Labgard Class II, Type A/B3 Laminar Flow Biological Safety Cabinet

Models
NU-425-300/400/600
Bench/Console

Operation & Maintenance Manual

Revised
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(Series 2X)

(NU-425-400/600 Only)

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OM0080

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Congratulations!

You have just purchased one of the finest Laminar Flow Biological Safety Cabinets available. With proper care, maintenance (certification), and laboratory procedure, this cabinet will give you years of product and personnel protection from particulate contaminants as prescribed in National Sanitation Foundation (NSF) Standard No. 49. Please read this manual carefully to familiarize yourself with proper installation, maintenance and operation of the cabinet. Appendix A lists Training Aid Materials, Films, Pamphlets and Books that may assist you in the proper application/procedure of the cabinet.

Acknowledgment

NuAire, Inc. acknowledges that some material in this manual reflects information supplied by the National Institutes of Health personnel both in verbal and written specifications. In particular, NuAire acknowledges that information in Section 8 was obtained from the following sources:

1. Technical Report No. FPS 56500000001. Prepared by Dow Chemical Co., for the National Cancer Institute, May 1, 1972.

2. Stolar MH, Power LA, Vielo CS: Recommendations for handling cytotoxic drugs in hospitals. Am J Hosp Pharm 1983;40:
1163-1171.

3. Anderson R.W., Director of Pharmacy, University of Texas, M.D. Anderson Hospital and Tumar Institute at Houston.

ABOUT THIS OPERATION & MAINTENANCE MANUAL

The information contained in this manual is intended to reflect our current production standard configuration model along with the more frequently purchased options. Any unique additions/modifications/shop drawings are appended in the back flap of this manual, along with any modifications and/or additions to procedures as outlined in this manual. A copy of the original factory test report is also appended to this manual. In case this manual and/or test report is lost or misplaced, NuAire retains a copy in our files. A replacement copy can be obtained by calling or writing NuAire, Inc. stating the model number and serial number and a brief description of the information desired.

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Laminar Flow Biological Safety Cabinet

Models NU-425-300/400/600

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MANUFACTURED BY:

NuAire, Inc. - Plymouth, Minnesota, U.S.A.

1.0 General Description

The LABGARD Model NU-425 Laminar Flow Biological Safety Cabinet (LFBSC) is a bench/table top model, optionally available with a base support stand, for operation as a console model.

The Laminar Flow Biological Safety Cabinet, (LFBSC) is a product resulting from the development of the "laminar flow" principle and the application of environmental controls as required in the field of biological research or chemical containment. The LFBSC, when used with proper technique, is an effective laboratory aid in obtaining the optimum control over product quality while reducing the potential for exposure of both product and personnel to airborne biological or particulate chemical agents in low to moderate risk-hazard research and drug preparation or product operations, as prescribed by the Center for Disease Control (CDC) Atlanta, Georgia.

The NU-425 bench LFBSC is known as a "convertible cabinet", meeting the requirements of Class II, Type A and, when vented to the outside, meeting the requirements of Class II, Type B3, hence the A/B3 designation. This is possible since NuAire's cabinet conforms to the following requirements:

1. Maintains inflow velocity of 100 LFPM (.51 M/S) through the work access opening.

2. Has HEPA filtered downflow air that is mixed with the inflow air from a common exhaust plenum (A or B3 requirements are identical).

3. Discharges all air to the outside atmosphere after HEPA filtration. (Type A may exhaust back to the laboratory).

4. Has all biologically contaminated ducts and plenums under negative pressure or surrounded by negative pressure. (Type A permits positive pressure contaminated ducts and plenums).

The LABGARD Bench/Console Model NU-425 has six distinct characteristics that enables it to perform the foregoing objectives:

HEPA Filtration
Controlled Airflow, Internally Balanced
Sealed Construction
Hepex Pressure Plenum
Minimum Air Turbulence
Front Maintenance

1.1 **High Efficiency Particulate Air (HEPA)** filtration is utilized for both supply (recirculated) and exhaust air systems. The HEPA filters are rated at 99.99% efficiency on removal of all particulate matter 0.3 micron with greater efficiency on larger and/or smaller particles.

1.2 **Controlled Air Flow** (see ACD-05179 Airflow Schematic) with an internal balancing damper establishes an optimum air balance between the cabinet's recirculated air system and the exhaust air system while:

a) Providing HEPA filtered air flowing in a unidirectional vertical manner (downward) through the work space at an average velocity of 70 LFPM (.35 M/S) measured in a horizontal plane defined by the bottom edge of the viewing window.

b) Exhausting approximately 30% of the recirculated air over a second HEPA filter which causes the working area of the cabinet to be slightly negative in pressure (as related to room pressure). The supply air replacing the exhausted air, flows through the work access opening at an average velocity of 105 +/-5 LFPM (.53 +/-.025 M/S), thus providing an air barrier curtain.

c) Ducting the work zone airflows such that the quantity of air leaving through the rear perforated area is half of the recirculated air quantity. The remainder, that is the other one-half (50%) of the recirculated air and the air entering through the work access opening enters the front perforated area.

d) Providing an **internal balancing damper** insures downflow/exhaust (work access in flow volume) ratios can be balanced to factory standards as the filters age and/or are eventually replaced.

1.3 **Sealed construction** requires that all recirculated and/or exhaust air plenums (from immediately downstream of the work surface to the discharge side of the supply and exhaust HEPA filters) be leak-tight. Plenums and penetrations as necessary for utilities, access panel doors, etc., are sealed in such a manner as to prevent escape of potentially contaminated air into the room.

1.4 **HEPEX Pressure Plenum** provided by the HEPEX Absolute Filter System results in greater reliability for the continuing Class 10, Federal Standard 209d (1), Bio-clean environment within the working zone of the cabinet. The air-space between the HEPEX and the cabinet structure is always less than room ambient pressure which prevents *any* air outflow from the LFBSC other than the filtered outflow from the exhaust filter. The absolute filter is nested in non-flammable elastomeric foam in a manner which ensures zero leak and preserves the Class 10 environment free from the rigors of shipping and moving.

(1) Air Cleanliness Standard, U.S.A.

1.5 **Minimum air turbulence** is maintained by having all work zone enclosure walls (including the viewing window) provide a fixed flow area perpendicular to the air flow streamlines. This condition of minimum turbulence with no upward or refluxing component is optimized by having each enclosure wall essentially become an extension of the true flow area of the HEPA filter - thus permitting the clean filtered air to flow downward like a huge piston forcing clean air onto the work tray before the air recirculates through the cabinet airflow/blower system.

Minimizing turbulence at the front opening is effected by the airfoil turning the air stream entering the cabinet to a direction parallel to the flow of the recirculated air within the unit thus preventing the recirculated air from flowing out through the front opening into the room and the room air entering the cabinet from overflowing onto the work surface.

Truncating the inlet grill against the side wall of the cabinet produces air velocities 25% greater around the side wall airfoil, protecting this critical area from migrating particles. In addition, the volume of air provided by the 10 inch (254mm) access opening produces a comprehensive "sphere of influence" throughout the work access opening for particulate control, since particles must have more energy to escape. Escape velocities are directly proportional to the volume, and inversely proportional to the area plus the square of distance from the inlet grill.

1.6 **Vibration is minimized** (less than 100 micro inches (2.54 micrometers) on the work surface) through the use of vibration isolators; first around the motor mounts fastening the motor to the blower and second when attaching the motor/blower combination to the frame. All blower scrolls are dynamically balanced.

1.7 **Front maintenance** permits a LFBSC to be permanently connected to a plant exhaust system and plumbing lines. Both supply (downflow) and exhaust HEPA filters are rapidly and easily removed from the front of the cabinet. All controls and adjustments are accessible from the front of the cabinet.

2.0 Construction Features

Standard Features

2.1 The NU-425 cabinet shell is pressure tight, consisting of an all welded, 16 gauge, type 304 stainless steel wrap. All welds are meticulously hand-finished and polished to be free of burrs. The wrap is structurally reinforced to minimize vibration and maintain surface flatness. The stainless steel is finished in easily cleanable No. 4 satin. The cold-rolled steel 14 gauge access panel and light/control center is finished in textured baked urethane. Colors available upon request.

2.2 All LABGARD controls are contained within an easily removable Control Center, placed at eye level for convenience. All connections from the Control Center to the cabinet are hermetically sealed at the cabinet shell, with quick disconnect electrical connections at the Control Center. The Control Center is hinged for easy access to electrical components and the fluorescent light.

2.3 All cabinet surfaces, interior and exterior, are constructed of, or furnished with, materials which are corrosion, flame and moisture resistant and which will not deteriorate under exposure to liquid or vapor phase decontaminates such as hydrogen peroxide, formaldehyde, alcohol, iodophers, peracetic acid. **USE OF CHLORINATED OR HALOGEN MATERIALS MAY DAMAGE STAINLESS STEEL.**

2.4 The work area consists of the following items going from front to back: the airfoil, the work access opening, the removable perforated stainless steel inlet grill, the removable solid stainless steel work tray and the perforated stainless steel air exhaust area located in the rear wall of the work area. The top lip of the airfoil is one inch above the removable solid stainless steel work tray which extends the full length and width of the work space.

2.5 Air leaves the work space via the perforated area in front of the work tray, and via a similar perforated opening extending the full length of the work space in the rear wall just above the work tray. The air removed via the front and rear perforated areas is mixed by the blower, exhausting approximately 30% through a HEPA filter located on top of the LFBSC and recirculating approximately 70% through a HEPA filter supplying the interior downflow.

2.6 The exhaust filter is protected with a perforated metal grill, to prevent blockage and/or damage of the exhaust HEPA. However, items should not be stored on the top of the cabinet. When exhausting the cabinet to the atmosphere, the grill is not used.

2.7 The supply filter is of full work zone depth and width and is protected with an easily removable, perforated metal diffuser, in order to check filter integrity.

2.8 Both the supply and exhaust HEPA filters are 99.99% efficient on particulate 0.3 microns in diameter with even greater efficiency on larger and/or smaller particles. When replacing the HEPA filters use only filters of the same size and flow rating as originally installed (see Replacement Parts List).

2.9 A drain-spillage plenum is located below the work surface, so arranged as to catch any spillage in the work area, and is easily cleaned after the removal of the solid work tray. A 3/8 inch (10mm) ball-type drain valve is located on the right front of the plenum to handle large spills. The drain spillage trough accommodates a minimum of five (5) liters. This area also forms the return air path to the blower.

