

SECTION 13 6019 – CLEANROOM CERTIFICATION

PART 1 - GENERAL

1.1 CONDITIONS AND REQUIREMENTS

- A. Clean Zone construction requirements are specified in Sections 01 5013 and 13 6013.
- B. Cleanroom cleaning procedures are specified in Section 13 6016.
- C. Testing and balancing of mechanical systems are specified in Mechanical Specification Sections.

1.2 DESCRIPTION

- A. Employ and pay for the services of a qualified Cleanroom Testing and Certification Agency, as a subcontractor to perform specified services:
 - 1. The Cleanroom Testing and Certification Agency shall be independent from the Cleanroom Contractor, system manufacturers and installers.
 - 2. Cleanroom testing and certification shall be a separate activity from other services which may be offered by the Cleanroom Testing and Certification Agency.
 - 3. The Cleanroom Testing and Certification Agency and the Cleanroom Air Systems Testing and Balancing Agency shall be different companies.
 - 4. Employment of the independent subcontractor shall in no way relieve the Contractor's obligation to perform the Contract work.
- B. Certification shall certify that the completed construction of the scheduled cleanroom areas complies with the air cleanliness classification required in accordance with International Organization for Standardization (ISO) 14644.
- C. Test method used for characterizing the performance of cleanrooms shall be in accordance with ISO 14644:
 - 1. Specific tests and the acceptance criteria shall comply as specified.
 - 2. Institute of Environmental Sciences and Technology IEST-RP-CC006.3, "Testing Cleanroom", is also an acceptable standard if the Certification Agency requests in writing to BNL. Request shall include the following minimum information:

- a. Desired test (s) substitution (s).
- b. Reasons for the substitutions.
- c. Verification that these substitutions are equal to or more stringent than the specified ISO Test.

1.3 REFERENCES

- A. ISO 1644-4 Cleanrooms and Associated Controlled Environments and ISO 14644, Cleanrooms and Associated Controlled Environments Parts 1 through 4.

International Organization for Standardization
Geneva, Switzerland
www.iso.org

- B. IES-RP-CC-006, Testing Cleanrooms and EIS-RP-CC-001, HEPA and ULPA Filters.

Institute of Environmental Services
940 East Northwest Highway
Mount Prospect, IL 60056

- C. NEBB Procedural Standards for Certified Testing of Cleanrooms.

National Environmental Balancing Bureau (NEBB)
8575 Grovemont Circle
Gaithersburg, MD 20877

- D. Federal Standard 209E, Airborne Particulate Cleanliness Class for Cleanrooms and Clean Zones:

General Services Administration
Specifications Activity
Printed Materials Supply
Bldg. 197, Naval Weapons Plant
Washington, DC 20407

- E. ESD Association Standards.

Electrostatic Discharge Association
200 Liberty Plaza
Rome, NY 13440

- F. NEBB, Procedural Standards for Measuring Sound and Vibration.

National Environmental Balancing Bureau (NEBB)
8575 Grovemont Circle
Gaithersburg, MD 20877

1.4 QUALITY ASSURANCE

- A. Certification Agency shall be N.E.B.B. (National Environmental Balancing Bureau) Certified.
- B. The Certification Agency shall have been in business a minimum of 15 years specializing in cleanroom testing and certifying work.
- C. Cleanroom Testing and Certification Agency shall supervise all tests and shall provide competent test technicians to conduct all tests in the presence of BNL's authorized representative:
 - 1. Test technicians shall have a minimum of four years uninterrupted service, devoted exclusively to the Testing and Certification of Cleanroom Facilities, or shall be directly supervised by a test technician with these qualifications.
- D. Test shall be performed after initial operating and balancing adjustments have been satisfactory completed:
 - 1. A copy of the Air Balancing report shall be provided by the Contractor to the Testing and certification Agency, and this report shall satisfy requirements that the facility is ready for "Cleanroom Certification" testing.
- E. Instrumentation to be used shall be in accordance with the descriptions given in each test procedure, and shall have a demonstrated accuracy and sensitivity suitable for the test procedure:
 - 1. Instruments shall be properly calibrated according to the manufacturer's recommendations, and shall be so certified by Cleanroom Testing and Certification Agency at the time of the test.
- F. No certification testing shall be initiated or conducted without notifying BNL's authorized representative.

