



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

STANDARD LOW BID PROJECT

October 22, 2007

FUME HOOD CONTROLS REPLACEMENT SCIENCE BUILDING

**SALT LAKE COMMUNITY COLLEGE
REDWOOD ROAD CAMPUS
SALT LAKE CITY, UTAH**

DFCM Project Number 07305660

Stanley Consultants Inc.
5353 South 960 East, Suite 220
Salt Lake City, Utah 84117

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Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM.

DFCM General Conditions dated May 25, 2005.

DFCM Application and Certification for Payment dated May 25, 2005.

Technical Specifications :

Drawings:

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

NOTICE TO CONTRACTORS

Sealed bids will be received by the Division of Facilities Construction and Management (DFCM) for:

FUME HOOD CONTROLS REPLACEMENT - SCIENCE BUILDING
SALT LAKE COMMUNITY COLLEGE - REDWOOD ROAD CAMPUS
SALT LAKE CITY, UTAH
DFCM PROJECT NO: 07305660

Bids will be in accordance with the Contract Documents that will be available at 4:00 PM on Monday, October 22, 2007, and distributed in electronic format only on CDs from DFCM, 4110 State Office Building, Salt Lake City, Utah and on the DFCM web page at <http://dfcm.utah.gov>. For questions regarding this project, please contact Craig Wessman, DFCM, at (801) 538-3246. No others are to be contacted regarding this bidding process. The construction budget for this project is \$300,000.

A **nonmandatory** pre-bid meeting will be held at 10:00 AM on Wednesday, October 24, 2007 in the Construction Trades Building Room 202, Salt Lake Community College Redwood Road Campus, approximately 4600 South Redwood Road, Salt Lake City, Utah. All bidders wishing to bid on this project are encouraged to attend.

Bids will be received until the hour of 2:30 PM on Thursday, November 1, 2007 at DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. NOTE: Bids must be received at 4110 State Office Building by the specified time.

A bid bond in the amount of five percent (5%) of the bid amount, made payable to the Division of Facilities Construction and Management on DFCM's bid bond form, shall accompany the bid.

The Division of Facilities Construction and Management reserves the right to reject any or all bids or to waive any formality or technicality in any bid in the interest of DFCM.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT
Marla Workman, Contract Coordinator
4110 State Office Building, Salt Lake City, Utah 84114

PROJECT DESCRIPTION

The existing controls for the fume hoods in the Science Building are to be removed and replaced with new controls to operate the hoods in a safe manner. These controls are to be connected to the campus Johnson Controls Metasys System to allow for monitoring the hood alarms and for the control of the make-up and exhaust air systems which serve the lab spaces. The exhaust system for the hoods and general lab space is a variable air volume type system and must maintain the proper air velocity through the hoods to meet the current standards for safe usage of fume hoods.

The work of replacement of the controls is expected to be completed during the break between fall and winter semesters (December 14, 2007 to January 7, 2008). Final completion of the air balancing and minor adjustments may happen up until the project completion date of January 18, 2008.

**PROJECT SCHEDULE**

PROJECT NAME: FUME HOOD CONTROLS REPLACEMENT - SCIENCE BUILDING SALT LAKE COMMUNITY COLLEGE – REDWOOD ROAD CAMPUS SALT LAKE CITY, UTAH				
DFCM PROJECT NO.: 07305660				
Event	Day	Date	Time	Place
Bidding Documents Available	Monday	October 22, 2007	4:00 PM	DFCM 4110 State Office Bldg SLC, UT and the DFCM web site *
Nonmandatory Pre-Bid Site Meeting	Wednesday	October 24, 2007	10:00 AM	Room 202 Construction Trades Bldg SLCC Redwood Rd Campus Approx 4600 S Redwood Rd Salt Lake City, UT
Last Day to Submit Questions	Thursday	October 25, 2007	4:00 PM	Craig Wessman – DFCM E-mail cwessman@utah.gov Fax (801)-538-3267
Addendum Deadline (exception for bid delays)	Monday	October 29, 2007	2:00 PM	DFCM web site *
Prime Contractors Turn In Bid and Bid Bond	Thursday	November 1, 2007	2:30 PM	DFCM 4110 State Office Bldg SLC, UT
Sub-Contractor List Due	Friday	November 2, 2007	2:30 PM	DFCM 4110 State Office Bldg SLC, UT Fax (801)-538-3677
Substantial Completion Date	Friday	January 18, 2008		

* **NOTE:** DFCM's web site address is <http://dfcm.utah.gov>



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

BID FORM

NAME OF BIDDER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Notice to Contractors" and in accordance with the "Instructions to Bidders", in compliance with your invitation for bids for the **FUME HOOD CONTROLS REPLACEMENT – SCIENCE BUILDING – SALT LAKE COMMUNITY COLLEGE – REDWOOD ROAD CAMPUS – SALT LAKE CITY, UTAH – DFCM PROJECT NO. 07305660** and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____)

(In case of discrepancy, written amount shall govern)

I/We guarantee that the Work will be Substantially Complete by **January 18, 2008**, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$125.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

The undersigned Contractor's License Number for Utah is _____

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in the Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract.

The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within the time set forth.

Type of Organization:

(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

Respectfully submitted,

Name of Bidder

ADDRESS:

Authorized Signature

INSTRUCTIONS TO BIDDERS

1. Drawings and Specifications, Other Contract Documents

Drawings and Specifications, as well as other available Contract Documents, may be obtained as stated in the Invitation to Bid.

2. Bids

Before submitting a bid, each contractor shall carefully examine the Contract Documents, shall visit the site of the Work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the Contract Documents. If the bidder observes that portions of the Contract Documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Representative and the necessary changes shall be accomplished by Addendum.

The bid, bearing original signatures, must be typed or handwritten in ink on the Bid Form provided in the procurement documents and submitted in a sealed envelope at the location specified by the Invitation to Bid prior to the deadline for submission of bids.

Bid bond security, in the amount of five percent (5%) of the bid, made payable to the Division of Facilities Construction and Management, shall accompany bid. **THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID.**

If the bid bond security is submitted on a bid bond form other than DFCM's required bid bond form, and the bid security meets all other legal requirements, the bidder will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. **NOTE: A cashier's check cannot be used as a substitute for a bid bond.**

3. Contract and Bond

The Contractor's Agreement will be in the form found in the specifications. The Contract Time will be as indicated in the bid. The successful bidder, simultaneously with the execution of the Contract Agreement, will be required to furnish a performance bond and a payment bond, both bearing original signatures, upon the forms provided in the procurement documents. The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the contract sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for subcontractors will be specified in the Supplementary General Conditions.

4. Listing of Subcontractors

Listing of Subcontractors shall be as summarized in the “Instructions and Subcontractor’s List Form”, which are included as part of these Contract Documents. The Subcontractors List shall be delivered to DFCM or faxed to DFCM at (801)538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the Contract Documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements is subject to a debarment hearing and may be debarred from consideration for award of contracts for a period of up to three years.

5. Interpretation of Drawings and Specifications

If any person or entity contemplating submitting a bid is in doubt as to the meaning of any part of the drawings, specifications or other Contract Documents, such person shall submit to the DFCM Project Manager a request for an interpretation thereof. The person or entity submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by addenda posted on DFCM’s web site at <http://dfcm.utah.gov>. Neither the DFCM nor A/E will be responsible for any other explanations or interpretations of the proposed documents. A/E shall be deemed to refer to the architect or engineer hired by DFCM as the A/E or Consultant for the Project.

6. Addenda

Addenda will be posted on DFCM’s web site at <http://dfcm.utah.gov>. Contractors are responsible for obtaining information contained in each addendum from the web site. Addenda issued prior to the submittal deadline shall become part of the bidding process and must be acknowledged on the bid form. Failure to acknowledge addenda may result in disqualification from bidding.

7. Award of Contract

The Contract will be awarded as soon as possible to the lowest, responsive and responsible bidder, based on the lowest combination of base bid and acceptable prioritized alternates, provided the bid is reasonable, is in the interests of the State of Utah to accept and after applying the Utah Preference Laws in U.C.A. Title 63, Chapter 56. DFCM reserves the right to waive any technicalities or formalities in any bid or in the bidding. Alternates will be accepted on a prioritized basis with Alternate 1 being highest priority, Alternate 2 having second priority, etc.

8. DFCM Contractor Performance Rating

As a contractor completes each DFCM project, DFCM, the architect/engineer and the using agency will evaluate project performance based on the enclosed “DFCM Contractor Performance Rating” form. The ratings issued on this project will not affect this project but may affect the award on future projects.

9. Licensure

The Contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

10. Permits

In concurrence with the requirements for permitting in the General Conditions, it is the responsibility of the Contractor to obtain the fugitive dust plan requirements from the Utah Division of Air Quality and the SWPPP requirements from the Utah Department of Environmental Quality and submit the completed forms and pay any permit fee that may be required for this specific project. Failure to obtain the required permit may result in work stoppage and/or fines from the regulating authority that will be the sole responsibility of the Contractor. Any delay to the project as a result of any such failure to obtain the permit or noncompliance with the permit shall not be eligible for any extension in the Contract Time.

11. Right to Reject Bids

DFCM reserves the right to reject any or all Bids.

12. Time is of the Essence

Time is of the essence in regard to all the requirements of the Contract Documents.

13. Withdrawal of Bids

Bids may be withdrawn on written request received from bidder prior to the time fixed for opening. Negligence on the part of the bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened.

14. Product Approvals

Where reference is made to one or more proprietary products in the Contract Documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the Contract Documents, the products of other manufacturers will be accepted, provided they equal or exceed the standards set forth in the drawings and specifications and are compatible with the intent and purpose of

the design, subject to the written approval of the A/E. Such written approval must occur prior to the deadline established for the last scheduled addenda to be issued. The A/E's written approval will be in an issued addendum. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the A/E.

15. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the contractor, subcontractor or sub-subcontractor.

16. Debarment

By submitting a bid, the Contractor certifies that neither it nor its principals, including project and site managers, have been, or are under consideration for, debarment or suspension, or any action that would exclude such from participation in a construction contract by any governmental department or agency. If the Contractor cannot certify this statement, attach to the bid a detailed written explanation which must be reviewed and approved by DFCM as part of the requirements for award of the Project.

**Division of Facilities Construction and****INSTRUCTIONS AND SUBCONTRACTORS LIST FORM**

The three low bidders, as well as all other bidders that desire to be considered, are required by law to submit to DFCM within 24 hours of bid opening a list of **ALL** first-tier subcontractors, including the subcontractor's name, bid amount and other information required by Building Board Rule and as stated in these Contract Documents, based on the following:

DOLLAR AMOUNTS FOR LISTING

PROJECTS UNDER \$500,000: ALL FIRST-TIER SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE: ALL FIRST-TIER SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the bid documents shall also be listed.
- The DFCM Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Bidder may not list more than one subcontractor to perform the same work.
- If there are no subcontractors for the job that are required to be reported by State law (either because there are no subcontractors that will be used on the project or because there are no first-tier subcontractors over the dollar amounts referred to above), then you do not need to submit a sublist. If you do not submit a sublist, it will be deemed to be a representation by you that there are no subcontractors on the job that are required to be reported under State law. At any time, DFCM reserves the right to inquire, for security purposes, as to the identification of the subcontractors at any tier that will be on the worksite.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Bidder shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

'SPECIAL EXCEPTION':

A bidder may list 'Special Exception' in place of a subcontractor when the bidder intends to obtain a subcontractor to perform the work at a later date because the bidder was unable to obtain a qualified or reasonable bid under the provisions of U.C.A. Section 63A-5-208(4). The bidder shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the bidder's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the bidder was unable to obtain a qualified subcontractor bid. The Director must find that the bidder complied in good faith with State law requirements for any 'Special Exception' designation, in order for the bid to be considered. If awarded the contract, the Director shall supervise the bidder's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

GROUNDS FOR DISQUALIFICATION:

The Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular bidder if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
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such other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of the Director, the Director may provide notice to the contractor and the contractor shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to twenty-four hours after the bid opening, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the Contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors:

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONTRACTOR LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self" *	\$300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	\$298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: \$350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

* Bidders may list "self", but it is not required.

PURSUANT TO STATE LAW - SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS SUBCONTRACTOR LIST SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.



SUBCONTRACTORS LIST
FAX TO 801-538-3677

PROJECT TITLE: _____

Caution: You must read and comply fully with instructions.

Table with 4 columns: TYPE OF WORK, SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION", SUBCONTRACTOR BID AMOUNT, CONT. LICENSE #

We certify that:

- 1. This list includes all subcontractors as required by the instructions, including those related to the base bid as well as any alternates.
2. We have listed "Self" or "Special Exception" in accordance with the instructions.
3. All subcontractors are appropriately licensed as required by State law.

FIRM: _____

DATE: _____

SIGNED BY: _____

NOTICE: FAILURE TO SUBMIT THIS FORM, PROPERLY COMPLETED AND SIGNED, AS REQUIRED IN THESE CONTRACT DOCUMENTS, SHALL BE GROUNDS FOR OWNER'S REFUSAL TO ENTER INTO A WRITTEN CONTRACT WITH BIDDER. ACTION MAY BE TAKEN AGAINST BIDDERS BID BOND AS DEEMED APPROPRIATE BY OWNER. ATTACH A SECOND PAGE IF NECESSARY.

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____."

The DFCM General Conditions ("General Conditions") dated May 25, 2005 on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____ DOLLARS AND NO CENTS (\$_____.00), which is the base bid, and which sum also includes the cost of a 100% Performance Bond and a 100%

CONTRACTOR'S AGREEMENT
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Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete by _____. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Invitation to Bid, Instructions to Bidders/ Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials purchased and on the site but not installed, for which the Contractor requests payment and agrees to

safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ (Seal)
Attorney-in-Fact

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____
Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General



CERTIFICATE OF SUBSTANTIAL COMPLETION

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

- As-built Drawings
- O & M Manuals
- Warranty Documents
- Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____(Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. The amount withheld pending completion of the list of items noted and agreed to shall be: \$_____. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

_____ by: _____
CONTRACTOR (include name of firm) (Signature) DATE

_____ by: _____
A/E (include name of firm) (Signature) DATE

_____ by: _____
USING INSTITUTION OR AGENCY (Signature) DATE

_____ by: _____
DFCM (Owner) (Signature) DATE

**General Contractor Performance Rating Form**

Project Name:		DFCM Project#	
Contractor: <small>(ABC Construction, John Doe, 111-111-1111)</small>	A/E: <small>(ABC Architects, Jane Doe, 222-222-2222)</small>	Original Contract Amount:	Final Contract Amount:
DFCM Project Manager:		Contract Date:	
Completion Date:		Date of Rating:	

Rating Guideline	QUALITY OF PRODUCT OR SERVICES	COST CONTROL	TIMELINESS OF PERFORMANCE	BUSINESS RELATIONS
5-Exceptional	Contractor has demonstrated an exceptional performance level in any of the above four categories that justifies adding a point to the score. Contractor performance clearly exceeds the performance levels described as "Very Good"			
4-Very Good	Contractor is in compliance with contract requirements and/or delivers quality product/service.	Contractor is effective in managing costs and submits current, accurate, and complete billings	Contractor is effective in meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is effective
3-Satisfactory	Minor inefficiencies/errors have been identified	Contractor is usually effective in managing cost	Contractor is usually effective in meeting milestones and delivery schedules	Response to inquires technical/service/administrative issues is somewhat effective
2-Marginal	Major problems have been encountered	Contractor is having major difficulty managing cost effectively	Contractor is having major difficulty meeting milestones and delivery schedule	Response to inquiries, technical/service/administrative issues is marginally effective
1-Unsatisfactory	Contractor is not in compliance and is jeopardizing achievement of contract objectives	Contractor is unable to manage costs effectively	Contractor delays are jeopardizing performance of contract objectives	Response to inquiries, technical/service/administrative issues is not effective

1. Rate Contractors quality of workmanship, management of sub contractor performance, project cleanliness, organization and safety requirement.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

2. Rate Contractor administration of project costs, change orders and financial management of the project budget.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

3. Rate Contractor's performance and adherence to Project Schedule, delay procedures and requirements of substantial completion, inspection and punch-list performance.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

4. Evaluate performance of contractor management team including project manager, engineer and superintendent also include in the rating team's ability to work well with owner, user agency and consultants.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

5. Rate success of Contractor's management plan, completion of the plans mitigation of project risks and performance of value engineering concepts.	Score
<u>Agency Comments:</u>	
<u>A & E Comments:</u>	
<u>DFCM Project Manager Comments:</u>	

Signed by:	Date:	Mean Score
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Additional Comments:

Technical Specifications

for

Science Lab Hood Controls Improvement Project

**State of Utah
Salt Lake Community College
Salt Lake City, Utah**

October 2007



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Engineering, Environmental and Construction Services - Worldwide

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Technical Specifications

for

Science Lab Hood Controls Improvement Project

**State of Utah
Salt Lake Community College
Salt Lake City, Utah**

October 12, 2007



A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

SCIENCE LAB HOOD CONTROLS
IMPROVEMENT PROJECT

STATE OF UTAH
SALT LAKE COMMUNITY COLLEGE
SALT LAKE CITY, UTAH

SPECIFICATIONS GROUP

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Drawing No.	Title	Rev. No.
G1	Title Sheet & Sheet Index	0
G2	Mechanical Schedules	0
G3	Control Schematic Details	0
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G5	Control Schematic Details	0
G6	Control Schematic Details	0
MD2.5	Partial Second Floor Mechanical Demolition Plan	0
MD2.7	Partial Third Floor Mechanical Demolition Plan	0
M2.5	Partial Second Floor Mechanical Plan	0
M2.7	Partial Third Floor Mechanical Plan	0
E2.5	Partial Second Floor Electrical Plan	0
E2.7	Partial Third Floor Electrical Plan	0

1.01 CONTRACT DESCRIPTION

- A. Work of this contract comprises Laboratory Fume Hood Controls Improvements including mechanical, electrical, and controls renovation of the existing Science Lab Building Lab Classrooms located at Salt Lake Community College, for the State of Utah-DFCM and Salt Lake Community College.
- B. Work of the Project includes the demolition and replacement of fume hood controls.
- C. Perform Work of Contract under a fixed cost contract with the Owners in accordance with the Conditions of Contract.
- D. Work of Contract is identified in the following Project Manual and on Drawings.

1.02 WORK BY OWNER

- A. Owner will award a contract for the supply and installation of Complete Working Control System which will commence on or about December 14, 2007,
- B. Work under this contract will include:
 - 1. Existing Controls Demolition: The Owner has contracted for demolition of the existing Crown Controls System in the Laboratory Classrooms, Lab Storage Rooms, and Lab Prep Rooms, and removal of its components. Also included: demolition of the existing Pneumatic HWS Reheat Control Valves associated with the Crown Controls. Also included: electrical disconnection of the existing Crown Controls.
 - 2. Provide New Controls System: The owner will contract for the contractors to provide a complete working new HVAC Controls System in the Laboratory Classrooms, Lab Storage Rooms, and Lab Prep Rooms. Also included: Provide new Electric HWS Reheat Control Valve Actuators associated with the existing Reheat coils in the rooms above. Also included: Provide all necessary electrical components and connections to allow the controls and control valves to function as designed on the original construction documents which were issued in 1993.
- C. Items noted NIC (Not in Contract), Variable Air Volume Dampers, Ductwork, and Piping. If the bidders or equipment manufacturers, cannot operate their control systems with the existing VAV butterfly dampers, then they shall be responsible for replacing the VAV dampers, supply reheat coils, and any ductwork modifications.
- D. Contractor shall remove and Owner will take possession of the following items prior to start of work:
 - 1. Existing Pneumatic Hot Water Control Valve Actuators, Johnson Controls V-3000-1.

1.03 OWNER-SUPPLIED PRODUCTS

- A. Owner's Responsibilities:
 - 1. Arrange for and deliver Owner-reviewed Shop Drawings, Product Data, and Samples, to Contractor.
 - 2. Arrange and pay for delivery to site.
 - 3. On delivery, inspect products jointly with Contractor.
 - 4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
 - 5. Arrange for manufacturers' warranties, inspections, and service.
- B. Contractor's Responsibilities:
 - 1. Review Owner-reviewed Shop Drawings, Product Data, and Samples.
 - 2. Receive and unload products at site; inspect for completeness or damage jointly with Owner.
 - 3. Handle, store, install and finish products.
 - 4. Repair or replace items damaged after receipt.

1.04 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Limit use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Use of site and premises by the public.
- B. Access to Site: Limited to Owners requirements.
- C. Emergency Building Exits During Construction: Limited to those adjacent to the work areas.
- D. Construction Operations: Limited to areas noted on Drawings.
- E. Time Restrictions for Performing Interior Work: Dec 14, 2007 – Jan 15, 2008. The bulk of the work shall occur during the Owners' Winter Break period. Other work hours shall be negotiated with the Owners to minimize any noise, disruptions, or shut-downs during normally scheduled class hours.
- F. Utility Outages and Shutdown: Limited to the area of the scope of work, During Unoccupied hours only, and limited to contractors' work hours.
- G. Coordinate use of premises under direction of Owner.

1.05 WORK SEQUENCE

- A. Construct Work in stages to accommodate Owner's occupancy requirements during the construction period, coordinate construction schedule and operations with Owner:
 - 1. Stage 1: Disconnect electrical from existing Crown Control System.
 - 2. Stage 2: Demolish existing Crown Control System, & HWS Reheat Control Valves.
 - 3. Stage 3: Provide new Control System for the existing Laboratory VAV boxes, new HWS Control Valves.
 - 4. Stage 4: Provide electrical equipment and connections for above Control System and Control Valves. Re-start electrical service.
 - 5. Stage 5: Provide Factory Start-up of new Control System. Provide Software & Programming of new Control System from the existing Johnson Controls Building Management System to include monitoring and control capabilities from the existing Head End Workstation.
 - 6. Stage 6: Provide Testing & Balancing Service and reports of new Control System.
 - 7. Stage 7: Provide Demonstration & Training of new Control System to the Owners.

1.06 OWNER OCCUPANCY

- A. Owner intends to re-occupy Laboratory portion of Science Lab Project by end of 2007-2008 Winter Break of SLCC.
- B. Owner will occupy premises as needed during entire period of construction to conduct normal operations, except for normal classroom schedule.
- C. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.
- D. Schedule the Work to accommodate Owner occupancy.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 CASH ALLOWANCES

- A. Differences in costs will be adjusted by Change Order.
- B. Allowances schedule:
 - 1. Section 01 70 00: Execution and Close Out Procedures: Include stipulated sum of \$5000 for expenses for factory training of Owners' personnel if required.
 - 2. Section 02 41 00: Include stipulated sum of \$5000 for unknown existing conditions and/or demolition coordination.
 - 3. Section 09 51 00: Acoustical Ceilings: Include stipulated sum of \$5000 for purchase, delivery, and installation of replacement ceiling tiles and/or grids.
 - 4. Section 26 05 00: Basic Electrical Materials & Methods: Include unit price of \$5000 for purchase, delivery, and installation of replacement light bulbs, light fixtures, and/or other electrical materials.

1.02 CONTINGENCY ALLOWANCES

- A. Include in Contract, a stipulated price of \$5000 for use upon Owner's instruction.
- B. Contractor's costs for products, delivery, installation, labor, insurance, payroll, taxes, bonding, equipment rental, overhead and profit will be included in Change Orders authorizing expenditure of funds from this Contingency Allowance.
- C. Funds will be drawn from Contingency Allowance only by Change Order.
- D. At closeout of Contract, funds remaining in Contingency Allowance will be credited to Owner by Change Order.

1.03 TESTING AND INSPECTION ALLOWANCES

- A. Costs included in testing and inspecting allowances: Cost of engaging a testing and inspecting agency; execution of tests and inspecting; and reporting results.
- B. Costs not included in testing and inspecting allowance but included in contract price:
 - 1. Costs of incidental labor and facilities required to assist testing or inspecting agency.
 - 2. Costs of testing services used by Contractor separate from Contract Document requirements.
 - 3. Costs of retesting upon failure of previous tests as determined by Engineer.
- C. Differences in cost will be adjusted by Change Order.

1.04 SCHEDULE OF VALUES

- A. Submit a printed schedule on Form(s) by Owners - Application and Certificate for Payment Sheet.
- B. Submit Schedule of Values in duplicate within 15 days after date of Owner-Contractor Agreement.
- C. Format: Use Table of Contents of this Project Manual. Identify each line item with number and title of major specification Section. Identify site mobilization, bonds and insurance.
- D. Include in each line item, amount of allowances specified in this section. *For unit cost allowances, identify quantities taken from Contract Documents multiplied by unit cost to achieve total for item.*
- E. Include within each line item, a direct proportional amount of Contractor's overhead and profit.
- F. Revise schedule to list approved Change Orders, with each Application for Payment.

1.05 APPLICATIONS FOR PAYMENT

- A. Submit 3 copies of each application on Owners' Form - Application and Certificate for Payment.
- B. Content and format: Use Schedule of Values for listing items in Application for Payment.
- C. Submit an updated construction schedule with each Application for Payment.
- D. Payment period: Submit at intervals stipulated in Agreement.
- E. Submit with transmittal letter as specified for Submittals in Section 01 33 00.
- F. Submit waivers.
- G. Substantiating data: When Engineer requires substantiating information, submit data justifying dollar amounts in question. Include following with application:
 - 1. Current construction photographs specified in Section 01 70 00.
 - 2. Partial release of liens from major subcontractors and vendors.
 - 3. Record documents as specified in Section 01 70 00, for review by Owner which will be returned to Contractor.
 - 4. Affidavits attesting to off-site stored products.

1.06 CHANGE PROCEDURES

- A. Submittals: Submit name of individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to Work.
- B. Engineer will advise of minor changes in Work not involving an adjustment to Contract Price or Contract Time by issuing supplemental instructions on Engineer's Instruction to Contractor (ITC) Form SC2264-1299.
- C. Engineer may issue a proposal request which includes detailed description of proposed change with supplementary or revised Drawings and Specifications, change in Contract Time for executing change. Contractor will prepare and submit an estimate within 3 days.
- D. Contractor may propose changes by submitting a request for change to Engineer, describing proposed change and its full effect on Work. Include a statement describing reason for change, and effect on Contract Price and Contract Time with full documentation *and a statement describing effect on Work by separate or other contractors*. *Document any requested substitutions in accordance with Section 01 60 00.
- E. Stipulated price Change Order: Based on proposal request and Contractor's fixed price quotation *or Contractor's request for a Change Order as approved by Engineer.
- F. Unit price Change Order: For contract unit prices and quantities, Change Order will be executed on a fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, execute Work under a Construction Change Directive.
- G. Construction Change Directive: Engineer may issue a directive, on Work Directive Change signed by Owner, instructing Contractor to proceed with a change in Work, for subsequent inclusion in a Change Order. Document will describe changes in Work, and designate method of determining any change in Contract Price or Contract Time. Promptly execute change.
- H. Time and material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in Conditions of Contract. Engineer will determine change allowable in Contract Price and Contract Time as provided in Contract Documents.

