ADDENDUM NO. 2

ISSUE DATE: November 1, 2021

RE: WIMR – LOADING DOCK AND PRIMATE CENTER
RENOVATION
UNIVERSITY OF WISCONSIN - MADISON

UW-Institution Project No. A-20-005
UWSA Project No. 1485-1972

BID DUE: Fire Suppression, Plumbing & Electrical Bidders: Bids received October 27, 2021.
Mechanical Bidders: November 16, 2021, 1:30 p.m.
GPC Bidders: November 30, 2021, 1:30 p.m.

FROM: Zimmerman Architectural Studios, Inc.
2122 West Mt. Vernon Avenue
Milwaukee, Wisconsin 53233

TO: Prospective Bidders

This Addendum forms a part of the Contract Documents and modifies the original Contract Documents dated September 24, 2021 as noted below. Acknowledgement receipt of this Addendum by inserting the number and issue date of this Addendum in the blank space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of (1) page and the attached documents:

Specifications (Revisions dated November 1, 2021):
SECTION 23 01 30.51 – HVAC AIR DUCT CLEANING
SECTION 23 31 00 – HVAC DUCTS AND CASINGS

Changes to Specifications:
1. Volume 3 - 23 01 30.51 HVAC Air Duct Cleaning Part 3
   a. REVISED cleaning location to immediate construction area.
2. Volume 3 - 23 31 00 HVAC DUCTS and CASINGS Part 3
   a. Revised cleaning location to immediate construction area.
   b. Removed greaseduct requirement.
   c. Revised stainless steel duct requirement.

END OF ADDENDUM

Zimmerman Architectural Studios, Inc.
2122 West Mt. Vernon Avenue
Milwaukee, Wisconsin 53233

The Board of Regents of the University of Wisconsin
on Behalf of The University of Wisconsin – Madison
C/O UWSA – Capital Planning and Budget
780 Regent Street, Suite 239
Madison, Wisconsin 53715
SECTION 23 01 30.51
HVAC AIR DUCT CLEANING

PART 1 - GENERAL

SCOPE
This section includes specifications for cleaning duct and HVAC systems on this project. Included are the following topics:

PART 1 - GENERAL
Scope
Reference Standards
Quality Assurance

PART 2 - PRODUCTS
General
Cleaners, Biocides and Encapsulants

PART 3 - EXECUTION
General
Cleaning
Biocides and Encapsulants

RELATED WORK
Section 01 91 01 or 01 91 02 – Commissioning Process
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
Section 23 31 00 - HVAC Ducts and Casings
Section 23 33 00 - Air Duct Accessories

REFERENCE
Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS
NADCA 1992-01 Mechanical Cleaning of Non-Porous Air Conveyance System Components
NADCA National Air Duct Cleaners Association
NAIMA Cleaning Fibrous Glass Insulated Air Duct Systems

QUALITY ASSURANCE
Refer to Division 1, Instructions to Bidders – Qualifications of Bidder and General Conditions - Equals and Substitutions.

A Regular Member in good standing of NADCA (National Air Duct Cleaners Association). Maintain membership for the entire duration of the project. Maintain a staff of at least one Certified Air System Cleaning Specialist (ASCS). If membership of the firm, or any certification of any staff performing work is terminated or expires during the duration of the project, contact Owner immediately.

SHOP DRAWINGS
Refer to Division 1, General Conditions, Submittals.

Include manufacturer's data and/or Contractor data for the following:

- List of equipment to be used.
- Product description and MSDS sheets for cleaners, biocides and encapsulants
- Access doors.
PART 2 - PRODUCTS

GENERAL
Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

CLEANERS, BIOSIDES AND ENCAPSULANTS
Manufacturer: H.B. Fuller/Foster, Porter, or approved equal.

Cleaners, biocides and encapsulants shall be waterbase products specifically designed for application to HVAC duct interiors and capable of being applied with airless spray equipment. Biocides and encapsulants must be colored differently than substrate to be coated.

Biocidal agents to be formulated for long term fungicidal activity with no loss on aging. Biocidal agents must be registered with the U.S. Environmental Protection Agency for use on the interior of HVAC duct systems.

Cured biocides and encapsulants must provide tough washable elastic protective finish able to withstand light impact or abrasion without breaking down over time or releasing fibers.

EQUIPMENT
Particulate Collection Equipment: Fan/filter unit sized to create sufficient quantity of negative pressure for capture and filtration of air and contaminants dislodged during duct cleaning. Equipment to include prefiltration and HEPA final filtration with 99.97% collection efficiency for 0.3 micron size particles.

