) 13.8.10.4.3.2

A high rise system for the purpose of this chapter is defined as a municipally connected fire alarm system consisting of a power limited fire alarm control unit listed by UL and/or approved by FMG, with voice communication and a two-way fire department communication system. All circuits for a high rise fire alarm system shall be installed in a Class "A" fashion as described in NFPA 72. Fire Alarm/Voice Communication Systems shall be provided in all high rise buildings regardless of the occupancy and shall operate as follows:

(Add) 13.8.10.4.3.3

The operation of any manual fire alarm box or the automatic activation of any heat detector, smoke detector, sprinkler flow switch, standpipe flow switch or other extinguishing system switch shall:

(Add) 13.8.10.4.3.3.1

Automatically sound a distinctive audible signal and activate the visible notification appliances on the floor where the alarm originated, one floor above and one floor below the floor where the alarm originated;

(Add) 13.8.10.4.3.3.2

Automatically notify the local fire department;

(Add) 13.8.10.4.3.3.3

Visually indicate the location of the origin of the alarm at the fire command center within the building;

(Add) 13.8.10.4.3.3.4

Interlock with the heating, ventilating and air conditioning [HVAC] control systems to provide for automatic fan shut-down as required in § 13.8.10.5.10;

(Add) 13.8.10.4.3.3.5

Interlock with all stairwell pressurization, smoke exhaust and smoke control systems to control HVAC operations as required in § 13.8.10.5.10. Stairwell pressurization, smoke exhaust and smoke control systems shall not be activated by the activation of manual fire alarm boxes;

(Add) 13.8.10.5.9

All required fire alarm systems shall be connected to au approved power source in the building and in addition shall have automatically charged storage type battery standby power (dry cell shall not be used) of sufficient capacity to operate the entire system as required by § 13.8.10.4 for the type of system after the principal source of power has failed. The fire alarm system must be able to function and sound the notification appliances for at least five (5) minutes following the required standby period.

(Add) 13.8.10.5.9.1

Systems utilizing an emergency generator as a source of standby power shall not be exempt from the above requirements for battery standby power.

(Add) 13.8.10.5.10

In all buildings having a fire alarm system, the fire alarm system shall be interconnected to the building's heating, ventilation and air conditioning [HVAC] controls so that the fan(s) supplying two thousand (2,000) cubic feet per minute (cfm) or greater capacity of any ventilating system not used for pressurization of a fire safe area or four (4) or more ceiling mounted industrial air circulation fans installed in one room shall automatically shut down any time, other than drills or when testing, that any initiating device connected to the fire alarm system is activated. If duct-type smoke detectors are installed in HVAC systems, the duct-type smoke detectors shall be connected to the fire alarm control unit to signal an audible and visual supervisory signal at the fire alarm control unit and annunciator. An alarm condition shall not occur unless specifically requested and authorized by the AHJ.

(Add) 13.8.10.5.10.1

EXCEPTION: Where total coverage smoke detection is installed in all areas of the smoke compartment served by the return air system, installation of air duct detectors in the return air system shall not be required, provided their function is accomplished by the design of the area detection system.

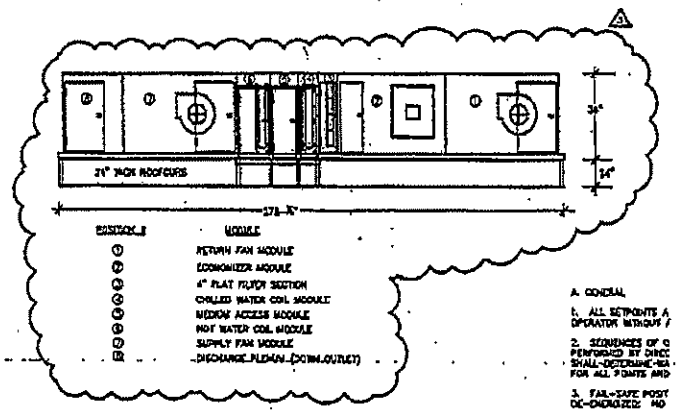
(Add) 13.8.10.5.10.2

Where installation of automatic smoke area detection is impractical dne to ambient conditions, automatic heat detection shall be permitted. In areas covered by automatic sprinkler systems, automatic heat detection shall not be required.

(Add) 13.8.10.5.10.3

EXCEPTION: See § 13.8.10.4.3.3.5.

(Add) 13.8.10.5.10.4



ROOF TOP AIR HANDLING UNIT CONFIGURATION (RTU-1A,1B,1C)

NTS

A. GENERAL

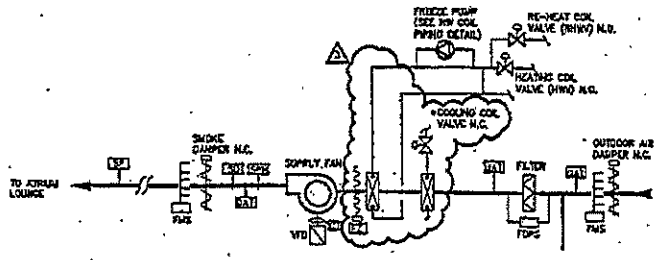
1. ALL SETPOINTS A OPERATOR WITHOUT F

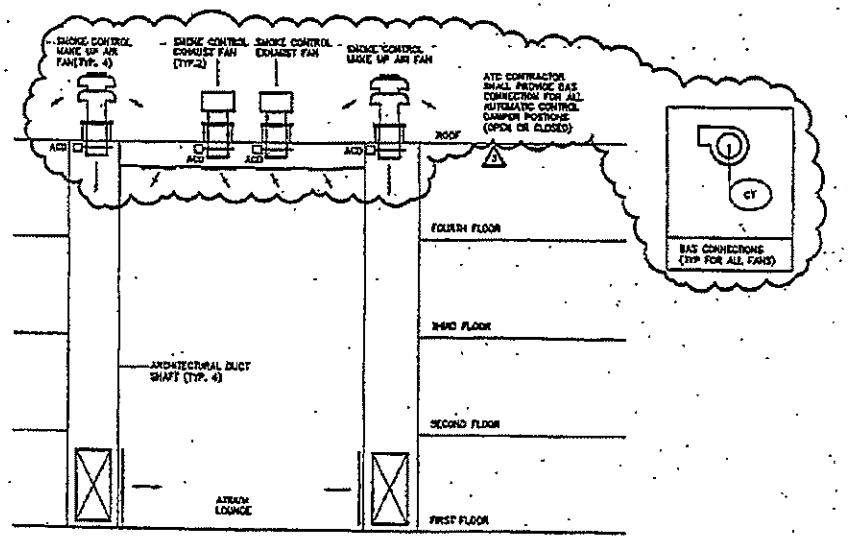
2. SEQUENCES OF O PERFORMED BY DIREC SHALL DETERMINE NEA FOR ALL POINTS AND

3. FAIL-SAFE POSIT DE-ENERGIZED AND

4. WHENEVER THE U DISCONNECTED, THE C FAIL-SAFE POSITION.

5. AIR FLOW MEASU OUTSIDE AIR, SUPPLY AND BY THE POSITION





SMOKE CONTROL SYSTEM FLOW DIAGRAM- (TYP. BUILDINGS A,B,&C)

FOR SMOKE EXHAUST SEQUENCE OF CONTROL, SEE FIRE ALARM DRAWINGS

R.G. Vanderweil Engineers, Inc.
274 Summer Street - Boston, MA 02210

The S.L.A.M. Collaborative
Glastonbury, CT
Tel 860 657-4077
Fax 860 657-3141

HVAC CONTROLS

University of Rhode Island
NEW STUDENT HOUSING
LOA# B03178

Scale: NTS
Reference: 1808
Date: 08/30/05
Proj. No.: 22562.00

Sketch No.: SKH3.21

ADDENDUM #3

September 20, 2006

Mr. Rick Bouchard
The S/L/A/M Collaborative
Somerset Square
80 Glastonbury Boulevard
Glastonbury, CT 06033-4415

Re: 22562 URI Housing
Atrium Smoke Control

Dear Rick:

In January of 2006 RGV received a letter of approval (as a result of an October 2004 review meeting) from the Rhode Island Building Code Commission for the design of the Atrium smoke control systems for URI Residence Halls (See attached). As Building A completion and occupancy nears I am submitting to you a smoke control system summary report to be reviewed and approved by the Rhode Island State Fire Marshal's Office. The summary report contains the following:

1. The atrium plan and section. (included as an attachment)
2. The Exhaust Method of smoke control in accordance with IBC 2003, Section 909.8 as approved by Rhode Island Building Code Commission.
3. Smoke exhaust calculations using an axisymetric smoke plume and a balcony spill smoke plume. These calculations are summarized below and are included as attachments.
4. Smoke control system acceptance test procedures as stated in IMC 2003, Section 909, to be performed by the contractor as specified in contract documents.
5. Sequence of operation as provided by Fire Alarm contractor and ATC contractor.

The Buildings

The program for this project is comprised of two sites. The North Site will contain two buildings and the South Site will contain one building. All three buildings are similar in arrangement and each has atriums requiring smoke control systems in accordance with section 909 of the IBC-2003. The governing building code for this project is the 2003 edition of the International Building Code (IBC-2003). Of the several available smoke control methods, we are requesting approval from the governing building official to use the Exhaust Method in accordance with section 909.8 of the IBC-2003. The details of our calculation procedure are provided in the following attachments:

274 Summer Street
Boston, Massachusetts 02210-1123
Tel: 617.423.7423, Fax: 617.956.4713
www.vanderweil.com

Mr. Rick Bouchard
The S/L/A/M Collaborative
22562 - Request for Additional Compensation - Sprinkler Design

1. Atrium Smoke Calculations Sheet – Axisymetric Plumes
2. Atrium Smoke Calculations Sheet – Balcony Spill & Window Plumes
3. Plan View of Atrium
4. Section View of Atrium

The Atriums

The atriums are comprised of four and five levels. The five level atrium has approximate dimensions of 45' (W) x 45'(L) x 58'(H). The four level atrium has approximate dimensions of 45' (W) x 45'(L) x 48'(H). On the first level, each atrium is open to egress pathways while on the second third, fourth, and fifth levels, each atrium is separated from egress pathways. On the first level, the perimeter corridor around each atrium will be separated from communicating spaces during a fire/smoke event with automatic closing doors (fire/smoke rated).

The Exhaust Method, ICB-2003, Section 909.8

Section 909.8.1 (Exhaust Rate) of the IBC-2003 requires that the largest calculated mass flow rate of possible smoke plumes be used to determine the volumetric flow rate of the smoke exhaust system. We have calculated this to be the axisymetric plume, which yields a smoke exhaust flow rate of ***47,000 cubic feet per minute (CFM).***

As approved by the governing building official the design of a ***47,000 CFM*** smoke exhaust system is being provided for each of the three atriums considered.

Please feel free to call with any questions.

Very truly yours,

R.G. Vanderweil Engineers LLP

Charles A. Clapp, P.E.
Project Manager

CAC/das

Cc: Jeff LaMothe (S/L/A/M)

Attachments

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
DIVISION OF CAPITAL PROJECTS AND PROPERTY MANAGEMENT
BUILDING CODE COMMISSION
One Capitol Hill
Providence, RI 02908-5859
(401) 222-3033 FAX # 222-2599

January 19, 2006

Chip Clapp
Vanderweil Engineers
274 Summer Street
Boston, MA 02210-1123

RE: URI Housing Atrium Smoke Control

Dear Chip:

This letter is in response to our conversation Wednesday January 18, 2006. I reviewed my notes and the previous correspondence regarding the smoke control systems design. Building code section 909.3 requires special inspections and testing. The procedure for this testing should be submitted to this office and testing shall be verified by the special inspector and this office.

My approval of the design concept does not infer compliance with Fire Codes. You will need acceptance by the RI State Fire Marshall's Office.

If I can be of any more help please do not hesitate to call.

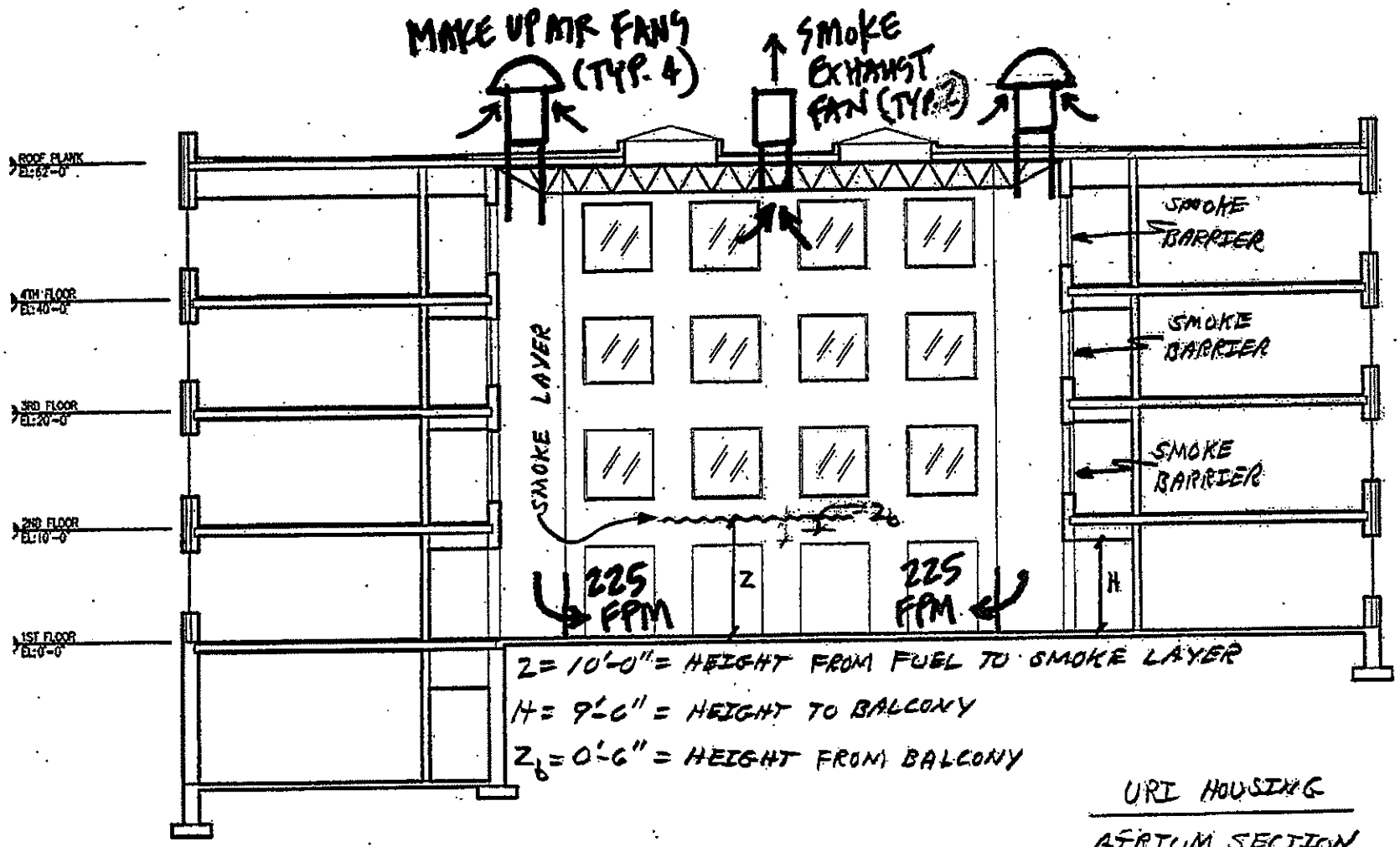
Very truly yours,

Stuart Cowen

Stuart Cowen
Mechanical Engineer

cc:D. DeDentro

4 STORY ATRIUM



Z = 10'-0" = HEIGHT FROM FUEL TO SMOKE LAYER

H = 9'-6" = HEIGHT TO BALCONY

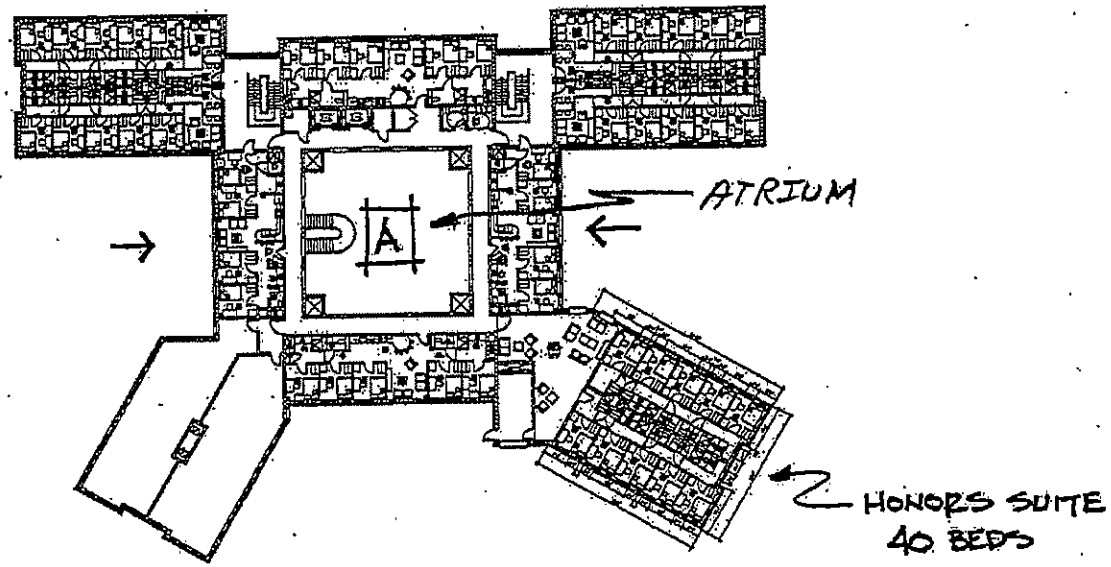
Z_b = 0'-6" = HEIGHT FROM BALCONY

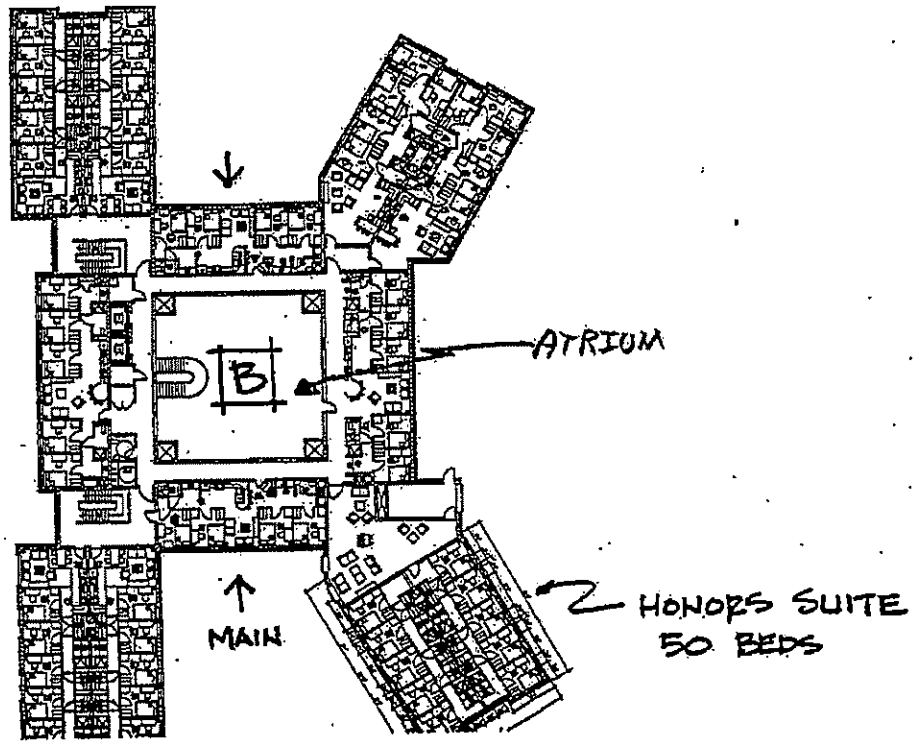
URI HOUSING

ATRIUM SECTION

(TYP.)

NORTH SITE APARTMENTS





URI HOUSING

ATRIUM PLAN

IBC 2003 Atrium Smoke Calculations

Vanderweil Engineers

Assumptions — 909.8 (same as UBC 905.5.2)

T_a =	75 °F (535 °R)	
z =	10.00 ft.	C_p = 0.24 BTU/lb°F (Specific heat of Air / Smoke)*
Q =	5,000 BTU/s	ρ = 0.074 lbs/ft³ (0.075 lbs/ft³ at 70 °F)*
Q_c =	3,500 BTU/s	

* SFPE Handbook, 3rd Edition; Page A23, Table B.2 (expressed in metric)

1. **Flame height** — IBC 9-3 (same as UBC 5-3)

$z_l = 0.533 Q_c^{2/5}$
$= 0.533 \times (3,500)^{2/5}$
$= 0.533 \times 26.16$
$= 13.9$ feet

2. **Axisymetric Plume** — IBC 9-3.1 (same as UBC 5-4) (for 'z' > flame height)

$m_p = 0.022 Q_c^{1/3} z^{5/3} + 0.0042 Q_c$
$= 0.022 \times (3,500)^{1/3} (10.0)^{5/3} + (0.0042 \times 3,500)$
$= 0.022 \times 15.18 \times 46.42 + 14.7$
$= 30.2$ lbs/s

3. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$
$= [3,500 / (0.24 \times 30.2)] + 75$
$= [3,500 / 7.25] + 75$
$= 482.89 + 75$
$= 558$ °F (1,018 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

4. **Smoke Density** (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$
$= 0.074 (535 / 1,018)$
$= 0.074 \times 0.53$
$= 0.039$ lbs/ft³

5. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p/\rho$
$= 60 \times 30.2 / 0.039$
$= 46,401$ cfm — **Flame height is > 'z.' Use formula below.**

6. **Axisymetric Plume** — IBC 9-3.3 (same as UBC 5-4) (for 'z' < flame height)

$m_p = 0.0208 Q_c^{3/5} z$
$= 0.0208 \times 3,500^{3/5} \times 10.00$
$= 0.0208 \times 133.80 \times 10.00$
$= 27.83$ lbs/s

7. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$
$= [3,500 / (0.24 \times 27.83)] + 75$
$= [3,500 / 6.68] + 75$
$= 524.03 + 75$
$= 599$ °F (1,059 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

8. **Smoke Density** (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$
$= 0.074 (535 / 1,059)$
$= 0.074 \times 0.51$
$= 0.038$ lbs/ft³

9. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p/\rho$
$= 60 \times 27.83 / 0.038$
$= 44,486$ cfm — **REQUIRED EXHAUST**

IBC 2003 Atrium Smoke Calculations

Vanderweil Engineers

Assumptions — 909.8 (same as UBC 905.5.2)

T_a =	75 °F (535 °R)	C_p =	0.24 BTU/lb°F	(Specific heat of Air / Smoke)*	
Q =	5,000 BTU/s	ρ =	0.074 lbs/ft³	(0.075 lbs/ft³ at 70 °F)*	
H =	9.50 ft. Height to balcony	A_W =	36.00 ft².	Window area	
W =	5.00 ft. Width of balcony spill	H_W =	6.00 ft.	Height of opening	
z_b =	0.50 ft. Height to Z from balcony	z_W =	2.00 ft.	Height of opening above floor	
Q_c =	3,500 BTU/s	$a = 2.4A_W^{2/5}H_W^{1/5} - 2.1H_W$		=	1.80

* SFPE Handbook, 3rd Edition; Page A23, Table B.2 (expressed in metric)

1. **Balcony Spill Plume** — IBC 9-5 (same as UBC 5-8)

$m_p = 0.124(QW^2)^{1/3}(z_b + 0.25H)$

$= 0.124 (5,000 \times 5.0^2)^{1/3} (1 + 0.25 \times 9.50)$

$= 0.124 (5,000 \times 25)^{1/3} (1 + 2.38)$

$= 0.124 (125,000)^{1/3} (3)$

$= 0.124 (50) (3)$

$= 17.83$ lbs/s

2. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

$= [3,500 / (0.24 \times 17.83)] + 75$

$= [3,500 / 4.28] + 75$

$= 818.14 + 75$

$= 893$ °F (1,353 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

3. **Smoke Density** (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$

$= 0.074 (535 / 1,353)$

$= 0.074 \times 0.40$

$= 0.029$ lbs/ft³

4. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p/\rho$

$= 60 \times 17.83 / 0.029$

$= 36,407$ cfm

5. **Window Plume** — IBC 9-6 (same as UBC 5-9)

$m_p = 0.077(A_W H_W^{1/2})^{1/3}(z_W + a)^{5/3} + 0.18 A_W H_W^{1/2}$

$= 0.077 (36.00 \times 6.00^{1/2})^{1/3} (2.00 + 1.80)^{5/3} + 0.18 \times 36.00 \times 6.00^{1/2}$

$= 0.077 (36.00 \times 2.45)^{1/3} (3.80)^{5/3} + 0.18 \times 36.00 \times 2.45$

$= 0.077 (88.18)^{1/3} (9.25) + 15.87$

$= 0.077 (4.45) (9.25) + 15.87$

$= 3.17 + 15.87$

$= 19.04$ lbs/s

6. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

$= [3,500 / (0.24 \times 19.04)] + 75$

$= [3,500 / 4.57] + 75$

$= 765.77 + 75$

$= 841$ °F (1,301 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

7. **Smoke Density** (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$

$= 0.074 (535 / 1,301)$

$= 0.074 \times 0.41$

$= 0.031$ lbs/ft³

8. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p/\rho$

$= 60 \times 19.04 / 0.031$

$= 37,492$ cfm

H occupancies shall be provided in accordance with Section 414.7.

[F] 908.2 Group H-5 occupancy. Emergency alarms for notification of an emergency condition in an HPM facility shall be provided as required in Section 415.9.4.6. A continuous gas-detection system shall be provided for HPM gases in accordance with Section 415.9.7.

[F] 908.3 Highly toxic and toxic materials. A gas detection system shall be provided for indoor storage and use of highly toxic and toxic gases to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit of the gas for which detection is provided. The system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit.

Exception: A gas detection system is not required for toxic gases when the physiological warning properties are at a level below the accepted PEL for the gas.

[F] 908.3.1 Alarms. The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station when a short-term hazard condition is detected. The alarm shall be both visible and audible and shall provide warning both inside and outside the area where gas is detected. The audible alarm shall be distinct from all other alarms.

Exception: Signal transmission to a constantly attended control station is not required when not more than one cylinder of highly toxic or toxic gas is stored.

[F] 908.3.2 Shutoff of gas supply. The gas detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for whichever gas is detected.

Exception: Automatic shutdown is not required for reactors utilized for the production of highly toxic or toxic compressed gases where such reactors are:

1. Operated at pressures less than 15 pounds per square inch gauge (psig) (103.4 kPa).
2. Constantly attended.
3. Provided with readily accessible emergency shutoff valves.

[F] 908.3.3 Valve closure. The automatic closure of shutoff valves shall be in accordance with the following:

1. When the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas room and compressed gas containers are not in gas cabinets or exhausted enclosures, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve for the compressed container of specific gas detected supplying the manifold shall automatically close.

Exception: When the gas-detection sampling point initiating the gas-detection system alarm is at a use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve in the gas valve enclosure for the branch line located in the piping distribution manifold enclosure shall automatically close.

[F] 908.4 Ozone gas-generator rooms. Ozone gas-generator rooms shall be equipped with a continuous gas-detection system that will shut off the generator and sound a local alarm when concentrations above the PEL occur.

[F] 908.5 Repair garages. A flammable-gas detection system shall be provided in repair garages for vehicles fueled by nonodorized gases in accordance with Section 406.6.6.

[F] 908.6 Refrigerant detector. Machinery rooms shall contain a refrigerant detector with an audible and visual alarm. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values for the refrigerant classification indicated in the *International Mechanical Code*. Detectors and alarms shall be placed in approved locations.

Exception: Detectors are not required in ammonia system machinery rooms equipped with a vapor detector in accordance with the *International Mechanical Code*.

SECTION 909
SMOKE CONTROL SYSTEMS

909.1 Scope and purpose. This section applies to mechanical or passive smoke control systems when they are required by other provisions of this code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-venting provisions found in Section 910. Mechanical smoke control systems shall not be considered exhaust systems under Chapter 5 of the *International Mechanical Code*.

909.2 General design requirements. Buildings, structures or parts thereof required by this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design. The construction documents shall include sufficient information and detail to adequately describe the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied by sufficient information and analysis to demonstrate compliance with these provisions.

909.3 Special inspection and test requirements. In addition to the ordinary inspection and test requirements which buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the construction documents shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The special inspections and tests required by this section shall be conducted under the same terms in Section 1704.

909.4 Analysis. A rational analysis supporting the types of smoke control systems to be employed, their methods of operation, the systems supporting them and the methods of construction to be utilized shall accompany the submitted construction documents and shall include, but not be limited to, the items indicated in Sections 909.4.1 through 909.4.6.

909.4.1 Stack effect. The system shall be designed such that the maximum probable normal or reverse stack effect will not adversely interfere with the system's capabilities. In determining the maximum probable stack effect, altitude, elevation, weather history and interior temperatures shall be used.

909.4.2 Temperature effect of fire. Buoyancy and expansion caused by the design fire in accordance with Section 909.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with the system's capabilities.

909.4.3 Wind effect. The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of Chapter 16.

909.4.4 HVAC systems. The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems status. The design shall consider the effects of the fire on the HVAC systems.

909.4.5 Climate. The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

909.4.6 Duration of operation. All portions of active or passive smoke control systems shall be capable of continued operation after detection of the fire event for not less than 20 minutes.

909.5 Smoke barrier construction. Smoke barriers shall comply with Section 709, and shall be constructed and sealed to limit leakage areas exclusive of protected openings. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls: $A/A_w = 0.00100$
2. Exit enclosures: $A/A_w = 0.00035$
3. All other shafts: $A/A_w = 0.00150$
4. Floors and roofs: $A/A_F = 0.00050$

where:

A = Total leakage area, square feet (m^2).

A_F = Unit floor or roof area of barrier, square feet (m^2).

A_w = Unit wall area of barrier, square feet (m^2).

The leakage area ratios shown do not include openings due to doors, operable windows or similar gaps. These shall be included in calculating the total leakage area.

909.5.1 Leakage area. The total leakage area of the barrier is the product of the smoke barrier gross area monitored by the allowable leakage area ratio, plus the area of other openings such as gaps and operable windows. Compliance shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems. Passive smoke control systems tested using other approved means such as door fan testing shall be as approved by the building official.

909.5.2 Opening protection. Openings in smoke barriers shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by door assemblies complying with Section 715.4.3.

Exceptions:

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors listed for releasing service installed in accordance with Section 907.11.
2. Fixed openings between smoke zones which are protected utilizing the airflow method.
3. In Group I-2, where such doors are installed across corridors, a pair of opposite-swinging doors without a center mullion shall be installed having vision panels with approved fire-rated glazing materials in approved fire-rated frames, the area of which shall not exceed that tested. The doors shall be close fitting within operational tolerances and shall not have undercuts, louvers or grilles. The doors shall have head and jamb stops, astragals or rabbets at meeting edges, and automatic-closing devices. Positive-latching devices are not required.
4. Group I-3.
5. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank-down capacity of greater than 20 minutes as determined by the design fire size.

909.5.2.1 Ducts and air transfer openings. Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) smoke damper complying with Section 716.

909.6 Pressurization method. The primary mechanical means of controlling smoke shall be by pressure differences across smoke barriers. Maintenance of a tenable environment is not required in the smoke control zone of fire origin.

909.6.1 Minimum pressure difference. The minimum pressure difference across a smoke barrier shall be 0.05-inch water gage (0.0124 kPa) in fully sprinklered buildings. In buildings permitted to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure differences at least two times the maximum calculated pressure difference produced by the design fire.

909.6.2 Maximum pressure difference. The maximum air pressure difference across a smoke barrier shall be determined by required door-opening or closing forces. The actual force required to open exit doors when the system is in the smoke control mode shall be in accordance with Section 1008.1.2. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(WA\Delta P)/2(W - d) \qquad \text{(Equation 9-1)}$$

where:

A = Door area, square feet (m^2).

d = Distance from door handle to latch edge of door, feet (m).

F = Total door opening force, pounds (N).

F_{dc} = Force required to overcome closing device, pounds (N).

K = Coefficient 5.2 (1.0).

W = Door width, feet (m).

ΔP = Design pressure difference, inches of water (Pa).

909.7 Airflow design method. When approved by the building official, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflow shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects.

909.7.1 Velocity. The minimum average velocity through a fixed opening shall not be less than:

$$v = 217.2\,[h\,(T_f - T_o)/(T_f + 460)]^{1/2} \qquad \text{(Equation 9-2)}$$

For SI: $v = 119.9\,[h\,(T_f - T_o)/T_f]^{1/2}$

where:

h = Height of opening, feet (m).

T_f = Temperature of smoke, °F (°K).

T_o = Temperature of ambient air, °F (°K).

v = Air velocity, feet per minute (m/minute).

909.7.2 Prohibited conditions. This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. In no case shall airflow toward the fire exceed 200 feet per minute (1.02 m/s). Where the formula in Section 909.7.1 requires airflow to exceed this limit, the airflow method shall not be used.

909.8 Exhaust method. When approved by the building official, mechanical smoke control for large enclosed volumes, such as in atriums or malls, shall be permitted to utilize the exhaust method. The design exhaust volumes shall be in accordance with this section.

909.8.1 Exhaust rate. The height of the lowest horizontal surface of the accumulating smoke layer shall be maintained at least 10 feet (3048 mm) above any walking surface which forms a portion of a required egress system within the smoke zone. The required exhaust rate for the zone shall be the largest of the calculated plume mass flow rates for the possible plume configurations. Provisions shall be made for natural or mechanical supply of air from outside or adjacent smoke zones to make up for the air exhausted. Makenp airflow rates, when measured at the potential fire location, shall not exceed 200 feet per minute (60 960 mm per minute) toward the fire. The temperature of the makeup air shall be such that it does not expose temperature-sensitive fire protection systems beyond their limits.

909.8.2 Axisymmetric plumes. The plume mass flow rate (m_p), in pounds per second (kg/s), shall be determined by placing the design fire center on the axis of the space being analyzed. The limiting flame height shall be determined by:

$$z_l = 0.533 Q_c^{2/5} \qquad \text{(Equation 9-3)}$$

For SI: $z_l = 0.166 Q_c^{2/5}$

where:

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat outpnt.

Q_c = Convective heat output, British thermal units per second (kW). (The value of Q_c shall not be taken as less than $0.70Q$).

z = Height from top of fuel surface to bottom of smoke layer, feet (m).

z_l = Limiting flame height, feet (m). The z_l value must be greater than the fuel equivalent diameter (see Section 909.9).

for $z > z_l$

$$m_p = 0.022 Q_c^{1/3} z^{5/3} + 0.0042 Q_c$$

For SI: $m_p = 0.071\, Q_c^{1/3} z^{5/3} + 0.0018 Q_c$

for $z = z_l$

$$m_p = 0.011\, Q_c$$

For SI: $m_p = 0.035 Q_c$

for $z < z_l$

$$m_p = 0.0208 Q_c^{3/5} z$$

For SI: $m_p = 0.032 Q_c^{3/5} z$

To convert m_p from pounds per second of mass flow to a volumetric rate, the following equation shall be used:

$$V = 60\, m_p/\rho \qquad \text{(Equation 9-4)}$$

where:

V = Volumetric flow rate, cubic feet per minute (m^3/s).

ρ = Density of air at the temperature of the smoke layer, pounds per cubic feet (T: in °F) [kg/m^3 (T: in °C)].

909.8.3 Balcony spill plumes. The plume mass flow rate (m_p) for spill plumes shall be determined using the geometrically probable width based on architectural elements and projections in the following equation:

$$m_p = 0.124(QW^2)^{1/3}(z_b + 0.25H) \quad \text{(Equation 9-5)}$$

For SI: $m_p = 0.36(QW^2)^{1/3}(z_b + 0.25H)$

where:

H = Height above fire to underside of balcony, feet (m).

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat output.

W = Plume width at point of spill, feet (m).

z_b = Height from balcony, feet (m).

909.8.4 Window plumes. The plume mass flow rate (m_p) shall be determined from:

$$m_p = 0.077(A_w H_w^{1/2})^{1/3}(z_w + a)^{5/3} + 0.18A_w H_w^{1/2} \quad \text{(Equation 9-6)}$$

For SI: $m_p = 0.68(A_w H_w^{1/2})^{1/3}(z_w + a)^{5/3} + 1.5A_w H_w^{1/2}$

where:

A_w = Area of the opening, square feet (m^2).

H_w = Height of the opening, feet (m).

m_p = plume mass flow rate, pounds per second (kg/s).

z_w = Height from the top of the window or opening to the bottom of the smoke layer, feet (m).

a = $2.4A_w^{2/5}H_w^{1/5} - 2.1H_w$

909.8.5 Plume contact with walls. When a plume contacts one or more of the surrounding walls, the mass flow rate shall be adjusted for the reduced entrainment resulting from the contact provided that the contact remains constant. Use of this provision requires calculation of the plume diameter, that shall be calculated by:

$$d = 0.48[(T_c + 460)/(T_a + 460)]^{1/2}z \quad \text{(Equation 9-7)}$$

For SI: $d = 0.48(T_c/T_a)^{1/2}z$

where:

d = Plume diameter, feet (m).

T_a = Ambient air temperature, °F (°K).

T_c = Plume centerline temperature, °F (°K).
$= 0.60(T_a + 460)Q_c^{2/3}z^{-5/3} + T_a$

z = Height at which T_c is determined, feet (m).

For SI: $T_c = 0.08T_aQ_c^{2/3}z^{-5/3} + T_a$

909.9 Design fire. The design fire shall be based on a Q of not less than 5,000 Btu/s (5275 kW) unless a rational analysis is performed by the registered design professional and approved by the building official. The design fire shall be based on the analysis in accordance with Section 909.4 and this section.

909.9.1 Factors considered. The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire and whether the fire is likely to be steady or unsteady.

909.9.2 Separation distance. Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration. The ratio of the separation distance to the fuel equivalent radius shall not be less than 4. The fuel equivalent radius shall be the radius of a circle of equal area to floor area of the fuel package. The design fire shall be increased if other combustibles are within the separation distance as determined by:

$$R = [Q/(12\pi q'')]^{1/2} \quad \text{(Equation 9-8)}$$

where:

q'' = Incident radiant heat flux required for nonpiloted ignition, Btu/ft² · s (W/m^2).

Q = Heat release from fire, Btu/s (kW).

R = Separation distance from target to center of fuel package, feet (m).

909.9.3 Heat-release assumptions. The analysis shall make use of best available data from approved sources and shall not be based on excessively stringent limitations of combustible material.

909.9.4 Sprinkler effectiveness assumptions. A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

909.10 Equipment. Equipment such as, but not limited to, fans, ducts, automatic dampers and balance dampers, shall be suitable for its intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as approved by the building official.

909.10.1 Exhaust fans. Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad \text{(Equation 9-9)}$$

where:

c = Specific heat of smoke at smoke layer temperature, Btu/lb°F (kJ/kg · K).

m = Exhaust rate, pounds per second (kg/s).

Q_c = Convective heat output of fire, Btu/s (kW).

T_a = Ambient temperature, °F (°K).

T_s = Smoke temperature, °F (°K).

Exception: Reduced T_s as calculated based on the assurance of adequate dilution air.