- I. Maintain detailed records of work done on time and material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in Work.
- J. Document each quotation for a change in cost or time with sufficient data to allow evaluation of quotation.
- K. Change Order Forms: Engineer's Change Order Form SC2264 1299.
- L. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in Conditions of Contract.
- M. Correlation of Contractor submittals:
 - 1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust Contract Price.
 - 2. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by change, and resubmit.
 - 3. Promptly enter changes in Project Record Documents.

1.07 DEFECT ASSESSMENT

- A. Replace Work, or portions of Work, not conforming to specified requirements.
- B. If, in opinion of Engineer, it is not practical to remove and replace Work, Engineer or Owner will direct an appropriate remedy or adjust payment.
- C. Defective Work may remain, but unit price will be adjusted to a new price at discretion of Engineer or Owner.
- D. Defective Work will be partially repaired to instructions of Engineer or Owner, and unit price will be adjusted to a new price at discretion of Engineer or Owner.
- E. Individual specification sections may modify these options or may identify a specific formula or percentage price reduction.
- F. Authority of Engineer or Owner to assess defect and identify payment adjustment, is final.
- G. Nonpayment for rejected products: Payment will not be made for rejected products for any of following:
 - 1. Products wasted or disposed of in a manner that is not acceptable.
 - 2. Products determined as unacceptable before or after placement.
 - 3. Products not completely unloaded from transporting vehicle.
 - 4. Products placed beyond lines and levels of required Work.
 - 5. Products remaining on hand after completion of Work.
 - 6. Loading, hauling, and disposing of rejected products.

1.08 UNIT ADJUSTMENT PRICES

- A. Unit adjustment prices will be used to adjust Contract Price for additions to or deductions from quantities required by Contract Documents.
 - 1. Additions to Work will be made at 115% of prices submitted.
 - 2. Deletions from Work will be made at 90% of prices submitted.
 - 3. Net changes of quantities shall first be determined before price factors are applied.
 - 4. Percentages specified will not be applied to unit adjustment prices quoted for Service Engineer.
- B. Unit adjustment prices apply only to additions to or deductions from quantities required by Contract Documents made necessary by unforeseen conditions or changes deemed necessary or desirable by Owner during construction. Additions or deductions necessary to accommodate equipment furnished

and installed under Agreement shall be made by Contractor at its expense, and unit adjustment prices shall not apply.

1.09 ALTERNATES

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.
- B. Coordinate related work and modify surrounding work as required.
- C. Base Bid: includes complete controls system to control existing supply, general exhaust, and hood exhaust VAV dampers in Laboratory areas based upon simple offset air flow control only.
- D. Alternate No. 1: Includes (2) Optional Pressure Sensor devices: TSI 800326, including parts and labor for complete working pressure verification devices.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 SUBSTITUTIONS

- A. Instructions to Bidders specify time restrictions for submitting requests for Substitutions during the bidding period to requirements specified in this section.
- B. For period of 15 days after effective date of Agreement, Engineer will consider formal requests from Contractor for substitution of products in place of those specified. After end of that period, requests will be considered only in case of product unavailability or other conditions beyond control of Contractor.
- C. Submit 3 copies of request for substitution for consideration using attached Product Substitution Request Form. Limit each request to one proposed Substitution. Support each request with:
 - 1. Complete data substantiating compliance of proposed substitutions with requirements stated in Contract Documents. Burden of proof is on proposer.
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature; identify:
 - 1) Product description.
 - 2) Reference standards.
 - 3) Performance and test data.
 - c. Samples, as applicable.
 - d. Name and address of similar projects on which product has been used, and date of each installation.
 - 2. Itemized comparison of proposed substitution with product specified; list significant variations.
 - 3. Data relating to changes in construction schedule.
 - 4. Any effect of substitution on separate contracts.
 - 5. List of changes required in other work or products.
 - 6. Accurate cost data comparing proposed substitution with product specified. Amount of any net change to Contract Price.
 - 7. Designation of required license fees or royalties.
 - 8. Designation of availability of maintenance services, sources, or replacement materials.
- D. Substitutions will not be considered for acceptance when:
 - 1. They are indicated or implied on Shop Drawings.
 - 2. They are requested directly by Subcontractor or supplier.
 - 3. Acceptance will require substantial revision of Contract Documents.
- E. Substitute products shall not be ordered or installed without written notification from Engineer of Owner's acceptance.
- F. Engineer will determine acceptability of proposed substitutions.

1.02 CONTRACTOR'S REPRESENTATION

- A. In making formal request for substitution Contractor represents that:
 - 1. It has investigated proposed product and has determined that it is equal to or superior in all respects to that specified.
 - 2. It will provide same warranties or Bonds for substitution as for product specified or as required by Owner.
 - 3. It will coordinate installation of accepted substitution into Work, and will make such changes as may be required for Work to be complete in all respects.
 - 4. It waives claims for additional costs caused by substitution which may subsequently become apparent.
 - 5. Cost data is complete and includes related costs under its Agreement, but not:
 - a. Costs under separate contracts.

- b. Engineer's costs for redesign or revision of Contract Documents.
- 6. It will reimburse Owner for charges of Engineer or Engineer's consultants for evaluating any proposed substitute, whether proposed substitute is accepted or rejected.

1.03 ENGINEER DUTIES

- A. Review Contractor's requests for substitution with reasonable promptness and advise Owner.
- B. Notify Contractor in writing of Owner's decision to accept or reject requested substitution.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PRODUCT SUBSTITUTION REQUEST FORM

To: _____

Project: _____

Specified Item: _____
 Section Page Paragraph Description

The undersigned request consideration of the following:

PROPOSED SUBSTITUTION _____

Attached data includes product description, specifications, drawings, photographs, performance, and test data adequate for evaluation of the request; applicable portions of the data are clearly identified.

Attached data also includes a description of changes to the Contract Documents that the proposed substitution will require for its proper installation.

The undersigned certifies that the following paragraphs, unless modified by attachments are correct:

1. The proposed substitution does not affect dimensions shown on Drawings.
2. The undersigned will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse affect on other trades, the construction schedule, or specified warranty requirements.
4. Maintenance and service parts will be locally available for the proposed substitution.

The undersigned further states that the function, appearance, and quality of the proposed substitution are equivalent or superior to the specified item.

Submitted by:

Signature _____

Firm _____

Address _____

Date _____

Telephone _____

Attachments

For use by Engineer/Architect

Approved Approved as noted

Not Approved Received too late

By _____

Date _____

Remarks _____

PART 1 GENERAL

1.01 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements *, with provisions for accommodating items installed later*.
- B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements, supports, and installation of mechanical and electrical Work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- E. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.
- F. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.02 COPIES OF DRAWINGS AND PROJECT MANUALS

- A. After Notice of Award, Contractor may obtain, at no charge, up to 5 sets of printed or hard copies of the Project Manual *and one set in electronic format*. Additional copies will be furnished upon request at the cost of reproduction plus handling charge. If Contractor's requirements for additional project manuals necessitates reprinting of project manuals, Contractor shall pay entire cost of such reprinting. Partial sets of project manuals will not be provided.
- B. Revised project manuals, if required, will be provided by Engineer to show authorized changes or extra Work under provisions of Item "A." preceding.
- C. After Notice of Award, Contractor may obtain, at no charge, up to 5 printed or hard copies of the Drawings and Project Manual *and one set in electronic format*. Additional copies will be furnished upon request at the cost of reproduction plus handling charge.
- D. Additional copies of project manuals and half-size and full-size Drawings may be obtained under following conditions:
 - 1. Project manuals:
 - a. Furnished at Engineer's reproduction cost plus handling charge.
 - b. If Contractor's requirement for additional project manuals necessitates reprinting of project manuals, Contractor shall pay entire cost of such reprinting.
 - c. Partial sets of project manuals will not be provided.
 - 2. Half-size Drawings:
 - a. Furnished at Engineer's reproduction cost plus handling charge.
 - b. If Contractor's requirement for additional Drawings necessitates reprinting of half-size Drawings, Contractor shall pay entire cost of such reprinting.
- E. Revised Drawings and project manuals, if required, will be provided by Engineer to show authorized changes or extra Work under following conditions:
 - 1. Project manuals: Furnished at no charge, in same quantity as original issuance.

2. Half-size Drawings:
 - a. Half-size Drawings will not be available as revised Drawings.
 - b. One revised, complete set of half-size Drawings will be issued, at no charge, for each half-size set originally issued and for each half-size set purchased by Contractor after Notice of Award.
3. Full-size Drawings:
 - a. One revised, complete set of full-size Drawings will be issued, at no charge, for each full-size set originally issued.
 - b. One revised, complete set of full-size Drawings will be issued, at no charge, for each full-size set originally issued, and for each full-size set purchased by Contractor after Notice of Award, up to 4 copies maximum.
4. One full-size reproducible set will be issued to accommodate fifth and subsequent sets purchased by Contractor. Contractor shall use reproducible set to complete printing for additional Drawings in its possession.

1.03 PROJECT SITE ADMINISTRATION

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out Work and perform construction as required by Contract Documents. Contractor shall at all times maintain good discipline and order at site.
- B. Except in connection with safety or protection of persons or Work or property at site or adjacent thereto, and except as otherwise indicated in Contract Documents, all Work at site shall be performed during regular working hours, and Contractor shall not permit overtime work or performance of Work on Saturday, Sunday, or any legal holiday without Owner's written consent given after prior written notice to Engineer.
- C. Incompetent or incorrigible employees shall be dismissed from Work by Contractor or its representative when requested by Engineer, and such persons shall not again be permitted to return to Work without written consent of Engineer.
- D. Workmanship shall be of best quality.

1.04 PROJECT MEETINGS

- A. Representatives of Contractor, Subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of entity each represents.
- B. Preconstruction meeting:
 1. Owner or Engineer will schedule a meeting after 5 days after Notice to proceed
 2. Location: A central site, convenient for all parties, designated by Owner.
 3. Attendance:
 - a. Owner's representative.
 - b. Engineer and its professional consultants.
 - c. Resident Project Representative.
 - d. Contractor's superintendent.
 - e. Major Subcontractors.
 - f. Major suppliers.
 - g. Others as appropriate.
 4. Agenda:
 - a. Execution of Owner-Contractor Agreement.
 - b. Submission of executed bonds and insurance certificates.
 - c. Distribution of Contract Documents.
 - d. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
 - e. Designation of personnel representing the parties in Contract, Owners, and the Engineer.
 - f. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.

- g. Scheduling.
 - 5. Record minutes and distribute copies within 2 days after meeting to participants, with one copy to Engineer, Owner, participants, and those affected by decisions made.
- C. Site mobilization meeting:
- 1. Engineer or Owner will schedule a meeting at the Project site prior to Contractor occupancy.
 - 2. Attendance required: Owner, Engineer, and, Contractor's Superintendent, and major Subcontractors.
 - 3. Agenda:
 - a. Use of premises by Owner and Contractor.
 - b. Owner's requirements and partial occupancy.
 - c. Construction facilities and controls provided by Owner.
 - d. Temporary utilities provided by Owner.
 - e. Building layout.
 - f. Security and housekeeping procedures.
 - g. Schedules.
 - h. Application for payment procedures.
 - i. Procedures for testing.
 - j. Procedures for maintaining record documents.
 - k. Requirements for start-up of equipment.
 - l. Inspection and acceptance of equipment put into service during construction period.
 - 4. Record minutes and distribute copies within 2 days after meeting to participants, with one copy to Engineer, Owner, participants, and those affected by decisions made.
- D. Progress meetings:
- 1. Schedule and administer meetings throughout progress of the Work at periodic maximum bi-weekly intervals.
 - 2. Engineer will hold called meetings as required by progress of Work.
 - 3. Location of meetings: Project field office of Contractors.
 - 4. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
 - 5. Attendance:
 - a. Engineer, and its professional consultants as needed.
 - b. Contractor and Subcontractors as appropriate to agenda.
 - c. Suppliers as appropriate to agenda.
 - d. Others.
 - 6. Suggested agenda:
 - a. Review, approval of minutes of previous meeting.
 - b. Review of Work progress since previous meeting.
 - c. Field observations, problems, conflicts.
 - d. Problems which impede construction schedule.
 - e. Review of off-site fabrication, delivery schedules.
 - f. Corrective measures and procedures to regain projected schedule.
 - g. Revisions to construction schedule.
 - h. Progress, schedule, during succeeding Work period.
 - i. Coordination of schedules.
 - j. Review submittal schedules; expedite as required.
 - k. Maintenance of quality standards.
 - l. Pending changes and substitutions.
 - m. Review proposed changes for:
 - 1) Effect on construction schedule and on completion date.
 - 2) Effect on other contracts of Project.
 - 3) Other business.
 - 7. Record minutes and distribute copies within 2 days after meeting to participants, with 1 copy to Engineer, Owner, participants, and those affected by decisions made.
- E. Preinstallation meeting:

1. When required in individual specification sections, convene a preinstallation meeting at Site prior to commencing work of the section.
2. Require attendance of parties directly affecting, or affected by, Work of the specific section.
3. Notify Engineer 2 days in advance of meeting date.
4. Prepare agenda and preside at meeting:
 - a. Review conditions of installation, preparation and installation procedures.
 - b. Review coordination with related work.
5. Record minutes and distribute copies within 2 days after meeting to participants, with 1 copy to Engineer, Owner, participants, and those affected by decisions made.

PART 2 PRODUCTS

2.01 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Motors: Specific motor type is specified in individual specification sections.
- B. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.
- C. Cord and Plug: Provide minimum 6' (2 m) cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

PART 3 EXECUTION

3.01 SPECIAL PROCEDURES

- A. Materials: As specified in product sections; match existing with new products and salvaged products for patching and extending work.
- B. Employ skilled and experienced installer to perform alteration work.
- C. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.
- D. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.
- E. Remove debris and abandoned items from area and from concealed spaces.
- F. Prepare surface and remove surface finishes to provide for proper installation of new work and finishes.
- G. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature and humidity.
- H. Remove, cut, and patch Work in a manner to minimize damage and to provide means of restoring products and finishes to original or specified condition.
- I. Refinish existing visible surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.
- J. Where new Work abuts or aligns with existing, provide a smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.
- K. When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and submit recommendation to Engineer for review.

- L. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.
- M. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections.
- N. Finish surfaces as specified in individual product sections.

END OF SECTION

PART 1 GENERAL

1.01 SUBMITTAL PROCEDURES

- A. Deliver 5 copies of submittals to person listed below when required by Specification Sections:
 - 1. Engineer
Mr Dan Rollins
Email: rollinsdan@stanleygroup.com
Stanley Consultants, Inc.
Suite 220
5353 S 960 E
Salt Lake City, UT 84117-7269
- B. Submittals shall be in English language.
- C. Weights, measures, and units shall be English units.
- D. Symbols and drawings shall conform to ANSI Y32.2/IEEE 315/CSA Z99.

1.02 CONTRACTOR RESPONSIBILITIES

- A. Review submittals prior to submission.
- B. Determine and verify:
 - 1. Field measurements.
 - 2. Field construction criteria.
 - 3. Catalog numbers and similar data.
 - 4. Conformance to Specifications.
- C. Coordinate each submittal with other submittals and with requirements of Work and of Contract Documents.
- D. Notify Engineer in writing, at time of submission, of any deviations in submittals from requirements of Contract Documents. Any such deviations permitted by Engineer will require modifications of Contract Documents.
- E. Provide space on Shop Drawings for Contractor and Engineer stamps.
- F. When Shop Drawings are revised for resubmission, identify all changes made since previous submission.
- G. Submittals containing language imposing duties on others (such as verification of dimensions or supply of related information) inconsistent with contract language shall be null and void.
- H. Submittals shall not be used as media for inquiries for information or for verification of information that must be supplied by others to Contractor. Inquiries or verification of information shall be made by separate Contractor submittal using Request for Information (RFI) process.
- I. Begin no fabrication or Work which requires submittal review until return of submittals by Engineer with stamp, as either "Reviewed", "Reviewed as Noted", or "Reviewed as Noted-Resubmit."
- J. Distribute copies of reviewed submittals that carry Engineer stamp as either "Reviewed" or "Reviewed as Noted" as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- K. Submittals not requested will not be recognized or processed.

1.03 ENGINEER DUTIES

- A. Review required submittals with reasonable promptness and in accord with schedule, only for general conformance to design concept of Project and compliance with information given in Contract Documents. Review shall not extend to means, methods, sequences, techniques, or procedures of construction or to safety precautions or program incident thereto. Review of a separate item as such will not indicate approval of assembly in which item functions.
- B. Affix stamp and initials or signature, and indicate requirements for resubmittal, or review of submittal. Engineer's action on submittals is classified as follows:
 - 1. Reviewed: Submittal has been reviewed and appears to be in conformance to design concept of Project and Contract Documents. Contractor may proceed with fabrication of work in submittal.
 - 2. Reviewed As Noted: Submittal has been reviewed and appears to be in conformance to design concept of Project and Contract Documents, except as noted by reviewer. Contractor may proceed with fabrication of work in submittal with modifications and corrections as indicated by reviewer.
 - 3. Reviewed As Noted-Resubmit: Submittal has been reviewed and appears to be in conformance to design concept of Project and Contract Documents, except as noted by reviewer. Contractor may proceed with fabrication of work in submittal with modifications and corrections as indicated by reviewer. Contractor shall make any corrections indicated by reviewer and resubmit for review.
 - 4. Resubmit: Submittal has been reviewed and appears not to be in conformance to design concept of Project or with Contract Documents. Contractor shall not proceed with fabrication of work in submittal, but instead shall make any corrections required by reviewer and resubmit for review.
 - 5. Returned without Review: Submittal is being returned without having been reviewed because: 1) not required by Contract Documents; 2) grossly incomplete; 3) indicates no attempt at conformance to Contract Documents; 4) cannot be reproduced; 5) lacks Contractor's completed approval stamp; or 6) lacks design professional's seal when required by law or Contract Documents. If submittal is required by Contract Documents, Contractor shall not proceed with Work as detailed in submittal, but instead shall correct defects and resubmit for review.
 - 6. For Information Only: Submittal has not been reviewed but is being retained for informational purposes only.
 - 7. Void: Submittal is voided because it is no longer required or has been superseded by another submittal.
- C. Return 4 copies of submittals to Contractor. Contractor shall make additional copies as required.
- D. *Submittals which do not contain markup, or which have minor markup that can be adequately described without referencing submittal, will not be returned. Reviewer will return signed submittal stamp with written description of Review's comments.*
- E. Review of submittals shall not relieve Contractor from responsibility for any variation from Contract Documents unless Contractor has, in writing, called Engineer's attention to such variation at time of submission, and Engineer has given written concurrence pursuant to Contract Documents to specific variation, nor shall any concurrence by Engineer or other reviewer relieve Contractor from responsibility for errors or omissions in submittals.

1.04 SHOP DRAWINGS SUBMITTALS

- A. Submit for review for limited purpose of checking for conformance to information given and design concept expressed in Contract Documents. Produce copies and distribute in accordance with article "Submittal Procedures" and for record documents purposes as described in Section 01 70 00.
- B. Designate in construction schedule, or in separate coordinated submittal schedule, dates for submission and dates that reviewed submittals will be needed.
- C. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in Work or in work of other contractors.

- D. Present in clear and thorough manner, complete with respect to dimensions, design criteria, materials of construction, and like information to enable review of information as required.
- E. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Drawings.
- F. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
- G. Equipment which is identified on Contract Documents with tag number or name shall be identified on Shop Drawing with same tag.
- H. Schedule submittals to expedite Project. Coordinate submission of related items.
- I. For each submittal for review, allow 10 days excluding delivery time to and from Contractor.
- J. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
- K. Shop Drawings may be submitted in electronic format.
 - 1. Submit electronic copy on CD or E-mail files.
 - 2. Text documents shall be submitted in .pdf or Word format.
 - 3. Drawings shall be submitted in .pdf or .tif format.
 - 4. Electronic submittal shall be suitable for reproduction in black and white.
- L. Number required:

Submit number of opaque reproductions which Contractor, Owner and/or approving agency (ies) requires, plus 1 copy which will be retained by Engineer.

Submit 1 opaque reproductions of each Shop Drawing.

- 1. If Shop Drawings are not submitted in electronic format, submit 5 copies of each Shop Drawing.
 - 2. Copies of Shop Drawings submitted shall be black line on white background.
 - 3. Reviewer will reproduce additional copies of Shop Drawings as required for internal distribution.
 - 4. Shop Drawings shall be suitable for reproduction in black and white. Shop Drawings submitted which are not suitable for reproduction will not be reviewed.
 - 5. If Contractor will not grant permission to reviewer to reproduce Shop Drawings, submit 7 copies of each Shop Drawing.
 - 6. Samples: Submit number stated in each Specification section.
 - 7. Drawings larger than 8-1/2" x 11" shall be rolled.
- M. Submittals shall contain:
- 1. Date of submission and dates of any previous submissions.
 - 2. Project title and number.
 - 3. Contract identification.
 - 4. Names of:
 - a. Contractor.
 - b. Supplier.
 - c. Manufacturer.
 - 5. Identification of product, with Specification section number and article number.
 - 6. Field dimensions, clearly identified as such.
 - 7. Relation to adjacent or critical features of Work or materials.
 - 8. Applicable standards, such as ASTM or Federal Specification numbers.
 - 9. Identification of deviations from Contract Documents.
 - 10. Identification of revisions on resubmittals.
 - 11. An 8" x 3" blank space for Contractor and reviewer stamps.
 - 12. Indication of Contractor's approval, initialed or signed, with wording substantially as follows:

"Contractor represents to Owner and Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, or assumes full responsibility for doing so and has reviewed or coordinated each submittal with requirements of Work and Contract Documents."

13. If Contract Documents include performance specifications stating required results which can be verified as meeting stipulated criteria, so that further design by Contractor prior to fabrication is necessary, Submittal depicting such design must be prepared under seal of professional engineer licensed in the State of Utah and Submittal shall be signed and sealed in accordance with applicable regulations and with following certification statement:

"I hereby certify that this engineering document was prepared by me or under my direct personal supervision, that I am a duly licensed professional engineer under laws of the State of Utah and I accept responsibility for adequacy of this document to meet criteria stipulated in Contract Documents."

N. Product Data:

1. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
2. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

O. Design Data:

1. Submit for Engineer's knowledge as contract administrator or for Owner.
2. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

P. Data Sheets:

1. Data Sheets may require information not known until Contractor's engineering is complete. Furnish estimated values based on good engineering judgment. Estimated values shall be identified by placement of "(est.)" next to value.
2. Data Sheets shall be updated and resubmitted by Contractor once final values are known.
3. Do not leave items blank or labeled "To Be Determined" or "Later."
4. Do not submit manufacturer Product Data instead of completed data sheets.

Q. Test Reports:

1. Submit for Engineer's knowledge as contract administrator or for Owner.
2. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

R. Certificates:

1. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor.
2. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
3. Certificates may be recent or previous test results on material or product, but must be acceptable to reviewer.

S. Manufacturer's Instructions:

1. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, *start-up,* adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
2. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

T. Manufacturer's Field Reports:

1. Submit report in duplicate within 30 days of observation for information.

2. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

U. Erection Drawings:

1. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.
2. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

V. Samples:

1. Samples for selection as specified in product sections:
 - a. Submit for aesthetic, color, or finish selection.
 - b. Submit samples of finishes from full range of manufacturers' standard colors, textures, and patterns for selection.
2. Submit to illustrate functional and aesthetic characteristics of product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
3. Include identification on each sample, with full Project information.
4. Submit number specified in individual Specification Sections; 1 of which will be retained by Engineer.
5. Reviewed Samples which may be used in Work are indicated in individual Specification Sections.
6. Samples will not be used for testing purposes unless specifically stated in specification section.
7. Field Samples and mock-ups:
 - a. Erect at Project Site, at location acceptable to Engineer.
 - b. Size or area: That specified in respective Specification Section.
 - c. Fabricate each Sample and mock-up complete and finished.
 - d. Remove mock-ups upon acceptance of Work or when acceptable to Engineer.

W. Proposed products list:

1. Within 15days after date of Notice to Proceed, submit list of major products proposed to Engineer for use, with name of manufacturer, trade name, and model number of each product.
2. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

X. Operations and maintenance manuals:

1. Designate in construction schedule, or in separate coordinated schedule, dates for submission and dates that reviewed operations and maintenance manuals will be needed.
2. Operations and maintenance manuals shall be presented in clear and thorough manner, complete with respect to dimensions, design criteria, materials of construction, and like information to enable reviewer to review information as required. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Drawings.
3. Sheet size: 8-1/2" x 11" minimum, larger size drawings shall be folded to 8-1/2" x 11", and inserted into pockets.

1.05 RESUBMISSION REQUIREMENTS

- A. Make any corrections or changes in submittals required by Engineer and resubmit until stamped as either "Reviewed," "Reviewed as Noted," or "For Information Only."
- B. Text and depictions changed on Submittal shall be back-circled (clouded).
- C. Engineer will assume that portions of Submittal not back-circled have not been changed by Contractor from previous submission.
- D. Indicate revision number and date in document revision block.

1.06 DISTRIBUTION

- A. Distribute reproductions of Shop Drawings which carry Engineer stamp as either "Reviewed" or "Reviewed as Noted" to:
 - 1. Job site file.
 - 2. Record Documents file.
 - 3. Subcontractors.
 - 4. Supplier or fabricator.
- B. Distribute Samples which carry Engineer stamp as either "Reviewed" or "Reviewed as Noted" as directed by Engineer.

1.07 CONSTRUCTION PROGRESS DOCUMENTATION

- A. Construction progress schedules:
 - 1. Submit initial schedules to Engineer within 15days after date established in Notice to Proceed. After review, resubmit required revised data within ten days.
 - 2. Submit preliminary outline Schedules to Engineer 15days after date established in Notice to Proceed for coordination with Owner's requirements. After review, submit detailed schedules within 10 days modified to accommodate revisions recommended by Engineer.
 - 3. Submit revised Progress Schedules with every second Application for Payment.
 - a. Distribute copies of reviewed schedules to Project site file, subcontractors, suppliers, and other concerned parties.
 - b. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.
- B. Form of schedules:
 - 1. Prepare schedules in form of horizontal bar chart.
 - a. Provide separate horizontal bar for each trade or operation.
 - b. Horizontal time scale: Identify first work day of each week.
 - c. Scale and spacing: To allow space for notations and future revisions.
 - d. Minimum sheet size: 8 ½" x 11".
 - 2. Prepare construction progress schedules as specified in Section 01 32 16.
 - 3. Format of listings: Table of Contents of this Project Manual.
 - 4. Format of listings: Chronological order of start of each item of Work.
 - 5. Identification of listings: By major Specification Section numbers.
- C. Submit computer generated network analysis diagram as specified in Section 01 32 16.
- D. Construction progress schedule shall show:
 - 1. Complete sequence of construction by activity, with Contract Price breakdown at each stage.
 - 2. Dates for beginning, and completion of, each major element of construction specifically listing:
 - a. Site clearing.
 - b. Site utilities.
 - c. Foundation Work.
 - d. Structural framing.
 - e. Subcontractor Work.
 - f. Equipment installations.
 - g. Finishes.
 - 3. Projected percentage of completion for each item, as of first day of each month.
- E. Submittal schedule shall show:
 - 1. Dates for Contractor's submittals.
 - 2. Dates submittals will be required for Owner-furnished products.
- F. Products delivery schedule show delivery dates for:
 - 1. Products specified under Section 01 20 00.
 - 2. Products furnished by Owner, Section 01 10 00.
- G. Progress revisions:

1. Indicate progress of each activity to date of submission.
 2. Show changes occurring since previous submission of schedule:
 - a. Major changes in scope.
 - b. Activities modified since previous submission.
 - c. Revised projections of progress and completion.
 - d. Other identifiable changes.
 3. Provide narrative report as needed to define:
 - a. Problem areas, anticipated delays, and impact on schedule.
 - b. Corrective action recommended, and its effect.
 - c. Effect of changes on schedules of other prime contractors.
- H. Distribution copies of reviewed schedules to:
1. Job site file.
 2. Subcontractors.
 3. Other concerned parties.
- I. Instruct recipients to report promptly to Contractor, in writing, any problems anticipated by projects shown in schedules.

