SECTION 23 0593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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LANL MASTER SPECIFICATION

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| Rev. 5 Summary of Changes: Updated LANL Group from MOF-SU to the more generic term LANL Start-up and Commissioning. Minor editorial updates. |

Word file online at <http://engstandards.lanl.gov>

This template must be edited for each project.  In doing so, specifier must add job-specific requirements.  Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.  Once the choice is made or text supplied, remove the brackets.  The specifications must also be edited to delete specification items for processes, items, or designs that are not included in the project -- and specifier’s notes such as these.  This specification template is tailored to meet requirements contained in the LANL Engineering Standards Manual (ESM). To seek a variance from requirements of the ESM that are applicable, contact the ESM Mechanical[POC](http://engstandards.lanl.gov/POCs.shtml#mech). Please contact POC with suggestions for improvement as well.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General requirements.

Specification developed for ML-4 projects.  For ML-1, 2, and 3 applications, additional requirements and independent reviews should be added if increased confidence in procurement or execution is desired; see ESM Chapter 1 Section Z10 Specifications and Quality sections.

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1. GENERAL
	1. SECTION INCLUDES
		1. Requirements of Subcontractor, LANL Startup and Commissioning, and LANL-procured TAB Agency.
		2. TAB of [air], [hydronics], [and] [refrigerating] systems.
		3. [Sound and vibration measurements of equipment operating conditions.]
	2. Definitions
		1. AABC: Associated Air Balance Council.
		2. LANL: Los Alamos National Laboratory.
		3. NEBB: National Environmental Balancing Bureau.
		4. STR : Subcontract Technical Representative.
		5. TAB: Testing, Adjusting, and Balancing.
		6. VAV: Variable Air Volume.
	3. LANL-PERFORMED WORK
		1. TAB will be performed by [LANL Startup and Commissioning] [an independent AABC or NEBB-certified TAB Agency, subcontracted and directed by LANL under a separate subcontract].
		2. When LANL Startup and Commissioning performs TAB activities in this specification, requirements related to AABC or NEBB certification and/or approval do not apply.
	4. Action SUBMITTALS
2. [TAB Agency] [LANL Startup and Commissioning] shall submit the following to LANL in accordance with 01 3300 *Submittal Procedures*:
3. Current AABC or NEBB certification (prior to starting work).
4. TAB instruments that are to be used and calibration dates per AABC or NEBB requirements (prior to starting work).
5. [Proposed](http://policy.lanl.gov/pods/policies.nsf/MainFrameset?ReadForm&DocNum=LIR402-1200-01&FileName=lir402120001.pdf) TAB procedures, together with the TAB schematic drawings and Report Forms, for review.
6. Field Reports indicating deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
7. Draft copies of test report for review prior to final acceptance TAB test result.
8. Final test reports that are signed and stamped by an AABC or NEBB TAB Supervisor on the latest edition of approved AABC or NEBB Report Forms.
	1. QUALITY ASSURANCE
		1. [TAB Agency] [LANL Startup and Commissioning] : Perform Work in accordance with the latest edition of AABC or NEBB procedural standards for TAB of environmental systems. All quality assurance provisions, recommendations, and suggested practices contained in these TAB standards are considered mandatory.
		2. [LEED Compliance: Compliance with ASHRAE 62.1, Section 7.2.2, Air Balancing and with ANSI/ASHRAE 90.1-[2019], Section 6.7.3.3, System Balancing]
		3. A LANL representative may witness all or portions of the TAB Agency’s Work.
	2. qualifications
		1. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum [three] [ ] years [documented] experience [certified by AABC] [certified by NEBB].
		2. Perform Work under supervision of [AABC Certified Test and Balance Engineer] [NEBB Certified Testing, Balancing and Adjusting Supervisor] [registered professional engineer experienced in performance of this Work and licensed [in State of New Mexico].
9. PRODUCTS
	1. INSTRUMENTS
		1. [The TAB Agency] [LANL Startup and Commissioning] shall furnish instruments required for testing, adjusting, and balancing.
		2. Instruments used for measurements shall meet AABC or NEBB-specified accuracy and calibration histories, and shall be available for spot-checking by LANL during testing.
10. EXECUTION
	1. SUBCONTRACTOR RESPONSIBILITIES
		1. Provide window in project schedule for completion of TAB services prior to final inspection of project.
		2. Have mechanical, controls, structural, and related electrical systems complete and operable before notifying LANL STR that project is ready for [TAB Agency] [LANL Startup and Commissioning] services and the requirements of Article 3.1 have been met. Provide advance written notice of not less than 15 calendar days.