909.10.2 Ducts. Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 909.10.1. Ducts shall be constructed and supported in accordance with the *International Mechanical Code*. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

Exception: Flexible connections (for the purpose of vibration isolation) complying with the *International Mechanical Code*, that are constructed of approved fire-resistance-rated materials.

909.10.3 Equipment, inlets and outlets. Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outside air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

909.10.4 Automatic dampers. Automatic dampers, regardless of the purpose for which they are installed within the smoke control system, shall be listed and conform to the requirements of approved, recognized standards.

909.10.5 Fans. In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the requirements of Chapter 16. Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts), as determined from measurement of actual current draw, and shall have a minimum service factor of 1.15.

909.11 Power systems. The smoke control system shall be supplied with two sources of power. Primary power shall be the normal building power systems. Secondary power shall be from an approved standby source complying with the ICC *Electrical Code*. The standby power source and its transfer switches shall be in a separate room from the normal power transformers and switch gear and shall be enclosed in a room constructed of not less than 1-hour fire-resistance-rated fire barriers ventilated directly to and from the exterior. Power distribution from the two sources shall be by independent routes. Transfer to full standby power shall be automatic and within 60 seconds of failure of the primary power. The systems shall comply with the ICC *Electrical Code*.

909.11.1 Power sources and power surges. Elements of the smoke management system relying on volatile memories or the like shall be supplied with uninterruptable power sources of sufficient duration to span a 15-minute primary power interruption. Elements of the smoke management system susceptible to power surges shall be suitably protected by conditioners, suppressors or other approved means.

909.12 Detection and control systems. Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907. Such systems shall be equipped with a control unit complying with UL 864 and listed as smoke control equipment.

Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power downstream of all disconnects and, through a preprogrammed weekly test sequence report, abnormal conditions audibly, visually and by printed report.

909.12.1 Wiring. In addition to meeting requirements of the ICC *Electrical Code*, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

[F] 909.12.2 Activation. Smoke control systems shall be activated in accordance with this section.

[F] 909.12.2.1 Pressurization, airflow or exhaust method. Mechanical smoke control systems using the pressurization, airflow or exhaust method shall have completely automatic control.

[F] 909.12.2.2 Passive method. Passive smoke control systems actuated by approved spot-type detectors listed for releasing service shall be permitted.

[F] 909.12.3 Automatic control. Where completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned automatic sprinkler system complying with Section 903.3.1.1, manual controls that are readily accessible to the fire department and any smoke detectors required by engineering analysis.

909.13 Control air tubing. Control air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections and shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

909.13.1 Materials. Control air tubing shall be hard drawn copper, Type L, ACR in accordance with ASTM B 42, ASTM B 43, ASTM B 68, ASTM B 88, ASTM B 251 and ASTM B 280. Fittings shall be wrought copper or brass, solder type, in accordance with ASME B 16.18 or ASME B 16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F (593°C) and liquids below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

Exception: Nonmetallic tubing used within control panels and at the final connection to devices, providing all of the following conditions are met:

1. Tubing shall be listed by an approved agency for flame and smoke characteristics.

2. Tubing and connected devices shall be completely enclosed within galvanized or paint-grade steel enclosure of not less than 0.030 inch (0.76 mm) (No. 22 galvanized sheet gage) thickness. Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or teflon or by suitable brass compression to male-barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within enclosure. Tubing bridging cabinet and door or moveable device shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing serving devices on doors shall be fastened along hinges.

909.13.2 Isolation from other functions. Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

909.13.3 Testing. Control air tubing shall be tested at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

909.14 Marking and identification. The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

[F] 909.15 Control diagrams. Identical control diagrams showing all devices in the system and identifying their location and function shall be maintained current and kept on file with the building official, the fire department and in the fire command center in format and manner approved by the fire chief.

[F] 909.16 Fire-fighter's smoke control panel. A fire-fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be located in a fire command center complying with Section 911, and shall comply with Sections 909.16.1 through 909.16.3.

[F] 909.16.1 Smoke control systems. Fans within the building shall be shown on the fire-fighter's control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone, and by pilot-lamp-type indicators as follows:

1. Fans, dampers aud other operating equipment in their normal status—WHITE.
2. Fans, dampers and other operating equipment in their off or closed status—RED.
3. Fans, dampers and other operating equipment in their on or open status—GREEN.
4. Fans, dampers and other operating equipment in a fault status—YELLOW/AMBER.

[F] 909.16.2 Smoke control panel. The fire-fighter's control panel shall provide control capability over the complete smoke-control system equipment within the building as follows:

1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes stairway pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans and other operating equipment used or intended for smoke control purposes.
2. OPEN-AUTO-CLOSE control over individual dampers relating to smoke control and that are also controlled from other sources within the building.
3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the fire-fighter's control panel.

Exceptions:

1. Complex systems, where approved, where the controls and indicators are combined to control and indicate all elements of a single smoke zone as a unit.
2. Complex systems, where approved, where the control is accomplished by computer interface using approved, plain English commands.

[F] 909.16.3 Control action and priorities. The fire-fighter's control panel actions shall be as follows:

1. ON-OFF, OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the fire-fighter's control panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the fire-fighter's control panel. The last control action as indicated by each fire-fighter's control panel switch position shall prevail. In no case shall control actions require the smoke control system to assume more than one configuration at any one time.

   Exception: Power disconnects required by the ICC *Electrical Code*.

2. Only the AUTO position of each three-position fire-fighter's control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, nonemergency, building control position. Where a fire-fighter's control panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described above. When directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. In no case shall control actions require the

smoke control system to assume more than one configuration at any one time.

[F] 909.17 System response time. Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. For purposes of smoke control, the fire-fighter's control panel response time shall be the same for automatic or manual smoke control action initiated from any other building control point. The total response time, including that necessary for detection, shutdown of operating equipment and smoke control system startup, shall allow for full operational mode to be achieved before the conditions in the space exceed the design smoke condition. The system response time for each component and their sequential relationships shall be detailed in the required rational analysis and verification of their installed condition reported in the required final report.

[F] 909.18 Acceptance testing. Devices, equipment, components and sequences shall be individually tested. These tests, in addition to those required by other provisions of this code, shall consist of determination of function, sequence and, where applicable, capacity of their installed condition.

[F] 909.18.1 Detection devices. Smoke or fire detectors that are a part of a smoke control system shall be tested in accordance with Chapter 9 in their installed condition. When applicable, this testing shall include verification of airflow in both minimum and maximum conditions.

[F] 909.18.2 Ducts. Ducts that are part of a smoke control system shall be traversed using generally accepted practices to determine actual air quantities.

[F] 909.18.3 Dampers. Dampers shall be tested for function in their installed condition.

[F] 909.18.4 Inlets and outlets. Inlets and outlets shall be read using generally accepted practices to determine air quantities.

[F] 909.18.5 Fans. Fans shall be examined for correct rotation. Measurements of voltage, amperage, revolutions per minute (rpm) and belt tension shall be made.

[F] 909.18.6 Smoke barriers. Measurements using inclined manometers or other approved calibrated measuring devices shall be made of the pressure differences across smoke barriers. Such measurements shall be conducted for each possible smoke control condition.

[F] 909.18.7 Controls. Each smoke zone, equipped with an automatic-initiation device, shall be put into operation by the actuation of one such device. Each additional device within the zone shall be verified to cause the same sequence without requiring the operation of fan motors in order to prevent damage. Control sequences shall be verified throughout the system, including verification of override from the fire-fighter's control panel and simulation of standby power conditions.

[F] 909.18.8 Special inspections for smoke control. Smoke control systems shall be tested by a special inspector.

[F] 909.18.8.1 Scope of testing. Special inspections shall be conducted in accordance with the following:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure-difference testing, flow measurements, and detection and control verification.

[F] 909.18.8.2 Qualifications. Special inspection agencies for smoke control shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

[F] 909.18.8.3 Reports. A complete report of testing shall be prepared by the special inspector or special inspection agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or mark. The report shall be reviewed by the responsible registered design professional and, when satisfied that the design intent has been achieved, the responsible registered design professional shall seal, sign and date the report.

[F] 909.18.8.3.1 Report filing. A copy of the final report shall be filed with the building official and an identical copy shall be maintained in an approved location at the building.

[F] 909.18.9 Identification and documentation. Charts, drawings and other documents identifying and locating each component of the smoke control system, and describing its proper function and maintenance requirements, shall be maintained on file at the building as an attachment to the report required by Section 909.18.8.3. Devices shall have an approved identifying tag or mark on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

[F] 909.19 System acceptance. Buildings, or portions thereof, required by this code to comply with this section shall not be issued a certificate of occupancy until such time that the building official determines that the provisions of this section have been fully complied with, and that the fire department has received satisfactory instruction on the operation, both automatic and manual, of the system.

Exception: In buildings of phased construction, a temporary certificate of occupancy, as approved by the building official, shall be permitted provided that those portions of the building to be occupied meet the requirements of this section and that the remainder does not pose a significant hazard to the safety of the proposed occupants or adjacent buildings.

909.20 Smokeproof enclosures. Where required by Section 1019.1.8, a smokeproof enclosure shall be constructed in accordance with this section. A smokeproof enclosure shall consist of an enclosed interior exit stairway that conforms to Section 1019.1 and an outside balcony or ventilated vestibule meeting the requirements of this section. Where access to the roof is required by the *International Fire Code*, such access

shall be from the smokeproof enclosure where a smokeproof enclosure is required.

909.20.1 Access. Access to the stair shall be by way of a vestibule or an open exterior balcony. The minimum dimension of the vestibule shall not be less than the required width of the corridor leading to the vestibule but shall not have a width of less than 44 inches (1118 mm) and shall not have a length of less than 72 inches (1829 mm) in the direction of egress travel.

909.20.2 Construction. The smokeproof enclosure shall be separated from the remainder of the building by not less than a 2-hour fire-resistance-rated fire barrier without openings other than the required means of egress doors. The vestibule shall be separated from the stairway by not less than a 2-hour fire-resistance-rated fire barrier. The open exterior balcony shall be constructed in accordance with the fire-resistance-rating requirements for floor construction.

909.20.2.1 Door closers. Doors in a smokeproof enclosure shall be self-closing or shall be automatic-closing by actuation of a smoke detector installed at the floor-side entrance to the smokeproof enclosure in accordance with Section 715.4.7. The actuation of the smoke detector on any door shall activate the closing devices on all doors in the smokeproof enclosure at all levels. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.3 Natural ventilation alternative. The provisions of Sections 909.20.3.1 through 909.20.3.3 shall apply to ventilation of smokeproof enclosures by natural means.

909.20.3.1 Balcony doors. Where access to the stairway is by way of an open exterior balcony, the door assembly into the enclosure shall be a fire door in accordance with Section 715.4.

909.20.3.2 Vestibule doors. Where access to the stairway is by way of a vestibule, the door assembly into the vestibule shall be a fire door complying with Section 715.4. The door assembly from the vestibule to the stairway shall have not less than a 20-minute fire protection rating complying with Section 715.4.

909.20.3.3 Vestibule ventilation. Each vestibule shall have a minimum net area of 16 square feet (1.5 m²) of opening in a wall facing an outer court, yard or public way that is at least 20 feet (6096 mm) in width.

909.20.4 Mechanical ventilation alternative. The provisions of Sections 909.20.4.1 through 909.20.4.4 shall apply to ventilation of smokeproof enclosures by mechanical means.

909.20.4.1 Vestibule doors. The door assembly from the building into the vestibule shall be a fire door complying with Section 715.4. The door assembly from the vestibule to the stairway shall have not less than a 20-minute fire protection rating in accordance with Section 715.4. The door from the building into the vestibule shall be provided with gaskets or other provisions to minimize air leakage.

909.20.4.2 Vestibule ventilation. The vestibule shall be supplied with not less than one air change per minute and the exhaust shall not be less than 150 percent of supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 6 inches (152 mm) of the floor level. The top of the exhaust register shall be located at the top of the smoke trap but not more than 6 inches (152 mm) down from the top of the trap, and shall be entirely within the smoke trap area. Doors in the open position shall not obstruct duct openings. Duct openings with controlling dampers are permitted where necessary to meet the design requirements, but dampers are not otherwise required.

909.20.4.2.1 Engineered ventilation system. Where a specially engineered system is used, the system shall exhaust a quantity of air equal to not less than 90 air changes per hour from any vestibule in the emergency operation mode and shall be sized to handle three vestibules simultaneously. Smoke detectors shall be located at the floor-side entrance to each vestibule and shall activate the system for the affected vestibule. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.4.3 Smoke trap. The vestibule ceiling shall be at least 20 inches (508 mm) higher than the door opening into the vestibule to serve as a smoke and heat trap and to provide an upward-moving air column. The height shall not be decreased unless approved and justified by design and test.

909.20.4.4 Stair shaft air movement system. The stair shaft shall be provided with a dampered relief opening and supplied with sufficient air to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) in the shaft relative to the vestibule with all doors closed.

909.20.5 Stair pressurization alternative. Where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the vestibule is not required, provided that interior exit stairways are pressurized to a minimum of 0.15 inch of water (37 Pa) and a maximum of 0.35 inch of water (87 Pa) in the shaft relative to the building measured with all stairway doors closed under maximum anticipated stack pressures.

909.20.6 Ventilating equipment. The activation of ventilating equipment required by the alternatives in Sections 909.20.4 and 909.20.5 shall be by smoke detectors installed at each floor level at an approved location at the entrance to the smokeproof enclosure. When the closing device for the stair shaft and vestibule doors is activated by smoke detection or power failure, the mechanical equipment shall activate and operate at the required performance levels. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.6.1 Ventilation systems. Smokeproof enclosure ventilation systems shall be independent of other building ventilation systems. The equipment and ductwork shall comply with one of the following:

1. Equipment and ductwork shall be located exterior to the building and directly connected to the

smokeproof enclosure or connected to the smokeproof enclosure by ductwork enclosed by 2-hour fire-resistance-rated fire barriers.

2. Equipment and ductwork shall be located within the smokeproof enclosure with intake or exhaust directly from and to the outside or through ductwork enclosed by 2-hour fire-resistance-rated fire barriers.
3. Equipment and ductwork shall be located within the building if separated from the remainder of the building, including other mechanical equipment, by 2-hour fire-resistance-rated fire barriers.

909.20.6.2 Standby power. Mechanical vestibule and stair shaft ventilation systems and automatic fire detection systems shall be powered by an approved standby power system conforming to Section 403.10.1 and Chapter 27.

909.20.6.3 Acceptance and testing. Before the mechanical equipment is approved, the system shall be tested in the presence of the building official to confirm that the system is operating in compliance with these requirements.

909.21 Underground building smoke exhaust system. Where required in accordance with Section 405.5 for underground buildings, a smoke exhaust system shall be provided in accordance with this section.

909.21.1 Exhaust capability. Where compartmentation is required, each compartment shall have an independent, automatically activated smoke exhaust system capable of manual operation. The system shall have an air supply and smoke exhaust capability that will provide a minimum of six air changes per hour.

[F] 909.21.2 Operation. The smoke exhaust system shall be operated in the compartment of origin by the following, independently of each other:

1. Two cross-zoned smoke detectors within a single protected area of a single smoke detector monitored by an alarm verification zone or an approved equivalent method.
2. The automatic sprinkler system.
3. Manual controls that are readily accessible to the fire department.

[F] 909.21.3 Alarm required. Activation of the smoke exhaust system shall activate an audible alarm at a constantly attended location.

SECTION 910
SMOKE AND HEAT VENTS

[F] 910.1 General. Where required by this code or otherwise installed, smoke and heat vents or mechanical smoke exhaust systems and draft curtains shall conform to the requirements of this section.

Exception: Frozen-food warehouses used solely for storage of Class I and II commodities where protected by an approved automatic sprinkler system.

[F] 910.2 Where required. Approved smoke and heat vents shall be installed in the roofs of one-story buildings or portions thereof occupied for the uses set forth in Sections 910.2.1 through 910.2.4.

[F] 910.2.1 Groups F-1 and S-1. Buildings and portions thereof used as a Group F-1 or S-1 occupancy having more than 50,000 square feet (4645 m²) in undivided area.

Exception: Group S-1 aircraft repair hangars.

[F] 910.2.2 Group H. Buildings and portions thereof used as a Group H occupancy as shown:

1. In occupancies classified as Group H-2 or H-3, any of which are over 15,000 square feet (1394 m²) in single floor area.

   Exception: Buildings of noncombustible construction containing only noncombustible materials.

2. In areas of buildings in Group H used for storing Class 2, 3, and 4 liquid and solid oxidizers, Class 1 and unclassified detonable organic peroxides, Class 3 and 4 unstable (reactive) materials, or Class 2 or 3 water-reactive materials as required for a high-hazard commodity classification.

   Exception: Buildings of noncombustible construction containing only noncombustible materials.

[F] 910.2.3 High-piled combustible storage. Buildings and portions thereof containing high-piled combustible stock or rack storage in any occupancy group in accordance with Section 413 and the *International Fire Code*.

[F] 910.2.4 Exit access travel distance increase. Buildings and portions thereof used as a Group F-1 or S-1 occupancy where the maximum exit access travel distance is increased in accordance with Section 1015.2.

[F] 910.3 Design and installation. The design and installation of smoke and heat vents and draft curtains shall be as specified in this section and Table 910.3.

[F] 910.3.1 Vent operation. Smoke and heat vents shall be approved and labeled and shall be capable of being operated by approved automatic and manual means. Automatic operation of smoke and heat vents shall conform to the provisions of this section.

[F] 910.3.1.1 Gravity-operated drop-out vents. Automatic smoke and heat vents containing heat-sensitive glazing designed to shrink and drop out of the vent opening when exposed to fire shall fully open within 5 minutes after the vent cavity is exposed to a simulated fire, represented by a time-temperature gradient that reaches an air temperature of 500°F (260°C) within 5 minutes.

[F] 910.3.1.2 Sprinklered buildings. Where installed in buildings provided with an approved automatic sprinkler system, smoke and heat vents shall be designed to operate automatically.

[F] 910.3.1.3 Nonsprinklered buildings. Where installed in buildings not provided with an approved automatic sprinkler system, smoke and heat vents shall operate automatically by actuation of a heat-responsive

Control Device		Qty	Product Number	Manufacturer	SD Number	Document Number	Description
Field Mounted Devices							
AE	1-6	6	CMA221.1U	SIEMENS		155 315	2PT SR,120V,62LBIN
CS	1-6	6	H908	VERIS		1006cut005	CURRENT SW SPLITCORE-ADJ W/LED
ES	1-6	6	PK-1200	REED		0401cut001	DAMPER END SW,BLADE ACTUATED
RE	1-6	6	RIBU1C	FUNCTIONAL DEVICES		1208cut013	RIB 120VAC 24VAC/DC SPDT
XFMR	1	1	120-24-1002TFCB	CORE		1202cut008	TRANSFORMER 120/24 100VA 2 HUB

SEQUENCE TO BE COORDINATED WITH FIRE ALARM CONTRACTOR.

When any smoke detector in the atrium detects an alarm the FAS will send a signal to open the vents located on the first floor (no DDC and no labor provided by Siemens). This will allow the make up air to enter the atrium.

The Fire Alarm System (FAS) will also send a signal to the DDC system in the event of an alarm condition. Once the DDC system receives the signal the following will occur.

The Smoke Make Up Air Units (SMAU-1A, 2A, 3A, and 4A) and the Smoke Exhaust Fans (SEF-1A and 2A) will start and run continuously. The discharge dampers on each fan will have end switches that are interlocked to the starter to prevent its operation until the dampers are open.

The fans will run until the fire alarm systems terminates the alarm condition signal it is sending to the DDC system.

All power for this system will be Emergency Power.

REVISION HISTORY

SIEMENS
Siemens Building Technologies
Building Automation Division
85 John Rd.
Unit 1
Canton, MA 02021
USA
PHONE 781-575-1900
FAX 781-575-9590

URI New Student Housing
Kingston, RI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
CPB	CPB			05/31/06

BLDG A: ATRIUM SMOKE SYSTEM

520-E -9624-

105

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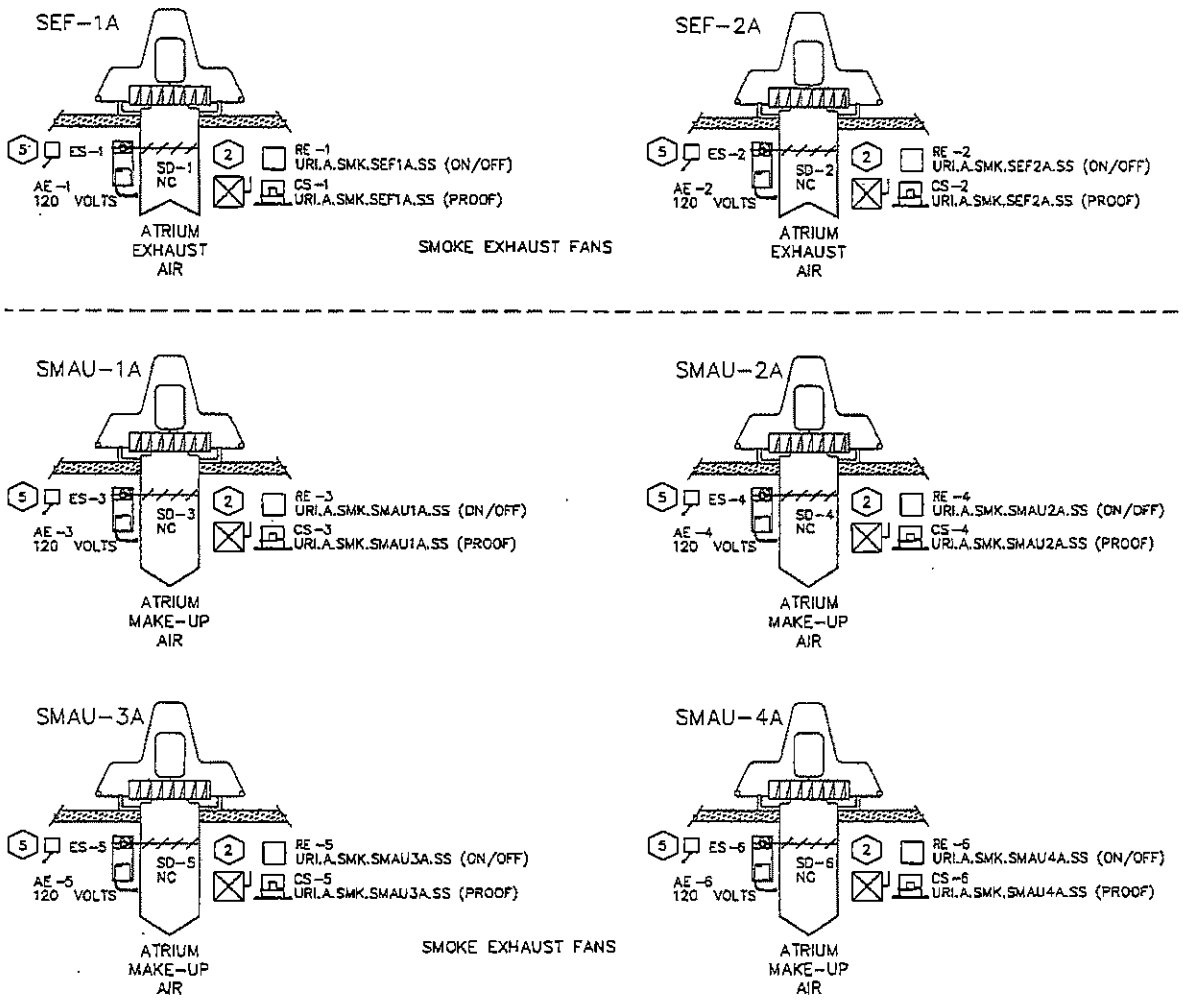

INSTALLATION NOTES:

1. SEE ELECTRICAL DRAWING FOR WIRING DETAILS
2. RELAYS LOCATED NEAR STARTER.
3. ALL FANS LOCATED ON ROOF.
4. FIRE ALARM SYSTEM TO PROVIDE CONTACT TO SIGNAL DDC IN EVENT OF AN ALARM.
5. MOUNT END SWITCH SO THE CONTACT IS MADE WHEN THE DAMPER IS 60% OPEN.

4 URI.A.SMK.FAS.ALM FAS. ALARM SIGNAL

PARTIAL COMPONENT PANEL CP-2

XFMR-1 100 VA

REVISION HISTORY

SIEMENS
Siemens Building Technologies
Building Automation Division
85 John Rd.
Unit 1
Canton, MA 02021
USA
PHONE: 781-575-1900
FAX: 781-575-9590

URI New Student Housing
Kingston, RI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
CPB	CPB		01/13/06	02/16/06

BLDG A: ATRUIM SMOKE SYSTEM

520-E -9624-
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105A

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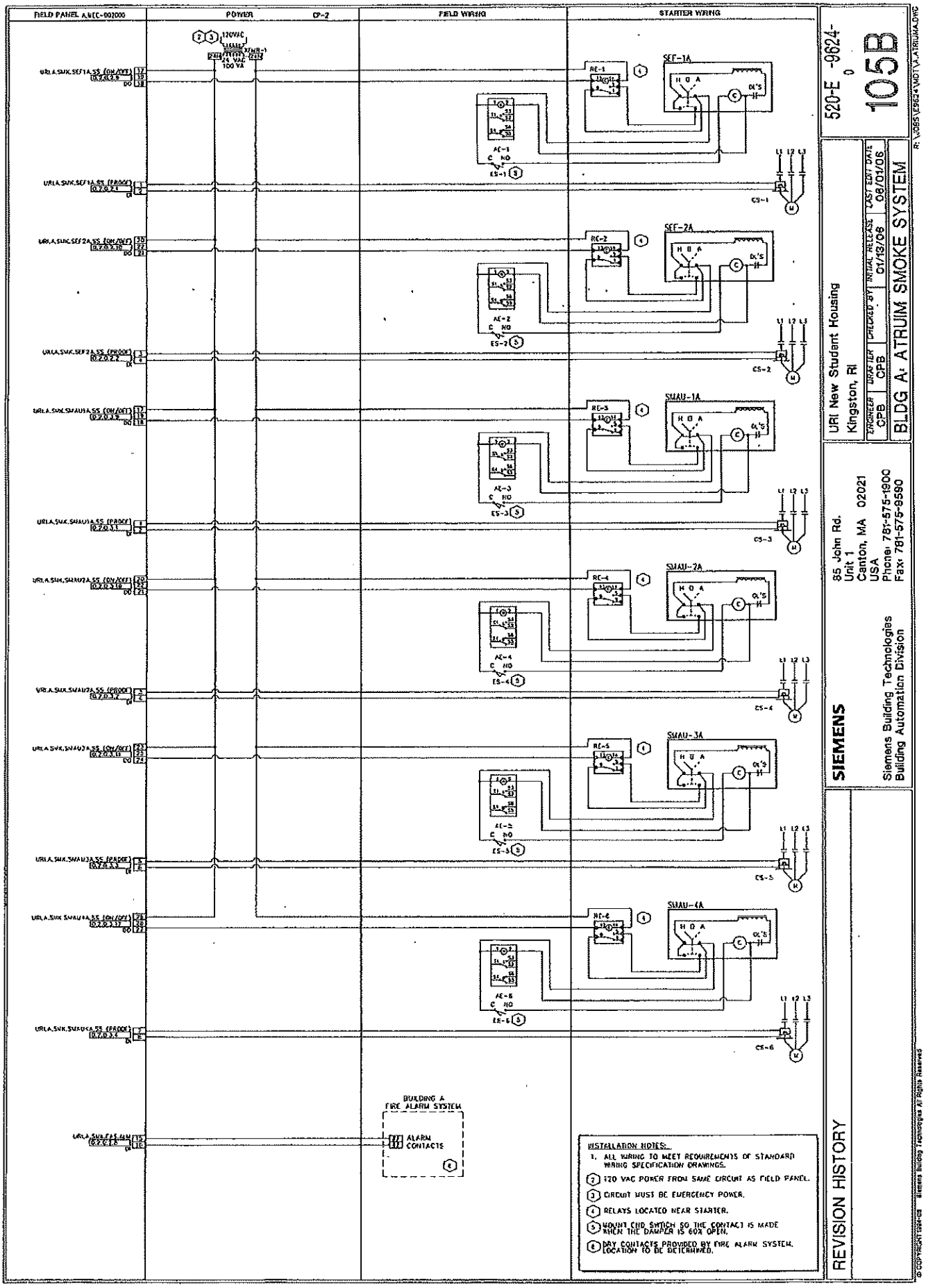

REVISION HISTORY

SIEMENS

Siemens Building Technologies
Building Automation Division

85 John Rd.
Unit 1
Canton, MA 02021
USA
Phone: 781-575-1900
Fax: 781-575-9590

URI New Student Housing
Kingston, RI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
CPB	CPB		01/18/08	08/01/08

BLDG A: ATRIUM SMOKE SYSTEM

520-E -9624-
0

105B

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Morin, David C.

From: Clapp, Charles [CClapp@Vanderweil.com]
Sent: Friday, December 15, 2006 11:15 AM
To: Morin, David C.
Cc: Jeff LaMothe; Browning, Christopher; 'Rick Bouchard'
Subject: URI smoke control system testing

David,
I wanted to follow up our telephone conversation from yesterday regarding the RI SFM office requesting Gilbane to provide a simulated smoke test for acceptance of the Building C Atrium smoke control system. Please read the inserted text from NFPA 92B appendix A. RGV does not recommend any simulated smoke testing as a prerequisite for acceptance.

Other Test Methods. Much can be accomplished to demonstrate smoke management system operation without resorting to demonstrations that use smoke or products that simulate smoke. The test methods previously described should provide an adequate means to evaluate the smoke management system's performance. Other test methods have been used historically in instances where the authority having jurisdiction requires additional testing. These test methods have limited value in evaluating certain system performance, and their validity as a method of testing a smoke management system is questionable.

As covered in the preceding chapters, the dynamics of the fire plume, buoyancy forces, and stratification are all major critical elements in the design of the smoke management system. Therefore, to test the system properly, a real fire condition would be the most appropriate and meaningful test. However, there are many valid reasons why such a fire is usually not practical in a completed building. Open flame/actual fire testing might be dangerous and should not normally be attempted. Any other test is a compromise. If a test of the smoke management system for building acceptance is mandated by the authority having jurisdiction, such a test condition would become the basis of design and might not in any way simulate any real fire condition. More importantly, it could be a deception and provide a false sense of security that the smoke management system would perform adequately in a real fire emergency.

Smoke bomb tests do not provide the heat, buoyancy, and entrainment of a real fire and are not useful in evaluating the real performance of the system. A system designed in accordance with this document and capable of providing the intended smoke management might not pass smoke bomb tests. Conversely, it is possible for a system that is incapable of providing the intended smoke management to pass smoke bomb tests. Because of the impracticality of conducting real fire tests, the acceptance tests described in this document are directed to those aspects of smoke management systems that can be verified.

It is an understatement to say that acceptance testing involving a real fire has obvious danger to life and property because of the heat generated and the toxicity of the smoke.

Charles A. Clapp, P.E.
Mechanical Engineer
R.G. Vanderweil Engineers, LLP
274 Summer Street
Boston, MA 02210-1123
Ph: 617-556-9392
Fax: 617-956-4864

TEST REPORT

R. G. Vanderweil Engineers, LLP

Submittal Package

URI Housing **Project#: 22562.00**

15000-004-00 Special Inspection Acceptance Test Report Closed: Yes

Author Company	Contact	Author Package#	Discipline	Date In	Date Out
		none	HVAC	10/6/2006	10/6/2006

Status: Reviewed

Reviewed and found generally acceptable. Submittal may contain minor corrections which must be complied with. No further submittal required.

Items:

#	Type	Description

Comments:

If item is not populated, comment is associated with submittal, otherwise comment is associated with submittal item.

1 Item:

Comment: System shall be adjusted to incorporate 4,800 CFM into ceiling plenum for discharge to perimeter of Atrium. Velocity at Atrium corner plenum louver face shall not exceed 200 FPM as designed

The S / L / A / M Collaborative

Supplemental Instructions No. 101

To: Gilbane Building Company

Date: October 12, 2006

Project: Univ. of Rhode Island
New Student Housing

Project No: 03216.00

The Work shall be carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Prior to proceeding in accordance with these instructions, indicate your acceptance of these instructions for minor change to the Work as consistent with the Contract Documents and return a copy to the Architect.

Item	Description
1	• Add wall penetrations for the smoke evacuation systems in all three buildings per the attached SSK-110, dated 10/12/06.

October 12, 2006
Issued:

Accepted:

J LaMothe
By: Jeff LaMothe

By:

Distribution:

Architecture
Planning
Interior Architecture
Structural Engineering
Landscape Architecture
Construction Services

Atlanta, GA

Boston, MA

Somerset Square
80 Glastonbury Boulevard
Glastonbury
Connecticut 06033-4415
Phone 860 657.8077
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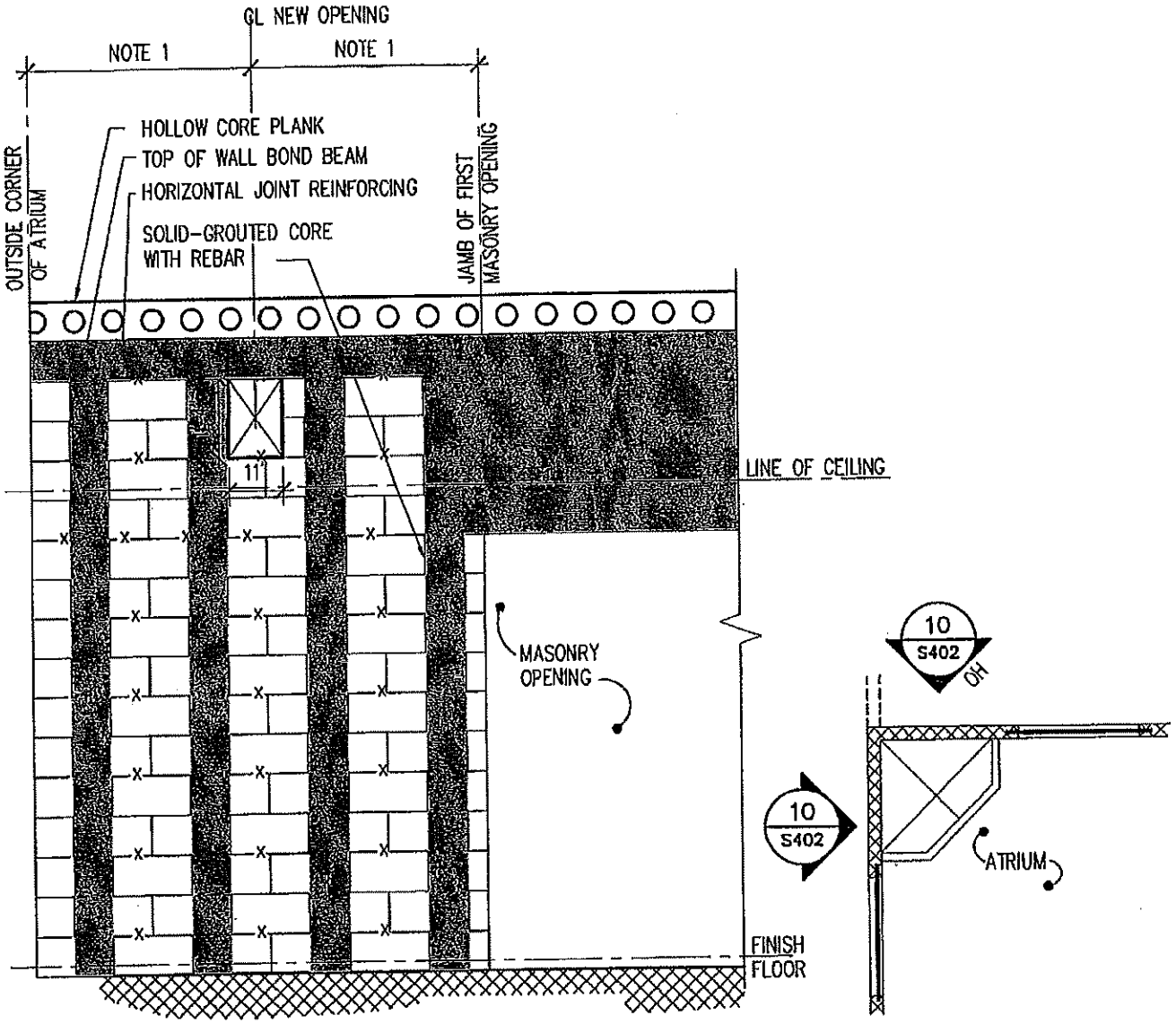
mail@slamcoll.com
www.slamcoll.com



10 / S402 ELEVATION

3/8" = 1'-0"

NOTES:
1. LOCATE NEW OPENING SO IT IS AS CLOSE TO THE CENTERLINE OF THE WALL PANEL AS POSSIBLE WITHOUT SEVERING ANY REBAR OR DAMAGING ANY SOLID GROUTED CELLS.
2. DETAIL APPLIES TO THE LOWEST LEVEL ONLY, AND SHALL BE APPLIED TO TWO WALLS AT EACH CORNER OF THE ATRIUM IN ALL THREE BUILDINGS. (TOTAL OF 24 PENETRATIONS REQUIRED.)

10A / S402 TYPICAL PART PLAN AT CORNER OF ATRIUM

1/8" = 1'-0"

The S I L A M Collaborative
Glastonbury, CT
Tel 860 657-8077
Fax 860 657-3141

SMOKE EVACUATION SYSTEM PENETRATIONS

University of Rhode Island
NEW STUDENT HOUSING
LOI# B03178

Scale:	AS NOTED
Reference:	S402
Date:	10/12/06
Proj. No.	03216.00

Sketch No: **SSK-110**

SI #101

Gilbane

Inspections and Tests

Detailed, Grouped by Each Inspection Number

URI New Student Housing | **Project # 113607000** Tel: Fax: | **Gilbane Building Company**

Number: A038 | **Date: 10/5/2006 12:00:00AM**

Installing Company:	Delta Mechanical - Smith, John	**Spec Section:**	15000
Inspecting Company:	SEI Companies - Goossens, Robert	**Sub Section:**	3.1.C
QC Company:	Gilbane Building Company - Morin, David	**Actual Start Time:**	02:25 PM
Accepting Company:	University of Rhode Island - DePace, Paul	**Actual Finish Time:**	02:45 PM

Description	System	Status
Atrium Smoke Exhaust	Smoke Exhaust	Completed

Location	Subsystem	Witnessed
Building A Atrium	Systems Testing	D. Morin/GBCO R. Goosens/SEI M. Suriani/URI V. Quintemo/RISFM J. Smith/Delta

Test Results

Conforming Notes

Non Conforming Notes

Notes

Velocities measured at MAU Grilles 225 FPM averaged across each face of each plenum.
Velocities at each SEF-2386 FPM

Adjust system to incorporate 4800 CFM into ceiling plenum. Velocity to be 200fpm or less at louver face of plenum as designed.

Total Make-up Air=46,748 CFM
Total Exhaust Air=46,984 CFM

Wind north at 9 mph
outside air at 64 degrees
indoor air at 68 degrees

Alarm initiation, damper opening sequence, alarm shutdown monitored.

Operation on emergency power to be completed.

REVIEWED CAC RGV 10/6/06

Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with.

REFER TO CONTRACT DOCUMENTS FOR SUBMITTAL REQUIREMENTS

DATE 10-6-06 BY CAC
R. G. VANDERWEIL ENGINEERS, INC.