2.10 The viewing window is a full counter balanced sliding 1/4 inch (6mm) tempered glass window that provides for smooth opening/closing. The window provides a 19 1/2 inch (495mm) maximum open area to fully closed. The window frame is constructed from type 304 stainless steel with all exposed edges deburred for easy cleaning, finished in No. 4 satin grain. Both audible and visual alarms are provided when the window is raised above the standard work opening height (10 inches (254mm) for the 4 & 6 foot cabinet, 8 inches (203mm) for the 3-foot cabinet, and optional for the 4 & 6 foot cabinet). The blower is shut off when the window is closed to prevent unnecessary motor overheating. The blower does not shut off for hinged window cabinets.

2.11 The two (T8) fluorescent lamps are cool white, rapid start type, located outside the work space, obscured from direct view providing an average uniform light intensity of 100 foot candles (1076 LUX) at the work surface. The electronic ballast contains thermal protection with automatic reset. **PLEASE NOTE, ELECTRONIC BALLASTS OPERATE WITH HIGH IN RUSH CURRENT. IT IS NOT RECOMMENDED TO USE THIS PRODUCT WITH GROUND FAULT CIRCUIT INTERRUPTERS (GFCI'S) BECAUSE THE BALLASTS MAY CAUSE THE GFCI TO TRIP.**

2.12 Electrical power is required from one 115 Vac, 60 Hz, 20 Amp power source. The power is distributed internally for the blower, lights and duplex outlets via solid state relays and triacs. Cabinet shell and all electrical components are grounded back to electrical source, to meet grounding continuity requirements for electrical safety.

2.13 The motor/blower requires 115 Volt, single phase, 60 Hz power and will not exceed a temperature of 105°C in a maximum ambient temperature of 48°C (120°F) under any maximum load condition (class "B" insulation). The thermal protector will not trip at 115% of the rated voltage under maximum load and ambient temperature conditions. The motor/blower is rated for 24 hour continuous operation and is lubricated for life.

2.14 The LABGARD has only one motor/blower fan system controlled by the motor voltage regulator for both the recirculated and exhaust air. The motor/blower and blades are fabricated of or protected with corrosion resistant materials to withstand normal laboratory or chemical fumes. The motor/blower will automatically compensate for airflow as the filters load with particulate to achieve a fan delivery fall off of no more than 10% as a result of a 80% increase in pressure drop across the filters. The Electronic Airflow Control System will provide a greater than 200% increase in pressure drop across the filters is achievable.

2.15 The LABGARD is designed for clean ability: surface decontamination is made simple by use of coved corners and an easily removable work tray over the spillage trough. Complete biological decontamination can be accomplished following the recommended NIH procedure using formaldehyde. The NIH procedure can be obtained from the National Audiovisual Center (GS) Washington, D.C., 20409 in the form of a tape cassette and slides.

2.16 Two outlets with drip-proof covers are located on either side of the rear divider panel above the work tray as standard (300 unit has only one centered on the rear divider panel). Collectively the outlets are rated at 115 Vac at 3 amperes maximum.

2.17 One ground-key cock for gas service is located in the right side wall as standard. One plugged penetration for future service is also provided. The valve body and handle is

made from chrome plated brass forgings with the valve ground and lapped and tested at 100 psi (7.0 Bar). Cocks have integral ten serration outlet and individually coded by a removable button on the handle. Cocks are rated 30 psi (2.0 Bar) working pressure.

2.18 A normally plugged D.O.P. challenge port is provided on the top of the cabinet. The port provides access to the pressure plenum for checking the concentration of D.O.P. challenging the HEPA filter, if the measuring instrument requires such access.

2.19 The textured baked urethane finish is a high-solids chemical agent resistant coating (CARC), and meets new United States Environmental Protection Agency (EPA) solvent emission regulations with less than 3.5 lb./gal. (.419Kg/Lit.) volatile organic content. The CARC coating contains no chlorinated hydrocarbons and withstand chemical and biological reagents absorption into the paint. They survive corrosive, humid and salt environments.

Optional Features

2.20 An ultraviolet light provides a minimum of 40 micro-watts per square centimeter on the work tray, controlled from the Control Center with a switch which is controlled so that the UV light cannot be used when the sliding window is opened or the normal fluorescent lamps are on (see Section 12.1).

2.21 Ground-key cocks (up to three) can be installed in either or both side walls. The type of service is indicated by a removable button on the handle. Needle valves for high pressure gases are optionally available.

2.22 The base support stand is constructed from 16 gauge, all welded 2-inch (51mm) square steel tubing, finished in textured baked urethane. The base stand heights are 26 1/2-inches or 32 1/2-inches (673mm or 825mm) which provide work surface heights of 30-inches or 36-inches (762mm or 914mm) respectively. The base support stand is available as a base storage cabinet, that is fabricated from 16-gauge cold-rolled steel. It consists of rear, end and bottom panels fastened to the base stand via screws. Sliding doors provide complete access to the 16-inch (406mm) cabinets interior height (depth is 22-inches) (559mm). NSF approved leg levelers permit ± 3/4-inch (20mm) of height adjustment. The base support stand is shipped knocked-down for on-site assembly.

2.23 NuAire offers an EXHAUST TRANSITION for use with LABGARD Laminar Flow Biological Safety Cabinet to provide a transition between the LABGARD and a plant exhaust system which preserves the air balance within the LABGARD. The hood provides access for replacement of the exhaust HEPA filter and means to conduct fumigation of the cabinet.

2.24 A lay-in Sorbent filter is available for the exhaust efflux. The Sorbent filter is a 2-inch (51mm) pack, bolted and gasketed to the exhaust HEPA filter via a CRS frame and held in place with spring clips

2.25 The cabinet can be configured with plastic storage trays, which are attached to the underside of the cabinet via stainless steel rails. The trays are high-impact polyethylene plastic available in red. The base stand without storage cabinets is a prerequisite for the trays.

2.26 Decorative side panels can be added to cover plumbing lines to the services within the interior. The panels are constructed from 16 gauge, cold rolled steel finished in textured baked urethane. Colors optional.

3.0 Models & Features

The model NU-425, Class II, Type A Laminar Flow Biological Safety Cabinet is manufactured in four sizes: 2 ft., 3 ft., 4 ft., and 6 ft. This manual only covers the 3, 4 and 6 foot cabinets.

3.1 Dimensions

	NU-425-300	NU-425-400	NU-425-600
Overall Dimensions - Inches (mm):			
Width (W)	41 5/8 (1057)	53 5/8 (1362)	77 5/8 (1972)
Depth (D) (includes Control Center):	32 7/8 (835)	32 7/8 (835)	32 7/8 (835)
Height (H) (includes Exhaust Grill):	63 (1600)	63 (1600)	63 (1600)
Base Stand, 30" (762mm) w.s.:	89.5 (2273)	89.5 (2273)	89.5 (2273)
Base Stand, 36" (914mm) w.s.:	95.5 (2426)	95.5 (2426)	95.5 (2426)
Interior Dimensions:			
Width (W):	36 3/8 (873)	46 3/8 (1178)	70 3/8 (1788)
Depth (D):	23 1/2 (597)	23 1/2 (597)	23 1/2 (597)
Height (H):	28 1/2 (724)	28 1/2 (724)	28 1/2 (724)

3.2 Standard Features

HEPEX Zero Leak Airflow System
Large HEPA Filters; 99.99% Efficient on 0.3 Microns
External Fluorescent Lighting: 100 Ft. Candles (1076 LUX)
Front Filter Removal
Sliding Glass View Screen; 19 1/2" (495mm) Opening to Fully Closing
Standard 10" (254mm) or Optional 8" (203mm) Access Opening (Standard 8" (203mm) for 3 Ft. Cabinet
Removable Work Tray
Metal Diffuser Over Supply HEPA
Tempered Glass Window
Two Outlets on Back wall (One for 300 Unit)
One Gas Service Ground Key Cock Right Side Wall
One Plugged Service
Spill Trough with 3/8" (10mm) Drain Valve
Return Air Plenum Paper Catch
Motor Voltage Regulator

3.3 Optional Features

8 Inch (203mm) Access Opening
Ultraviolet Light
Ground Fault Interrupter for Electrical System
Additional Service Valves for Gas, Air, Vacuum
Remote Service Valves
Additional Duplex Outlet
IV Bar with 6 Stainless Steel Hooks
Exhaust Transitions - Thimble or Gas Tight
Alarm Systems
Exhaust Interlocks
Base Support Stand (available in standard working surface heights of 30 or 36 inches) (762 or 914mm) with or without storage shelves
Adjustable Control for Support Stand or Storage Cabinet
Hinged Viewing Window
Microscope Viewing Window
Sinks with Hot/Cold or DI Water Faucets
Storage Pull-Out Trays
Lay in Sorbent Exhaust Filter
Decorative Side Panels (hides plumbing fixture connections)
Permanent Plenum w/Quick Release Supply Filter
Metal Framed HEPA Filters
HEPA Filters 99.999% @ 0.3 Micron
Arm Rest

4.0 Test Performance & Procedures

All equipment is thoroughly inspected at the NuAire Factory at the time of shipment. Quality control is maintained by constant surveillance over the product, beginning at the receipt of purchased material and concluding with a final inspection which certifies cabinet performance to the National Sanitation Foundation Standard No. 49, as well as any unique customer requirements. In all instances where product quality cannot be easily assessed on the end item, product inspection is performed during sub-assembly fabrication. The following test procedures are conducted on each cabinet and a copy of the test report is included with each unit.

4.1 Personnel, Product & Cross-Contamination Tests (See Note)

NSF Std. No. 49 and defines testing procedures using an aerosolized spore solution to challenge the containment properties of the cabinet.

4.1.1 Personnel Protection Test

The spores are aerosolized via a nebulizer placed 14" (356mm) above the work surface, 4" behind the view screen, directed at the view screen. The challenge is 1×10^8 spores per milliliter solution. Six air samplers (AGI's) are placed above and below the work access opening centered around a cylinder, simulating an arm and two slit air samplers are placed 8" (203mm) from each end of the work access opening. No more than 10 CFUs* can be recovered from the AGI's and 5 from the slit sampler for a thirty minute test. Total of 3 tests.

4.1.2 Product Protection Test

The entire work surface is covered with open agar settling plates. The nebulizer is placed 4" (102mm) inches from the bottom outside edge of the view screen directed at the view screen. A cylinder is placed directly below the nebulizer 2" (50mm) above the work tray simulating an arm. No more than 5 CFUs* can be recovered for a 5 minute test. Total of 3 tests.

4.1.3 Cross Contamination Test

The entire work surface is covered with open agar settling plates. The nebulizer is placed 3 to 5 inches (76-127mm) above the work surface, against a side wall, directed toward the other side wall. No more than 2 CFUs* can be recovered at a distance greater than 14 inches (356mm) from the challenged side wall. Both side walls are challenged 3 times.