1.5 SUBMITTALS

- A. Information to be submitted with Bid or Work Proposals:
 - 1. Submit qualifications and references of the proposed Testing and Certification Agency, supervisor and personnel.
 - 2. Submit a list of cleanroom projects similar in size, general scope and cleanliness classes to this project.
 - 3. Submit program of test procedure and specimen copy to each of the typical report forms and charts proposed for use for the project.
 - 4. Submit complete list if instruments proposed to be used, organized in appropriate categories, with data sheets for each indicating:

- a. Manufacturer and model number.
- b. Size, capacity and sensitivity range.
- c. Serial number.
- d. Latest calibration date and method of calibration employed.

B. Certification Testing Submittals:

1. Submit a schedule for performing all tests specified, indicating the duration of the testing period for each room identified in the Schedule of Required Classifications.
2. After completion and acceptance of all required tests, the Cleanroom Testing and Certification Agency shall compile all of the test and certification data and shall submit three copies of the completed report to BNL and Architect for approval:
 - a. The report shall include a signed and dated certificate, stating compliance with the specified performance criteria.
 - b. The report submitted shall include and seal of the Supervisor.
 - c. Contents of completed report shall be in accordance with the NEBB *Procedural Standard for Certified Testing of Cleanrooms*. The Cleanroom Certification report shall include, but is not limited to the following items:
 - 1) Tabulate all test data on 8-1/2 inch by 11 inch sheets bound in a report. Identify all test data by grid location. Grids shall be reviewed with BNL and Architect prior to award of Contract.
 - 2) Drawings: Include prints of the Cleanroom Floor Plans and Reflected Ceiling Plans made from the contract drawings with testing and certification locations shown on the drawings. (Sample Test Report Forms may be found in Chapter 13-- Sample Test Report Forms in the NEBB Procedural Standards for Certified Testing of Cleanrooms)
 - 3) Test Equipment: Furnish a complete list of all test equipment used in performing the work with serial numbers and verification of the latest calibration dates. All equipment will be reviewed with BNL and Architect prior to commencement of certification test work.
 - 4) Furnish in the report, a written statement, signed by the Supervisor, stating that all work has been performed in accordance with the requirements of this section unless specifically noted otherwise in the report.
 - 5) Include a description of all tests performed, included the purpose, instrumentation, procedures, results and analysis of the data. Data shall be presented and graphically displayed on NEBB forms to permit full understanding of all tests by BNL and Architect.

3. Submit reports of all initial tests and retesting required after corrective measures have been taken.

PART 2 – PRODUCTS

2.1 CLEANROOM SYSTEMS

- A. the certification Agency shall provide all materials and testing equipment and instruments to perform the certification work and required submittals.
- B. Refer to Sections 136013 and 136016 for Clean Zone and Protocol requirements for working in the clean zones.
- C. The Contract shall supply the Certification Agency with any required protocol requirements such as apparel and cleaning materials.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

- A. Prior to the start of Cleanroom Certification Testing, the Testing and Certification Agency shall verify that the work of the Air and Water Balancing Subcontractor has been completed:
 1. In addition, the Testing and Certification Agency shall verify that all construction Contract work has been completed within the clean space.
 2. Prior to the start of Airborne Particle Monitoring, the Cleanroom shall be cleaned to the satisfaction of the Testing and Certification Agency:
 - a. All Pre-Certification requirements and procedures have been completed and the Certification Agency has provided BNL and the Architect written notification that pretesting procedures have been completed and the testing schedule is ready to be initiated.
 - b. Final Cleanroom Cleaning and Project Commissioning shall be completed prior to start of Certification Activities

3.2 TEST PROCEDURE S- GENERAL

- A. The Testing and Certification Agency shall report the location of all sample points on an accurate grid diagram which represents the actual ceiling layout.
- B. Discrepancies with acceptance criteria shall be promptly reported to BNL's authorized representative, who shall approve the Cleanroom Contractor's defect resolution strategy.
- C. The Testing and Certification Agency shall observe all temperature and humidity sequencing testing by the Air Balancing Subcontractor.

- D. All work shall be scheduled and coordinated to accommodate phased completion.