Signature

10/6/06
Signed Date

R. G. Vanderweil Engineers, LLP

Submittal Package

URI Housing **Project#: 22562.00**

15600-042-00 **Atrium Smoke Test** **Closed: Yes**

Author Company	Contact	Author Package#	Discipline	Date In	Date Out
		0002-15000-0	HVAC	10/13/2006	10/26/2006

Status: Reviewed

Reviewed and found generally acceptable. Submittal may contain minor corrections which must be complied with. No further submittal required.

Items:

#	Type	Description

Comments:

If item is not populated, comment is associated with submittal, otherwise comment is associated with submittal item.

1 Item:

Comment: Provide air flow measurements at grilles and fans.

Gilbane

Transmittal Cover Sheet

Detailed, Grouped by Each Transmittal Number

URI New Student Housing | **Project # 113607000** Tel: Fax: | **Gilbane Building Company**

Date: 10/5/2006 | **Reference Number: 0097**

Transmitted To	Transmitted By
Clapp, Charles R.G. Vanderweil Engineers 274 Summer Street Boston, MA 02210-1123 Tel: 617-423-7423 Fax: 617-956-4864	Morin, David Gilbane Building Company University of Rhode Island Gilbane c/o Postal Services, 6 Garage Road Kingston, RI 02881 Tel: Fax: 401-874-5784

☐ **Acknowledgement Required**

Package Transmitted For:	Delivered Via	Tracking Number
Information, As Requested,	Email	

Item #	Qty	Item	Reference	Description	Notes	Status
001	1	Inspections and Tests	A038 - Atrium Smoke Exhaust	Smoke Exhaust	Inspections and Tests A038 - Atrium Smoke Exhaust	

Cc:	Company Name	Contact Name	Copies	Notes

Remarks

Chip,

Attached are the results of the Smoke Evacuation System test.

REVIEWED

Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with.

REFER TO CONTRACT DOCUMENTS FOR SUBMITTAL REQUIREMENTS

DATE 10.26.06 BY cc
R. G. VANDERWEIL ENGINEERS, INC.

Signature

10/5/06
Signed Date

Gilbane

Inspections and Tests

Detailed, Grouped by Each Inspection Number

URI New Student Housing | **Project # 113607000** Tel: Fax: | **Gilbane Building Company**

Number: A038 | **Date: 10/5/2006 12:00:00AM**

Installing Company:	Delta Mechanical - Smith, John	**Spec Section:**	15000
Inspecting Company:	SEI Companies - Goossens, Robert	**Sub Section:**	3.1.C
QC Company:	Gilbane Building Company - Morin, David	**Actual Start Time:**	02:25 PM
Accepting Company:	University of Rhode Island - DePace, Paul	**Actual Finish Time:**	02:45 PM

Description	System	Status
Atrium Smoke Exhaust	Smoke Exhaust	Completed

Location	Category	Witnesses
Building A Atrium	Systems Testing	D. Morin/GBCO R. Goosens/SEI M. Surani/URI V. Quintemo/RISFM J. Smith/Delta

Test Results:

Conforming Notes: | **Non Conforming Notes:**

Notes:

Velocities measured at MAU Grilles-225 FPM averaged across each face of each plenum.
Velocities at each SEF-2385 FPM

Total Make-up Air=46,748 CFM
Total Exhaust Air=46,984 CFM

Wind north at 9 mph
outside air at 64 degrees
indoor air at 68 degrees

Alarm initiation, damper opening sequence, alarm shutdown monitored.

Operation on emergency power to be completed.

Signature

10/6/06
Signed Date

COOK MODEL QMXU – EF-1A & EF-2A

FREE FLOW AREA

Ø42.5" = $21.25^2 \cdot \pi$ = 9.85 SQ FT

VELOCITY MEASURED AT 2385 FPM

2385 · 9.85 = 23,492 CFM

2 FAN OUTPUT = 46,984 CFM

COOK MODEL QMXS SMAU-1A THRU -4A

FREE FLOW AREA

2 GRILLES AT 9'-6" x 1'-6" = 28.5 SQ FT
1 GRILLE AT 9'-6" x 3'-10" = 36.42 SQ FT

VELOCITY MEASURED AT 225 FPM

TOTAL PER PLENUM = 64.92 SQ FT

GRILLE OPEN AREA ALLOWANCE: 64.92 x .8 = 51.94 SQ FT

VELOCITY MEASURED AT 225 FPM

225 · 51.94 = 11,687 CFM

4 FAN OUTPUT = 46,748 CFM

SEi COMPANIES

Acceptance Testing Procedure

Atrium Smoke Control

Project: URI – Residence Hall Building A

Date of test: 10/5/06

System Tag: EF-1, EF-1A, SMAU 1-4

Temperature: 67°

System Service: Atrium

Humidity: 54%

I. Unit Status / Acceptance

This procedure was prepared in accordance with the design sequence of operations and approved ATC and equipment submittals for the above system. The purpose for this procedure is to verify that this system functions and performs in accordance with the design and design intent. Any required corrective action items identified through the execution of the procedure will be entered into the project corrective action log. These items must be addressed and corrected by the appropriate contractor prior to final acceptance of this system by the owner.

- ☑ All prerequisite checklist items including all required manufacturer start up checklists have been successfully completed and documentation has been submitted to the CA for record prior to execution of this procedure.
- ☑ All required preliminary testing and balancing (TAB) has been successfully completed and documentation has been submitted to the CA for record prior to execution of this procedure.
- ☑ ATC point to point check out has been successfully completed and documentation has been submitted to the CA for record prior to execution of this procedure.
- ☑ All corrective action items identified as a result of execution of this procedure have been resolved.
- N/A ☐ All required trending data has been submitted for review
- N/A ☐ Deferred or seasonal testing is required as described below and will be scheduled at a later date

NOTES:

Robert W. Sweeney	10/6/06
Witnessing Commissioning Agent	**Date**

Acceptance Test Procedure.
URI Residence Hall – Building A
Atrium Smoke Control

II. Attendees	
Name / Firm	Name / Firm
Dave Morin	Gilbane
Robert Goossens	CA - SEi
Mike Green	EL – Fire Controls Contractor
Mike Suriani	URI – Safety Services
Vincent Quinterno	Rhode Island – Division of State Fire Marshal
John Smith	Delta Mechanical

III. Pre Functional Test Inspection / Observations		
Item	Acceptable (Y/N)	Notes
Fans Clearly Identified	Y	
Electrical disconnects clearly identified	Y	
ATC for Fan is complete	Y	
Unit has been tested and balanced	Y	
Controls for other roof top units complete	Y	
No excessive vibration or noise	Y	

IV. Functional Tests				
ID	Test	Expected Results	Acceptable (Y/N)	Notes
1	**Actuator Test:** Command damper actuator 100% open and 100% closed and verify at the actuator and at the front end.	Dampers opens & closes – for Exhaust fans and Supply fans	Y	
2	**Normal Off:** Units are in normal condition, active signal form FAS.	Fans off	Y	
		Dampers closed	Y	
3	**Simulate alarm condition:** Signal alarm condition from the Fire Alarm System, or break particle bean in atrium area	Signal from FA system	Y	
		Exhaust Fans starts after end switch is 60% open on damper.	Y	
		Supply fan starts after end switch is 60% open on damper.	Y	
		Required pressure maintained	Y	
		Fan remains on as long as condition is active at FAS.	Y	

4	**Status of RTU-1, MAU-1, and MAU-2:** Simulate smoke condition.	Roof top units RTU-1, MAU-1, and MAU-2 de-energize. Units remain off.	Y	
		Return FAS to normal (re-set / Clear condition) Units RTU-1, MAU-1, MAU-2 auto re-start and return to normal control.	Y	
		Alarm generated at BMS		

NOTES:

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence

Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SMAU-1A

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-009207

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence

Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SMAU-2A

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-009206

Equipment Data:

Fan Data		Motor Data	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence

Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SMAU-3A

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-009209

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence

Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SMAU 4A

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-009211

Equipment Data:

Fan Data		Motor Data	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence
Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SEF-1A

Manufacturer: Cook
Model: 300QMXU
Serial No.: 010S890192-007205

Equipment Data:

Fan Data		Motor Data	
Design CFM	23500	Horsepower	25
RPM	1274	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION -0- DATE:10/5/06

Building Number: North Woods Residence

Building Name: Building A

Description of Equipment/System(s): Smoke Evacuation System

Proposed Start-Up Date: 10/5/06	
Date/Time of Inspection: 10/5/06	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Smoke Evac Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building A-roof mounted fans
Applicable Specifications:	Applicable Drawings/Details: AH105

Equipment Designation: SEF-2A

Manufacturer: Cook

Model: 300QMXU

Serial No.: 010S890192-007204

Equipment Data:

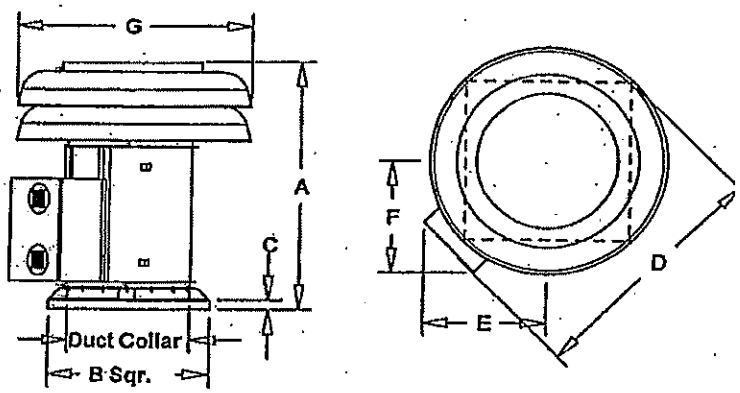
Fan Data		Motor Data	
Design CFM	23500	Horsepower	25
RPM	1274	Power	460/3/60hz
		RPM	1725

COOK

MARK:	SMUA-1A TO 4C
PROJECT:	URI STUDENT HOUSI
DATE:	01-05-2006

QMXS

Mixed-Flow Supply Blower
Low Pressure
Belt Drive
Arrangement 9



STANDARD CONSTRUCTION FEATURES:

High efficiency mixed flow wheel - Continuously welded steel housing with Lorenized powder coating - Welded aerodynamic straightening vanes - Spun aluminum top cap - Integral curb cap - Adjustable motor plate utilizing threaded studs for positive belt tensioning - Weather cover - Heavy duty ball or roller bearings with copper extended lube lines - Lifting lugs - Access door - Belt tunnel.

Performance

Qty	Catalog Number	Flow (CFM)	SP (inwc)	Fan RPM	Bhp (HP)
12	225QMXS	11750	2.50	1603	7.12

Altitude (ft): 62 Temperature (F): 70

Motor Information

HP	RPM	Volts/Ph/Hz	Enclosure	Mounted
10	1725	460/3/60	ODP -PE	Yes

Motor efficiency exceeds EPACT requirements

Sound Data 8 Octave Bands dB (10^{-12} Watts)

	1	2	3	4	5	6	7	8	LwA
Inlet	84	87	83	84	82	80	77	74	87
Outlet	87	88	89	88	85	81	78	75	90

Dimensions (inches)

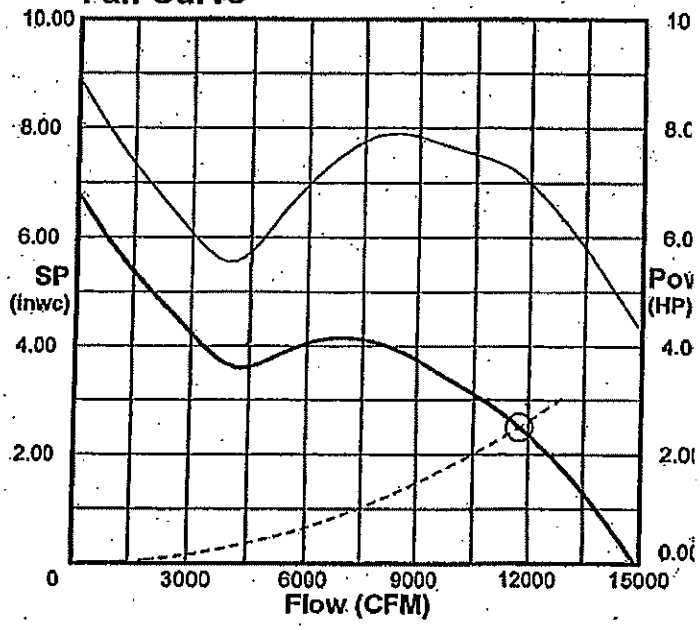
A	79-9/16
B Sqr.	43
C	3
D	68-1/8
E	35-1/2
F	33
G	62-5/8
Duct Collar	31-15/16
Unit Wt(lbs)***	1106

***Includes fan, motor & accessories.

Accessories:

Premium Efficiency Motor (Min. 91.7%)
STD DISCONNECT NEMA 3
ROOF CURB RCG 41-13.5H
ACCESS DOOR-HINGED
DRAIN
UNIT INCL 200K BRGS
ANTICONDENSATE COAT

Fan Curve



Fan Curve Legend

CFM vs SP	———
CFM vs HP	———
System Curve	- - - -
Point of Operation	○

COOK

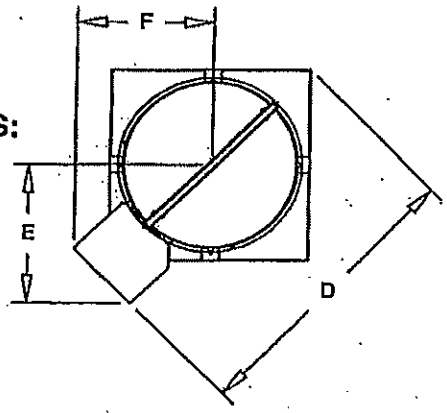
MARK: SMOKE EF-1A TO 2C	
PROJECT: URI STUDENT HOUSI	
DATE: 01-05-2006	

QMXU

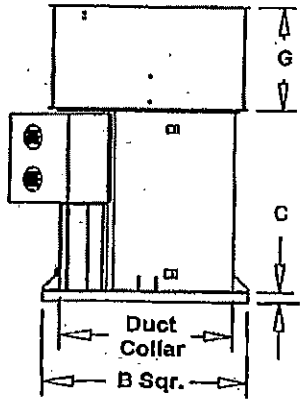
Mixed-Flow Upblast Blower
Low Pressure
Belt Drive

STANDARD CONSTRUCTION FEATURES:

High efficiency mixed flow wheel - Continuously welded steel housing with Lorenized powder coating - Welded aerodynamic straightening vanes - Butterfly dampers and windband - Integral curb cap - Adjustable motor plate utilizing threaded studs for positive belt tensioning - Weather cover - Heavy duty ball or roller bearings with copper extended lube lines - Lifting lugs - Drain - Access door - Enclosed belt tunnel.



Top View



Side View

Performance

Qty	Catalog Number	Flow (CFM)	SP (inwc)	Fan RPM	Bhp (HP)
6	300QMXU	23500	2.00	1274	12.3

Altitude (ft): 62 Temperature (F): 70

Motor Information

HP	RPM	Volts/Ph/Hz	Enclosure	Mounted
25	1725	460/3/60	ODP -PE	Yes

Motor efficiency exceeds EPACT requirements

Dimensions (Inches)

A	90-1/4
B Sqr.	54
C	3
D	82
E	40
F	37-5/8
G	30-1/2
Duct Collar	42-1/2
Unit Wt(lbs)***	1783

***Includes fan, motor & accessories.

Sound Data 8 Octave Bands dB (10^{-12} Watts)

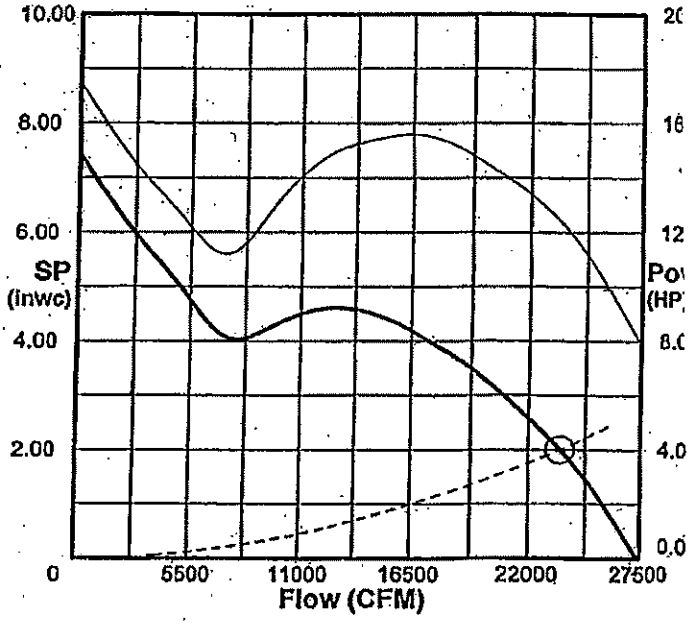
	1	2	3	4	5	6	7	8	LwA
Inlet	83	88	89	86	85	83	79	71	90
Outlet	88	91	95	93	90	86	81	74	95

Accessories:

Premium Efficiency Motor (Min. 93.6%)
ROOF CURB RCGH 52-13.5H
UL762 (327Y-300DEG)
ACCESS DOOR-HINGED
FLANGED INLET-STL
HEAT SHIELD
RUB RING/SHAFT SEAL
ALUMINUM DAMPER DOOR
ANTICONDENSATE COAT

Provide disconnect

Fan Curve



Fan Curve Legend

CFM vs SP	———
CFM vs HP	———
System Curve	- - - -
Point of Operation	○

v5.1.11.84B1

Operation & Maintenance Data

COOK

QMX

Mixed Flow Inline

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

This publication contains the installation, operation and maintenance instructions for standard units of the *QMX-Mixed Flow Inline.*

- QMX
- QMX-HP
- QMXE
- QMXS
- QMXE-HP
- QMXS-HP
- QMXU
- QMXU-HP
- QMXLE
- QMXLE-HP

Carefully read this publication prior to any installation or maintenance procedure.

Loren Cook catalog, *QMX*, provides additional information describing the equipment, fan performance, available accessories, and specification data.

For additional safety information, refer to AMCA publication 410-96, *Safety Practices for Users and Installers of Industrial and Commercial Fans*.

All of the publications listed above can be obtained from Loren Cook Company by phoning (417)869-6474, extension 166; by FAX at (417)832-9431; or by e-mail at info@lorencook.com.

For information on special equipment, contact Loren Cook Company Customer Service Department at (417)869-6474.

Receiving and Inspection

Carefully inspect the fan and accessories for any damage and shortage immediately upon receipt of the fan.

- Turn the wheel by hand to ensure it turns freely and does not bind.
- Inspect inlet vane dampers (if supplied) for free operation of all moving parts.
- Record on the *Delivery Receipt* any visible sign of damage.

WARNING!
This unit has rotating parts. Safety precautions should be exercised at all times during installation, operation and maintenance.
ALWAYS disconnect power prior to working on fan.

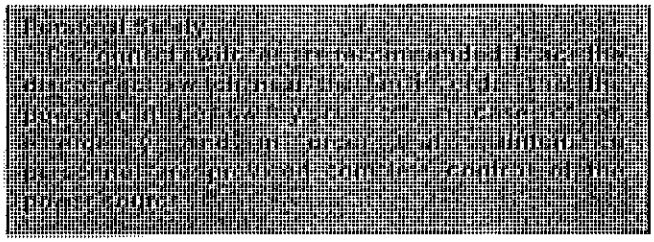
Handling

Lift the fan by lifting lugs. Never lift by the shaft, motor, or housing.

Storage

If the fan is stored for any length of time prior to installation, completely fill the bearings with grease or moisture-inhibiting oil. Refer to *Lubricants* on page 6. Also, store the fan in its original crate and protect it from dust, debris and the weather.

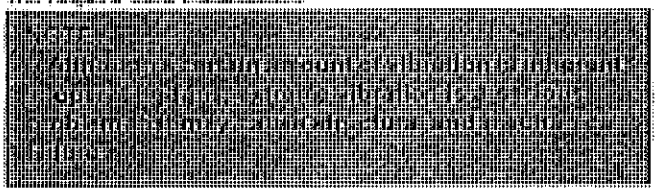
- Cover the inlet and outlet, and belt tunnel opening to prevent the accumulation of dirt and moisture in the housing.
- Periodically rotate the wheel and operate inlet vane dampers (if supplied) to keep a coating of grease on all internal bearing parts.
- Periodically inspect the unit to prevent damaging conditions.



Installation

QMX and QMX-HP can be mounted horizontally or vertically to a floor or a ceiling in various motor positions and discharges. QMXU, QMXU-HP, QMXE, QMXE-HP, QMXS and QMXS-HP are all designed to be roof mounted on typical roof curbs. The QMXLE or QMXLE-HP units, however, should not be mounted on sheet metal roof curbs, but supported by integral members of the roof structure, designed and constructed by others per local requirements and environments.

Most motors are shipped mounted on the fans with belts and drives installed. However, extremely heavy motors are shipped separately, and some motors are shipped separately due to height limitations. These motors and drives will require field installation.

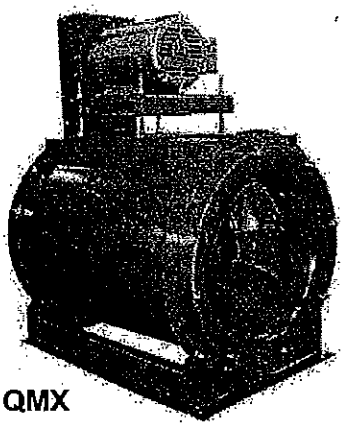


Isolation Installation

To help prevent vibration and noise from being transferred to the building, isolators are recommended.

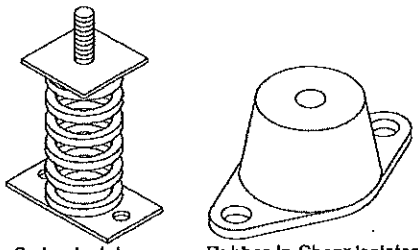
Floor Mounted Spring Isolators

a. Mount fan on isolation base or rails (if supplied).
b. Elevate fan (or isolation base) to operating height and insert blocks to hold in position.
c. Position isolators under the fan and vertically align by inserting leveling bolt through mounting holes in the fan or the base. The isolator must be installed on a level surface.



QMX

d. Adjust the isolators by turning the leveling nut counter clockwise several turns at a time alternately on each isolator until the fan weight is transferred onto the isolators and the fan raises uniformly off the blocks. Then remove the blocks.
e. Turn lock nut onto leveling bolt and secure firmly in place against the top of the mounting flange or frame.
f. Secure isolators to mounting surface.



Spring Isolator Rubber-In-Shear Isolator

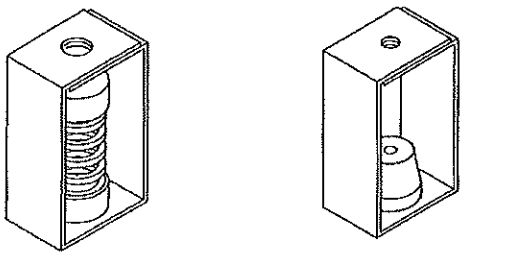
Figure 1 -Floor Mount Isolators

Floor Mounted Rubber-In-Shear (RIS) Isolators

a. Mount fan on isolation base or rails (if supplied).
b. Elevate fan to provide room to insert isolators between the fan and foundation and block in position.
c. Position isolators under fan and secure bolts.
d. Remove blocks and allow fan to rest on floor. Isolators must be installed on a level surface (leveling should not be required).
e. Secure isolators to mounting surface.

Ceiling Mounted Spring and Rubber-in-Shear (RIS) Isolators

a. Elevate fan to operating height and brace.
b. Attach threaded rod to overhead support structure directly above each mounting hole. Rod should extend to within a few feet of fan.
c. Attach isolator to end of threaded rod using a nut on each side of isolator bracket.
d. Insert another section of threaded rod through the fan mounting hole and isolator.
e. Attach two nuts to threaded rod in isolator.
f. Place adjusting nut and locking nut on threaded rod near fan mounting bracket.
g. Alternately rotate adjusting nut at each mounting location until the fan weight is uniformly transferred to the isolators. Remove bracing.



Ceiling Mounted Spring Isolator Rubber-In-Shear Ceiling Isolators

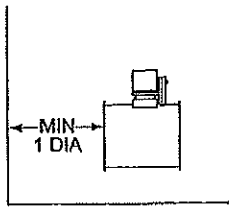
Figure 2 - Ceiling Mount Isolators

Duct Installation

Efficient fan performance relies on the proper installation of inlet and discharge ducts. Be sure your fan conforms to the guidelines below.

Non-Ducted Inlet Clearance

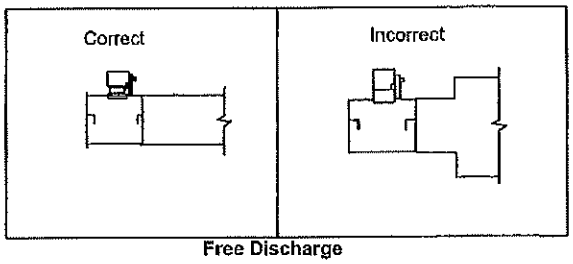
If your fan has an open inlet (no duct work), the fan must be placed 1 effective wheel diameter away from walls and bulkheads.



Non-ducted Inlet Clearance

Free Discharge

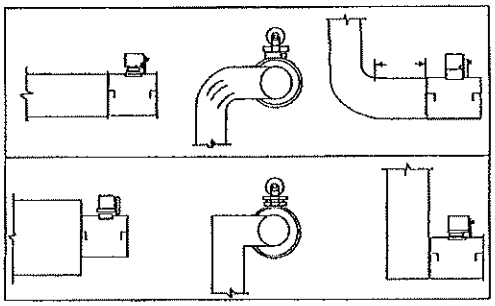
Avoid a free discharge into the plenum. This will result in lost efficiency because it doesn't allow for a static regain.



Free Discharge

Inlet Duct Turns

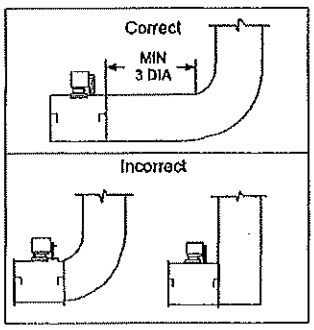
For ducted inlets, allow at least 3 effective wheel diameters between duct turns or elbows and the fan inlet.



Inlet Duct Turns

Discharge Duct Turns

Where possible, allow 3 duct diameters between duct turns or elbows and the fan outlet. Refer to the drawing below.



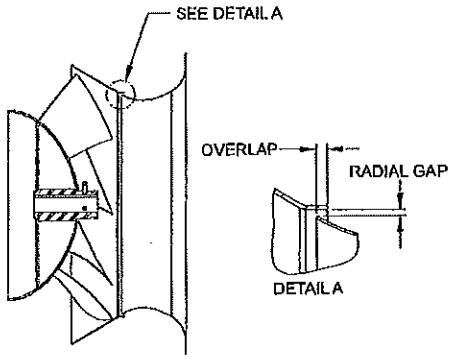
Discharge Duct Turns

Wheel-to-Inlet Clearance

The correct wheel-to-inlet clearance is critical to proper fan performance. This clearance should be verified before initial start-up since rough handling during shipment could cause a shift in fan components. Refer to wheel/inlet drawing below for correct overlap.

Adjust the overlap by loosening the wheel hub and moving the wheel along the shaft to obtain the correct value. Trim balance as necessary following procedure (.0785 in/sec max).

A uniform radial gap (space between the edge of the cone and the edge of the inlet) is obtained by loosening the inlet cone bolts and repositioning the inlet cone.



Wheel/Inlet Overlap

Unit Size	Overlap
90	0.16
120	0.19
135	0.20
150	0.22
165	0.23
180	0.24
202	0.27
225	0.29
245	0.31
270	0.33
300	0.37
330	0.41
365	0.45
402	0.50
445	0.55
490	0.61
540	0.67
600	0.76

Belt and Pulley Installation

Belt tension is determined by the sound the belts make when the fan is first started. Belts will produce a loud squeal which dissipates after the fan is operating at full capacity. If the belt tension is too tight or too loose, lost efficiency and possible damage can occur.

Do not change the pulley pitch diameter to change tension. This will result in a different fan speed.

a. Loosen motor plate adjustment bolts and move motor plate in order that the belts can easily slip into the grooves on the pulleys. Never pry, roll, or force the belts over the rim of the pulley.
b. Adjust the motor plate until proper tension is reached. For proper tension, a deflection of approximately 1/4" per foot of center distance should be obtained by firmly pressing the belt. Refer to *Figure 3*.
c. Lock the motor plate adjustment nuts in place.
d. Ensure pulleys are properly aligned. Refer to *Figure 4*.

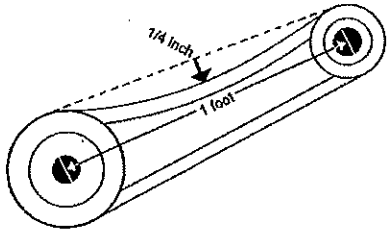


Figure 3

Pulley Alignment

Pulley alignment is adjusted by loosening the motor pulley setscrew and by moving the motor pulley on the motor shaft or by moving the entire motor along the motor mounting bracket.

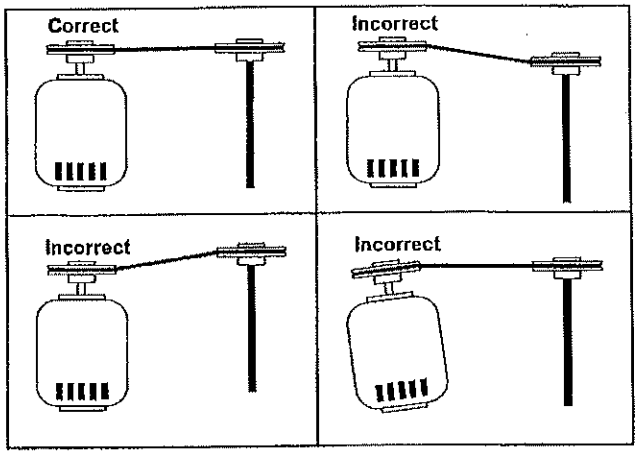


Figure 4

Figure 4 illustrates correct and incorrect pulley alignment. A recommended method of inspecting the pulley alignment is shown in *Figure 5*. With the shorter leg of a carpenter's square or other straight edge lying along the case of the motor, adjust the position of the motor pulley (or the motor until the longer leg of the square is parallel to the belt.

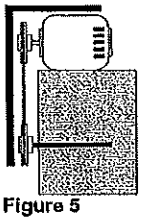


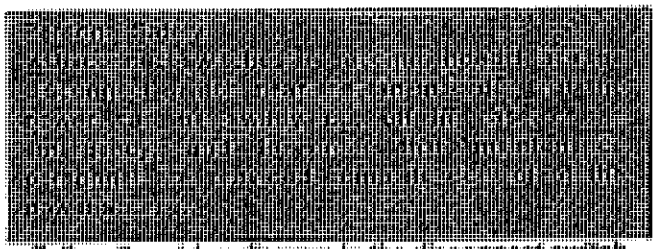
Figure 5

Wiring Installation

All wiring should be in accordance with local ordinances and the National Electrical Code, NFPA 70. Ensure the power supply (voltage, frequency, and current carrying capacity of wires) is in accordance with the motor nameplate.

Lock off all power sources before unit is wired to power source.

Leave enough slack in the wiring to allow for motor movement when adjusting belt tension. Some fractional motors have to be removed in order to make the connection with the terminal box at the end of the motor. To remove motor, remove bolts securing motor base to power assembly. Do not remove motor mounting bolts.



Follow the wiring diagram in the disconnect switch and the wiring diagram provided with the motor. Correctly label the circuit on the main power box and always identify a closed switch to promote safety (i.e., red tape over a closed switch).

Use of Variable Frequency Drives

Motors -

Motors that are to be operated using a Variable Frequency Drive (VFD) must be VFD compatible. At a minimum, this must be a Premium Efficiency motor with Class F insulation. Motors that are not supplied by Loren Cook Company should have the recommendation of the motor manufacturer for use with a VFD.

Grounding -

The fan frame, motor and VFD must be connected to a common earth ground to prevent transient voltages from damaging rotating elements.

Wiring -

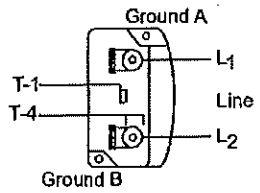
Line reactors may be required to reduce over-voltage spikes in the motors. The motor manufacturer should be consulted for recommended line impedence and usage of line reactors or filters, if the lead length between the VFD and the motor exceeds 10 feet (3m).

Fan -

It is the responsibility of the installing body to perform coast-down tests and identify any resonant frequencies after the equipment is fully installed. These resonant frequencies are to be removed from the operating range of the fan by using the "skip frequency" function in the VFD programming. Failure to remove resonant frequencies from the operating range will decrease the operating life of the fan and void the warranty.

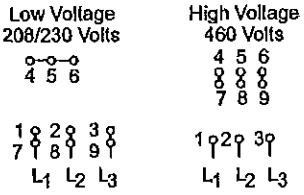
Wiring Diagrams

Single Speed, Single Phase Motor

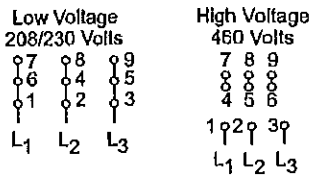


When ground is required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-1 and T-4.

3 Phase, 9 Lead Motor Y-Connection

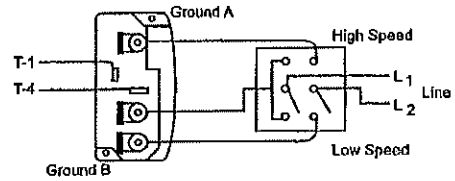


3 Phase, 9 Lead Motor Delta-Connection



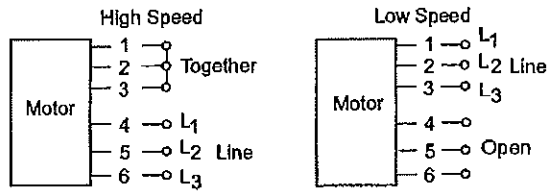
To reverse, interchange any 2 line leads.

2 Speed, 2 Winding, Single Phase Motor



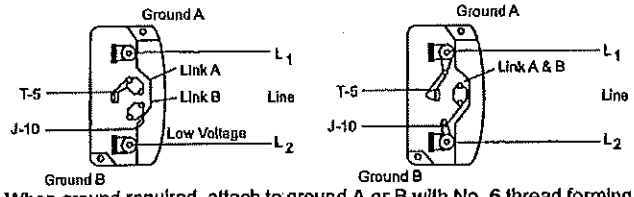
When ground required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-1 and T-4 leads.

2 Speed, 1 Winding, 3 Phase Motor



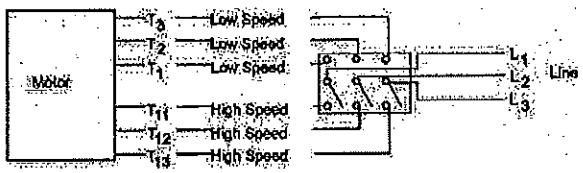
To reverse, interchange any 2 line leads. Motors require magnetic control.

Single Speed, Single Phase, Dual Voltage



When ground required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-5 and J-10 leads.

2 Speed, 2 Winding, 3 Phase



To reverse: High Speed-interchange leads T_{11} and T_{12}.
Low Speed-interchange leads T_1 and T_2. Both Speeds-interchange any 2 line leads.

Wheel Rotation

Test the fan to ensure the rotation of the wheel is the same as indicated by the arrow marked Rotation.

115 and 230 Single Phase Motors

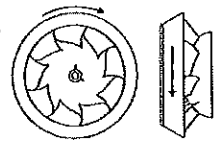
Fan wheel rotation is set correctly at the factory. Changing the rotation of this type of motor should only be attempted by a qualified electrician.

208, 230, and 460, 3 Phase Motors

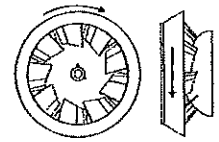
These motors are electrically reversible by switching two of the supply leads. For this reason, the rotation of the fan cannot be restricted to one direction at the factory. See Wiring Diagrams for specific information on reversing wheel direction.

Do not allow the fan to run in the wrong direction. This will overheat the motor and cause serious damage. For 3-phase motors, if the fan is running in the wrong direction, check the control switch. It is possible to interchange two leads at this location so that the fan is operating in the correct direction.

QMX



QMX-HP



Final Installation Steps

a. Inspect fasteners and setscrews, particularly fan mounting and bearing fasteners, and tighten according to the recommended torque shown in the table *Recommended Torque for Setscrews/Bolts*.
b. Inspect for correct voltage with voltmeter.
c. Ensure all accessories are installed.

Operation

Pre-Start Checks

a. Lock out all the primary and secondary power sources.
b. Ensure fasteners and setscrews, particularly those used for mounting the fan, are tightened.
c. Inspect belt tension and pulley alignment.
d. Inspect motor wiring.
e. Ensure belt touches only the pulley.
f. Ensure fan and ductwork are clean and free of debris.
g. Inspect wheel-to-inlet clearance. The correct wheel-to-inlet clearance is critical to proper fan performance.
h. Close and secure all access doors.
g. Restore power to the fan.

Start Up

Turn the fan on. In variable speed units, set the fan to its lowest speed and inspect for the following:

- Direction of rotation.
- Excessive vibration.
- Unusual noise.
- Bearing noise.
- Improper belt alignment or tension (listen for squealing).
- Improper motor amperage or voltage.

If a problem is discovered, immediately shut the fan off. Lock out all electrical power and check for the cause of the trouble. See Troubleshooting.

Inspection

Inspection of the fan should be conducted at the first **30 minute, 8 hour** and **24 hour** intervals of satisfactory operation. During the inspections, stop the fan and inspect as per the *Conditions Chart*.

30 Minute Interval

Inspect bolts, setscrews, and motor mounting bolts. Adjust and tighten as necessary.

8 Hour Interval

Inspect belt alignment and tension. Adjust and tighten as necessary.

24 Hour Interval

Inspect belt tension. Adjust and tighten as necessary.

Recommended Torque for Setscrews/Bolts (IN/LB)

Setscrews				Hold Down Bolts	
Size	Key Hex Across Flats	Recommended Torque			
		Min.	Max.	Size	Wrench Torque
No.10	3/32"	28	33	3/8"-16	240
1/4"	1/8"	66	80	1/2"-13	600
5/16"	5/32"	126	156	5/8"-11	1200
3/8"	3/16"	228	275	3/4"-10	2100
7/16"	7/32"	29	348	7/8"-9	2400
1/2"	1/4"	42	504	1" -8	3000
5/8"	5/16"	92	1104		
3/4"	3/8"	120	1440		

Maintenance

Establish a schedule for inspecting all parts of the fan. The frequency of inspection depends on the operating conditions and location of the fan.

Inspect fans exhausting corrosive or contaminated air within the first month of operation. Fans exhausting contaminated air (airborne abrasives) should be inspected every three months.

Regular inspections are recommended for fans exhausting non-contaminated air.

It is recommended the following inspection be conducted twice per year.

- Inspect bolts and setscrews for tightness. Tighten as necessary.
- Inspect belt wear and alignment. Replace worn belts with new belts and adjust alignment as needed. Refer to *Belt and Pulley Installation*, page 3.
- Bearings should be inspected as recommended in the *Conditions Chart*.
- Inspect variable inlet vanes (if supplied) for freedom of operation and excessive wear. The vane position should agree with the position of the control arm. As the variable inlet vanes close, the entering air should spin in the same direction as the wheel.
- Inspect springs and rubber isolators for deterioration and replace as needed.
- Inspect for cleanliness. Clean exterior surfaces only. Removing dust and grease on motor housing assures proper motor cooling. Removing dirt from the wheel and housing prevents imbalance and damage.