4.2 Leak Tightness Test

The cabinet work zone opening as well as the exhaust HEPA filter area are sealed with a plate clamped into place. The cabinet is pressurized, to 2 inches of water gage (50 mm) using air. All welds, joints, access door/panels and penetrations in the cabinet structure are probed for leaks using soap solution. The cabinet must hold 2 inches water gage (50 mm) pressure, with no detectable leaks, or hold pressure within 10% for 30 minutes.

*CFU = Colony Forming Unit

4.3 HEPA Filter Integrity/Housing & Frame Leak Test

Both supply and exhaust HEPA filters are scanned for leaks around the filter seal periphery, filter housing and filter media. Passes are made overlapping to ensure complete coverage. D.O.P. smoke is introduced upstream using one Laskin Nozzle per each 135 CFM (752 m^3/H). Downstream measurements using an Aerosol Linear Photometer must be less than 0.01% of upstream concentration.

4.4 Downflow Air Velocity Measurement

NuAire establishes an average downflow air velocity of 70 LFPM ± 5 LFPM (.35 m/s ±.025 m/s). Measurements are taken on an approximate 6 inch (152mm) grid using an Alnor 8500 Thermoanemometer in a horizontal plane defined by the bottom edge of the viewing window. All measurements fall between ±20 percent of the stated average velocity. Average velocity will fall between 65-75 LFPM (.32-.38 m/s).

4.5 Smoke Flow Patterns

Smoke is passed 1-1/2 inches (38mm) in front of the entire perimeter of the work access opening; all smoke movement shall be inward. Airflow within the work area shall be downward with no dead spots, refluxing or drift.

4.6 Inflow Air Velocity Measurement

(Direct Reading Instrument or Calculated Inflow Velocity)
Inflow air volume is measured at the work access opening using a direct reading instrument (shortridge flowhood ADM-870). Air velocities from the exhaust HEPA filters can also be measured on a 4 inch by 4 inch (102mm by 102mm) grid using an Alnor 8500 or TSI 8355 Thermoanemometer. The inflow air volume quantity is sufficient to provide a calculated velocity of 105, ± 5 LFPM (.53 ± .025 m/s) through the work access opening.

4.7 Temperature Rise

The cabinet, operated with lights on, exhibits no more than 8.5°C (15°F) temperature rise over ambient after 4 hours of operation.

4.8 Lighting Intensity

Lighting Intensity, measured on a 6 inch (152mm) grid, with an average background of 20-40 foot-candles (215-430 LUX), average between 90 (968) to 120 (1291) foot-candles (LUX) on the work tray. Individual readings are not below 60 (646), nor above 175 (1883) foot-candles (LUX), on the work tray as measured by a DLM2 light meter.

4.9 Noise Level

Overall noise measured 12 inches (305mm) in front of the work area opening and at a level 15 inches (381mm) above the work tray will not exceed 67 dbA with a background not over 55 dbA using a General Radio 1982 or Quest Model 1800 Sound Level Meter.

4.10 Vibration

Vibration amplitude will not exceed 200 micro inches RMS is measured with a Bruel and Kjaer, type 2511 in the center of the work tray in three principle plane (no dimensional requirements) at 20 to 20,000 hertz.

4.11 Electrical Leakage Test

A.C. electrical leakage shall not exceed 500 micro amperes using a Simpson Model 229 or equivalent tester.

4.12 Dielectric Voltage - Withstand

1770 (**VDC ONLY**) volts is applied between dead metal parts and the hot/neutral power source lead with no electrical breakdown using an Associated Research Model 4045AI.

4.13 Grounding Continuity

The resistance between the green bonding conductor of supply cord and any dead metal part of the cabinet shall not exceed 0.10 ohms.

Note: NuAire has conducted the test on a representative production cabinet in order to validate the design and containment properties of the design. NuAire will periodically conduct these tests as a Quality Assurance measure. Cabinets so tested are labeled and decontaminated prior to shipment. These tests may also be conducted at customer request and expense. All of the other above tests are conducted on each cabinet prior to shipment and a copy of the test report accompanies this Operation and Maintenance Manual.

5.0 Warranty

NuAire, Inc. warrants that it will repair F.O.B. its factory or furnish without charge F.O.B. its factory a similar part to replace any material in its equipment within 36 months after the date of sale if proved to the satisfaction of the company to have been defective at the time it was sold provided that all parts claimed defective shall be returned, properly identified to the company at its factory, charges prepaid. Factory installed equipment or accessories are warranted only to the extent guaranteed by the original manufacturer, and this warranty shall not apply to any portion of the equipment modified by the user. Claims under this warranty should be directed to NuAire, Inc. setting forth in detail the nature of the defect, the date of the initial installation and the serial and model number of the equipment.

This warranty shall not apply to any NuAire product or part thereof which has been subject to misuse, abuse, accident, shipping damage, improper installation or service, or damage by fire, flood or acts of God. If the serial number of this product is altered, removed or defaced as to be illegible, the Warranty shall be null and void in its entirety.

The warranty is for the sole benefit of the original purchaser and is not assignable or transferable. Prior to returning any item, for any reason, contact NuAire for a Return Authorization Number. This number must accompany all returns. Any product shipped to NuAire without this number will be returned refused shipment or collect freight.

6.0 Shipments

NuAire takes every reasonable precaution to assure that your LABGARD cabinet arrives without damage. Motor carriers are carefully selected and shipping cartons have been specially designed to insure your purchase. However, damage can occur in any shipment and the following outlines the steps you should take on receipt of a NuAire LABGARD cabinet to be sure that if damage has occurred, the proper claims and actions are taken immediately.

6.1 Damaged Shipments

6.1.1 Terms are factory, unless stated otherwise. Therefore, it is important to check each shipment before acceptance.

6.1.2 If there is visible damage, the material can be accepted after the driver makes a notation on the consignee's copy of the freight bill. Then an inspection must be made to verify the claim against the carrier. This inspection is the basis of your filing the claim against the carrier.

6.1.3 If concealed damage is found, it is absolutely necessary to NOTIFY THE FREIGHT AGENT AT ONCE, and request an inspection. Without this inspection, the transportation company may not accept a claim for loss or damage. If the carrier will not perform the inspection, an affidavit must be prepared stating that he was contacted on a certain date and that he failed to comply with the request. This along with other papers in the customer's possession will support the claim.

7.0 Installation Instructions

7.1 Location

Within the laboratory, pharmacy, etc., the ideal location of the biological safety cabinet is away from personnel traffic lanes, air vents (in or out), doors and/or any other source of disruptive air currents.

If drafts or other disruptive air currents exceed the inflow velocity of the cabinet through the access opening, the *potential* exists for contaminated air to exit or enter the work zone area of the cabinet. It depends on the severity of the air current. **REMEMBER: A BIOLOGICAL SAFETY CABINET IS NO SUBSTITUTE FOR GOOD LABORATORY TECHNIQUE.**

Where space permits, a clear 12" (305mm) area should be permitted on each side of the cabinet for maintenance purposes. The electrical outlet into which the cabinet is connected should be readily accessible for maintenance purposes. A MINIMUM CLEARANCE OF 6" (152MM) IS REQUIRED FROM THE TOP OF THE CABINET TO THE CEILING FOR PROPER VENTILATION OF THE EXHAUST EFFLUX. HOWEVER, FOR CERTIFICATION OR COMMISSIONING, 18 INCHES (451MM) IS REQUIRED TO OBTAIN VALID EXHAUST MEASUREMENTS.

If it is desired to exhaust the cabinet to the outside, NuAire offers two general categories of exhaust transitions which will capture the exhaust efflux from the cabinet. These are:

Thimble or Air Gap Exhaust Transitions (with and without integral fan)
Gas-Tight Exhaust Transitions

Both types of transitions have some common attributes, in addition to some that are unique. The exhaust transition selected is dependent on desired performance of the cabinet, capabilities of the plant exhaust system and expenditure desired. See separate instruction sheets for a discussion of exhaust transitions and installation requirements.

7.2 Set-Up Instructions

Remove outer shipping protection (carton or crating). The cabinet is fastened to the base skid and it is usually the best procedure to leave the skid in place until the cabinet is located in its approximate position to facilitate ease in handling. It can then be removed from the skid by removing the banding, bolts and screws holding the cabinet to the skid. It may be necessary to remove the Control Center in order to gain passage through a doorway. It may easily be removed by following the instructions on drawing BCD-05145.

7.2.1 Base Stand Assembly

The base stand is shipped knocked down in a separate carton and is assembled per drawing BCD-05147 if accompanied with the unit. Remove the banding holding the cabinet to the base skid. Lift the cabinet from the base skid and place on the floor. Now lift the cabinet on top of the base and bolt the base stand to the cabinet using two 3/8" - 16 x 3/4" bolts and washers provided for the front base stand tabs and two 1/4" acorn nuts for the rear weld studs. Place the cabinet in its desired location.

The base stand storage cabinets will usually be shipped according to customer requirements. If it is shipped unassembled, it can be assembled per drawing BCD-05146. It is recommended that the upper and lower base stand braces be installed first, then the rear and bottom panels (the end panels are always prefastened). Once assembled, fasten the cabinet per the above instructions.

Remove the plastic cap protecting the drain valve threads and install the drain valve, on the bottom right front of the cabinet using Loctite 242 furnished to the threads and rotate the valve body until it is secure (see ACD-01855).

7.2.2 Leveling

Using a level placed on the work tray, adjust the leg levelers, first, end to end, then, front to back. The NSF approved leg levelers provide a ± 3/4" (20mm) adjustment.

7.2.3 Bench Installation (BCD-05154)

Place the cabinet on the bench with approximately a 2" (50mm) overhang clearance for installation of the drain valve. If the drain valve is not desired, place the cabinet in its desired location and using RTV caulk, seal all around the base of the cabinet and the bench. this provides a tight seal to prevent bench spills from migrating under the cabinet.

If a drain valve is desired, remove the handle from the valve stem to gain clearance for valve body rotation. Add Loctite 242 (furnished) to the threads and rotate valve body until secure, with the valve stem (for handle) on the left side. Re-install handle to valve stem. Adjust the cabinet on bench to provide a 1-1/2" (38mm) overhang and seal the interface of the bench and cabinet, using RTV caulk as above.

7.2.4 Plumbing Services

Ground key cocks with the type of service specified by the removable button on the handle, are located in the work zone. The Ground Key cocks are not recommended for pressure over 30 p.s.i. (2.0 BAR). Reducing valves should installed external to the cabinet if necessary. Ground key cocks should never be used for oxygen service. A special needle valve for oxygen service is required and available upon request.