1.08 PHOTOGRAPHIC DOCUMENTATION

- A. Provide photographs of construction throughout progress of Work produced by an experienced photographer, acceptable to Engineer.
- B. Each month submit photographs.
- C. Photographs: Digital or 3"x5" developed prints.
- D. Take 2 interior photographs of Controls work indicating relative progress of Work, 5 days maximum prior to submitting.
- E. Take photographs as evidence of existing project conditions as follows:
 1. Interior views: Before & after.
- F. Identify each print on back, or attached Word document. Identify name of Project, contract number orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.
- G. Deliver negatives or digital files to Owner with Project Record Documents. Catalog and index in chronological sequence; provide typed table of contents.

1.09 SAFETY PROCEDURES MANUAL

- A. Prepare and submit to Owner safety procedures manual defining Contractor's safety program for work on site. Manual shall include:
 1. Safety responsibilities of Contractor's personnel.
 2. Description of Contractor's safety program.
 3. Requirements of use of personal protective equipment.
 4. General safety-related rules of conduct.
 5. Fire prevention measures.
 6. Accident reporting procedures.
 7. Procedures for hot work (welding, cutting, etc.), overhead work, and work in enclosed, confined spaces (tank, boiler, etc.). Reference 29 CFR Part 1910.

1.10 SUBMITTAL TRANSMITTAL FORM PROCEDURES

- A. Submittals shall be accompanied by completed copies of Submittal Transmittal form, bound herein. An electronic version of transmittal form is available and may be obtained from Engineer. Reproduce additional copies required.
- B. Submit copies of transmittal form for initial submittals and resubmittals. Sequentially number transmittal form. Revise submittals with original number and sequential alphabetic suffix.
- C. Prior to submittal, complete information under heading "Contractor's Transmittal."
- D. Engineer will complete information under "Reviewer's Action." reviewer.
- E. Do not include submittals for more than one section of Specifications on Submittal Transmittal form.
- F. Identify project title, location, and number and contract title and number.
- G. Identify preparer name and, submittal number, including preparer's submittal revision number.
- H. A brief description under "Title" should clearly identify specific application of equipment or material covered by Submittal, utilizing where possible same title used in Drawings and Specifications.
- I. Identify Specification Section number.
- J. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with requirements of Work and Contract Documents.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1 GENERAL

1.01 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on Shop Drawings or as instructed by manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.02 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

1.03 BUILDING CODES AND PERMITS

- A. Obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses.
- B. Pay all governmental charges and inspection fees necessary for prosecution of Work, which are applicable at time of opening of Bids. Pay all charges of utility service companies for connections to Work. Owner will pay all charges of such companies for capital costs related thereto.
- C. Give all notices and comply with all laws, ordinances, building and construction codes, rules, and regulations applicable to Work. If Contractor observes that Specifications or Drawings are at variance therewith, give Engineer prompt written notice thereof, and any necessary changes shall be adjusted by appropriate Modification.
- D. If Contractor performs any Work knowing or having reason to know that it is contrary to such laws, ordinances, rules, and regulations, and without such notice to Engineer, Contractor shall bear all costs arising therefrom; however, it shall not be Contractor's primary responsibility to make certain that Specifications and Drawings are in accordance with such laws, ordinances, rules, and regulations.

1.04 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

- B. Conform to reference standard by date of issue current on date for receiving bids, except where a specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. Should specified reference standards conflict with Contract Documents, request clarification from the Engineer before proceeding.
- E. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.
- F. Abbreviations used in Drawings and Specifications are as specified in ASME Y14.38 and IEEE 260.
- G. Schedule of references:
 - 1. AABC - Associated Air Balance Council
 - 2. AAMA - American Architectural Manufacturers Association
 - 3. ACGIH - American Conference of Governmental Industrial Hygienists
 - 4. ADC - Air Diffusion Council
 - 5. AMCA - Air Movement and Control Association
 - 6. ANSI - American National Standards Institute
 - 7. ARI - Air-Conditioning and Refrigeration Institute
 - 8. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
 - 9. ASME - American Society of Mechanical Engineers
 - 10. ASTM – International Standards Worldwide
 - 11. CISCA - Ceilings and Interior Systems Construction Association
 - 12. EIA - Electronic Industries Alliance
 - 13. ETL - Electrical Testing Laboratory
 - 14. FCC – Federal Communications Commission
 - 15. FM – FM Global
 - 16. ICBO - International Conference of Building Officials
 - 17. ICC - International Code Council, Inc.
 - 18. IEEE - Institute of Electrical and Electronics Engineers
 - 19. ISO - International Standards Organization
 - 20. NEBB - National Environmental Balancing Bureau
 - 21. NEMA - National Electrical Manufacturers' Association
 - 22. NFPA - National Fire Protection Association
 - 23. OSHA – U. S. Department of Labor, Occupational Safety and Health Administration
 - 24. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association

1.05 MOCK-UP REQUIREMENTS

- A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.
- B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.
- C. Accepted mock-ups shall be a comparison standard for the remaining Work.
- D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.06 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and train owners/operators as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Engineer 15 days in advance of required observations. Observer subject to approval of Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 01 33 00, article "Manufacturers' Field Reports."

PART 2 EXECUTION

2.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

2.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

2.03 FIELD PERFORMANCE TESTS

- A. Notify Engineer when Work is considered to be complete, in operating condition, and ready for inspection and tests.
- B. Engineer will conduct tests it deems necessary to determine if equipment or system functions properly.
- C. If equipment or system fails to function properly, Contractor shall make necessary corrections, including replacement, at no cost to Owner, and after such corrections are completed, demonstrate to Engineer that equipment or system functions properly.
- D. If equipment or system fails to function properly, or guaranteed performance is not indicated, Contractor shall make necessary corrections, including replacement, at no cost to Owner, and after such corrections are completed, demonstrate to Engineer that equipment or system functions properly and guaranteed performance is obtainable.
- E. After system or equipment necessary for operation of Work is in operating condition, Contractor shall supervise operation of equipment or system for period sufficient to assure proper functioning, and make necessary observations, investigations, and adjustment.

- F. Notify Engineer when Work is considered to be complete, in operating condition, and ready for inspection and tests.
- G. Engineer will conduct tests it deems necessary to determine if equipment or system functions properly.
- H. If equipment or system fails to function properly, Contractor shall make necessary corrections, including replacement, at no cost to Owner, and after such corrections are completed, demonstrate to Engineer that equipment or system functions properly.
- I. If equipment or system fails to function properly, or guaranteed performance is not indicated, Contractor shall make necessary corrections, including replacement, at no cost to Owner, and after such corrections are completed, demonstrate to Engineer that equipment or system functions properly and guaranteed performance is obtainable.

END OF SECTION

PART 1 GENERAL

1.01 PRODUCTS

- A. Provide products of qualified manufacturers suitable for intended use. Provide products of each type by a single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer for components being replaced.

1.02 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.03 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.04 PRODUCT OPTIONS

- A. Products specified by reference standards or by description only: Any product meeting those standards or description.
- B. Products specified by naming one or more manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products specified by naming one or more manufacturers with a provision for substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

1.01 EXISTING PRODUCT REQUIREMENTS

- A. Contractor shall remove existing piping, conduit, wiring, structural materials, and equipment not required for, or used in, new installation.
- B. Existing Johnson Controls pneumatic hot water control valve actuators which are removed may be salvaged or reused elsewhere by owners provided they are in good condition and their reuse is approved by Engineer and Owner.
- C. Materials removed from existing structure and not reused shall become property of Contractor unless otherwise specified.
- D. Salvageable materials and equipment removed and not reused shall be stored in place designated by Owner and shall remain Owner's property.

1.02 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Owner will occupy all of the building as specified in Section 01 11 00.

1.03 FINAL CLEANING

- A. Owner will provide final cleaning after final acceptance.
- B. Execute final cleaning prior to final project assessment.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. Replace filters of operating equipment.
- F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.04 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Engineer and Owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.

- F. Execute start-up under supervision of applicable manufacturer's representative Contractor's personnel in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 01 30 00 that equipment or system has been properly installed and is functioning correctly.

1.05 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel 1 week prior to date of Substantial Completion.
- B. Demonstrate Project equipment and instruct in a classroom environment located at the site* and instructed by a qualified manufacturer's representative who is knowledgeable about the Project.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season within 6 months.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.
- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at designated location.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. Amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.06 TESTING, ADJUSTING AND BALANCING

- A. Owner will appoint, employ, and pay for services of an independent firm to perform testing, adjusting, and balancing.
- B. Owner will appoint and employ services of an independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services from cash allowance specified in Section 01 20 00.
- C. Independent firm will perform services specified in Section 23 05 93.
- D. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

1.07 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.08 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress, not less than weekly.
- E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Field changes of dimension and detail.
 - 2. Details not on original Contract Drawings.
- G. Submit documents to Engineer.

1.09 OPERATION AND MAINTENANCE DATA

- A. Operation and maintenance data shall be in English language.
- B. Submit data bound in 8-1/2" x 11" (A4) text pages, 3-D side ring binders with durable plastic covers.
- C. Prepare binder cover with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," title of project, and subject matter of binder when multiple binders are required.
- D. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- F. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.

2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - f. Maintenance instructions for *special* finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Air and water balance reports.
 - c. Certificates.
 - d. Photocopies of warranties and bonds.

G. Submit draft copy of completed volumes 15 days prior to final inspection. Draft copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.

H. Submit 3 sets of revised final volumes, within 10days after final inspection.

1.10 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Preliminary:

1. Provide 2 copies with shipped with equipment.
2. Submit 2 copies to Owner.
3. Submit 2 copies to Engineer of proposed formats and outlines of contents prior to start of Work. Engineer will review draft and return 1 copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within 10 days after acceptance.

C. Submit 1 copy of completed volumes 15 days prior to final inspection. Copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.

D. Submit 3 sets of revised final volumes in final form within 10days after final inspection.

E. Each item of equipment and each system: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

F. Panelboard circuit directories: Provide electrical service characteristics, controls, and communications; typed by label machine.

G. Include color-coded wiring diagrams as installed.

H. Operating procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

I. Maintenance requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

- J. Provide servicing and lubrication schedule, and list of lubricants required.
- K. Include manufacturer's printed operation and maintenance instructions.
- L. Include sequence of operation by controls manufacturer.
- M. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- N. Provide control diagrams by controls manufacturer as installed.
- O. Provide Contractor's coordination drawings, with color-coded piping diagrams as installed.
- P. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- Q. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- R. Include test and balancing reports as specified in Section 01 40 00.
- S. Additional requirements: As specified in individual product specification sections.
- T. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.11 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site and place in location as directed, obtain receipt prior to final payment.

1.12 PRODUCT WARRANTIES AND PRODUCT BONDS

- A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers, within ten days after completion of the applicable item of work.
- B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.
- C. Verify that documents are in proper form, contain full information, and are notarized.
- D. Co-execute submittals when required.
- E. Provide Table of Contents and assemble in 3-D side ring binder with durable plastic cover.
- F. Submit prior to final Application for Payment.
- G. Time of Submittals:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty or bond period.

1.13 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components indicated in specification sections for during the warranty period.
- B. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- D. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

1.01 SECTION INCLUDES

- A. Cutting and patching requirements.
- B. Materials.
- C. Inspection.
- D. Preparation.
- E. Performance.

1.02 CUTTING AND PATCHING REQUIREMENTS

- A. Contractor shall be responsible for cutting, fitting, and patching, including attendant excavation and backfill, required to complete Work or to:
 - 1. Make its several parts fit together properly.
 - 2. Uncover portions of Work to provide for installation of ill-timed Work.
 - 3. Remove and replace defective Work.
 - 4. Remove and replace Work not conforming to requirements of Contract Documents.
 - 5. Remove samples of installed Work as specified for testing.
 - 6. Provide routine penetrations of nonstructural surfaces for installation of piping and electrical conduit.

1.03 SUBMITTALS

- A. Submit written request to Engineer well in advance of executing cutting or alteration which affects:
 - 1. Work of Owner or any separate contractor.
 - 2. Structural value or integrity of any element of Project.
 - 3. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
 - 4. Efficiency, operational life, maintenance, or safety of operational elements.
 - 5. Visual qualities of sight-exposed elements.
- B. Request shall include:
 - 1. Identification of Project.
 - 2. Description of affected Work.
 - 3. Necessity for cutting, alteration, or excavation.
 - 4. Effect on work of Owner or separate contractor, or structural or weatherproof integrity of Project.
 - 5. Description of proposed Work:
 - a. Scope of cutting, patching, alteration, or excavation.
 - b. Trades who will execute Work.
 - c. Products proposed to be used.
 - d. Extent of refinishing to be done.
 - 6. Alternatives to cutting and patching.
 - 7. Cost proposal, when applicable.
 - 8. Written permission of any separate Contractor whose work will be affected.
- C. Should conditions of Work or schedule indicate change of products from original installation, Contractor shall submit request for substitution.
- D. No cutting or alteration for which written request is submitted shall be performed without written acceptance of Engineer.
- E. Submit written notice to Engineer designating date and time Work will be uncovered.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Comply with specifications and standards for each specific product involved.

PART 3 EXECUTION**3.01 INSPECTION**

- A. Inspect existing conditions of Project, including elements subject to damage or to movement during cutting and patching.
- B. After uncovering Work, inspect conditions affecting installation of products, or performance of Work.
- C. Report unsatisfactory or questionable conditions to Engineer in writing; do not proceed with Work until Engineer has provided further instructions.

3.02 PREPARATION

- A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of Work.
- B. Provide devices and methods to protect other portions of Project from damage.
- C. Provide protection from elements for that portion of Project which may be exposed by cutting and patching Work, and maintain excavations free from water.

3.03 PERFORMANCE

- A. Execute cutting and demolition by method which will prevent damage to other Work, and will provide proper surfaces to receive installation of repairs.
- B. Employ original installer or fabricator to perform cutting and patching for:
 - 1. Weather-exposed or moisture-resistant elements.
 - 2. Sight-exposed finished surfaces.
- C. Execute fitting and adjustment of products to provide finished installation to comply with specified products, functions, tolerances, and finishes.
- D. Restore Work which has been cut or removed; install new products to provide completed Work in accordance with requirements of Contract Documents.
- E. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- F. Refinish entire surfaces as necessary to provide even finish to match adjacent finishes:
 - 1. For continuous surfaces, refinish to nearest intersection.
 - 2. For assembly, refinish entire unit.

END OF SECTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Removal, disposal, salvage, storage of existing controls and associated work.
- B. Demolition work of this contract includes, but is not limited to:
 - 1. Existing Crown Controls fume hood control components.
 - 2. Existing pneumatic actuators on the hot water reheat control valves.
 - 3. Existing pneumatic tubing which serves above actuators.
- C. Remove and reinstall:
 - 1. Existing ceiling tiles.
- D. Perform reinstallation work by competent workers familiar with installation of fume hood controls, Johnson Controls components, and associated electrical equipment.
- E. Inspect buildings and structures where demolition is required. Contractor shall also inspect existing Drawings of buildings and structures before bidding; Drawings are available from Owner. Contractor shall be familiar with items that require demolition and patching.
- F. Excavation and dewatering required to accomplish this Work shall be included in Contractor's Bid.
- G. Contractor is responsible for determining actual site conditions, extent to which demolition is required, and method of demolition.
- H. Schedule work with Owner and work in other parts of these Contract Documents. See Demolition Restraints and Scheduled Outages listed under Bidder's Representation in Supplementary Conditions.
- I. Perform work in accordance with Drawings and Specifications and as required for proper execution of work under this Contract. Conform to applicable requirements of state and other governmental agencies for demolition work.

1.02 WORK BY OTHERS

- A. Owner will remove following:
 - 1. Sensitive laboratory items which may be damaged by work overhead.
 - 2. Items which should be prevented from dirt and dust accumulation.
 - 3. Hazardous chemicals in the contract work areas.

1.03 SALVAGEABLE ITEMS

- A. Following equipment shall be removed and remain property of Owner. Contractor shall remove salvageable equipment and transport to Owner's designated storage area.
- B. Salvageable equipment list:
 - 1. Pneumatic Hot Water Valve Actuators.
 - 2. _____.
 - 3. _____.
- C. Tag salvageable items and submit list to Owner identifying equipment and tag numbers.
- D. Upon delivery of a salvaged item to designated storage area, Contractor shall receive from Owner receipt indicating delivery of that item.

1.04 QUALITY ASSURANCE

- A. Temporary electrical construction necessary to maintain existing system during construction shall comply with NEC Article 590.

1.05 SUBMITTALS

- A. Two weeks prior to any removal, Contractor shall submit demolition plan to Engineer for review. Plans shall include sequence of performing proposed work, requirements for interruptions to public use of area, and requirements for Contractor use of public streets and facilities.
- B. Submit two copies of photographs taken of existing construction to remain. Include adjacent private properties that might be disturbed by demolition operations.

1.06 SCHEDULING

- A. Perform Work in manner which will provide least interference and most protection to public and existing construction. Contractor's operations subject to approval by Owner prior to commencement of Work.
- B. Carefully coordinate time and manner of demolition work with Engineer to assure continued operation of existing facilities and to maintain construction schedule requirements.
- C. Schedule and perform work in accordance with following general sequence. Coordinate specific details of work with Owner and Contract. Owner's use of premises shall have priority over work in all Contract(s).
- D. Take care to minimize outages of electrical systems.
- E. Coordinate electrical system outages with Owner and service utility. Notify Owner in writing at least 24 hours prior to electrical outage. Indicate system to be disabled, areas affected, proposed date and time of outage, duration, and work to be performed.
- F. Outages of following electrical systems shall be performed only with written permission of Owner.
 - 1. Power distribution.
 - 2. Fire alarm.
 - 3. Telephone.

1.07 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be made for demolition work under this contract except as specifically described and listed in Agreement. Include costs in connection with Work in lump sum Contract Price or unit price for demolition.
- B. Measurement for payment for undefined concrete demolition will be performed by Contractor and verified by Engineer during removal of material.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 PROTECTION

- A. Protect existing facilities from damage by falling debris, dust, and construction operations.
- B. Provide shoring and bracing where necessary to support existing construction and protect personnel during demolition operation.

3.02 DEMOLITION - GENERAL

- A. Remove existing construction as specified and shown and as required to permit new construction.
- B. Perform removal in manner that will minimize dust, noise, and other nuisance. Maintain haul routes for disposal of material clean and free of debris.
- C. Remove existing construction carefully providing for neat and orderly junctions at construction to remain in place. Final appearance of exposed surfaces shall be similar and equal to that of adjacent existing work. Grind off rough surfaces to remove sharp projections.
- D. Perform demolition operations in manner that in no way endangers personnel, public, existing structures, utilities, roadways, or facilities not to be demolished.
- E. Any portion of existing construction whether structural, or accessory which has become unstable through removal of other parts of construction shall be removed as soon as practicable, and no such unstable part shall be left free-standing or inadequately braced against causes of collapse at end of each day's work.
- F. No demolition shall be performed on piping, electrical circuits, or equipment until system has been isolated by Owner. Contractor shall verify isolation of system.
- G. Contractor shall relocate existing active miscellaneous piping, conduit, and electrical circuits and devices not detailed on Drawings but required for installation of equipment and items installed by this Contract.
- H. To reduce fire hazards during demolition, Contractor shall:
 - 1. Before removing any part of any building, remove volatile or flammable materials, such as fuel oil, gasoline, kerosene, benzene, cleaning fluids, paints, thinners, cloth, loose paper, combustible trash, coal, and similar materials which might serve as ready fuel for small fires.
 - 2. Maintain stairways in usable condition to highest or lowest level until that portion of structure is removed.
 - 3. Maintain sufficient number of fire extinguishers to check and extinguish small fires in areas where Work is being performed.
 - 4. Wherever cutting torch or other equipment which might cause fire is being used, fire extinguishers shall be kept nearby and ready for instant use. Users of such equipment shall be instructed in proper method of preventing fires and extinguishing fire.
 - 5. Fires will not be permitted in Project area.
 - 6. Burning of waste lumber and other building materials or trash on Site will not be permitted.

3.03 DEMOLITION OF ARCHITECTURAL, STRUCTURAL, AND SITE MATERIALS

- A. Remove as shown and specified or as required to permit new construction.
- B. Structural parts of buildings, such as columns, beams, and joists supporting floor of any story shall be left in place until walls, flooring, and partitions of that story are completely removed, beginning at top and working downward. Exception to this requirement will be made in case of nonrigid frames or concrete buildings.
- C. If Contractor elects to use an alternate procedure for progressive or simultaneous wrecking of all parts of building, Contractor's proposed method shall not increase danger to Contractor's personnel, Owner's personnel, or to adjacent structures. Contractor shall notify Owner in writing of any such alternate procedure proposed before implementing such procedures.
- D. No wall or part thereof shall be permitted to fall outwardly from any building or into plant basement or floor except through chutes or by other controlled means or methods which will ensure safety and minimize dust, noise, and other nuisance.

- E. Any part of building, whether structural, or accessory, which has become unstable through removal of other parts shall be removed as soon as practicable, and no such unstable part shall be left free-standing or inadequately braced against cause of collapse at end of day's work.
- F. Structural steel in building:
 - 1. Provide temporary support or complete new work required for support prior to removal. Maintain existing parts until equipment supported by part is removed or modified.
 - 2. Remove and dispose of steel indicated on Drawings including miscellaneous associated steel. Do not remove bolts and/or rivets of common connections; cut member being removed to leave connection unless shown otherwise.
 - 3. Where steel penetrates masonry or concrete wall, cut flush with wall unless shown otherwise.
 - 4. Where applicable, remove anchor bolts and grout to top or face of existing concrete. Make provisions to ensure smooth surface where grout is removed.
 - 5. Care shall be taken not to damage any portion of existing structural steel that is to remain intact.
- G. Remove and dispose of portion of existing building walls to limits required by new construction and required for removal or placement of materials and equipment. Replace removed portions with same type construction.
- H. Material shall be removed completely from building and site and other areas which are to remain. Contractor shall make special inspections by its job superintendent and quality control personnel to assure that material is not left in areas where they can get into operating systems.
- I. Provide temporary, insulated, weathertight closure over openings above grade in buildings to remain.
 - 1. Closures shall remain in place at all times except as directed by Engineer and as required for demolition and construction operations.
 - 2. Closure shall be constructed to prevent water and material from entering building opening. Construct closure to protect interior of building from weather.
 - 3. Closure shall be adequate in strength and anchorage to withstand uplift and wind loading in accordance with ANSI A58.1.
 - 4. Repair and maintain closure until Work is accepted as complete. Damage by other contractors will be repaired at their expense.
 - 5. Closure not replaced by permanent construction under this contract will be removed later by Owner under separate contract.

3.04 DEMOLITION OF MECHANICAL ITEMS

- A. Remove mechanical equipment and materials as shown on Drawings and as specified.
- B. Removal shall include but not limited to piping, valves, * _____ * equipment, hangers, and associated accessories.

3.05 DEMOLITION OF ELECTRICAL ITEMS

- A. Examination:
 - 1. Verify that abandoned wiring and equipment serve only abandoned facilities.
 - 2. Demolition drawings are based on cursory field observation and existing record documents. Report discrepancies to Owner before disturbing existing installation.
- B. Preparation:
 - 1. Before beginning underground demolition, contact Owner, and local utilities locating service *JULIE* at least 24 hours before digging.
 - 2. Contact Owner to determine equipment items are to be salvaged and delivered to storage area. Other equipment shall become property of Contractor and shall be removed from job site.
 - 3. Disconnect electrical systems in or on walls, floors, and ceilings scheduled for removal.
 - 4. Coordinate utility service outages with utility company.
 - 5. Provide temporary wiring and connections to maintain existing systems in service during construction.

6. Existing electrical service: maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 7. Existing fire alarm system: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Notify Owner *and local fire department* at least 24 hours before partially or completely disabling system.
 8. Existing telephone system: Maintain existing system in service until *new system is complete and ready for service.* *new system is accepted.* Disable system only to make switchovers and connections. Notify Owner *and telephone utility company* at least 24 hours before partially or completely disabling system.
- C. Demolition and extension of existing electrical work:
1. Remove, relocate, and extend existing installations to remain to accommodate new construction.
 2. Remove abandoned wiring to source of supply.
 3. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
 4. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
 5. Disconnect and remove the following:
 - a. Abandoned panelboards and distribution equipment.
 - b. Devices and equipment serving utilization equipment that has been removed.
 - c. Abandoned light fixtures, including brackets, stems, hangers, and other accessories.
 6. Repair adjacent construction and finishes damaged during demolition and extension work.
 7. Maintain safe access to existing electrical installations which remain active.
- D. Disposal of equipment containing polychlorinated biphenyl compounds (PCBs): Transformers, capacitors, and lamp ballasts containing PCBs shall be disposed of in accordance with CFR 40 Part 761. Ballasts, even those labeled "no PCBs", shall be disposed of accordingly. Deliver equipment to an Environmental Protection Agency (EPA) approved incinerator or ballast recycling service for disposal. Provide Owner with manifest and certificate of destruction pursuant to CFR 40 Part 761, Subpart K.

3.06 SALVAGE OF MATERIALS

- A. Salvageable materials, except items specified to remain property of Owner, shall become property of Contractor and shall be removed from site as Work progresses.
- B. Certain equipment and material shall be removed and reinstalled as indicated on Drawings and specified herein. Contractor shall remove such items, store if required, and reinstall as indicated. In the event of loss or damage to such material or equipment, Contractor shall replace items without additional cost to Owner.

3.07 DISPOSAL OF MATERIALS

- A. Storage of materials to be removed not permitted to accumulate on site. Promptly remove and dispose of non-salvageable equipment and materials.
- B. Debris shall not be allowed to accumulate on roofs, floors, or in areas outside of and around any buildings being removed. Waste materials and debris resulting from Work shall be removed and disposed of daily by Contractor in disposal area obtained by Contractor.
- C. Burning of waste lumber and other building materials or trash on Site will not be permitted.
- D. No material, obstructions, or debris shall be placed or allowed to accumulate within 15' of any fire hydrant. Fire hydrants shall be accessible at all times.

