Water-Jacketed,
US Autoflow Automatic CO_2 Incubator

Models
NU-4750, NU-4850, NU-4950
(D/E/G)

Operation & Maintenance Manual

June, 2008
Revision 12

Series 4 or Higher 4750D/G
Series 5 or Higher 4750/E, 4850D, 4950G
Series 6 or Higher 4850/E/G, 4950/D/E

For 115 Vac, 60 Hz Only

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Water-Jacketed, US Autoflow
Automatic CO_2 Incubator
Operation & Maintenance Manual
Models NU-4750/D/E/G, NU-4850/D/E/G, NU-4950/D/E/G

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US Autoflow Automatic CO_2, Water-Jacketed Incubator

Models NU-4750/D/E/G, NU-4850/D/E/G, NU-4950/D/E/G

Operation & Maintenance Manual

1.0 General Description

The NuAire US Autoflow Automatic CO_2 water-jacketed Incubator has been designed to provide a reliable controlled in vitro environment for optimum tissue cell culture growth. The chamber also provides an environment for the storage and preservation of embryos, gametes and animal tissue cell cultures at on near body temperature. Six parameters contribute to optimum growth conditions. These are:

1. Humidity
2. Precise temperature control
3. Precise CO_2 control
4. Sterility
5. Precise O_2 control
6. Reliability

Like all NuAire equipment, the US Autoflow has been designed to provide the highest quality standards of performance with matching computer technology, precise temperature control and CO_2 gas control system combining state-of-the-art technology with years of design, quality and manufacturing experience.

In order to accomplish the foregoing objectives, the US Autoflow features the following:

1.1 Extra Large (20 gallon) Water-Jacket - Each Chamber

The outer stainless steel wall is lined with a space-age insulation providing a R5.0 rating, minimizing heat loss. The large 20 gallon (75.7 liters) water-jacket utilizes water, one of natures best "sinks" of heat. Its high capacity to hold heat makes it the ideal medium to surround a chamber in order to obtain temperature uniformity. In fact, the ability of materials to hold heat, called the specific heat, uses water as the comparative standard. The large water-jacket surrounding the chamber permits the water to circulate within the jacket, producing a temperature uniformity of ±0.2°C. The larger the mass, the less susceptible the environment within the chamber is to environment fluctuations outside. It also adds cabinet stability for the growth of vibration sensitive cells.

1.2 NuAire Incubator Control Electronics

The NuAire Incubator Control Electronics (NICE) is a state-of-the-art microcomputer based control system specifically designed to service the precise control requirements of the chambers environment, providing optimum programmable conditions for culture growth. The microcomputer is "user friendly" with status indicators, LED display of control parameters, Hidden key and three touch control key pads to permit efficient operator entry of data.

The microcomputer is supported with Read Only Memory (ROM) containing executable software, Random Access Memory (RAM) for temporary storage and Electronically Erasable Programmable Read Only Memory (EEPROM) for control set points and parameters. The EEPROM provides for indefinite storage of these values during periods of power off or power interruption (power fault tolerant).

The microcomputer includes a complete internal diagnostic software package that permits fault isolation detection down to the failed component.

1.3 CO_2 Display and Control

The NuAire US Autoflow employs a solid-state single gas analyzer for carbon dioxide. This innovative analyzer utilizes a filter correlation technique for non-dispersive infrared analysis of CO_2. The analyzer consists of an optical bench incorporating an infrared source, sample cell, and infrared detector. The amount of power radiating on the detector is an approximate logarithmic function of the CO_2 concentration in the gas between source and detector. Detector linearization is performed with 32-bit digital accuracy. The measurement of CO_2 is independent of humidity and temperature variations within the chamber.

1.4 All Stainless Steel Construction

The US Autoflow's exterior is constructed of 16 gauge, type 304L stainless steel with the interior being 16 gauge, type 304L polished stainless steel using coved corner construction, which provides an easily cleanable (for decontamination) inert surface that does not promote biological growth. All exposed edges are deburred to insure no sharp edges. The exterior is finished in a textured polyurethane finish, which is resistant to chemicals and easily cleaned using mild household detergents. In addition all shelves, shelf supports and guide rails are easily removable and can be autoclaved to remove contamination.

1.5 Relative Humidity Display and Control (NU-4850, NU-4950)

Conventionally, humidification of the chamber is achieved through the process of water evaporation from a water reservoir pan placed in the chamber. The NU-4850 & NU-4950 models humidify the chamber by injecting a heated water vapor from a reservoir located outside of the chamber. This gives the operator control over the amount of humidity in the chamber from below ambient to 95%. After a door opening, the recovery time to 95% $\pm$3% is 10 minutes on average with all settings at default values. The control system has a $\pm$3% accuracy from any given setpoint.

The control system uses a solid-state capacitance humidity sensor to monitor the relative humidity within the chamber. If humidity is required, the control system will activate solenoid valve. The pump will then draw chamber air to itself, through a humidified heated enclosure and returned to the chamber. The control will continue until the setpoint is achieved. The relative humidity display and control option offers an accurate and reliable method to control humidity when required.

1.6 O_2 Display and Control (NU-4950)

The US AutoFlow has an available optional Oxygen display and control system. The system controls from 21% (ambient level) down to 2%. The recovery time from ambient to 5% ± 2% is typically less than 10 minutes. The accuracy is ±1% from any given set point.

Oxygen sensor is a fuel cell type, which generates a linear mVDC signal based on O_2 content in the chamber. The sensor is unaffected by CO, H_2 and various acidic gases such as CO_2, H_2S, NOx, SOx, etc.

A sensor automatic monitoring is provided to monitor the O_2 sensor as fuel cell depletes. The automatic monitoring occurs every 24 hours and lasts 2 minutes. During automatic monitoring events, all the displays are locked on existing reading. Control keys are also locked. At this time, air inject valve is energized to draw fresh air through the O_2 sensor. A new O_2 span value is stored in memory for use as the 21.0% of O_2 reference point. During automatic monitoring, the new span value in mV is also compared with original voltage outputs. If the current output is less than 70% of original output, an “RPL” replace message is indicated on the O_2 display.

2.0 Performance Parameters

2.1 Each chamber's water-jacket holds 20 gallons (75.7 liters) of water that, in conjunction with the microcomputer control system, provides an interior chamber temperature uniformity of ±0.2°C at 37.0°C.

2.2 The US Autoflow's microcomputer temperature control system has two temperature sensors: one in the water jacket and one in the chamber. The chamber temperature sensor compares the values to a setpoint and executes a time proportional control algorithm that energizes a solid-state switch, supplying power to the heater.

2.3 The CO_2 percentage is controlled by a solid-state infrared gas analyzer which provides accurate monitoring of CO_2, regardless of changes in temperature or humidity within the chamber.

2.4 Calibration of the infrared CO_2 gas analyzer is accomplished simply through a front panel diagnostic procedure to assure accuracy and minimize downtime.

2.5 Automatic recovery of CO_2 to 5.0 $\pm$0.2% CO_2 within 3-1/2 minutes after a door opening at default control, inject and delay settings.

2.6 The outer door includes a radiant heater in order to minimize condensation on the inner glass door. A magnetic outer door gasket helps to insure a tight seal against the cabinet.

2.7 The inner glass door is 3/16 inch (5mm) tempered with smooth-ground edges and seals are tight against a removable U-grooved silicone rubber gasket. The door latch is cam action. A solid-state magnetic switch monitors door motion.

2.8 All electronic controls are modular and easily removed through the front or side service control center.

2.9 All control electronics are protected with a circuit breaker that will trip at 145% of load rating in less than 2 seconds. Should the circuit breaker open (pop-out button will appear), merely depress to reset.

2.10 A water fill access port is provided on the front of the US Autoflow. Removal of a ¼ inch NPT plated brass fill plug allows filling using a ¼ inch NPT hose adapter (provided).

2.11 The US Autoflow has factory installed adjustable leveling legs to compensate for uneven laboratory surfaces.

2.12 The entire interior shelving assembly is easily removable for decontamination. Shelves and brackets are constructed from 18 gauge, type 304 polished stainless steel.

2.13 A thru-wall access port is provided for operating electrical appliances such as roller apparatus, rockers, etc.

2.14 A CO_2 sample port is provided on the front panel to check the concentration of CO_2 in the chamber.

2.15 A water level sensor is provided to monitor the level of water within the jacket.

2.16 A water-jacket valve is provided on the bottom of the unit for ease of draining.

3.0 Models, Features & Specifications

NuAire offers various Water-Jacketed US Autoflow Automatic models:

- NU-4750/D/E/G*: TEMP/CO_2 Display and Control
- NU-4850/D/E/G*: TEMP/CO_2/RH Display and Control
- NU-4950/D/E/G*: TEMP/CO_2/RH/O_2 Display and Control
  *D: 100VAC/50-60Hz
  *E: 230VAC/50-60Hz
  *G: 220VAC/50-60HZ

3.1 Weight (lbs/kg - per unit):

	NU-4750/D/E/G	NU-4850/D/E/G	NU-4950/D/E/G
Dry:	222 / 101	232 / 105	232 / 105
Operational (RH system & jacket filled)	392 / 178	412 / 188	412 / 188
Shipping:	291 / 132	301 / 137	301 / 137

3.2 Dimensions (see also Specification Drawing BCD-07342)

Overall Dimensions - inches (mm):	**All Models**
Width:	31.00 (787.40)
Height:	34.00 (863.60)
Depth:	25.50 (647.70)

Shelf Capacity:

Size:	19.25 Inches (489mm) x 19.25 Inches (489mm)
Supplied:	4 Shelves
Max. Capacity:	20 Shelves
Max. Weight Capacity:	30 lbs (Do not slide shelf out with more than 20 lbs on it.)