3.3 ON-SITE PRE-INSTALLATION TESTING OF HEPA FILTERS

- A. This Testing Requirement is based on IEST Recommended Practices.
- B. A random selection of 1 out of 10 HEPA filters shall be tested individually for leaks by full Polystyrene Latex Spheres (PSL) challenge and scan with discrete particle counter test. Testing shall be performed in a suitably isolated and clean area.
- C. Each filter to be tested shall be clamped into a holding fixture which provides complete access to the downstream face of the filters and upstream plenum for supplying the air and test smoke mixture to the filter.
 - 1. The upstream plenum shall have two sample ports, one on each side and the 100 percent reading shall be taken at the lower of the two to assure sufficient concentration.
- D. Filter shall be tested at an average flow rate equal to operating design flow rate within ± 20 percent.
 - 1. A shielded hot-wire anemometer (0.43 fps-49 fps) face velocity profile, 12 in. downstream of filter face shall establish the average velocity across the face of the filter pack.
 - 2. Velocity shall be uniform within these limits without evidence of "dead spots."
- E. Instrumentation and Equipment:
 - 1. A particle counter that conforms to the following Table.
 - 2. A hand held isokinetic sampling probe configured to provide adequate residence time while scanning. Probe shall conform to the requirements of the following Table.
 - 3. An aerosol particle generator as described in the following Table.
 - 4. A diluter or a reduced flow rate particle counter that conforms to the requirements of the following Table.

Test	Equipment/ Instrumentation	Description	Calibration Interval
Leak Testing (w/Particle Counter) (Section 10.12, 10.13 & 11.14)	Particle Counter (Scanning)	A light scattering instrument with display or recording means to count and size discrete particles in air, as defined by ASTM F50-69. Instruments of this type shall provide for a minimum sampling flow rate of 28.3 L/min (1.0 cfm) and a threshold size discrimination of a minimum of 0.3 micrometer (microns) in size.	12 Months
	Scanning Probes	Near-Isokinetic (square or rectangular) scanning probe fitted with a sampling tube no longer than 8 meters (25 feet).	Not Required
	Aerosol Generator	A device that can aerosolize either a polydispersed or a monodispersed artificial particle medium for filter integrity testing, including Laskin nozzle type, thermal generator, atomizer, etc.	Not Required
	Diluter	A device used with the scanning particle counter to sample the aerosol challenge upstream of a filter under test. The resulting counts after dilution should not exceed 100,000 particles.	12 Months

F. The challenge aerosol particle concentration must be greater than 3.53×10^7 (35,300,000) particles per cubic meter, (3×10^6 [3,000,000] particles per cubic foot of air) based on using a probe that is 0.4 inches in the direction of scan and at a scan rate of 2 inches per second. This concentration will allow a (212,000,000) particles per cubic meter, (6×10^6 [6,000,000] particles per cubic foot of air) are desirable and will increase the accuracy with which leaks are detected.

G. Test Procedures:

1. Verify that the design airflow velocity has been balanced by a NEBB Certified TAB Firm prior to performing the filter installation leak test.
2. Introduce the aerosol into the air supplied to the filters in a manner which will produce a uniform challenge concentration at each of the filters being exposed at the same time.
3. Measure the upstream particle concentration as the challenge is introduced. Verify that the upstream particle challenge shall be greater than 3.53×10^7 (35,300,000) particles per cubic meter, (1×10^6 [1,000,000] particles per cubic foot of air). While this concentration will allow a reasonable scan rate, a higher concentration will improve the accuracy and may allow for increased scan rate.
4. The resulting upstream challenge concentration, along with other information specified below is used in Equation 10-2 to calculate the *Acceptable Scan Rate* when utilizing a Discrete Particle Counter Test.

5. Using the resulting scan rate (Sr), scan the filter face and the perimeter of the filter assembly by passing the probe in slightly overlapping strokes so that the entire area of the filter and installation is tested. The probe should be held approximately 25 mm (1 inch) from the area to be tested during scanning. Separate passes should be made around the entire periphery of the filter, along the bond between the filter pack and the frame, and around the seal between the filter and the device.

Equation 10-2

$$S_r = \frac{C_c \times L_s \times F_s \times D_p}{60 \times N_p}$$

Where:

Sr = Acceptable Scan Rate—cm/s (in/s)

Cc = Upstream challenge concentration—particles/L (particles/ft³)

Ls = Significant leak—percentage of upstream concentration (typically 0.01%)

Fs = Sample flow rate of instrument used—L/min (cfm)

Dp = Probe dimension parallel to scan direction—cm (inches)

Np = Number of particle counts that indicate the leak (1 through 10)

60 = Conversion—60 sec/min

NOTE: If a lower value of Np is used (1), the allowable scan rate will be increased but the probability of finding a leak will be decreased and the probability of false leaks is increased. If a larger Np is used (3 or greater) the allowable scan rate is decreased but the probability of detecting a leak is increased.