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Not all items below may apply. Edit list to match project scope.

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* + 1. Complete operational readiness prior to commencement of TAB services. Verify the following:
			1. Field quality control testing, cleaning, and adjusting specified in individual sections have been performed.
			2. Doors, windows and ceilings are installed. Pipe penetrations and other holes or openings are sealed.
			3. Systems are started and operating in safe and normal condition.
			4. Temperature control systems are fully installed and operating. Testing and programming of all system components and the overall system has been completed and test reports accepted by the LANL STR.
			5. Laboratory airflow control systems are fully installed and operating. Testing and programming of all system components and the overall system has been completed and test reports accepted by the LANL STR.
			6. Proper thermal overload protection is in place for electrical equipment.
			7. Construction filters have been replaced and the final filters are clean and in-place.
			8. Duct systems are clean of debris.
			9. Fans are rotating correctly, and fan belts, if equipped, are aligned and tight.
			10. Fire, smoke, and manual volume dampers are in place and open and the location of volume dampers are accessible and appropriate for effective balancing.
			11. Air coil fins are cleaned and combed.
			12. Access doors are closed and duct end caps are in place.
			13. Air outlets and inlets are installed and connected.
			14. Fume hoods and other local exhaust ventilation inlets are installed and connected.
			15. Duct and piping supports are installed.
			16. Duct systems are leak and pressure tested and test reports accepted by LANL STR.
			17. Hydronic systems are leak tested and test reports accepted by LANL STR.
			18. Hydronic systems are flushed, filled and vented, and test reports accepted by LANL STR.
			19. Refrigerant systems are leak tested and test reports accepted by LANL STR.
			20. Pumps are rotating correctly.
			21. Start-up screens from pump suction diffusers are removed.
			22. Proper strainer baskets are clean and in place.
			23. Service and balance valves are fully open.
			24. Pressure gauges, temperature gauges, test fittings, etc., are installed.
		2. Put HVAC systems and equipment into full operation and continue operation during times of testing and balancing.
			1. Do not operate equipment until properly lubricated and brought into manufacturer's specified operating conditions.
		3. Provide labor and materials to make any change in sheaves, belts, and dampers, required for correct balance as requested by [the TAB Agency] [LANL Startup and Commissioning].
		4. Provide labor, i.e., remove and reinstall ceiling tiles, etc., to access concealed equipment as requested by [TAB Agency] [LANL Startup and Commissioning].
		5. After [TAB Agency] [LANL Startup and Commissioning] is notified and TAB work started, should system(s) be found to not be in readiness or a dispute occurs as to readiness of system(s), the STR may require a joint inspection be made by representatives of LANL, the TAB Agency [LANL Startup and Commissioning] and the Subcontractor.
			1. Should inspection reveal TAB services notification to have been premature, cost of work previously accomplished by TAB Agency [LANL Startup and Commissioning] shall be paid for by the Subcontractor.
			2. Such items as are not ready for TAB services shall be completed and placed in operational readiness by Subcontractor, and TAB services shall again be scheduled.
	1. LANL RESPONSIBILITIES
		1. Provide TAB Agency [LANL Startup and Commissioning] with Subcontract Drawings, approved submittal data, specifications and supplements required for TAB Agency to accomplish review, inspection and TAB services outlined in this specification.