Conditions Chart			
RPM	Temperature	Fan Status	Greasing Interval
'00	Up to 120°F	Clean	6 to 12 months
500	Up to 150°F	Clean	2 to 6 months
1000	Up to 210°F	Clean	2 weeks to 2 months
1500	Over 210°F	Clean	Weekly
Any Speed	Up to 150°F	Dirty	1 week to 1 month
Any Speed	Over 150°F	Dirty	Daily to 2 weeks
Any Speed	Any Temperature	Very Dirty	Daily to 2 weeks
Any Speed	Any Temperature	Extreme Conditions	Daily to 2 weeks

Lubricants

Loren Cook Company uses petroleum lubricant in a lithium base. Other types of grease should not be used unless the bearings and lines have been flushed clean. If another type of grease is used, it should be a lithium-based grease conforming to NLGI grade 2 consistency.

A NLGI grade 2 grease is a light viscosity, low-torque, rust-inhibiting lubricant that is water resistant. Its temperature range is from -30°F to +200°F and capable of intermittent highs of +250°F.

Motor Bearings

Motor bearings are pre-lubricated and sealed. Under normal conditions they will not require further maintenance for a period of ten years. However, it is advisable to have your maintenance department remove and disassemble the motor, and lubricate the bearings after three years of operation in excessive heat and or in a contaminated airstream consisting of airborne abrasives.

Fan Bearings

QMX bearings are lubricated through a grease fitting on the outer housing and should be lubricated by the schedule, *Conditions Chart*.

For best results, lubricate the bearing while the fan is in operation. Pump grease in slowly until a slight bead forms around the bearing seals. Excessive grease can burst seals thus reducing bearing life.

In the event the bearing cannot be seen, use no more than three injections with a hand-operated grease gun.

Motor Services

Should the motor prove defective within a one-year period, contact your local Loren Cook representative or your nearest authorized electric motor service representative.

Changing Shaft Speed

All belt driven fans with motors up to and including 5 HP are equipped with variable pitch pulleys. To change the fan speed, perform the following:

a. Loosen setscrew on driver (motor) pulley and remove key, if equipped.
Turn the pulley rim to open or close the groove facing. If the pulley has multiple grooves, all must be adjusted to the same width.
c. After adjustment, inspect for proper belt tension.

Speed Reduction

Open the pulley in order that the belt rides deeper in the groove (smaller pitch diameter).

Speed Increase

Close the pulley in order that the belt rides higher in the groove (larger pitch diameter). Ensure that the speed limits of the fan and the horsepower limits of the motor are maintained.

Pulley and Belt Replacement

a. Loosen and remove belts by adjusting motor mounting plate.
b. Remove pulleys from their respective shafts.
c. Clean the motor and fan shafts.
d. Clean bores of pulleys and coat the bores with heavy oil.
e. Remove grease, rust, or burrs from the pulleys and shafts.
f. Remove burrs from shaft by sanding.
g. Place fan pulley on fan shaft and motor pulley on its shaft. Damage to the pulleys can occur when excessive force is used in placing the pulleys on their respective shafts.
h. Tighten in place.
i. Install belts on pulleys and align as described in the *Belt and Pulley Installation* section.

Bearing Replacement

The fan bearings are pillow block ball bearings.

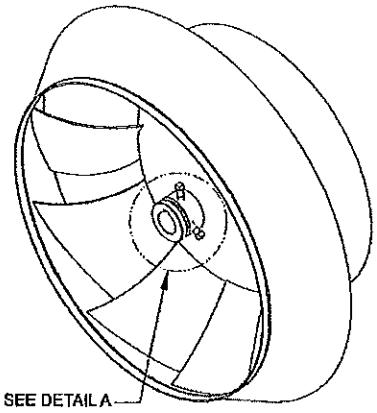
a. Loosen and remove belts by adjusting motor mounting plate
b. Remove the bearing cover by removing the bolts around the perimeter of the bearing cover. ***Do not remove fan sheave yet.***
c. Remove inlet cone by removing attaching bolts/nuts around perimeter of the inlet plate.
d. Remove wheel by loosening setscrews and sliding off shaft.
e. Record the location of the fan sheave from end of shaft, and remove the sheave.
f. Record the distance from the bearing to the end of the shaft.
g. Loosen setscrews on bearings and remove shaft.
j. Remove bearings from bearing base and replace with new ones, noting the exact location of each; **do not fully tighten base bolts.**
k. Slide shaft through bearings until shaft protrudes the same amount as measured above. Tapping the inner race of each bearing with a soft driver may be required. **Do not hammer the end of the shaft or the bearing housing.**
l. Return setscrews to same location as marked above and tighten one setscrew on each bearing to half its specified torque.
m. Rotate the shaft to allow the bearings to align themselves.
n.Replace wheel but do not tighten yet.

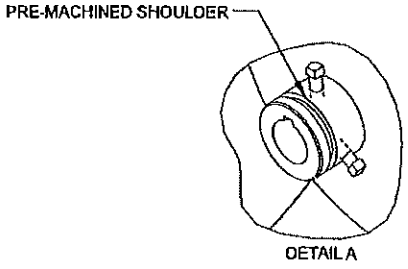
o. Replace inlet cone. Wheel may need to be moved to allow proper alignment. Care should be taken to insure that inlet cone is centered inside wheel before and after tightening attaching bolts.
p. Slide wheel on shaft to achieve proper wheel/inlet overlap and tighten wheel set screws. Refer to Wheel-to-Inlet Clearance on page 3.
q. Tighten hold-down bolts to proper torque.
r. Turn the shaft by hand. resistance should be the same as it was before hold-down bolts were fully tightened.
s. Tighten all bearing setscrews to full specified torque.
t. Replace the sheave, align with motor sheave, and adjust the belt tension.
u. Test run fan and retighten all setscrews and bolts, and trim balance as necessary (.0785 in/sec max).
v. Replace discharge cover.

Wheel Replacement

The wheel has a pre-machined shoulder in the hub for the use of most 2 and 3 jaw mechanical puller.

a. Align center of the puller with the center of the shaft.
b. Ensure all setscrews in the hub, normally two, are fully removed.
c. Slowly remove wheel from the shaft.

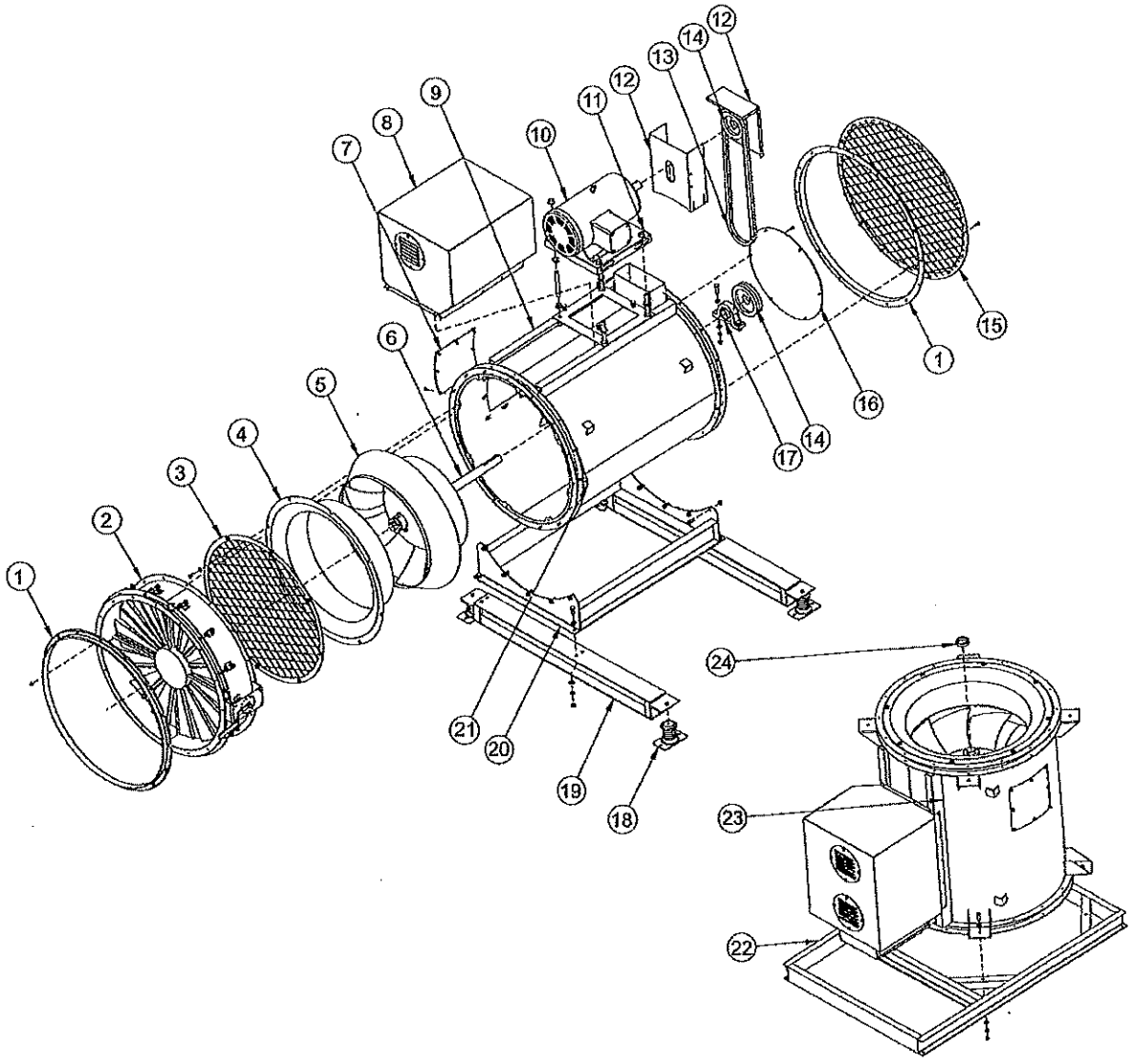




Troubleshooting

Problem and Potential Cause
Low Capacity or Pressure •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Poor fan inlet or outlet conditions. There should be a straight clear duct at the inlet or outlet. •Improper wheel alignment.
Excessive Vibration and Noise •Damaged wheel. •Belts misaligned. •Belts too loose; worn or oily belts. •Loose fasteners. •Speed too high. •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Bearing set screws loose. •Bearings need lubrication or replacement. •Debris in impeller. •Fan surge. •See page 4 for issues regarding use of VFD.
Overheated Motor •Motor improperly wired. •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Cooling air diverted or blocked. •Improper inlet clearance. •Incorrect fan speed. •Incorrect voltage.
Overheated Bearings •Improper bearing lubrication •Excessive belt tension.

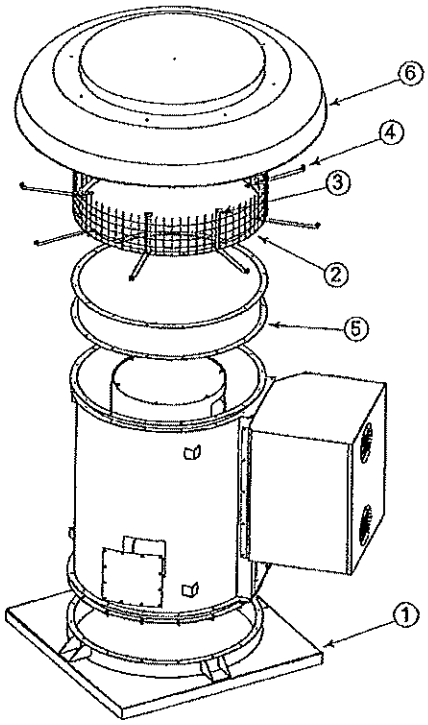
QMX/QMX-HP Parts List
(Horizontal Mount Shown)



ITEM NUMBER	ITEM DESCRIPTION
1	COMPANION FLANGE (OPTIONAL)
2	EXTERNAL INLET VANE DAMPER (OPTIONAL)
3	INLET SAFETY SCREEN (OPTIONAL)
4	INLET CONE
5	MIX-FLOW WHEEL
6	SHAFT
7	ACCESS DOOR (OPTIONAL)
8	MOTOR COVER (OPTIONAL)
9	HOUSING-HORIZONTAL MOUNT
10	MOTOR
11	MOTOR PLATE
12	BELT GUARD

ITEM NUMBER	ITEM DESCRIPTION
13	BELT
14	DRIVE PULLEY
15	DISCHARGE SAFETY SCREEN (OPTIONAL)
16	BEARING COVER
17	BEARINGS (2 REQUIRED)
18	ISOLATOR (4 REQUIRED OPTIONAL)
19	ISOLATION RAILS-HORIZONTAL MOUNT (OPTIONAL)
20	BASE-HORIZONTAL MOUNT
21	THRUST RESTRAINT-HORIZONTAL MOUNT (OPTIONAL)
22	ISOLATION STRUCTURE-VERTICAL MOUNT (OPTIONAL)
23	HOUSING-VERTICAL MOUNT
24	SHAFT LOCKING COLLAR-VERTICAL MOUNT

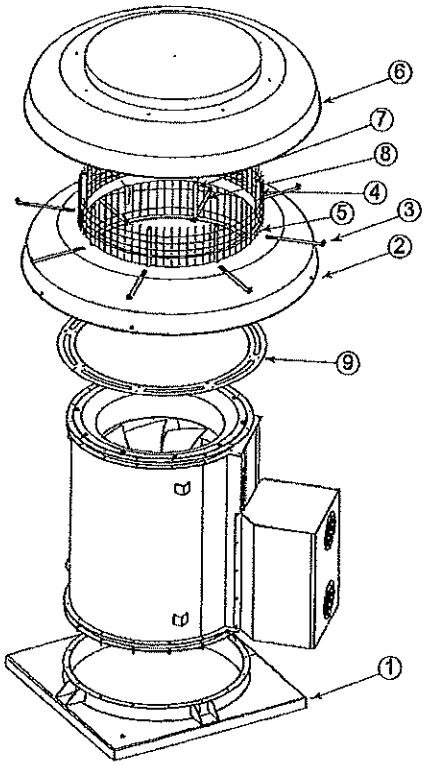
QMXE/QMXE-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXE Birdscreen
3	QMXE Top Cap Post
4	QMXE Baffle Brace
5	QMXE Top Cap Extension (for Size 90 only)
6	QMXE Top Cap

See common parts (not shown) listed on page 8.

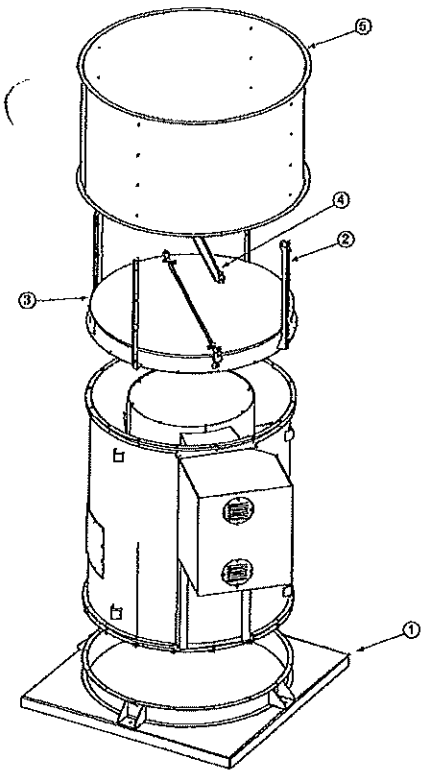
QMXS/QMXS-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXS Top Cap-Open
3	QMXS Upper Baffle Brace
4	QMXS Top Cap Post
5	QMXS Birdscreen
6	QMXS Top Cap
7	QMXS Lower Top Cap Post
8	QMXS Lower Baffle Brace
9	QMXS Adapter Plate

See common parts (not shown) listed on page 8.

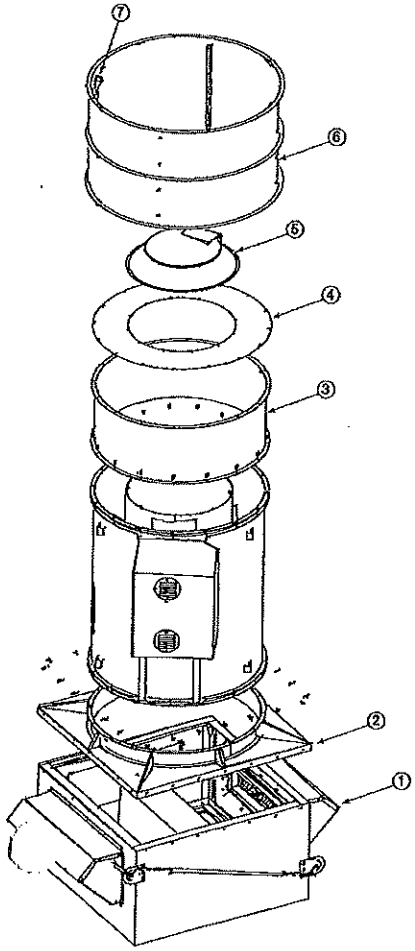
QMXU/QMXU-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXU Lifting Lug
3	QMXU Damper
4	QMXU Damper Stop
5	QMXU Windband

See common parts (not shown) listed on page 8.

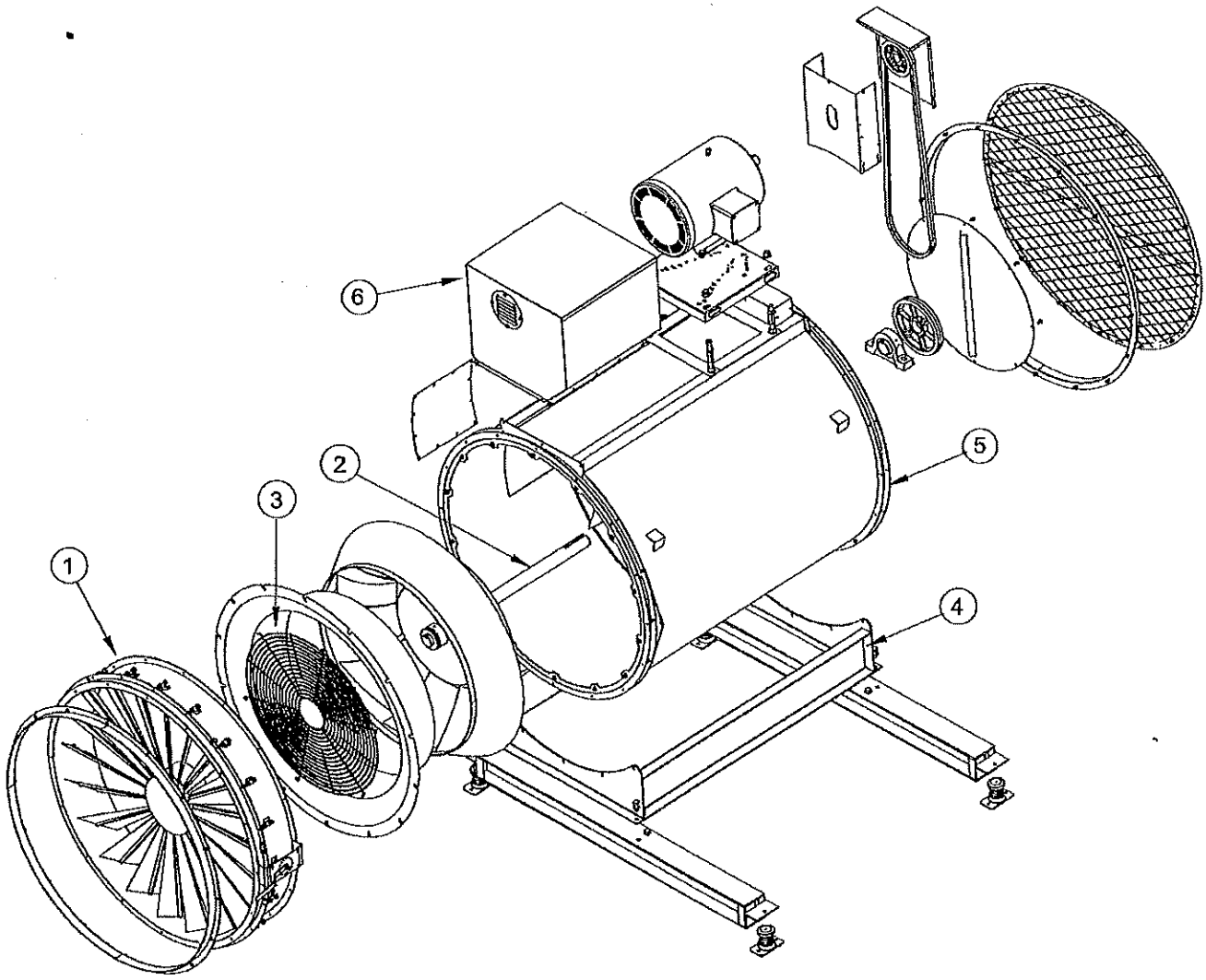
QMXLE/QMXLE-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMXLE Mixing Box
2	QMXLE Curb Cap
3	QMXLE Middle Section
4	QMXLE Adapter Plate
5	QMXLE Stack Damper
6	QMXLE Windband
7	QMXLE Lifting Lug

See common parts (not shown) listed on page 8.

Arrangement 3 Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	Arr. 3 Bearing Support
2	Arr. 3 Shaft
3	Arr. 3 Spiral Guard
4	Arr. 3 Base
5	Arr. 3 Housing
6	Arr. 3 Motor Cover

See common parts (not shown) listed on page 8.

Limited Warranty

Loren Cook Company warrants that your Loren Cook fan was manufactured free of defects in materials and workmanship, to the extent stated herein. For a period of one (1) year after date of shipment, we will replace any parts found to be defective without charge, except for shipping costs which will be paid by you. This warranty is granted only to the original purchaser placing the fan in service. This warranty is void if the fan or any part thereof has been altered or modified from its original design or has been abused, misused, damaged or is in worn condition or if the fan has been used other than for the uses described in the company manual. This warranty does not cover defects resulting from normal wear and tear. To make a warranty claim, notify Loren Cook Company, General Offices, 2015 East Dale Street, Springfield, Missouri 65803-4637, explaining in writing, in detail, your complaint and referring to the specific model and serial numbers of your fan. Upon receipt by Loren Cook Company of your written complaint, you will be notified, within thirty (30) days of our receipt of your complaint, in writing, as to the manner in which your claim will be handled. If you are entitled to warranty relief, a warranty adjustment will be completed within sixty (60) business days of the receipt of your written complaint by Loren Cook Company. This warranty gives only the original purchaser placing the fan in service specifically the right. You may have other legal rights which vary from state to state.

Gilbane
University of Rhode Island
Facilities Services
8 Garage Road
Kingston, RI 02881

Gilbane

BUILDING C

Eddy

SMOKE EXHAUST SYSTEM

TESTING PROTOCOL

UNIVERSITY OF
Rhode Island

Gilbane

University of Rhode Island
New Student Housing

Testing Protocol
Atrium Smoke Exhaust System
Building C

Construction Manager
Gilbane Building Company

Commissioning Agent
SEI Companies

Electrical Contractor
R. F. Audet

Fire Alarm Contractor
Simplex/Grinnell

Mechanical Contractor
Delta Mechanical

Sheet Metal Contractor
Unique Metal Works

Balancing Contractor
R. K. Baker and Associates, Inc.

Atrium Smoke Control
Proposed Testing Protocol

URI-New Student Housing

Prior to testing the Atrium Smoke Control System, verify the completion of the building system, including the following features:

1. Integrity of partitions and floor penetrations
2. Firestopping
3. Doors and closers related to the Smoke Exhaust area
4. Glazing at Atrium area

Testing is to include the following sub-systems to the extent that they affect or are affected by the operation of the Smoke Exhaust system:

1. Fire Alarm System
2. Building Management System
3. HVAC System and Equipment
4. Electrical Equipment
5. Temperature Control System
6. Normal and Emergency Power sources
7. Automatic Fire Suppression System
8. Automatic operating doors and closers
9. Emergency Elevator operation

The following parameters are to be measured during acceptance testing:[1]

1. Total volumetric flow rate.
2. Airflow velocities.[2]
3. Airflow direction
4. Door opening forces[3]
5. Pressure differentials
6. Ambient temperature
7. Measure and verify fan motor current draw.[4]

The following equipment will be needed to perform acceptance testing:

1. Differential pressure gauges, inclined water manometers or electric manometer [instrument ranges 0-0.25 in. w.g. (0-62.5 Pa) and 0-0.50 in. w.g. (0-125 Pa) with 50 ft of tubing]
2. Scale suitable for measuring door opening force (15 lbf to start door, 5 lbf to full open)
3. Anemometer, including traversing equipment.
4. Ammeter
5. Door wedges
6. Tissue paper roll or other convenient device for indicating direction of airflow
7. Signs indicating that a test of the smoke evacuation system is in progress and that doors are not to be opened.

Instruments for testing shall have been calibrated within one month prior to test. Calibration shall be traceable to NBS Standards. Calibration certificates for test equipment used must be provided.

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[1] NFPA 92B-8.3.2
[2] NFPA 92B-4.6
[3] NFPA 92B-4.6.3
[4] IBC 909.10.5

Sequence of Operation

The following sequence applies to Smoke Exhaust Fans SEF-1C & SEF-2C, and Makeup Air Fans SMAU-1C through SMAU-4C:[5]

1. The system shall be available 24 hours per day, 7 days a week; all equipment and controls shall be on legally required standby power.
2. Upon activation of any Atrium associated smoke detection device the Fire Alarm System shall perform the following functions:
    a. Send a signal to the Automatic Control Dampers (located in the fan curbs) to allow Smoke Exhaust Make-up Air to enter the Atrium.
    b. Send a signal to the Atrium Makeup Air and Exhaust Fans.
3. The following shall occur when the Atrium Smoke Control System is activated:
    a. Automatic Control Dampers shall open.
    b. Magnetic hold-open devices on Doors 1L1A, 1L1B, 101B and 111Ashall be de-energized.
    c. When the Automatic Control Dampers are proven 60% open, the Smoke Make-up Air Fans (SMAU-1C through SMAU-4C) and Smoke Exhaust Fans (SEF-1C & SEF-2C) shall be energized and run continuously until the Fire Alarm System terminates the signal via the Fire Alarm Control Panel.
    d. The Fans will then be de-energized and the Automatic Control Dampers shall close.

Prior to acceptance testing, all building equipment must be placed in normal operating mode, including equipment that is not used to implement smoke exhaust, such as elevator shaft vents and machine room fans and vents, general exhaust and supply air through Atrium Supply Diffusers .

Weather data shall be recorded, including wind speed, direction and outside temperature. Extreme changes in conditions during the test shall be recorded.[6]
Testing on Stand-by Power to all Smoke Exhaust System components must be conducted while on both Normal and Emergency Power. Disconnect Normal Power at the Main Service disconnect to simulate the true operating conditions in this mode.

The acceptance testing must demonstrate that the correct outputs are produced for a given input for each control sequence specified. The following sequences are to be followed and documented:[7]

1. Normal mode
2. Automatic Smoke Exhaust mode for Fire Alarm
3. Manual override of normal and automatic exhaust modes
4. Return to normal

With the HVAC System in normal mode, measure pressure differences across all door barriers and airflow velocities at interfaces with open areas.
Activate the Smoke Exhaust System. Verify and record the operation of all fans, dampers, doors and related components. Measure fan exhaust capacities and air velocities at Exhaust Fans and at First Floor Atrium make-up air grilles. Velocity at make-up air grilles not to exceed 200 fpm.[8]
Using a scale, measure the force required to open the First Floor Atrium Corridor doors to ensure that the force required to set the doors in motion does not exceed 15 lbs, and the force to bring the door to full open does not exceed 5 lbs.
Measure and record the pressure differences across all doors that separate the Smoke Exhaust area from adjacent spaces and the velocities at interfaces with open spaces.

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[5] Contract Document H608, Detail for Smoke Control System Diagram as amended by Sketch SKH3.21.
[6] NFPA 92B-4.8
[7] NFPA 92B-8.3.4.4
[8] IBC 909.7.2

Appendix

NFPA 92B 2005 Edition

Standard for Smoke Management Systems in Malls, Atria and Large Spaces
Chapter 4-paragraphs 4.6, 4.6.3 and 4.8
Chapter 8-paragraphs 8.3.2 and 8.3.4.4

Rhode Island Fire Safety Code

Rules and Regulations
Promulgated by the Board of Appeal and Review
Chapter 13-paragraphs (Add) 13.8.10.4.3.3.5 and (Add) 13.8.10.5.10

International Building Code 2003

Section 909, Smoke Control Systems

System Summary Report

Provided by Vanderweil Engineers

Seimens Building Technologies

Submittal for Building Controls, Sheets 305, 305A and 305B

University of Rhode Island New Student Housing

Construction documents prepared by The S/L/A/M Collaborative and R.G. Vanderweil Engineers, including but not limited to: Sketch SKE-72 and Drawing H608 as amended by Addendum 3, Sketch SKH3.21

4.5.2 System Startup.
4.5.2.1 The smoke management system shall achieve full operation prior to conditions in the space reaching the design smoke conditions.
4.5.2.2 The determination of the time it takes for the system to become operational shall consider the following events (as appropriate to the specific design objectives):
(1) Time for detection of the fire incident
(2) HVAC system activation time including shut-down and start-up of air handling equipment, opening and closing of dampers, and opening and closing of natural ventilation devices

4.5.3 Duration.
4.5.3.1 When the design of the smoke management system is based on occupants exiting a space before being exposed to smoke or before tenability thresholds are reached, the system shall remain operational for the duration required.
4.5.3.2 Smoke management systems designed to maintain tenable conditions shall not be required to prevent the descent of a smoke layer in spaces where tenable conditions are demonstrated.
4.5.3.3 When the design of the smoke management system is based on occupants' exiting a space before being exposed to smoke or before tenability thresholds are reached, a timed egress analysis shall be conducted.

4.5.4 Manual Override.
4.5.4.1 A means of manually starting and stopping the smoke management system shall be provided at an approved location accessible to the fire department.
4.5.4.2 Manual controls shall be able to override automatic system operation.

4.6* Makeup Air.
Makeup air shall be provided by fans or by openings to the outside.
4.6.1 The supply points for the makeup air shall be located beneath the smoke layer interface.
4.6.2 Mechanical makeup air shall be less than the mass flow rate of the mechanical smoke exhaust.
4.6.3 The makeup air shall not cause door-opening force to exceed allowable limits.
4.6.4* The makeup air velocity shall not exceed 200 ft/mm (1.02 m/sec) where the makeup air could come into contact with the plume unless a higher makeup air velocity is supported by engineering analysis.

4.7 Operating Conditions.
The smoke management system components shall be capable of continuous use at the maximum temperatures expected over the design interval time.

4.8* Weather Data.
Designs shall incorporate the effect of outdoor temperature and wind on the performance of the smoke management system.

4.9* Stratification of Smoke.
For large spaces where smoke stratification can occur, one of the following detection schemes shall be used:
(1)* An upward beam to detect the smoke layer
(2)* Detection of the smoke layer at various levels
(3)* Horizontal beams to detect the smoke

NFPA 92B, Chapter 8 Testing

8.1 General.
8.1.1* Each system shall be tested against its specific design criteria using component system testing, acceptance testing, and periodic testing and maintenance.
8.1.2 Construction documents shall include all acceptance testing procedures and pass/fail criteria.

8.2 Component System Testing
8.2.1* Responsibility for testing shall be defined clearly prior to component system testing.
8.2.2 Prior to testing, the party responsible for testing shall verify completeness of building construction, including the following architectural features:
(1) Smoke barriers including joints therein
(2) Firestopping
(3) Doors and closers related to smoke control
(4) Glazing that encloses a large-volume space
8.2.3* Operational testing of each individual system component shall be performed.
8.2.4* Testing shall include all subsystems to the extent that they affect or are affected by the operation of the smoke management system.
8.2.5 A11 documentation from component system testing shall be available for inspection.

8.3 Acceptance Testing.
8.3.1* **General.** Acceptance testing shall demonstrate that the fmal integrated system installation complies with the specific design and is functioning properly.
8.3.2 Test Parameters. Where appropriate to the design, the following parameters shall be measured during acceptance testing:
(1) Total volumetric flow rate
(2) Airflow velocities
(3) Airflow direction
(4) Door-opening forces
(5) Pressure differences
(6) Ambient indoor and outdoor temperatures
(7) Wind speed and direction

8.3.3 Measurement Locations. The locations for measurement of the parameters identified in 8.3.2 shall be in accordance with nationally recognized methods.
8.3.4 Testing Procedures. The acceptance testing shall include the procedures described in 8.3.4.1 through 8.3.4.5.
8.3.4.1* Prior to beginning acceptance testing, all building equipment shall be placed in the normal operating mode, including equipment that is not used to implement smoke management.
8.3.4.2* If standby power and been provided for the operation of the smoke management system, the acceptance testing shall be conducted while on both normal and standby power.
8.3.4.3 The acceptance testing shall include demonstratmg that the correct outputs are produced for a given input for each control sequence specified.

8.3.4.4 The complete smoke management sequence shall be demonstrated for the following:
(1) Normal mode
(2) Automatic smoke management mode for first alarm
(3) Manual override of normal and automatic smoke management modes
(4) Return to normal
8.3.4.5* Acceptance tests for the fire protective signaling system in conjunction with the smoke management system shall be permitted.

8.3.5* System Testing.
8.3.5.1 Specific smoke management performance criteria shall be developed by the system designer and described in the construction documents.
8.3.5.2 Acceptance testing to verify system performance shall include the following:
(1) Prior to performance testing, verify the exact location of the perimeter of each large-volume space smoke management system, identify any door openings into that space, and identify all adjacent areas that are to remain open and that are to be protected by airflow alone. For larger openings, measure the velocity by making appropriate traverses of the opening.
(2) Activate the smoke management system. Verify and record the operation of all fans, dampers, doors and related equipment. Measure fan exhaust capacities and air velocities through inlet doors and grilles or at supply grilles if there is a mechanical makeup air system. Measure the force to open exit doors.
(3) Where appropriate to the design, measure and record the pressure difference across all doors that separate the smoke management system area from adjacent spaces and the velocities at interfaces with open areas.

8.3.6 Testing Documentation.
8.3.6.1 Upon completion of acceptance testing, a copy of all operational testing documentation shall be provided to the owner.
8.3.6.2 This documentation shall be available for reference for periodic testing and maintenance.
8.3.7 Owner's Manuals and Instruction. Information shall be provided to the owner that defines the operation and maintenance of the system.
8.3.8 Modifications.
8.3.8.1 All operation and acceptance tests shall be performed on the applicable part of the system wherever there are system changes and modifications.
8.3.8.2 Documentation shall be updated to reflect these changes or modifications.

8.4 Periodic Testing.
8.4.1* Proper maintenance of the system shall, as a minimum, include the periodic testing of all equipment, such as initiating devices, fans, dampers, controls, doors and windows.
8.4.2* The equipment shall be maintained in accordance with the manufacturer's recommendations.
8.4.3 The periodic tests shall determine the airflow quantities and the pressure differences at the following locations:
(1) Across smoke barrier openings
(2) At the air makeup supplies
(3) At smoke exhaust equipment
8.4.4 All data points shall coincide with the acceptance test location to facilitate comparison measurements.

NFPA 92B, Chapter 8 Testing, continued

8.4.5 The system shall be tested at least semiannually by persons who are thoroughly knowledgeable in the operation, testing, and maintenance of the systems.
8.4.5.1 The results of the tests shall be documented in the operations and maintenance log and made available for inspection.
8.4.5.2 The smoke management system shall be operated for each sequence in the current design criteria.
8.4.5.3 The operation of the correct outputs for each given input shall be observed.
8.4.5.4 Tests shall also be conducted under standby power if applicable.
8.4.6* Special arrangements shall be considered for the introduction of large quantities of outside air into occupied areas or computer centers when outside temperature and humidity conditions are extreme and when such unconditioned air could damage contents.

End of Reference

Extract from Rhode Island Fire Safety Code, Chapter 13

(Add) 13.8.10.4.3.2

A high rise system for the purpose of this chapter is defined as a municipally connected fire alarm system consisting of a power limited fire alarm control unit listed by UL and/or approved by FMG, with voice communication and a two-way fire department communication system. All circuits for a high rise fire alarm system shall be installed in a Class "A" fashion as described in NFPA 72. Fire Alarm/Voice Communication Systems shall be provided in all high rise buildings regardless of the occupancy and shall operate as follows:

(Add) 13.8.10.4.3.3

The operation of by annual fire alarm box or the automatic activation of ally heat detector, smoke detector, sprinkler flow switch standpipe flow switch or other extinguishing system switch shall:

(Add) 13.8.10.4.3.3.1

Automatically sound a distinctive audible signal and activate the visible notification appliances on the floor week: the alarm originated one floor above and one floor below the floor where the alarm originated;

(Add) 13.8.10.4.3.3.2

Automatically notify the local fire department;

(Add) 13.8.10.4.3.3.3

Visually indicate the location of the origin of the alarm at the fire command center within the building;

(Add) 13.8.10.4.3.3.4

Interlock with the heating, ventilating and air conditioning [HVAC] control systems to provide for automatic fan shut-down as required in § 13.8.10.5.10;

(Add) 13.8.10.4.3.3.5

Interlock with all stairwell pressurization, smoke exhaust and smoke control systems to control HVAC operations as required in § 13.8.10.5.10. Stairwell pressurization, smoke exhaust and smoke control systems shall not be activated by the activation of mammal fire alarm boxes;

(Add) 13.8.10.5.9

AII required fire alarm systems shall be connected to an approved power source in the building and in addition shall have automatically charged storage type battery standby power (dry cell shall not be used) of sufficient capacity to operate the entire system as required by § 13.8.10.4 for the type of system after the principal source of power has failed. The fire alarm system must be able to function and sound the notification appliances for at least live (5) minutes following the required standby period.

(Add) 13.8.10.5.9.1

Systems utilizing in emergency generator as a source of standby power shall not be exempt from the above requirements for battery standby power.

(Add) 13.8.10.5.10

In all buildings having a fire alarm system, the fire alarm system shall be interconnected to the building's heating, ventilation and air conditioning (HVAC controls so that the fan(s) supplying two thousand (2,000) cubic feet per minute (cfm) or greater capacity of any ventilating system not used for pressurization of a fire safe area or four (4) or more ceiling mounted industrial air circulation fans installed in one room shall automatically shut down ally time, other than drills or when testing, that any initiating device connected to the fire alarm system is activated. If duct-type smoke detectors are installed in HVAC systems, the duct-type smoke detector shall be connected to the fire alarm control unit to signal an audible and visual supervisory signal at the fire alarm control unit and annunciator. An alarm condition shall not occur unless specifically requested and authorized by the AHJ.

(Add) 13.8.10.5.10.1

EXCEPTION: Where total coverage smoke detection is installed in all areas of the smoke compartment served by the return air system, installation of air duct detectors in the return air system shall not be required, provided their function is accomplished by the design of the area detection system.

(Add) 1.3.8.10.5.10.2

Where installation of automatic smoke area detection is impractical due to ambient conditions, automatic heat detection shall be permitted. In areas covered by automatic sprinkler systems, automatic heat detection shall not be required.

(Add) 13.8.10.5.10.3

EXCEPTION- See § 13.8.10.4.3.3.5.