Water Pan:

Dimensions:	Mean Length	18.00” (457mm)
	Mean Width	18.00” (457mm)
	Depth	1.250” (38mm)
Capacity:	Maximum Capacity	7.75 Liters
	Recommended Fill	6.5 Liters

3.3 NU-4750 Standard Features

- 100% stainless steel chamber construction
- Large capacity water-jacket (20 gallon) (75.7 liters)
- Temperature Control System (Default Set-Point 37.0°)
  - Chamber Temperature Range: 18°C to 55°C (5°C above ambient to 30°C ambient max.)
  - Chamber temperature uniformity: ±0.2°C at 37°C
  - Temperature sensitivity: ±0.0125°C
- CO_2 Control System (Default Set-Point 5.0%)
  - CO_2 Range: 0-20%
  - CO_2 Accuracy: ±0.1%
  - CO_2 Recovery to 5.0 ±0.2%: Less than 3 minutes
- Remote Alarm Output Contacts

3.4 NU-4850 Additional Features

- RH Control System (Default Set-Point 90%)
  - RH Range: Ambient to 95%
  - RH Accuracy: ±3%
  - RH Recovery to 95% ±3%: 10 minutes *

3.5 NU-4950 Additional Features

- O_2 Control System (Default Set-Point 21%)
  - O_2 Range: 2-21%
  - O_2 Accuracy: ±1%
  - O_2 Recovery to 5% ±2%: 10 minutes *

Note: All recovery ratings are at default control & option settings.

3.6 Standard Items Packed with Unit

- (4) Stainless Steel Shelves
- (8) Stainless Steel Shelf Brackets
- (4) Stainless Steel Shelf Bracket Supports
- (1) Full Size Water Pan with Supports (supplied with all units)
- (1) Fill Port Hose Adaptor
- (1) Fill Port Plug
- (1) Gas Tube with Filter
- (1) 6 feet (2m), Fill Tube
- (1) Electrical Cord 8 foot (2.5m)
- (1) Operation & Maintenance Manual
- (1) Operating Instructions

3.7 Optional Features

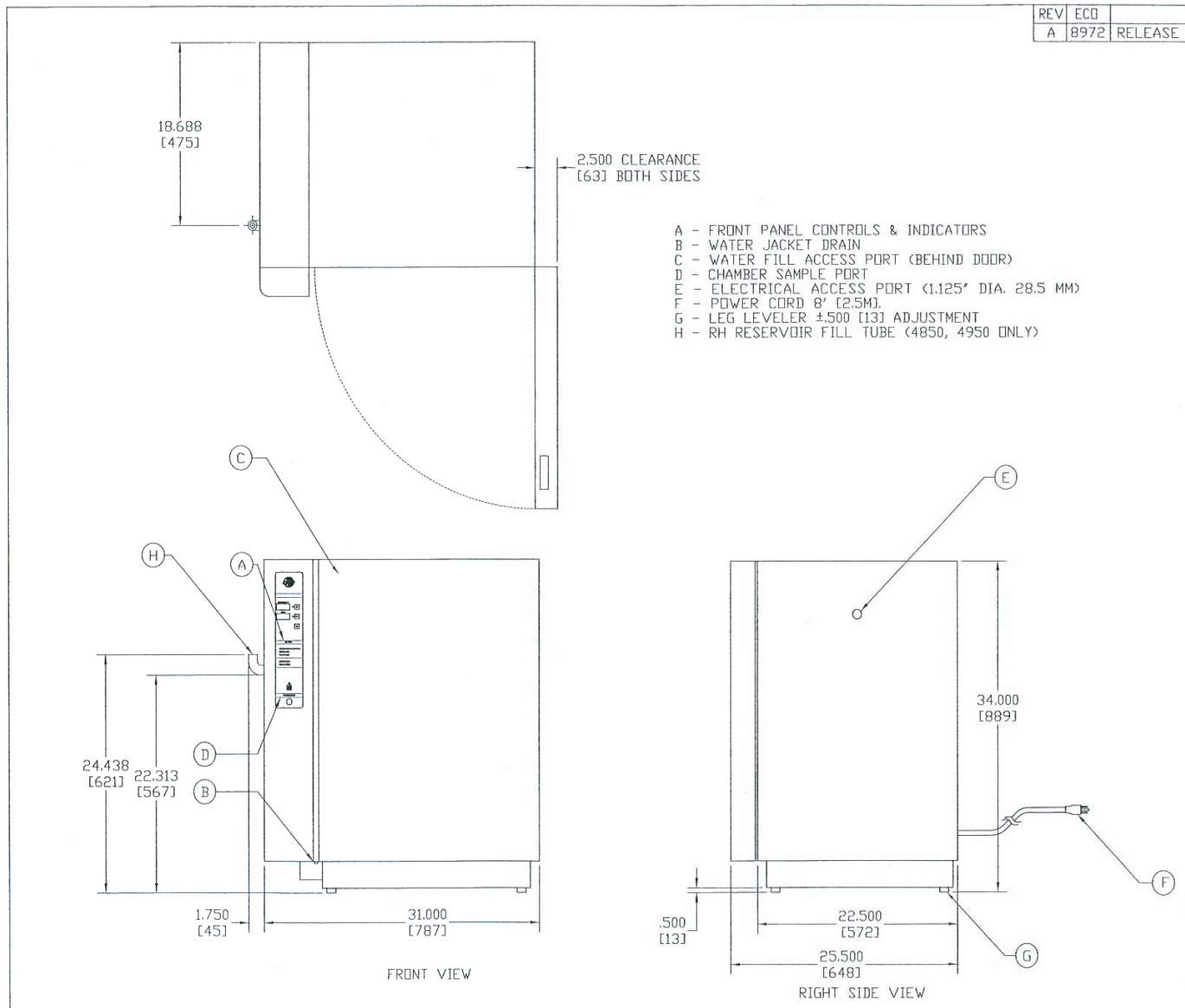
- Model Number I01 Automatic CO_2 Tank Switch (Internal)
- Model Number I09 Automatic N_2 Tank Switch (Internal)
- Model Number I11 Internal Coil for Chilled Water
- Model Number I18 RS-232 Communications Interface
- Model Number I44 Chart Recorder Multi-Signal Outputs

3.8 Accessories

- Model NU-1550 Automatic Tank Switch (External) (115 VAC)
- Model NU-1550E Automatic Tank Switch (External) (230 VAC)
- Model NU-1552 CO_2/O_2 Tank Alarm (115 VAC)
- Model NU-1551E CO_2/O_2 Tank Alarm (230 VAC)
- Model NU-1553 Stacking Rack (Single Unit)
- Model NU-1555 Additional Stainless Steel Water Pan
- Model NU-1556 Additional Tubing Kit
- Model NU-1557 Additional Shelves
- Model NU-1559 CO_2 Analyzer Fyrite Kit (Dry) 0-20% (Replacement fluid required)
- Model NU-3550 O_2 Analyzer Fyrite Kit (Dry) 0-60% (Replacement fluid required)
- Model NU-1561 Replacement Fluid for CO_2 Analyzer (two bottles/carton)**
- Model NU- 3551 Replacement Fluid for O_2 Analyzer (two bottles/carton)**
- Model NU-1564 CO_2 Regulator, Two-Stage
- Model NU- 3556 N_2 Regulator, Two-Stage
- Model NU-1574 Platform w/Combination Castors
- Model NU-1575 Moisture Proof Duplex Outlet (115 VAC)
- Model NU-2568 Surge Protector (115 VAC)

**Fyrite Replacement Fluid may only be ordered when shipment is possible by UPS Ground Service.

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
A	8972	RELEASE TO PRODUCTION	10/05/04	KF	KCK



ORIGINAL

NU-4750, 4850, 4950/D/E/G
SPECIFICATIONS

DFTM	KF	10/05/04	CHKD	KCK	SHEET 1 OF 1

DRAWING NUMBER BCD-10404 A

4.0 Test Performance & Procedures

All equipment is thoroughly inspected by NUAIRE at the time of shipment. Quality control is maintained by constant surveillance over each product, beginning at the receipt of purchased material and concluding with a final inspection before packing. In all instances where product quality cannot be easily assessed on the end item (i.e. water-jacket leak tightness), the product is inspected 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 Visual Inspection

4.1.1 Each US Autoflow is visually inspected to insure that the interior is clean and free from scratches, nicks, and burrs, and that all welds, both interior and exterior, are ground and polished smooth.

4.1.2 Painted surfaces are inspected to be free of scratches, nicks, insufficient covering and runs.

4.1.3 The doors open and close freely without binding of the hinges. The gasket seals the inner glass door tightly. The glass door is free of scratches.

4.2 Electrical Tests

4.2.1 Electrical Leakage Test
All Autoflow Incubators may not exceed 0.5 milliampere in the normal running mode and may not exceed 3.5 milliampere in a single fault condition (ex. open ground).

4.2.2 Dielectric Voltage
All Autoflow Incubators are required to withstand 1770 VDC (2150 VDC for 230 VAC units) between dead metal parts and the hot/neutral power source leads with no electrical breakdown. This is factory tested using Associated Research Model 520L and 7564SA.

4.2.3 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.

4.3 Functional Tests

The following functional tests are performed on every unit at the end of a continuous 48-hour burn in period.

4.3.1 Control Systems
All diagnostic functions are exercised to insure proper operation of control systems, components and alarms.

4.3.2 CO_2 Control
Each unit is calibrated to function at 5%. CO_2 is introduced into the chamber and allowed to stabilize for ten minutes at 5% concentration. The concentration is checked with an independent measuring instrument. Each unit is monitored during the 48-hour burn in period and only accepted with zero failures.