		2. Provide TAB Agency [LANL Startup and Commissioning] with copies of accepted test reports as listed in Paragraph 3.1.C.
		3. Notify TAB Agency [LANL Startup and Commissioning] within 48 hours of receipt of written notification from Subcontractor that system(s) will be ready for testing, adjusting and balancing.
	2. [TAB AGENCY] [LANL Startup and Commissioning] RESPONSIBILITIES
		1. GENERAL
			1. Review, inspect, test, adjust and balance systems, as outlined in this Section.
			2. Promptly report any conditions that prevent system balancing to LANL STR.
			3. Cooperate with Subcontractor but do not instruct or direct Subcontractor in any of the work, but make such reports as are necessary directly to LANL STR.
			4. Do not provide any construction labor or materials to modify systems.
		2. TOLERANCES
			1. Air Handling Systems: Adjust to within plus or minus 10 percent of design flow rates.
			2. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design flow rates to space. Adjusts outlets and inlets in space to within plus or minus 10 percent of design flow rates.
			3. Hydronic Systems: Adjust to within plus or minus 10 percent of design flow rates.
		3. ADJUSTING
			1. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
			2. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
			3. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
		4. AIR SYSTEM PROCEDURE
			1. Adjust air handling and distributions systems to obtain required or design supply, return and exhaust airflow rates.
			2. Make airflow rate measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct. Use the Equal Area method for rectangular ducts.
			3. Measure airflow rates at air inlets and outlets.
			4. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
			5. Use volume control devices to regulate airflow rates only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
			6. Vary total system airflow rates by adjustment of fan speeds. Vary branch airflow rates by damper regulation.
			7. Provide system schematic with design and actual airflow rates recorded at each outlet or inlet.
			8. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
			9. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Check dampers for proper operation.
			10. Check leakage across outside air, return air, and exhaust dampers in closed position.
			11. At modulating damper locations, take measurements and balance at extreme conditions. Balance variable volume systems at maximum airflow rate, full cooling, and at minimum airflow rate, full heating.
			12. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately [0.05] inches positive static pressure [near building entries] [in normally occupied areas].
			13. Adjust air quantities for multi-zone units with mixing dampers set first for cooling, then heating, then modulating.
			14. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
			15. On fan powered VAV boxes, adjust airflow switches for proper operation.
		5. WATER SYSTEM PROCEDURE
			1. Adjust water systems, after air balancing, to obtain design flow rates.
			2. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rate for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
			3. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
			4. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
			5. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
			6. Where available pump capacity is less than total flow requirements or individual system parts simulate full flow in one part by temporary restriction of flow to other parts.
	3. TAB AGENCY TEST REPORT FORMS
		1. Submit draft of Test Report to LANL for review prior to final acceptance TAB test result as required by Paragraph 1.4.A.5.
		2. Final report forms shall contain the following minimum data.