December 15, 2006

Mr. Rick Bouchard
The SLAM Collaborative
Somerset Square
80 Glastonbury Boulevard
Glastonbury, CT 06033-4415

Re: 22562 URI Housing
Atrium Smoke Control

Dear Rick:

As Building C completion nears I am submitting to you a smoke control system summary report to be reviewed and approved by the Rhode Island State Fire Marshal's Office. A separate summary report for Building C is being submitted as requested by the SFM office, due to the differences in the architectural layout of the atrium (connecting bridge at third floor) from buildings A & B. The smoke exhaust rate calculations remain the same as were approved by the State Building Commissions office for all Buildings A, B, & C, because of the same smoke layer height being the determining factor in the overall atrium smoke exhaust volume. The summary report contains the following:

1. The atrium plan and section. (included as an attachment)

2. The Exhaust Method of smoke control in accordance with IBC 2003, Section 909.8 as approved by Rhode Island Building Code Commission.

3. Smoke exhaust calculations using an axisymetric smoke plume and a balcony spill smoke plume. These calculations are summarized below and are included as attachments.

4. Smoke control system acceptance test procedures as stated in IMC 2003, Section 909, to be performed by the contractor as specified in contract documents.

5. Sequence of operation as provide by Fire Alarm contractor and ATC contractor.

The Building

Building C has an atrium requiring a smoke control system in accordance with section 909 of the IBC-2003. The governing building code for this project is the 2003 edition of the International Building Code (IBC-2003). Of the several available smoke control methods, we received approval from the governing building official to use the Exhaust Method in accordance with section 909.8 of the IBC-2003. The details of our calculation procedure are provided in the following attachments:

1. Atrium Smoke Calculations Sheet – Axisymetric Plumes
2. Atrium Smoke Calculations Sheet – Balcony Spill & Window Plumes
3. Plan View of Atrium
4. Section View of Atrium

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Mr. Rick Bouchard
The SLAM Collaborative
22562 – URI Housing Building C

The Atrium

The atrium is comprised of five levels. The atrium has approximate dimensions of 50' (W) x 50' (L) x 59' (H). On the first level, the atrium is open to egress pathways while on the second, fourth, and fifth levels, the atrium is separated from egress pathways. On the third level an enclosed bridge or "upper lounge" crosses the atrium and connects the north and south side corridors but is separated from the atrium by a smoke barrier enclosure. On the first level, the perimeter corridor around the atrium will be separated from communicating spaces during a fire/smoke event with automatic closing doors (fire/smoke rated).

The Exhaust Method, ICB-2003, Section 909.8

Section 909.8.1 (Exhaust Rate) of the IBC-2003 requires that the largest calculated mass flow rate of possible smoke plumes be used to determine the volumetric flow rate of the smoke exhaust system. We have calculated this to be the axisymetric plume, which yields a smoke exhaust flow rate of ***47,000 cubic feet per minute (CFM).***

As approved by the governing building official the design of a ***47,000 CFM*** smoke exhaust system is being provided for the atrium.

Please feel free to call with any questions.

Very truly yours,

R.G. Vanderweil Engineers, LLP

Charles A. Clapp, P.E.
Project Manager

CAC/das

Attachments

IBC 2003 Atrium Smoke Calculations

Vanderweil Engineers

Assumptions — 909.8 (same as UBC 905.5.2)

T_a =	75	°F (	535	°R)	
z =	10.00	ft.			
Q =	5,000	BTU/s			
Q_c =	3,500	BTU/s			

C_p = 0.24 BTU/lb°F (Specific heat of Air / Smoke)*

ρ = 0.074 lbs/ft^3 (0.075 lbs/ft^3 at 70 °F)*

* SFPE Handbook, 3rd Edition; Page A23, Table B.2 (expressed in metric)

1. **Flame height** — IBC 9-3 (same as UBC 5-3)

$z_l = 0.533 Q_c^{2/5}$

= 0.533 (3,500)$^{2/5}$

= 0.533 x 26.16

= 13.9 feet

2. **Axisymetric Plume** — IBC 9-3.1 (same as UBC 5-4) (for 'z' > flame height)

$m_p = 0.022 Q_c^{1/3} z^{5/3} + 0.0042 Q_c$

= 0.022 x (3,500)$^{1/3}$ (10.0)$^{5/3}$ + (0.0042 x 3,500)

= 0.022 x 15.18 x 46.42 + 14.7

= 30.2 lbs/s

3. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

= [3,500 / (0.24 x 30.2)] + 75

= [3,500 / 7.25] + 75

= 482.89 + 75

= 558 °F (1,018 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

4. **Smoke Density** — (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$

= 0.074 (535 / 1,018)

= 0.074 x 0.53

= 0.039 lbs/ft^3

5. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p / \rho$

= 60 x 30.2 / 0.039

= 46,401 cfm — **Flame height is > 'z.' Use formula below.**

6. **Axisymetric Plume** — IBC 9-3.3 (same as UBC 5-4) (for 'z' < flame height)

$m_p = 0.0208 Q_c^{3/5} z$

= 0.0208 x 3,500$^{3/5}$ x 10.00

= 0.0208 x 133.80 x 10.00

= 27.83 lbs/s

7. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

= [3,500 / (0.24 x 27.83)] + 75

= [3,500 / 6.68] + 75

= 524.03 + 75

= 599 °F (1,059 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

8. **Smoke Density** — (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$

= 0.074 (535 / 1,059)

= 0.074 x 0.51

= 0.038 lbs/ft^3

9. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60 m_p / \rho$

= 60 x 27.83 / 0.038

= 44,486 cfm — **REQUIRED EXHAUST**

IBC 2003 Atrium Smoke Calculations

Vanderweil Engineers

Assumptions — 909.8 (same as UBC 905.5.2)

T_a =	75 °F (535 °R)		C_p =	0.24 BTU/lb°F	(Specific heat of Air / Smoke)*
Q =	5,000 BTU/s		ρ =	0.074 lbs/ft³	(0.075 lbs/ft³ at 70 °F)*
H =	9.50 ft.	Height to balcony	A_w =	36.00 ft².	Window area
W =	5.00 ft.	Width of balcony spill	H_w =	6.00 ft.	Height of opening
z_b =	0.50 ft.	Height to Z from balcony	z_w =	2.00 ft.	Height of opening above floor
Q_c =	3,500 BTU/s		$a = 2.4A_w^{2/5}H_w^{1/5} - 2.1H_w$		= 1.80

* SFPE Handbook, 3rd Edition; Page A23, Table B.2 (expressed in metric)

1. **Balcony Spill Plume** — IBC 9-5 (same as UBC 5-8)

$m_p = 0.124(QW^2)^{1/3}(z_b + 0.25H)$

= 0.124 (5,000 x 5.0 ^{2})$^{1/3}$ (1 + 0.25 x 9.50)
= 0.124 (5,000 x 25)$^{1/3}$ (1 + 2.38)
= 0.124 (125,000)$^{1/3}$ (3)
= 0.124 (50) (3)
= 17.83 lbs/s

2. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

= [3,500 / (0.24 x 17.83)] + 75
= [3,500 / 4.28] + 75
= 818.14 + 75
= 893 °F (1,353 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

3. **Smoke Density** — (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

$\rho = \rho_a (T_a / T_s)$

= 0.074 (535 / 1,353)
= 0.074 x 0.40
= 0.029 lbs/ft³

4. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60m_p/\rho$

= 60 x 17.83 / 0.029
= 36,407 cfm

5. **Window Plume** — IBC 9-6 (same as UBC 5-9)

$m_p = 0.077(A_w H_w^{1/2})^{1/3}(z_w + a)^{5/3} + 0.18A_w H_w^{1/2}$

= 0.077 (36.00 x 6.00 $^{1/2}$)$^{1/3}$(2.00 + 1.80)$^{5/3}$ + 0.18 x 36.00 x 6.00 $^{1/2}$
= 0.077 (36.00 x 2.45)$^{1/3}$ (3.80)$^{5/3}$ + 0.18 x 36.00 x 2.45
= 0.077 (88.18)$^{1/3}$ (9.25) + 15.87
= 0.077 (4.45) (9.25) + 15.87
= 3.17 + 15.87
= 19.04 lbs/s

6. **Smoke Temperature** — IBC 9-9 (same as UBC 5-13)

$T_s = [Q_c/(C_p \times m_p)] + T_a$

= [3,500 / (0.24 x 19.04)] + 75
= [3,500 / 4.57] + 75
= 765.77 + 75
= 841 °F (1,301 °R)

A calculation is necessary for the code solutions but for which there is no formula in the code

7. **Smoke Density** — (Ideal Gas Law) — NFPA 92B, Page 27, under A.2.4.1.3 (8) (expressed in metric)

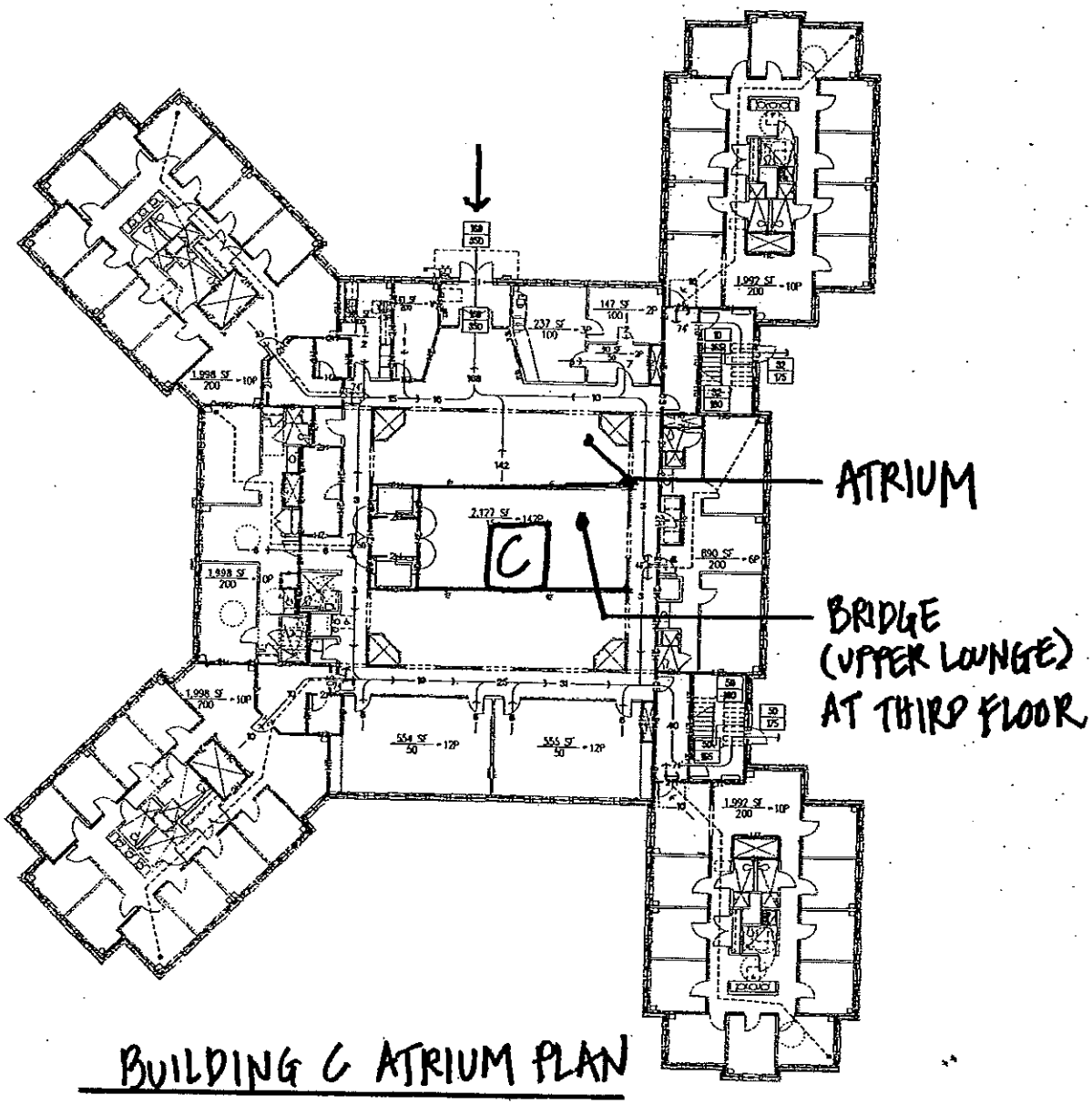
$\rho = \rho_a (T_a / T_s)$

= 0.074 (535 / 1,301)
= 0.074 x 0.41
= 0.031 lbs/ft³

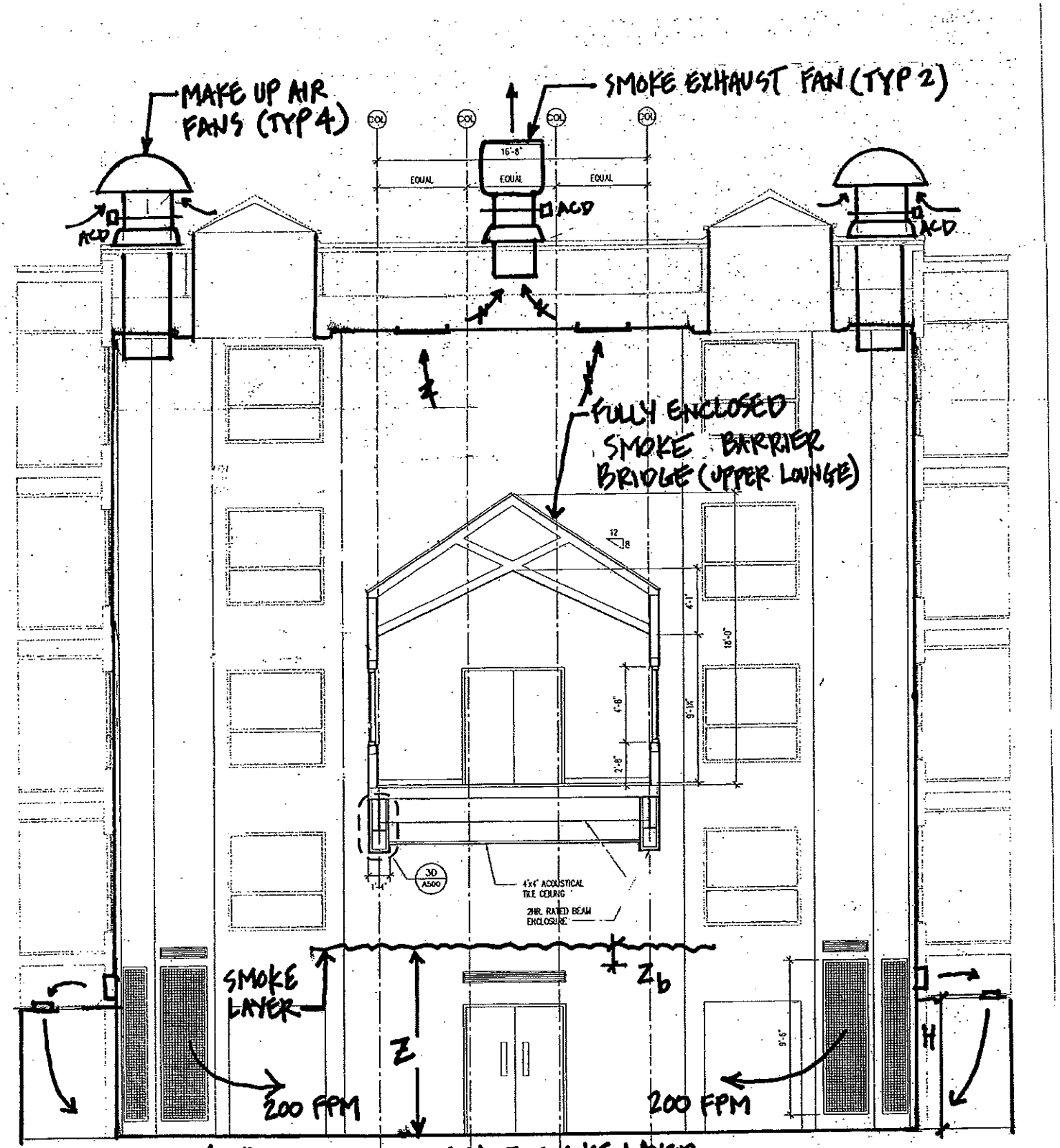
8. **Volumetric Smoke Production** — IBC 9-4 (same as UBC 5-7)

$V = 60m_p/\rho$

= 60 x 19.04 / 0.031
= 37,392 cfm



BUILDING C ATRIUM PLAN



Z = 10'-0" = HEIGHT FROM FUEL TO SMOKE LAYER
H = 9'-6" = HEIGHT TO BALCONY
Z_b = 0'-6" = HEIGHT FROM BALCONY

BUILDING C
ATRIUM SECTION 1/8"=1'-0"

H occupancies shall be provided in accordance with Section 414.7.

[F] 908.2 Group H-5 occupancy. Emergency alarms for notification of an emergency condition in an HPM facility shall be provided as required in Section 415.9.4.6. A continuous gas-detection system shall be provided for HPM gases in accordance with Section 415.9.7.

[F] 908.3 Highly toxic and toxic materials. A gas detection system shall be provided for indoor storage and use of highly toxic and toxic gases to detect the presence of gas at or below the permissible exposure limit (PEL) or ceiling limit of the gas for which detection is provided. The system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit.

Exception: A gas detection system is not required for toxic gases when the physiological warning properties are at a level below the accepted PEL for the gas.

[F] 908.3.1 Alarms. The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station when a short-term hazard condition is detected. The alarm shall be both visible and audible and shall provide warning both inside and outside the area where gas is detected. The audible alarm shall be distinct from all other alarms.

Exception: Signal transmission to a constantly attended control station is not required when not more than one cylinder of highly toxic or toxic gas is stored.

[F] 908.3.2 Shutoff of gas supply. The gas detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for whichever gas is detected.

Exception: Automatic shutdown is not required for reactors utilized for the production of highly toxic or toxic compressed gases where such reactors are:

1. Operated at pressures less than 15 pounds per square inch gauge (psig) (103.4 kPa).
2. Constantly attended.
3. Provided with readily accessible emergency shutoff valves.

[F] 908.3.3 Valve closure. The automatic closure of shutoff valves shall be in accordance with the following:

1. When the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas room and compressed gas containers are not in gas cabinets or exhausted enclosures, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve for the compressed container of specific gas detected supplying the manifold shall automatically close.

Exception: When the gas-detection sampling point initiating the gas-detection system alarm is at a use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve in the gas valve enclosure for the branch line located in the piping distribution manifold enclosure shall automatically close.

[F] 908.4 Ozone gas-generator rooms. Ozone gas-generator rooms shall be equipped with a continuous gas-detection system that will shut off the generator and sound a local alarm when concentrations above the PEL occur.

[F] 908.5 Repair garages. A flammable-gas detection system shall be provided in repair garages for vehicles fueled by nonodorized gases in accordance with Section 406.6.6.

[F] 908.6 Refrigerant detector. Machinery rooms shall contain a refrigerant detector with an audible and visual alarm. The detector, or a sampling tube that draws air to the detector, shall be located in an area where refrigerant from a leak will concentrate. The alarm shall be actuated at a value not greater than the corresponding TLV-TWA values for the refrigerant classification indicated in the *International Mechanical Code*. Detectors and alarms shall be placed in approved locations.

Exception: Detectors are not required in ammonia system machinery rooms equipped with a vapor detector in accordance with the *International Mechanical Code*.

SECTION 909
SMOKE CONTROL SYSTEMS

909.1 Scope and purpose. This section applies to mechanical or passive smoke control systems when they are required by other provisions of this code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-venting provisions found in Section 910. Mechanical smoke control systems shall not be considered exhaust systems under Chapter 5 of the *International Mechanical Code*.

909.2 General design requirements. Buildings, structures or parts thereof required by this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design. The construction documents shall include sufficient information and detail to adequately describe the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied by sufficient information and analysis to demonstrate compliance with these provisions.

909.3 Special inspection and test requirements. In addition to the ordinary inspection and test requirements which buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the construction documents shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The special inspections and tests required by this section shall be conducted under the same terms in Section 1704.

909.4 Analysis. A rational analysis supporting the types of smoke control systems to be employed, their methods of operation, the systems supporting them and the methods of construction to be utilized shall accompany the submitted construction documents and shall include, but not be limited to, the items indicated in Sections 909.4.1 through 909.4.6.

909.4.1 Stack effect. The system shall be designed such that the maximum probable normal or reverse stack effect will not adversely interfere with the system's capabilities. In determining the maximum probable stack effect, altitude, elevation, weather history and interior temperatures shall be used.

909.4.2 Temperature effect of fire. Buoyancy and expansion caused by the design fire in accordance with Section 909.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with the system's capabilities.

909.4.3 Wind effect. The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of Chapter 16.

909.4.4 HVAC systems. The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems status. The design shall consider the effects of the fire on the HVAC systems.

909.4.5 Climate. The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

909.4.6 Duration of operation. All portions of active or passive smoke control systems shall be capable of continued operation after detection of the fire event for not less than 20 minutes.

909.5 Smoke barrier construction. Smoke barriers shall comply with Section 709, and shall be constructed and sealed to limit leakage areas exclusive of protected openings. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls: $A/A_w = 0.00100$
2. Exit enclosures: $A/A_w = 0.00035$
3. All other shafts: $A/A_w = 0.00150$
4. Floors and roofs: $A/A_F = 0.00050$

where:

A = Total leakage area, square feet (m^2).

A_F = Unit floor or roof area of barrier, square feet (m^2).

A_w = Unit wall area of barrier, square feet (m^2).

The leakage area ratios shown do not include openings due to doors, operable windows or similar gaps. These shall be included in calculating the total leakage area.

909.5.1 Leakage area. The total leakage area of the barrier is the product of the smoke barrier gross area monitored by the allowable leakage area ratio, plus the area of other openings such as gaps and operable windows. Compliance shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems. Passive smoke control systems tested using other approved means such as door fan testing shall be as approved by the building official.

909.5.2 Opening protection. Openings in smoke barriers shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by door assemblies complying with Section 715.4.3.

Exceptions:

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors listed for releasing service installed in accordance with Section 907.11.
2. Fixed openings between smoke zones which are protected utilizing the airflow method.
3. In Group I-2, where such doors are installed across corridors, a pair of opposite-swinging doors without a center mullion shall be installed having vision panels with approved fire-rated glazing materials in approved fire-rated frames, the area of which shall not exceed that tested. The doors shall be close fitting within operational tolerances and shall not have undercuts, louvers or grilles. The doors shall have head and jamb stops, astragals or rabbets at meeting edges, and automatic-closing devices. Positive-latching devices are not required.
4. Group I-3.
5. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank-down capacity of greater than 20 minntes as determined by the design fire size.

909.5.2.1 Ducts and air transfer openings. Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) smoke damper complying with Section 716.

909.6 Pressurization method. The primary mechanical means of controlling smoke shall be by pressure differences across smoke barriers. Maintenance of a tenable environment is not required in the smoke control zone of fire origin.

909.6.1 Minimum pressure difference. The minimum pressure difference across a smoke barrier shall be 0.05-inch water gage (0.0124 kPa) in fully sprinklered buildings. In buildings permitted to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure differences at least two times the maximum calculated pressure difference produced by the design fire.

909.6.2 Maximum pressure difference. The maximum air pressure difference across a smoke barrier shall be determined by required door-opening or closing forces. The actual force required to open exit doors when the system is in the smoke control mode shall be in accordance with Section 1008.1.2. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(WA\Delta P)/2(W-d) \qquad \text{(Equation 9-1)}$$

where:

A = Door area, square feet (m^2).

d = Distance from door handle to latch edge of door, feet (m).

F = Total door opening force, pounds (N).

F_{dc} = Force required to overcome closing device, pounds (N).

K = Coefficient 5.2 (1.0).

W = Door width, feet (m).

ΔP = Design pressure difference, inches of water (Pa).

909.7 Airflow design method. When approved by the building official, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflow shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects.

909.7.1 Velocity. The minimum average velocity through a fixed opening shall not be less than:

$$v = 217.2\,[h\,(T_f - T_o)/(T_f + 460)]^{1/2} \qquad \text{(Equation 9-2)}$$

For SI: $v = 119.9\,[h\,(T_f - T_o)/T_f]^{1/2}$

where:

h = Height of opening, feet (m).

T_f = Temperature of smoke, °F (°K).

T_o = Temperature of ambient air, °F (°K).

v = Air velocity, feet per minute (m/minute).

909.7.2 Prohibited conditions. This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. In no case shall airflow toward the fire exceed 200 feet per minute (1.02 m/s). Where the formula in Section 909.7.1 requires airflow to exceed this limit, the airflow method shall not be used.

909.8 Exhaust method. When approved by the building official, mechanical smoke control for large enclosed volumes, such as in atriums or malls, shall be permitted to utilize the exhaust method. The design exhaust volumes shall be in accordance with this section.

909.8.1 Exhaust rate. The height of the lowest horizontal surface of the accumulating smoke layer shall be maintained at least 10 feet (3048 mm) above any walking surface which forms a portion of a required egress system within the smoke zone. The required exhaust rate for the zone shall be the largest of the calculated plume mass flow rates for the possible plume configurations. Provisions shall be made for natural or mechanical supply of air from outside or adjacent smoke zones to make up for the air exhausted. Makeup airflow rates, when measured at the potential fire location, shall not exceed 200 feet per minute (60 960 mm per minute) toward the fire. The temperature of the makeup air shall be such that it does not expose temperature-sensitive fire protection systems beyond their limits.

909.8.2 Axisymmetric plumes. The plume mass flow rate (m_p), in pounds per second (kg/s), shall be determined by placing the design fire center on the axis of the space being analyzed. The limiting flame height shall be determined by:

$$z_l = 0.533 Q_c^{2/5} \qquad \text{(Equation 9-3)}$$

For SI: $z_l = 0.166 Q_c^{2/5}$

where:

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat output.

Q_c = Convective heat output, British thermal units per second (kW). (The value of Q_c shall not be taken as less than $0.70Q$).

z = Height from top of fuel surface to bottom of smoke layer, feet (m).

z_l = Limiting flame height, feet (m). The z_l value must be greater than the fuel equivalent diameter (see Section 909.9).

for $z > z_l$

$$m_p = 0.022 Q_c^{1/3} z^{5/3} + 0.0042 Q_c$$

For SI: $m_p = 0.071\, Q_c^{1/3} z^{5/3} + 0.0018 Q_c$

for $z = z_l$

$$m_p = 0.011\, Q_c$$

For SI: $m_p = 0.035 Q_c$

for $z < z_l$

$$m_p = 0.0208 Q_c^{3/5} z$$

For SI: $m_p = 0.032 Q_c^{3/5} z$

To convert m_p from pounds per second of mass flow to a volumetric rate, the following equation shall be used:

$$V = 60 m_p/\rho \qquad \text{(Equation 9-4)}$$

where:

V = Volumetric flow rate, cubic feet per minute (m^3/s).

ρ = Density of air at the temperature of the smoke layer, pounds per cubic feet (T: in °F) [kg/m^3 (T: in °C)].

909.8.3 Balcony spill plumes. The plume mass flow rate (m_p) for spill plumes shall be determined using the geometrically probable width based on architectural elements and projections in the following equation:

$$m_p = 0.124(QW^2)^{1/3}(z_b + 0.25H) \quad \text{(Equation 9-5)}$$

For SI: $m_p = 0.36(QW^2)^{1/3}(z_b + 0.25H)$

where:

H = Height above fire to underside of balcony, feet (m).

m_p = Plume mass flow rate, pounds per second (kg/s).

Q = Total heat output.

W = Plume width at point of spill, feet (m).

z_b = Height from balcony, feet (m).

909.8.4 Window plumes. The plume mass flow rate (m_p) shall be determined from:

$$m_p = 0.077(A_w H_w^{1/2})^{1/3}(z_w + a)^{5/3} + 0.18 A_w H_w^{1/2} \quad \text{(Equation 9-6)}$$

For SI: $m_p = 0.68(A_w H_w^{1/2})^{1/3}(z_w + a)^{5/3} + 1.5 A_w H_w^{1/2}$

where:

A_w = Area of the opening, square feet (m^2).

H_w = Height of the opening, feet (m).

m_p = plume mass flow rate, pounds per second (kg/s).

z_w = Height from the top of the window or opening to the bottom of the smoke layer, feet (m).

$a = 2.4 A_w^{2/5} H_w^{1/5} - 2.1 H_w$

909.8.5 Plume contact with walls. When a plume contacts one or more of the surrounding walls, the mass flow rate shall be adjusted for the reduced entrainment resulting from the contact provided that the contact remains constant. Use of this provision requires calculation of the plume diameter, that shall be calculated by:

$$d = 0.48\,[(T_c + 460)/(T_a + 460)]^{1/2} z \quad \text{(Equation 9-7)}$$

For SI: $d = 0.48\,(T_c/T_a)^{1/2} z$

where:

d = Plume diameter, feet (m).

T_a = Ambient air temperature, °F (°K).

T_c = Plume centerline temperature, °F (°K).
$= 0.60\,(T_a + 460)\,Q_c^{2/3} z^{-5/3} + T_a$

z = Height at which T_c is determined, feet (m).

For SI: $T_c = 0.08\,T_a Q_c^{2/3} z^{-5/3} + T_a$

909.9 Design fire. The design fire shall be based on a Q of not less than 5,000 Btu/s (5275 kW) unless a rational analysis is performed by the registered design professional and approved by the building official. The design fire shall be based on the analysis in accordance with Section 909.4 and this section.

909.9.1 Factors considered. The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire and whether the fire is likely to be steady or unsteady.

909.9.2 Separation distance. Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration. The ratio of the separation distance to the fuel equivalent radius shall not be less than 4. The fuel equivalent radius shall be the radius of a circle of equal area to floor area of the fuel package. The design fire shall be increased if other combustibles are within the separation distance as determined by:

$$R = [Q/(12\pi q'')]^{1/2} \quad \text{(Equation 9-8)}$$

where:

q'' = Incident radiant heat flux required for nonpiloted ignition, Btu/ft² · s (W/m^2).

Q = Heat release from fire, Btu/s (kW).

R = Separation distance from target to center of fuel package, feet (m).

909.9.3 Heat-release assumptions. The analysis shall make use of best available data from approved sources and shall not be based on excessively stringent limitations of combustible material.

909.9.4 Sprinkler effectiveness assumptions. A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

909.10 Equipment. Equipment such as, but not limited to, fans, ducts, automatic dampers and balance dampers, shall be suitable for its intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as approved by the building official.

909.10.1 Exhaust fans. Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad \text{(Equation 9-9)}$$

where:

c = Specific heat of smoke at smoke layer temperature, Btu/lb°F (kJ/kg · K).

m = Exhaust rate, pounds per second (kg/s).

Q_c = Convective heat output of fire, Btu/s (kW).

T_a = Ambient temperature, °F (°K).

T_s = Smoke temperature, °F (°K).

Exception: Reduced T_s as calculated based on the assurance of adequate dilution air.

909.10.2 Ducts. Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 909.10.1. Ducts shall be constructed and supported in accordance with the *International Mechanical Code*. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

Exception: Flexible connections (for the purpose of vibration isolation) complying with the *International Mechanical Code*, that are constructed of approved fire-resistance-rated materials.

909.10.3 Equipment, inlets and outlets. Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outside air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

909.10.4 Automatic dampers. Automatic dampers, regardless of the purpose for which they are installed within the smoke control system, shall be listed and conform to the requirements of approved, recognized standards.

909.10.5 Fans. In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the requirements of Chapter 16. Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts), as determined from measurement of actual current draw, and shall have a minimum service factor of 1.15.

909.11 Power systems. The smoke control system shall be supplied with two sources of power. Primary power shall be the normal building power systems. Secondary power shall be from an approved standby source complying with the ICC *Electrical Code*. The standby power source and its transfer switches shall be in a separate room from the normal power transformers and switch gear and shall be enclosed in a room constructed of not less than 1-hour fire-resistance-rated fire barriers ventilated directly to and from the exterior. Power distribution from the two sources shall be by independent routes. Transfer to full standby power shall be automatic and within 60 seconds of failure of the primary power. The systems shall comply with the ICC *Electrical Code*.

909.11.1 Power sources and power surges. Elements of the smoke management system relying on volatile memories or the like shall be supplied with uninterruptable power sources of sufficient duration to span a 15-minute primary power interruption. Elements of the smoke management system susceptible to power surges shall be suitably protected by conditioners, suppressors or other approved means.

909.12 Detection and control systems. Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907. Such systems shall be equipped with a control unit complying with UL 864 and listed as smoke control equipment.

Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override, the presence of power downstream of all disconnects and, through a preprogrammed weekly test sequence report, abnormal conditions audibly, visually and by printed report.

909.12.1 Wiring. In addition to meeting requirements of the ICC *Electrical Code*, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

[F] 909.12.2 Activation. Smoke control systems shall be activated in accordance with this section.

[F] 909.12.2.1 Pressurization, airflow or exhaust method. Mechanical smoke control systems using the pressurization, airflow or exhaust method shall have completely automatic control.

[F] 909.12.2.2 Passive method. Passive smoke control systems actuated by approved spot-type detectors listed for releasing service shall be permitted.

[F] 909.12.3 Automatic control. Where completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned automatic sprinkler system complying with Section 903.3.1.1, manual controls that are readily accessible to the fire department and any smoke detectors required by engineering analysis.

909.13 Control air tubing. Control air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections and shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

909.13.1 Materials. Control air tubing shall be hard drawn copper, Type L, ACR in accordance with ASTM B 42, ASTM B 43, ASTM B 68, ASTM B 88, ASTM B 251 and ASTM B 280. Fittings shall be wrought copper or brass, solder type, in accordance with ASME B 16.18 or ASME B 16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F (593°C) and liquids below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

Exception: Nonmetallic tubing used within control panels and at the final connection to devices, providing all of the following conditions are met:

1. Tubing shall be listed by an approved agency for flame and smoke characteristics.

2. Tubing and connected devices shall be completely enclosed within galvanized or paint-grade steel enclosure of not less than 0.030 inch (0.76 mm) (No. 22 galvanized sheet gage) thickness. Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or teflon or by suitable brass compression to male-barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within enclosure. Tubing bridging cabinet and door or moveable device shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing serving devices on doors shall be fastened along hinges.

909.13.2 Isolation from other functions. Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

909.13.3 Testing. Control air tubing shall be tested at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

909.14 Marking and identification. The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

[F] 909.15 Control diagrams. Identical control diagrams showing all devices in the system and identifying their location and function shall be maintained current and kept on file with the building official, the fire department and in the fire command center in format and manner approved by the fire chief.

[F] 909.16 Fire-fighter's smoke control panel. A fire-fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be located in a fire command center complying with Section 911, and shall comply with Sections 909.16.1 through 909.16.3.

[F] 909.16.1 Smoke control systems. Fans within the building shall be shown on the fire-fighter's control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone, and by pilot-lamp-type indicators as follows:

1. Fans, dampers and other operating equipment in their normal status—WHITE.
2. Fans, dampers and other operating equipment in their off or closed status—RED.
3. Fans, dampers and other operating equipment in their on or open status—GREEN.
4. Fans, dampers and other operating equipment in a fault status—YELLOW/AMBER.

[F] 909.16.2 Smoke control panel. The fire-fighter's control panel shall provide control capability over the complete smoke-control system equipment within the building as follows:

1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes stairway pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans and other operating equipment used or intended for smoke control purposes.
2. OPEN-AUTO-CLOSE control over individual dampers relating to smoke control and that are also controlled from other sources within the building.
3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the fire-fighter's control panel.

Exceptions:

1. Complex systems, where approved, where the controls and indicators are combined to control and indicate all elements of a single smoke zone as a unit.
2. Complex systems, where approved, where the control is accomplished by computer interface using approved, plain English commands.

[F] 909.16.3 Control action and priorities. The fire-fighter's control panel actions shall be as follows:

1. ON-OFF, OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the fire-fighter's control panel, no automatic or manual control from any other control point within the building shall contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices), such means shall be capable of being overridden by the fire-fighter's control panel. The last control action as indicated by each fire-fighter's control panel switch position shall prevail. In no case shall control actions require the smoke control system to assume more than one configuration at any one time.

   Exception: Power disconnects required by the ICC *Electrical Code*.

2. Only the AUTO position of each three-position fire-fighter's control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, nonemergency, building control position. Where a fire-fighter's control panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described above. When directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. In no case shall control actions require the

smoke control system to assume more than one configuration at any one time.

[F] 909.17 System response time. Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. For purposes of smoke control, the fire-fighter's control panel response time shall be the same for automatic or manual smoke control action initiated from any other building control point. The total response time, including that necessary for detection, shutdown of operating equipment and smoke control system startup, shall allow for full operational mode to be achieved before the conditions in the space exceed the design smoke condition. The system response time for each component and their sequential relationships shall be detailed in the required rational analysis and verification of their installed condition reported in the required final report.

[F] 909.18 Acceptance testing. Devices, equipment, components and sequences shall be individually tested. These tests, in addition to those required by other provisions of this code, shall consist of determination of function, sequence and, where applicable, capacity of their installed condition.

[F] 909.18.1 Detection devices. Smoke or fire detectors that are a part of a smoke control system shall be tested in accordance with Chapter 9 in their installed condition. When applicable, this testing shall include verification of airflow in both minimum and maximum conditions.

[F] 909.18.2 Ducts. Ducts that are part of a smoke control system shall be traversed using generally accepted practices to determine actual air quantities.

[F] 909.18.3 Dampers. Dampers shall be tested for function in their installed condition.

[F] 909.18.4 Inlets and outlets. Inlets and outlets shall be read using generally accepted practices to determine air quantities.

[F] 909.18.5 Fans. Fans shall be examined for correct rotation. Measurements of voltage, amperage, revolutions per minute (rpm) and belt tension shall be made.

[F] 909.18.6 Smoke barriers. Measurements using inclined manometers or other approved calibrated measuring devices shall be made of the pressure differences across smoke barriers. Such measurements shall be conducted for each possible smoke control condition.

[F] 909.18.7 Controls. Each smoke zone, equipped with an automatic-initiation device, shall be put into operation by the actuation of one such device. Each additional device within the zone shall be verified to cause the same sequence without requiring the operation of fan motors in order to prevent damage. Control sequences shall be verified throughout the system, including verification of override from the fire-fighter's control panel and simulation of standby power conditions.

[F] 909.18.8 Special inspections for smoke control. Smoke control systems shall be tested by a special inspector.

[F] 909.18.8.1 Scope of testing. Special inspections shall be conducted in accordance with the following:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure-difference testing, flow measurements, and detection and control verification.

[F] 909.18.8.2 Qualifications. Special inspection agencies for smoke control shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

[F] 909.18.8.3 Reports. A complete report of testing shall be prepared by the special inspector or special inspection agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or mark. The report shall be reviewed by the responsible registered design professional and, when satisfied that the design intent has been achieved, the responsible registered design professional shall seal, sign and date the report.

[F] 909.18.8.3.1 Report filing. A copy of the final report shall be filed with the building official and an identical copy shall be maintained in an approved location at the building.

[F] 909.18.9 Identification and documentation. Charts, drawings and other documents identifying and locating each component of the smoke control system, and describing its proper function and maintenance requirements, shall be maintained on file at the building as an attachment to the report required by Section 909.18.8.3. Devices shall have an approved identifying tag or mark on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

[F] 909.19 System acceptance. Buildings, or portions thereof, required by this code to comply with this section shall not be issued a certificate of occupancy until such time that the building official determines that the provisions of this section have been fully complied with, and that the fire department has received satisfactory instruction on the operation, both automatic and manual, of the system.

Exception: In buildings of phased construction, a temporary certificate of occupancy, as approved by the building official, shall be permitted provided that those portions of the building to be occupied meet the requirements of this section and that the remainder does not pose a significant hazard to the safety of the proposed occupants or adjacent buildings.