4.3.3 CO_2 Recovery
Each unit is exercised for CO_2 recovery time at the end of the 48-hour burn in period. The door is opened for 1 minute to deplete the CO_2. After the door is closed, the unit shall recover to 5.0 $\pm$0.2% within 3-1/2 minutes.

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 24 months parts and labor after the date of sale if proven 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.

NuAire, Inc. warrants the water jacket and will repair or replace F.O.B. its factory or furnish without charge F.O.B. its factory the water-jacket within five years after the date of sale if proved to the satisfaction of the company to have been defective at the time it was sold.

This warranty shall not apply to any NuAire product or part thereof, which has been subject to misuse, abuse, filling the water-jacket improperly, using additives in water-jacket, 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, Inc. takes every reasonable precaution to assure that your Incubator arrives without damage. Motor carriers are carefully selected and shipping cartons have been specifically 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 Incubator
to be sure that if damage has occurred, the proper claims and actions are taken immediately.

6.1 Damaged Shipments

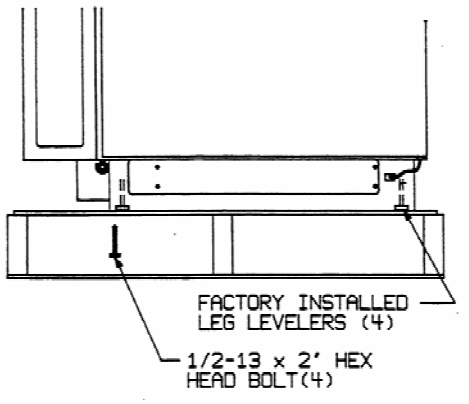
6.1.1 Terms are F.O.B. factory, unless stated otherwise. Therefore, it is important to check each shipment before acceptance.

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

The US Autoflow is fastened to the base skid and it is usually the best procedure to leave the skid attached until the US Autoflow is located in its approximate position, to facilitate ease in handling. The base skid can then be removed by removing the four bolts holding the cabinet to the skid. Examine the US Autoflow carefully. INSPECT both the exterior and the interior of the US Autoflow for any transit damage before discarding the shipping crate (see Section 6.1.3).



7.1 Location

In locating the US Autoflow, consider all possible conditions that might affect its performance, as well as laboratory procedures for its intended purpose. Do not locate near heating or cooling ducts, or next to equipment that generates heat (steam radiators, stoves, ovens, autoclaves, etc.). Avoid direct sun rays and rapidly moving air currents. The US Autoflow needs even heat loss on all surfaces in order to maintain an internal temperature variation of less than 0.2 degrees C. As a result, a minimum of 2 inches (50 mm) must be allowed between the rear and sides of the US Autoflow and any walls, partitions or obstructions to facilitate adequate convection of air around the US Autoflow's water-jacket. For maintenance/service purposes, the control center side containing the electronics should remain accessible.

7.2 Leveling

The US Autoflow should be leveled prior to filling the water, and should rest firmly on the bench or floor. Uneven water levels may cause false "Low Water" indications on the front panel as well as to affect the water circulation paths within the water-jacket, which could cause condensation on the walls of the chamber. Leveling feet are provided for this purpose, factory installed into the base of the US Autoflow. Turning the adjustable leveling feet counter-clockwise raises the US Autoflow. The leveling feet height should be approximately ¼ inch (6 mm) below the US Autoflow Base.

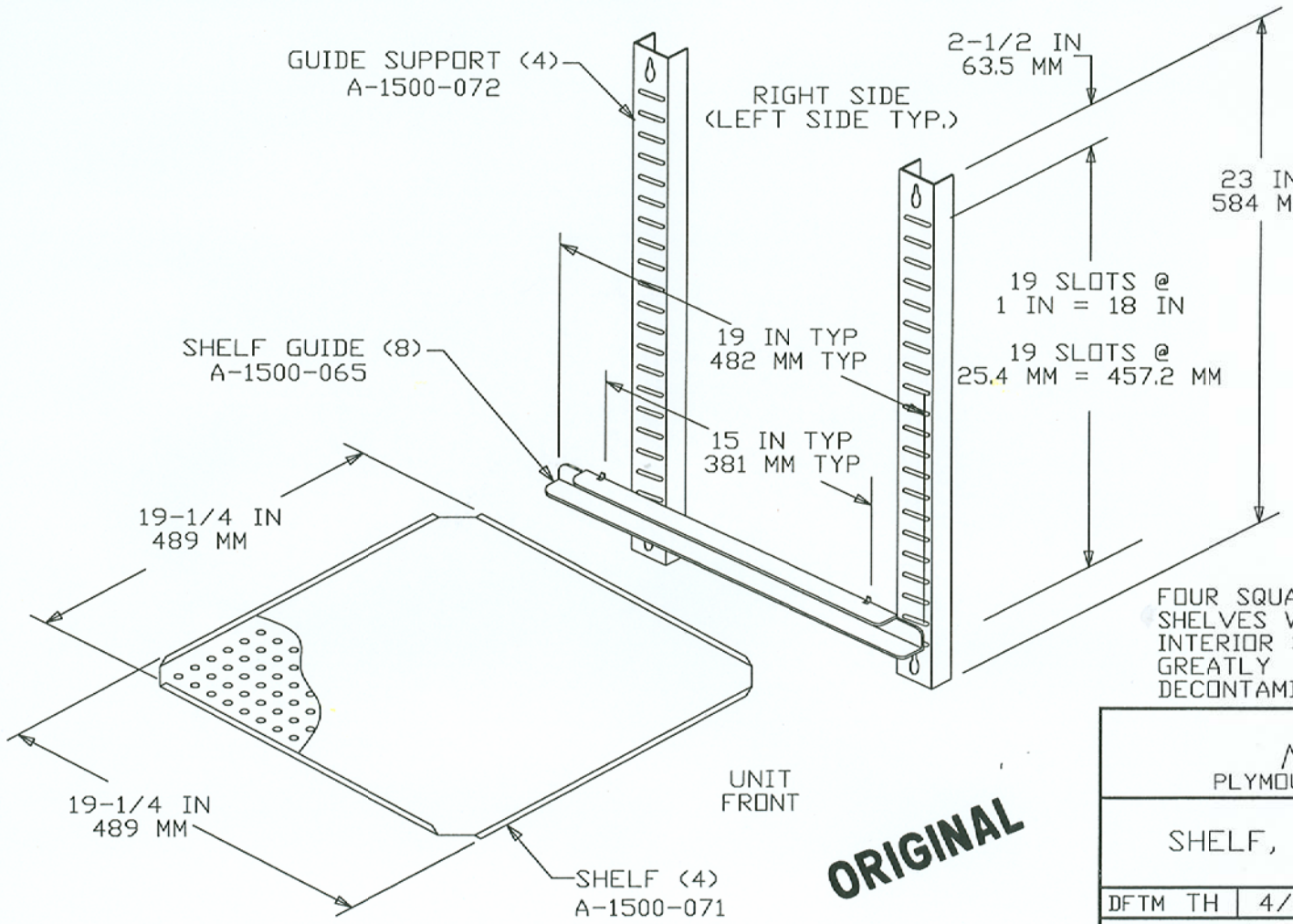
7.3 Spring Pump Assembly Shipping Foam

The spring pump assembly contains a piece of foam packing used to immobilize the pump during shipping: **IMPORTANT: FOAM MUST BE REMOVED BEFORE OPERATION!** To access, first remove the side access cover. After popping front control panel open, grasp foam from end and carefully remove. It may be saved for any future shipping. Close front control panel and replace side access cover and screws.

7.4 Shelf & Water Pan Installation

Before installation of the shelves, NuAire recommends to decontaminate all surfaces within the interior chamber, glass door and outer door with gasket. They can be wiped down with a disinfectant of 70 percent alcohol or similar non-corrosive anti-microbial agent.

REV	ECO	DESCRIPTION	DATE	INL	INL
C	9730	UPDATE SHELF PART #	4/23/07	CV	KCK



ORIGINAL

FOUR SQUARE STAINLESS STEEL SHELVES WITH REMOVABLE INTERIOR SHELF ASSEMBLY GREATLY SIMPLIFIES DECONTAMINATION PROCEDURES.

NUAIRE
PLYMOUTH, MINNESOTA

SHELF, INSTALLATION

DFTM TH	4/9/92	SHEET 1	OF 1

DRAWING NUMBER ACD-04119 C

Provided with each US Autoflow are four shelves. The shelves are easily installed per Drawing ACD-04119, by attaching the guide supports to the stainless steel pins in the interior of the chamber. Additional shelves and shelf guides are available. The water pan is installed on two shelf guides at the bottom of the shelf rack.

7.5 Electrical

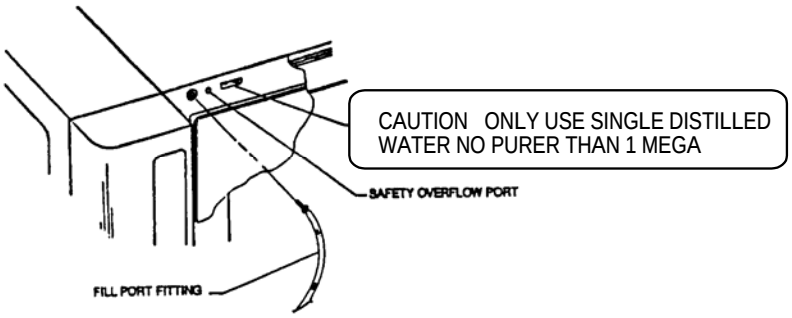
The electrical supply circuit to the US Autoflow must conform to all national and local electrical codes. Consult the US Autoflow's serial-data plate, located on the upper corner of the right side of the Incubator, for voltage, cycle, phase and ampere requirements before making connection. Plug the power cord securely into a grounded power source. VOLTAGE SHOULD NOT VARY MORE THAN 5% FROM SERIAL PLATE RATINGS. A separate branch circuit is recommended to prevent possible loss of product due to overloading or failure of other equipment on the same circuit. A SURGE PROTECTOR IS STRONGLY RECOMMENDED to avoid power-related faults.