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To clarify equipment included in performance measurements, consider adding specific equipment numbers cross-referenced to the equipment schedule on the drawings

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* + 1. Report Forms
			1. Title Page:
				1. Name of Testing, Adjusting, and Balancing Agency
				2. Address of Testing, Adjusting, and Balancing Agency
				3. Telephone and website address of Testing, Adjusting, and Balancing Agency
				4. Project name
				5. Project location
				6. Subcontract Technical Representative (STR)
				7. Project Subcontractor
				8. Project altitude
				9. Report date
			2. Summary Comments:
				1. Design versus final performance
				2. Notable characteristics of system
				3. Description of systems operation sequence
				4. Summary of outdoor and exhaust flows to indicate building pressurization
				5. Nomenclature used throughout report
				6. Test conditions
			3. Instrument List:
				1. Instrument
				2. Manufacturer
				3. Model number
				4. Serial number
				5. Range
				6. Calibration date
			4. Electric Motors:
				1. Manufacturer
				2. Model/Frame
				3. HP/BHP
				4. Phase, voltage, amperage; nameplate, actual, no load
				5. RPM
				6. Service factor
				7. Starter size, rating, heater elements
				8. Sheave Make/Size/Bore
			5. V-Belt Drive:
				1. Identification/location
				2. Required driven RPM
				3. Driven sheave, diameter and RPM
				4. Belt, size and quantity
				5. Motor sheave diameter and RPM
				6. Center to center distance
			6. Pump Data:
				1. Identification/number
				2. Manufacturer
				3. Size/model
				4. Impeller size: Include info on how this is determined (i.e., pump curves, etc.)
				5. Service
				6. Design flow rate, pressure drop, BHP
				7. Actual flow rate, pressure drop, BHP
				8. Discharge pressure
				9. Suction pressure
				10. Total operating head pressure
				11. Shut off, discharge and suction pressures
				12. Shut off, total head pressure
			7. Air-Cooled Condenser:
				1. Identification/number
				2. Location
				3. Manufacturer
				4. Model number
				5. Serial number
				6. Entering DB air temperature, design and actual
				7. Leaving DB air temperature, design and actual
				8. Number of compressors
			8. Chillers:
				1. Identification/number
				2. Manufacturer
				3. Capacity
				4. Model number
				5. Serial number
				6. Evaporator entering water temperature, design and actual
				7. Evaporator leaving water temperature, design and actual
				8. Evaporator pressure drop, design and actual
				9. Evaporator water flow rate, design and actual
				10. Condenser entering water temperature, design and actual
				11. Condenser pressure drop, design and actual
				12. Condenser water flow rate, design and actual
			9. Cooling Tower:
				1. Tower identification/number
				2. Manufacturer
				3. Model number
				4. Serial number
				5. Rated capacity
				6. Entering air WB temperature, specified and actual
				7. Leaving air WB temperature, specified and actual
				8. Ambient air DB temperature
				9. Condenser water entering temperature
				10. Condenser water leaving temperature
				11. Condenser water flow rate
				12. Fan RPM
			10. Heat Exchanger:
				1. Identification/number
				2. Location
				3. Service
				4. Manufacturer
				5. Model number
				6. Serial number
				7. Steam pressure, design and actual
				8. Primary water entering temperature, design and actual
				9. Primary water leaving temperature, design and actual
				10. Primary water flow, design and actual
				11. Primary water pressure drop, design and actual
				12. Secondary water leaving temperature, design and actual
				13. Secondary water leaving temperature, design and actual
				14. Secondary water flow, design and actual
				15. Secondary water pressure drop, design and actual
			11. Cooling Coil Data:
				1. Identification/number
				2. Location
				3. Service
				4. Manufacturer
				5. Air flow, design and actual
				6. Entering air DB temperature, design and actual
				7. Entering air WB temperature, design and actual
				8. Leaving air DB temperature, design and actual
				9. Leaving air WB temperature, design and actual
				10. Water flow, design and actual
				11. Water pressure drop, design and actual
				12. Entering water temperature, design and actual
				13. Leaving water temperature, design and actual
				14. Saturated suction temperature, design and actual
				15. Air pressure drop, design and actual
			12. Heating Coil Data:
				1. Identification/number
				2. Location
				3. Service
				4. Manufacturer
				5. Air flow, design and actual
				6. Water flow, design and actual
				7. Water pressure drop, design and actual
				8. Entering water temperature, design and actual
				9. Leaving water temperature, design and actual
				10. Entering air temperature, design and actual