3.08 PATCHING

- A. Patch openings in walls, foundations, and checker plating caused by demolition. Use materials comparable to adjacent undisturbed surfaces for patching.
- B. Any new construction work that affects existing building structures shall be patched to match existing surrounding materials. This includes roofing, walls, walks, flooring ceilings, and any other materials that affect structural or architectural integrity of building.

3.09 REPAIR AND RESTORATION

- A. Contractor shall be responsible for damage to personnel, public, roadways, streets, structures, utilities, facilities, and equipment caused by operations and shall repair any damage at its own expense or replace items damaged beyond repair.
- B. Do not operate vehicles or equipment on existing construction or roadways that could be damaged.
- C. Backfill applicable excavated areas, open pits, and other depressions as work progresses. Backfill materials shall conform to requirements of Drawings and other specification sections.
- D. Grade areas disturbed by construction to smooth, uniform surfaces sloped to drain.
- E. Replace construction removed to facilitate operations with construction of equal quality to that removed.

3.10 CLEAN-UP

- A. Maintain public streets, alleys, or other thoroughfares used in carrying out disposal free of litter or soil attributable to this operation. Equip and load trucks or other vehicles to prevent leakage, blowing off, or other escape of any portion of whatsoever is being hauled. Cost incurred by Owner in cleaning up such litter will be charged to Contractor and deducted from monies due or to become due it under this contract.
- B. Upon completion of demolition work in each area, thoroughly clean area of materials not to remain.
- C. Remove materials (except paint) adhered to construction to remain.
- D. Leave areas in broom clean and vacuumed condition.

END OF SECTION

- 1) D. Rollins
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fibrous acoustical tiles and panels.
- B. Metal suspension systems.
- C. Acoustical insulation above ceilings.

1.02 ENVIRONMENTAL REQUIREMENTS

- A. Do not install acoustical ceilings until building is enclosed, sufficient heat is provided, dust-generating activities have terminated, and overhead mechanical work is completed, tested, and approved.
- B. Permit wet work to dry prior to commencement of installation.
- C. Maintain uniform temperatures of 60°F to 85°F (15°C to 29°C) and maximum humidity of 70% prior to, during, and after installation.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Verify and match existing tile manufacturer for any replacement tiles.
- B. Armstrong World Industries, Inc.
- C. Celotex Corp.
- D. Chicago Metallic Corp.
- E. USG Interiors, Inc.
- F. Materials referenced in this Section are manufactured by Armstrong World Industries, Inc., unless indicated otherwise.
- G. Metal suspension systems:
 - 1. Conform to ASTM C635, either intermediate duty systems or heavy-duty systems as required to support the ceiling, lighting fixtures, sound insulation, and air diffusers specified. Provide necessary metal trim, including angles for attachment to diffusers for support of ceiling panels.
 - 2. Types:
 - a. "Prelude XL":
 - 1) Material: Double-web, hot-dipped galvanized steel with *steel* *aluminum* cap.
 - 2) Face dimension: 15/16" (24 mm).
 - 3) Profile: Exposed tee.
 - 4) Surface finish: *Baked polyester paint.* *Anodized.*
 - 5) Color: *White.* *_____ metallic.* *_____ aluminum.*
 - 6) Use: All areas requiring suspended ceiling system except as noted.
 - b. "Prelude Plus XL Fire Guard":
 - 1) Material: Double-web, hot-dipped galvanized steel with aluminum cap.
 - 2) Face dimension: 15/16" (24 mm).
 - 3) Profile: Exposed tee.
 - 4) Surface finish: *Baked polyester paint.* *Anodized.*
 - 5) Color: *White aluminum.* *Natural aluminum.*

- 6) Use: All areas of high humidity, areas requiring sanitary conditions.
- c. "AL Prelude Plus XL" (all aluminum):
 - 1) Material: Double-web aluminum finish and cap.
 - 2) Face dimension: 15/16" (24 mm).
 - 3) Profile: Exposed tee.
 - 4) Surface finish: Anodized.
 - 5) Color: White aluminum.
 - 6) Use: Indoor swimming pools.
3. Ceiling system shall bear UL label for compliance with requirements for fire-rating.
4. Carrying channels and hangers: Material, size and type to suit application and to rigidly secure complete finished ceiling system with maximum deflection of 1/360.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install suspension system in accordance with ASTM C636 and manufacturer's recommendations.
- B. In seismic zones, install system in accordance with ASTM E580.
- C. Use centerlines of room as starting point for grid or panel layout, unless otherwise shown on Drawings.
- D. Coordinate ceiling panel layout with lighting fixtures and mechanical items to provide neat, symmetrical ceiling pattern.
- E. Install wall molds at perimeter of ceilings. Fit moldings tightly and evenly to walls. Miter corners where wall moldings intersect or install corner caps.
- F. Fit suspension system, trim angles, and acoustical material around obstructions in neat manner.
- G. For concealed spline tiles, arrange tiles so minimum of tile units are less than one-half width.
- H. Provide additional hangers and inserts where required.
- I. Make joints true to line, with exposed surfaces flush and level.
- J. Provide for expansion and contraction at building expansion joints.
- K. Cut tegular-edged acoustical tile end pieces and rabbet cut edge to rest on wall mold.
- L. Support edges of acoustical panels, including those at ceiling penetrations for fixtures and diffusers. Supporting units shall lie flat in suspension system.
- M. Provide removable units where access is required above ceiling.
- N. For concealed spline tiles, securely attach identification disc near one corner of face of each removable tile directly below each valve, flow indicator, damper, balancing cock, air vent, or other apparatus requiring access above ceiling system. Discs shall be 3/4" (19 mm) diameter, stamped with letters "AP," and finished to match color of acoustical tile.
- O. Install hold-down clips on lay-in type acoustical panels within 20'-0" (6 m) of exterior doors.
- P. Dimensions given for ceiling tile are modular grid dimensions. Actual tile size is responsibility of manufacturer and ceiling system installer for coordination with suspension system as specified and as shown on Drawings.

3.02 CLEANING AND ADJUSTMENT

- A. Upon completion of installation, clean components of acoustical treatment system in accordance with manufacturer's recommendations.
- B. Adjust any sags or twists that develop in ceiling system and replace any part that is damaged or faulty.

END OF SECTION

- 1) D. Rollins
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Procedures, general.
- B. Final reports.
- C. Contractor responsibilities.
- D. Preparation.
- E. Schedule of systems requiring testing, adjusting, and balancing services.

1.02 SYSTEM REQUIREMENTS

- A. Prepare each system for testing and balancing.
- B. Cooperate with testing organization, provide access to equipment and systems. Operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.
- C. Notify testing organization 7days prior to time system will be ready for testing, adjusting, and balancing.
- D. Perform specified services with Contractor's qualified personnel, or employ and pay for qualified organization to perform specified services.
- E. Perform testing of control station equipment, balancing of distribution system, and adjustment of terminal devices for HVAC systems of Project.
- F. Perform testing of hydronic systems, adjust and record liquid flow at each piece of equipment.
- G. Provide instruments required for testing, adjusting, and balancing operations.
 - 1. Make instruments available to Engineer to facilitate spot checks during testing.
 - 2. Retain possession of instruments; remove from Site at completion of services.
- H. Furnish material, tools, and labor required to perform start-up of each respective item of equipment, instrument and system:
- I. Provide information and assistance required, cooperate with test, adjust, and balance services.
- J. Comply strictly with specified manufacturer's or Engineer's procedures in starting up specified systems.

1.03 SUBMITTALS

- A. Prior to start of Work, submit name of organization and Contractor personnel proposed to perform services. Designate managerial responsibilities for coordination of entire testing, adjusting, and balancing.
- B. Submit documentation to confirm organization and personnel qualifications.
- C. Submit 3 preliminary specimen copies of each of report forms proposed for use.

- D. Fifteen days prior to Substantial Completion, submit 3 copies of final reports. Submit reports of testing, adjusting, and balancing which is postponed due to seasonal, climatic, occupancy, or other reasons beyond Contractor's control, promptly after execution of those services.
- E. Schedule of start-up to Engineer.
- F. Contractor shall prepare instrument calibration reports in duplicate for each instrument and control loop. Include instrument calibration data and status of equipment. Note any deficiencies yet to be corrected on instruments that are suitable for operation (e.g.: broken lenses, faulty local indicators on transmitters that can still perform correct output transmission) Contractor shall correct these deficiencies at earliest possible date. Copies shall be submitted for Resident Project Representative's review. Each calibration report shall be signed by Contractor's representative witnessing test.
1. Electrical systems test reports: Typewritten, listing equipment used, person or persons performing tests, date tested, circuits tested, and results of tests.
 2. Environmental test reports:
 - a. Preliminary:
 - 1) Submit 3 copies of documentation to confirm compliance with quality assurance provisions:
 - a) Organization supervisor and personnel training and qualifications.
 - b) Specimen copy of each report form proposed for use.
 - 2) Second: At least 15 days prior to starting field work, submit 3 copies of:
 - a) Set of report forms filled out as to design flow values and installed equipment pressure drops, and required cfm for air terminals.
 - b) Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each. Show:
 - (1) Discrepancies noted between data shown and Contract Documents.
 - (2) Additional, or more accurate, instruments required.
 - (3) Requests for re-calibration of specific instruments.
 - 3) Third: At least 15 days prior to Contractor's request for final inspection, submit three copies of final reports, on applicable reporting forms, for review.
 - a) Schedule testing and balancing of parts of systems which is delayed due to seasonal, climatic, occupancy, or other conditions beyond control of Contractor, as early as proper conditions will allow, after consultation with Engineer.
 - b) Submit report of delayed testing promptly after execution of those services.
 - b. Form of final reports:
 - 1) Each individual final reporting form must bear signature of person who recorded data and that of testing, adjusting, and balancing supervisor of reporting organization.
 - 2) When more than 1 certified organization performs testing, adjusting, and balancing services, firm having managerial responsibility shall make submittals.
 - 3) Identify instruments of types that were used, and last date of calibration of each.
 - 4) Record and submit all data measured including air flow, liquid flows, pressure drops, motor loads * * and all other data requested in "Environmental Systems," this Section.
- G. At completion of Work, Contractor shall submit to Owner certification that equipment has been commissioned and is in operating condition in accordance with Contract Documents.
- H. Final reports:
1. Organization having managerial responsibility shall make reports.
 2. Each form: Bear signature of recorder, and that of supervisor of reporting organization.
 3. Identify each instrument used and latest date of calibration of each.

1.04 QUALITY ASSURANCE

- A. Comply with procedural standards of certifying association under whose standards service will be performed.

- B. Notify Engineer 3days prior to beginning of operations.
- C. Accurately record data for each step.
- D. Comply with applicable procedures and standards of certification sponsoring association; either:
 - 1. "National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution-Hydrionics Systems," by AABC, or "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems," by NEBB.
 - 2. Perform services under direction of supervisor who is designated and qualified under certification requirements of sponsoring association.
 - 3. Calibration and maintenance of instruments shall be in accordance with requirements of standards, and calibration histories for each instrument shall be available for examination.
 - 4. Accuracy of measurements shall comply with requirements of standards.
- E. Comply fully with procedural standards of certifying association under whose standards service will be performed.
 - 1. Execute each step of prescribed testing, adjusting, and balancing procedures without omission.
 - 2. Accurately record required data.

1.05 JOB CONDITIONS

- A. Prior to start of testing, adjusting, and balancing, verify that required "job conditions" are met:
 - 1. Systems installation is complete and in full operation.
 - 2. Outside conditions are within reasonable range relative to design conditions.
 - 3. Special equipment such as computers, laboratory equipment, and electronic equipment are in full operation.
- B. Verify that requirements for preparation for testing and balancing have been met for elements of each of systems that require testing.

1.06 COORDINATION

- A. Coordinate services with Work of various trades to ensure rapid completion of services.
- B. Promptly report to Engineer any deficiencies noted during performance of services.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Provide and maintain tools and test equipment in first-class condition and quantities sufficient to assure successful performance and completion of required Work.
- B. Furnish and use materials in accordance with these Specifications. Materials shall be of first-class quality, free from defects or imperfections, of recent manufacture, unused and of classification and grade specified.
- C. Test equipment shall have recent calibration checks by equipment manufacturer or authorized facility to assure accuracy of commissioning process.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing. Retain possession of instruments and remove at completion of services.

- B. Verify installation of system to be tested is complete and in continuous operation.
- C. Verify ambient conditions and related facilities are in full operation.

3.02 MECHANICAL SYSTEMS

- A. Bearings:
 - 1. Inspect for cleanliness; clean and remove foreign materials.
 - 2. Verify alignment.
 - 3. Replace defective bearings, and those that run roughly or noisily.
 - 4. Grease as necessary, and in accordance with manufacturer's recommendations.
- B. Drives:
 - 1. Adjust tension in V-belt drives, and adjust varipitch sheaves and drives for proper equipment speed.
 - 2. Adjust drives for alignment of sheaves and V-belts.
 - 3. Clean; remove foreign materials before starting operation.
- C. Motors:
 - 1. Check each motor for amperage comparison to nameplate value.
 - 2. Correct conditions which produce excessive current flow, and which exist due to equipment malfunction.

3.03 ENVIRONMENTAL SYSTEMS

- A. Perform testing of central station equipment, balancing of distribution systems, and adjusting of terminal devices for:
 - 1. Air handling units.
 - 2. Return, supply, and exhaust fans.
 - 3. Air distribution systems.
 - 4. Water distribution systems.
 - 5. Pumps.
 - 6. Chillers.
 - 7. Boilers and heat exchangers.
 - 8. Heating terminal units.
 - 9. Volume Control Units (VCU): Minimum and maximum airflow.
 - 10. Domestic hot water recirculation systems.
- B. Air balancing:
 - 1. Make measurements in accordance with recognized procedures and practices of certifying association.
 - 2. Measure air volume discharged at each outlet and adjust air outlets to design air volumes within 10% over or under. For variable air volume system, measure air volume discharge at each outlet and adjust both maximum and minimum cfm within 10% over or under design settings.
 - 3. Adjust fan speeds and motor drives within drive limitations for required air volume. Set speed to provide air volume at farthest distance without excess static pressure.
 - 4. Measure and adjust air supply and exhaust fan units to deliver design conditions at 100%.
 - 5. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
 - 6. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan.
 - 7. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
 - 8. Evaluate space and zone temperature conditions to determine adequate performance of systems to maintain temperatures without draft.
 - 9. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

10. Mark balancing dampers and cocks.

C. Hydronic balancing:

1. Make measurements in accordance with recognized procedures and practices of certifying association.
2. Measure and adjust water flow for design conditions, within 10% over or under.
3. Check conditions at heating coils for required performance at design conditions.
4. Check conditions at primary source equipment for performance of design conditions.

3.04 INSTRUMENTATION SYSTEMS

- A. Commission controls and instruments prior to start-up to assure in situ performance in accordance with specifications under simulated operating conditions. Contractor to determine initial start-up conditions.
- B. Remove shipping stops from instruments before starting with procedures listed herein. Contractor shall have instruction manuals available, and shall install miscellaneous components such as charts, illumination, mercury, etc., which have been supplied separately but are integral parts of equipment.
- C. If any doubt exists as to correct method for calibrating or checking calibration of instrument, manufacturer's printed recommendations shall be used.
- D. Many instruments contain small supply pressure gages or output pressure gages. Calibration of these gages will not be required. However, if gage is found to be defective, instrument involved shall be immediately called to attention of Engineer and reporting of its condition confirmed in writing.
- E. If any instrument cannot be properly adjusted, it shall be immediately called to attention of Engineer and report of its condition confirmed in writing.
- F. Instrument check: Verify data on nameplate with respect to conditions of range, operating temperature, specific gravity, and components as stated on unit specifications. Any discrepancies shall be immediately called to attention of Engineer and report of condition confirmed in writing.
- G. Verify that control valve seats are free from foreign material, and are properly positioned for intended service.
- H. Test procedures:
 1. Check handswitches, pushbuttons, and pilot lights.
 2. Check interlocking circuits installed for conformance to schematic diagrams and "Sequence of Operation."
 3. Perform Work of placing in initial operation equipment installed or wired under this contract, following instructions and recommendations of equipment manufacturers.
 - a. After energizing and prior to start-up, check control circuits *and programs* for proper sequence of operation and interlocking functions.
 - b. Wiring changes required as result of such checks shall be properly identified by changing terminal strip and/or wiring markers.
 4. Contractor shall provide necessary construction labor to make equipment final adjustments that are required to place systems in good operating condition, and furnish labor to assist in solving instrument or control problems.
 5. Contractor shall calibrate instruments and components in accordance with manufacturer's calibration data over full operational range, prove instruments to be within published specification, accuracy, and affix calibration sticker. Instruments shall be calibrated individually and where applicable, as system *(i.e., control loop transmitter, controller, and valve)*. Components which have adjustable features shall be carefully set for specific conditions and applications of this Project. Each calibration sticker shall be signed by Contractor's representative witnessing test.
 6. Calibration sticker shall contain the following information: Equipment identification tag number, range of calibration, and date and name of person doing calibration.

7. Pressure gages: Shall be checked at 10%, 50%, and 90% of their ranges for linearity within Manufacturer's stated specifications.
8. Gages not meeting manufacturer's specifications shall be repaired or replaced.
9. Dial thermometers shall be checked at mid-range and ambient temperature. Thermometers not meeting manufacturer's specifications shall be repaired or replaced.
10. Temperature switches: Calibrate in accordance with manufacturer's specifications.
11. Valves and operations:
 - a. Control valves: Operation of control valve shall be verified within limits of practicality. Particular attention must be given to manufacturer's instructions and applicable nameplate data in reference to valve spring scale and actuation conditions. Pay close attention to bench set.
 - b. Valve action: Check valve action for conformance to specifications.
 - c. Valve positioner: Check for conformance to specifications relative to spring action and input range (particularly for split range applications), valve action, and length of stroke. If valve positioner is fitted with standard characterized cam, check to see if proper cam is mounted. If specifications call for specially cut cam, refer this item in writing to Engineer for handling. Do not cut or modify standard cam.
12. Panel-mounted instruments:
 - a. Receiver instruments: Check zero and span at 10%, 50% and 90% of range by impressing measured signal into input or signal connections or instrument.
 - b. Controllers:
 - 1) Controllers shall be checked for proper operation and adjusted in accordance with manufacturer's instructions. Vary process input signal and check output signal for direction.
 - 2) Set initial proportional band, reset rate, and rate time as recommended by Manufacturer. It may be necessary to determine process dynamics in actual operation before settings can be made.
 - 3) Control loops shall be observed for operability and conformance to specifications by impressing simulated input signal at primary element and checking response of final control element.
 - c. Integrators, ratio relays, etc.: Check in conformance to manufacturer's recommendations. Receiver integrators can be calibrated for proper operation and multiplication factor by feeding maximum input signal 20 mA for specified period of time with stop watch. Check in conformance with manufacturer's recommendations. Ratio signals can be simulated to check proper ratio settings and output.
13. Controllers; field mounted: Simulate "Set Point" and "Measured Variable" signals at controller, with separate regulated signals. Check operation as in Item "11., b." preceding.
14. Acceptable calibration standards:
 - a. Vacuum or draft:
 - 1) 0" to 5" w.c.: Inclined water filled manometer graduated in tenths and inches of water.
 - 2) 5" to 25" Hg: Mercury manometer graduated in inches of mercury.
 - 3) 5" to 60" H₂O: Water manometer graduated in inches of water.
 - b. Pressure:
 - 1) 0" to 5" w.c.: Inclined water filled manometer graduated in tenths and inches of water.
 - 2) 5" to 60" w.c.: Water manometer graduated in inches of water.
 - 3) 3 to 25 psig: Mercury manometer graduated in psi.
 - 4) 25 to 150 psig: Precision pressure gage, 0-160 psi, 1/4 of 1% accuracy, 8-1/2" dial minimum.
 - 5) 150 to 750 psig: Precision pressure gage, 0-800 psi, 1/2 of 1% accuracy, 8-1/2" dial minimum.
 - 6) 750 to 2,750 psig: Precision pressure gage, 0-3,000 psi, 1/2 of 1% accuracy, 8-1/2" dial minimum.
 - c. Differential:
 - 1) 0" to 5" w.c.: Inclined water filled manometer graduated in tenths and inches of water.
 - 2) 5" to 300" w.c.: Mercury manometer graduated in inches of water.
 - 3) 5 to 25 psig: Mercury manometer graduated in psi.
 - 4) Above 25 psig: Use pressure gages listed hereinbefore.

- d. Temperatures:
 - 1) -20 to 250°F: Laboratory thermometers of suitable range.
 - 2) Other ranges: Use thermocouple and precision potentiometer.
- e. Others:
 - 1) Precision millivolt potentiometer: Portable.
 - 2) Rotameter: Range, 6.5 to 65 cu cm/min of air.
 - 3) Equipment as specified by manufacturer's instructions.
 - 4) Wallace & Tiernan or Mansfield-Green pneumatic calibrator; range, vacuum to +24 psi:
For vacuum, pressure, or differential.

3.05 SCHEDULE OF SYSTEMS REQUIRING TESTING, ADJUSTING, AND BALANCING SERVICES

- A. Supply VAVs, General Exhaust VAVs, Hood Exhaust VAVs, Supply diffusers, Exhaust diffusers, and Hot Water Reheat coil control valves within the Laboratory areas of the 2nd & 3rd floors.
- B. Exhaust Fans serving the laboratory Areas: EF-1, 2, 3.
- C. Supply Air Handler serving the laboratory areas: AH-4.

END OF SECTION

- 1)
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. HVAC instrumentation for use with control system specified in Section 23 09 23.

1.02 RELATED SECTIONS

- A. Section 23 09 23 - Direct Digital Controls: Owner instruction.
- B. Section 23 09 23 - Sequence of Operation.

1.03 SUBMITTALS

- A. Specification Data Sheets for control components.
- B. Complete instruction manual covering function and operation of control components.
- C. Bill of Materials.

1.04 QUALITY ASSURANCE

- A. Manufacturer shall guarantee control device installed under this Specification to be free from defects in workmanship and material under normal use for a period of one year from date of acceptance of building by Owner.
- B. Replace defective material or workmanship within guarantee period, immediately, without cost to Owner.
- C. Control devices shall be by same manufacturer insofar as practicable. Control devices shall be provided by control system manufacturer unless noted otherwise.

1.05 WARRANTY

- A. Room control system shall have a limited 2-year warranty for all parts. Warranty shall commence on date of shipment from manufacturer.

PART 2 PRODUCTS

2.01 THERMOSTATS AND TEMPERATURE SENSORS

- A. Electronic space temperature sensor with set point adjustment:
 - 1. Single- or dual-scaled set point adjustment as required for application.
 - 2. Sensor: Nickel or platinum 1000-ohm resistance type.
 - 3. Accuracy: $\pm 1^{\circ}\text{F}$.
 - 4. Override button: Integral momentary pushbutton.
 - 5. Locking cover with concealed set point and thermometer, suitable for institutional use.
 - 6. Manufacturer: TSI.

2.02 SENSORS

- A. Temperature:
 - 1. Type: 1000-ohm resistance.
 - 2. Element: Nickel, platinum, or silicon.
 - 3. Accuracy: $\pm 1^{\circ}\text{F}$.
 - 4. Manufacturer: TSI.

2.03 DUCT PRESSURE TRANSMITTER

- A. Electronic:
 - 1. Power: 24 volts dc.
 - 2. Output: 4 to 20 mA.
 - 3. Operational pressure range suitable for application.
 - 4. Temperature limits: 0°F to 175°F.
 - 5. Accuracy: $\pm 1\%$ full span including nonlinear hysteresis, and nonrepeatability.
 - 6. Manufacturer: TSI.

2.04 LOW DIFFERENTIAL PRESSURE TRANSMITTER AND GAGE

- A. Diameter: 4".
- B. Pressure range: 0 to 2" or 0 to 6", as appropriate for installation.
- C. Power: 24 volts dc.
- D. Output: 4 to 20 mA.
- E. Accuracy: $\pm 2\%$ full span output.
- F. Manufacturer: Dwyer Series 605 Magnehelic, or equal.

2.05 ROOM PRESSURE CONTROLLER

- A. Provide room controller system to maintain measured laboratory pressurization independent of supply and exhaust flow volumes. System shall ensure that air flows into laboratory space from areas of low hazard to comply with requirement for air flow monitors in ANSI Z9.5.
- B. Room control systems designed to solely maintain specific pressure differential are unacceptable.
- C. System shall be completely independent for each individual laboratory. System shall not depend on measurements from other laboratory control systems.
- D. System shall independently control supply and general exhaust with 0-10 volt dc signals to maintain a difference between supply and exhaust flow volumes (offset). If offset is greater than setpoint, room controller shall decrease general exhaust flow rate and then increase supply flow rate to its maximum set point until desired offset is achieved. If offset is less than setpoint, room controller shall decrease supply flow rate to its ventilation minimum setpoint and then increase general exhaust flow rate until desired offset is achieved. Room controller shall receive voltage signals related to supply, general exhaust, and fume hood or total exhaust air flow volumes.
- E. Room controller shall control space temperature by modulating reheat valve with a 0-10 volt dc control signal and supply air volume. When space is too warm, room controller shall close reheat valve and then increase supply air volume. When space is too cool, room controller shall reduce supply air volume to its ventilation minimum set point and then open reheat valve. Exhaust air volume will follow supply air volume to maintain room balance. Room controller shall accept a 1000 W platinum RTD temperature sensor. Room controller shall always provide additional supply air as needed for to maintain room balance.
- F. To ensure fast, accurate control, room control system shall have a PID control algorithm with two sets of tuning constants. Two sets of tuning constants enable fast response to large disturbances while maintaining stability at setpoint. Control sensitivity defining breakpoint between input and steady state response shall be adjustable. Room control system shall update control output 10 times per second.