Portable pressure washers to be capable of 500 psig to 1000 psig operation.

Power brush systems designed specifically for duct cleaning.

PART 3 - EXECUTION

GENERAL
Use products and equipment in accordance with manufacturers instructions.

CLEANING
Clean ductwork systems and associated turning vanes, dampers, coils, VAV boxes, drain pans, plenums, diffusers, registers, grilles and louvers; air handling units and associated fans, coils, drain pans, plenums and dampers; fans; terminal units and other equipment described below:

<table>
<thead>
<tr>
<th>System/Component</th>
<th>Location</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Duct Systems</td>
<td>Throughout Building</td>
<td>Remove</td>
</tr>
<tr>
<td>Liner, Clean, Encapsulant</td>
<td>Immediate Dock and Vivarium</td>
<td></td>
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<tr>
<td>Transfer Duct Systems</td>
<td>Throughout Building</td>
<td>Clean</td>
</tr>
<tr>
<td>Exhaust/Relief Duct Systems</td>
<td>Throughout Building</td>
<td>Clean</td>
</tr>
<tr>
<td>Outside Air/Mixed Air Duct Systems</td>
<td>Throughout Building</td>
<td>Clean</td>
</tr>
<tr>
<td>Packaged Air Conditioning Units</td>
<td>Throughout Building</td>
<td>Clean</td>
</tr>
<tr>
<td>Exhaust Fans</td>
<td>Throughout Building</td>
<td>Clean</td>
</tr>
</tbody>
</table>

Visually inspect systems and site prior to cleaning. Document and report damaged system components to Owner’s Construction Representative prior to cleaning. Mark damper and other component positions prior to cleaning and reset after cleaning to original position. Establish a specific, coordinated plan detailing how each area of the building will be protected during the various phases of work.

Protect building occupants, components and furnishings from cleaning activities. Use polyethylene sheeting covers and barriers where cleaning will disperse debris outside the HVAC systems. Install critical barriers within the building, at inlets/outlets and within the system to prevent migration of dust and debris to clean areas.

Use particulate collection equipment to remove and capture debris. Connect to system downstream of cleaning operations. Wherever possible, duct exhaust to the exterior of the building. Avoid discharge near air intakes and points of entry. Arrange source of makeup air to flow from clean area to work area.
negatively pressurizing work area. Take measures to control offensive odors and vapors during the cleaning process.

Clean systems using mechanical cleaning methods, such as vacuum cleaning, compressed air sweeping and mechanical brushing, designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. No cleaning methods are to be used which damage components of the system or negatively alter the integrity of the system.

Clean fibrous glass thermal or acoustical insulation with HEPA vacuuming equipment. Document locations of damage, deterioration, delamination, mold, fungus growth or excessive moisture which cannot be restored by cleaning or resurfacing with repair coating. Report locations and conditions to Architect/Engineer and Owner’s Project Representative for determination of removal and/or replacement.

Where fibrous glass thermal or acoustical insulation is to be removed, scrape and brush metal clean. Remove loose fasteners, weld pins where required for cleaning work and sheet metal covers associated with insulation. Patch and seal fastener openings.

Clean coils to restore pressure drop to within 10% of design rating. Where design rating is unknown, coils must be cleaned free of foreign material and chemical residue. Cleaning methods used must not bend, erode or damage coil surfaces, fins or tubes. Clean coil drain pans and drain. Make drain fully operational. Where wet methods are used, thoroughly rinse coils and drains pans with clean water to remove latent residues. Provide temporary drain pans below coils without drain pans to capture water.

Where systems and equipment containing filters are cleaned, obtain replacement filters from building occupant and replace existing filters.

Verification of HVAC system cleanliness will be performed after cleaning and prior to application of biocides and encapsulants. The Contractor shall notify the Owner’s Construction Representative and Architect/Engineer in advance of verification. Verification will consist of inspection by the Contractor, Owner’s Construction Representative and/or Architect/Engineer. If surfaces are visibly clean, no contaminants are evident through visual inspection and coils are within 10% of design pressure drop, the HVAC system shall be considered clean. However the Owner reserves the right to further verify system cleanliness through third party gravimetric or wipe testing analysis per NADCA standards.

**BIOCIDES AND ENCAPSULANTS**

Biocides and encapsulants are to be applied only after cleaning and verification have been completed and surfaces are dry. System fans are to remain off and critical barriers maintained to prevent migration of biocides and encapsulants from the HVAC systems.

Apply biocides to the following surfaces which are suspected of or have been tested and verified for microbial contamination:

- Outdoor air intake drain pans.