7.6 Precaution for US Autoflow Filling

To prepare the US Autoflow for filling, turn on main power switch located on back panel and set mode switch to setup. The digital indicator should light up as well as the low water light.

7.7 Filling & Draining the Water-Jacket

The fill port plug is located on the front top left side behind the exterior door. Install the fill port fitting. Place the tubing over the adapter and connect the other end to either a funnel or serrated tap. Use single distilled water**, NO PURER THAN 1 MEGAOHM.** Fill the water jacket until the "LOW WATER" light turns off. Add an additional 3 to 4 liters of water, remove the tube adapter, and replace with the fill port plug.



CAUTION

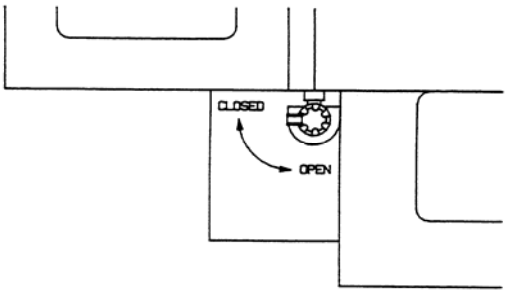
Be sure to position and level the US Autoflow as desired before filling with water.

DO NOT OVERFILL!

The water jacket requires no anti-bacterial agents. The US Autoflow already incorporates a copper tube producing copper sulfate which eliminates bacterial growth within the water jacket. **ABSOLUTELY NO CHLORINATED OR HALOGEN MATERIALS ARE TO BE USED IN THE WATER JACKET.**

A safety overfill port is located next to the fill port plug so if overfill does occur, the water will be relieved through the port.

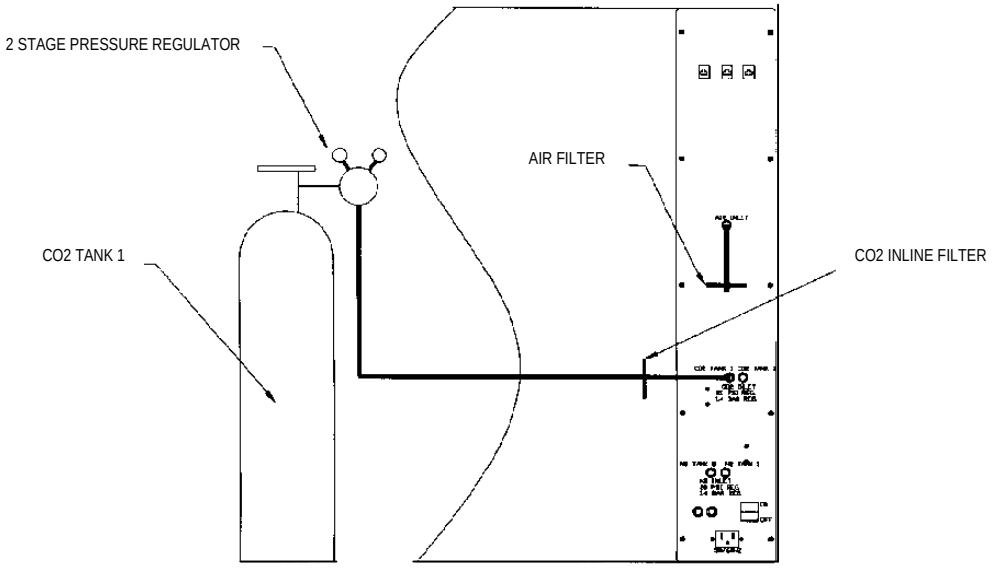
The can be drained from the drain plug located on the bottom left side. The drain uses a ball valve to control the drain water. If the valve stem is horizontal, the drain is closed and if it is vertical, the drain is open. A white safety plug must be removed prior to draining located on the bottom of the ball valve. It also insures no leakage will occur.



7.8 Air Inlet Connection

An air inlet tubing kit consists of one foot clear vinyl tube and (1) 50mm polypropylene .3 micron HEPA filter. Locate the air inlet port on the back panel of the unit. Remove cover cap, connect one end of tubing to the air inlet port, and the other end of tubing to the air filter.

CAUTION: This is a free air supply. DO NOT CONNECT to pressurized source.



7.9 CO_2/N_2* Tube Connection

Included with every US Autoflow is a tubing kit consisting of (1) six foot (2 m) vinyl tube and (1) 50 mm polypropylene 0.3 micron HEPA filter.
*for NU-4950 Model

7.9.1 CO_2/N_2 Supply

1. Before the CO_2/N_2 supply is turned on to the US Autoflow, fill the water jacket and set the temperature (See Section 8.7.1.).

CAUTION:
CO_2/N_2 Pressure to the US Autoflow is rated at 20 PSIG or 1.4 BAR.
Do not exceed 25 PSIG or 1.8 BAR

2. CO_2/N_2 of medical grade is recommended.
3. A two-stage pressure regulator, Linde #19590 (NU-1564), or equal, is recommended.
4. DO NOT USE a single stage regulator.

7.9.2 CO_2/N_2 Pressure Regulators

The regulator's high-pressure stage, direct from supply cylinder must have a range of 0 to 2000 PSI or 0 to 140 BAR. This gauge indicates actual tank pressure. The low-pressure stage should have a range of 0 to 30 PSI or 0 to 2 BAR (100 PSI or 6 BARS maximum). This gauge will indicate the actual CO_2/N_2 pressure into the US Autoflow system. Some single stage CO_2/N_2 pressure regulators have two gauges. USE A TWO STAGE REGULATOR. All NuAire Autoflow's use CO_2/N_2 in such small quantities that precise metering of CO_2 input pressure is important for maximum performance of the US Autoflow.

To connect the regulator: First, open the CO_2/N_2 cylinder slightly for an instant (this is termed "cracking the valve"). This will blow out dust or dirt that may have collected in the valve outlet. BE SURE to keep your face away from the valve outlet to protect your eyes from dust or dirt. Second, MAKE SURE the regulator pressure-adjusting screw is released by turning it counterclockwise until it turns freely. Third, attach the regulator to the cylinder valve and tighten the connection nut with a wrench. BE SURE DISC GASKET IS IN PLACE BEFORE MAKING CONNECTION.

7.9.3 CO_2/N_2 Connection

High concentration of CO_2/N_2 gas can cause asphyxiation! Install Incubator in well ventilated area.

This Incubator is designed to be operated with CO_2/N_2 gas only. Connecting a flammable or toxic gas can result in a hazardous condition. Gases other than CO_2/N_2 should be connected to this equipment. CO_2 gas cylinders have a UN1013 label on the cylinder and are equipped with a CGA 320 outlet valve. Check the gas cylinder for the proper identification labels.

Do not use CO_2 gas cylinders equipped with siphon tubes. A siphon tube is used to extract liquid CO_2 from the cylinder which can damage the pressure regulator. Consult with your gas supplier to ensure that the CO_2 cylinder does no contain a siphon tube.

Connect the CO_2 & N_2 supply from the low-stage of the two-stage regulator to the inlet fitting located on the Incubator back panel. The filter should be inserted downstream of the low-stage regulator before the inlet nozzle to the US Autoflow. Observe proper flow orientation of the filter (look for "in" on filter). The tubing is easily cut with a sharp knife.

7.9.4 CO_2/N_2 Supply Adjustment

With the regulator OFF (i.e. fully counterclockwise), open the cylinder valve slowly-usually 1 to 2 turns is sufficient.

NEVER STAND IN FRONT OR BEHIND THE REGULATOR WHEN OPENING THE VALVE. ALWAYS STAND TO ONE SIDE.

The cylinder tank pressure should read 700 to 800 PSI (48 to 55 BAR) for CO_2 , or 2550 to 2650 PSI (176 to 183 BAR) for N_2, more or less, depending on the temperature of the cylinder. Next turn the regulator's pressure adjusting screw clockwise until the low-pressure gauge reads 20 PSI or 1.4 BAR. The CO_2 connection is now complete.

NOTE: OSHA requires the CO_2/N_2 tanks to be physically restrained (i.e. via chained to wall) to prevent accidental damage to cylinder.

If optional feature Model Number I01/I09, CO_2/N_2 Automatic Tank Switch (Internal) is purchased; separate installation instructions are provided.

8.0 US Autoflow Operation

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, as well as repair.

ATTENTION ACCOMPANY'S INFORMATION OR IMPORTANT SYMBOL

POTENTIAL ELECTRICAL HAZARD ONLY QUALIFIED PERSON TO ACCESS

The US Autoflow is designed to provide a sterile, constant temperature and high humidity controlled atmosphere for optimum growth of tissue cell cultures or other organisms requiring this precise environment. To operate the US Autoflow properly, the following parameters must be reviewed, carefully set and/or prepared.

8.1 Sterility

The environment provided by the US Autoflow is not selective. As a result, any contamination within the chamber is subjected to the same environment as the specimens. Therefore, before placing any cultures in the US Autoflow, the shelves, and shelf brackets should be sterilized. The interior side-walls, top, bottom, door, as well as the gasket should be wiped clean with a 70% solution of isopropyl alcohol or other disinfectant, to remove any contamination. Use mild detergent to clean exterior of US Autoflow.

8.2 Humidity

Humidification of the US Autoflow Model NU-4750 Series is achieved through the process of water evaporation (vapor pressure) from a stainless steel water pan (NuAire Model NU-1555) placed near the bottom of the US Autoflow shelf rack. Materials of different thermal resistance (i.e. glass, plastic) do not offer sufficient thermal recovery and are not recommended for use. Although some metals offer better thermal coefficients than stainless steel, dissimilar metals cause electrolysis in the acid atmosphere (carbonic acid) and should **never** be used, or placed within the US Autoflow's chamber.