- G. Local audible and visual alarms and relay contacts shall be enabled whenever supply or exhaust air volume falls below configurable low alarm set point, after a configurable delay. A mute key shall temporarily silence audible alarm. Manual or automatic reset of alarms shall be configurable.
- H. Room control system shall have an emergency key and an emergency input contact to enable emergency mode. Room control system will drive supply and general exhaust dampers to achieve maximum pressurization in emergency mode.
- I. Room controller shall have an occupancy switch input. When occupancy switch input closes to indicate unoccupied conditions, room controller shall utilize a second minimum supply flow set point. Under unoccupied conditions, room controller will not increase supply flow rate for cooling.
- J. Calibration of air flows shall be done electronically through use of integral keypad. Calibration shall consist of adjusting sensor zero point and sensor span to match a reference measurement. Password protection of calibration items shall limit unauthorized access. Remote calibration, calibrating through use of potentiometers or factory calibration alone is not acceptable.
- K. Room control system shall measure supply flow volume and exhaust flow volume. Systems that measure room pressure differential are not allowed.
- L. Room control system shall accept up to 4 supply, 2 general exhaust, and 7 other exhaust flow measurements. Flow measurements shall be 0-10 volt signals, linear with respect to either velocity pressure or velocity.
- M. Room controller shall have a digital display of all configuration parameters. Configuration shall be done through a keypad integral to controller. Password protection shall limit unauthorized access to configuration parameters. Controller shall also have indicator lights for low and high alarm, normal operating conditions and mute. Analog outputs of supply and exhaust flow volumes shall be user-configurable to either 0 10 volt or 4 20 mA. Room controller shall have an RS-485 communications port, supporting Modbus and Johnson Controls N2 protocols for seamless integration to building automation system.
- N. Manufacturer: TSI Inc. "Sureflow" Model 8682.
 - 1. Systems and equipment by manufacturers other than TSI shall be part of a completely designed, tested, cataloged, and factory coordinated package from a single manufacturer. Manufacturer shall have successful customer installations of room control systems in operation for a period of over five years.
 - 2. Equipment other than that manufactured by TSI will only be considered for acceptance if substituted equipment is equal to every aspect of operation capabilities, capacities, and control sequence intent. Engineer shall be sole judge of equivalence.
 - 3. Alternate manufacturer shall provide separate concordance schedule indicating section, paragraph, and subparagraph of these specifications with a direct statement designating compliance with these specifications. For all areas of non-compliance, alternate manufacturer shall detail specific approach taken. Alternate manufacturer shall detail impact of any substitutions on user safety, energy costs, and sizing of ducts, fans, boilers, chillers, air handlers and any other equipment. Alternate manufacturers approved to bid must comply with intent and requirements of specification.

2.06 FUME HOOD VELOCITY SENSOR/CONTROLLER

- A. Type: Electronic.
- B. Control range: 0" w.g. to 1.5" w. g.
- C. Output: 0-5 volts dc.
- D. Sensitivity: $\pm 1\%$ full span, maximum.
- E. Repeatability: $\pm 0.005\%$ full span, maximum.
- F. Manufacturer: TSI 800320.

2.07 DAMPER ACTUATORS

- A. Type: Electronic.
- B. Power: 24 volts ac or volts dc, to suit application.
- C. Size adequate to provide smooth modulating action or 2-position action, as required.
- D. Input: 0 - 10 volts dc or 4-20 mA, as required.
- E. Output feedback.
- F. Enclosure: NEMA 3R.
- G. Spring return: As required.
- H. Manufacturer: TSI 800360.

2.08 CONTROL VALVES

- A. Re-use existing Johnson Controls Hot Water Control valves.

2.09 CONTROL VALVE ACTUATORS

- A. Type: Low-voltage, electronic.
- B. Power: 24 volts ac or volts dc, to suit application.
- C. Size: Adequate to provide smooth modulating action or 2-position action, as required.
- D. Input: 0 to 10 volts dc or 4 to 20 mA, as required.
- E. Output feedback.
- F. Spring return: As required.
- G. Manufacturer: Johnson Controls, Inc., Series VA 7152-1001, Proportional acting.

2.10 AIR FLOW RATE MEASUREMENT STATIONS

- A. Construction: 16-gage galvanized steel, epoxy-coated in fume exhaust applications. Copper air straighteners, sensor, and manifolds.

- B. Dimensions: Equal to duct dimensions where mounted.
- C. Furnish with pressure to electric transducer for static and total pressure measurement, as indicated on Drawings.

2.11 CONTROL STEP-DOWN TRANSFORMER

- A. Primary voltage: 120 volts, 60 Hz, single-phase.
- B. Secondary voltage: 24 volts ac.
- C. Size: As required to power control devices.
- D. Manufacturer: TSI, or equal.

2.12 TRANSDUCERS

- A. Current:
 - 1. Output: 4-20 mA or 0 to 10 volts dc.
 - 2. Accuracy: $\pm 1\%$.
 - 3. Select transducer for normal measured amperage to be near 50% of full scale range.
 - 4. Provide transducer for monitoring amperage of motors.
 - 5. Manufacturer: TSI, or equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Size control apparatus to supply and/or operate and control devices served.
- B. Furnish motor operators and duct velocity sensor controller, to high velocity terminal device manufacturer for factory mounting.
- C. Furnish automatic control valves automatic dampers, immersion wells, flow switches, and other devices to be installed by others.
- D. Provide temperature control wiring. Wiring shall include line voltage and low-voltage wiring. Install wiring by licensed electrician employed by Contractor and shall be installed in accordance with provisions of Division 16.
- E. Pneumatic equipment performing interlocking functions shall be panel-mounted and located within 5'-0" of equipment disconnect or starting device unless otherwise indicated.
- F. Provide numbered terminal strips in control panels for interfacing with others. Furnish others with control drawings indicating points of electrical interface.
- G. Provide compressed air gage within 6" of each damper and valve operator.
- H. Provide pressure differential gage across ends of filter bank. Mount gages in control panel face.

3.02 INSTALLATION

- A. Compressed air piping shall be hard drawn seamless, copper tubing, except fire retardant polyethylene tubing shall be used in concealed spaces not used as air duct.
- B. Exposed tubing and tubing within mechanical spaces shall be hard drawn seamless copper.

- C. Exposed tubing and conduit shall run parallel to or at right angles to building structure. Adequately support tubing at uniform intervals.
- D. Use sweat fittings throughout for copper tubing except for final connection to operators or other devices where compression fittings would be more suitable.
- E. Polyethylene tubing shall be coded and installed in accessible tube trays with no concealed splices.
- F. Mount room thermostats and temperature sensors 5'-0" above floor, vertically aligned with light switches.
- G. Horizontally align room humidistats and humidity sensors with thermostats.
- H. Room pressure controller:
 - 1. Install room controller system in each laboratory, as recommended by manufacturer's installation instructions.
 - 2. Connect control wiring as required.
 - 3. Start-up, calibration, and training
 - a. Manufacturer or a factory-authorized representative shall perform system start up. Start-up shall include calibration of controls. Calibration shall be performed only after substantial completion of building. Ceilings and doors shall be installed and HVAC systems (exhaust and supply fans) shall be properly air-balanced. Balancing contractor shall be responsible for final verification and reporting of all air flows.
 - b. Manufacturer or a factory-authorized representative shall provide 8 hours minimum of training for building personnel.

3.03 ADJUSTMENT

- A. After completion of installation, regulate and adjust thermostats, temperature sensors, humidity sensors, humidistats, pressure sensors, controllers, operators, and other equipment provided.

END OF SECTION

- 1) D. Rollins
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Modify existing Johnson Controls N2 Direct digital control (DDC) building automation system, including controllers, communications, software, and other components necessary to connect to, monitor, and control the laboratory fume hood controls system upgrades.

1.02 RELATED SECTIONS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.

1.03 SYSTEM REQUIREMENTS

- A. DDC system shall be modular in nature and expandable.
- B. Failure of single component shall not interrupt normal operation of other components.
- C. Furnish 10% minimum expansion capacity for I/O terminations and cards. Provide 20% spare cabinet space.
- D. Power: 120 volts ac, single-phase, 3-wire, 60 Hz, 120 voltage shall be supplied to various system cabinets as required. Provide DDC system with necessary power conversion devices to supply other system voltages as required.
- E. Power line filtering: Provide transient voltage and surge suppression for workstations and controllers, either internally or as an external component. Provide surge protection with following at a minimum:
 - 1. Dielectric strength: 1,000 volts.
 - 2. Response time: 10 nanoseconds or less.
 - 3. Transverse mode noise attenuation: 65 dB or greater.
 - 4. Common mode noise attenuation: 150 dB or better at 40 Hz to 100 Hz.
- F. DDC I/O modules shall be available for following signals, as a minimum:
 - 1. 4-20 mA dc powered or nonDDC-powered input for control, alarm, display, and/or trend recording.
 - 2. 4-20 mA dc output (load 0-600 ohms, minimum) for final control device manipulation.
 - 3. Grounded and ungrounded thermocouple inputs for control, alarm, display, and/or trend recording. System shall be capable of accepting Types E, J, and K thermocouples as a minimum.
 - 4. 0-10 volts dc nonpowered input.
 - 5. 0-10 volts dc output for final control device manipulation.
 - 6. Grounded and ungrounded 3-wire RTD inputs (100 ohm platinum, European or American Standard, or 10 ohm copper) for control, alarm, display, and trend recording.
 - 7. Discrete inputs (dry contacts/switches), DDC-powered or 120 volts ac nonDDC-powered, for "On/Off" field device status monitoring. Inputs shall be protected against effects of contact bounce and noise.
 - 8. NonDDC-powered discrete outputs (dry contacts) for field device "Start/Stop." Both latched and momentary contacts (normally open and normally closed) shall be available.
 - 9. Pulsed inputs: 0-8,000 Hz maximum range.
- G. Protect inputs and outputs so shorting of point itself, to another point, or ground shall cause no damage to controller. Protect input and output points from voltage up to 24 volts of any duration so contact with voltage will cause no damages to controller.
- H. Tie hardwired inputs and outputs into control system through building controllers, custom application controllers, network controllers, application specific controllers, or system integrators.

- I. Stability of control: Control loops shall maintain measure variable at setpoint within tolerances shown in table below.

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g. ±0.01 in. w.g.	0-6 in. w.g. -0.1 to 0.1 in. w.g.
Airflow	±10% of full scale	
Space Temperature	±2°F	
Duct Temperature	±3°F	
Humidity	±5%	
Fluid Pressure	±1.5 psig ±1 in. w.g.	0-150 psig 0-50 in. w.g. differential

1.04 NETWORK REQUIRMENTS

- A. Detection and accommodation of single or multiple failures of workstations, DDC panels, or network media. Network shall include provisions for automatically re-configuring itself to allow operational equipment to perform their designated functions as effectively as possible in event of single or multiple failures.
- B. Message and alarm buffering to prevent information from being lost.
- C. Error detection, correction, and re-transmission to guarantee data integrity.
- D. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in event operator device does not respond.
- E. Commonly available, multiple sourced, networking components shall be used to allow system to coexist with other networking applications. Following are acceptable technologies: Arcnet and/or Ethernet and/or service telephone pairs and/or broadband.
- F. Provide automatic synchronization of real-time clocks in DDC panels.
- G. All Points shall be considered global points. Any program in any controller on network shall be able to reference any point in any controller regardless of its location on network.

1.05 PERFORMANCE REQUIREMENTS

- A. Functional description; system entry shall:
 - 1. Allow entry to remote control data points.
 - 2. Add, delete, or reset alarm limits.
 - 3. Reset program start-stop times.
 - 4. Add or delete start-stop programs.
 - 5. Reset analog units.
 - 6. Reassign analog units.
- B. Capabilities:
 - 1. Address and digitally display analog valves.
 - 2. Transmit temperature, pressure, or other analog values from remote data gathering panels to CPU.
 - 3. Two- and 3-mode control capability for remote control of motor loads or changeover functions.
 - 4. Alarm abnormal on-off conditions.

1.06 SUBMITTALS

- A. Product Data: Include data concerning dimensions, capacities, technical data, and product specification sheets for:
1. Direct digital controllers.
 2. Control panels.
 3. Power supplies.
 4. Operator Interface equipment.
 5. With existing Operator workstations, modify or upgrade the following as needed:
 - a. CPU.
 - b. Monitors.
 - c. Printers.
 - d. Keyboard.
 - e. Power supply.
 - f. Battery backup.
 - g. Interface equipment between CPU and control panels.
 - h. Operating system software.
 - i. Operator interface software.
 - j. Color graphic software.
 - k. Third-party software.
- B. Shop Drawings:
1. DDC system drawings:
 - a. Provide single schematic showing controllers, operator workstations, printers and other major components of control system. Devices downstream of controller need not be shown unless not shown on controlled systems schematic drawings.
 - b. Indicate control, communication, and power wiring. Provide wiring size and type on drawing, or provide table indicating sizes and types of wiring.
 2. Controlled systems drawings:
 - a. Provide separate drawing for each controlled system.
 - b. Show basic equipment arrangements including fans, pumps, variable speed drives, coils, valves, dampers, boilers, refrigeration compressors, expansion valves, hot water pumping system control; duct pressure sensors, and space static sensors.
 - c. Show sensors and other input devices and controlled devices.
 - d. Each schematic shall have control points labeled with point names shown or listed. Where control point is shown on multiple drawings, point shall be labeled with same point name.
 - e. Provide list of instrumentation for each controlled system. List shall include element name, type of device, manufacturer, model number, and product data sheet number.
 - f. Provide complete description of operation of control system, including sequences of operation.
 - g. Provide point list for each controller. Point list shall identify each point by name, type of point (AO, AI, DI, DO, and VP), alarms associated with point, and controlled device associated with point (where applicable). System setpoints shall be identified as virtual points and initial setpoint shall be noted.
 - h. Include schematic electrical wiring diagram showing control wiring and power wiring interlocks. Wiring schematic shall indicate wire size and type.
 - i. Show exact terminal numbers of electrical components furnished and panel wiring.
 - j. Number wires within temperature control panels.
 - 1) 120-volt wiring: Number from 700 and above.
 - 2) Low-voltage wiring: Number from 1 to 699.
 3. Software logic control drawings:
 - a. Provide signal flow chart which includes control loops. Where output or input of control loop is interconnected to other control loops, control loops shall be shown on same drawing.
 - b. Indicate source or destination for measured variable input, setpoint (manual or reset schedule), enable/disable, and output signals.
 - c. Reference software modules (control modules i.e. PID module, or reset schedules of enthalpy calculations, etc.) or other software programming to algorithmic program code.
 - d. Control loop parameter settings shall be shown on drawings as part of "as-built" documentation including proportional band, reset, derivative, dead band, alarm limits, and other control adjustments. When control loops are contingent on other events or measured

- values, such as fan operation or outdoor temperature (as in economizer mode), contingencies shall be displayed on Drawings.
- e. Software logic control drawings and algorithmic program code shall constitute entire software for control loops.
 - f. Drawing shall include terminal number, wire number, and cable number references. Referenced notations shall be identical to notations used on hardware.
- C. Quality assurance data:
1. Training manuals: Provide course outline and training manuals for training classes at least 2 weeks prior to first scheduled class.
 2. Monthly reports: Submit report including full set of commissioning control loop trend log documentation for selected time periods during previous month.
 3. Installation-inspection report indicating by system, each outstanding item on Owner's adjustment list.
- D. Closeout submittals:
1. Operating and maintenance manuals:
 - a. Provide 3 copies of available operating manuals for equipment provided by respective manufacturers, including nonproprietary software manuals for DDC system.
 - b. Provide 3 copies of available maintenance manuals for equipment provided by respective manufacturers.
 2. Project record documentation:
 - a. System schematic drawings: Provide for each local control processor and 3 complete sets of system schematic drawings for remote central processor.
 - b. Control schematic drawings:
 - 1) Provide control schematic drawings for each local control processor.
 - 2) Include control settings at time job is approved by *Owner* *Engineer* including setpoints, reset schedules, proportional bands, reset parameters, derivative parameters, time delays, and other tuning parameters necessary to completely define control system programming. Reference tuning parameters to specific trend log data set which shall be retained on file as integral part of project record documentation.
 - 3) Reference software modules identified on Drawings to specific algorithmic program code.
 - c. Algorithmic program code: Provide 3 copies at remote central processors listed by same designation on control schematic drawings with master index using same designation on control schematic drawings which identifies page number on which to find any software module.
 - d. Equipment parts list: Provide complete list identifying every part of every piece of equipment provided.
 - e. Include portions of certain equipment such as printed circuit boards within local control processors and remote central processor; relays within panels; variable air volume and constant volume box damper operators, control valves, and flow sensors.
 3. Commissioning control loop trend log documentation. Time increment of these commissioning control loop trend log sets shall be 5 minutes and shall cover 24-hour time period.

1.07 QUALITY ASSURANCE

- A. DDC system components shall be from one control manufacturer insofar as practicable.
- B. Qualifications:
1. System manufacturer and installers shall have been in business of designing, manufacturing, and installing control systems for minimum of 10 years and shall also have minimum of 10 years experience in design and installation of DDC control systems.
 2. System manufacturer shall directly supervise entire control system installation. Representative in direct employ of control system manufacturer shall be on Site at all times during control system installation including demolition, piping, and device installation.
 3. System manufacturer shall have office capable of providing emergency and regular service within 2-hour drive of Site.

1.08 WARRANTY

- A. Guarantee automated control system to be free from defects in workmanship and material under normal use for period of 2 years after acceptance by Owner.
- B. Make necessary repairs due to defects in workmanship or materials during guarantee period immediately and without additional cost to Owner.
- C. Software documentation: Guarantee software changes made during warranty agreement period will be loaded into monitoring processor "master software library" same day as work is performed and hard copy documentation will be provided within 3 working days of when work is performed.

1.09 OWNER'S INSTRUCTION

- A. Upon completion of work and acceptance by Owner, factory representatives under direct employ of temperature control manufacturer shall provide minimum of 8 hours of instruction to 3 of Owner's operating personnel responsible for mechanical systems.
- B. Train Owner's operating personnel to perform following:
 - 1. Day-to-day operations:
 - a. Proficiently operate system.
 - b. Understand control system architecture and configuration.
 - c. Understand DDC system components.
 - d. Understand system operation, including DDC system control and optimizing routines (algorithms).
 - e. Operate workstation and peripherals.
 - f. Log on and off system.
 - g. Access graphics, point reports, and logs.
 - h. Adjust and change system setpoints, time schedules, and holiday schedules.
 - i. Recognize malfunctions of system by observation of printed copy and graphical visual signals.
 - j. Understand system drawings and operation and maintenance manual.
 - k. Understand job layout and location of control components.
 - l. Access data from DDC controllers.
 - m. Operate portable operator's terminals.
 - 2. Advanced operations:
 - a. Make and change graphics on workstation.
 - b. Create, delete and modify alarms, including annunciation and routing of alarms.
 - c. Create, delete, and modify point trend logs and graph or print both on ad-hoc basis and at user-definable time intervals.
 - d. Create, delete, and modify reports.
 - e. Add remove and modify system's physical points.
 - f. Create modify and delete programming.
 - g. Add panels when required.
 - h. Add operator interface stations.
 - i. Create, delete, and modify system displays both graphical and others.
 - j. Perform DDC system field checkout procedures.
 - k. Perform DDC controller unit operation and maintenance procedures.
 - l. Perform workstation and peripheral operation and maintenance procedures.
 - m. Perform DDC system diagnostic procedures.
 - n. Configure hardware including PC boards, switches, communication and I/O points.
 - o. Maintain calibrate, troubleshoot, diagnose, and repair hardware.
 - p. Adjust, calibrate, and replace system components.
 - 3. System management and administration:
 - a. Maintain software and prepare backups.
 - b. Interface with job-specific, third-party operator software.
 - c. Add new users and understand password security procedures.

- C. Divide objectives of training into multiple logical lessons. Participants may attend 1 or more of lessons depending on level of knowledge required.
- D. Provide additional 24-hour period of instruction at beginning of next heating and cooling season.

1.10 MAINTENANCE

- A. After completion of installation, and during guarantee period, manufacturer shall provide monthly inspections of control system. Furnish written reports to Owner detailing findings of each inspection and actions taken to remedy off-normal conditions.
- B. Calibration: Maintain "stable operation" of control loops and controlled devices and maintain calibration of microprocessor controllers, microprocessor monitoring equipment, control dampers, thermostats, and other equipment necessary for stable operation of installed control system.
- C. Replacement and reprogramming: Replace malfunctioning equipment and reprogram software in environmental control system within 72 hours after recognition of unstable operation.
- D. Stock parts required by control system; maintained in stock and available for delivery within 2 days.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Johnson Controls for BMS equipment in order to connect fume hood control system to communicate and operate with existing Building Management Systems.
- B. TSI Incorporated for Lab Classroom Fume Hood Controls Systems.
- C. Phoenix Controls Corporation.
- D. Triatek, Inc.
- E. Wholesalers, contractors, franchised dealers, or firms whose principal business is not that of manufacturing and installing energy management and automatic temperature control systems not acceptable.

2.02 COMMUNICATIONS

- A. Johnson Controls N2 Network: Communication involving control components shall conform to existing Johnson Controls N2 Network.
- B. Panels, controllers, and operator workstations shall transfer information via network composed of high-speed Local Area Network (LAN), field bus, dial-up communication, or combination of above.
- C. High-speed LAN:
 - 1. Operation: Under Arcnet or Ethernet protocol at minimum speed of 10 Mbps.
 - 2. Support multi-user communication and multi-session activity.
 - 3. Connections: Coaxial cable, fiber optical cable, shielded twisted pair, or combination of these connections for panel, controller, and workstation connections.
- D. Field bus: Operate under RS485 protocol at minimum speed of 9600 Baud.
- E. Dial-up communication:
 - 1. Type: Auto-dial/auto-answer.

2. Provide auto-dial/auto-answer communications to allow stand-alone DDC panels to communicate with remote operator devices on intermittent basis via telephone lines.
 3. Dial-up standalone DDC panels: Auto-dial panels shall automatically place calls to workstations to report critical alarms, or to upload trend and historical information for archiving.
 - a. Standalone DDC panels shall analyze and prioritize alarms to minimize initiation of calls. Noncritical alarms shall be buffered in memory and reported as group of alarms, or until operator manually requests upload of alarms.
 - b. Auto-dial program shall include provisions for handling busy signals, "no-answers," and incomplete data transfers. Default devices shall be called when communications cannot be established with primary devices.
 4. Dial-up workstations: Operators at dial-up workstations shall be able to perform control functions, report functions, and database generation and modification functions as described for workstations connected via local area network. Provide routines to automatically answer calls, and either file or display information sent from remote DDC panels.
 - a. Operator shall be able to access remote buildings by selection of any facility by its logical name. PC dial-up program shall maintain user-definable cross-reference of buildings and associated telephone numbers, so user shall not be required to remember or manually dial telephone numbers.
 - b. PC workstation may serve as operator device on local area network as well as dial-up workstation for multiple auto-dial DDC panels or networks. Alarm and data file transfers handled via dial-up transactions shall not interfere with local area network activity, nor shall local area network activity keep workstation from handling incoming calls.
 5. One-way dial communication shall function as specified above, except for auto-answer feature.
 6. Dial-up communications shall make use of Hayes compatible 28,800 Baud modems and voice grade telephone lines. Each standalone DDC panel may have its own modem, or group of standalone DDC panels may share modem.
- F. Third-party communication: Panels shall have capability to communicate with third-party controllers as required to control device and to monitor alarms as specified in this Section.
- G. Provide communication media, connectors, repeaters, hubs, and routers necessary for communication network.

2.03 CONTROLLERS

- A. Consist of microprocessor-based digital control processor, input/output modules, communication controller modules, and power supply modules. Provide capability to be used for minimum of following applications:
 1. Building controllers.
 2. Custom application controllers.
 3. Network controllers.
 4. System integrators.
- B. Construction of each module:
 1. Electronic, solid-state, printed circuit board.
 2. Plug-in type connections.
- C. Provide sufficient memory to support:
 1. Control processes.
 2. Energy management applications.
 3. Alarm management.
 4. Trend data for points.
 5. Custom processes.
 6. Operator input/output.
 7. Dial-up communications.
 8. Manual override monitoring.
 9. Other functions as necessary for complete system operation.

- D. Inputs/outputs:
 - 1. Analog inputs.
 - 2. Analog outputs.
 - 3. Digital inputs.
 - 4. Digital outputs.
 - 5. Pulse inputs.
- E. Communication:
 - 1. Provide serial communications ports to support multiple operator input/output devices.
 - 2. Provide communication ports for connection to other panels and application-specific controllers.
 - 3. Building controllers, custom application controllers, network controllers, and system integrators shall communicate with other BACnet devices on network using "Read" (execute and initiate) and "Write" (execute and initiate) property services as defined in ASHRAE 135
- F. Override switches and monitoring:
 - 1. Provide hardware override switches for automatic or centrally executed commands at panel.
 - 2. Override shall be by switches at panel.
 - 3. Switches:
 - a. "Hand-Off-Auto" operator switches for binary control points and gradual switches for analog control-type points.
 - b. Operable whether panel is powered or not.
 - 4. Panel shall monitor status or position of overrides and report to operator workstation any changes in position or status.
- G. Provide indicator lamps for:
 - 1. Panel power.
 - 2. CPU status.
 - 3. Error status.
- H. Provide lockable enclosure for each panel.
- I. Battery backup: Provide for panel memory and real-time clock for minimum of 24 hours.
- J. Upon restoration of normal power, panel shall automatically resume operation without manual intervention and automatically recharge standby battery.
- K. Controller hardware shall be suitable for following ambient conditions:
 - 1. Outdoor location: -40°F to 150°F.
 - 2. Indoor location: 32°F to 120°F.

2.04 APPLICATION-SPECIFIC CONTROLLERS (ASC)

- A. Each ASC shall perform its specified control responsibilities independently of other controllers in network.
- B. Each ASC shall be microprocessor-based digital control processor.
- C. Provide controller with sufficient memory to support:
 - 1. Control processes.
 - 2. Energy management applications.
 - 3. Operator I/O.
- D. Setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that power failure does not require reprogramming ASC.
- E. Provide controller with connection for use by portable service terminal.

- F. Controller shall support necessary inputs and outputs to perform specified sequences in totally stand-alone fashion.
- G. Controller shall control devices as specified in this Section.
- H. Provide communication ports for connection to other panels and application specific controllers.
- I. Application specific controllers shall communicate with other BACnet devices on network using "Read" (execute) property service as defined in ASHRAE 135.
- J. Variable air volume (VAV) controllers:
 - 1. Support, but not be limited to, control of following:
 - a. Single-duct VAV.
 - b. Supply or exhaust VAV.
 - 2. Each controller: Minimum 4 inputs and 4 outputs.
 - a. Inputs: Include both analog and digital type.
 - b. Outputs: As required to control device(s) as specified in this Section.
 - 3. Manage own alarm conditions and report alarms as specified.
 - 4. Automatically maintain history of associated zone temperature for past 24 hours. Store minimum of 2 samples per hour.
- K. Laboratory controllers:
 - 1. Minimum of 16 inputs and 8 outputs.
 - a. Inputs: Include both analog and digital type.
 - b. Outputs: As required to control devices as specified in Section 23 09 93.
 - 2. Manage own alarm conditions and report alarms as specified.
- L. Air handling unit (AHU) & Exhaust Fan (EF) controllers:
 - 1. Verify control of existing AH-4 & EF-1,2,3. Modify as needed.
 - 2. Minimum 16 inputs and 16 outputs.
 - a. Inputs: Include both analog and digital type.
 - b. Outputs: As required to control devices as specified in Section 23 09 93.
 - 3. Manage own alarm conditions and report alarms as specified.
 - 4. Automatically maintain history of associated zone temperature(s) for past 24 hours. Store minimum of 2 samples per hour.