Apply encapsulants to the following surfaces where microbial contamination is not suspected:

- Damaged fibrous glass thermal or acoustical insulation.
- Sheet metal where thermal or acoustical insulation has been removed.

Biocides and encapsulants to be directly sprayed (not fogged), brushed or rolled onto surfaces to achieve a continuous film of thickness recommended by manufacturer. Increase application rate on porous or rough surfaces. Protect coils, fan blades, bearings, damper linkages and seals, fire/smoke dampers, humidifiers, airflow sensors, pressure sensors, temperature sensors and humidity sensors during application of biocides and encapsulants. Clean any overspray from these components immediately. Allow products to fully cure prior to using HVAC systems. Operate systems during unoccupied hours flushing with fresh air to purge system prior to occupied use.

**CLEANING REPORT**

Provide a report describing pre-cleaning inspection and damage, systems cleaned, methods and materials used, problems encountered, final verification and any remaining problems noted. Submit three copies to Owner’s Construction Representative.

**ACCESS DOORS**
Install access doors where indicated on the drawings and in locations where access is required for cleaning or inspection. See specification Section 23 33 00 for access door requirements.

Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils if not existing.

END OF SECTION
SECTION 23 31 00
HVAC DUCTS and CASINGS

PART 1 - GENERAL

SCOPE
This section includes specifications for all duct systems used on this project. Included are the following topics:

PART 1 - GENERAL
Scope
Related Work
Reference
Reference Standards
Quality Assurance
Shop Drawings
Design Criteria
Delivery, Storage And Handling

PART 2 - PRODUCTS
General
Ductwork Pressure Class
Ductwork System Class
Materials
High Pressure Ductwork (Pressure class 3 inch and over)
Low Pressure Ductwork (Maximum 2 inch pressure class)
Duct Sealant
Gaskets

PART 3 - EXECUTION
Installation
Ductwork Support
High Pressure Duct (Pressure class 3 inch and over)
Low Pressure Duct (Maximum 2 inch pressure class)
Cleaning
Leakage Test
Structural Test
Construction Verification

APPENDIX
Duct Leakage Test Report
Duct Structural Test Report

RELATED WORK
Section 23 01 30.51 – HVAC Air Duct Cleaning
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
Section 23 08 00 – Commissioning of HVAC
Section 23 33 00 – Air Duct Accessories

REFERENCE
Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS
ANSI SS-EN 485-2 Aluminum and Aluminum Alloys- Sheet, Strip and Plate- Part 2: Mechanical Properties
ASTM B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM A90 Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A623 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM 924 Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method
ASTM C 1071 Specification for Fibrous Glass Duct Lining Insulation
ASTM C 411  Test Method for Hot Surface Performance of High Temperature Thermal
Insulation
ASTM E 84  Test Method for Surface Burning Characteristics of Building Materials
ASTM C 1338 Test Method for Determining Fungal Resistance of Insulation Materials and
Facings
ASTM G 21  Standard Practice for Determining Resistance of Synthetic Polymeric Materials
to Fungi
ASTM C 916  Standard Specification for Adhesives for Duct Thermal Insulation
NFPA 90A  Standard for the Installation of Air Conditioning and Ventilating Systems
UL 181  Standard for Safety for Factory Made Air Ducts and Air Connectors.
NAIMA  Fibrous Glass Duct Liner Standard

QUALITY ASSURANCE
Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Refer to division 1, General Conditions, Submittals.

Include manufacturer's data and/or Contractor data for the following:
- Fabrication and installation drawings.
- Schedule of duct systems including material of construction, gauge, pressure class, system class,
  method of reinforcement, joint construction, fitting construction, and support methods, all with
details as appropriate.
- Duct sealant and gasket material.
- Duct liner including data on thermal conductivity, air friction correction factor, and limitation on
temperature and velocity.

DESIGN CRITERIA
Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified
operating conditions.

Use material, weight, thickness, gauge, construction and installation methods as outlined in the following
SMACNA publications, unless noted otherwise:
- HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005

Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke
developed rating no higher than 50.

DELIVERY, STORAGE AND HANDLING
Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.

Protect Ductwork against damage.

Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material
on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end
caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.