USE ONLY DISTILLED WATER, NO PURER THAN 1 MEGAOHM in the stainless steel pan. The water should be changed at least once a week, preferably more often. FLOODING THE BOTTOM OF THE US AUTOFLOW IS NOT RECOMMENDED since it is difficult to change the water weekly and almost necessitates the use of chemicals which are not recommended and may damage the stainless steel. Also, it promotes condensation on the US Autoflow's inner walls because it steals the natural convection, heat flow through the inner chamber and condensation points occur. **ABSOLUTELY NO CHLORINATED OR HALOGEN MATERIALS ARE TO BE USED IN THE CHAMBER.**

Humidity recovery will be back 95% within 15-20 minutes after a 30 second door opening with a water reservoir area of 361 square inches (i.e. a NU-1555 full-sized pan). Contamination in the water pan, may be avoided by adding a small amount of copper sulfate to it after each decontamination of the chamber.

Condensation on the door walls, top or bottom of the chamber indicates the door heat duty cycle setting is too high and should be corrected by calibration (see Section 9.2).

The US Autoflow – Models NU-4850 & 4950 series are provided with relative humidity display and control system, most of the above can be applied with the exception of the water pan. The RH Reservoir, located on the left side of the unit, can be monitored for water level visually. Use only single distilled water, **NO PURER THAN 1 MEGAOHM** to fill the reservoir. The relative humidity control system will control any given setpoint between ambient and 95% RH. The alarm setpoints are preset at 5% over the setpoint and not being able to reach the setpoint to within 5% after 4 hours.

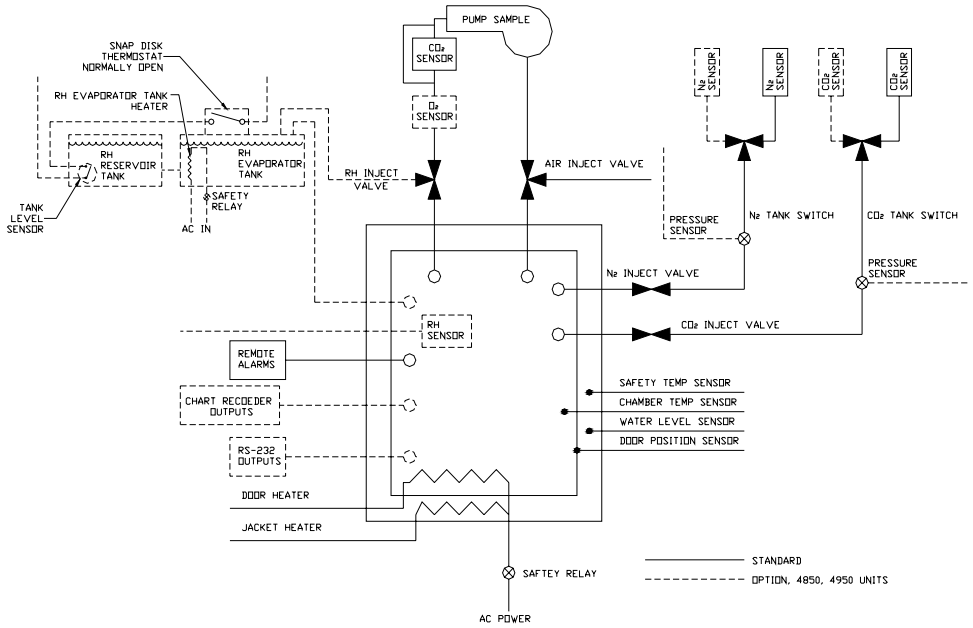
The relative humidity control system is programmed with a **H**umidity **C**ontrol alarm system. The **HC** alarm system is designed to prevent the uncontrolled injection of humidity into the Incubator chamber. Uncontrolled injection has two primary causes. The easiest one to detect is a bad or disconnected RH sensor. If the measured output voltage of the humidity sensor falls outside of the normal range, an **HC** alarm is declared without delay by the control board. This portion of the **HC** alarm system is not selectable, and is active any time the RH control system is enabled.

A second option menu selectable part of the humidity control alarm system was designed to detect an RH sensor that is out of calibration or not responsive. During an RH recovery, if the inject solenoid is engaged for too long, or if it cycles on and off too many times without reaching setpoint, an **HC** alarm is declared. The length of time or the number of cycles that a solenoid turns on before an alarm declaration is user adjustable (see Section 8.8.4 for the user selectable portions of the system). This portion of the humidity control alarm system is also inhibited by a cold evaporator box signal sent via a snap disc thermostat mounted on the evaporator box. It is also inhibited by a low reservoir water level signal sent via a float switch in the reservoir. Both conditions will light the yellow LED labeled RH reservoir.

No matter what event triggers an **HC** alarm, the alarm sequence is always the same. First an alarm is sounded (with audible and visual clues) and the RH evaporator box heat is turned off. After 2-1/2 hours, the air-inject solenoid opens and will run for a period of one half hour. At this time (three hours from alarm declaration), the air solenoid turns off, and the RH inject solenoid turns on and stays on until the alarm is cleared. This gives the user some humidity in the Incubator, but prevents the continuous, uncontrolled injection of hot water vapor. Temperature and gas control are unaffected by humidity control alarms (see Section 11 Error Indicators & Troubleshooting for identifying and responding to the humidity control alarm indicators. Read section **9.4** before determining the RH set-point and/or calibrating the system.

8.3 System Introduction

The NuAire Incubator Control Electronics (NICE) system is designed to service the control requirements of the US Autoflow Incubator chamber. Temperature and CO_2 level are controlled by preset values to provide optimum conditions for culture growth within a chamber. Operator input is coordinated through the control panel keypad and status displays. Below figure shows the various inputs and outputs of the system.



US AUTOFLOW CONTROL INPUTS AND OUTPUTS

The NuAire Incubator Control Electronics is a state-of-the-art microcomputer based system that provides:

8.3.1 Single chamber control in a single electronic package.

8.3.2 Enhanced information presentation of the following:

- Chamber temperature (set point and actual)
- CO_2 level (set point and actual)
- Humidity level (set point and actual) (NU-4850 & NU-4950)
- Humidity/O_2 level (set point and actual) (NU-4950)
- Output and alarm status:
  - Water Jacket Heater Status
  - CO_2 Control Status
  - Water-Jacket Low Water Status
  - Door Ajar Status
  - System Alarm Condition Status
  - Optional, CO_2 Tank Selection
  - RH Control Status (NU-4850 & NU-4950)
  - RH Reservoir Tank Status (NU-4850 & NU-4950)
  - O_2 Control Status (NU-4950)
  - Optional, N_2 Tank Status (NU-4950)

8.3.3 Simplified Operator Controls. The control panel is operated using five keypads, run/setup key, Up/Down arrow keys, Select key and Hidden key (NuAire logo). The run/setup key controls the Incubator's two modes, Run or Setup. To change modes, press and hold the run/setup key for three seconds. If in Run mode, the green LED above the run/setup key should be on solid. If in Setup mode, the green LED above the run/setup key should be blinking, as well as the temperature and CO_2 displays indicating "SETUP". In the Run mode, the unit is fully functional with all control/alarms activated. In the Setup mode, the unit is inactive, no control/alarms exists. The Select key controls the current active parameter. As the Select key is repeatedly depressed, the corresponding green LED next to the parameter will indicate the parameter which is active. Each depression advances to the next parameter. The Up or Down arrow keys are used for setpoint parameter changes by depressing the Up or Down arrow key when the selected parameter is activated. As Hidden key is pressed, it allows access to diagnosis, option and reset modes.

Password Protection - The US Autoflow has the ability to offer password protection of the setup parameters. By activating the password function in the option configuration parameters (Section 8.8.4), the use of the Up, Down, and Select keys are required in the correct order to access the set up mode.

8.3.4 Automatic notification of abnormal situations. The red alarm LED on the control panel indicators will light to indicate a fault within the system. Such faults include:

- System intermittent
- Temperature Control Fault (temperature exceeds set point by more than 1.0°C, or does not reach to setpoint within 4 hours)
- CO_2 Control Fault (CO_2 exceeds set point by more than 1.0% or doesn't reach setpoint within 30 minutes).
- Humidity Control Fault (Relative humidity exceeds set point by more than 5.0% or doesn't reach setpoint within 4 hours).
- O_2 Control Fault (O_2 exceeds set point by more than 5.0% or doesn't reach setpoint within 1hour).

8.3.5 Provision for add-on expansion capability. Options include:

- Remote communication capability (RS-232)
- Chart recorder output (0-10VDC) of individual monitored parameters
- Automatic tank switch(es)

8.3.6 Diagnostic and calibration assists. By pressing hidden key, diagnostic mode is entered. In this mode:

- Individual analog inputs may be displayed to assist calibration

- Individual outputs may be forced to an **ON** or **OFF** condition
- Individual digital inputs may be displayed
- Front panel lamps may be tested
- Memory and internal processor diagnostics may be selected
- All options may be individually tested

8.4 Front Control Panel

The system front control panel contains the following functions described in detail (see Dwg BCD-07343, 07344, 07345).

8.4.1 Heat Jacket Status LED

The jacket heat green LED indicates when the chamber heater is turned on. A blinking LED indicates chamber heater is being cycled to maintain chamber setpoint temperature.

8.4.2 Door Ajar Status LED

The door ajar yellow LED indicates when the inner glass door is not closed. The LED acts upon a magnetic switch located along the lower right corner of the inner glass door.