External connection is to 3/8 inch NPT coupling in the inner side walls. Connection to plant utilities should be made with proper materials for the individual service and according to national and/or local codes. It is not recommended that flammable gases be used in the cabinet. However, if flammable gas is used, emergency shut-off valves should be located in an accessible area external to the cabinet. Observe all labels pertaining to the type of service and operating pressure. **THIS UNIT HAS NOT BEEN EVALUATED FOR USE WITH FLAMMABLE, TOXIC OR EXPLOSIVE SUBSTANCES. USE AT YOUR OWN RISK.**

7.2.5 Electrical Services

The NU-425 series Biological Safety Cabinets may be "hardwired" (optional) or connected via an electrical power cord which is standard. The unit requires 115 VAC at 20 Amps, 60 Hz, single phase. It is recommended that power to the unit be on its own branch circuit, protected with a 20 Amp circuit breaker respectively or fuse at the distribution panel.

PLEASE NOTE, THIS UNIT CONTAINS ELECTRONIC BALLASTS FOR THE FLUORESCENT LIGHTING. ELECTRONIC BALLASTS OPERATE WITH HIGH INRUSH CURRENT. IT IS NOT RECOMMENDED TO USE THIS PRODUCT WITH GROUND FAULT CIRCUIT INTERRUPTERS (GFCI'S) BECAUSE THE BALLASTS MAY CAUSE THE GFCI TO TRIP.

7.2.6 Final Assembly

Remove the protective cardboard cover over the exhaust HEPA filter, located under the protective screen if in place. The exterior surface and viewing glass are easily cleaned with any mild household detergent cleaner using a soft cloth. Harsh chemicals, solvent-type cleaners and abrasive cleaners should not be used.

Do not attempt to clean the HEPA filter media. Cabinet interior walls or work surface are easily cleaned with any mild household detergent cleaner using a soft cloth. Turn the cabinet on and let it operate for 60 minutes before using it as a LFBSC.

7.3 Certification

After installation and prior to use, NuAire recommends that the cabinet be certified or commissioned to factory standards. At a minimum, the following tests should be performed (see Section 4.0).

1. HEPA filter media
2. Filter frame leak test
3. Airflow velocities
4. Airflow smoke patterns

Of these tests, in order to insure that no disruptive air currents are penetrating the air inflow barrier (see Section 7.1) smoke flow tests must be performed at a minimum (only biological testing can confirm containment). These tests must result in the containment of smoke passed around the perimeter of the work access opening, as well as, no refluxing or drift of smoke within the interior of the cabinet.

It is recommended that these tests be performed by a qualified technician who is familiar with the methods and procedures for certifying Biological Safety Cabinets (see Appendix B).

AFTER THE INITIAL CERTIFICATION, NUAIRE RECOMMENDS THAT THE CABINET BE RECERTIFIED AT A MINIMUM ON AN ANNUAL BASIS AND AFTER EVERY FILTER CHANGE OR MAINTENANCE ACTION OR ANY TIME THE OPERATOR FEELS IT IS NECESSARY.

Note that the LABGARD cabinets, filters and seals provide premium performance; Quality Control in both design and manufacturing assure superior reliability. However, protection to both product and operator is so vital that certification to the performance

requirements should be accomplished as stated to ensure biologic al safety established by the factory standards.

Labgard Class II, Type A/B3
Laminar Flow Biological Safety Cabinet
Models NU-425-300, 400, 600

Catalog Number	Catalog Number		
	NU-425-300 **Nominal 3 foot (0.9m)**	**NU-425-400** **Nominal 4 foot (1.2m)**	**NU-425-600** **Nominal 6 foot (1.8m)**
Performance Specifications 1. Personal Protection 2. Product Protection 3. Air Cleanliness/Laminarity	NIH-03-112c NSF Std. No. 49 NSF Std. No. 49 Fed. Std. 209d, Class 10	NIH-03-112c NSF Std. No. 49 NSF Std. No. 49 Fed. Std. 209d, Class 10	NIH-03-112c NSF Std. No. 49 NSF Std. No. 49 Fed. Std. 209d, Class 10
NSF Std. No. 49 Class	Class 11, Type A/B3	Class 11, Type A/B3	Class 11, Type A/B3
Style of Cabinet	Bench top/console w/base stand/storage cabinet	Bench top/console w/base stand/storage cabinet	Bench top/console w/base stand/storage cabinet
Cabinet Construction	All welded stainless steel 16GA, Type 304 pressure tight design	All welded stainless steel 16GA, Type 304 pressure tight design	All welded stainless steel 16GA, Type 304 pressure tight design
Diffuser for Air Supply (Metal)	Non-flammable	Non-flammable	Non-flammable
HEPA Filter Seal Type: Supply Filter-99.99% Eff. on 0.3 microns Exhaust Filter-99.99% Eff. on 0.3 microns	HEPEX Seal Neoprene, Springloaded	HEPEX Seal Neoprene, Springloaded	HEPEX Seal Neoprene, Springloaded
Fumigation per NIH/NSF Procedure	Yes	Yes	Yes
Standard Services: Service Coupling (3/8 inch NPT) Gas Valve/Service Coupling (3/8inch NA) Duplex Outlet	 One, Right Sidewall One, Right Sidewall One, Backwall Center	 One, Right Sidewall One, Right Sidewall Two, Backwall	 One, Right Sidewall One, Right Sidewall Two, Backwall
Optional Services: Gas Cocks 3/8" NPT Ultraviolet Light Standard/Cup Sinks	 Up to 3 ea. Sidewall One, Backwall Left or Right Work Surface	 Up to 3 ea. Sidewall One, Backwall Left or Right Work Surface	 Up to 3 ea. Sidewall One, Backwall Left or Right Work Surface
Cabinet Size Inches (mm): Height (Fully Assembled) Height (Minimum for Transport) Width Depth (with Control Center)	 63 (1600) 60 (1524) 41 5/8 (1057) 32 7/8 (835)	 63 (1600) 60 (1524) 53 5/8 (1362) 32 7/8 (835)	 63 (1600) 60 (1524) 77 5/8 (1972) 32 7/8 (835)
Work Access Opening Inches (mm): Standard Opening Height/Optional Standard Inflow Velocity	 8 (203) 105 FPM (.53 m/s)	 10 (254)/8 (203) 105 FPM (.53 m/s)	 10 (254)/8 (203) 105 FPM (.53 m/s)
Work Zone Inches (mm): Height Width Depth	 28 1/2 (724) 34 3/8 (873) 23 1/2 (597)	 28 1/2 (724) 46 3/8 (1178) 23 1/2 (597)	 28 1/2 (724) 70 3/8 (1788) 23 1/2 (597)
Viewing Window Inches (mm): Standard is tempered sliding glass Hinged Tempered Glass (optional)	Fully closed to 19 1/2 (495) open 8 (203) opening	Fully closed to 19 1/2 (495) open 8 (203) & 10 (254) openings	Fully closed to 19 1/2 (495) open 8 (203) & 10 (254) openings
Required Exhaust CFM/CMH Standard/ Optional: Gas-Tight (NU-916/919) Thimble (NU-918/917) Thimble (NU-916)	 200 (340) 282 (479) 326 (554)	 338 (575)/270 (459) 438 (739)/370 (624) 496 (842)/428 (727)	 513 (872)/410 (697) 647 (1100)/545 (925) 709 (1205)/606 (1030)
Plant Duct Static Pressure Eng/Metric	0.05-0.1"/1.27-2.54mm	0.05-0.1"/1.27-2.54mm	0.05-0.1"/1.27-2.54mm
Heat Rejected,BTU,Per Hour(non-vented) (vented)	1442 865	1937 1162	2435 1460

Electrical:	UL/UL-C Listed	UL/UL-C Listed	UL/UL-C Listed
Volts, AC 60 Hz	115	115	115
Amps: Blower/Lights	7	9	11/*9
Amps: Duplex	3	3	3
Amps: Total	10	12	14/*12
12 ft. Power Cord (one)	14 GA - 3 Wire, 15A	14 GA - 3 Wire, 15A	*12/14 GA-3 Wire, 20/15A
Crated Shipping Weight:	340 lbs./154 kg.	490 lbs./222 kg.	680 lbs./308 kg.
Net Weight	305 lbs./138 kg.	441 lbs./200 kg.	598 lbs./271 kg.

*15A Configuration does not include accessory outlet

8.0 Operating the NU-425

8.1 Operator Controls & Indicators

The following is a description of the controls and indicators found on both the front panel (see Drawing BCD-05322) and cabinet.

8.1.1 Circuit Breaker-Blower (Top of Control Center)

The motor/blower is protected with a circuit breaker. The circuit breaker in conjunction with the motor's thermal protector is designed to open under locked rotor or half-wave power conditions. Should the circuit breaker open (pop-out button will appear) merely depress to reset. If the circuit breaker continually opens, a failure has occurred in the motor or solid-state speed controller. Consult a qualified repair technician or NuAire, Inc. for replacement.

8.1.2 Circuit Breaker-Outlets (Top of Control Center)

The duplex outlet located in the side wall of the work area is protected with a 3 amp circuit breaker. The circuit breaker may trip at 110% of load rating but will trip at 145% of load rating in less than 2 seconds. Should the circuit breaker open, (pop-out button will appear), unplug the appliance plugged into the outlet and merely depress the pop-out button to reset.

8.1.3 Fluorescent/U.V. Light Switch

This switch provides on/off control for the fluorescent light and/or the ultraviolet (U.V.) light if present (optional). With the U.V. light option, the switch provides for on-center off-on operation so that both the fluorescent light and the U.V. light cannot be energized at the same time. Proper care should be exercised when the U.V. light is on (see Section 12.1).

8.1.4 Outlet Switch

This switch provides on/off control for the 115 VAC power available in the outlet(s) within the cabinet workzone.

8.1.5 Blower Switch

The blower switch applies power to the internal motor/blower when in the ON position. The blower switch also has a second set of poles which are available for use as a contact closure for an exhaust system. In addition, power can be applied to the accessory outlet located on the upper left corner of the cabinet, behind the front window assembly.

The purpose of the outlet is to provide "switched" power for the following (see also 8.1.11):

(1) Exhaust transition with integral blower

The rating of the outlet is 115 VAC at 2 amp maximum.

8.1.6 Indicator Light

A green neon indicator light is located above the Blower on/off switch and indicates when power is applied to the blower.

8.1.7 Audible Alarm Enable

As the sliding window is raised above its normal working height, a micro switch located in the glide channel activates both an audible and visual alarm. This

switch disables the audible alarm but will not disable the red indicator visual alarm.