				11. Leaving air temperature, design and actual
				12. Air pressure drop, design and actual
			13. Electric Duct Heater:
				1. Manufacturer
				2. Identification/number
				3. Location
				4. Model number
				5. Design kW
				6. Number of stages and readings
				7. Phase, voltage, amperage
				8. Test voltage (each phase)
				9. Test amperage (each phase)
				10. Air flow, specified and actual
				11. Temperature rise, specified and actual
			14. Unit Ventilator and Fan Coil Data:
				1. Manufacturer
				2. Identification/number
				3. Location
				4. Model number
				5. Size
				6. Air flow, design and actual
				7. Water flow, design and actual
				8. Water pressure drop, design and actual
				9. Entering water temperature, design and actual
				10. Leaving water temperature, design and actual
				11. Entering air temperature, design and actual
				12. Leaving air temperature, design and actual
			15. Air Moving Equipment (e.g., Air Handling Unit, etc.):
				1. Location
				2. Manufacturer
				3. Model number
				4. Serial number
				5. Arrangement/Class/Discharge
				6. Air flow, design and actual
				7. Return air flow, design and actual
				8. Outside air flow, design and actual
				9. Return air temperature
				10. Outside air temperature
				11. Required mixed air temperature
				12. Actual mixed air temperature
				13. Design outside/return air ratio
				14. Actual outside/return air ratio
				15. Total static pressure (total external), specified and actual
				16. Inlet pressure
				17. Discharge pressure
				18. Sheave Make/Size/Bore
				19. Number of Belts/Make/Size
				20. Fan RPM
			16. [Exhaust] [or] [Return] Fan Data:
				1. Location
				2. Manufacturer
				3. Model number
				4. Serial number
				5. Air flow, specified and actual
				6. Total static pressure (total external), specified and actual
				7. Inlet pressure
				8. Discharge pressure
				9. Sheave Make/Size/Bore
				10. Number of Belts/Make/Size
				11. Fan RPM
			17. Duct Traverse: Use Log method for rectangular ducts
				1. System zone/branch
				2. Duct size
				3. Area
				4. Design velocity
				5. Design air flow
				6. Test velocity
				7. Test air flow
				8. Duct static pressure
				9. Air temperature
				10. Air correction factor
			18. Air Monitoring Station Data:
				1. Identification/location
				2. System
				3. Size
				4. Area
				5. Design velocity
				6. Design air flow
				7. Test velocity
				8. Test air flow
			19. Flow Measuring Station:
				1. Identification/number
				2. Location
				3. Size
				4. Manufacturer
				5. Model number
				6. Serial number
				7. Design Flow rate
				8. Design pressure drop
				9. Actual/final pressure drop
				10. Actual/final flow rate
				11. Station calibrated setting
			20. Terminal Unit Data:
				1. Manufacturer
				2. Type, constant, variable, single, dual duct
				3. Identification/number
				4. Location
				5. Model number
				6. Size
				7. Minimum static pressure
				8. Minimum design air flow
				9. Maximum design air flow
				10. Maximum actual air flow
				11. Inlet static pressure
			21. Air Distribution Test Sheet:
				1. Air terminal number
				2. Room number/location
				3. Terminal type
				4. Terminal size
				5. Area factor
				6. Design velocity
				7. Design air flow
				8. Test (final) velocity
				9. Test (final) air flow
				10. Percent of design air flow

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To clarify equipment included in sound and vibration measurements, consider adding a list to this subparagraph.

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* + - 1. Sound Level Report:
				1. Location
				2. Octave bands - equipment off
				3. Octave bands - equipment on
				4. RC level - equipment on

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To clarify equipment included in sound and vibration measurements, consider adding a list to this subparagraph.

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* + - 1. Vibration Test:
				1. Location of points:

Fan bearing, drive end

Fan bearing, opposite end

Motor bearing, center (when applicable)

Motor bearing, drive end

Motor bearing, opposite end

Casing (bottom or top)

Casing (side)

Duct after flexible connection (discharge)

Duct after flexible connection (suction)

* + - * 1. Test readings:

Horizontal, velocity and displacement

Vertical, velocity and displacement

Axial, velocity and displacement

* + - * 1. Normally acceptable readings, velocity and acceleration
				2. Unusual conditions at time of test
				3. Vibration source (when non-complying)

END OF SECTION

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Do not delete the following reference information.

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THE FOLLOWING STATEMENT IS FOR LANL USE ONLY

This project specification section is based on LANL Master Specification Section 23 0593 Rev. 5, dated April 30, 2024.