8.4.3 Low Water Status LED

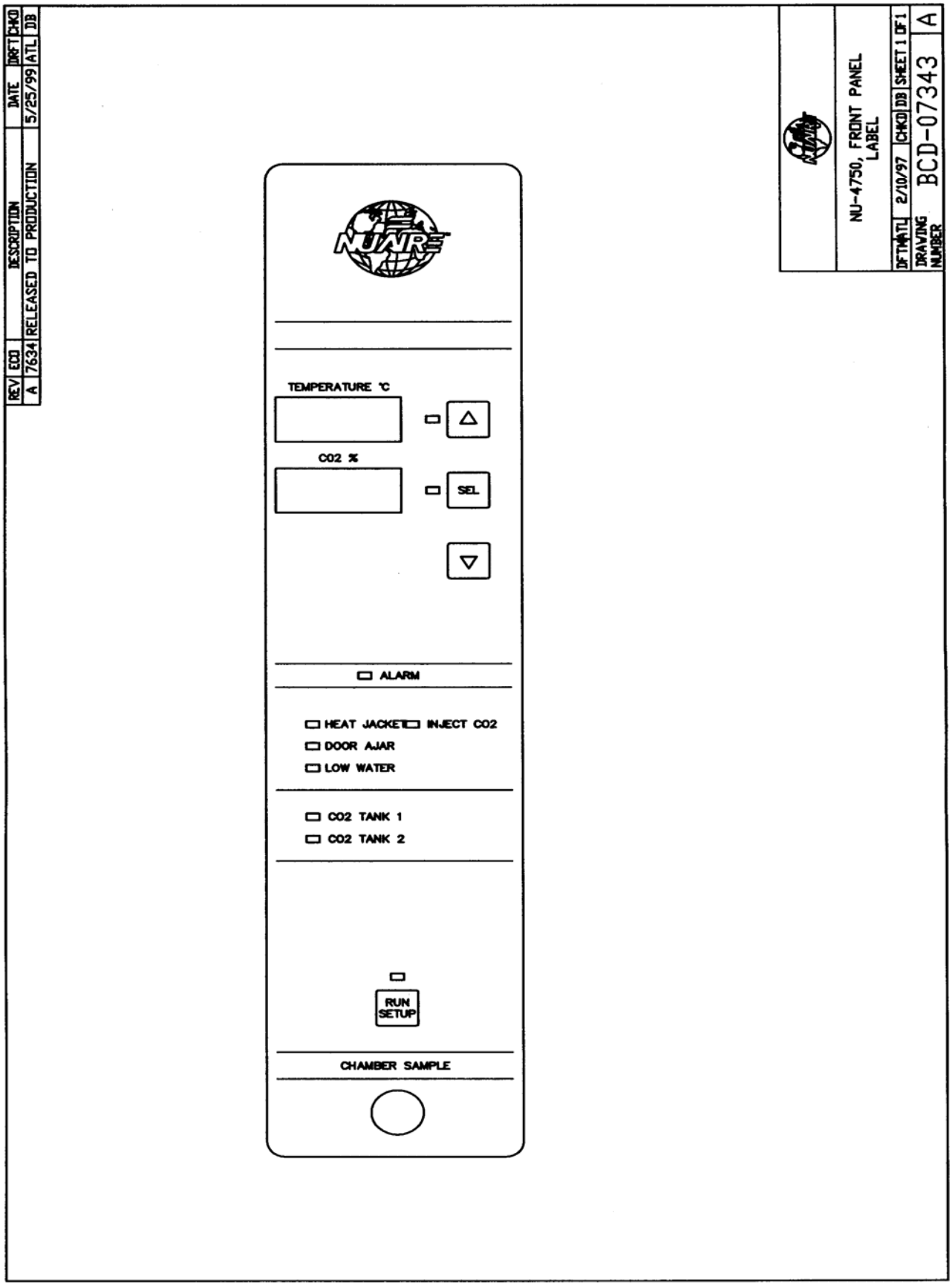
The low water yellow LED indicates when the water-jacket requires additional water. If the low water light is lit, the water-jacket should be filled as soon as possible to avoid uneven heating of the chamber.

8.4.4 Inject CO_2 Status LED

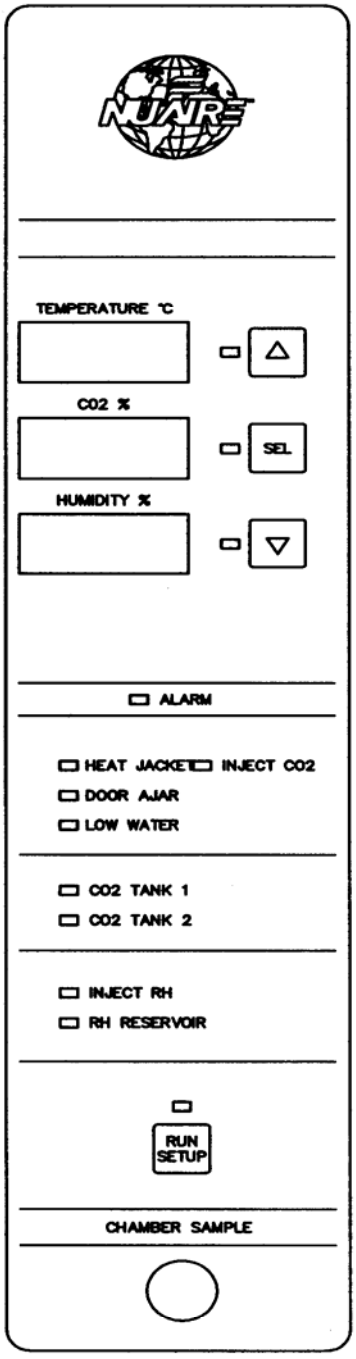
The control CO_2 green LED indicates when the CO_2 control valve is open and CO_2 is flowing into the chamber.

8.4.5 CO_2 Tank 1 Status LED

The CO_2 tank 1 green LED indicates when the US Autoflow is consuming CO_2 from tank 1.


REV | ECO | DESCRIPTION | DATE | DRFT | CHKD
A | 7634 | RELEASED TO PRODUCTION | 5/25/99 | ATL | DB
NU-4750, FRONT PANEL LABEL
DFTM ATL | 2/10/97 | CHKD DB | SHEET 1 OF 1
DRAWING NUMBER BCD-07343 A
TEMPERATURE °C
CO2 %
SEL
ALARM
HEAT JACKET
INJECT CO2
DOOR AJAR
LOW WATER
CO2 TANK 1
CO2 TANK 2
RUN SETUP
CHAMBER SAMPLE

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
A	7634	RELEASED TO PRODUCTION	5/25/99	ATL	DB

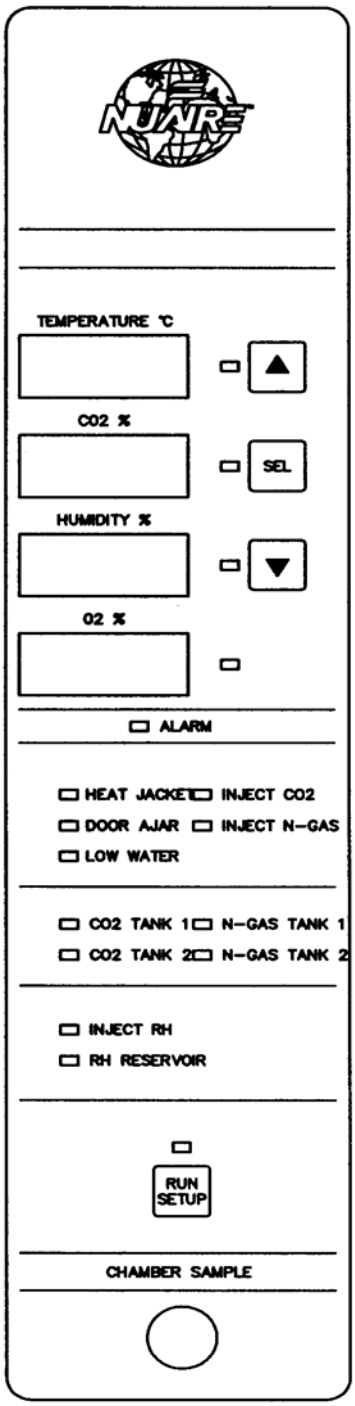


NU-4850, FRONT PANEL LABEL

DFTM/ATL	5/6/99	CHKD	DB	SHEET 1 OF 1

DRAWING NUMBER BCD-07344 A

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
A	7634	RELEASED TO PRODUCTION	5/25/99	ATL	DB



NU-4950, FRONT PANEL LABEL

DFTR/ATL	5/6/99	CHKD	DB	SHEET 1 OF 1	A
DRAWING NUMBER	BCD-07345				

8.4.6 CO_2 Tank 2 Status LED (Option)

The CO_2 tank 2 yellow LED indicates when the US Autoflow is consuming CO_2 from tank 2.

8.4.7 Inject N_2 Status LED (NU-4950)

The control N_2 green LED indicates when the N_2 control valve is open and N_2 is flowing into the chamber.

8.4.8 N_2 Tank 1 Status LED (NU-4950)

The N_2 tank 1 green LED indicates when the US Autoflow is consuming N_2 from tank 1.

8.4.9 N_2 Tank 2 Status LED (NU-4950 Option)

The N_2 tank 2 yellow LED indicates when the US Autoflow is consuming N_2 from tank 2.

8.4.10 RH Inject Status LED (NU-4850 and NU-4950)

The control RH green LED indicates when the RH control valve is open and water vapor is flowing into the chamber.

8.4.11 RH Reservoir Status LED (NU-4850 & NU-4950)

The reservoir yellow LED indicates one of two conditions.