(BCD-05322)
(REV A)

8.1.8 Airflow Control

The operating airflows within the cabinet (i.e. 70 LFPM (.35 m/s) downflow and 105 LFPM (.53 m/s) air inflow barrier) are controlled by a potentiometer and an exhaust damper (see Section 9.4). The potentiometer controls the operating voltage applied to the motor/blower. The potentiometer is adjustable over 270 degrees with a slotted screwdriver, which varies the applied voltage from 70 to 115 VAC. **THIS ADJUSTMENT SHOULD ONLY BE MADE BY A QUALIFIED TECHNICIAN EMPLOYING THE PROPER INSTRUMENTS IN ORDER TO INSURE AIRFLOWS PER NSF STD. NO. 49.**

8.1.9 Minihelic Gauge

The unit is equipped with a minihelic gauge. The minihelic gauge displays the static pressure within the pressure plenum supplying the downflow and exhaust filters. The gauge is calibrated in "inches of water gauge" pressure. As the HEPA filters load with particulate matter, the amount of static pressure will increase, giving and indication of the "health" of the cabinet. The initial pressure reading will be approximately 0.40" w.g. ±0.05" w.g. depending on altitude from sea-level. At each 0.1" w.g. increment, the cabinet airflow should be checked by a qualified technician, unless certified on a yearly (or sooner) basis.

8.1.10 Sliding Window Operation (see also 8.1.7)

The cabinet has a full counter balanced and removable sliding tempered glass window with two operational features. As the window is raised above its specified operating height, an audible alarm alerts the operator of possible compromised personnel protection. At the same time, an audible and visual alarm is activated. The audible alarm may be switched off while the visual alarm remains until lowered to the safe operating position. When the window is lowered below 2 inches (50mm), the motor/blower automatically shuts down, to prevent stress on the motor/blower in the form of overheating. The maximum window height is 19 1/2 inches (495mm).

8.1.11 Convenience/Accessory Outlet

A convenience/accessory outlet is located in the upper left hand corner in back of the window assembly. The outlet is normally wired "hot" through the motor/blower circuit breaker. If an accessory is purchased (i.e. exhaust transition w/integral fan) the outlet is defined as an accessory outlet supplying 115 VAC at 2.0 amp maximum, and is wired to the blower switch (see 8.1.5 for details).

8.2 Operating Guidelines

The intent herein is to present general operational guidelines that will aid in the use of the Laminar Flow Biological Safety Cabinet (LFBSC) to control airborne contaminants of low to moderate risk as stated in Technical Report No. FPS 56500000001 prepared by Dow Chemical U.S.A. for the National Cancer Institute, May 1, 1972.

8.2.1 Procedure protocols defined in terms of the barrier or control concepts unique to LFBSC must be developed in order to obtain a maximum potential for safety and protection. The pre-planning necessary to develop these protocols is based on

several fundamental considerations, each of which will contribute to optimum benefits from the equipment:

a. Minimize disruption of "air curtain"
b. Minimize room activity
c. Utilize unidirectional air flow
d. Employ aseptic techniques

8.2.2 Minimize Penetration of "Air Curtain"

The minimum number of items necessary should be placed into the cabinet to prevent overloading, but the work should also be planned to minimize the number of times an operator's hands and arms must enter and leave the air curtain at the open face. The ideal situation is to have everything needed for the complete procedure placed in the hood before starting, so that nothing need pass in or out through the air barrier at the face until the procedure is completed. This is especially important in working with moderate risk agents.

Unnecessary raising of the hands inside the cabinet above the level of the work opening should be avoided. This presents an inclined plane from hands to elbows along which the downflow of air may run to, and possibly out, the open face.

Note: When working with agents of lower risk, it is not as important for all materials to be placed in the cabinet before starting, or for the procedure to be completely finished before materials are removed. Also, the time period for a unit may be continued over a more extended period during which entries and withdrawals from the cabinet may be made.

8.2.3 Minimize Room Activity

Activity in the room itself should be held to a minimum. Unnecessary activity may create disruptive air currents as well as interfere with the work of the operator. A person walking past the front of a cabinet can cause draft velocities up to 175 fpm (.89 m/s), which are sufficient to disrupt the air balance of the laminar flow unit.

8.2.4 Utilize Unidirectional Air Flow

The operator must keep two important facts in mind: (1) The air, as supplied to the work area through filters from the top, is contaminant free and (2) Airborne contamination generated in the work area is controlled by the unidirectional flow of parallel air streams in a top-to-bottom direction.

A solid object placed in a laminar air stream will disrupt the parallel flow and consequently, the capability of controlling lateral movement of airborne particulates. A cone of turbulence extends below the object and laminarity of the air stream is not regained until a point is reached downstream, approximately equal to three to six times the diameter of the object. Within the parameters of this cone, particles may be carried laterally by multidirectional eddy currents.

Transfer of viable materials and manipulations which may generate aerosols should not be performed above sterile or uninoculated materials. Items should be localized on the work surface in "clean" and "dirty" groups.

8.2.5 Employ Aseptic Technique

The operator must not assume an attitude of "let the cabinet do it" when performing procedures within a LFBSC. Properly balanced and properly used cabinets will do an excellent job of controlling airborne contamination and containing viable agents, but the cabinet will not eliminate contact transmission of contamination. Normal laboratory contamination control procedures and basic aseptic techniques are necessary to obtain maximum benefit from the cabinet. For example, open bottle, tube or flask mounts should be kept as parallel as possible to the downflow to minimize capture of chance particulates. This precaution is merely an extension of good aseptic technique as practiced on open bench tops. The good laboratory practices designed to minimize creation and/or release of aerosols to the environment should not be discontinued.

Items of equipment in direct contact with the etiologic agent must remain in the cabinet until enclosed or until surface-decontaminated. Trays of discard pipettes must be covered before removal from the cabinet (aluminum foil may substitute for fabricated covers).

If an accident occurs which spills or splatters suspensions of etiologic agent around the work area, all surfaces and items in the cabinet must be surface-decontaminated before being removed.

Applying a burner flame to flask and tube necks when mating surfaces of sterile assemblies is a conventional method of minimizing chance contamination. However, the efficiency of this operation is usually related to the removal of airborne contamination occurring while the item is uncovered. If the manipulation is carried out in an environment free of airborne particulates, then the need for the flaming operation is essentially removed. This is one of the additional advantages of the LFBSC - use of the gas burner is seldom necessary.

The gas burner flame in one of these units not only contributes significantly to the heat build-up, it also disrupts the laminar air streams which must be maintained for maximum efficiency. If the procedure demands use of a flame, a burner with a pilot light should be used so that the flame can be ignited only when actually required and immediately turned off again after use. **DO NOT USE CONSTANT FLAME GAS BURNERS**. It should also be placed to the rear of the work space where resulting air turbulence will have a minimal effect. If cabinet air is inadvertently turned off, the flame could damage the HEPA filters.

In brief, the considerations which should be made in order to obtain optimal personnel safety and product protection may be reiterated:

a. Pre-plan and procedures carefully
b. Minimize disruption of the "air curtain"
c. Minimize room activity
d. Utilize unidirectional air flow
e. Employ aseptic techniques

8.3 Operating Sequence

8.3.1 Start Up

Turn on cabinet blower and lights, check air intake and exhaust portals of the cabinet to make sure they are unobstructed. The electronic airflow control system will automatically control airflows to specified setpoints. However, upon filter loading, the cabinet may be required to be rebalanced or filters replaced. Only a qualified maintenance technician should perform cabinet balancing and filter replacement.

Note: Some cabinets are equipped with ultraviolet (UV) lights. Good procedure includes the decontamination or wipedown of cabinet surfaces with chemical disinfectant before work commences. This practice eliminates the need for UV lights, whose primary utility in this application is inactivation of surface contamination since the filters effectively remove all airborne contaminants. UV lights, therefore, are not recommended in the LFBSC.

Allow blowers to operate for a minimum of 15 minutes before aseptic manipulations are begun in the cabinet. If the filtered air exhausted from the unit is discharged into the room, as in some installations, an additional advantage is obtained from purification (filtration) of the room air circulated through the equipment. Because of this characteristic contributing to the quality of the laboratory environment, some owners of LFBSC leave them in operation beyond the time of actual use.

8.3.2 Wipedown

The interior surfaces of the work space should next be disinfected by wiping them thoroughly with 70% alcohol or similar non-corrosive anti microbial agents. **USE OF CHLORINATED OR HALOGEN MATERIALS IN THE CABINET MAY DAMAGE STAINLESS STEEL.**

8.3.3 Materials & Equipment

The apparatus and materials should next be placed into the cabinet. Care must be exercised that no items be placed over the front intake grills. Materials should be arranged so that clean, dirty (used), and virus materials are well separated. Passage of contaminated materials over uninoculated cultures or clean glassware should be avoided and transfer of viable materials should be performed as deeply into the cabinet (away from open face) as possible.

8.3.4 Air Purge

Additional purging of the work space without user activity should be allowed for 2-3 minutes after materials and apparatus have been placed in it. This will rid the area of all "loose" contamination that may have been introduced with the items.

8.3.5 Perform Work

The work can now be performed. The technician performing the work is encouraged to wear a long-sleeved gown with knit cuffs and rubber gloves. This will minimize the shedding of skin flora into the work area and concurrently protect the hands and arms from viable agent contamination. At a minimum, the hands and arms should be washed well with germicidal soap before and after work in the cabinet. For the preparation of antineoplastic drugs, the following procedures summarize those contained in OSHA Instruction PUB 8-1.1, "Work Practice Guidelines for Personnel Dealing with Cytotoxic (Antineoplastic) Drugs." The above document should be thoroughly studied/reviewed prior to drug preparation in the cabinet.

a. A sterile plastic-backed absorbent drape should be placed on the work surface during mixing procedures. The drape should be exchanged whenever significant spillage occurs, or at the end of each production sequence.

b. Vials should be vented with a filter needle to eliminate internal pressure or vacuum.

c. Before opening ampoules, care should be taken to insure that no liquid remains in the tip of the ampoule. A sterile gauze sponge should be wrapped around the neck of the ampoule while opening.

d. Final drug measurement should be performed prior to removing the needle from the stopper of the vial.

e. A non-splash collection vessel should be available in the biological safety cabinet to discard excess drug solutions.

8.3.6 Terminal Purging & Wipedown

Following completion of work, allow the cabinet to run for 2-3 minute period without personnel activity to purge the unit. the decontamination of the interior surfaces should be repeated after removal of all materials, cultures, apparatus, etc. A careful check of grills and diffuser grids should be made for spilled or splashed nutrients which may support fungus growth and resulting spore liberation that contaminates the protected work environment.

8.3.7 Paper Catch/Prefilter

A permanent paper catch is installed behind the rear divider panel of the work zone. This area forms the return air path to the motor/blower; and if the air flow is blocked, it could seriously affect the performance of the cabinet. Therefore, **THE PAPER CATCH SHOULD BE CHECKED AND CLEANED NO LESS THAN A WEEKLY BASIS;** daily basis if procedures dictate the use of paper products. Any paper removed must be properly disposed of as *Contaminated Hazardous Waste*. The above procedures also applies to all units configured with a prefilter.

8.3.8 Shut Down

Turn off blowers and lights. Do not use cabinet as a depository for excess lab equipment during periods of non-operation. If antineoplastic agents are being prepared in the cabinet, it is recommended to let the cabinet run 24 hours per day. This lessens the possibility that contaminants may escape.