2.05 OPERATOR WORKSTATION SOFTWARE

- A. Operating system:
 - 1. Provide concurrent multitasking operating system for each operator workstation, and portable operator workstation.
 - 2. Allow multiple concurrent displays of different types of system displays.
 - 3. Provide same version of operating system for all operator workstations and portable operator workstations.
 - 4. Compatible with controller software and editing applications provided by Contractor.
 - 5. Perform the following actions through DDC system software provided by Contractor.
 - a. Allow system monitoring and programming.
 - b. Allow operator to select choices through interactive menu system displaying prompts instructing operator how to proceed to higher or lower level menus.
 - c. Allow user to communicate directly with panels and controllers and integrate information as required.
 - d. Operator functions: Selectable through use of mouse.
 - 6. Support use of other common software applications (Microsoft Excel and Word, WordPerfect, etc.).
 - 7. Acceptable systems include, Windows 98, Windows XP Professional, Windows 2000, UNIX, and OS/2.
- B. Applications:

1. Provide following application programs for each operator workstation and portable operator workstation:
 - a. Word processing program.
 - b. Spreadsheet program.
2. Application software shall be compatible with DDC system software provided to allow editing and saving of reports, and logs from DDC system software.

2.06 DDC SYSTEM SOFTWARE

- A. Provide software required to integrate fume hood controls into existing operating DDC system.
- B. Store programming for each controller and panel in said controller or panel, not on remote workstation, controller, or panel.
- C. Save copy of programming of each controller and panel on operator workstation as backup in case controller or panel memory is lost.
- D. Once programmed, controllers and panels shall act as stand-alone devices.
- E. Input, output, software, and other points: Accessible on entire network as global points. No special programming shall be required to share points between controllers, panels, operator workstations, and other network devices.
- F. Assign each connected I/O point, variable, controller, panel, operator workstation, or other system component unique identifier.
 1. Identifier: User-changeable and minimum of 16 alpha/numeric characters.
 2. User shall be able to add more detailed description to each point or system component.
- G. User shall be able to reprogram panels and controllers without replacement of panels or controllers.
- H. Provide software licensing agreement to Owner allowing Owner to write and modify software. Provide automatic upgrades of software to Owner when software provided has "bugs," or "errors." Provide maintenance upgrades of software to Owner during warranty period.
- I. Network-wide strategy development: Inputs and outputs for any process shall not be restricted to single DDC panel, but shall be able to include data from any and other DDC panels to allow development of network-wide control strategies. Processes shall allow operator to use results of one process as input to any number of other processes (cascading).
- J. System shall allow, as minimum, following actions to occur from operator workstation:
 1. Start-up or shutdown selected equipment.
 2. Adjust setpoints.
 3. Add/Modify/Delete time programming.
 4. Enable/Disable process execution.
 5. Lock/Unlock alarm reporting for each point.
 6. Enable/Disable totalization for each point.
 7. Enable/Disable trending for each point.
 8. Override PID loop setpoints.
 9. Enter temporary override schedules.
 10. Define holiday schedules.
 11. Change time/date.
 12. Enter/Modify analog alarm limits.
 13. Enter/Modify analog warning limits.
 14. View limits.
 15. Enable/Disable demand limiting for each meter.
 16. Enable/Disable duty cycle for each load.

17. Add/Delete/Modify stand-alone DDC controllers.
 18. Add/Delete/Modify operator workstations.
 19. Add/Delete/Modify application specific controllers.
 20. Add/Delete/Modify control loops.
 21. Add/Delete/Modify energy management applications.
 22. Add/Delete/Modify points of any type, and associated point parameters, and tuning constants.
 23. Add/Delete/Modify alarm reporting definition for each point.
- K. System graphics: Provide color graphics software package displaying current values updated within 1 second.
1. Separate graphics display for each controlled system (air handling unit, cooling system, heating system, exhaust fan system, etc).
 2. Display value of each digital input, analog input, digital output, and analog output on screen next to peripheral device. Display alarm points on screen next to respective device. Show setpoints for active control loops on screen next to control variable.
 - a. Values of analog inputs: In units measured (i.e. cfm, degrees F., psi, etc) and displayed at measured accuracy.
 - b. Values of digital inputs: In state of measured device (i.e., clogged air filter/unclogged air filter or supply fan motor on/supply fan motor off).
 - c. Values of analog outputs: Percentage open units (i.e., heating valve = 50% open, return air damper = 25% open).
 - d. Values of digital outputs: Specified in state of controlled device (i.e., supply fan motor = command to start; status = on).
 3. Provide libraries, compatible with graphic development package, of pre-engineered screens and symbols depicting standard HVAC equipment (i.e. fans, pumps, air handling units, terminal units, chillers, boilers, etc), and electrical symbols.
 4. Graphic development package shall use mouse or similar pointing device in conjunction with drawing program to allow user to perform following:
 - a. Define symbols.
 - b. Position and size symbols.
 - c. Define background screens.
 - d. Define connecting lines and curves.
 - e. Locate, orient, and size descriptive text.
 - f. Define and display colors for elements.
 - g. Establish correlation between symbols or text and associated system points or other displays.
 - h. Capturing or converting graphics from CADD programs. (I.e. AutoCAD, MircoStation, etc.)
- L. System applications: Each operator workstation shall provide operator interface and off-line storage of system information. Provide following applications at each workstation:
1. Automatic system database save and restore.
 - a. Each operator workstation shall store on hard disk a copy of current database of each controller or panel.
 - b. Update database whenever change is made in any system panel.
 - c. Storage shall be automatic and shall not require operator intervention.
 - d. Provide continuous supervision of integrity of controller and panel databases.
 - e. Automatically restore database to panels upon detection of database loss to restore proper operation.
 - f. Operator shall be able to disable feature individually on each operator workstation.
 2. Manual database save and restore.
 - a. Allow system operator with proper password to save database from any system panel
 - b. Allow system operator with proper password to clear any system panel database and manually initiate download of specified database to any panel in system.
 3. System configuration and definition:
 - a. Temperature and equipment control strategies and energy management routines shall be definable by operator.
 - b. System definition and modification procedures shall not interfere with normal system operation and control.
 4. On-line help.

- a. Provide for applications and provide relevant data for that particular screen.
 - b. Context sensitive system to assist operation in operating and editing system.
 - c. Use hypertext to link-related information.
5. Security:
- a. Require each operator to log onto system with user name and password in order to view, edit, add, or delete data.
 - b. Provide minimum of 3 levels of password access for operators. Activities possible at each access level shall be as follows:
 - 1) Level 1: Full access
 - 2) Level 2: Modify setpoints, override commands, Change schedules, create trend logs, and other activities as defined by Owner.
 - 3) Level 3: Read only access.
 - c. Provide a minimum of 20 access groups to limit portion of network that an individual password can access. One of the access groups shall allow full access to all components on network. Composition of each access group shall be user definable.
6. System diagnostics:
- a. System shall automatically monitor operation of all workstations, printers, modems, network connections, panels, and controllers.
 - b. Failure of any device: Annunciated to operator.
7. Alarm:
- a. Processing:
 - 1) Any object in system shall be configurable to alarm in and out of normal state.
 - 2) Operator shall be able to configure alarm limits, alarm limit differentials, states, and reactions for each object in system.
 - b. Message configuration: Alarms shall use English language descriptor for object in alarm. Use of abbreviations or point names is not acceptable.
 - c. Reactions:
 - 1) Operator shall be able to determine actions to take during alarm.
 - 2) Actions shall include following:
 - a) Logging.
 - b) Printing.
 - c) Starting programs.
 - d) Displaying messages.
 - e) Dialing out to remote stations.
 - f) Providing audible annunciation.
 - g) Displaying specific system graphics.
 - 3) Each action shall be configurable by workstation and by time of day.
8. Trending and trend logs:
- a. Operator shall be able to define:
 - 1) Custom trend log for any data object in system in addition to trend logs specified herein.
 - 2) Trends for purpose of collection performance data over extended periods of time. Data shall be measured or calculated as either analog or binary.
 - a) Sample intervals: From 1 minute to 2 hours.
 - b) Each controller: Capable of storing minimum of 5,000 data samples.
 - b. Trend data: Sampled and stored on controller panel, be archivable on hard disk, and be retrievable for use in spreadsheets and standard database programs. Archiving of data shall occur based upon either user-defined interval, manual command, or when trend buffers become full.
 - c. Point histories:
 - 1) Provide minimum of 24-hour storage capability for inputs and outputs from panel.
 - 2) Point history files for binary inputs and outputs shall include record of last 10 status changes or commands from each point.
 - 3) Take point histories automatically at interval of 30 minutes.
9. Alarm and event log. Generate reports automatically or manually and allow operator to direct alarm and event logs to displays, printers (including printers connected to operator workstation not directly to control system network), or disk files.
10. Object and property status and control.

11. Clock synchronization.
 12. Reports and Logs: Generate reports automatically or manually and allow operator to direct alarm and event logs to displays, printers (including printers connected to operator workstation not directly to control system network), or disk files. As minimum, system shall allow user to easily obtain following types of reports:
 - a. General listing of points in network.
 - b. List of temperature points.
 - c. List of pressure points.
 - d. List of flow meter points including kW/kWh.
 - e. List of start and stop points.
 - f. List of binary status points.
 - g. Filter pressure drop.
 - h. List of pump status points.
 - i. List of AHU and exhaust fan status points.
 - j. List of chiller status points.
 - k. List of supply air, return air, and mixed air temperature points.
 - l. List points currently in alarm.
 - m. List of off-line points.
 - n. List points currently in override status.
 - o. List of disabled points.
 - p. List points currently locked out.
 - q. List of items defined in "Follow-Up" file.
 - r. List weekly schedules.
 - s. List holiday programming.
 - t. List of limits and dead bands.
 - u. Set of points monitored by base EMS.
 - v. Summaries provided for specific points, for logical point group, for user-selected group of groups, or for entire facility without restriction due to hardware configuration of facility management system. Under no conditions shall operator need to specify address of hardware controller to obtain system information.
 - w. Third-party interface, system data, including transactions, alarms, totalization files, etc., shall be stored on workstation disk drive in industry standard database format (e.g., dBase IV) compatible with off-the-shelf third-party database and spreadsheet programs.
- M. Workstation application editors:
1. Provide at each operator workstation to support editing of system applications.
 2. Download applications and execute at 1 or more controllers and panels in system.
 3. Controller editors:
 - a. Provide full screen editor for each type of application.
 - b. Each editor shall allow operator to view and change following for all controllers and panels:
 - 1) Configuration.
 - 2) Name.
 - 3) Control parameters.
 - 4) Setpoints.
 4. Schedule editor:
 - a. Provide for all scheduling applications.
 - b. Allow operator to choose year and month to set up unique schedules.
 5. Custom application programming:
 - a. Either text-based language or by graphical language.
 - b. Operator shall have ability to create, edit and download custom programs without interfering with normal operation of DDC system.
 - c. Ability to utilize pre-tested control algorithms to perform standard control functions. Algorithms shall include, but not be limited to, following:
 - 1) 2-position control.
 - 2) Proportional (P) control.
 - 3) Proportional, Plus Integral (PI) control.
 - 4) Proportional, Integral, Plus Derivative (PID) control.
 - 5) Automatic control loop tuning.

- d. Ability to utilize mathematical, psychrometric, logical, curve fitting, calendars, alarms, and trend functions. Functions shall include, but not be limited to, following:
 - 1) Mathematical functions:
 - a) Addition.
 - b) Subtraction.
 - c) Division.
 - d) Multiplication.
 - e) Square roots.
 - f) Exponentials.
 - g) Logarithms.
 - 2) Psychrometric functions:
 - a) Enthalpy.
 - b) Wet bulb.
 - c) Dew point.
 - d) Relative humidity.
 - 3) Logical functions:
 - a) Boolean logic statements.
 - b) Greater than.
 - c) Less than.
 - d) Equal to.
 - 4) On-delays and off-delays.
 - 5) Calendar functions:
 - a) Time of day.
 - b) Time interval.
 - c) Date.
 - e. Self-documenting or documentation for specified control sequences shall be provided, consisting of either flow chart showing input variables, control constants, and output variables, or written description of what each component of control loop accomplishes.
 - 6. Simulation:
 - a. System software shall have ability to run off-line simulations of control programming.
 - b. Simulation mode shall allow user to change input variables and setpoints and to observe effect input variable change or setpoint change has on control outputs.
- N. Controller software: Furnish following applications software for building and energy management. Software applications shall reside and operate in system controllers. Editing of applications shall occur at operator workstation.
- 1. System security:
 - a. Secure user access using individual security passwords and user names.
 - b. Passwords restricting user to objects, applications, and system functions as assigned by system manager.
 - c. Record user Log On/Off attempts.
 - d. System shall protect itself from unauthorized use by automatically logging off following last keystroke. Delay time shall be user-definable.
 - 2. Scheduling: Provide capability to schedule each object or group of objects in system. Each schedule shall consist of following:
 - a. Weekly schedule:
 - 1) Provide separate schedules for each day of week.
 - 2) Each schedule:
 - a) Include capability for start, stop, optimal start, optimal stop and morning warmup and night economizer.
 - b) Capable of consisting of minimum of 10 events.
 - 3) When group of objects are scheduled together, provide capability to adjust start and stop times for each object in group.
 - b. Exception schedule:
 - 1) Provide ability for operator to designate any day of year as exception schedule.
 - 2) Capable of being defined up to 1 year in advance.

- 3) Once exception schedule is executed, schedule shall be discarded and replaced by standard schedule for that day of week.
- c. Holiday schedule:
 - 1) Provide capability to define up to 99 special or holiday schedules.
 - 2) Able to be placed on scheduling calendar and be repeated each year.
 - 3) Length of each holiday period: Definable from operator workstation.
3. Grouping:
 - a. Provide standard application for proper coordination of equipment.
 - b. Application shall provide operator with method of grouping together equipment based on function and location.
 - c. Group may then be used for scheduling and other applications.
4. Alarm requirements:
 - a. Alarm management:
 - 1) Provide to monitor, buffer, and direct alarm reports to operator devices and memory files.
 - 2) Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to noncritical alarms, minimize network traffic, and prevent alarms from being lost.
 - 3) At no time shall DDC panel's ability to report alarms be affected by either operator activity at PC workstation or local I/O device, or communications with other panels on network.
 - b. Alarm or point change reports: Include point English language description, and time and date of occurrence.
 - c. User shall be able to define specific system reaction for each alarm. Prioritize alarms to minimize nuisance reporting and to speed operator response to critical alarms. Provide minimum of 3 priority levels. Each DDC panel shall automatically inhibit reporting of selected alarms during system shutdown and start-up. Users shall have ability to annually inhibit alarm reporting for each alarm and be able to define under which conditions point changes need to be acknowledged by operator, and/or set to follow-up files for retrieval and analysis at later date.
 - d. Direct alarm reports, messages, and files to user-defined list of operator devices or PC disk files used for archiving alarm information. Alarms shall be automatically directed to default device in event primary device is found to be off-line. When alarm is sent directly to printer, alarm shall be spooled and printed after document printing at time of alarm.
 - e. In addition to point's descriptor and time and date, user shall be able to print, display, or store 65-character alarm message to more fully describe alarm condition or direct operator response. Each stand-alone DDC panel shall be capable of storing library of at least 250 alarm messages. Each message may be assignable to any number of points in panel.
 - f. Auto-dial alarm management:
 - 1) In dial-up applications: Only critical alarms shall initiate call to remote operator device.
 - 2) In other cases: Call activity shall be minimized by time-stamping and saving reports until operator scheduled time, manual request, or until buffer space is full. Alarm buffer must store minimum of 50 alarms.
 - g. Transaction logging:
 - 1) Automatically log operator commands and system events to disk in PC industry standard database format.
 - 2) Log operator commands initiated from direct-connected workstations, dial-up workstations, and local DDC panel network terminal devices to transaction file. Data shall be available at operator workstation.
 - 3) Provide utility to allow user to search transaction file using standard database query techniques, including searching by dates, operator name, data point name, etc.
 - 4) Transaction file shall be accessible with standard third-party database and spreadsheet package.
5. Maintenance management: System shall monitor equipment status and generate maintenance messages based on user-designated run-time, starts, and/or calendar date limits.
6. Sequencing: Provide application software based upon sequences of operation specified to properly sequence fume hood controls.
7. Staggered start: Provide application to prevent controlled equipment from simultaneously restarting after power outage. Order in which equipment (or groups of equipment) is started, along with time delay between starts shall be definable by user.

8. Energy calculations:
 - a. Provide software to allow instantaneous power (e.g. kW) or flow rates (e.g. gpm) to be accumulated and converted to energy usage data.
 - b. Provide algorithm calculating sliding window average (e.g. rolling average). Algorithm shall be flexible to allow window intervals to be user-specified (e.g., 15 minutes, 30 minutes, 60 minutes, etc.)
 - c. Provide algorithm calculating fixed window average. Digital input signal shall define start of window period to synchronize fixed window average with that used by utility.
9. Equipment and system protection:
 - a. System software:
 - 1) Include provisions for limiting of equipment cycling.
 - 2) Provide protection against excessive demand situations during startup periods by incorporating time delays between successive start commands.
 - 3) Provide automatic restart of equipment based on current program time and program requirements without operator intervention.
 - b. Upon resumption of normal power, panels and controllers shall analyze status of controlled equipment, compare status with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
10. Run-time totalization: Provide software for binary input objects. A high runtime alarm shall be assigned, as required, from operator workstation.
11. Control algorithms:
 - a. Proportional-Integral Derivative (PID) control:
 - 1) Supply algorithm with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate time varying analog value used to position output or stage series of outputs.
 - 3) Controlled variable, setpoint, and PID gains shall be edited from operator workstation.
 - b. On/Off control with differential:
 - 1) Provide algorithm allowing binary output to be cycled-based on controlled variable and setpoint.
 - 2) Algorithm: Direct-acting or reverse-acting and incorporating adjustable differential.

2.07 INSTRUMENTATION AND CONTROL DEVICES

- A. As specified in Section 23 09 13.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

- A. Install equipment in readily accessible locations as defined in latest edition of NEC.
- B. Control panels: Wall-mounted or free-standing, supported from floor. Support from adjacent equipment or piping not acceptable.
- C. Recess wall-mounted control panels located in occupied spaces within wall on which it is mounted. Coordinate requirements with other trades.
- D. Size control apparatus to supply and/or operate and control devices served.
- E. Select building controllers and custom application controls to provide minimum of 15% spare I/O point capacity for each point type. A minimum of 1 spare of each point type is required. No additional controller boards, or point modules shall be required to implement use of spare points.
- F. Install equipment, wiring, and raceway parallel to or at right angles to building structure. Provide adequate support at uniform intervals.

- G. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- H. Provide numbered terminal strips in control panels for interfacing with others. Furnish others with control drawings indicating points of electrical interface.
- I. Provide complete programming of control functions, sequences, setpoints, alarms, and graphic displays.
- J. Provide separate controller for each air handling unit or other HVAC system, unless noted otherwise on Drawings.
- K. Assign points associated with controller to that controller. Points used for control loop reset may be common for several or all controllers (i.e. outdoor air temperature, or space temperature, position of controlled device, etc.).

3.02 WIRING INSTALLATION

- A. Provide temperature control wiring. Include line voltage, low-voltage wiring, and communication wiring. Wiring shall be installed by licensed electrician employed by Contractor and in accordance with provisions of Division 26.
- B. Control and interlock wiring: Comply with national and local electrical codes and Division 26. Requirements of Division 26 shall take precedence.
- C. NEC Class 1 (line voltage) wiring: UL-listed in approved raceway according to NEC and Division 26 requirements.
- D. Low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.
- E. Control wiring, Class 1 and Class 2, shall be installed in approved metallic raceway or cable tray.
- F. Provide raceway and cable tray as required for control system. Control system wiring shall not use building communication or other raceway, unless noted otherwise.
- G. Where NEC Class 2 (current-limited) wiring is installed in concealed and accessible locations, include ceiling return air plenums. Cables shall be in approved metallic raceway or cable tray. Cables used in cable tray shall be UL-listed for intended applications.
- H. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring, except for purpose of interfacing both (e.g., relays and transformers).
- I. Do not install wiring in raceway containing tubing.
- J. Make wire-to-device connections at terminal block or terminal strip. Make wire-to-wire connections at a terminal block.
- K. Neatly bundle and anchor wiring within enclosures to permit access and prevent restriction to devices and terminals.
- L. Allowable voltage for control wiring, maximum: 120 volts. If only higher voltages are available, provide step-down transformers.
- M. Install wiring as continuous lengths with no splices permitted between termination points.

- N. Size of raceway and size and type of wire shall be responsibility of Contractor, in accordance with manufacturer's recommendations and NEC requirements, unless noted otherwise.
- O. Include 1 pull string in each raceway 1" (25 mm) or larger.
- P. Use coded conductors throughout with conductors of different colors.
- Q. Locate control and status relays in designated enclosures only. Enclosures include packaged equipment control panel enclosures, unless enclosures also contain Class 1 starters.
- R. Conceal raceways, except within mechanical electrical or service rooms. Install raceway to maintain minimum clearance of 6" (150 mm) from height of temperature equipment (e.g. steam pipes or flues).
- S. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on flexible duct strap or tie rods. Raceways shall not be run on or attached to ductwork.
- T. Adhere to Division 26 requirements where raceway crosses building expansion joints.
- U. Install insulated bushings on raceways ends and openings to enclosures. Seal top end of vertical raceways.
- V. Terminate control and/or interlock wiring and maintain updated wiring diagrams with terminations identified at job site.
- W. Flexible metal raceways and liquidtight, flexible metal raceways shall not exceed 3' (1 m) in length and shall be supported at each end. Flexible metal raceway less than 1/2" (13 mm) shall not be used. In areas exposed to moisture, including chiller and boiler rooms, use liquidtight, flexible metal raceways.
- X. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends and left clean and free of obstructions. Join raceway sections with couplings in accordance with local and national codes. Make terminations with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.03 COMMUNICATION WIRING INSTALLATION

- A. Provide N2 communication wiring from existing N2 network to connect to fume hood control devices shown in laboratory areas.
- B. Install in accordance with provisions for wiring.
- C. Install cabling in neat and workmanlike manner. Follow manufacturer's installation recommendations for communication cabling.
- D. Do not install communication wiring in raceway and enclosures containing Class 1 or Class 2 wiring.
- E. Maximum pulling, tension, and bend radius for cable installation: In accordance with manufacturer's instructions.
- F. Verify integrity of entire network following cable installation. Use appropriate test measures for each particular cable. Replace wiring not meeting performance requirements at no cost to Owner.
- G. When cable enters or exits building, install lightning arrester between lines and ground in accordance with manufacturer's instructions.
- H. Runs of communication wiring shall be unspliced length when length is commercially available.

- I. Label communication wiring to indicate origination and destination data.
- J. Grounding of coaxial cable: In accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding".

3.04 PROGRAMMING

- A. Provide sufficient internal memory for specified sequences of operation and trend logging. Provide minimum of 25% of available memory free for future use.
- B. Point naming, system points: Modular in design allowing easy operator interface without use of written point index.
 - 1. Point names shall match point naming shown in points list on Drawings.
 - 2. Point names shall use following conventions: (AAAA.BBBBBB.CCC.DD.EEE)
 - a. Location in building or building identifier. (AAAA).
 - b. System (BBBBB).
 - c. Component or process of system (CCC).
 - d. Unique identifier (DD)
 - e. Type of variable (EEE).
 - 1) Temperature (T).
 - 2) Humidity (H).
 - 3) Setpoint (SP).
 - 4) Pressure (P).
 - 5) Control Valve (ACV).
 - 6) Damper Actuator (DA).
 - 7) Current (I).
- C. Software programming:
 - 1. Provide complete programming of DDC system for complete fume hood operating system, including control functions, sequencing, setpoints, alarms, and graphic displays.
 - 2. Imbed into control programming sufficient comment statements to clearly describe each section of program. Comment statements shall use same language used in sequences of operation.
 - 3. Provide record documentation of complete programming.
- D. Operator interface:
 - 1. Provide graphic displays for each controlled system.
 - a. Displays shall show following:
 - 1) System schematic or floor plan
 - 2) Input and output points for system shown.
 - 3) Virtual or calculated points for system shown.
 - b. Point information shall update automatically as new data is received.
 - c. For terminal equipment, graphic summary table is acceptable.
 - 2. Provide installation, start-up, and troubleshooting of operator interface software.
 - 3. Set up user access and passwords as directed by Owner.
 - 4. Set up following trend logs:
 - a. Discharge air temperature for each air handling unit.
 - b. Space temperature for each terminal unit.
 - c. Chilled water supply and return temperatures.
 - d. Outdoor air temperature (dry bulb and wet bulb).
 - e. Heating water supply and return temperatures.
 - 5. Set up alarms notifications and alarm conditions as shown on Drawings.

3.05 FIELD QUALITY CONTROL

- A. After completion of installation, regulate and adjust thermostats, humidistats, pressure sensors, controllers, operators, and other equipment provided under this Contract.

- B. Verify control wiring is properly connected and free of shorts and ground faults. Verify terminations are tight.
- C. Enable control systems and verify calibration of input devices individually. Perform calibration procedures according to manufacturer's recommendations.
- D. Verify digital output devices (relays, solenoid valves, 2-position actuators and control valves, magnetic starter, etc) operate properly and normal positions are correct.
- E. Verify analog output devices are functional, start and span are correct, and directions and normal positions are correct.
- F. Check control valves and damper actuators for proper action and closure. Make adjustments to valve stem and damper blade travel.
- G. Verify system operation adheres to sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune DDC control loops and optimum start/stop routines.
- H. Alarms and interlocks:
 - 1. Check each alarm separately by including appropriate signal at value to trip alarm.
 - 2. Trip interlocks using field contact to check logic, and to ensure fail-safe condition for all actuators in proper direction.
 - 3. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.06 DEMONSTRATION AND ACCEPTANCE

- A. Prior to acceptance, control system shall undergo series of performance test to verify operation and compliance with this specification. Tests shall occur after Contractor has completed installation, start-up of systems, and performed control system checkout and initial testing.
- B. Performance tests specified shall be performed in addition to tests Contractor performs necessary as part of installation, start-up, and debugging process. *Engineer**Owner* will be present to observe and review test, unless noted otherwise.
- C. Notify EngineerOwner in writing minimum of 7 days in advance of start of tests.
- D. Provide equipment required to prove proper operation.
- E. Demonstrate compliance with sequences of operation through all modes of operation.
- F. Demonstrate complete operation of operator interface.
- G. Demonstrate following additional items:
 - 1. DDC loop response.
 - 2. Demand limiting.
 - 3. Optimum start-stop.
 - 4. Interface to building fire alarm system.
- H. Repeat tests which fail to demonstrate operation of system. Repair or revise hardware or software as necessary to successfully complete tests.
- I. Upon receipt of adjustment list from Owner, Contractor shall prepare written report indicating by system, each outstanding item on adjustment list. Contractor shall correct items appearing on installation-inspection report and present written request for reinspection and approval to Owner.

3.07 SEQUENCE OF OPERATION

- A. Room Pressure Control: The Supply Air flow rate and the Exhaust Air flow rates are measured continuously. The room pressure controller modulates the supply and general exhaust dampers to maintain a difference(offset) between the total supply and total exhaust flow volumes. This offset shall maintain the laboratory at a negative balance relative to the corridor.
- B. Temperature Control Sequence: The temperature of the lab or lab classroom is measured continuously. The room pressure controller controls the heating valve, supply air volume, and the total exhaust volume to maintain temperature set point.