Offsite storage agreements do not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

PART 2 - PRODUCTS

GENERAL
All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork
and spiral duct take-offs 12” and below may be 26 gauge where allowed in SMACNA HVAC Duct
Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

**DUCTWORK PRESSURE CLASS**

Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes not indicated on the drawings to be as follows:

<table>
<thead>
<tr>
<th></th>
<th>Calc. S.P. in</th>
<th>Pressure Class in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vivarium Supply duct upstream of air terminals</td>
<td>2.6</td>
<td>4</td>
</tr>
<tr>
<td>Vivarium Supply duct downstream of air terminals</td>
<td>0.8</td>
<td>2</td>
</tr>
<tr>
<td>Transfer air ducts</td>
<td>0.3</td>
<td>1</td>
</tr>
<tr>
<td>Duct Area Supply duct</td>
<td>0.8</td>
<td>2</td>
</tr>
<tr>
<td>Exhaust air ducts upstream of air terminal</td>
<td>-0.8</td>
<td>-2</td>
</tr>
<tr>
<td>Exhaust air ducts downstream of air terminal</td>
<td>-1.9</td>
<td>-4</td>
</tr>
<tr>
<td>Outside air ducts</td>
<td>-0.9</td>
<td>-2</td>
</tr>
</tbody>
</table>

**DUCTWORK SYSTEM CLASS**

Duct system classes not indicated on the drawings to be as follows:

**MATERIALS**

**Galvanized Steel Sheet:** Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide “Paint Grip” finish or galvanneal sheet metal for ductwork that will be painted.

**Aluminum Sheet:** Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture.

**Stainless Steel Sheet:** Use ASTM A167, Type 304 or 316 stainless steel sheet as specified, 316L if welded ductwork, with No. 2B finish for concealed work and No. 3 finish for exposed work, in the vivarium space only.

**Uncoated Black Steel Sheet:** First quality, soft steel sheet capable of welding or double seaming without fracture.

**Polyvinylchloride Coated Steel Sheet:** Use hot-dipped galvanized steel sheet with prime coat and a polyvinyl chloride film on both sides. Thickness of coating to be a minimum of 4 mils on each side. United Sheet Metal Uni-Coat, made by United McGill Co., may be used at contractor's option.

Where any duct surface is scratched, marred, or otherwise damaged, paint with PVC aerosol spray.

All couplings shall be slip-joint construction with a minimum 2 inches insertion length. Seal all couplings with sealants as specified.

**Prefabricated Grease Ducts:** Dual-wall construction with stainless steel inner liner, insulation and stainless steel (for exposed locations) or aluminized steel (for concealed locations) shell. Furnish all items which form a part of the assembly, including, tee sections, straight sections, elbows, end caps, cleanouts, expansion joints, fan/hood.
transitions, supports, flashing, counter flashing, and insulated roof thimble where required. Each section shall bear the factory applied Underwriters Laboratories Label.

**HIGH PRESSURE DUCTWORK (Pressure class 3 inch and over)**

Manufacturers:
- Ajax, Semco, United Sheet Metal, Sheet Metal Connectors or approved equal.
- Machine formed round and/or flat oval spiral lock seam duct constructed of galvanized steel.
- Rectangular high pressure duct using a transverse joint system as manufactured by Ductmate, Nexus, TDC, TDF, or approved equal, may be used at contractor's option. Duct to be flanged, gasketed and sealed.
- Contractor fabricated ductwork meeting specified construction standards is acceptable with prior approval of Architect/Engineer. Submit construction details, a description of materials to be used, type of service, reinforcing methods, and sealing procedures.
- Use a perforated inner liner on double wall high-pressure duct. Annular space between inner liner and outer duct to be filled with 1 inch glass fiber insulation.
- Use cemented slip joints with 2 inch minimum overlap, flanged connections, or welded/brazed connections, unless noted otherwise for special applications. Prime coat welded joints.
- Provide standard 90 degree conical tee takeoffs except for exhaust at velocities over 2000 feet per minute, use 45° lateral connections; straight taps or bullhead tees are not acceptable.
- Internal bracing will not be accepted on ductwork below 48 inches.
- Use turning vanes as specified in Section 23 33 12.
- Provide bellmouth fittings or expanded fittings at each duct connection to air plenums.
- Provide pressure relief fittings as indicated on the plans and/or details.
- Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

**LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)**

Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.

- Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork.
- Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.
- Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.
- Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.
- Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.
- Button punch snaplock construction will not be accepted on aluminum ductwork.
- Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of the Architect/Engineer.
- Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
**PART 3 - EXECUTION**

**INSTALLATION**
 Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.

Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.

Test openings for test and balance work will be provided under Section 23 05 93.

Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.

Install duct to pitch toward outside air intakes and drain to outside of building. Solder or seal seams to form watertight joints.

Where two different metal ducts meet, the joint shall be installed in such a manner that metal ducts do not contact each other by using proper seal or compound.