909.20 Smokeproof enclosures. Where required by Section 1019.1.8, a smokeproof enclosure shall be constructed in accordance with this section. A smokeproof enclosure shall consist of an enclosed interior exit stairway that conforms to Section 1019.1 and an outside balcony or ventilated vestibule meeting the requirements of this section. Where access to the roof is required by the *International Fire Code*, such access

shall be from the smokeproof enclosure where a smokeproof enclosure is required.

909.20.1 Access. Access to the stair shall be by way of a vestibule or an open exterior balcony. The minimum dimension of the vestibule shall not be less than the required width of the corridor leading to the vestibule but shall not have a width of less than 44 inches (1118 mm) and shall not have a length of less than 72 inches (1829 mm) in the direction of egress travel.

909.20.2 Construction. The smokeproof enclosure shall be separated from the remainder of the building by not less than a 2-hour fire-resistance-rated fire barrier without openings other than the required means of egress doors. The vestibule shall be separated from the stairway by not less than a 2-hour fire-resistance-rated fire barrier. The open exterior balcony shall be constructed in accordance with the fire-resistance-rating requirements for floor construction.

909.20.2.1 Door closers. Doors in a smokeproof enclosure shall be self-closing or shall be automatic-closing by actuation of a smoke detector installed at the floor-side entrance to the smokeproof enclosure in accordance with Section 715.4.7. The actuation of the smoke detector on any door shall activate the closing devices on all doors in the smokeproof enclosure at all levels. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.3 Natural ventilation alternative. The provisions of Sections 909.20.3.1 through 909.20.3.3 shall apply to ventilation of smokeproof enclosures by natural means.

909.20.3.1 Balcony doors. Where access to the stairway is by way of an open exterior balcony, the door assembly into the enclosure shall be a fire door in accordance with Section 715.4.

909.20.3.2 Vestibule doors. Where access to the stairway is by way of a vestibule, the door assembly into the vestibule shall be a fire door complying with Section 715.4. The door assembly from the vestibule to the stairway shall have not less than a 20-minute fire protection rating complying with Section 715.4.

909.20.3.3 Vestibule ventilation. Each vestibule shall have a minimum net area of 16 square feet (1.5 m^2) of opening in a wall facing an outer court, yard or public way that is at least 20 feet (6096 mm) in width.

909.20.4 Mechanical ventilation alternative. The provisions of Sections 909.20.4.1 through 909.20.4.4 shall apply to ventilation of smokeproof enclosures by mechanical means.

909.20.4.1 Vestibule doors. The door assembly from the building into the vestibule shall be a fire door complying with Section 715.4. The door assembly from the vestibule to the stairway shall have not less than a 20-minute fire protection rating in accordance with Section 715.4. The door from the building into the vestibule shall be provided with gaskets or other provisions to minimize air leakage.

909.20.4.2 Vestibule ventilation. The vestibule shall be supplied with not less than one air change per minute and the exhaust shall not be less than 150 percent of supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 6 inches (152 mm) of the floor level. The top of the exhaust register shall be located at the top of the smoke trap but not more than 6 inches (152 mm) down from the top of the trap, and shall be entirely within the smoke trap area. Doors in the open position shall not obstruct duct openings. Duct openings with controlling dampers are permitted where necessary to meet the design requirements, but dampers are not otherwise required.

909.20.4.2.1 Engineered ventilation system. Where a specially engineered system is used, the system shall exhaust a quantity of air equal to not less than 90 air changes per hour from any vestibule in the emergency operation mode and shall be sized to handle three vestibules simultaneously. Smoke detectors shall be located at the floor-side entrance to each vestibule and shall activate the system for the affected vestibule. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.4.3 Smoke trap. The vestibule ceiling shall be at least 20 inches (508 mm) higher than the door opening into the vestibule to serve as a smoke and heat trap and to provide an upward-moving air column. The height shall not be decreased unless approved and justified by design and test.

909.20.4.4 Stair shaft air movement system. The stair shaft shall be provided with a dampered relief opening and supplied with sufficient air to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) in the shaft relative to the vestibule with all doors closed.

909.20.5 Stair pressurization alternative. Where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the vestibule is not required, provided that interior exit stairways are pressurized to a minimum of 0.15 inch of water (37 Pa) and a maximum of 0.35 inch of water (87 Pa) in the shaft relative to the building measured with all stairway doors closed under maximum anticipated stack pressures.

909.20.6 Ventilating equipment. The activation of ventilating equipment required by the alternatives in Sections 909.20.4 and 909.20.5 shall be by smoke detectors installed at each floor level at an approved location at the entrance to the smokeproof enclosure. When the closing device for the stair shaft and vestibule doors is activated by smoke detection or power failure, the mechanical equipment shall activate and operate at the required performance levels. Smoke detectors shall be installed in accordance with Section 907.10.

909.20.6.1 Ventilation systems. Smokeproof enclosure ventilation systems shall be independent of other building ventilation systems. The equipment and ductwork shall comply with one of the following:

1. Equipment and ductwork shall be located exterior to the building and directly connected to the

smokeproof enclosure or connected to the smokeproof enclosure by ductwork enclosed by 2-hour fire-resistance-rated fire barriers.

2. Equipment and ductwork shall be located within the smokeproof enclosure with intake or exhaust directly from and to the outside or through ductwork enclosed by 2-hour fire-resistance-rated fire barriers.
3. Equipment and ductwork shall be located within the building if separated from the remainder of the building, including other mechanical equipment, by 2-hour fire-resistance-rated fire barriers.

909.20.6.2 Standby power. Mechanical vestibule and stair shaft ventilation systems and automatic fire detection systems shall be powered by an approved standby power system conforming to Section 403.10.1 and Chapter 27.

909.20.6.3 Acceptance and testing. Before the mechanical equipment is approved, the system shall be tested in the presence of the building official to confirm that the system is operating in compliance with these requirements.

909.21 Underground building smoke exhaust system. Where required in accordance with Section 405.5 for underground buildings, a smoke exhaust system shall be provided in accordance with this section.

909.21.1 Exhaust capability. Where compartmentation is required, each compartment shall have an independent, automatically activated smoke exhaust system capable of manual operation. The system shall have an air supply and smoke exhaust capability that will provide a minimum of six air changes per hour.

[F] 909.21.2 Operation. The smoke exhaust system shall be operated in the compartment of origin by the following, independently of each other:

1. Two cross-zoned smoke detectors within a single protected area of a single smoke detector monitored by an alarm verification zone or an approved equivalent method.
2. The automatic sprinkler system.
3. Manual controls that are readily accessible to the fire department.

[F] 909.21.3 Alarm required. Activation of the smoke exhaust system shall activate an audible alarm at a constantly attended location.

SECTION 910
SMOKE AND HEAT VENTS

[F] 910.1 General. Where required by this code or otherwise installed, smoke and heat vents or mechanical smoke exhaust systems and draft curtains shall conform to the requirements of this section.

Exception: Frozen-food warehouses used solely for storage of Class I and II commodities where protected by an approved automatic sprinkler system.

[F] 910.2 Where required. Approved smoke and heat vents shall be installed in the roofs of one-story buildings or portions thereof occupied for the uses set forth in Sections 910.2.1 through 910.2.4.

[F] 910.2.1 Groups F-1 and S-1. Buildings and portions thereof used as a Group F-1 or S-1 occupancy having more than 50,000 square feet (4645 m²) in undivided area.

Exception: Group S-1 aircraft repair hangars.

[F] 910.2.2 Group H. Buildings and portions thereof used as a Group H occupancy as shown:

1. In occupancies classified as Group H-2 or H-3, any of which are over 15,000 square feet (1394 m²) in single floor area.

   Exception: Buildings of noncombustible construction containing only noncombustible materials.

2. In areas of buildings in Group H used for storing Class 2, 3, and 4 liquid and solid oxidizers, Class 1 and unclassified detonable organic peroxides, Class 3 and 4 unstable (reactive) materials, or Class 2 or 3 water-reactive materials as required for a high-hazard commodity classification.

   Exception: Buildings of noncombustible construction containing only noncombustible materials.

[F] 910.2.3 High-piled combustible storage. Buildings and portions thereof containing high-piled combustible stock or rack storage in any occupancy group in accordance with Section 413 and the *International Fire Code*.

[F] 910.2.4 Exit access travel distance increase. Buildings and portions thereof used as a Group F-1 or S-1 occupancy where the maximum exit access travel distance is increased in accordance with Section 1015.2.

[F] 910.3 Design and installation. The design and installation of smoke and heat vents and draft curtains shall be as specified in this section and Table 910.3.

[F] 910.3.1 Vent operation. Smoke and heat vents shall be approved and labeled and shall be capable of being operated by approved automatic and manual means. Automatic operation of smoke and heat vents shall conform to the provisions of this section.

[F] 910.3.1.1 Gravity-operated drop-out vents. Automatic smoke and heat vents containing heat-sensitive glazing designed to shrink and drop out of the vent opening when exposed to fire shall fully open within 5 minutes after the vent cavity is exposed to a simulated fire, represented by a time-temperature gradient that reaches an air temperature of 500°F (260°C) within 5 minutes.

[F] 910.3.1.2 Sprinklered buildings. Where installed in buildings provided with an approved automatic sprinkler system, smoke and heat vents shall be designed to operate automatically.

[F] 910.3.1.3 Nonsprinklered buildings. Where installed in buildings not provided with an approved automatic sprinkler system, smoke and heat vents shall operate automatically by actuation of a heat-responsive

Control Device		Qty	Product Number	Manufacturer	SD Number	Document Number	Description
Field Mounted Devices							
AE	1-6	6	GMA221.1U	SIEMENS		155 315	2PT SR,120V,62LBIN
CS	1-6	6	H908	VERIS		1006cut005	CURRENT SW SPLITCORE-ADJ W/LED
ES	1-6	6	PK-1200	REED		0401cut001	DAMPER END SW,BLADE ACTUATED
RE	1-6	6	RIBU1C	FUNCTIONAL DEVICES		1206cut013	RIB 120VAC 24VAC/DC SPDT
XFMR	1	1	120-24-1002TFCB	CORE		1202cut008	TRANSFORMER 120/24 100VA 2 HUB

SEQUENCE TO BE COORDINATED WITH FIRE ALARM CONTRACTOR.

When any smoke detector in the atrium detects an alarm the FAS will send a signal to open the vents located on the first floor (no DDC and no labor provided by Siemens). This will allow the make up air to enter the atrium.

The Fire Alarm System (FAS) will also send a signal to the DDC system in the event of an alarm condition. Once the DDC system receives the signal the following will occur.

The Smoke Make Up Air Units (SMAU-1A, 2A, 3A, and 4A) and the Smoke Exhaust Fans (SEF-1A and 2A) will start and run continuously. The discharge dampers on each fan will have end switches that are interlocked to the starter to prevent its operation until the dampers are open.

The fans will run until the fire alarm systems terminates the alarm condition signal it is sending to the DDC system.

All power for this system will be Emergency Power.

REVISION HISTORY

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URI New Student Housing
Kingston, RI

ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
CPB	CPB			06/31/06

BLDG C: ATRUIM SMOKE SYSTEM

520-E -9624-

305

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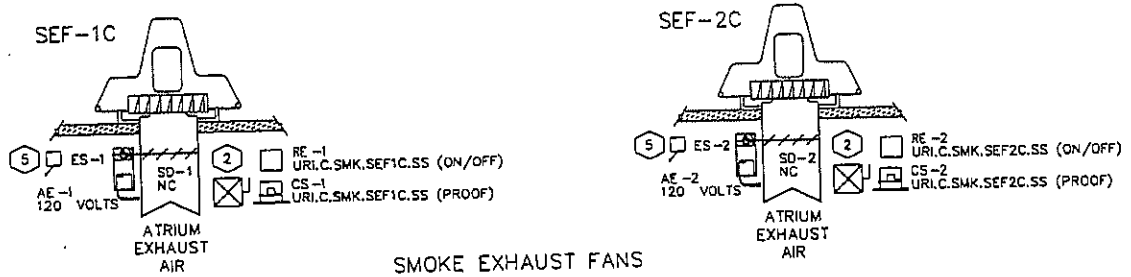


SMOKE EXHAUST FANS

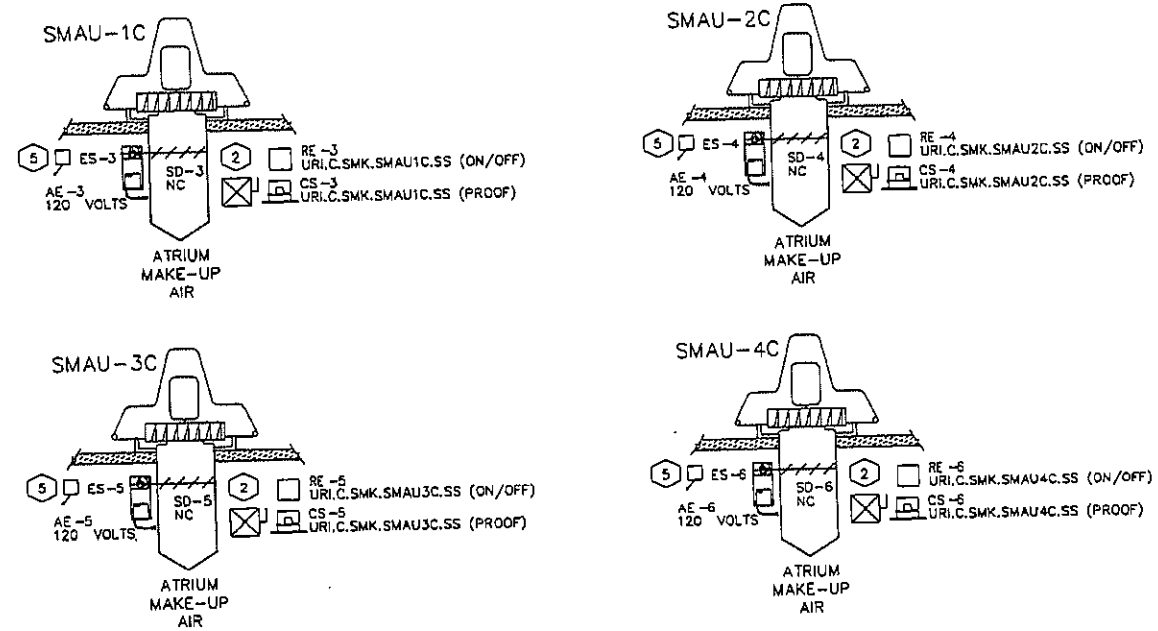
INSTALLATION NOTES:

1. SEE ELECTRICAL DRAWING FOR WIRING DETAILS
2. RELAYS LOCATED NEAR STARTER.
3. ALL FANS LOCATED ON ROOF.
4. FIRE ALARM SYSTEM TO PROVIDE CONTACT TO SIGNAL DDC IN EVENT OF AN ALARM.
5. MOUNT END SWITCH SO THE CONTACT IS MADE WHEN THE DAMPER IS 60% OPEN.

4 URI.C.SMK.FAS.ALM
FAS ALARM SIGNAL

PARTIAL COMPONENT
PANEL CP-2

XFMR-1
100 VA



SMOKE MAKE-UP FANS

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ENGINEER	DRAFTER	CHECKED BY	INITIAL RELEASE	LAST EDIT DATE
CPB	CPB		01/13/06	02/16/06

BLDG C: ATRIUM SMOKE SYSTEM

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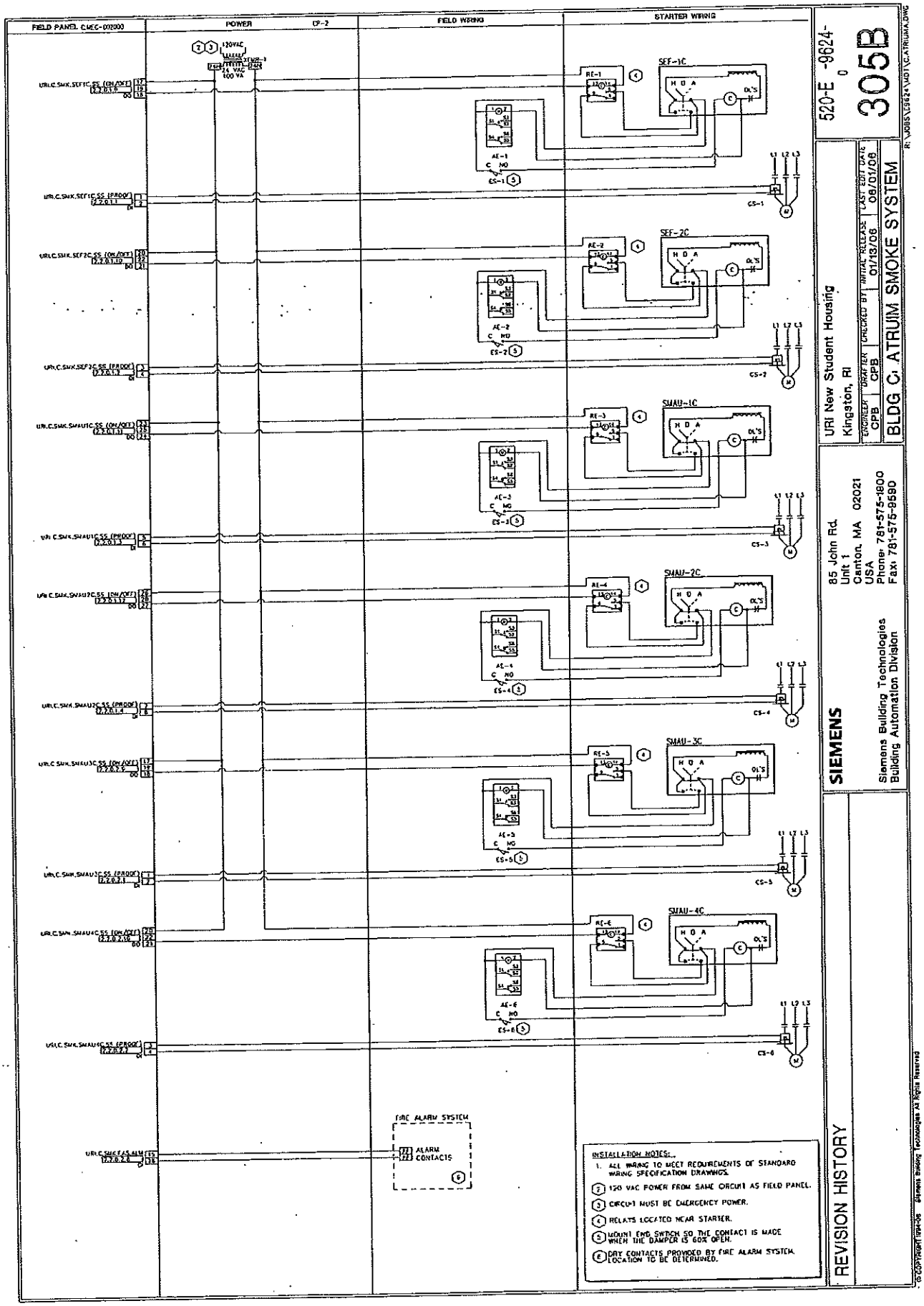
FIELD PANEL CMEC-002000
POWER
CP-2
FIELD WIRING
STARTER WIRING
120VAC
SEF-1C
SEF-2C
SMAU-1C
SMAU-2C
SMAU-3C
SMAU-4C
FIRE ALARM SYSTEM
ALARM CONTACTS
INSTALLATION NOTES:
1. ALL WIRING TO MEET REQUIREMENTS OF STANDARD WIRING SPECIFICATION DRAWINGS.
2. 120 VAC POWER FROM SAME CIRCUIT AS FIELD PANEL.
3. CIRCUIT MUST BE EMERGENCY POWER.
4. RELAYS LOCATED NEAR STARTER.
5. MOUNT END SWITCH SO THE CONTACT IS MADE WHEN THE DAMPER IS 60% OPEN.
6. DRY CONTACTS PROVIDED BY FIRE ALARM SYSTEM. LOCATION TO BE DETERMINED.
SIEMENS
Siemens Building Technologies
Building Automation Division
85 John Rd.
Unit 1
Canton, MA 02021
USA
Phone: 781-575-1800
Fax: 781-575-9580
URI New Student Housing
Kingston, RI
ENGINEER CPB
DRAFTER CPB
CHECKED BY
INITIAL RELEASE 01/13/06
LAST EDIT DATE 08/01/08
BLDG C: ATRIUM SMOKE SYSTEM
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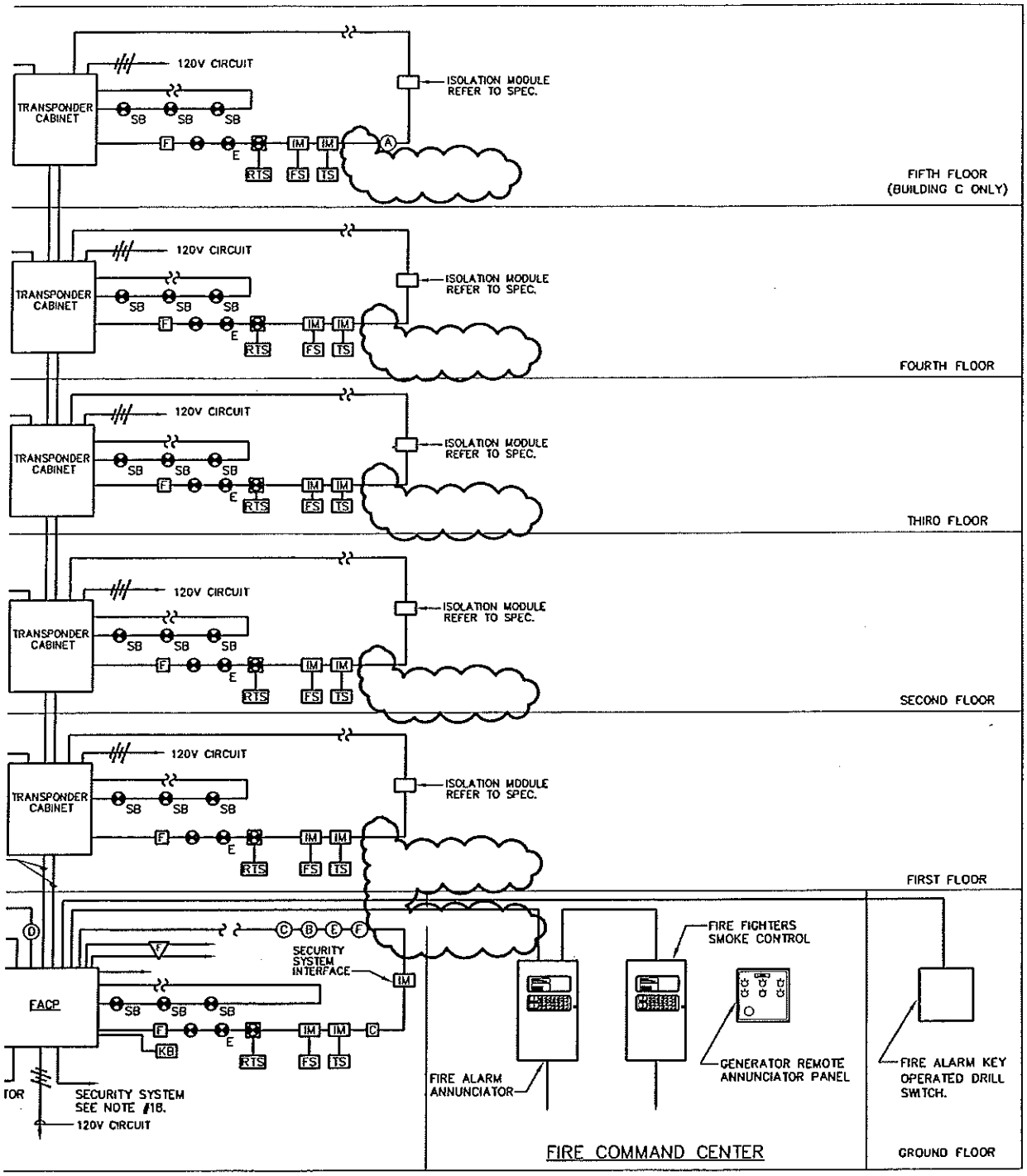


TYPICAL FIRE ALARM RISER

N.T.S.

HOISTWAY

R.G. Vanderweil Engineers, Inc.
274 Summer Street - Boston, MA 02210

The S I L A M Collaborative
Glastonbury, CT
Tel. 860 657-8077
Fax 860 657-3141

REVISED FIRE ALARM RISER IN RESPONSE TO RFI #416

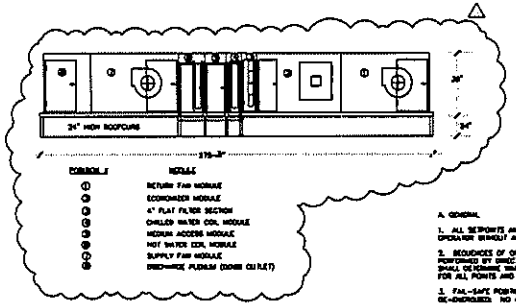
University of Rhode Island
NEW STUDENT HOUSING
LO# B03178

Scale: NTS
Reference: E603
Date: 7/14/06
Proj. No. 2256200

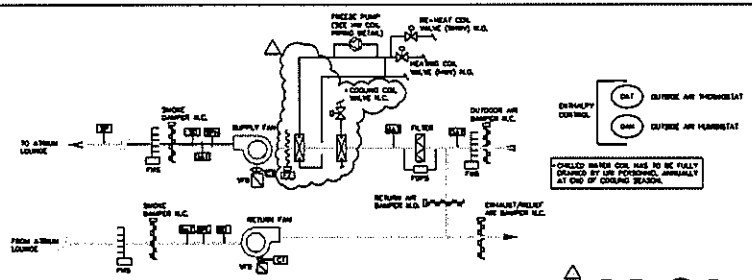
Sketch No: **SKE-72**

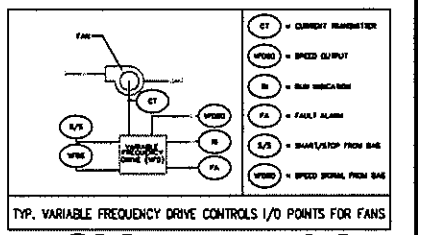
RFI #416

H:\22562.00\CLEC\sketches\SKE-72.dwg SKE-71 July 14, 2006 - 3:02 PM dgluchocki



ROOF TOP AIR HANDLING UNIT CONFIGURATION (RTU-1A,1B,1C)





TYP. VARIABLE FREQUENCY DRIVE CONTROLS I/O POINTS FOR FANS

A. GENERAL

1. ALL SETPOINTS AND TIME DELAYS HEREINCE SHALL BE ADJUSTABLE BY THE OPERATOR EITHER AT ANY HARDWARE OR SOFTWARE DEVICE.

2. SEQUENCES OF OPERATIONS OUTLINED (UNLESS OTHERWISE SPECIFIED) SHALL BE MONITORED BY DIRECT DIGITAL CONTROL FIELD PANELS (DDCPNL). THE DDCPNL SHALL DETERMINE WARM-UP, OCCUPIED, AND UNOCCUPIED MODE OPERATION, BASED FOR ALL POINTS AND VARIABLES SHALL BE COORDINATED WITH OWNER.

3. FAIL-SAFE POSITIONS ARE POSITION THAT DEVICES WILL GO TO WHEN DE-ENERGIZED. NO = NORMALLY OPEN, NC = NORMALLY CLOSED.

4. WHENEVER THE UNIT IS OFF PER THE CONTROL SYSTEM OR MAIN POWER IS DISCONNECTED, THE CONTROL DEVICES FOR THE UNIT SHALL GO TO THEIR FAIL-SAFE POSITION.

5. AIR FLOW MEASURING STATION (FMS) SHALL BE USED TO MONITOR AND DISPLAY OUTSIDE AIR, SUPPLY AIR, AND RETURN AIR VOLUMES ON ATTENDED WORKSTATIONS AND AT THE CONTROL SYSTEM CONTROLLER VIA TRANSDUCERS. FMS AND FLOW SHALL BE USED BY THE CONTROL SYSTEM TO REACH RETURN FAN WITH THE SUPPLY FAN TO PROPORTION THE SPACE AND ENSURE MINIMUM OUTSIDE AIR VOLUMES FOR VENTILATION IS MAINTAINED.

B. SAFETIES

1. THE FOLLOWING SAFETIES, EACH WITH ITS OWN MANUAL RESET BUTTON, SHALL SHUT DOWN UNIT AND THE CONTROL SYSTEM SHALL REMAIN RESPECTIVE ALARM.

a. SUPPLY SMOKE DETECTOR AND/OR RETURN SMOKE DETECTOR (SD) IS ACTIVATED. SMOKE DETECTORS SHALL BE FURNISHED AND WIRED TO THE FIRE ALARM SYSTEM BY SECTION 16000. A/C CONTRACTOR SHALL INSTALL DETECTORS AND WIRE TO CONTROL SYSTEM.

b. FREEZESTAT (FS) INDICATES AIR TEMPERATURE AT STAT HAS DROPPED BELOW 38°. CHILLED WATER CONTROL VALVE AND HOT WATER CONTROL VALVE SHALL FULLY OPEN, HOT WATER FREEZE PROTECTION PUMP SHALL START.

c. FREEZE PUMP FAILS AS SENSED BY CURRENT TRANSDUCER WHEN OUTSIDE AIR TEMPERATURE IS BELOW 38°F.

d. DISCHARGE STATIC PRESSURE HIGH LIMIT (DPH) INDICATES MORE THAN 4 1/2 " W.G. WHEN THE UNIT STATUS IS ON (WITH A 3 MINUTE DELAY).

e. RETURN STATIC PRESSURE LOW LIMIT (DPL) INDICATES LESS THAN -2 1/2" INDICATING STATIC PRESSURE WHEN THE UNIT STATUS IS ON (WITH A 3 MINUTE DELAY).

f. THE CONTROL SYSTEM SHALL INITIATE AN ALARM, DESCRIBING THE ALARM IF ANY OF THE FOLLOWING CONDITIONS ARE MET:

a. SUPPLY OR RETURN FAN(S) ARE COMMANDED TO RUN AND ANYTIME AFTER A 10 SECOND DELAY THE CONTROL SYSTEM SENSES NO STATUS VIA THE FANS CURRENT TRANSFORMER RELAYS (CTR).

b. FILTER DIFFERENTIAL PRESSURE SWITCH (TYPE) SENSES GREATER THAN 0.8" W.G. FOR 10 MINUTES.

c. DISCHARGE AIR TEMPERATURE SENSOR (SAT) GOES 5 DEGREES BELOW THE MINIMUM COOLING DISCHARGE AIR SETPOINT FOR 10 MINUTES WHEN STATUS IS ON.

d. ALL CONTROL SYSTEM SENSORS SHALL HAVE A HIGH AND LOW SOFTWARE ALARM LIMIT TO INDICATE TEMPERATURE PROBLEMS OR A FAULTY SENSOR.

e. WHENEVER A LIMIT IS SHUT DOWN BECAUSE OF ONE OF THE SAFETIES, THE CONTROL SYSTEM SHALL REMAIN IN MEMORY THE REASONS AND SETPOINT OF EACH DEVICE TO HELP THE OPERATOR IN BALANCING THE REASON FOR THE SHUTDOWN.

C. VENTILATION AND VOLUMETRIC CONTROL

1. THE CONTROL SYSTEM SHALL MEASURE OUTSIDE AIR VOLUMES THROUGH THE AIR FLOW MEASURING STATION (FMS) DURING OCCUPIED CYCLE. THE BMS SHALL MODULATE EXHAUST AIR, OUTSIDE AIR, AND RETURN AIR DAMPERS TO MAINTAIN VENTILATION AIR VOLUME (CFM) REQUIREMENTS AS LISTED IN THE AHU SCHEDULES. DURING WARM UP AND UNOCCUPIED CYCLES VENTILATION CFM SHALL BE ZERO.

2. THE CONTROL SYSTEM SHALL MEASURE SUPPLY AND RETURN AIR VOLUMES THROUGH SUPPLY AND RETURN AIR FLOW MEASURING STATIONS (FMS). DURING OCCUPIED CYCLE THE CONTROL SYSTEM SHALL MODULATE RETURN FAN VFD SO THAT THE AIR VOLUME (CFM) DIFFERENTIAL WITH SUPPLY AIR VOLUME IS EQUAL TO THE DIFFERENCE AS SCHEDULED (200 CFM).

D. FREEZE PROTECTION PUMP

1. WHEN OUTSIDE AMBIENT AIR TEMPERATURE DROPS BELOW 40°F AS SENSED BY OUTSIDE AIR THERMOSTAT, THE FREEZE PROTECTION PUMP SHALL BE ENERGIZED AND OPERATE CONTINUOUSLY. WHEN OUTSIDE AMBIENT AIR TEMPERATURE RISES ABOVE 40°F FOR 10 CONSECUTIVE MINUTES, FREEZE PROTECTION PUMP SHALL BE DEENERGIZED.

E. OCCUPIED MODE

1. UPON START UP COMMAND, SUPPLY AND RETURN SMOKE ISOLATION DAMPERS SHALL OPEN. ONCE SMOKE ISOLATION DAMPERS ARE PROVED OPEN, THE UNIT FANS SHALL START WITH THEIR RESPECTIVE VARIABLE FREQUENCY DRIVES (VFD) AT MINIMUM SPEED. THE RETURN FAN SHALL START FIRST FOLLOWED BY THE SUPPLY FAN IN 15 SECONDS. AFTER A 30 SECOND DELAY, THE SUPPLY AND RETURN FANS SHALL RUN CONTINUOUSLY UNDER VENTILATION AND VOLUMETRIC CONTROL AS STATED ABOVE WITH THE SUPPLY FAN VFD CONTROLLED BY SPACE THERMOSTAT/TEMPERATURE SENSOR. AFTER A SECOND 30 SECOND DELAY, THE OUTDOOR AIR DAMPERS SHALL BE ALLOWED TO OPEN TO THEIR MINIMUM POSITION DURING OCCUPIED MODE ONLY).

2. THE CONTROL SYSTEM SHALL HAVE ENTHALPY BASED ECONOMIZER CYCLE. DDC SYSTEM SHALL COMPARE OUTSIDE AIR ENTHALPY WITH RETURN AIR ENTHALPY (CALCULATED BY DDC SYSTEM USING TEMPERATURE AND HUMIDITY). WHEN OUTSIDE AIR ENTHALPY IS LESS THAN RETURN AIR ENTHALPY, ENTHALPY ECONOMIZER WILL BE AVAILABLE. WHEN ENTHALPY ECONOMIZER IS AVAILABLE, DDC SYSTEM SHALL MODULATE RETURN/EXHAUST/OUTDOOR AIR DAMPERS TO MAINTAIN DAT SETPOINT. WHEN OUTSIDE AIR ENTHALPY EXCEEDS RETURN AIR ENTHALPY, DDC SYSTEM SHALL DISENGAGE ECONOMIZER MODE, AND ADJUST RETURN AIR, EXHAUST AIR, OUTSIDE AIR DAMPERS AND MODULATE CHILLED WATER COIL CONTROL VALVE TO MAINTAIN DAT SETPOINT.

a) UNITS SUPPLY AND RETURN SMOKE ISOLATION DAMPERS SHALL OPEN. ONCE SMOKE ISOLATION DAMPERS ARE PROVED OPEN, FANS(S) SHALL START WITH THEIR RESPECTIVE VFD'S AT MINIMUM SPEEDS.

b) DISCHARGE AIR SENSOR SHALL MODULATE HEATING CONTROL VALVE TO MAINTAIN DISCHARGE AIR SETPOINT OF 59° F.

c) INDEPENDENT CYCLE OUTSIDE AIR AND RELIEF OR EXHAUST DAMPERS SHALL BE FULLY CLOSED. RETURN DAMPERS SHALL BE FULLY OPEN.

4. WHEN TEMPERATURE AT SPACE THERMOSTAT/TEMPERATURE SENSORS RISE TO 78 DEGREES UNIT SHALL SHUTDOWN.

5. IF SPACE THERMOSTAT/ TEMPERATURE SENSOR IS CALLING FOR HEAT AFTER A 3° DEADBAND, THE COOLED COIL VALVE SHALL BE CLOSED. THE SUPPLY AND RETURN FAN VFD'S SHALL BE AT THEIR MINIMUM SPEEDS. THE HOT WATER COIL VALVE SHALL MODULATE TO MAINTAIN SAT SETPOINT AS REQUIRED TO SATISFY THE SPACE THERMOSTAT/ TEMPERATURE SENSOR. IF THE HOT WATER COIL VALVE IS OPEN MORE THAN THE SPACE TEMPERATURE SETPOINT IS NOT SATISFIED, THE SUPPLY AND RETURN FAN VFD'S SHALL MODULATE FROM MINIMUM TO MAXIMUM SPEED TO SATISFY THE SPACE THERMOSTAT/ TEMPERATURE SENSOR SETPOINT.

F. UNOCCUPIED CYCLE

1. UNITS SHALL NORMALLY BE OFF.

2. WHEN UNIT IS OFF MIXED AIR TEMPERATURE SENSOR (MAT) SHALL MODULATE HEATING COIL CONTROL VALVE AS REQUIRED TO LIMIT TEMPERATURE AT MAT TO 55°F.

3. WHEN TEMPERATURE AT SPACE THERMOSTAT/TEMPERATURE SENSORS GOES BELOW ITS SETBACK SETPOINT OF 55° F, THE FOLLOWING SHALL HAPPEN IN SEQUENCE:

a) UNITS SUPPLY AND RETURN SMOKE ISOLATION DAMPERS SHALL OPEN. ONCE SMOKE ISOLATION DAMPERS ARE PROVED OPEN, FANS(S) SHALL START WITH THEIR RESPECTIVE VFD'S AT MINIMUM SPEEDS.

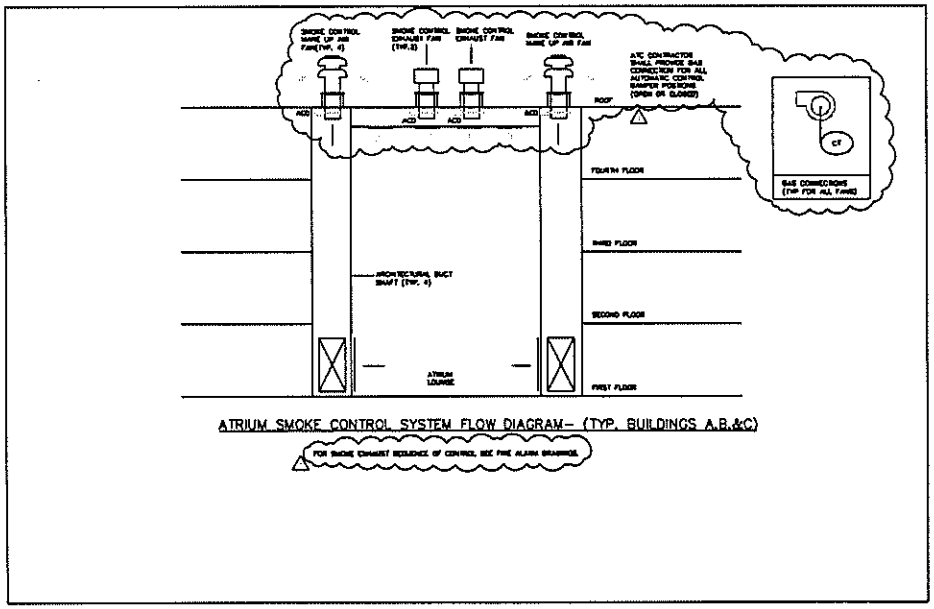
b) DISCHARGE AIR SENSOR SHALL MODULATE HEATING CONTROL VALVE TO MAINTAIN DISCHARGE AIR SETPOINT OF 59 DEGREES.

c) THROUGHOUT CYCLE OUTSIDE AIR AND RELIEF OR EXHAUST DAMPERS SHALL BE FULLY CLOSED RETURN DAMPERS SHALL BE FULLY OPEN.

d) AFTER STARTING IN WARMUP CYCLE, UNIT SHALL RUN FOR AT LEAST 15 MINUTES BEFORE STOPPING REGARDLESS OF SPACE TEMPERATURE SHALL AFTER STOPPING UNIT SHALL REMAIN OFF FOR AT LEAST 15 MINUTES BEFORE RESTARTING.