6. When scanning a filter and the supporting assembly installation a particle count detection exceeding Np will indicate a potential leak. If particles are registered that exceeds Np, then the particle concentration penetrating the defect shall be determined if a significant leak exists.
 7. Scanning method shall conform to ISET-RP-CC006.
- H. Acceptance: An unacceptable leak is defined as a sustained reading greater than 0.010% of the measured upstream concentration for the particle size of interest, or as specified in the contract documents or as agreed to between the BNL and the Clean Room Testing Firm.
- I. Repairs: Filters may be repaired providing:
1. The size of the repair(s) is not greater than 3% of each filter face area. Additionally, a repair area shall have a minimum dimension which shall not exceed 38 mm (1.5 inches) or as specified in the contract documents or as agreed to between the BNL and the Clean Room Testing Firm.
 2. Repairs to filter installation leaks may be made by procedures specified in the contract documents or as agreed to between the BNL and the Clean Room Testing Firm.

- J. The Testing and Certification Agency shall keep a daily record of the defective filters found during on-site testing.
 - 1. Defective filters shall be re-boxed immediately, before being repaired, until such time that the problem is identified,
 - 2. The integrity of the filters is the responsibility of the Contractor.

3.4 CLEANROOM PERFORMANCE TESTING

- A. The following tests in Section 3.5 shall be required for rooms listed in the Schedule of Classifications Section 3.6.
- B. Certified Tester may use ISO or IEST Testing Criteria using the stringent testing procedure providing acceptability of the requirements.
- C. All testing shall be applicable to “as built” “At rest” or “operational” state and “non-unidirectional” or “unidirectional” airflow. Refer to Section 3.6 for required criteria.

3.5 SCHEDULE OF ACCEPTANCE CRITERIA

- A. In addition to the general basis cleanliness requirements in ISO 14644, comply with the following criteria:

ISO TEST NO.	CERTIFICATION TEST	1 ST FLOOR CLEANROOM 1-260, 1-261, 1-264	2 ND FLOOR CLEANROOM 2-228, 2-228A/B
	Class	ISO-7 (CL-10,000 Fed. 209)	ISO-6 (CL-1,000 Fed. 209)
B.1	Airborne particle Count Test	ISO Class 7 ISO 14644-1	ISO-Class 6 ISO 14644-1
B.4	Air Flow Test	Refer to paragraph 3.6 Schedule of Classifications ISO 14644-1, -2	Refer to paragraph 3.6 Schedule of Classifications ISO 14644-1, 2
B.5	Air Pressure Difference Test	Refer to Mechanical drawings- airflow diagrams ISO 14644-1, -2	Refer to Mechanical drawings- airflow diagrams ISO 14644-1, -2
B.6	Installed Filter System Leakage Test	B.6.1.3	B6.1.3
B.7	Airflow direction Test and Visualization	Not required ISO 14644-2	Not required ISO 14644-2

B.8	Temperature Test	Refer to Mechanical drawings- airflow diagrams	Refer to Mechanical drawings- airflow diagrams
		68° +/- 1°F	68° +/- 1°F
B.9	Humidity Test	Refer to Mechanical drawings- airflow diagrams	Refer to Mechanical drawings- airflow diagrams
		Winter 30% +/- 5% Summer 50% +/- 5%	Winter 30% +/- 5% Summer 50% +/- 5%
		ISO 7726	ISO 7726
B.10	Electrostatic Test	Not Required	Not Required
		B.10.2.1.1 B.10.2.1.2	B.10.2.1.1 B.10.2.1.2
B.11	Particle Deposition Test	Not Required	Not Required
B.12	Recovery Test	Not Required	Not Required
B.13	Containment Leak Test	Not Required	Not Required
--	Vibration	Not Required	Not Required
--	Noise Level Test	Not Required	Not Required

3.6 SCHEDULE OF REQUIRED CLASSIFICATIONS

Room No.	Room Name	Class	Occupancy State	ACH	FPM
1-260	Cleanroom	ISO-7/10,000	As-built	107	16
1-261	Support	ISO-7/10,000	As-built	127	19
1-264	Gowning	ISO-7/10,000	As-built	120	18
2-228	Gowning	ISO-6/1,000	As-built	140	21
2-228 a/b	Cleanroom	ISO-6/1,000	As-built	200	30

3.7 FINAL GASKETING LEAKAGE TEST

- A. While performing final HEPA filter installation leak test, scan ceiling grids for leakage at gasketing, perimeter ceiling angle condition and at any fixture mounted through the HEPA filters, with particle counter using the same procedures as in the final HEPA filter installation leak test.
1. Notify BNL and Architect in advance of this work and allow BNL's authorized representative to witness test.
 2. Report all locations of ceiling grid leakage to Clean Zone Director for immediate defect resolution.
- B. Retest all locations of leaks after defects have been corrected.

END OF SECTION 13 6019