END OF SECTION

- 1)
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Local sensors and input devices.
- B. Remote panels.
- C. Data transmission system.

1.02 DESIGN REQUIREMENTS

- A. High-speed direct digital communications network shall be employed as primary means of data transmission. Network capability shall possess sufficient operating speed and signal characteristics to serve all functions relating to fume hood controls automation monitor and control.
- B. Information shall be transmitted via coaxial cable and twisted, shielded pair with drain wire for noise suppression.
- C. System shall consist of remote wiring, controllers, and all input and output sensors and devices necessary to communicate between control systems served and panels. Engineering, installation, supervision, calibration, software programming and checkout necessary shall be provided by manufacturer.
- D. Contractor shall provide complete connections and operable system between existing building system and laboratory fume hood control system.

1.03 PERFORMANCE REQUIREMENTS

- A. Functional description; system entry shall:
 - 1. Allow entry to remote control data points.
 - 2. Add, delete, or reset alarm limits.
 - 3. Reset program start-stop times.
 - 4. Add or delete start-stop programs.
 - 5. Reset analog units.
 - 6. Reassign analog units.
- B. Capabilities:
 - 1. Address and digitally display analog valves.
 - 2. Transmit temperature, pressure or other analog values from remote data gathering panels to CPU.
 - 3. Two- and three-mode control capability for remote control of motor loads or changeover functions.
 - 4. Alarm abnormal on-off conditions.

1.04 SUBMITTALS

- A. Product Data: Specification data sheets for system components.
- B. Shop Drawings
 - 1. System components drawings.
 - 2. Control drawings showing sensors, controllers, interface to equipment supplied by others, and installation methods, locations, and routings.
- C. Quality assurance data:
 - 1. Bill of materials.
 - 2. Complete documentation on system software and hardware prior to installation.

3. Control system program listings and software flow charts.

D. Closeout submittals: Complete instruction manual covering function and operation of each control component.

1.05 WARRANTY

A. Manufacturer shall guarantee automated control system to be free from defects in workmanship and material under normal use for a period of two years after acceptance by Owner.

B. Manufacturer shall make necessary repairs due to defects in workmanship or materials during guarantee period immediately and without cost to Owner.

C. After completion of installation, and during guarantee period, manufacturer shall provide monthly inspections of control system. Furnish written reports to Owner detailing findings of each inspection and actions taken to remedy off-normal conditions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Johnson Controls to match existing Johnson Controls N2 Network.

2.02 PANELS

A. Construction: All steel, with hinged doors.

B. Electrical connections: Quick disconnect connections for coaxial cable and terminal strips for local signal collection wiring; plug in connections for printed circuit boards; plug-in connections for diagnostic simulator; factory prewired.

C. Furnish 10% minimum future expansion capacity. Maximum number of points per panel shall be no greater than 20.

D. Panels shall meet UL 864 specifications.

2.03 BINARY POINT MODULE

A. Electronic, solid-state, printed circuit board construction, 24-volt dc current.

B. Plug-in type connections.

C. Eight points each module.

D. Suitable for 2-mode input signal.

2.04 ANALOG POINT MODULE

A. Electronic, solid-state, printed circuit board construction, 24-volt, dc current.

B. Plug-in type connections.

C. Four points each module.

D. Suitable for analog to digital conversion.

2.05 START/STOP POINT MODULE

- A. Electronic, solid-state, printed circuit board construction, 24-volt dc current.
- B. Plug-in connections.
- C. Four points each module.
- D. Suitable for 2-mode or 3-mode output signal.

2.06 RESET POINT MODULE

- A. Electronic, solid-state, printed circuit board construction, 24-volt dc current.
- B. Plug-in connections.
- C. Four points each module.
- D. Suitable for digital to analog conversion.

2.07 COAXIAL CABLE

- A. Type RG-58A.

2.08 TWISTED PAIR CABLE

- A. 18-gage.
- B. Shielded.
- C. Drain wire entire length of cable.

PART 3 EXECUTION

3.01 INSTALLATION

- A.

3.02 INSPECTION

- A. Acceptance procedure:
 - 1. Upon successful completion of system installation, Contractor shall furnish written request for inspection and approval to Owner.
 - 2. Upon receipt of adjustment list from Owner, Contractor shall prepare a written report indicating by system, each outstanding item on adjustment list. Contractor shall correct all items appearing on installation-inspection report and present written request for reinspection and approval to Owner.

END OF SECTION

- 1) D. Rollins
- 2)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General electrical requirements for equipment and services including, but not limited to:
 - 1. Factory wiring.
 - 2. Low voltage field wiring.
 - 3. Low voltage splices and terminations.
 - 4. Low voltage cabinets and electrical enclosures.
 - 5. Equipment safety grounding.
 - 6. Low voltage fuses and fuse blocks.
 - 7. Electrical meters.
 - 8. Control relays and switches.
 - 9. Pushbuttons.
 - 10. Indicating lights.
 - 11. Alarm and trip contacts.
 - 12. Low voltage starters.
 - 13. Low voltage circuit breakers and disconnect switches.
 - 14. Auxiliary power transformers.
 - 15. Power factor correction capacitors.
 - 16. Outlet, pull, and junction boxes.
 - 17. Plates and covers.
 - 18. Wiring devices,
 - 19. Welding receptacles.
 - 20. Panelboards.
 - 21. Welding.
 - 22. Shop finish.
 - 23. Rust-inhibiting compounds.
 - 24. Galvanizing.
 - 25. Packaging, identification, and tagging.
 - 26. Nameplates.
 - 27. Trip setting coordination.
 - 28. Grounding and bonding.
 - 29. Fireproofing and fire ratings.
 - 30. Testing and demonstration.

1.02 RELATED SECTIONS

- A. Section 02 41 00 – Demolition: Demolition of electrical items.

1.03 DESIGN REQUIREMENTS

- A. Service conditions: Provide equipment and material suitable for intended service and installation at location indicated.
- B. Low-voltage auxiliary and control power.
 - 1. Electrical power for ac control and instrumentation equipment:
 - a. Provide devices necessary for proper operation and protection of equipment during electrical power supply and ambient temperature fluctuations specified.
 - b. Design for continuous operation at any voltage from 85% to 110% of nominal voltage. Dropout voltage shall be 60% of nominal for relays and 75% for contactors and starters.
 - 2. Electrical power for dc devices:
 - a. Design for continuous operation on ungrounded station battery system, capable of maintaining operation at any voltage from 80% to 112% of nominal voltage.
 - b. Electrical devices served shall not impose ground connection on supply.

- C. Auxiliary power: Design auxiliary equipment for low voltage service, with electrical power designed to operate from one of nominal electrical power sources as follows and as indicated on Drawings:

Volts	Phase	Frequency
480Y/277	3 or 1	60
208Y/120	3 or 1	60

1.04 SUBMITTALS

- A. Submit with Bid: Description of manufacturer's standard factory test procedure for logic systems.
- B. Product Data:
1. List of proposed material identifying manufacturer, type and model number for equipment to be provided for complete job.
 2. Manufacturer's catalog sheets marked to indicate specific type, model or catalog number of equipment to be provided.
 3. Equipment drawings, elementary diagrams, schematics, wiring, performance curves, instruction manuals, and all other documentation necessary for complete description of material being supplied and as required to support installation, commissioning and maintenance of equipment. Manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted.
 4. List of recommended spare parts required for equipment start-up, commissioning and operation.
 5. List of special maintenance tools required for installation and operation of equipment.
 6. If necessary, provide additional data to clearly demonstrate that proposed alternate equipment meets or exceeds equipment as specified.
- C. Operation and maintenance manuals. Provide at minimum:
1. Itemized equipment list.
 2. General description and technical data.
 3. Receiving, storage, installation, and testing instructions.
 4. Operating and maintenance procedures.
 5. Complete set of final drawings requiring no further action.
 6. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
 7. Spare parts list.
 8. Lubrication recommendations.
 9. Warranty information.

1.05 QUALITY ASSURANCE

- A. Manufacturer qualifications:
1. Manufacturer of equipment specified shall be recognized in industry for normally supplying this type of equipment.
 2. Manufacturer shall be ISO certified.
 3. When requested by Engineer, provide list of similar equipment installations that have employed identical equipment from manufacturer.
- B. Installer qualifications:
1. Installer shall be skilled in trade and shall have thorough knowledge of products and equipment specified.
 2. Cutting, drilling, trenching, or channeling necessary to properly install equipment shall be performed by competent skilled crafts people in safe, professional manner.
- C. Regulatory requirements: Perform electrical construction in accordance with NEC, local and state codes as applicable to job site.

- D. Materials and equipment furnished for permanent installation shall be new, unused, and undamaged.
- E. Asbestos not allowed.
- F. Parts shall be manufactured to American industry standard sizes and gages to facilitate maintenance and interchangeability. Metric sized components not allowed unless specifically requested and approved.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Pack, ship, handle, and store in accordance with manufacturer's requirements.
- B. Ship equipment completely factory assembled unless physical size, arrangement, configuration, or shipping and handling limitations make this impracticable. Shipping splits and required field assembly shall be identified with equipment submittals.
- C. Costs associated with sections, accessories, or appurtenances requiring field assembly shall be Contractor's responsibility.
- D. Separately packaged parts and accessories shall be consolidated and shipped together with equipment. Mark each container clearly to identify contents and as belonging with main equipment.
 - 1. Provide individual weatherproof itemized packing slips attached to outside of each container for contents included. Provide duplicate inside each container.
 - 2. Attach master packing list, covering accessory items for equipment, to main piece of equipment.
 - 3. Mark each container with project identification number for equipment and container number followed by total number of containers.
- E. Equipment shall be suitably protected during shipment, handling, and storage. Damage incurred during shipment shall be repaired at not cost to Owner.
- F. Protect coated surfaces against impact, abrasion, and discoloration.
- G. Electrical equipment and insulation systems shall be protected against ingress of moisture. Use space heaters if necessary to protect against moisture.
- H. Exposed threads shall be greased and protected.
- I. Pipe, tube, and conduit connections shall be closed with rough usage plugs. Seal and tape open ends of piping, tubing, and conduit.
- J. Equipment openings shall have covers, and taped to seal equipment.
- K. Store materials in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

1.07 SCHEDULING

- A. Coordinate with Owner early and late shipping and delivery schedules for items requiring storage and handling at Site.

1.08 WARRANTY

- A. Electrical equipment shall be provided with manufacturer's standard warranty, but not less than 1 year.

1.09 MAINTENANCE

- A. Extra materials: Provide touchup paint in same type and color to repair at least 25% of finish-painted equipment surface. Paint shall be sufficient to perform touch-up painting in accordance with shop-applied material instructions for repair painting.
- B. Each piece of equipment shall be furnished with special tools as required for installation, maintenance, and dismantling of equipment.
 - 1. Furnish in quantities as necessary to complete work on schedule.
 - 2. Tools shall be new and shall become property of Owner.
 - 3. Tools and intended use shall be identified in assembly instructions. Tools shall only be used for their intended purpose.

PART 2 PRODUCTS

2.01 FACTORY WIRING

- A. Select cable for electrical and environmental conditions of installation, and suitable for unusual service conditions where encountered.
 - 1. Proper temperature application cable shall be used throughout, but shall be not less than 90°C rated.
 - 2. Conductors routed over hinges shall use extra-flexible stranding.
 - 3. Cable insulation shall be rated for maximum service voltage used, but not less than 600 volts.
 - 4. Splices not allowed.
- B. Panel, control cabinet, switchboard, motor control center, and switchgear wiring shall use flame retardant cross-linked polyethylene (XLP) or flame retardant ethylene-propylene rubber (EPR) insulation that meet or exceed requirements of UL 44 for Types SIS, and XHHW.
 - 1. Minimum size: No. 14 AWG (1.5 mm²).
 - 2. Conductors: Annealed bare copper Class B stranding passing IEEE 1202 and UL VW-1 flame test.
- C. Instrumentation, thermocouple, and thermocouple extension wire shall use twisted shielded pairs/triads having flame retardant cross-linked polyethylene (XLPE) insulation, and chlorinated polyethylene (CPE) jacket.
 - 1. Minimum size: No. 16 AWG (1.0 mm²).
 - 2. Conductor type:
 - a. Instrument: Annealed copper Class B stranding.
 - b. Thermocouple: Solid alloy, ANSI MC 96.1.
 - 3. Provide each pair/triad with shield.
 - 4. Shielding shall consist of aluminum-polyester tape and flexible strand tin-coated No.18 AWG (0.75 mm²) copper drain wire.
 - 5. Drain wire for each instrument cable shall be insulated with spaghetti sleeve. One end of shield wire shall be terminated on grounded terminal.
 - 6. Cables shall pass IEEE 1202 and ICEA 70,000 Btu/Hr vertical tray flame test, and each conductor shall pass UL VW-1 flame test.
- D. Terminations:
 - 1. Conductor terminal connectors shall be insulated, ring tongue, compression type connectors properly sized for conductor and terminal.
 - a. Connectors shall be constructed of copper and shall be tin-plated.
 - b. Interior surface of connector wire barrel shall be serrated; exterior surface of connector wire barrel shall be furnished with crimp guides.
 - 2. Non-insulated terminal connectors shall be used for conductors terminated on devices equipped with individual fitted covers, such as, but not limited to, control switches and lockout relays.
 - 3. Connections requiring disconnect plug and receptacle type devices shall be provided with factory-terminated conductors on each plug and receptacle.
 - a. Plugs and receptacles shall be factory wired into junction boxes containing terminal blocks for external connections.

- b. Conductors on disconnect portion of plug-receptacle assemblies shall be in common jacket.
4. Prior to shipment of equipment, remove temporary wiring installed in factory for equipment testing.
5. Current transformers shall terminate on shorting type terminal blocks. Ship with shorting jumpers installed.

E. Identification and labeling:

1. Provide conductor identification sleeve on each end of each internal conductor. Mark each sleeve with opposite end destination identification with nonsmudging, permanent black ink. Sleeves shall be UV-resistant self-adhesive type or PVC, not less than 1/2" long.
2. Permanently label each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices to coincide with identification indicated on manufacturer's drawings.

2.02 FIELD WIRING

A. Nationally or internationally recognized cable manufacturer shall produce cable provided.

1. Metal-clad cable, NEC Type MC, may not be substituted in place of cable and conduit unless specified otherwise, or unless approved in writing.
2. Comply with code and Project requirements directly associated with use of each cable type.

B. Cables specified are for voltages 600 volts and below.

C. Wiring shall be copper with not less than 98% conductivity, unless specified otherwise.

D. General-purpose building conductor used on interior lighting circuits and general-purpose branch circuits routed entirely in conduit shall be single conductor.

1. Voltage rating: 600-volt.
2. Conductor: Class B, solid or stranded, annealed, uncoated copper, minimum size No. 12 AWG (4.0mm²).
3. Insulation: PVC complying with physical and electrical requirements of UL for type THHN/THWN.
4. Jacket: Overall clear nylon jacket applied over conductor insulation, UL-listed as gasoline and oil resistant.
5. Provide conductor sizes No. 8 AWG and smaller in colors to match wire color-codes. Sizes No. 6 AWG and larger shall be color-coded with field-applied tape.
6. Rated continuous operating temperature shall be 90°C in wet and dry locations for operation at maximum 75°C.

E. Single-conductor, low-voltage power cable for motors, feeders, branch circuits, and dc circuits routed in conduit, duct bank, or cable tray:

1. Voltage rating: 600-volt.
2. Conductor: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm²).
3. Insulation: Ethylene propylene rubber (EPR), complying with physical and electrical requirements for NEC Type RHH or RHW-2.
4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked low-smoke, nonhalogen polyolefin (XLPO).
5. Conductor sizes No. 8 AWG and smaller shall be provided in colors to match wire color-codes. Sizes No. 6 AWG and larger may be color-coded with field applied tape.
6. Wire shall be identified by surface marking indicating manufacturer, conductor size, conductor material, voltage rating, UL symbol, and listed type.
7. Cables smaller than No. 1/0 AWG (50 mm²) shall be routed entirely in conduit and duct bank in. Sizes No. 1/0 AWG (50 mm²) and larger may be routed in cable tray, if so rated.
8. Conductors shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and UL VW-1 vertical flame test.
9. Temperature rating shall be 90° C for normal operation in wet or dry locations.

F. Multiconductor, low-voltage power cables for motors, feeders, and branch circuits routed in cable tray, conduit or duct bank:

1. Voltage rating: 600-volt.
2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm²).

3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO), complying with physical and electrical requirements for NEC Type XHHW-2.
 4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; cross-linked, low-smoke, nonhalogen polyolefin (XLPO).
 5. Phase conductors shall be cabled together with Class B stranded, uncoated copper grounding conductor and fillers. Ground wire size shall comply with requirements of UL 1277.
 6. Cover cable assembly with helically applied polyester binder tape with minimum 10% overlap.
 7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing as suitable for cable tray use.
 8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
 9. Conductors shall be temperature rated for 90°C maximum continuous operating temperature in wet or dry locations.
- G. Multiconductor, low-voltage power cables for motors fed from adjustable speed drives, any installation.
1. Voltage rating: 600-volt.
 2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 10 AWG (4.0mm²)
 3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) complying with physical and electrical requirements for NEC Type XHHW-2.
 4. Jacket: Flame-retardant, polyvinyl chloride (PVC).
 5. Ground conductors: 3 segmented Class B strand, annealed copper conductors sized to meet requirements of UL 1569.
 6. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing.
 7. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL-approved and marked with FT-4 designation.
 8. Rated for Class 1, Div 1 hazardous locations.
 9. Conductors shall be temperature rated for 90°C maximum continuous operating temperature in wet or dry locations.
- H. Multiconductor cable for control, interlocks, current transformers (CTs), voltage transformers (VTs), meters, and relays routed in cable tray and conduit:
1. Voltage rating: 600-volt.
 2. Sizes:
 - a. Motor control, switchgear and breaker control, interlock control, metering, relaying, and general power control circuits shall be minimum size No. 14 AWG (1.5 mm²).
 - b. CT and VT circuits shall be minimum No. 10 AWG (4.0 mm²).
 3. Conductors: Annealed, bare copper, Class B, stranded.
 4. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO), complying with physical and electrical requirements for NEC Type XHHW-2.
 5. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked, low-smoke, nonhalogen polyolefin (XLPO).
 6. Conductors shall be cabled together with nonhygroscopic fillers.
 7. Cover cable assembly with helically applied binding tape with minimum 10% overlap.
 8. Marking:
 - a. Insulated conductors shall have colored insulation meeting ICEA Method 1, Table 2 color code to identify conductors.
 - b. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and UL listing as rated for cable tray.
 9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
 10. Temperature rating shall be 90°C maximum continuous operating temperature in wet or dry locations.

- I. Instrumentation cable installed indoor or outdoor routed in cable tray, conduit, and ducts:
 1. Voltage rating: 600-volt.
 2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 16 AWG (1.0 mm²).
 3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO).
 4. Jacket: Flame-retardant, heat, moisture, and sunlight resistant; cross-linked, low-smoke, nonhalogen polyolefin (XLPO).
 5. Pairs/triads: Each twisted with lay not exceeding 2" (50 mm).
 6. Color code: Pairs black/white, Triads black/white/red.
 7. Assembly:
 - a. Each pair or triad shall be cabled together with aluminum/polyester tape shield helically wrapped with minimum lap of 15% of tape width and isolation tape. Entire cable assembly shall have overall aluminum/polyester tape shield helically wrapped.
 - b. Flexible strand tin-coated No.18 AWG (0.75 mm²) copper drain wire shall be helically wound between twisted conductors and tape shield.
 8. Each instrumentation cable shall be identified by means of surface ink printing indicating manufacturer, conductor size, and quantity, UL listing.
 9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
 10. Temperature rating shall be 90°C maximum continuous operating temperature in wet or dry locations.

- J. Thermocouple extension cable circuited in cable tray or conduit:
 1. Voltage rating: 600-volt.
 2. Conductors: Minimum No. 16 AWG solid alloy (+Chromel / -Constantan) in accordance with ANSI and ASTM/ISA Type EX, KX or JX as indicated on Drawings.
 3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or cross-linked polyolefin (XLPO).
 4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; cross-linked, low-smoke, nonhalogen polyolefin (XLPO).
 5. Color code: Yellow (+Chromel) and red (-Constantan), meeting requirements of UL, type "PLTC."
 6. Assemble insulated conductors with 1.5" to 2.5" twisted lay.
 7. Assembly: Provide with helically applied, laminated aluminum/polyester tape shield, with minimum lap of 15% of tape width. Flexible strand tin-coated No.18 AWG (0.75 mm²) copper drain wire shall be helically wound between twisted conductors and tape shield.
 8. Each thermocouple cable shall be identified by means of surface ink printing indicating manufacturer, conductor size, UL listing as "PLTC," thermocouple type.
 9. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL VW-1 vertical flame test.
 10. Temperature rating shall be 90°C maximum continuous operating temperature in wet or dry locations.

- K. Provide high-temperature wire around process equipment operating at temperatures exceeding standard cable ratings.
 1. Voltage rating: 600-volt.
 2. Temperature rating: Up to 1000°C.
 3. Conductor: Stranded, "A" nickel.
 4. Insulation: Layers of ceramic fiber braids.
 5. Jacket: Overall metallic sheath.

- L. Category 6 communication cable circuited in tray, conduit or used for field wiring internal to cabinets.
 1. Conductor: Solid, bare copper minimum No. 23 AWG.
 2. Insulation: Fluorinated ethylene propylene (FEP) insulated singles.
 3. Insulated conductors: Unshielded, twisted 4 pairs enclosed with a spline fluorinated ethylene propylene filler material.
 4. Cable assembly shall be covered with clear "Flamearrest" jacket, sequentially marked at 2' (600 mm) intervals. Ripcord shall be integrally installed to allow easy removal of jacket material.
 5. Each communication cable shall be identified by means of surface ink printing indicating manufacturer, model, or catalog number. Cable shall meet TIA/EIA Draft 9A CAT6.
 6. Cables shall be capable of passing UL flame test Type CMP.

7. Manufacturer: Belden "DataTwist" 7852A.
- M. Twin-axial communication cable installed indoors in cable tray and conduit:
1. Voltage rating: 600-volt.
 2. Conductor: One pair, bare copper, No. 18 AWG with 7 x 26 stranding.
 3. Insulation: Flame-retardant polyolefin.
 4. Assembly: Aluminum foil-polyester tape shield with No. 20 AWG, 7 x 28 stranded tinned copper drain wire with 100% shield coverage, and tinned copper braid shield with minimum 55% coverage. Overall cable assembly shall be Type "PLTC."
 5. Jacket: Polyvinyl chloride (PVC).
 6. Cable shall be UL-listed 1581 for flame resistance.
 7. Temperature rating shall be 75°C in dry maximum operating temperatures in dry locations.
 8. Manufacturer: Belden, "DataTray" 600-volt, industrial twin-axial cable, Catalog Number 3072F.

2.03 SPLICES AND TERMINATIONS

- A. Splices, except as in lighting and general purpose power circuits specified below, not allowed unless specifically indicated on Drawings or required for connection to equipment.
- B. Temperature rating of splices and terminations shall be rated no less than 75°C.
- C. Splices allowed in lighting and general-purpose power circuits.
1. Provide wire and cable connectors of high-conductivity, corrosion-resistant material with contact area equal to at least current carrying capacity of wire or cable.
 2. General lighting and general-purpose building power circuits:
 - a. Twist-type, insulated spring connectors for splices on solid or stranded conductors smaller than No. 6 AWG.
 - b. Use indent, hex screw, or bolt clamp-type connectors, with or without tongue for splices on solid or stranded conductors No. 6 AWG and larger.
 - c. Apply insulating 600-volt tape.
- D. Insulating tapes and compounds for terminations and splices shall be UL-listed for intended use, location, and voltage by manufacturer.
- E. Termination of conductors to equipment with bolted connections:
1. Use compression type lugs:
 2. Compression lugs for cables 250 kcmil and larger shall have at least 2 clamping elements of compression indents, and provision for at least 2 bolts for joining to apparatus terminals.
 3. Crimping hand tools used for securing conductors in compression type connectors or terminal lugs shall be made for purpose and conductor sizes involved.
 4. Crimping tools shall be ratchet-type preventing tool from opening until crimp action is completed.
 5. Tools shall be product approved by connector manufacturer.
- F. Terminals:
1. Conductors No. 10 AWG and smaller: Marathon 1500 Series.
 2. Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.
- G. Coordinate sizes and types of conductor terminals for 600-volt power cable terminations in equipment with furnished conductor and terminal connector data.
- H. Provide 600-volt rated terminal blocks for instrumentation and control conductors for connection to circuits external to specified equipment, and for internal circuits crossing shipping splits.
1. Use crimp-on terminals matching termination point terminations in manufacturer-furnished panels. Splices not allowed.
 2. Terminal blocks for thermocouple extension wire: Buchanan "Medium Duty" with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc. Type TL terminal lugs.

3. Furnish with white marking strips.
 4. Where permitted by safety codes and standards, provide without covers. Neither step-type terminal blocks nor angle mounting of terminal blocks allowed.
 5. Fuses may be mounted on terminal blocks.
 6. Maximum 2 conductors in accordance with termination point.
- I. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure.
1. Group-in instrument and control compartment for easy accessibility.
 2. Provide sufficient space on each side of each terminal block to allow orderly arrangement of leads to be terminated on block.
 3. Locate auxiliary equipment in compartments, enclosures, or junction boxes so service personnel will have direct access without interference from structural members and instruments without removal of barriers, cover plates, or wiring.
 4. Do not mount terminal blocks in compartments containing cables or buses operating at voltages above 600 volts.
 5. Size for wire sizes of incoming conductors as necessary.
- J. Install shorting-type terminal blocks nearest current transformer in accessible location for each set of CTs supplied with equipment furnished, no other shorting-type terminal blocks allowed, unless specified otherwise.
- K. Install din-rail mounted miniature circuit breakers (MCB) for protection of VT circuits on line and load side. Breakers shall have alarm contacts wired to terminal blocks.
- L. Terminate each conductor in multiconductor control cable or as shown on Drawings. Provide 10% spare terminals for circuit modifications.
- M. Each control switch and lockout relay shall have minimum of 4 spare normally open and 4 spare normally closed contacts wired out to terminal blocks.
- N. Circuit identification number listed on either circuit schedule or panel schedule shall be used to identify circuit, positioned as near as possible to end of each conductor on multiple single wire circuits and on cable jacket for multiconductor cables.
- O. Cable designations shall be visible after installation without requiring physical movement of cable.