1. The RH reservoir tank requires refilling. The LED remains lit until the reservoir is refilled.
2. The RH evaporator tank is below temperature. Two conditions would cause this.
    A. When an HC alarm is declared the evaporator tank heater is shut off. When it cools below operating temperature a temperature sensitive switch will turn on the RH reservoir light. This would be in conjunction with HC flashing in the RH display unless it has already been cleared.
    B. A heater fault will also cause the evaporator box to cool below operating temperature. Refer to Sections 8.2 (description of RH systems), 8.8.4 (options menu) and 11.0 (error indicators & troubleshooting) for detailed explanations and actions required to respond to the condition. The LED will stay lit until the evaporator tank is heated back to temperature.

Note: When either condition exist the user portion of the **HC** system is inhibited until the condition is remedied.

8.4.12 Alarm Status LED

The alarm red LED indicates an abnormal status condition. The alarm LED is always accompanied by an additional LED or display that specifies the abnormality. If the Alarm Status LED is on continuously, a catastrophic condition exists. A catastrophic temperature control condition will de-energize the safety relay and cause the chamber to cool below the set point. The audible alarm ringback function may be silenced for fifteen minutes by pressing any key.

8.4.13 Chamber Sample

The chamber sample port is provided to measure CO_2 percentage (or O_2 percentage) manually with a CO_2 (O_2) Fyrite instrument, or other suitable instrument.

8.4.14 Parameter Indicators

The parameter indicators, green LED's, located next to the display indicate the activated parameter being shown in the three-digit display. If the parameter indicator is activated, the parameter (i.e. CO_2) may be altered via the arrow keypad.

8.4.15 Run/setup key

The run/setup key is used to select the operating mode of the US Autoflow chamber, Setup or Run. To initiate Run or Setup, press and hold the run/setup key for three seconds until the unit changes state. A green LED above the run/setup key indicates if the unit is in Run mode (solid LED) or is in Setup mode (blinking LED).

8.4.16 Selection & Arrow Keypad

The selection and arrow keypad (KEYPAD INPUT SHOULD BE DONE WITH FINGER ONLY, DO NOT USE PENCIL OR SHARP INSTRUMENTS) is used for all operator interaction with the system. The "SEL" key is always active, repeated depression of this key causes display of the next value in sequence as listed for the parameter indicators. The arrow keypads are used to input setpoints and access the calibration functions.

8.5 US Autoflow Rear Panel

The US Autoflow rear control panel contains the following functions described in detail (see Drawing BCD-07347).

8.5.1 Power Cord

The power cord is an 8-foot (2 m) in length, type "SVT" molded plug, allowing for long life and easy cleanability.

8.5.2 Circuit Breaker

All control electronics are protected with a circuit breaker that will trip at 145% of load rating in less than 2 seconds. Should the circuit breaker open (pop-out button will appear), merely depress to reset.

8.5.3 CO_2 Inlet

The CO_2 inlets provide a fitting for clear vinyl tubing. Be sure to follow the recommended inlet pressure to insure proper flow rates and consistent CO_2 percentage readings.

8.5.4 N_2 Inlet (NU-4950)

The N_2 inlets provide a fitting for clear vinyl tubing. Be sure to follow the recommended inlet pressure to insure proper flow rates and consistent N_2 percentage readings.

8.5.5 Air Inlet

The Incubator is provided with clear vinyl tubing and 0.3 micron HEPA filter. This is a free air supply, **DO NOT CONNECT** with pressurized source.

8.5.6 RS-232 Communication Interface (Option)

The Incubator is provided with RJ-45 telephone type connection for one to one communication interface with a serial printer.

8.5.7 Chart Recorder Multi-Signal Outputs (Option)

The Chart Recorder Output board is provided as an option, which allows output signals of temperature, CO_2%, RH%, O_2%. The output signals are conditioned and linearized. There are 3 analog signals to choose from: 0 to 5 VDC, 0-10 VDC, and 4-20 MA. Connection to chart recorder or other monitoring device is via RJ-45 telephone type jack.

8.5.8 Remote Alarm Contacts

The Incubator is provided with RJ-11 telephone type connection to remote alarm device.
See section 12.0 for detail configuration and connection

8.5.9 Power Switch

The power switch, located at the bottom of the rear panel, controls all power to the Incubator.

8.5.10 CO_2/N_2 Internal Tank Switch(es) (Option)

The internal tank switch is an option which is factory installed at the time of manufacture. The tank switch performs the critical back-up function of switching tank 1 and tank 2 and back again when each depleted tank is replaced.

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
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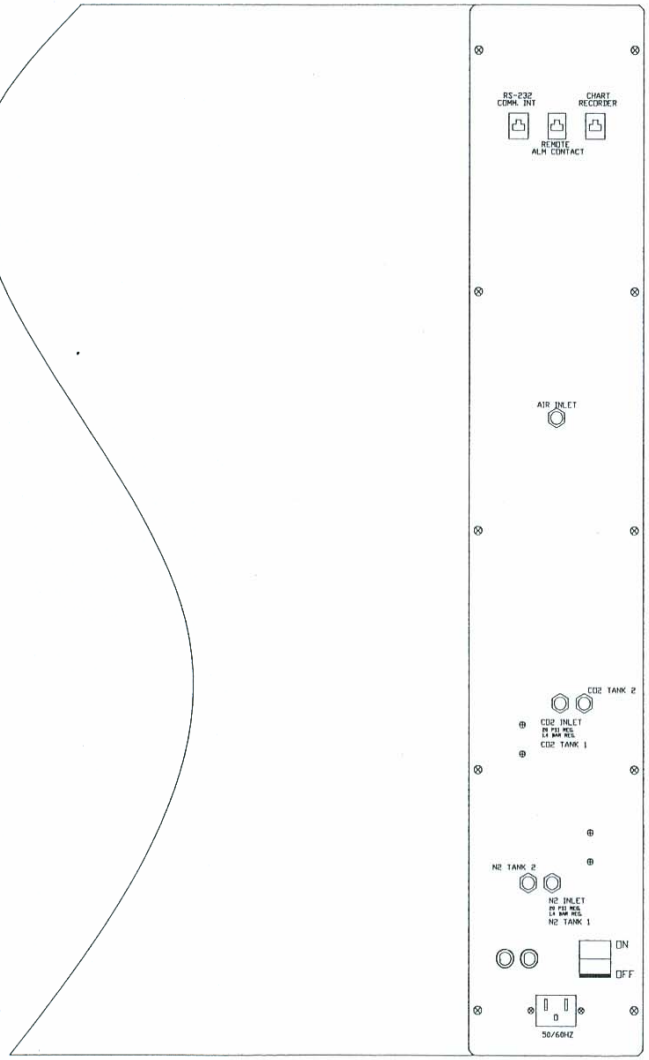


NU-4950/D/E/G
REAR PANEL, ARRANGEMENT

DFTMATL	5/6/99	CHKD	DB	SHEET 1 OF 1

DRAWING NUMBER BCD-07347 B

8.6 Run Mode Operator Interactions

In general, there is no need for operator interaction in "RUN" mode. However, operator interaction is required to perform calibration functions and abnormal condition status. If an abnormal condition has, or does, exist for a particular parameter, a blinking green LED next to the parameter will be lit. This could be a catastrophic alarm condition, which could harm the tissue culture cells. It does indicate an operational abnormality and should be checked. To acknowledge the abnormality, simply press and hold the run/setup key for three seconds to setup and then press and hold the run/setup key for three seconds back to Run. The blinking green LED will then extinguish. If the abnormality still exists, the blinking green LED will again be lit. Let run normally, if the blinking green LED doesn't come back on, everything is normal. If the blinking green LED does come back on, use the troubleshooting guide to correct the abnormality (see Section 11.0).

8.7 Setup Mode Operator Interactions

8.7.1 Chamber Temperature, CO_2%, Humidity Percent, O_2% Setpoint

Setpoint values are entered by pressing the "SEL" key until the LED is lit next to the desired parameter indicator. The value of the selected parameter will be shown in the display in the form "XX.X". To enter a setpoint, perform the following:

Chamber Temperature — Default Set-Point

- Press and hold run/setup key for three seconds to Setup. 37.0°
- Press [SEL] to indicate green LED next to chamber temperature display.
- Press ↑ or ↓ to indicate desired temperature.
- Press run/setup key back to Run.

CO_2 Percent[1]

- Press and hold run/setup key for three seconds to Setup. 5.0%
- Press [SEL] to indicate green LED next to CO_2 percent display.
- Press ↑ or ↓ to indicate desired CO_2 percent.
- Press run/setup key back to Run.

Humidity Percent (NU-4850, NU-4950) 90%

- Press and hold run/setup key for three seconds to Setup.
- Press [SEL] to indicate green LED next to humidity percent display.
- Press ↑ or ↓ to indicate desired humidity percent.
- Press run/setup key back to Run.

O_2 Percent (NU-4950)[2,3] 21%

- Press and hold run/setup key for three seconds to Setup.
- Press [SEL] to indicate green LED next to O_2 percent display.
- Press ↑ or ↓ to indicate desired O_2 percent.
- Press run/setup key back to Run.

[1]Please note, when the CO_2 setpoint is set for 0.0%, the CO_2 control system is turned off and all alarms are inhibited.

[2]Please note, when the O_2 setpoint is set for 21%, the O_2 control system is turned off and all alarms are inhibited. Additionally, since O_2% directly affects RH%, the RH setpoint will be automatically adjusted when the O_2% is decreased. The following table describes the relationship.

16% = <O2 SP = <21%, then max RH% = 95%
11% = <O2 SP <16%, then max RH% = 94%
06% = <O2 SP <11%, then max RH% = 92%
O2 SP <6%, then max RH% = 90%

[3]When selecting a setpoint of 10% or below set the air inject time to 0 (zero). See item 17 in section 8.8.4.