8.4 Antineoplastic Decontamination Procedures

This procedure should be executed following a spillage and/or periodic maintenance, testing or relocation of the cabinet. In addition, if the cabinet is being relocated or turned off for an extended period, the work access opening and exhaust HEPA filter opening should be sealed with plastic.

8.4.1 Preparation

Prior to beginning decontamination activity, personnel should put on a Tyvek[1] isolation gown, 2 pair of vinyl gloves and a full faced HEPA filtered respirator. All protective garments should be contained in 4 mil plastic bags and labeled for disposal as chemotherapy waste after completion of the procedure (see also Section 9.0 of the Operation and Maintenance Manual). For the purpose of this procedure, the term **CLEANING** is defined as the operation of wiping down with a cloth wetted with a clean hot (above 60°C) detergent solution, followed by wiping down repeatedly with sterile water to rinse. All cloths shall be contained in 4 mil plastic bags and labeled for disposal as chemotherapy waste.

8.4.2 Procedure

a. Make sure that the cabinet remains in operational mode with internal blower on.

b. Open the hinged or sliding view screen and secure in the full open position.

CAUTION: With the view screen in the full open position, personnel protection is compromised and a full faced HEPA filtered respirator must be worn.

c. Clean all readily accessible surfaces of the cabinet.

d. Remove perforated metal diffuser screen from the underside of the supply HEPA filter and place on the cabinet work tray.

Note: Depending on the model, the diffuser screen is secured to the cabinet by #8-32 screws or 1/4" - 20 acorn nuts, 3 places. It is purposely a tight fit and is secured to the back wall with projecting threadless studs.

e. Clean both sides of the perforated metal diffuser screen and remove it from the cabinet.

f. Lift the cabinet work tray, clean both sides and remove it from the cabinet.

g. Remove the front perforated grill, place on the cabinet floor and clean both sides. Remove from cabinet.

[1] Available from Lab Safety Supply, Janesville, WI 53547-1368, or other laboratory, industrial, or hospital supply distributors.

h. Clean work tray supports.

i. Working from top to bottom, clean all inside surfaces of the cabinet. Take care **not** to wet the HEPA filter. If liquid has collected in the plenum drain, aspirate it using an IV tubing into an evacuated container. Label the evacuated container for disposal as chemotherapy waste.

j. Clean the plenum drain area and wipe dry.

k. If the cabinet requires maintenance and/or replacement of the HEPA filters, the operation should be halted at this point to allow trained personnel to complete replacement of the HEPA and/or maintenance action required.

8.4.3 Assembly

a. Replace front (if removed) grill.

b. Replace the work tray and carefully tighten the thumb screws.

c. Replace perforated metal diffuser screen over the underside of the supply HEPA filter.

d. Wipe down all exposed surfaces of the work area with 70% isopropyl alcohol.

e. Prepare for aseptic operation.

9.0 General Maintenance

CAUTION: All maintenance actions on this equipment must be performed by a qualified technician who is familiar with the proper maintenance procedures required for this equipment. This includes both certification as well as repair.

No maintenance should be performed on the interior of the LABGARD cabinet (*area behind access panels)* unless the cabinet has been sterilized, is known to be biologically clean, or known to be chemically inert. For Biological contamination, the LABGARD can be decontaminated following NIH procedures: Obtain ***Formaldehyde Decontamination*** from the National Audiovisual Center (GSA), Washington, D.C. 20409 in the form of a tape cassette and slides for approximately $10.00.

If the cabinet has been used to prepare antineoplastic drugs, (chemotherapy), or other toxic chemicals, decontamination of the cabinet *cannot* be accomplished by the above procedure. It is recommended that the following protective measures be taken:

1. ***Gloves***
   Gloves must be worn. Care must be taken not to cut, puncture, or tear the gloves. No one glove material is impervious to all CYTAs; disposable surgical or polyvinyl chloride (PVC) gloves provide substantial but not complete protection. PVC gloves probably are more protective than surgical gloves, but they are stiffer and less tactile. Gloves should be discarded after each use. Gloves should be tucked into the cuffs of the gown. Double gloving should be considered.

2. ***Face & Eye Protection***
   A disposable dust and mist respirator and either a plastic face shield (preferred) or chemical splash goggles must be worn. The face shield or goggles should be wiped clean with a suitable tissue and water after each use.

3. ***Gowns***
   A protective garment must be worn. The garment should be made of lint-free, low-permeability fabric and must have a closed front, leg sleeves, and elastic or knit closed cuffs. Tyvek[1] isolation gowns are one example of an acceptable garment. The garment must be worn outside the work area. Disposable gowns are preferred over reusable. Front-buttoned coats are not recommended.

4. ***Hair & Shoe Covers***
   Disposable hair and shoe covers should be worn.

5. ***Motion***
   Slow and deliberate motions are necessary when working in the interior of the cabinet, in order to minimize the generation of particulates.

Please consult with NuAire, Inc. about any unique contamination problems.

Normally, no preventive maintenance is required on the interior of the cabinet (i.e., the area behind the access panel containing the HEPA filters and motor (blower assembly). All required adjustments in order to maintain proper cabinet airflows are external to the cabinet interior. The motor is lubricated for life and is thermally protected with automatic reset.

[1] Available from Lab Safety Supply, Janesville, WI 53547-1368, or other laboratory, industrial, or hospital supply distributor

NuAire does, however, recommend that the LABGARD have the integrity of the HEPA filters verified by a qualified technician per paragraph 4.3 after the unit has been initially installed. Therefore, certification per Section 4.0 should be performed on an annual basis for whenever the operator has reason to believe it necessary, especially if the cabinet has been moved to a new location, or the minihelic gauge has increased by 0.1" w.g.

9.1 Lamp Replacement, Fluorescent

The two (T8) fluorescent lamps are cool white, rapid start and placed external to the cabinet to aid maintenance and minimize heat build-up within the cabinet. The life rating of the lamp is 9000 hours based on three hour burning cycles.

To replace a lamp, it is necessary to remove the lamp assembly.

1. First, switch Cabinet Light Switch off.

2. Second, remove the screws at each upper side of the Control Center and allow the Control Center to rotate down, resting on the safety straps.

3. The lamp is now directly exposed for replacement.

4. The lamp bulb is removed by displacing the lamp to one side against the compressible lamp holder and lifting out the lamp.

5. Reverse the procedure to reinstall the lamp assembly being careful not to pinch the safety straps, cable or tubing during closure of the control center.

9.2 HEPA Filter/Motor Replacement (Drawing BCD-05153)

The HEPA Filters under normal usage and barring an accident (a puncture), do not need replacement until the efflux velocity cannot be maintained or the access inflow velocity cannot be maintained at 100 LFPM (.51 m/s)(min.). This may permit the average downflow velocity to be as low as 65 LFPM (.32 m/s) as long as no point falls below 20 percent of the average downflow velocity.

The HEPA Filters should not be replaced until the entire cabinet has been decontaminated or known to be biologically "clean". See Section 9.0 General Maintenance for additional precautions for chemical contamination.

9.2.1 Procedure (see Drawing BCD-05153)

CAUTION: Disconnect electrical power from the unit before attempting any maintenance action.

Step 1: Remove screws at each upper side of the control center and allow the control center to rotate down, resting on the safety straps. Second, remove the front decorative panel which is held into position by (3) knurled nuts on the top edge and (6) knurled screws on the front.

Step 2: Place sliding window into lowest position and remove front filter panel, which is held into position by Phillip pan head screws. Once the screws are removed, the panel is held into position by smooth weldstuds located on the top corner of the front filter panel. Use the window stop brackets as handles to remove the panel.

CAUTION: Screws are used in lieu of acorn nuts, and lockwashers. The screws have O-rings and should be replaced if damaged or badly deformed.

The interior of the cabinet is now fully exposed for replacement of the filters and/or motor/blower.

Step 3: Filter Removal

It is not always necessary to replace both the supply and exhaust filters at the same time. If during the course of certifications, the downflow falls off while the exhaust increases (i.e. greater than 110 LFPM)(.56 m/s), the supply filter is "loading" faster than the exhaust filter, and only the supply filter may need replacement. The opposite might also happen depending upon many factors.

a. To remove the supply filter:

1. First, remove the HEPEX/choke tray band clamp between the supply HEPEX and the exhaust filter choke tray. Separate the plenum from the choke tray.

Note: Double sticky back gasket is used to hold the plenum to the choke tray and should be replaced when reassembling.

2. Remove the 2 supply filter hold-down clips (1 each side) holding the filter down.

3. Remove the HEPEX pressure plenum from the blower assembly. The HEPEX is clamped to the blower assembly via a band clamp.

4. Carefully remove the supply filter and HEPEX. The HEPEX can be folded neatly to seal the contaminated side of the HEPA. Direct exposure should be avoided.

CAUTION: Dispose of spent HEPA filters properly. Avoid direct contact to "dirty side" of the filters. Label toxic waste.

b. To remove the Exhaust HEPA:

1. Relax the exhaust filter seal loading mechanism by turning the four threaded bolts counterclockwise until one can see a definite release of the loading springs.

2. Pull the exhaust choke tray free and remove the filter. It is not necessary to remove the tray, although it is free to move forward several inches, if necessary, to free the HEPA filter.

Step 4: Filter Installation

When installing new filters, use only filters of the same rated flow and size as originally installed. It is recommended that a new HEPEX/Supply filter be installed since the HEPEX is factory installed to the filter. However, field installation kits are available separately from the filter (see Section 13.0).

a. To install the supply filter, simply reverse the procedure outlines in Step 3a, above.

Note: Be sure to open the choke plate fully before inserting the filter into the tray. This will assist in adjusting the airflow.

b. To install the exhaust filter, apply a thin layer of silicone grease to the top and bottom gaskets of the filter and carefully insert into the exhaust choke tray.

Position the filter frame within the outside walls of the exhaust opening on the top of the hood. Tighten the spring loaded bolts, 4 places, depressing the gasket material by 1/8 inch (3mm).

Step 5: Motor/Blower Assembly Removal

a. It is recommended that the motor/blower to be removed as a single unit. To remove, disconnect electrical connections to the motor, remove the HEPEX pressure plenum and unbolt the motor/blower assembly from the roof of the cabinet (4 places). Always inspect the rubber isolation motor mounts and replace those that are cracked or visibly show stress.

b. Replace the motor exactly as originally installed in the blower housing, paying particular attention to the correct electrical connections (see Electrical Schematic).

c. Re-install the new motor/blower assembly.