4. WHEN ALL OF THE SENSORS ARE WITHIN ONE DEGREE OF OCCUPIED HEATING SETPOINT AND/OR OCCUPIED CYCLE HAS BEEN ENCOUNTERED, THE UNITS SHALL GO TO OCCUPIED MODE.

AIR HANDLING UNITS (RTU-1, 2, 3) FLOW DIAGRAM AND CONTROL SEQUENCE



ATRIUM SMOKE CONTROL SYSTEM FLOW DIAGRAM- (TYP. BUILDINGS A,B,&C)

FOR SMOKE EXHAUST SEQUENCE OF CONTROL SEE FIRE ALARM DRAWINGS

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274 Summer Street - Boston, MA 02210

UNIVERSITY OF Rhode Island

NEW STUDENT HOUSING

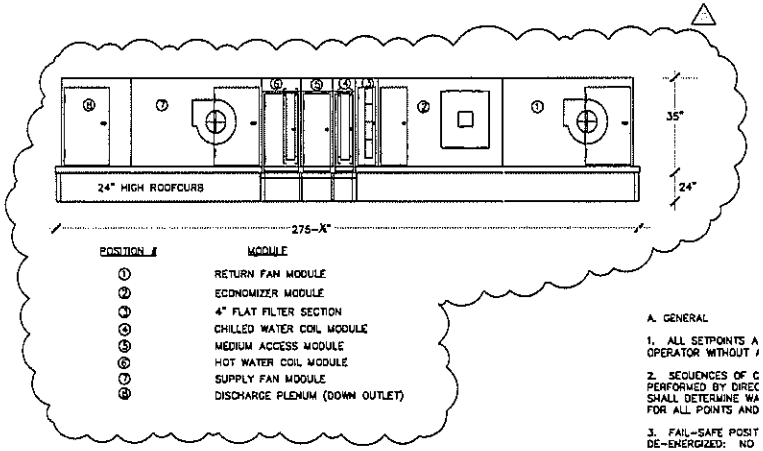
Kingston, RI 02881

7-29-05 Issue for Construction

HVAC FLOW DIAGRAMS AND CONTROLS SHEET 9

July 29, 2005

H608



ROOF TOP AIR HANDLING UNIT CONFIGURATION (RTU-1A,1B,1C)

NTS

A. GENERAL

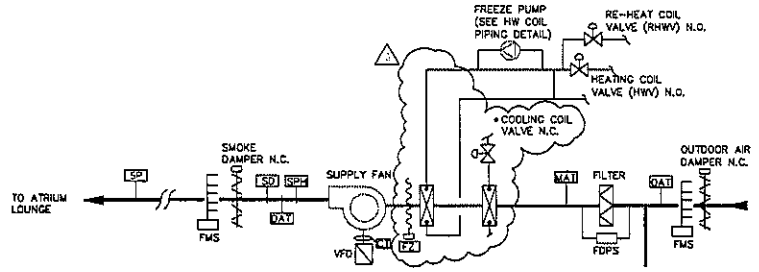
1. ALL SETPOINTS A
OPERATOR WITHOUT

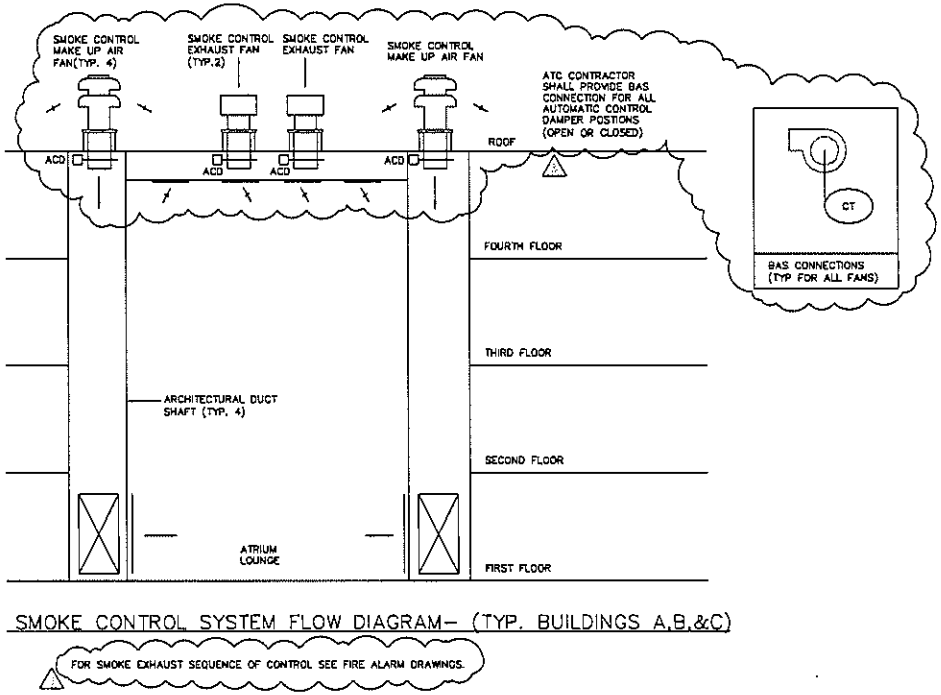
2. SEQUENCES OF C
PERFORMED BY DIREC
SHALL DETERMINE WA
FOR ALL POINTS AND

3. FAIL-SAFE POSIT
DE-ENERGIZED: NO

4. WHENEVER THE U
DISCONNECTED, THE
FAIL-SAFE POSITION.

5. AIR FLOW MEASU
OUTSIDE AIR, SUPPLY





SMOKE CONTROL SYSTEM FLOW DIAGRAM- (TYP. BUILDINGS A,B,&C)

FOR SMOKE EXHAUST SEQUENCE OF CONTROL SEE FIRE ALARM DRAWINGS.

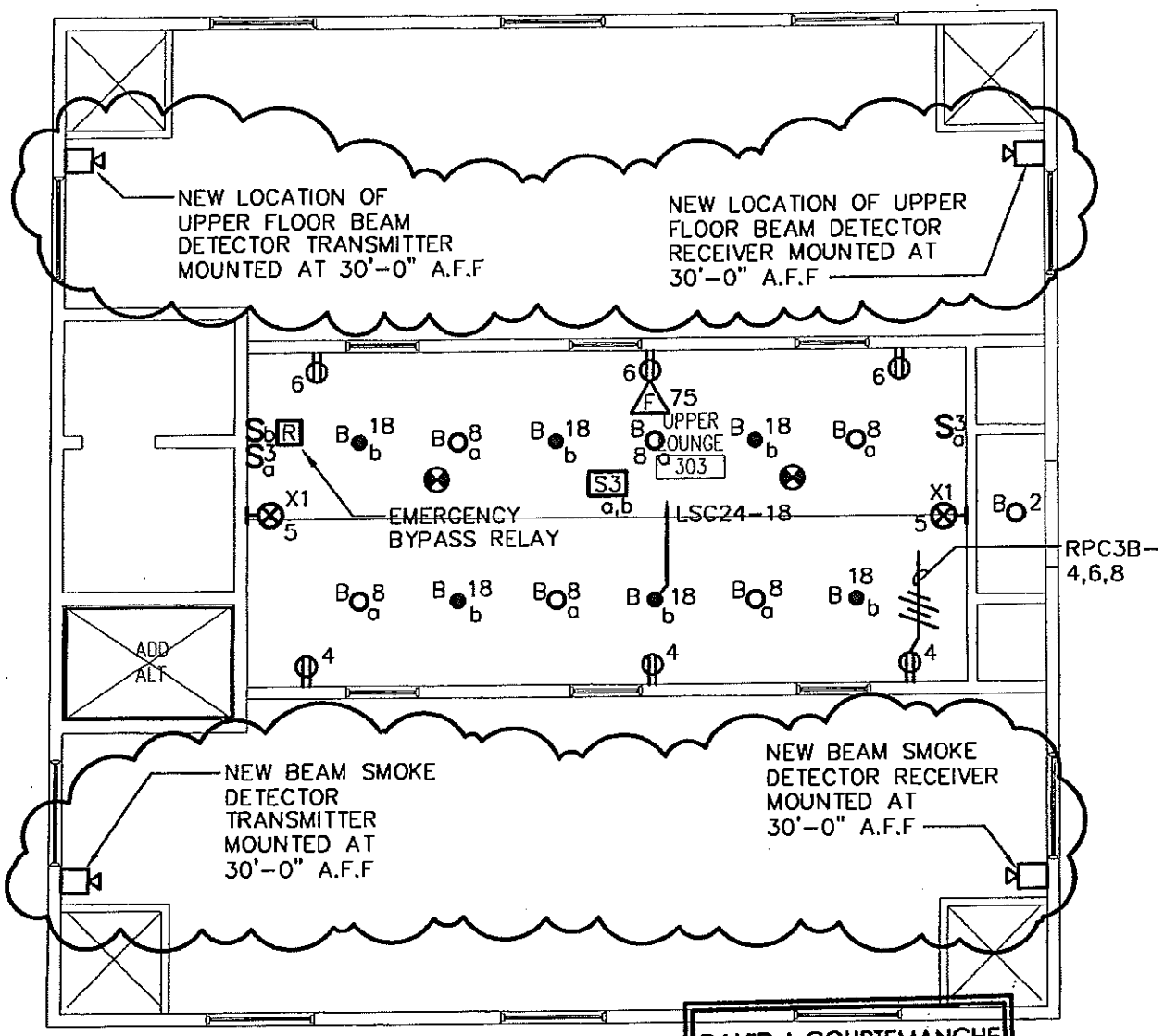
R.G. Vanderweil Engineers, Inc.
274 Summer Street - Boston, MA 02210

The SILIAIM Collaborative
Glastonbury, CT
Tel. 860 657-8077
Fax 860 657-3141

HVAC CONTROLS

University of Rhode Island
NEW STUDENT HOUSING
LOI# B03178

Scale:	NTS
Reference:	H608
Date:	09/30/05
Proj. No.	22562.00
Sketch No:	SKH3.21
	ADDENDUM #3



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No. 7733

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BUILDING C FIRE ALARM REVISION

University of Rhode Island
NEW STUDENT HOUSING
LOI# B03178

Scale:	NTS
Reference:	
Date:	12/01/06
Proj. No.	2256200

Sketch No: **SKE-76**

TEST REPORT

Gilbane

Transmittal Cover Sheet

Detailed, Grouped by Each Transmittal Number

URI New Student Housing | **Project # 113607000** Tel: Fax: | **Gilbane Building Company**

Date: 4/26/2007 **Reference Number: 0127**

Transmitted To:	Transmitted By:
Clapp, Charles R.G. Vanderweil Engineers 274 Summer Street Boston, MA 02210-1123 Tel: 617-423-7423 Fax: 617-956-4864	Morin, David Gilbane Building Company University of Rhode Island Gilbane c/o Postal Services, 6 Garage Road Kingston, RI 02881 Tel: Fax: 401-874-5784

☐ **Acknowledgement Required**

Package Transmitted For:	Delivered Via:	Tracking Number:
Information,	Email	

Item #	Qty	Item	Reference	Description	Notes	Status
001	1	Inspections and Tests	C041-R1 - Atrium Smoke Exhaust	Smoke Exhaust	Inspections and Tests C041-R1 - Atrium Smoke Exhaust	

Cc: Company Name	Contact Name	Copies	Notes
SEI Companies	Goossens, Robert	1	

Remarks

Please find attached a revised Atrium Smoke Exhaust test for Building C.

Signature

4/26/07

Signed Date

Gilbane

Inspections and Tests

Detailed, Grouped by Each Inspection Number

URI New Student Housing | **Project # 113607000** | **Gilbane Building Company**
Tel: Fax:

Number: C041-R1 **Date: 4/20/2007 12:00:00AM**

Installing Company:	Delta Mechanical - Smith, John	**Spec Section:**	15000
Inspecting Company:	SEI Companies - Goossens, Robert	**Sub Section:**	3.1.C
QC Company:	Gilbane Building Company - Morin, David	**Actual Start Time:**	12:30 PM
Accepting Company:	University of Rhode Island - DePace, Paul	**Actual Finish Time:**	02:30 PM

Description	System	Status
Atrium Smoke Exhaust	Smoke Exhaust	Completed

Location	Category	Witnesses
Building C Atrium	Systems Testing	

Test Results:

Conforming Notes: **Non Conforming Notes:**

Notes:

Velocities measured at Make-up Air Grilles= 182 FPM (averaged across each face of each plenum and transfer opening).
Velocities at SEF Fans= 2,395 FPM

Total Make-up Air= 47,041 CFM
Total Exhaust Air= 47,386 CFM
Total Diferential= -345

Wind northwest at 15 mph
Outside air at 63 degrees
Indoor air at 74 degrees

Alarm initiation, damper opening sequence, alarm shutdown monitored.

Door opening forces measured at:
Entry Vestibule- 9 lbs
Corridor #111- 11 lbs
Corridor #131- 11 lbs

Signature

4/26/07
Signed Date

West Side Residence
NSH-Bldg C

Smoke Management System
Fan Performance

	Measurement:			Design:	Δ
Exhaust Fan #1					
Enter Fan Duct Diameter	42.5 inches				
Enter Velocity Measured	2425 FPM				
		Duct Radius =	21.25 inches		
		Duct Area =	9.85 Sq Ft		
		Fan Output =	23,890 CFM	23,500 CFM	390.10
Exhaust Fan #2					
Enter Fan Duct Diameter	42.5 inches				
Enter Velocity Measured	2385 FPM				
		Duct Radius =	21.25 inches		
		Duct Area =	9.85 Sq Ft		
	2405 (Average)	Fan Output =	23,496 CFM	23,500 CFM	-3.96
Plenum Output					
SMAU-1					
Enter Velocity Measured	150 FPM	Face Grille Area =	36.42 Sq Ft		
	183 FPM	Side Grille #1 Area =	14.25 Sq Ft		
	190 FPM	Side Grille #2 Area =	14.25 Sq Ft		
	113 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
	129 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
		Fan Output =	11,640 CFM	11,750 CFM	-109.69
SMAU-2					
Enter Velocity Measured	144 FPM	Face Grille Area =	36.42 Sq Ft		
	185 FPM	Side Grille #1 Area =	14.25 Sq Ft		
	197 FPM	Side Grille #2 Area =	14.25 Sq Ft		
	150 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
	190 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
		Fan Output =	11,836 CFM	11,750 CFM	85.86
SMAU-3					
Enter Velocity Measured	139 FPM	Face Grille Area =	36.42 Sq Ft		
	185 FPM	Side Grille #1 Area =	14.25 Sq Ft		
	195 FPM	Side Grille #2 Area =	14.25 Sq Ft		
	200 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
	172 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
		Fan Output =	11,727 CFM	11,750 CFM	-22.96
SMAU-4					
Enter Velocity Measured	145 FPM	Face Grille Area =	36.42 Sq Ft		
	194 FPM	Side Grille #1 Area =	14.25 Sq Ft		
	184 FPM	Side Grille #2 Area =	14.25 Sq Ft		
	190 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
	200 FPM	Transfer Opening (2) Area =	1.33 Sq Ft		
		Fan Output =	11,838 CFM	11,750 CFM	87.59
	182.6 (Average)	Total Exhaust =	47,386 CFM	47,000 CFM	386.14
		Total Make-Up Air =	47,041 CFM	47,000 CFM	40.79
				Total Δ	-345

Gilbane

Inspections and Tests

Detailed, Grouped by Each Inspection Number

URI New Student Housing	Project # 113607000 Tel: Fax:	Gilbane Building Company

Number: C041 **Date: 1/16/2007 12:00:00AM**

Installing Company:	Delta Mechanical - Smith, John	**Spec Section:**	15000
Inspecting Company:	SEI Companies - Goossens, Robert	**Sub Section:**	3.1.C
QC Company:	Gilbane Building Company - Morin, David	**Actual Start Time:**	10:30 AM
Accepting Company:	University of Rhode Island - DePace, Paul	**Actual Finish Time:**	02:30 AM

Description	System	Status
Atrium Smoke Exhaust	Smoke Exhaust	Completed

Location	Category	Witnesses
Building C Atrium	Systems Testing	D. Morin/GBCO H. Vasquez/GBCO R. Sitnik/GBCO R. Goosens/SEI M. Suriani/URI

Test Results:

Conforming Notes: **Non Conforming Notes:**

Notes:

Velocities measured at MAU Grilles= 176 FPM averaged across each face of each plenum.
Velocities at each SEF= 3,000 FPM at SEF-1C, 2850 FPM at SEF-2C

Total Make-up Air= 42,003 CFM
Total Exhaust Air= 57,623 CFM

Wind northwest at 12 mph
outside air at 33 degrees
indoor air at 68 degrees

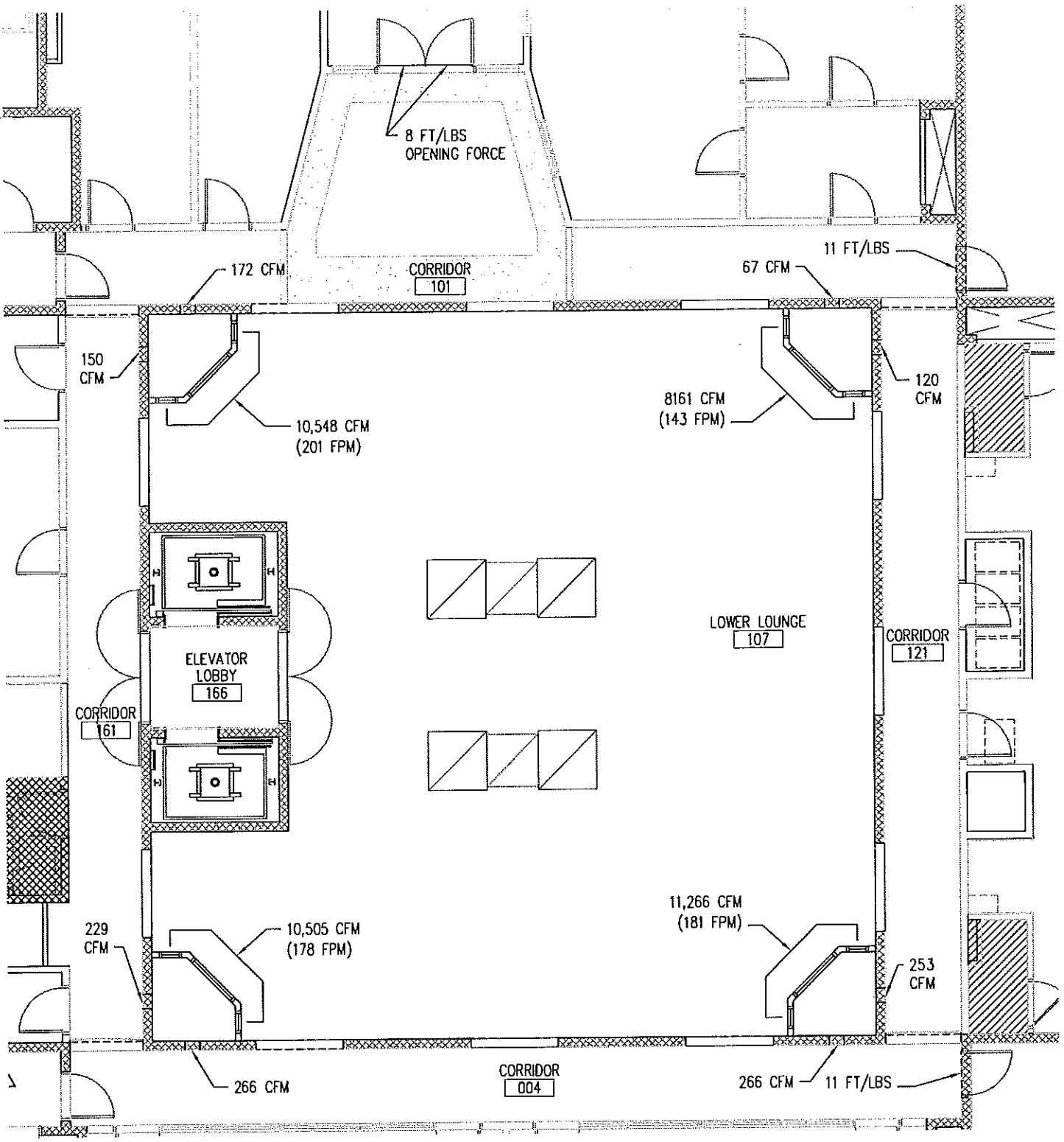
Alarm initiation, damper opening sequence, alarm shutdown monitored.

Door opening forces measured at:
Entry Vestibule- 8 lbs
Corridor #111- 11 lbs
Corridor #131- 11 lbs

REVISED - SEE REPORT C041-R1

Signature

1/16/07
Signed Date



BUILDING C

SMOKE EVACUATION AIR FLOW VALUES

SIZE	CODE IDENT.	DRAWING NUMBER	REVISION
A		SK-M-008	0
SCALE: NTS		DATE: 01/16/07	SH. OF

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION 0 DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System-Exhaust Fan

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building C-Roof mounted smoke exhaust fans
Applicable Specifications: 15600-2.36	Applicable Drawings/Details: CH106, SK-M-005

Equipment Designation: SEF-1C

Manufacturer: Cook

Model: 300QMXU

Serial No.: 010S890192-00/0007206

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	23500	Horsepower	25
RPM	1274	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION 0 DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System-Exhaust Fan

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building C-Roof mounted smoke exhaust fans
Applicable Specifications: 15600-2.36	Applicable Drawings/Details: CH106, SK-M-005

Equipment Designation: SEF-2C

Manufacturer: Cook

Model: 300QMXU

Serial No.: 010S890192-00/0007201

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	23500	Horsepower	25
RPM	1274	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION **Start-Up Walk-Down Inspection**	**REVISION 0** DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System Make-up Air

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique

Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By	Building C-Roof mounted smoke exhaust system make-up air fans
Bldg. Area/Level/Rm(s)/CL	
(Attach marked-up drawings)	

Applicable Specifications: 15600-2.36	Applicable Drawings/Details: CH106, SK-M-005

Equipment Designation: SMAU-1C

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-00/0009212

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION 0 DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System Make-up Air

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building C-Roof mounted smoke exhaust system make-up air fans

Applicable Specifications: 15600-2.36

Applicable Drawings/Details: CH106, SK-M-005

Equipment Designation: SMAU-2C

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-00/0009204

Equipment Data:

Fan Data		Motor Data	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION Start-Up Walk-Down Inspection	REVISION 0 DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System Make-up Air

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building C-Roof mounted smoke exhaust system make-up air fans
Applicable Specifications: 15600-2.36	Applicable Drawings/Details: CH106, SK-M-005

Equipment Designation: SMAU-3C

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-00/0009203

Equipment Data:

Fan Data		**Motor Data**	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

URI-NSH	QUALITY IN CONSTRUCTION **Start-Up Walk-Down Inspection**	**REVISION 0** DATE:12/18/06

Building Number: **New Residence Hall**

Building Name: **Building C**

Description of Equipment/System(s): Atrium Smoke Exhaust System Make-up Air

Proposed Start-Up Date: 1/6/07	
Date/Time of Inspection: 1/6/07	Trade Contractor(s): Delta Mechanical/Unique
Description of work to be completed before turnover	Atrium Smoke Exhaust Test
Location of Inspection By Bldg. Area/Level/Rm(s)/CL (Attach marked-up drawings)	Building C-Roof mounted smoke exhaust system make-up air fans
Applicable Specifications: 15600-2.36	Applicable Drawings/Details: CH106,SK-M-005

Equipment Designation: SMAU-4C

Manufacturer: Cook

Model: 225QMXS

Serial No.: 010S890192-00/0009202

Equipment Data:

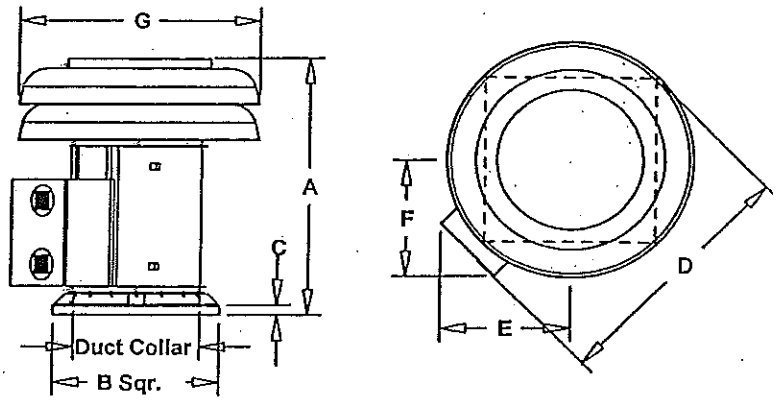
Fan Data		**Motor Data**	
Design CFM	11750	Horsepower	10
RPM	1603	Power	460/3/60hz
		RPM	1725

COOK

MARK:	SMUA-1A TO 4C
PROJECT:	URI STUDENT HOUSIN
DATE:	01-05-2006

QMXS

Mixed-Flow Supply Blower
Low Pressure
Belt Drive
Arrangement 9



STANDARD CONSTRUCTION FEATURES:

High efficiency mixed flow wheel - Continuously welded steel housing with Lorenized powder coating - Welded aerodynamic straightening vanes - Spun aluminum top cap - Integral curb cap - Adjustable motor plate utilizing threaded studs for positive belt tensioning - Weather cover - Heavy duty ball or roller bearings with copper extended lube lines - Lifting lugs - Access door - Belt tunnel.

Performance

Qty	Catalog Number	Flow (CFM)	SP (inwc)	Fan RPM	Bhp (HP)
12	225QMXS	11750	2.50	1603	7.12

Altitude (ft): 62 Temperature (F): 70

Motor Information

HP	RPM	Volts/Ph/Hz	Enclosure	Mounted
10	1725	460/3/60	ODP -PE	Yes

Motor efficiency exceeds EPACT requirements

Sound Data 8 Octave Bands dB (10^{-12} Watts)

	1	2	3	4	5	6	7	8	LwA
Inlet	84	87	83	84	82	80	77	74	87
Outlet	87	88	89	88	85	81	78	75	90

Dimensions (inches)

A	79-9/16
B Sqr.	43
C	3
D	68-1/8
E	35-1/2
F	33
G	62-5/8
Duct Collar	31-15/16
Unit Wt(lbs)***	1106

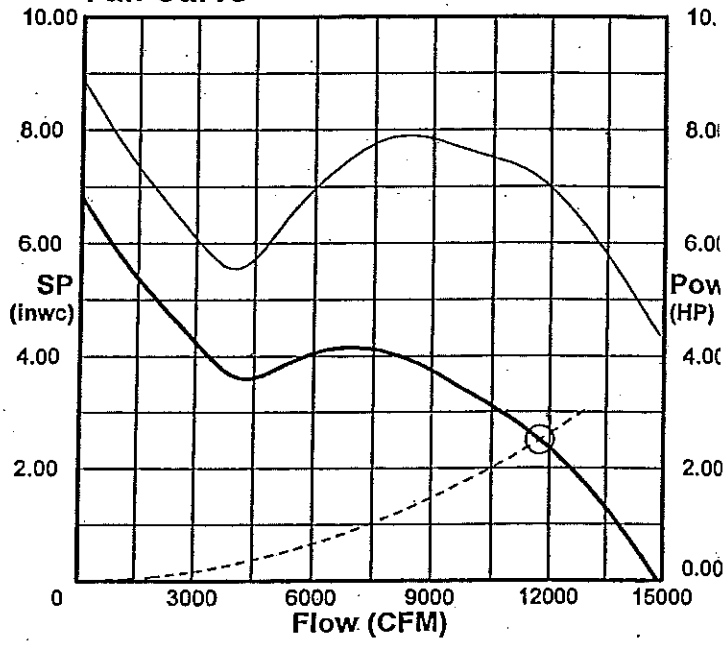
***Includes fan, motor & accessories.

Accessories:

Premium Efficiency Motor (Min. 91.7%)
STD DISCONNECT NEMA 3
ROOF CURB RCG 41-13.5H
ACCESS DOOR-HINGED
DRAIN
UNIT INCL 200K BRGS
ANTICONDENSATE COAT

SF x RPM

Fan Curve



Fan Curve Legend

CFM vs SP	———
CFM vs HP	———
System Curve	- - - - -
Point of Operation	○

COOK

c UL us

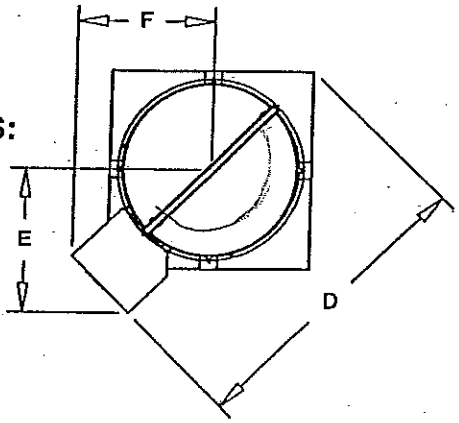
MARK:	SMOKE EF-1A TO 2C
PROJECT:	URI STUDENT HOUSIN
DATE:	01-05-2006

QMXU

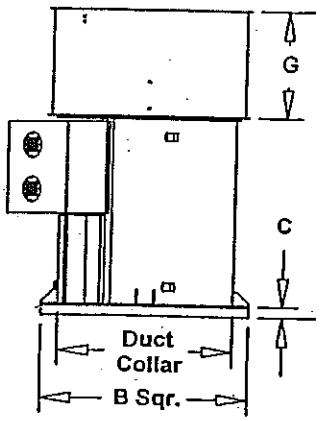
Mixed-Flow Upblast Blower
Low Pressure
Belt Drive

STANDARD CONSTRUCTION FEATURES:

High efficiency mixed flow wheel - Continuously welded steel housing with Lorenized powder coating - Welded aerodynamic straightening vanes - Butterfly dampers and windband - Integral curb cap - Adjustable motor plate utilizing threaded studs for positive belt tensioning - Weather cover - Heavy duty ball or roller bearings with copper extended lube lines - Lifting lugs - Drain - Access door - Enclosed belt tunnel.



Top View



Side View

Performance

Qty	Catalog Number	Flow (CFM)	SP (inwc)	Fan RPM	Bhp (HP)
6	300QMXU	23500	2.00	1274	12.3

Altitude (ft): 62 Temperature (F): 70

Motor Information

HP	RPM	Volts/Ph/Hz	Enclosure	Mounted
25	1725	460/3/60	ODP -PE	Yes

Motor efficiency exceeds EPACT requirements

Sound Data 8 Octave Bands dB (10^{-12} Watts)

	1	2	3	4	5	6	7	8	LWA
Inlet	83	88	89	86	85	83	79	71	90
Outlet	88	91	95	93	90	86	81	74	95

Dimensions (inches)

A	90-1/4
B Sqr.	54
C	3
D	82
E	40
F	37-5/8
G	30-1/2
Duct Collar	42-1/2
Unit Wt(lbs)***	1783

***Includes fan, motor & accessories.

Accessories:

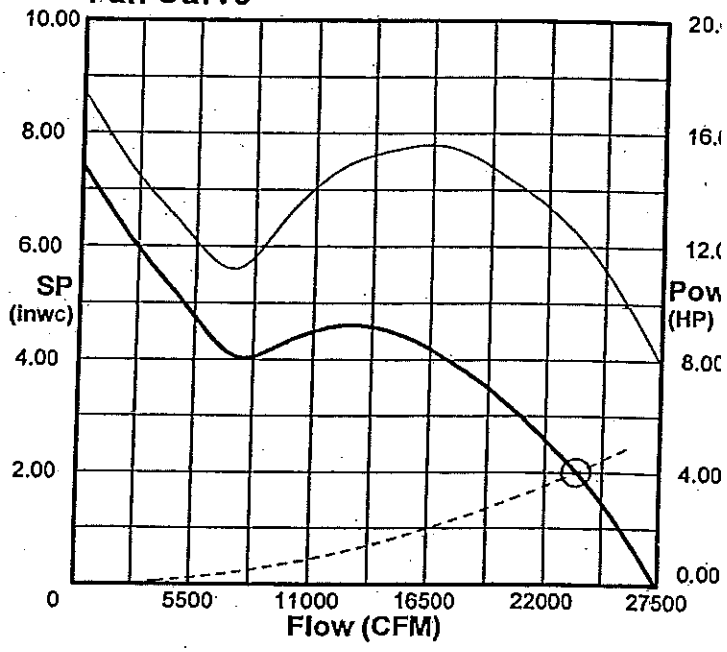
Premium Efficiency Motor (Min. 93.6%)
ROOF CURB RCGH 52-13.5H
UL762 (327Y-300DEG)
ACCESS DOOR-HINGED
FLANGED INLET-STL
HEAT SHIELD
RUB RING/SHAFT SEAL
ALUMINUM DAMPER DOOR
ANTICONDENSATE COAT

10,325F

22034cfm

Provide disconnect

Fan Curve



Fan Curve Legend

CFM vs SP	———
CFM vs HP	———
System Curve	- - - - -
Point of Operation	○

Operation & Maintenance Data

COOK

QMX

Mixed Flow Inline

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

This publication contains the installation, operation and maintenance instructions for standard units of the *QMX-Mixed Flow Inline*.

- **QMX**
- **QMX-HP**
- **QMXE**
- **QMXS**
- **QMXE-HP**
- **QMXS-HP**
- **QMXU**
- **QMXU-HP**
- **QMXLE**
- **QMXLE-HP**

Carefully read this publication prior to any installation or maintenance procedure.

Loren Cook catalog, *QMX*, provides additional information describing the equipment, fan performance, available accessories, and specification data.

For additional safety information, refer to AMCA publication 410-96, *Safety Practices for Users and Installers of Industrial and Commercial Fans*.

All of the publications listed above can be obtained from Loren Cook Company by phoning (417)869-6474, extension 166; by FAX at (417)832-9431; or by e-mail at info@lorencook.com.

For information on special equipment, contact Loren Cook Company Customer Service Department at (417)869-6474.

Receiving and Inspection

Carefully inspect the fan and accessories for any damage and shortage immediately upon receipt of the fan.

- Turn the wheel by hand to ensure it turns freely and does not bind.
- Inspect inlet vane dampers (if supplied) for free operation of all moving parts.
- Record on the *Delivery Receipt* any visible sign of damage.

WARNING
This unit has rotating parts. Safety precautions should be exercised at all times during installation, operation, and maintenance.
ALWAYS disconnect power prior to working on fan.

Handling

Lift the fan by lifting lugs. Never lift by the shaft, motor, or housing.

Storage

If the fan is stored for any length of time prior to installation, completely fill the bearings with grease or moisture-inhibiting oil. Refer to *Lubricants* on page 6. Also, store the fan in its original crate and protect it from dust, debris and the weather.

- Cover the inlet and outlet, and belt tunnel opening to prevent the accumulation of dirt and moisture in the housing.
- Periodically rotate the wheel and operate inlet vane dampers (if supplied) to keep a coating of grease on all internal bearing parts.
- Periodically inspect the unit to prevent damaging conditions.

Personal Safety
Disconnect switches are recommended. Place the disconnect switch near the fan in order that the power can be safely cut off in case of an emergency, and in order that maintenance personnel are provided complete control of the power source.

Installation

QMX and QMX-HP can be mounted horizontally or vertically to a floor or a ceiling in various motor positions and discharges. QMXU, QMXU-HP, QMXE, QMXE-HP, QMXS and QMXS-HP are all designed to be roof mounted on typical roof curbs. The QMXLE or QMXLE-HP units, however, should not be mounted on sheet metal roof curbs, but supported by integral members of the roof structure, designed and constructed by others per local requirements and environments.

Most motors are shipped mounted on the fans with belts and drives installed. However, extremely heavy motors are shipped separately, and some motors are shipped separately due to height limitations. These motors and drives will require field installation.

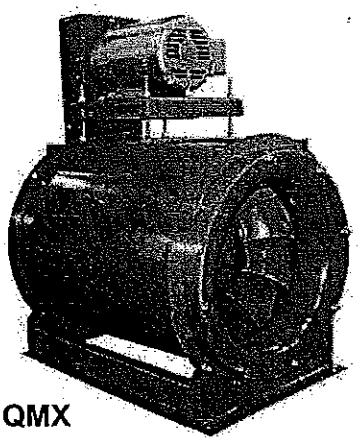
NOTE
Although a certain amount of vibration is present in operating fans, excessive vibration is a source of problems that may cause structural and mechanical failure.

Isolation Installation

To help prevent vibration and noise from being transferred to the building, isolators are recommended.

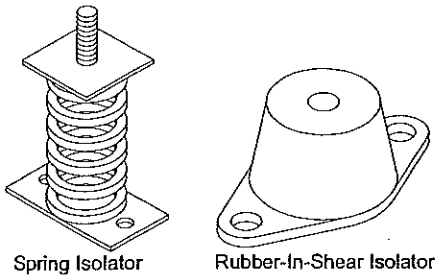
Floor Mounted Spring Isolators

a. Mount fan on isolation base or rails (if supplied).
b. Elevate fan (or isolation base) to operating height and insert blocks to hold in position.
c. Position isolators under the fan and vertically align by inserting leveling bolt through mounting holes in the fan or the base. The isolator must be installed on a level surface.



QMX

d. Adjust the isolators by turning the leveling nut counter clockwise several turns at a time alternately on each isolator until the fan weight is transferred onto the isolators and the fan raises uniformly off the blocks. Then remove the blocks.
e. Turn lock nut onto leveling bolt and secure firmly in place against the top of the mounting flange or frame.
f. Secure isolators to mounting surface.



Spring Isolator Rubber-In-Shear Isolator

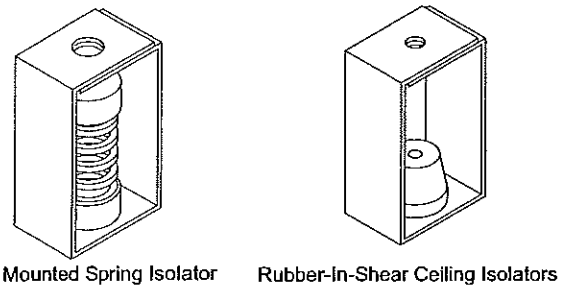
Figure 1 -Floor Mount Isolators

Floor Mounted Rubber-In-Shear (RIS) Isolators

a. Mount fan on isolation base or rails (if supplied).
b. Elevate fan to provide room to insert isolators between the fan and foundation and block in position.
c. Position isolators under fan and secure bolts.
d. Remove blocks and allow fan to rest on floor. Isolators must be installed on a level surface (leveling should not be required).
e. Secure isolators to mounting surface.

Ceiling Mounted Spring and Rubber-in-Shear (RIS) Isolators

a. Elevate fan to operating height and brace.
b. Attach threaded rod to overhead support structure directly above each mounting hole. Rod should extend to within a few feet of fan.
c. Attach isolator to end of threaded rod using a nut on each side of isolator bracket.
d. Insert another section of threaded rod through the fan mounting hole and isolator.
e. Attach two nuts to threaded rod in isolator.
f. Place adjusting nut and locking nut on threaded rod near fan mounting bracket.
g. Alternately rotate adjusting nut at each mounting location until the fan weight is uniformly transferred to the isolators. Remove bracing.