Install all motor operated dampers and connect to or install all equipment furnished by others. Blank off all unused portions of louvers, as indicated on the drawings, with 1-1/2 inch board insulation with galvanized sheet metal backing on both sides.

Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

Provide adequate access to ductwork for cleaning purposes.

Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.

Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.

Install prefabricated grease ductwork assemblies in accordance with manufacturer requirements and NFPA 96.
During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

**DUCTWORK SUPPORT**

Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.

Stainless steel air-craft cable hanging systems are allowed on round ductwork under 12 inches diameter if installed utilizing two fasteners with two cable loops. Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching serrated spring loaded wedge mechanism fasteners rated for actual load. Comply with the manufacturer’s installation instructions.

**HIGH PRESSURE DUCT (Pressure class 3 inch and over)**

Seal all duct in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

**LOW PRESSURE DUCT (Maximum 2 inch pressure class)**

Seal all ducts, except for transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.

Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheet metal screws or pop rivets. Trapeze hangers may be used at contractor's option.

**CLEANING**

Remove all dirt and foreign matter from the entire immediate dock and vivarium duct systems and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.

Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

**LEAKAGE TEST**

Test all ductwork in accordance with test methods described in Section 4 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.

If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.

Leakage rate shall not exceed more than 5% of the system air quantity for low pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.

Leakage rate shall not exceed more that 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.

Leakage test for ductwork downstream of air terminal devices may be omitted but will not relieve the contractor from duct sealing requirements.

Submit a signed report to the Division's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

**STRUCTURAL TEST**

Random test all ductwork per Owner direction. Do not insulate ductwork until it has been successfully tested.

Test pressure shall be equal to the duct pressure class.

Deflection limits shall not exceed those listed in accordance with Chapter 11 of SMACNA HVAC Duct Construction Standards, 3.0 Performance Requirements.

Submit a signed report to the Division's Construction Representative, indicating test apparatus used, results of the structural test, and any remedial work required.
CONSTRUCTION VERIFICATION

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION
# APPENDIX

## DUCT LEAKAGE TEST REPORT

**University of Wisconsin-System**

Owner Project Number:________

Date Submitted:________

### Project Information

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Location</th>
<th>Contractor</th>
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<table>
<thead>
<tr>
<th>System Fan No</th>
<th>Leakage Class (C_L)</th>
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<table>
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<th>Data Fan Design CFM</th>
<th>Duct Pressure Class (P_C)</th>
<th>Test Pressure (P_T)</th>
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**Test Equipment**

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<th>Model No</th>
<th>Serial No</th>
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</table>

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

Note that due to normal construction sequencing it is usually necessary to test risers separately prior to enclosing chases.

### Design Data

<table>
<thead>
<tr>
<th>Duct Section</th>
<th>Duct Shape</th>
<th>Duct Surface (Ft²)</th>
<th>Allowable Leakage Factor (P&lt;sup&gt;65&lt;/sup&gt;C&lt;sub&gt;L&lt;/sub&gt;)</th>
<th>CFM for Section</th>
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<th>Pressure (in. wc.)</th>
<th>Field Test Data</th>
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### Field Test Data

<table>
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<tr>
<th>Duct Section</th>
<th>Duct Shape</th>
<th>Duct Surface (Ft²)</th>
<th>Allowable Leakage Factor (P&lt;sup&gt;65&lt;/sup&gt;C&lt;sub&gt;L&lt;/sub&gt;)</th>
<th>CFM for Section</th>
<th>Diameter</th>
<th>Pressure (in. wc.)</th>
<th>Date</th>
<th>Performed By</th>
<th>Observed By</th>
<th>Actual CFM</th>
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**TOTAL**

A-20-005/1485-1972 – WIMR Dock & Primate Center Renovation

23 31 00-8
DUCT STRUCTURAL TEST REPORT

University of Wisconsin-System

Owner Project Number:_______

Date Submitted:___________

Project Name:________________________________________________________

Location:____________________________________________________________

Contractor:__________________________________________________________

System Data

Fan No:_______________

Description of Test Method:

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

Test Equipment

Manufacturer:_______________________ Model No:___________ Serial No:________

Indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

<table>
<thead>
<tr>
<th>Design Data</th>
<th>Field Test Data</th>
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<tbody>
<tr>
<td>Duct Test Shape</td>
<td>Duct Pressure Class</td>
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<td>H</td>
<td>W</td>
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</tbody>
</table>

END OF SECTION

A-20-005/1485-1972 – WIMR Dock & Primate Center Renovation

23 31 00-9