9.3 Sliding Window Replacement & Adjustment

The sliding window replacement is accomplished by removing the front decorative panel, control center and window glide assemblies (see BCD-05144). The sliding window adjustment may be required due to everyday use over the life of the cabinet. The left window glide is stationary since it contains the microswitches that monitor window height. The right window glide is adjustable by a set screw and tension screw method (see Drawing BCD-05144). When adjusting the sliding window, be sure to verify proper microswitch operation. If the sliding window is too loose, the sliding window will not properly activate the microswitches, thus causing potential operational malfunctions to occur.

9.4 Airflow Calibration

The NU-425 Airflow Calibration Consists of adjustments to balance the airflow within the cabinet. **THIS WORK SHOULD BE DONE ONLY BY A QUALIFIED TECHNICIAN WHO CAN MEASURE THE AIRFLOW FROM THE FILTERS WITH A SUITABLE VELOMETER.** NuAire provides two adjustments to balance the airflow within the cabinet. These are:

a. blower speed adjustment via motor voltage regulator
b. exhaust filter choke

The blower speed control system adjusts the cabinets total volume of airflow while the choke adjusts or balances the exhaust airflow as well as makes up for filter resistance tolerances. Since it has been NuAire's experience that the filters may not "load" evenly, both adjustments are necessary for proper cabinet performance.

The cabinet is considered to be certifiable if the following airflow measurements are present:

a. Downflow average: 70 LFPM ± 5 LFPM (.35 m/s ± .025 m/s).

b. Inflow average: 105 LFPM ± 5 LFPM (.53 m/s ± .025 m/s) using the direct inflow measurement method or related value using the calculated inflow velocity measurement method. Both values are published in the NSF or NuAire listing.

BEFORE STARTING AIRFLOW CALIBRATION PROCEDURE. LET THE CABINET RUN FOR AT LEAST 10 MINUTES.

9.4.1 Downflow Calibration

Step 1:
- Place a velometer in the cabinet workzone on the horizontal plane defined by the bottom edge of the viewing window. Spot check several points on the recommended downflow velocity test grid found in table 9.0.

Step 2:
- If necessary, adjust airflow control potentiometer, located under the removable cap plug on front panel, to the above stated airflow requirements.

Step 3:
- Proceed to inflow calibration

9.4.2 Inflow Calibration

Step 1:

- Measure the inflow velocity using the recommended procedure found in Table 9.0. If necessary, adjust the exhaust filter choke, located under the front decorative panel, to achieve the correct average inflow velocity within the stated range of 105 ± 5 LFPM (.53 ± .025 m/s).

- Less than 100 LFPM (.51 m/s);

  First, open the choke plate or make sure it is open. If this is insufficient, then increase the motor speed control.

- Greater than 110 LFPM (.56 m/s);

  First, adjust the motor speed control to achieve 1/2 the exhaust excess, then close the choke plate to achieve the balance. In this fashion, the downflow should remain nearly constant (i.e. what the reduced speed took away, the choke plate restores).

Note: The choke plate adjustment requires a 3/16 inch (5mm) Allen wrench with a six inch (152mm) length. While monitoring the exhaust flow to check position, turning the set screw clockwise will open the choke while turning the set screw counter clockwise closes the choke.

Step 2:

- Once exhaust adjustment is complete, return the downflow calibration and then check average downflow velocity. If the downflow average remains within the correct range, the calibration is complete. If not, readjust as necessary to obtain the correct calibration range.

9.5 Filter Integrity Check

In order to check filter and filter seal integrity, the HEPA filter media and seals must be directly accessible, by the measuring instrument (See Section 4.3).

The diffuser plate placed below the HEPA to protect the filter during normal usage may be removed as follows: The diffuser is secured to the cabinet shell by #1/4-20 acorn nuts located immediately behind the front viewing window. After removing the fasteners, drop the front of the diffuser plate several inches and pull forward gently. Note, that the diffuser is purposely a tight fit - it is secured to the back wall of the cabinet interior by a light push - fit with projecting studs.

The exhaust filter is typically more difficult to check, since charcoal filters, or exhaust transitions could cover the filter. Access panels are usually provided and should be removed. If an air gap exhaust transition is provided, the air gap must be sealed with duct tape or other suitable means to prevent contaminated air from migrating into the exhaust efflux. All exhaust blowers/fans should be turned off during the check.

Table 9.0

Recommended Measurement Methods for Cabinet Downflow & Inflow.

A. Downflow Measurement

a. Instruments: Alnor 8500 or TSI 8355 Thermoanemometer

b. Procedure: Supply filter efflux is measured on a grid, in a horizontal plane defined by the bottom edge of the window. No readings should be taken closer than 6 inches (152mm) from the inside perimeter.

c. Test Data - Inches (mm):

300	6 (152)	11.594 (295)	17.188 (437)	22.782 (597)	28.375 (721)						
400	6 (152)	11.729 (298)	17.458 (443)	23.187 (589)	28.916 (735)	34.645 (880)	40.375 (1026)				
600	6 (152)	11.838 (301)	17.676 (449)	23.514 (597)	29.352 (746)	35.190 (894)	41.028 (1042)	46.866 (1190)	52.704 (1339)	58.542 (1487)	64.375 (1635)
6 (152)											
11.750 (298)											
17.5 (445)											

Number of Readings:	Average Velocity ft./min.(m/s)

d. Acceptance Criteria:

1. Average downflow velocity = **65 to 75 fpm (.33 to .38 m/s)**
2. Individual readings must be within ±20 percent of the average downflow velocity.

B. Inflow Measurement

a. Instrument: Shortridge Flowhood ADM-870 or Alnor 8500 or TSI 8355 Thermoanemometer.

b. Procedure:

The inflow velocity is measured by using a Direct Inflow Measurement (DIM) Instrument (i.e. shortridge flowhood). The DIM Instrument can be used directly on the cabinet with NO CORRECTION FACTORS REQUIRED since NSF has tested the cabinet using the same technique. The DIM Instrument should be equipped with a flowhood that is as close as possible to the width of the cabinet (i.e. NU-425-400 should use 1 x 4 foot flowhood). The DIM Instrument should also be duct taped to the cabinet to prevent any sneak air paths from occurring.

The DIM Instrument will read inflow volume (i.e. CFM). Use the window access opening area to calculate inflow velocity.

The calculated inflow velocity measurement method may also be used, but the setpoint values must be obtained in the NSF Standard 49 cabinet listing. Exhaust filter air velocity is measured on a four by four (102mm by 102mm) grid scale four inches (102mm) above the filter, starting from the inner edge of the filter frame. Use the area table to calculate the inflow velocity based upon the exhaust air volume.

c. Test Data - Inches (mm):

1. Dim Measurement

Inflow Volume ft.^{3}/min.(m^3/s)	Access Opening ft.^{2}(m^2)	Inflow Velocity

		ft./min(m/s)

2. Calculated Inflow Velocity Measurement - Inches (mm):

3.25 (83)							Number of Readings
7.25 (784)							Ave. Exhaust Vel. ft./min.(m/s)
11.25 (2.86)							Exhaust Area ft.^{2}(m^2)
15.25 (387)							Calc. Exhaust Volume ft.^{3}/min.(m^3/s)
19.25 (489)							Access Opening ft.^{2}(m^2)
300	3.250 (83)	7.250 (184)					Inflow Velocity ft./min(m/s)
400	4.250 (108)	8.250 (210)	12.250 (311)				
600	4.250 (108)	8.250 (210)	12.250 (311)	16.250 (413)	20.250 (514)	24.250 (616)	

d. Acceptance Criteria:

1. Access Opening inflow velocity = **100 to 110 fpm (.51 to .56 m/s)**

Areas for Calculation

Cab. Size	**Exhaust Filter Area ft^2 (m^2)**	**8 Inch (203mm) Window Access Opening Area ft^2 (m^2)**	**10 Inch (254mm) Window Access Opening Area ft^2 (m^2)**
300	1.56 (.144)	1.91 (.177)	2.39 (.222)
400	2.44 (.226)	2.58 (.239)	3.22 (.299)
600	4.28 (.397)	3.91 (.363)	4.89 (.454)

9.6 Cabinet Leak Tightness Test

The cabinet leak tightness test can be performed by several different methods. However, to perform the test, the window access area and the exhaust HEPA filter area must be sealed to pressurize the cabinet. The window access area may be sealed by a custom plate or plastic and duct tape. The exhaust HEPA filter area may also be sealed by a custom plate or plastic and duct tape. Sealing should be accomplished on the cabinet face and cabinet top to assure a flat sealable surface. For test procedures, see Section 4.2.

10.0 Error Indicators & Troubleshooting

Audible alarms and error indicators occur for a variety of reasons. Whenever an alarm condition is present, the audible alarm and error indicator will be presented and stay on until the error is cleared. When presented with an error indicator, please perform the following:

Step 1: NOTE ALL ERROR INDICATORS. When the cabinet is running, any and all red indicators display an error.

Step 2: VERIFY ERROR INDICATORS. Error indicators can be verified by turning the errored function on/off.

Step 3: MONITOR RE-OCCURRENCE OF ERROR INDICATORS. If re-occurrence of the error indicator is immediate or daily, use guide below to correct the situation.

Error Indicator Troubleshooting Guide

Error Indicator	Indicator	Correction
Window alarm	Sliding window is above it's standard working height or microswitch is not operating properly.	Verify standard working height and window microswitch operation.
Cabinet fluorescent lights won't turn on.		Check blower/light circuit breaker on top of control center. Check fluorescent lamps. Check voltage to light ballasts. Check ballast. Check light switch.
Cabinet blower won't turn on.		Check sliding window for correct operational height. Check blower/light circuit breaker on top of control center. Check voltage to blower. At motor voltage regulator and at bulkhead connector. Check wiring to blower. Check blower capacitor. Check sliding window blower cutoff microswitch. Check blower motor. (Note: blower motor has internal thermal protector. Let blower motor cool off for a minimum of 30 minutes to assure thermal protector is not open.)

Cabinet outlets won't turn on.		Check outlet circuit breaker on top of control center. Check voltage to outlets.
Error Indicator	Indicator	Correction
Cabinet ultraviolet light won't turn on.		Check blower/light circuit breaker on top of control center. Check ultraviolet lamp. Check voltage to ultraviolet ballasts. Check ballast. Check light switch.
Blower/lights circuit breaker continues to trip after reset.		Check for short on output of circuit breaker. Replace circuit breaker. Isolate output of circuit breaker by disconnecting control center connectors, light circuit, motor voltage regulator, etc. to isolate the short.
Minihelic gauge	Minihelic gauge reads "NO" or "LOW FLOW"	Check minihelic gauge operation. Check for pinched tubing in control center. Make sure airflow is not too low.

11.0 Remote Contacts

11.1 Exhaust System Contacts

The exhaust system contacts are single pole normally open contact closure outputs which are activated whenever the blower switch is turned on. The contact points are located on the blower switch. Contact ratings are 250 VAC maximum at 2 Amps.