2.04 ELECTRICAL ENCLOSURES

- A. Size junction boxes, pull boxes, and enclosures in accordance with requirements of NEC.
- B. Junction boxes and pull boxes 4" (100 mm) trade size or smaller in any dimension shall be galvanized malleable iron, or cast ferrous metal NEMA rated for installed location. Do not use concentric knockouts.
- C. Junction boxes, pull boxes, and electrical enclosures 4" (100 mm) trade size and larger in any dimension shall be as follows, unless required otherwise.
1. NEMA rating for electrical enclosures installed in nonhazardous locations:
 - a. Indoor:
 - 1) Dry environmentally controlled area: NEMA 12.
 - 2) Noncorrosive wet or hose-down area: NEMA 4.
 - 3) Corrosive wet or hose-down area: NEMA 4X
 - b. Outdoor:
 - 1) Corrosive area: NEMA 4X.
 - 2) Noncorrosive area hose-down or spray area: NEMA 4.
 - 3) Noncorrosive area nonhose-down area NEMA 3R.

2. Construct noncast-metal electrical enclosures from reinforced steel plate capable of supporting devices mounted on or within enclosure without deflection. Steel plate thickness shall conform to UL requirements.
 3. Enclosures shall be of adequate strength to support mounted components during shipment and installation.
 4. Conduit entrances shall be field drilled.
 5. Electrical enclosures located in outdoor, wet, or hose down areas shall be provided with space heaters. Provide space heaters completely wired within enclosure. Provide following:
 - a. Space heater.
 - b. Adjustable thermostat with set point temperature indicator.
 - c. One miniature circuit breaker protective device.
 - d. Space heaters, thermostat, and protection shall not interfere with cable into or out of enclosure, or with maintenance or replacement of devices within enclosure.
 - e. Use of space heaters shall not change or discolor any painted surface.
 - f. Space heater capacity shall maintain enclosure internal temperature above dew point under specified service conditions.
 - g. Space heaters shall be rated for 240 volts ac minimum, and shall be sized for operation on applied voltage of 120 volts ac.
- D. Outdoor electrical enclosures with ventilating openings:
1. Louver on outdoor electrical equipment and protect in accordance with NEMA type.
 2. Equip openings on outdoor electrical equipment with fine mesh filters and stainless steel bug screens.

2.05 OUTLET BOXES

- A. Outlet boxes for concealed wiring systems shall be sheet metal, galvanized or cadmium plated.
- B. Boxes shall be minimum 4" (100 mm) square, 1-1/2" (38 mm) deep, sized to accommodate devices and number of conductors in accordance with NEC. Equip with plaster ring or cover as necessary for flush finish.
- C. Exposed conduit systems shall have surface-mounted boxes unless specified otherwise. Boxes for exposed wiring in nonhazardous, noncorrosive, and nonweatherproof locations shall be malleable iron, cadmium finish or cast aluminum alloy, minimum 4" (100 mm) square, 1-1/2" (38 mm) deep.
- D. Enclosures shall be as required for areas in which they are installed and as specified.
1. Boxes shall be installed flush in masonry construction and be designed for intended use.
 2. Recessed boxes where fixture will be mounted shall be minimum 4" (100 mm) and octagonal in shape or 4" (100 mm) square by 1-1/2" (38 mm) deep with round plaster ring. Where used as junction box, boxes shall be minimum 4" (100 mm) square by 2-1/8" (53 mm) deep.
 3. Outlet boxes for wall concealed telephone and signaling systems shall be 4" (100 mm) square by 1-1/2" (38 mm) deep, minimum. Furnish with plaster ring and cover plate.
 4. Floor boxes for floor outlets shall be cast-metal with threaded conduit entrances, brass flange ring and brass duplex flap cover plate. Boxes shall be watertight and have leveling and adjustment screws for adjusting cover plate to finished floor. Boxes shall be minimum 4" (100 mm) diameter and 3-1/2" (88 mm) deep with approved gasket or seal between adjusting ring and box.
 5. Floor outlets for combination signaling, data, and power outlets shall be constructed of steel base, PVC housing, and steel bracket to allow feed through wiring as well as activation load-bearing support. Box construction shall meet UL 514A requirements.
 - a. Entire housing shall be removable for unrestricted access.
 - b. Once assembled, PVC housing shall be capable of carrying 6,000 lb load.
 - c. Coordinate outlet requirements with communication system requirements.
 6. Floor boxes in 2-hour rated floors shall be secured in cored hole and shall be UL classified and listed for 2-hour rated floors.

2.06 PULL AND JUNCTION BOXES

- A. Furnish junction boxes and pull boxes were shown on Drawings, and where necessary to facilitate pulling wires and cables without damage.
- B. Above ground boxes shall be formed from sheet steel, with corners folded in and securely welded with inward flange on each of 4 edges.
- C. Drill box for mounting and attachment of cover; galvanize after fabrication.
- D. Cover shall be made of one-piece galvanized steel and provided with stainless steel round head machine screws.
- E. Box and cover shall be made of code gage steel, or heavier if shown on Drawings.
- F. Boxes shall be minimum 4-1/2" (100 mm) deep. Size shall be in accordance with NEC. Use next larger standard size when necessary in accordance with manufacturer standard sizes.
- G. Pull and junction boxes shall be furnished without knockouts for field drilling.
- H. Enclosures shall be as required for areas in which installed and in accordance with requirements specified.
- I. Underground boxes shall be specifically designed and constructed for intended installed location, and shall be either pre-formed concrete or PVC. Covers shall be capable of withstanding, without failure, type of traffic in general area.
- J. If pull and junction boxes are exposed in and around architecturally finished surfaces, paint box to match finish of nearby surfaces, unless indicated otherwise.
- K. Bolt-on junction box covers 3'-0" square or larger, or heavier than 25 lb. shall have permanent rigid handles. Covers larger than 3'-0" x 4'-0" shall be split.

2.07 EQUIPMENT SAFETY GROUNDING

- A. Install exposed raceway electrically continuous. Conduit and tray shall not be considered to be only ground conductor.
- B. Furnish equipment that is part of integral shipping unit or assembly with bare copper ground conductor extending to central ground connection lug. Lug shall be suitable for field connection to local ground. Electrical equipment shall be considered any device that is energized.
- C. Single-point ground connections required for proper operation of electronic equipment shall be insulated from equipment safety ground. Such connections shall be extended, using insulated cable, to single insulated termination point suitable for field connection to appropriate ground system.
- D. Conduits that contain power circuits shall have ground conductor installed inside conduit. Ground conductor shall be bonded to equipment or tray or duct ground at both ends.
- E. Provide ground bushing on each conduit containing power circuit. Connect ground bushings together inside enclosure and to enclosure ground lug or ground bus.
 - 1. Use No. 8 AWG conductor for ground bushings trade size 1-1/2" (38 mm) and smaller.
 - 2. Ground bushings larger than 1-1/2" (38 mm) shall be sized in accordance with requirements of NEC, but in no case shall they be smaller than No. 8 AWG.

- F. Ground conductor: Uninsulated, Class B standard, round soft drawn uncoated copper as defined in ICEA S-19-81, unless specified otherwise.
- G. Hardware: Clamps, bolts, washers, nuts, and other hardware used with grounding conductor shall be copper, copper alloy, high copper alloy, or silicon bronze.

2.08 PIN AND SOCKET CONNECTORS

- A. Unless shown on Drawings, not allowed.

2.09 FUSES AND FUSE BLOCKS

- A. Modular-type, Class H screw terminal fuse blocks with Bakelite frame and reinforced retaining clips. Blocks shall be similar in construction and by same manufacturer.
- B. Slow blow fuses: Bussmann Type MDL or Gould Shawmut Type GDL with ampere ratings of 1/4, 1/2, 1, or 2.
- C. Fast acting fuses: Bussmann Type NON or Gould Shawmut Type OT with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.
- D. Extremely fast acting fuses: Bussmann Type KAB with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.

2.10 CONTROL RELAYS

- A. General service, industrial grade auxiliary relays rated 600-volt.
- B. Contacts shall be reversible from N.O. to N.C. in field.
- C. Timing relays for critical service: Agastat Series 7000.

2.11 CONTROL SWITCHES

- A. Multistage, rotary-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.
- B. Handles shall be black, fixed, modern, pistol grip type. Provide engraved black plastic escutcheon plates with targets.
- C. Provide with colored LED lamps and nameplates as required.

2.12 PUSHBUTTONS

- A. Standard pushbuttons shall be heavy, industrial-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.
- B. Provide with colored LED lamps and nameplates as required.

2.13 INDICATING LIGHTS

- A. Status indicating lights shall be high-intensity, cluster, LED-type for panel mounting.
- B. Coordinate indicating light colors with indicated conditions as follows. Indicating lights shall be energized when condition exists and shall be de-energized when condition does not exist:
 1. Red: Equipment energized: such as motor running, valve open, or breaker closed.
 2. Green: Equipment de-energized: such as motor stopped, valve closed, or breaker open.
 3. Amber: Equipment abnormality: such as motor trip, breaker trip, or relay trip.

4. White: Monitoring of control power or trip coil: such as lockout relay trip coil monitor or breaker trip coil monitor. Light is on during normal circuit operation and off during loss of power or loss of coil.
5. Blue: Loss of control power.

2.14 ALARM AND TRIP CONTACTS

- A. Alarm contacts for remote annunciation shall be suitable for operation at 120 volts ac and 125 volts dc. Contacts shall be rated at least 0.5-ampere make and break, minimum.
- B. Alarm contacts shall be normally closed contacts that open to alarm condition.
- C. Trip contacts for remote trip shall be suitable for operation at 125 volts dc and shall be rated 5 amperes make or break, minimum.

2.15 PLATES AND COVERS

- A. Provide finish plates and covers of appropriate type and size for wiring and control devices, signal, and communication outlets.
- B. Mark each plate and cover to show circuit and panel designation. Unless indicated to be engraved plate, use self-sticking, clear membrane, UV-resistant labels with typed black letters. Handwritten labels not allowed.
- C. Coordinate color with adjacent surfaces.
- D. Raised cover galvanized steel plates shall be acceptable for use on surface-mounted outlet boxes in unfinished areas where weatherproof plates are not required.
- E. For weatherproof installations, cover plates shall be gasketed and rated for NEMA Type 4 installation.
- F. Device plate mounting hardware shall be countersunk and finished to match plate.

2.16 WIRING DEVICES

- A. Where more than one flush device is indicated in same location, mount devices in gangs under common plate.
- B. Switches for control of ac lighting panel load circuits, single-pole, 3-way, and 4-way, shall be premium, heavy-duty specification-grade, and meet FS W-S-896E. Switches shall be rated for use at 120 or 277 volts and 20 amperes minimum.
- C. Device color, if not shown on Drawings, shall be coordinated to match adjacent finishes.
- D. Wall switches requiring pilot light indication shall have red LED pilot light when toggled "On."
- E. Pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, and center "Off."
- F. Standard convenience outlets: Premium, heavy-duty, specification-grade, duplex, 3-wire, grounding, 20-ampere, 125-volt for 120-volt circuits, and rated 250-volts for 240 or 208-volt circuits.
- G. Ground fault circuit interrupter (GFI) receptacles: Duplex, 20-ampere, and 125 volts, feed-through type.
- H. Isolated ground (IG) outlets: Duplex, 3-wire, with isolated grounding terminal, 20-ampere, and 125 volts. Outlets shall be orange in color, unless specified otherwise.

2.17 IDENTIFICATION AND TAGGING

- A. Conduits inside manholes, hand holes, building entrance pull boxes, and junction boxes shall be provided with 19-gage stainless steel identification tags, with 1/2" (13 mm) stamped letters and numbers.
 - 1. Attach conduit identification tags with stainless steel banding. Tag position shall be readily visible for inspection.
 - 2. Tags shall provide, as minimum:
 - a. Circuit origination and destination.
 - b. Voltage.
 - c. Number of conductors in accordance with phase.
 - d. Number of phase conductors.
- B. Cables passing through or terminating in manholes, hand holes, and pull boxes shall have 19-gage stainless steel identification tags with stamped lettering that provides circuit identification information.
- C. Provide power, control, and instrumentation cables with permanent type identification markers with typed cable numbers and from/to information at each point of termination. Cable numbers and from/to information will be provided for circuits not associated with low-voltage panelboards.
 - 1. Position cable markers to be readily visible for inspection.
 - 2. Cable numbers shall match those as shown on Drawings.
 - 3. Provide wire tags at each termination point for each conductor. Tags shall be permanent, wrap around, heat-shrinkable type with typewritten information.
- D. Color-code power conductors with electrical tape or provide with colored jacket.
 - 1. Source voltage of 208Y/120 volts:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - 2. Source voltage of 120/240 volts:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White.
 - 3. Source voltage of 480Y/277 volts:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
 - 4. Source voltage of 240/120-volt delta: High-leg systems shall not be used without Engineer approval.
 - 5. Service entrance and equipment ground conductors shall be bare copper or green insulated conductor. Equipment bonding conductors shall be bare copper.
 - 6. Isolated ground conductors shall be insulated; green in color with integral yellow stripe. No substitutions.

2.18 EQUIPMENT NAMEPLATES

- A. Laminated white-over-black plastic such that face is white with black letters, with 1/8" (3 mm) engraved letters securely fastened with minimum of 2 self-tapping, stainless steel screws.
- B. Motor starters, either separately mounted or contained in motor control centers, shall have nameplates identifying related equipment. Where separate control and indicating lights are used, starters shall have engraved or etched legends ("start", "stop", etc.) as shown on Drawings.
- C. Provide control stations with nameplates identifying related equipment. Control and indicating lights shall have engraved or etched legends as shown on Drawings.

- D. Circuit breakers within main switchboards and distribution switchboards shall be provided with nameplates identifying related equipment being served.
- E. Fused and nonfused switches shall have 2 front cover-mounted nameplates.
 - 1. Nameplate containing permanent record indicating switch type, manufacturer's name, catalog number, and appropriate rating for equipment served.
 - 2. Provide additional nameplate to identify associated equipment.
- F. Panelboards shall have front cover-mounted nameplates identifying panelboard, matching information shown on Drawings and associated panel schedule. Nameplate shall have at least 4 lines of text consisting of:
 - 1. Line 1: Panel equipment identification number.
 - 2. Line 2: IEEE Voltage Designation.
 - 3. Line 3: Appropriate description from which power is derived, (i.e. fed from HP1 through XFMR-LP1).
 - 4. Line 4: Location of power source, (i.e. PP-1, NW wing).
- G. Lighting and auxiliary power transformers shall have front cover-mounted nameplates identifying transformer, matching information shown on Drawings. Nameplate shall have at least 2 lines of text that consist of:
 - 1. Line 1: Transformer equipment identification number.
 - 2. Line 2: Location of derived power source (i.e. fed from MDB, Elec Rm Basement).
- H. Nameplates shall meet requirements of NFPA 70E

2.19 HARDWARE

- A. Provide hardware including, but not limited to, anchor bolts, nuts, washers, expansion anchors, wire nuts needed for installation.
- B. Hardware smaller than 3/4" (19 mm) shall match NEMA standard size bolt holes on motors and electrical equipment.

2.20 LOGIC SYSTEMS FACTORY TESTING

- A. Prior to shipment, test electrical equipment containing solid-state logic systems in accordance with manufacturer's standard tests for minimum of 120 hours under power.
 - 1. Components tested shall include electronic devices; power supplies, input-output devices, operator interface devices, and interconnecting cables provided with system.
 - 2. System shall be tested as complete assembly. Testing of individual components or modules not allowed as system tests.
- B. System test shall include:
 - 1. Means of confirming logic or mathematical design response of system by simulating changes in system input.
 - 2. Test shall repeatedly cycle system through operations system will be expected to perform in service with loads on various components equivalent to those which will be experienced in actual service.
 - 3. Adjustment of power source voltages to high and low limits. Verify correct operation of system at both high and low power source voltage limits.
- C. System shall be tested and verified capable of providing surge withstand capability in accordance with requirements of ANSI C37.90.1.
- D. Perform tests with solid-state logic system exposed to ambient temperature appropriate to service for which associated electrical equipment is designed.

PART 3 EXECUTION

3.01 EXAMINATION OF SITE

- A. Contractor shall be responsible for familiarity with Project Site conditions. Equipment furnished and installed shall be capable of withstanding most severe conditions that will be encountered.

3.02 PROTECTION OF WORK

- A. Protect installed Work and provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- B. Damage occurring to building or equipment during installation shall be repaired or replaced to conditions existing prior to damage at no additional cost or delay to project or Owner.

3.03 INSTALLATION

- A. Install equipment and materials in accordance with manufacturer's recommendations and Drawings.
- B. Details for equipment and systems installed in accordance with industry standard techniques will not be furnished.
- C. Installation details furnished on Drawings shall be followed unless found to be unsafe, inappropriate for equipment specified, or unachievable due to site conditions.
- D. Except as otherwise specified or indicated on Drawings, equipment shall be installed plumb, square, and level.
- E. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on earth-bearing walls shall be separated from wall not less than 1/4" (6 mm) by corrosion-resistant spacers.
- F. Substations, switchgear, motor control centers, and similar equipment located outdoors shall be permanently sealed at base. Openings into equipment shall be screened or sealed as to prevent entrance of birds, rodents, and insects the size of wasps and mud daubers.
 - 1. Sealing material at base shall be concrete grout.
 - 2. Small cracks and openings shall be sealed from inside with silicone sealant.
 - 3. Large openings shall use galvanized screen mesh.

3.04 CABLE

- A. Prior to installation of each cable or cable group into assigned raceway, verify that raceway has been correctly sized.
 - 1. Where raceway is not indicated in circuit schedule or on Drawings, size in accordance with requirements of NEC.
 - 2. If raceway size indicated on Contract Documents is inadequate, notify Engineer.
- B. Replace cables pulled into wrong raceway or cut too short to rack and train.
- C. Do not reinstall cables installed in wrong raceway and removed. Discard cables unless inspected and accepted by Owner's Representative in writing.
- D. Carefully lay or pull circuits in cable tray so neither cables nor tray is damaged.
- E. Protect cables from dirt, water, oil, damaging chemicals, and from physical injury prior to, and during installation.

- F. Cables shall be cut sufficiently long to conform to contour of trays, with particular attention paid to vertical inside bends.
- G. Remove excessive slack so cables lie parallel to sides of trays.
- H. Multiple single-conductor power cables No. 1/0 AWG (50 mm²) or larger installed in cable tray that constitute single power circuit shall be grouped together in triplexed or quadriplexed arrangement. Maintain cable spacing to be 2.15 x O.D. of largest conductor in group or adjacent group.
- I. Multiconductor power cables No. 4/0 AWG (120 mm²) or larger installed in cable tray shall be installed in single layer with maintained spacing of not less than 1 cable diameter of largest cable.
- J. Fasten cables to cable tray with rated nylon ties to hold cables in place.
- K. Perform fishing and pulling with flexible round metal tape, CO₂ propelled polyethylene cord, nylon rope, or manila rope.
- L. Cable damage caused by improper pulling tension and excessive sidewall pressures shall be considered for any cable pulls that require use of mechanized cable pulling machine, whether installed underground or overhead.
 - 1. NEC requirements shall be used as guideline. Calculations shall be performed for duct bank runs over 300' (90 m), and for installations in conduit over 100' (30 m).
 - 2. Monitor pulling tension during installation of cable. Tension shall not exceed maximum recommended by cable manufacturer.
 - 3. To avoid damage from excessive sidewall pressure at bends, pulling tension shall not exceed cable manufacturer's recommendation.
 - 4. Pulling mechanisms, manual or power type, shall have rated capacity in tons legibly marked on mechanism.
 - 5. During installation, observer shall constantly watch dynamometer and record maximum tension achieved during pull.
 - a. If excessive strain develops, stop pulling operation at once. Determine difficulty and correct.
 - b. Provide records of dynamometer readings to Engineer.
 - c. Inform Owner prior to cable pulls.
 - 6. Do not use woven wire cable grips. Use only pulling eyes for pulling cables.
 - 7. As soon as cable is pulled into place, remove pulling eyes and reseal cable.
- M. Insert reliable nonfreezing type of swivel or swivel connection between pulling rope and eye to prevent twisting under strain.
- N. Only use lubricants as recommended by cable manufacturer. Water-based lubricants not allowed.
- O. Outside of each cable reel shall be carefully inspected. Remove protruding nails, fastenings, or other objects that might damage cable.
 - 1. Perform visual inspection for flaws, breaks, or abrasions in cable sheath as cable leaves reel. Pulling speed shall be slow enough to permit inspection.
 - 2. Damage to sheath or finish of cable shall be sufficient cause for rejecting cable.
 - 3. Cable damaged during installation shall be replaced at no expense to Owner.
- P. Permanent radius of each bend after cable installation shall be in accordance with manufacturer's recommendations.
- Q. Cable supports and securing devices shall have bearing surfaces located parallel to surfaces of cable sheath. Install to provide adequate support without deformation of cable jackets or insulation.
- R. Provide adequate cable end lengths. Properly install in junction boxes and manholes to avoid longitudinal strains and distorting pressures on cable at conduit bushings and duct end bells.

- S. Final inspection shall be made after cables are in place. Where supports, bushings, and end bells deform cable jacket, provide additional supports.
- T. Splices, joints, and connections shall be made only in accessible junction boxes in accordance with methods specified and instructions of cable manufacturer. Splices not allowed unless shown on Drawings.
- U. Rough-in wiring terminated in junction boxes shall have at least 8" (200 mm) of free conductor coiled in box for connection to equipment and receptacles.
- V. Circuit information for circuits originating from panelboards is indicated on panel schedules. Other circuits are identified on circuit schedule.
 - 1. Do not combine receptacle loads with lighting loads.
 - 2. Circuits fed from panelboards shall not be combined with circuits from circuit schedule.
- W. Panelboard circuits are indicated as individual runs. Circuits may be combined into common conduits in accordance with rules of NEC. Perform work associated with combining of circuits at no additional cost to Owner.

3.05 WIRING DEVICES, BOXES, AND FITTINGS

- A. Install galvanized or cadmium plated, threaded, malleable iron boxes and fittings in:
 - 1. Embedded in concrete walls, ceiling, and floors.
 - 2. Outdoor exposed faces of masonry walls.
 - 3. Locations where weatherproof cover is required by code or this specification.
- B. Install galvanized or cadmium plated sheet steel boxes in:
 - 1. Indoor exposed faces of masonry walls.
 - 2. Interior partition walls.
 - 3. Joist supported ceilings.
- C. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.
- D. Telephone and communication conduit systems shall have separate junction boxes and pull fittings.
- E. Finish openings so standard sized cover plates can be used. Oversized plates not allowed.
- F. Mount wall switches 3'-6" (1050 mm) above finished floor or grade unless specified otherwise. After circuits are energized, test wall switches for proper operation.
- G. Outlets:
 - 1. Standard mounting height: 18" (450 mm) above finished floor, unless specified otherwise.
 - 2. Outlets outdoors, garages, basements, shops, storerooms, and other rooms where equipment may be hosed down: 4'-0" (1200 mm) above finished floor or grade.
 - 3. Surface-mount welding receptacles 4'-0" (1200 mm) above finished floor or grade.
 - 4. After circuits are energized, test each receptacle for correct polarity.
 - 5. Test GFCI receptacles for proper operation.
 - 6. Mount wall thermostats 5'-6" (1650 mm) above finished floor unless noted otherwise. Thermostats mounted shall be suitably insulated from wall temperatures.
- H. Communication outlets shall be 18" (450 mm) above finished floor unless required otherwise. Outlets outdoors, garages, basements, shops, storerooms, and rooms where equipment may be hosed down shall be 4'-0" (1200 mm) above floor.
- I. Clock outlets shall be located 7'-0" (2.13 m) above finished floor or grade.

3.06 GROUNDING AND BONDING

- A. Electrical system and equipment grounding shall be installed in accordance with NEC and shall conform to following, where applicable:
 - 1. Ground conductors shall be bare or green-insulated in accordance with NEC.
 - 2. Cable shall be soft-drawn copper or copper bar, sized in accordance with drawings and NEC, but not smaller than No. 12 AWG.
 - 3. Ground cable splices and joints inaccessible upon completion of construction shall meet requirements of IEEE 837 and shall be exothermic weld or compression system type.
 - 4. Ground cable through exterior building walls not in conduit shall enter within 3' (1 m) below finished grade and shall be provided with water stop. Installation of water stop shall include filling space between strands with solder and soldering 12" (300 mm) copper disc over cable.
 - 5. Ground cable near base of structure shall be in undisturbed earth and as far from structure as excavation permits, but not closer than 6" (150 mm).
 - 6. Copper ground conductor in addition to conduit connection shall ground each piece of electrical equipment.
 - 7. Copper or high-conductivity copper alloy ground lugs or clamps shall make ground connections to equipment and ground buses. Connections to enclosures not provided with ground buses or ground terminals shall be made by clamp-type lugs added under permanent assembly bolts or under new bolts drilled and added through enclosures other than explosionproof, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers not permitted.
 - 8. Bond grounding system to water piping by connection to first flange inside building from main that will form good ground connection. Make connection with copper bar or strap by drilling and tapping flange and providing bolted connection.
 - 9. Ground conductors on equipment shall be formed to contour of equipment and firmly supported.
 - 10. Ground rods not described elsewhere shall be minimum 5/8" (16 mm) diameter by 10' (3.0 m) long, with copper jacket bonded to steel core.
 - 11. Make connections to ground grid where shown on Drawings.
 - 12. Verify connections by performing continuity checks.

3.07 FIRE PROOFING AND FIRE RATINGS

- A. Maintain fire-resistive integrity during construction.
- B. Penetrations through fire-resistive structures shall be sealed with fire-resistive material compatible with construction penetration.
- C. Where required by codes, local building officials, or fire marshal, furnish UL fire sealing systems and install in accordance with manufacturer's recommendations.

3.08 STARTUP AND TESTING

- A. Clean equipment interiors and exteriors prior to start-up and testing.
- B. Unless specified otherwise, tests performed shall be standard tests listed by ANSI/IEEE for intended equipment.
- C. Equipment shall be checked and placed in service ready for operation.
- D. Circuits shall be electrically tested after installation. Test power and motor circuits prior to final connection to equipment. Splices shall be complete prior to testing.
 - 1. Provide equipment and labor required for testing.
 - 2. Circuit failing to test satisfactorily shall be replaced or repaired, and retested at no additional cost to Owner.
 - 3. Check power and motor circuits, dc power, and control circuits for:
 - a. Correct terminations.
 - b. Continuity.

- c. Unintentional shorts and grounds.
4. Check power conductors for correct phasing.
5. Motor circuits shall be checked for proper rotation and motors "bumped" to verify correct machine rotation.
6. Control, instrumentation, and thermocouple wire shall be checked for correct termination, continuity, freedom from shorts or grounds, and identification.
7. Current transformer wiring shall be loop checked by injecting current at one end of loop and checking with clip-on ammeter at each field termination point to assure continuity and phase identification.
8. Voltage transformer wiring shall be tested by applying voltage at one point and checking with voltmeter phase rotation meter and phase angle meter at each field termination point to assure continuity, identification and phase shift.

3.09 DEMONSTRATION

- A. Final start-up and check out shall be completed prior to Owner acceptance of project.
- B. Electrical installation shall be complete in every detail and capable of normal operation in presence of Owner or Owner's Representative to verify its readiness.

END OF SECTION

- 1) D. Rollins
- 2)