Ceiling Mounted Spring Isolator Rubber-In-Shear Ceiling Isolators

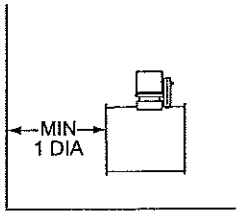
Figure 2 - Ceiling Mount Isolators

Duct Installation

Efficient fan performance relies on the proper installation of inlet and discharge ducts. Be sure your fan conforms to the guidelines below.

Non-Ducted Inlet Clearance

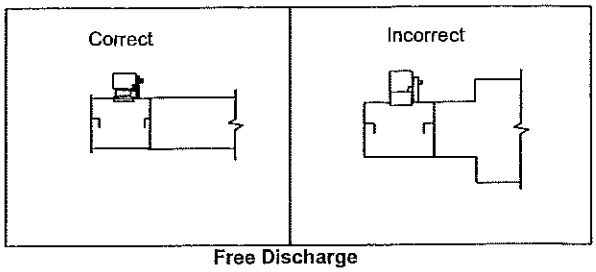
If your fan has an open inlet (no duct work), the fan must be placed 1 effective wheel diameter away from walls and bulkheads.



Non-ducted Inlet Clearance

Free Discharge

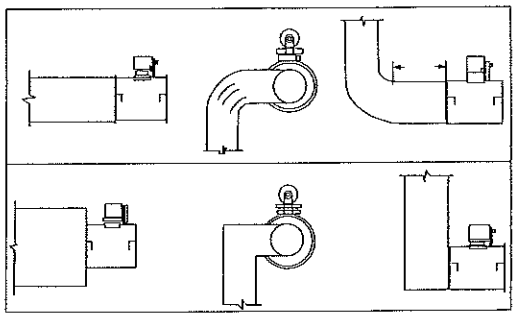
Avoid a free discharge into the plenum. This will result in lost efficiency because it doesn't allow for a static regain.



Free Discharge

Inlet Duct Turns

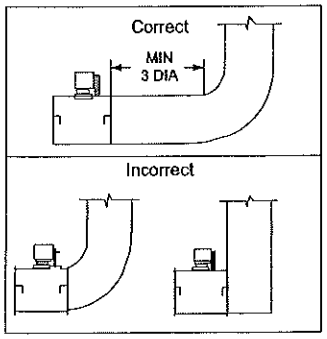
For ducted inlets, allow at least 3 effective wheel diameters between duct turns or elbows and the fan inlet.



Inlet Duct Turns

Discharge Duct Turns

Where possible, allow 3 duct diameters between duct turns or elbows and the fan outlet. Refer to the drawing below.



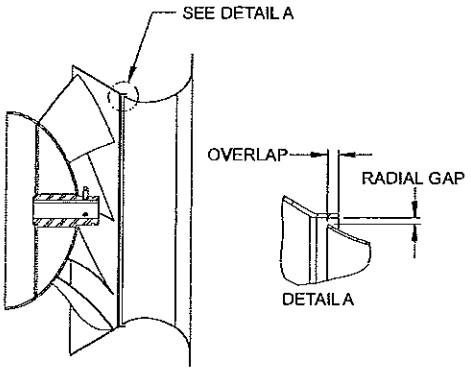
Discharge Duct Turns

Wheel-to-Inlet Clearance

The correct wheel-to-inlet clearance is critical to proper fan performance. This clearance should be verified before initial start-up since rough handling during shipment could cause a shift in fan components. Refer to wheel/inlet drawing below for correct overlap.

Adjust the overlap by loosening the wheel hub and moving the wheel along the shaft to obtain the correct value. Trim balance as necessary following procedure (.0785 in/sec max).

A uniform radial gap (space between the edge of the cone and the edge of the inlet) is obtained by loosening the inlet cone bolts and repositioning the inlet cone.



Wheel/Inlet Overlap

Unit Size	Over-lap
90	0.16
120	0.19
135	0.20
150	0.22
165	0.23
180	0.24
202	0.27
225	0.29
245	0.31
270	0.33
300	0.37
330	0.41
365	0.45
402	0.50
445	0.55
490	0.61
540	0.67
600	0.76

Belt and Pulley Installation

Belt tension is determined by the sound the belts make when the fan is first started. Belts will produce a loud squeal which dissipates after the fan is operating at full capacity. If the belt tension is too tight or too loose, lost efficiency and possible damage can occur.

Do not change the pulley pitch diameter to change tension. This will result in a different fan speed.

a. Loosen motor plate adjustment bolts and move motor plate in order that the belts can easily slip into the grooves on the pulleys. Never pry, roll, or force the belts over the rim of the pulley.
b. Adjust the motor plate until proper tension is reached. For proper tension, a deflection of approximately 1/4" per foot of center distance should be obtained by firmly pressing the belt. Refer to *Figure 3*.
c. Lock the motor plate adjustment nuts in place.
d. Ensure pulleys are properly aligned. Refer to *Figure 4*.

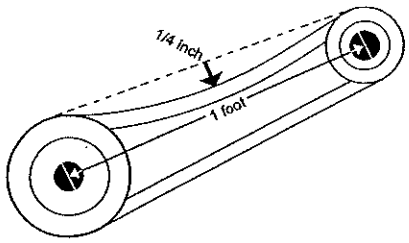


Figure 3

Pulley Alignment

Pulley alignment is adjusted by loosening the motor pulley setscrew and by moving the motor pulley on the motor shaft or by moving the entire motor along the motor mounting bracket.

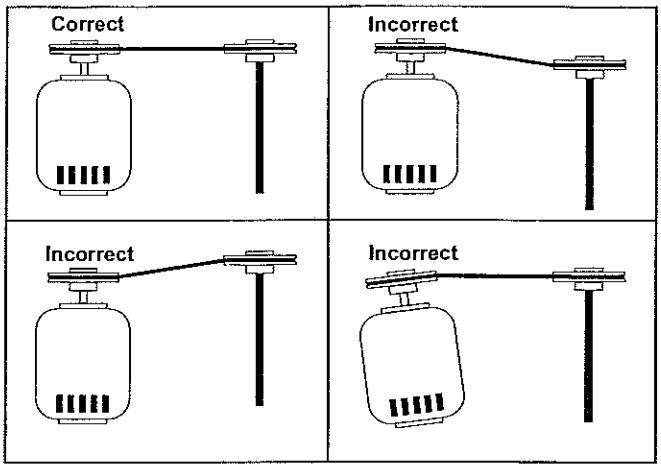


Figure 4

Figure 4 illustrates correct and incorrect pulley alignment. A recommended method of inspecting the pulley alignment is shown in *Figure 5*. With the shorter leg of a carpenter's square or other straight edge lying along the case of the motor, adjust the position of the motor pulley (or the motor until the longer leg of the square is parallel to the belt.

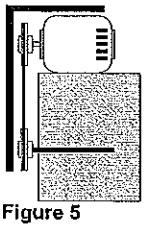


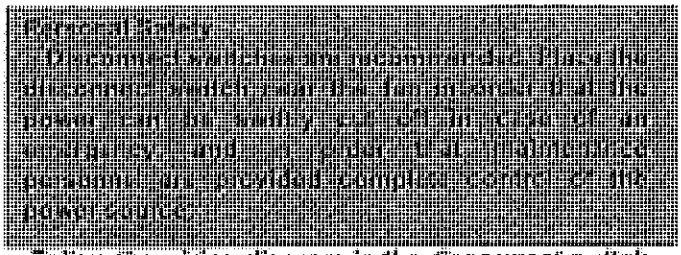
Figure 5

Wiring Installation

All wiring should be in accordance with local ordinances and the National Electrical Code, NFPA 70. Ensure the power supply (voltage, frequency, and current carrying capacity of wires) is in accordance with the motor nameplate.

Lock off all power sources before unit is wired to power source.

Leave enough slack in the wiring to allow for motor movement when adjusting belt tension. Some fractional motors have to be removed in order to make the connection with the terminal box at the end of the motor. To remove motor, remove bolts securing motor base to power assembly. Do not remove motor mounting bolts.



Follow the wiring diagram in the disconnect switch and the wiring diagram provided with the motor. Correctly label the circuit on the main power box and always identify a closed switch to promote safety (i.e., red tape over a closed switch).

Use of Variable Frequency Drives

Motors -

Motors that are to be operated using a Variable Frequency Drive (VFD) must be VFD compatible. At a minimum, this must be a Premium Efficiency motor with Class F insulation. Motors that are not supplied by Loren Cook Company should have the recommendation of the motor manufacturer for use with a VFD.

Grounding -

The fan frame, motor and VFD must be connected to a common earth ground to prevent transient voltages from damaging rotating elements.

Wiring -

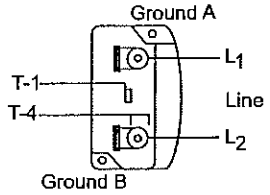
Line reactors may be required to reduce over-voltage spikes in the motors. The motor manufacturer should be consulted for recommended line impedence and usage of line reactors or filters, if the lead length between the VFD and the motor exceeds 10 feet (3m).

Fan -

It is the responsibility of the installing body to perform coast-down tests and identify any resonant frequencies after the equipment is fully installed. These resonant frequencies are to be removed from the operating range of the fan by using the "skip frequency" function in the VFD programming. Failure to remove resonant frequencies from the operating range will decrease the operating life of the fan and void the warranty.

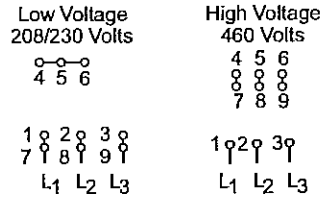
Wiring Diagrams

Single Speed, Single Phase Motor

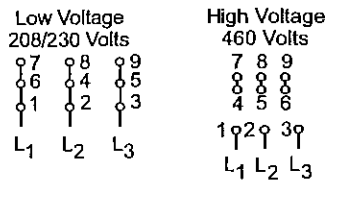


When ground is required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-1 and T-4.

3 Phase, 9 Lead Motor Y-Connection

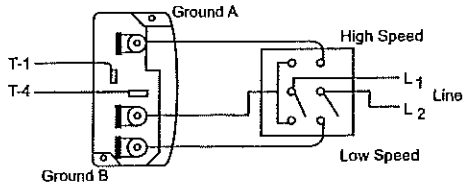


3 Phase, 9 Lead Motor Delta-Connection



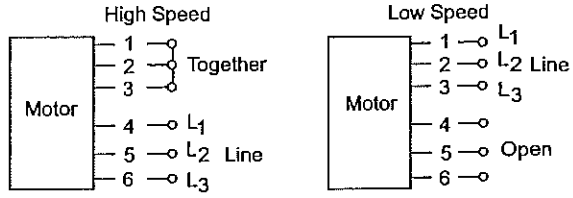
To reverse, interchange any 2 line leads.

2 Speed, 2 Winding, Single Phase Motor



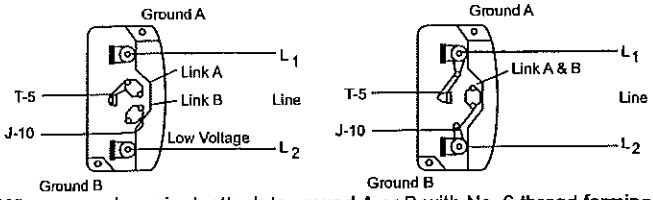
When ground required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-1 and T-4 leads.

2 Speed, 1 Winding, 3 Phase Motor



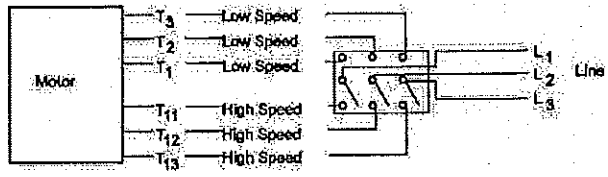
To reverse, interchange any 2 line leads. Motors require magnetic control.

Single Speed, Single Phase, Dual Voltage



When ground required, attach to ground A or B with No. 6 thread forming screw. To reverse, interchange T-5 and J-10 leads.

2 Speed, 2 Winding, 3 Phase



To reverse: High Speed-interchange leads T_{11} and T_{12}.
Low Speed-interchange leads T_1 and T_2. Both Speeds-interchange any 2 line leads.

Wheel Rotation

Test the fan to ensure the rotation of the wheel is the same as indicated by the arrow marked Rotation.

115 and 230 Single Phase Motors

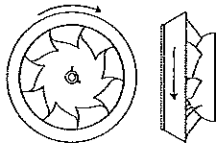
Fan wheel rotation is set correctly at the factory. Changing the rotation of this type of motor should only be attempted by a qualified electrician.

208, 230, and 460, 3 Phase Motors

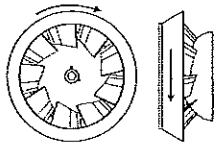
These motors are electrically reversible by switching two of the supply leads. For this reason, the rotation of the fan cannot be restricted to one direction at the factory. See Wiring Diagrams for specific information on reversing wheel direction.

Do not allow the fan to run in the wrong direction. This will overheat the motor and cause serious damage. For 3-phase motors, if the fan is running in the wrong direction, check the control switch. It is possible to interchange two leads at this location so that the fan is operating in the correct direction.

QMX



QMX-HP



Final Installation Steps

a. Inspect fasteners and setscrews, particularly fan mounting and bearing fasteners, and tighten according to the recommended torque shown in the table *Recommended Torque for Setscrews/Bolts*.
b. Inspect for correct voltage with voltmeter.
c. Ensure all accessories are installed.

Operation

Pre-Start Checks

a. Lock out all the primary and secondary power sources.
b. Ensure fasteners and setscrews, particularly those used for mounting the fan, are tightened.
c. Inspect belt tension and pulley alignment.
d. Inspect motor wiring.
e. Ensure belt touches only the pulley.
f. Ensure fan and ductwork are clean and free of debris.
g. Inspect wheel-to-inlet clearance. The correct wheel-to-inlet clearance is critical to proper fan performance.
h. Close and secure all access doors.
g. Restore power to the fan.

Start Up

Turn the fan on. In variable speed units, set the fan to its lowest speed and inspect for the following:

- Direction of rotation.
- Excessive vibration.
- Unusual noise.
- Bearing noise.
- Improper belt alignment or tension (listen for squealing).
- Improper motor amperage or voltage.

If a problem is discovered, immediately shut the fan off. Lock out all electrical power and check for the cause of the trouble. See Troubleshooting.

Inspection

Inspection of the fan should be conducted at the first **30 minute, 8 hour** and **24 hour** intervals of satisfactory operation. During the inspections, stop the fan and inspect as per the *Conditions Chart*.

30 Minute Interval

Inspect bolts, setscrews, and motor mounting bolts. Adjust and tighten as necessary.

8 Hour Interval

Inspect belt alignment and tension. Adjust and tighten as necessary.

24 Hour Interval

Inspect belt tension. Adjust and tighten as necessary.

Recommended Torque for Setscrews/Bolts (IN/LB)

Setscrews				Hold Down Bolts	
Size	Key Hex Across Flats	Recommended Torque			
		Min.	Max.	Size	Wrench Torque
No.10	3/32"	28	33	3/8"-16	240
1/4"	1/8"	66	80	1/2"-13	600
5/16"	5/32"	126	156	5/8"-11	1200
3/8"	3/16"	228	275	3/4"-10	2100
7/16"	7/32"	29	348	7/8"-9	2400
1/2"	1/4"	42	504	1" -8	3000
5/8"	5/16"	92	1104		
3/4"	3/8"	120	1440		

Maintenance

Establish a schedule for inspecting all parts of the fan. The frequency of inspection depends on the operating conditions and location of the fan.

Inspect fans exhausting corrosive or contaminated air within the first month of operation. Fans exhausting contaminated air (airborne abrasives) should be inspected every three months.

Regular inspections are recommended for fans exhausting non-contaminated air.

It is recommended the following inspection be conducted twice per year.

- Inspect bolts and setscrews for tightness. Tighten as necessary.
- Inspect belt wear and alignment. Replace worn belts with new belts and adjust alignment as needed. Refer to *Belt and Pulley Installation*, page 3.
- Bearings should be inspected as recommended in the *Conditions Chart*.
- Inspect variable inlet vanes (if supplied) for freedom of operation and excessive wear. The vane position should agree with the position of the control arm. As the variable inlet vanes close, the entering air should spin in the same direction as the wheel.
- Inspect springs and rubber isolators for deterioration and replace as needed.
- Inspect for cleanliness. Clean exterior surfaces only. Removing dust and grease on motor housing assures proper motor cooling. Removing dirt from the wheel and housing prevents imbalance and damage.

Conditions Chart			
RPM	Temperature	Fan Status	Greasing Interval
100	Up to 120°F	Clean	6 to 12 months
500	Up to 150°F	Clean	2 to 6 months
1000	Up to 210°F	Clean	2 weeks to 2 months
1500	Over 210°F	Clean	Weekly
Any Speed	Up to 150°F	Dirty	1 week to 1 month
Any Speed	Over 150°F	Dirty	Daily to 2 weeks
Any Speed	Any Temperature	Very Dirty	Daily to 2 weeks
Any Speed	Any Temperature	Extreme Conditions	Daily to 2 weeks

Lubricants

Loren Cook Company uses petroleum lubricant in a lithium base. Other types of grease should not be used unless the bearings and lines have been flushed clean. If another type of grease is used, it should be a lithium-based grease conforming to NLGI grade 2 consistency.

A NLGI grade 2 grease is a light viscosity, low-torque, rust-inhibiting lubricant that is water resistant. Its temperature range is from -30°F to +200°F and capable of intermittent highs of +250°F.

Motor Bearings

Motor bearings are pre-lubricated and sealed. Under normal conditions they will not require further maintenance for a period of ten years. However, it is advisable to have your maintenance department remove and disassemble the motor, and lubricate the bearings after three years of operation in excessive heat and or in a contaminated airstream consisting of airborne abrasives.

Fan Bearings

QMX bearings are lubricated through a grease fitting on the outer housing and should be lubricated by the schedule, *Conditions Chart.*

For best results, lubricate the bearing while the fan is in operation. Pump grease in slowly until a slight bead forms around the bearing seals. Excessive grease can burst seals thus reducing bearing life.

In the event the bearing cannot be seen, use no more than three injections with a hand-operated grease gun.

Motor Services

Should the motor prove defective within a one-year period, contact your local Loren Cook representative or your nearest authorized electric motor service representative.

Changing Shaft Speed

All belt driven fans with motors up to and including 5 HP are equipped with variable pitch pulleys. To change the fan speed, perform the following:

a. Loosen setscrew on driver (motor) pulley and remove key, if equipped.
b. Turn the pulley rim to open or close the groove facing. If the pulley has multiple grooves, all must be adjusted to the same width.
c. After adjustment, inspect for proper belt tension.

Speed Reduction

Open the pulley in order that the belt rides deeper in the groove (smaller pitch diameter).

Speed Increase

Close the pulley in order that the belt rides higher in the groove (larger pitch diameter). Ensure that the speed limits of the fan and the horsepower limits of the motor are maintained.

Pulley and Belt Replacement

a. Loosen and remove belts by adjusting motor mounting plate.
b. Remove pulleys from their respective shafts.
c. Clean the motor and fan shafts.
d. Clean bores of pulleys and coat the bores with heavy oil.
e. Remove grease, rust, or burrs from the pulleys and shafts.
f. Remove burrs from shaft by sanding.
g. Place fan pulley on fan shaft and motor pulley on its shaft. Damage to the pulleys can occur when excessive force is used in placing the pulleys on their respective shafts.
h. Tighten in place.
i. Install belts on pulleys and align as described in the *Belt and Pulley Installation* section.

Bearing Replacement

The fan bearings are pillow block ball bearings.

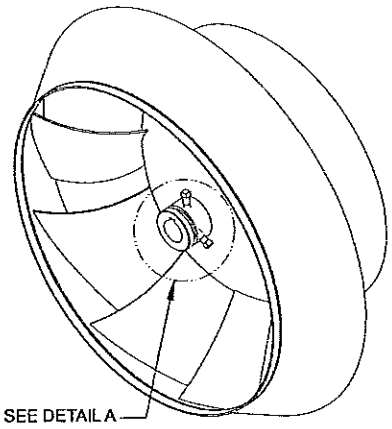
a. Loosen and remove belts by adjusting motor mounting plate
b. Remove the bearing cover by removing the bolts around the perimeter of the bearing cover. ***Do not remove fan sheave yet.***
c. Remove inlet cone by removing attaching bolts/nuts around perimeter of the inlet plate.
d. Remove wheel by loosening setscrews and sliding off shaft.
e. Record the location of the fan sheave from end of shaft, and remove the sheave.
f. Record the distance from the bearing to the end of the shaft.
g. Loosen setscrews on bearings and remove shaft.
j. Remove bearings from bearing base and replace with new ones, noting the exact location of each; **do not fully tighten base bolts.**
k. Slide shaft through bearings until shaft protrudes the same amount as measured above. Tapping the inner race of each bearing with a soft driver may be required. **Do not hammer the end of the shaft or the bearing housing.**
l. Return setscrews to same location as marked above and tighten one setscrew on each bearing to half its specified torque.
m. Rotate the shaft to allow the bearings to align themselves.
n. Replace wheel but do not tighten yet.

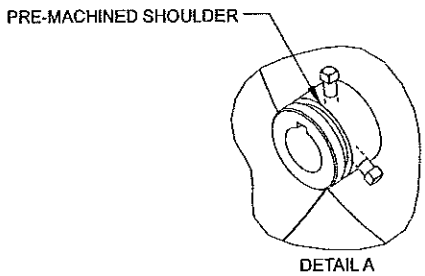
o. Replace inlet cone. Wheel may need to be moved to allow proper alignment. Care should be taken to insure that inlet cone is centered inside wheel before and after tightening attaching bolts.
p. Slide wheel on shaft to achieve proper wheel/inlet overlap and tighten wheel set screws. Refer to Wheel-to-Inlet Clearance on page 3.
q. Tighten hold-down bolts to proper torque.
r. Turn the shaft by hand. resistance should be the same as it was before hold-down bolts were fully tightened.
s. Tighten all bearing setscrews to full specified torque.
t. Replace the sheave, align with motor sheave, and adjust the belt tension.
u. Test run fan and retighten all setscrews and bolts, and trim balance as necessary (.0785 in/sec max).
v. Replace discharge cover.

Wheel Replacement

The wheel has a pre-machined shoulder in the hub for the use of most 2 and 3 jaw mechanical puller.

a. Align center of the puller with the center of the shaft.
b. Ensure all setscrews in the hub, normally two, are fully removed.
c. Slowly remove wheel from the shaft.

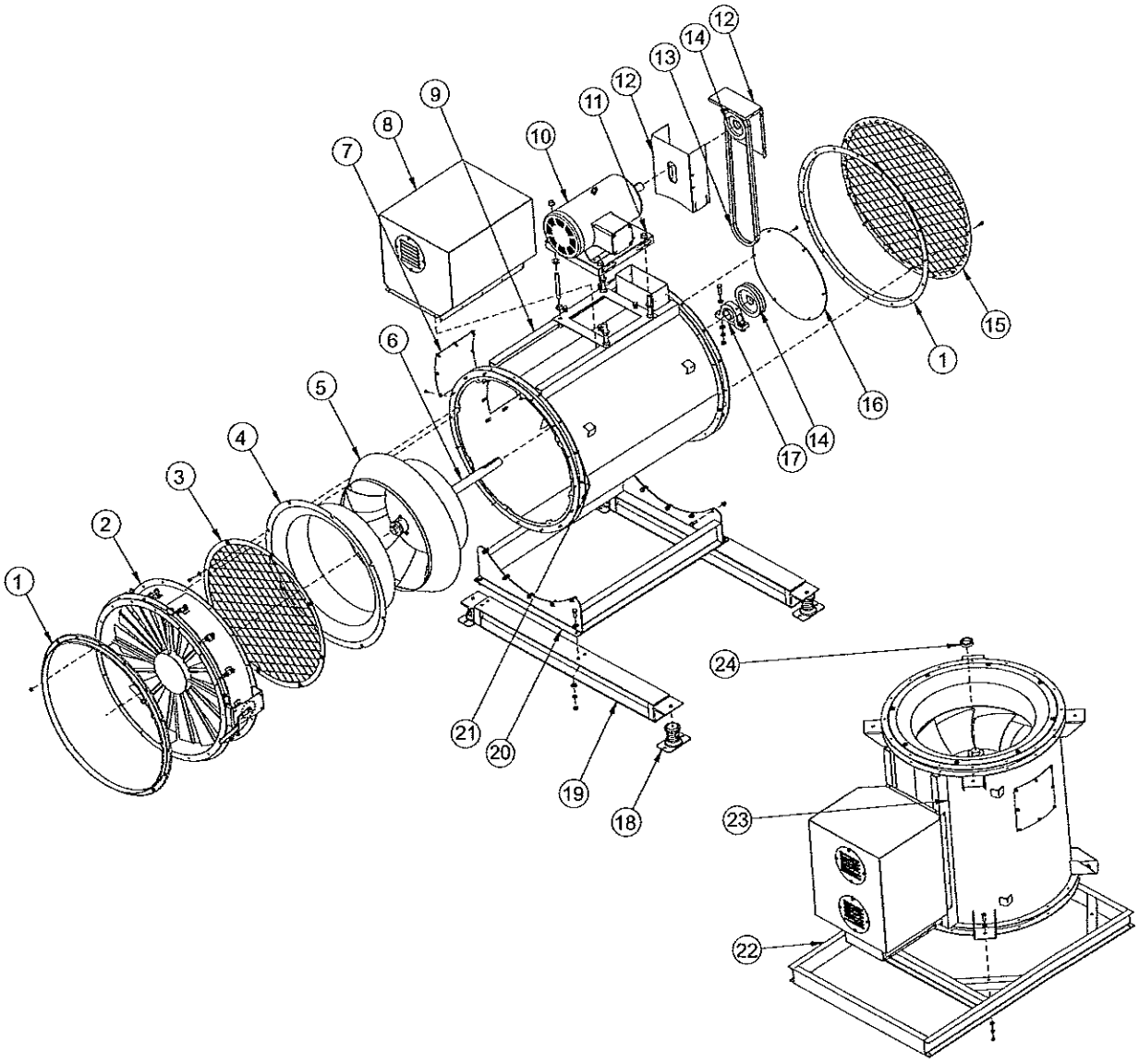




Troubleshooting

Problem and Potential Cause
Low Capacity or Pressure •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Poor fan inlet or outlet conditions. There should be a straight clear duct at the inlet or outlet. •Improper wheel alignment.
Excessive Vibration and Noise •Damaged wheel. •Belts misaligned. •Belts too loose; worn or oily belts. •Loose fasteners. •Speed too high. •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Bearing set screws loose. •Bearings need lubrication or replacement. •Debris in impeller. •Fan surge. •See page 4 for issues regarding use of VFD.
Overheated Motor •Motor improperly wired. •Incorrect direction of rotation. Make sure the fan rotates in same direction as the arrows on the motor or belt drive assembly. •Cooling air diverted or blocked. •Improper inlet clearance. •Incorrect fan speed. •Incorrect voltage.
Overheated Bearings •Improper bearing lubrication •Excessive belt tension.

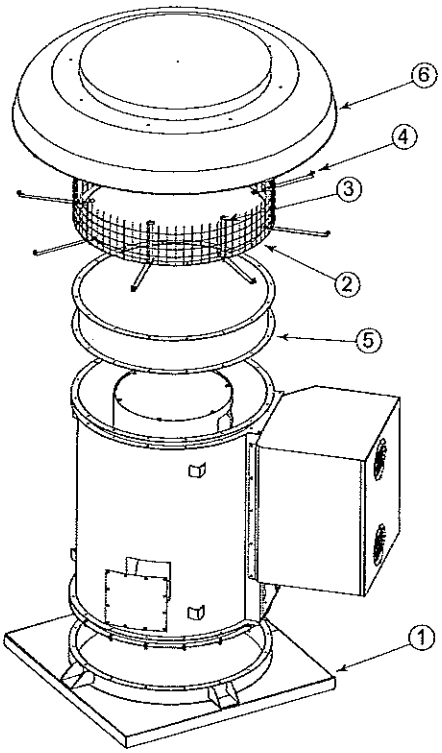
QMX/QMX-HP Parts List
(Horizontal Mount Shown)



ITEM NUMBER	ITEM DESCRIPTION
1	COMPANION FLANGE (OPTIONAL)
2	EXTERNAL INLET VANE DAMPER (OPTIONAL)
3	INLET SAFETY SCREEN (OPTIONAL)
4	INLET CONE
5	MIX-FLOW WHEEL
6	SHAFT
7	ACCESS DOOR (OPTIONAL)
8	MOTOR COVER (OPTIONAL)
9	HOUSING-HORIZONTAL MOUNT
10	MOTOR
11	MOTOR PLATE
12	BELT GUARD

ITEM NUMBER	ITEM DESCRIPTION
13	BELT
14	DRIVE PULLEY
15	DISCHARGE SAFETY SCREEN (OPTIONAL)
16	BEARING COVER
17	BEARINGS (2 REQUIRED)
18	ISOLATOR (4 REQUIRED OPTIONAL)
19	ISOLATION RAILS-HORIZONTAL MOUNT (OPTIONAL)
20	BASE-HORIZONTAL MOUNT
21	THRUST RESTRAINT-HORIZONTAL MOUNT (OPTIONAL)
22	ISOLATION STRUCTURE-VERTICAL MOUNT (OPTIONAL)
23	HOUSING-VERTICAL MOUNT
24	SHAFT LOCKING COLLAR-VERTICAL MOUNT

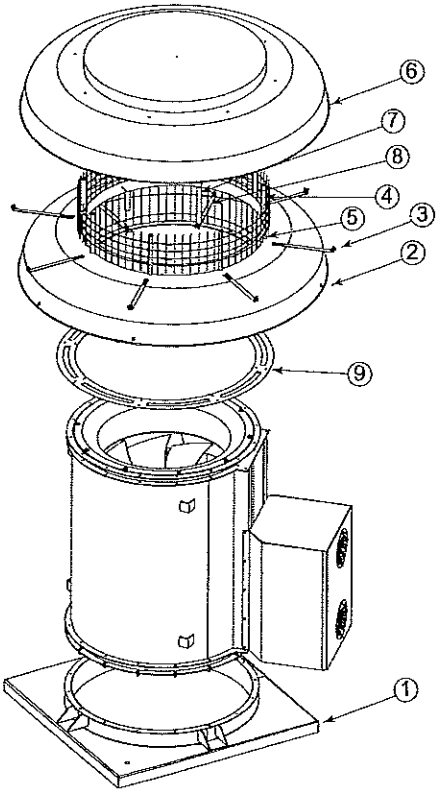
QMXE/QMXE-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXE Birdscreen
3	QMXE Top Cap Post
4	QMXE Baffle Brace
5	QMXE Top Cap Extension (for Size 90 only)
6	QMXE Top Cap

See common parts (not shown) listed on page 8.

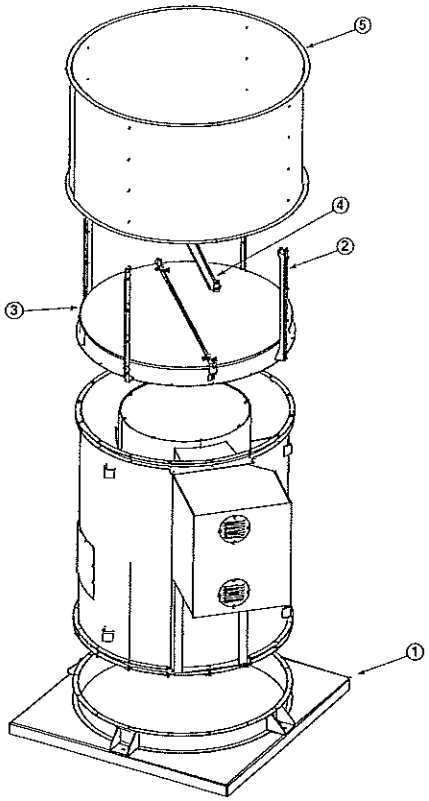
QMXS/QMXS-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXS Top Cap-Open
3	QMXS Upper Baffle Brace
4	QMXS Top Cap Post
5	QMXS Birdscreen
6	QMXS Top Cap
7	QMXS Lower Top Cap Post
8	QMXS Lower Baffle Brace
9	QMXS Adapter Plate

See common parts (not shown) listed on page 8.

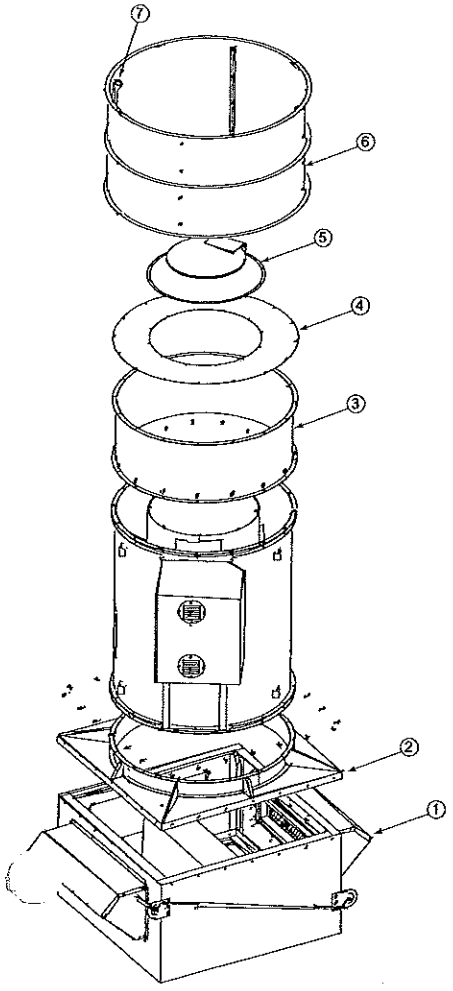
QMXU/QMXU-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMX Curb Cap
2	QMXU Lifting Lug
3	QMXU Damper
4	QMXU Damper Stop
5	QMXU Windband

See common parts (not shown) listed on page 8.

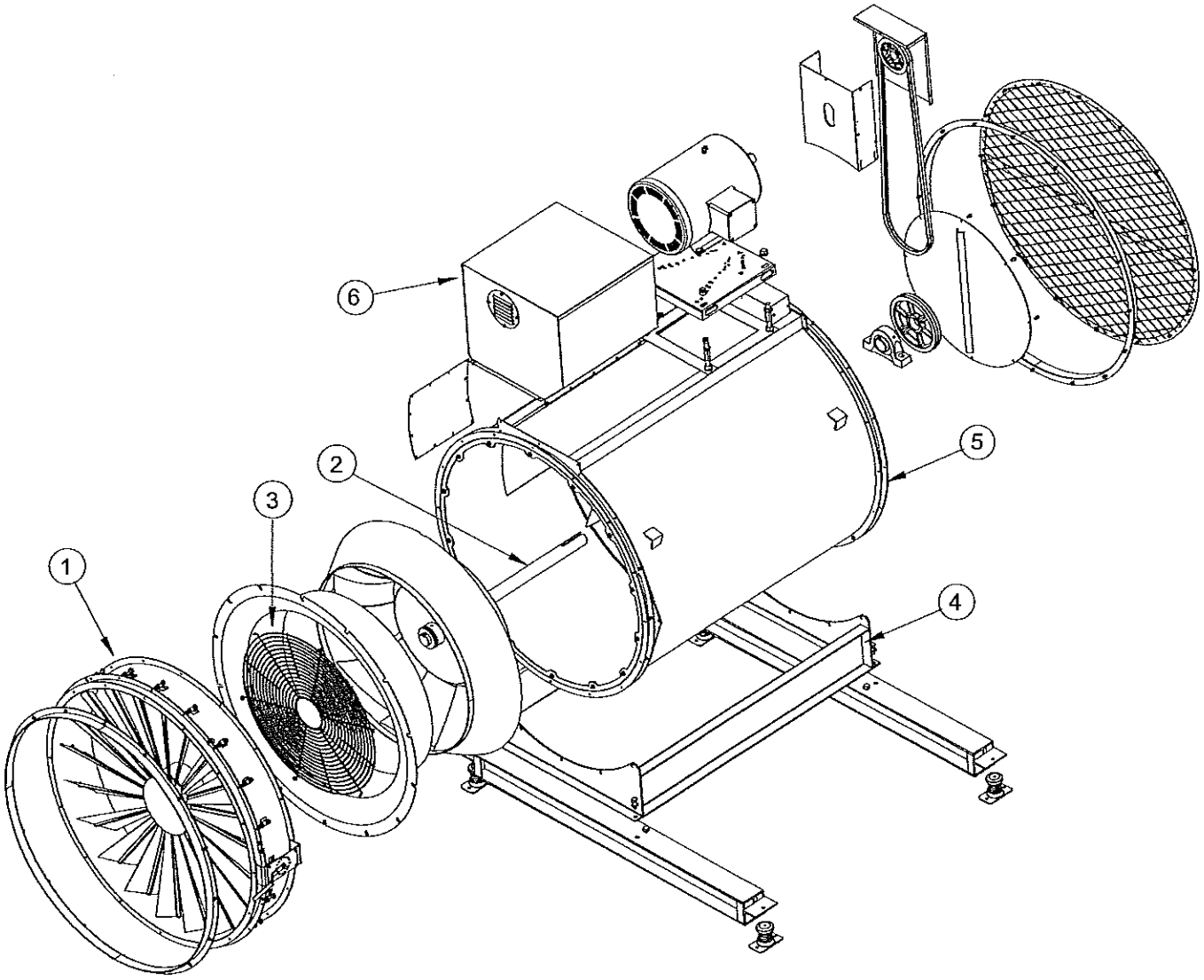
QMXLE/QMXLE-HP Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	QMXLE Mixing Box
2	QMXLE Curb Cap
3	QMXLE Middle Section
4	QMXLE Adapter Plate
5	QMXLE Stack Damper
6	QMXLE Windband
7	QMXLE Lifting Lug

See common parts (not shown) listed on page 8.

Arrangement 3 Parts List



ITEM NUMBER	ITEM DESCRIPTION
1	Arr. 3 Bearing Support
2	Arr. 3 Shaft
3	Arr. 3 Spiral Guard
4	Arr. 3 Base
5	Arr. 3 Housing
6	Arr. 3 Motor Cover

See common parts (not shown) listed on page 8.

Limited Warranty

Loren Cook Company warrants that your Loren Cook fan was manufactured free of defects in materials and workmanship, to the extent stated herein. For a period of one (1) year after date of shipment, we will replace any parts found to be defective without charge, except for shipping costs which will be paid by you. This warranty is granted only to the original purchaser placing the fan in service. This warranty is void if the fan or any part thereof has been altered or modified from its original design or has been abused, misused, damaged or is in worn condition or if the fan has been used other than for the uses described in the company manual. This warranty does not cover defects resulting from normal wear and tear. To make a warranty claim, notify Loren Cook Company, General Offices, 2015 East Dale Street, Springfield, Missouri 65803-4637, explaining in writing, in detail, your complaint and referring to the specific model and serial numbers of your fan. Upon receipt by Loren Cook Company of your written complaint, you will be notified, within thirty (30) days of our receipt of your complaint, in writing, as to the manner in which your claim will be handled. If you are entitled to warranty relief, a warranty adjustment will be completed within sixty (60) business days of the receipt of your written complaint by Loren Cook Company. This warranty gives only the original purchaser placing the fan in service specifically the right. You may have other legal rights which vary from state to state.