12.0 Optional Equipment

12.1 Ultraviolet Lamp

12.1.1 Overview

The germicidal ultraviolet is primarily intended for the destruction of bacteria and other microorganisms in the air or on directly exposed surfaces. Approximately 95% of the ultraviolet radiation's from germicidal tubes are in the 253.7 manometer region. This is a region in the ultraviolet spectrum which is near the peak of germicidal effectiveness. The exposure necessary to kill bacteria is the product of time and intensity. High intensities for a short period of time, or low intensities for a longer period are fundamentally equal in lethal dosage on bacteria (disregarding the life cycle of bacteria). The intensity of light falling on a given area is governed by the inverse law; that is the killing intensity decreases as the distance increases from the tube.

The germicidal tube is placed in the cabinet to provide an average intensity of 100 microwatts per centimeter (for a new tube) falling on a horizontal plane defined by the bottom of the work surface. The minimum requirement per paragraph 5.12 of NSF Standard 49 is 40 microwatts per square centimeter (ref. NSF Std. #49, June, 1976).

Since ultraviolet rays will not penetrate ordinary glass, it is recommended that the sliding window be closed while the ultraviolet light is on within the cabinet; or that personnel leave the cabinet face area.

12.1.2 Operation

The operation of the ultraviolet lamp is accomplished by closing the sliding window and pressing the UV switch located on the front panel.

12.1.3 Precaution

The rays from germicidal tubes may cause a painful but temporary irritation of the eyes and reddening of the skin, if of sufficiently high intensity, or if exposure covers a prolonged period of time. For this reason, one should avoid direct eye and skin exposure to ultraviolet light. If exposure cannot be avoided, it is necessary for personnel to wear eye goggles or face shields, and long sleeve gowns with rubber gloves.

Since ultraviolet rays will not penetrate ordinary glass, it is recommended that the sliding window be closed while the ultraviolet light is on within the cabinet; or that personnel leave the cabinet face area.

12.1.4 Maintenance

The output of an ultraviolet lamp deteriorates with burning age. The useful life of the lamp is approximately 3750 hours under specific test conditions. If the tube is turned on every day for 12 hours, the tube will last approximately one year.

It is recommended that either a time schedule be established or the tube's output be measured periodically and the tube replaced when its output falls below 40 microwatts per square centimeter or exceeds 3750 hours of operation. Lamps should be allowed to operate approximately 5 to 10 minutes (longer when the lamp is in low temperatures) to warm up sufficiently and wiped clean of dust or dirt before reading the output with a meter. Even minute amounts of dust will absorb ultraviolet energy. The lamp may be cleaned with a lint-free cloth dampened with alcohol or ammonia and water.

13.0 Electrical/Environmental Requirements

13.1 Electrical

NU-425-300	115V, 60Hz, 1 Phase, 10 Amps
NU-425-400	115V, 60Hz, 1 Phase, 12 Amps
NU-425-600	115V, 60Hz, 1 Phase, 14 Amps

13.2 Operational Performance

Environment Temperature Range:	60°F-85°F (15°C - 30°C)
Environment Humidity:	20% - 60% Relative Humidity

13.3 Light Exposure

Standard Fluorescent Lighting @ 150 ft. candles (1614 LUX) maximum intensity.

13.4 Installation Category: 2.0

Installation category (overvoltage category) defines the level of transient overvoltage which the instrument is designed to withstand safely. It depends on the nature of the electricity supply and its overvoltage protection means. For example, in CAT II, which is the category used for instruments in installations supplied from a supply comparable to public mains such as hospital and research laboratories and most industrial laboratories, the expected transient overvoltage is 2500 V for a 230 V supply and 1500 V for a 120 V supply.

13.5 Pollution Degree: 2.0

Pollution degree describes the amount of conductive pollution present in the operating environment. Pollution degree 2 assumes that normally only non-conductive pollution such as dust occurs with the exception of occasional conductivity caused by condensation.

13.6 Chemical Exposure

Chemical exposure should be limited to antibacterial materials used for cleaning and disinfecting. Chlorinated and Halogen materials are not recommended for use on stainless steel surfaces. Chamber decontamination can be accomplished by paraformaldehyde, vapor phased Hydrogen Peroxide or Ethylene Oxide without degradation of cabinet materials.

13.7 EMC Performance (classified for light industrial)

Conducted Emissions:	CISPR 11, Class B & EN55011
Radiated Emission:	CISPR 11, Class B & EN55011
Radiated Immunity:	EN50082-1, IEC 801-3, Level 2
ESD Immunity:	EN50082-1, IEC 801-2, Level 2
EFT/BURST Immunity:	EN5082-1, IEC 801-4, Level 2

(Note: The EMC performance requirements are generated within the product enclosure. The enclosure will be all metal grounded to earth. In addition, the membrane front panel will also include a ground plane for maximum protection and an electrostatic shield.

Energies Required to Destroy Some Microorganisms By Ultraviolet Radiations(e)

Mold Spores	Microwatt seconds per cm/2	Protozoa	Microwatt seconds per cm/2
Penicillum roqueforti	26,400	Paramecium	200,000(a)
Penicillium expansum	22,000		
Penicillium digitiatum	88,000	**Nematode Eggs**	40,000(b)
Aspergillus glaucus	88,000		
Aspergillus flavus	99,000	**Algae**	22,000(c)
Aspergillus niger	330,000		
Rhizopus nigricans	220,000	**Virus**	
Mucor racemosus A	35,200	Baceriophage (E. Coli)	6,600
Mucor racemosus B	35,200	Tobacco Masaic	440,000
Oospora lactis	11,000	Influenze	3,400(d)
Yeasts			
Saccharomyces	13,200		
ellipsoideus	17,600		
Saccharomyces cerevisiae	13,200		
Brewers' yeast	6,600		
Baker's yeast	8,800		
Common yeast cake	13,200		
Bacteria			
Streptococcus lactis	8,800		
Strep. hermolyticus (alpha type)	5,500		
Staphylococcus aureus	6,600		
Staphylococcus albus	5,720		
Micrococcus sphaeroides	15,400		
Sarcina lutea	26,400		
Pseudomonas fluorescens	7,040		
Escherichia coli	7,040		
Proteus vulgaris	7,480		
Serratia marcescens	6,160		
Bacillus subtilis	11,000		
Bacillus subtilis spores	22,000		
Spirillum rubrum	6,160		

References:

(a) Luckiesh, Matthew (1946) Application of Germicidal, Ethyemal and Infrared Energy, D. Van Nostrand o., New York, New York, pp 253

(b) Hollaender (1942) Aerobiology, A.A.A.S. (for 90% inactivation), pp 162

(c) Ellis, C. and Wells, O.O. (1941) The Chemical Action of Ultraviolet Rays, Reinhold Publishing Corp., pp. 713-714

(d) Hollaender, A., Oliphant, J.W. (1944) The inactivation effect of monochromatic ultraviolet. Radiation on Influenze Virus (for 90% inactivation) Jour. of Bact. 48, pp. 447-454

(e) This table, "Energies Required to Destroy Some Microorganisms by Ultraviolet Radiations" comes from Westinghouse brochure entitled - "Westinghouse Sterilamp Germicidal Ultraviolet Tubes"

APPENDIX A

Slide-Tape Cassettes

1. Assessment of Risk in the Cancer Virus Laboratory
   Catalog No. NAC 009770

2. Effective Use of a Laminar Flow Biological Safety Cabinet
   Catalog No. NAC 005133

3. Formaldehyde Decontamination of Laminar Flow Biological Safety Cabinets
   Catalog No. NAC 005137

4. Certification of Class II (Laminar Flow) Biological Safety Cabinets
   Catalog No. NAC 009771

5. Hazard Control in the Animal Laboratory
   Catalog No. NAC 009432

6. Selecting a Biological Safety Cabinet
   Catalog No. NAC 000709

These slide-type cassettes are available for purchase from the National Audiovisual Center. Write to:

Sales Branch
National Audiovisual Center (GSA)
Washington, D.C. 20409
Phone: 1-800-788-6282

Films

1. Air Sampling for Microbiological Particulates (M-926).
2. Handling for Laboratory Guinea Pig (T2618-X).
3. Handling the Laboratory Mouse (T2617-X).
4. Infectious Hazards of Bacteriological Techniques (M-382).
5. Laboratory Design for Microbiological Safety (M-1091).
6. Plastic Isolators: New Tools for Medical Research (M-599).
7. Safe Handling of Laboratory Animals (M-455).
8. Surface Sampling for Microorganisms (Rodac Method)(M-924).
9. Surface Sampling for Microorganisms (Swab Method)(M-925).

These films are available (for loan without charge) from:

Media Researches Branch
National Medical Audiovisual Center (Annex)
Station K
Atlanta, Georgia 30324

The same films (except 2 and 3) can be rented or bought from:

National Audiovisual Center (GSA)

(Rental Branch) or (Sales Branch)
Washington, D.C. 20409

Books, Pamphlets & Magazines

NIH-03-112c, Specification for a Class **I**, Type A: National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

NSF Standard No. 49: National Sanitation Foundation; NSF Building; Ann Arbor, Michigan 48105

General Purpose Biological Safety Cabinet Class **I**, Type B; National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

National Cancer Institute Safety Standards for Research Involving Chemical Carcinogens DHEW Publication No. (NIH) 77-900: National Institutes of Heath; Public Service; Bethesda, Maryland 20014

Guide for the Care and Use of Laboratory Animals DHEW Publication No. (NIH) 74-23: National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

NIH Biohazard Safety Guide: G.P.O. Stock 1740-00383/Superintendent of Documents; U.S. Government Printing Office; Washington, D.C. 20402

Biohazard Control and Containment in Oncogenic Virus Research: DHEW Publication No. (NIH) 73-459: National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

Assessment of Risk of Human Infection in the Microbiological Lab: 2nd Ed., A.G. Wedum and R.H. Kruse, Mis Pub-30; Department of the Army; Fort Detrick; Frederick, Maryland 21701

Design Criteria for Viral Oncology Research Facilities: DHEW Publication No. (NIH) 78-891 National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

Classification for Etiologic Agents on the Basis for Hazard: Department of Health, Education and Welfare; Public Health Service; Center for Disease Control; Atlanta, Georgia 30333

Safety and Operation Manual High Containment Research Facility: National Cancer Institute; Public Health Service; Bethesda, Maryland 20014

Contaminant Dispersion and Dilution in a Ventilated Space: National Cancer Institute; National Institutes of Health; Bethesda, Maryland 20014

Handling of Infectious Agents: National Cancer Institute; National Institutes of Health; Bethesda, Maryland 20014

Federal Register; Recombinant DNA Research; Vol. 41, No. 131: National Institutes of Health; Public Health Service; Bethesda, Maryland 20014

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