8.7.1.1 Automatic Adjustment of Post Inject Delay Times

Post inject delays are automatically adjusted according to the O2 set point to facilitate gas and RH recovery after a door opening. The value displayed in the option menu will not change but is the basis for a formula in the software that calculates the new delay time depending on the O_2 set point. As the set point is reduced the delay times are shortened. The following table illustrates this formula:

AUTOMATICALY ADJUSTED DELAY TIME = [1] SELECTED DELAY TIME – (2 x (21 - SELCTED O2 SET POINT)

Example: If the user changed the $C0_2$ delay time from 50 (default) to 40 seconds and changed to a 10% O_2 set point. By using the formula above, the delay time would be calculated as follows: **40- (2 x (21-10)) = 18 seconds**

[1] Selected delay time is the value that shows in the display when accessing one of the inject delays whether it is the default or user selected. The default values are used in the following table illustrating how the O_2 set point affects the post injection delay times.
[2]Equals the menu default delay value.

O_2 SET POINT (%)	O_2 / RH ADJUSTED DELAY TIME (SECONDS)	**CO_2** ADJUSTED DELAY TIME (SECONDS)
21	[2]40	[2]50
20	38	48
19	36	46
18	34	44
17	32	42
16	30	40
15	28	38
14	26	36
13	24	34
12	22	32
11	20	30
10	18	28
9	16	26
8	14	24
7	12	22
6	10	20
5	8	18
4	6	16
3	4	14
2	2	12

Systems affected: In the Option Configuration Parameter Section 8.8.4 items 14 - CO2 inject delay time, 15 – N-gas delay time, & 16 - RH inject delay time.

8.7.1.2 When the CO_2 system is active the level of CO_2 inversely affects the O_2 present in the chamber. This Incubator is programmed to adjust the maximum O_2 setpoint as indicated by the following table.

CO_2 Setpoint	Automatic max. O_2 Adjustment
0.1% to 1.0%	None
1.1% to 3.0%	20.0%,
3.1% to 6.0%	19.0%
6.1% to 10.0%	18.0%
10.1% to 15.0%	17.0%
15.1% to 20.0%	16.0%

8.8 Diagnostic Interactions

The US Autoflow has two types of general diagnostic methods, Power-up self-test and Diagnostic Mode tests.

8.8.1 Power-Up Self Test

The power-up self-test is comprised of the following sequential tests:

1) Tests all main control board memory.
2) Verifies its non-volatile memory (EEPROM) and displays the current version of program.
3) The digital displays of systems that are active will blink until either the run/setup key is pressed to Setup and back to Run or the [SEL] key is pressed.

8.8.2 Diagnostic Mode Tests

The Diagnostic Mode allows the operator to configure and/or check the Incubator for input/output signals manually and individually. The diagnosis mode has three menus to select from that are following:

- Tst - test output parameters
- Opt - option configuration parameters
- Rst - reset, master

To initiate the diagnosis mode, perform the following:

a) Press and hold Hidden key (flag on NuAire logo) for four seconds (in either Run or Setup mode), the temperature display will indicate the first menu "tst"
b) To advance to second menu, press ↑ key, temp. display will indicate "opt"
c) To advance to the third menu, press ↑ key, temp. display will indicate "rst".
d) To repeat the menus, continue to press the ↑ which will advance the menus in a round robin fashion.
e) To enter to desired menu, press the SEL key while desired menu is indicated on temp. display.

The "tst" and "opt" menus each have several function parameters as described below. The "rst" menu performs a master reset function which clears the microprocessor's memory and reset all parameters to their default conditions.

To enter the function parameters, press the SEL key while the temp. display indicates the desired menu. Then, while in the menu, press SEL key to advance through the function parameters, again, in a round robin fashion. Once in the desired function parameter, press the ↑ or ↓ key to alter or toggle on/off. To exit the diagnostic mode at any time, press the Hidden key several times.

.

8.8.3 Test Output Parameters

1. All Lights Display/LED Test
2. SAF -Safety Relay (**yes**/no)
3. CHt -Chamber Temp. Sensor (**0**,25,50,75,100)
4. SF.t -Safety Temp. Sensor (**0**,25,50,75,100)
5. CO2 -CO_2 Inject Valve (on/**off**)
6. P 12 -Power Supply Regulated +12 VDC
7. - 12 -Power Supply Regulated -12 VDC
8. O2 -N-Gas Inject Valve (on/**off**)
9. rH -RH Inject Valve (on/**off**)
10. Ct2 -CO_2 Tank 2 Valve (on/**off**)
11. nt2 -N-Gas Tank 2 Valve (on/**off**)
12. dor -Door Heater (**0**, 25, 50, 75, 100)
13. H2.H -RH Reservoir Heater (on/**off**)
14. A ir -Air Inject Valve (on/**off**)
15. ALr -Alarm Relay (on/**off**)

(Note: Default values are in bold)

Once you have made your menu selection, you will remain within that menu selection until you exit the diagnostic mode. If another menu selection is desired, you must re-enter the diagnostic mode via the hidden key.

To exit the function parameters, press the hidden key (flag on NuAire logo). The following is a description of each function parameter.

FUNCTION DESCRIPTION **READOUT DISPLAYED**

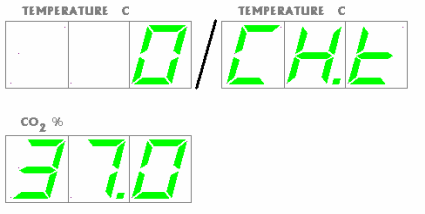
Note: / - Indicates alternating displays
or *- Indicates displays you can choose*

1. *Display/LED Test*
   This function will turn all individual LED's and value segments on, sequentially turn them all off and repeat the sequence until another function is selected.

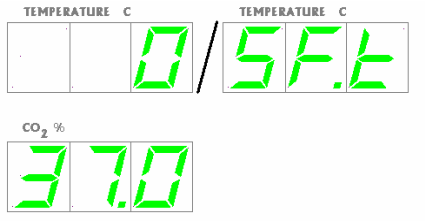
   All Lights

2. *Safety Relay*
   This function shows the current state of the safety relay. The CO_2 percent display will show "yes" or "no" corresponding to the relay condition.

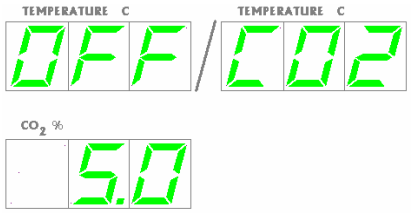
3. *Chamber Temperature Sensor*
This function shows the current value of the chamber temperature sensor on the temperature display.
This function also allows the jacket heater to be turned on at different percentages (0,25,50,75,100) alternating with the temperature (function 2 – Safety Relay should be "NO" to force heater output).



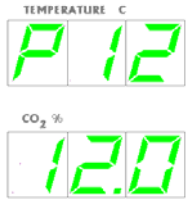
3. *Safety Temperature Sensor*
This function shows the current value of the water-jacket temperature sensor on the temperature display.
This function also allows the jacket heater to be turned on at different percentages (0,25,50,75,100) alternating with the temperature (function 2 – Safety Relay should be "NO" to force heater output).



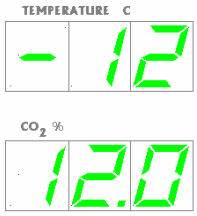
5. *CO_2 Inject Valve*
This function shows the current state of the CO_2 inject valve. The CO_2 percent display will show "on" or "off" corresponding to the valve condition.



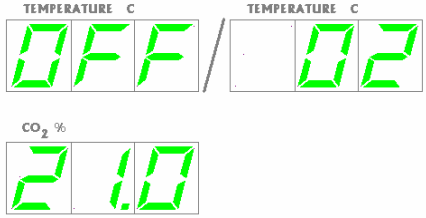
6. *Power Supply Regulated +12 VDC*
This function shows the current state of the regulated +12 VDC power supply.



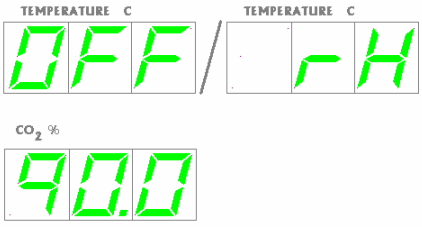
7. *Power Supply Regulated -12 VDC*
This function shows the current state of the regulated -12 VDC power supply.



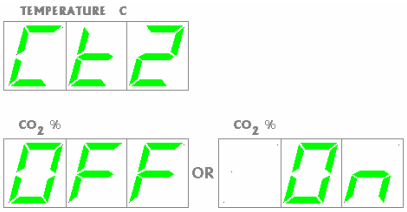
8. *N-Gas Inject Valve*
This function shows the current state of the N-Gas inject valve. he CO_2 percent display will show "on" or "off" corresponding to the valve condition.



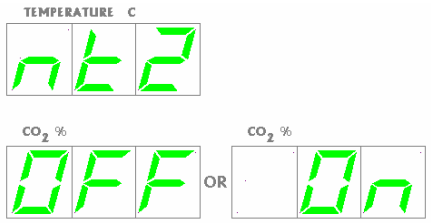
9. *RH Inject Valve*
This function shows the current state of the RH inject valve. The CO_2 percent display will show "on" or "off" corresponding to the valve condition.



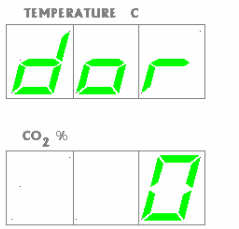
10. *CO_2 Tank 2 Valve*
    This function shows the current state of the CO_2 tank 2 valve. The CO_2 percent display will show “on” or “off” corresponding to the valve condition.



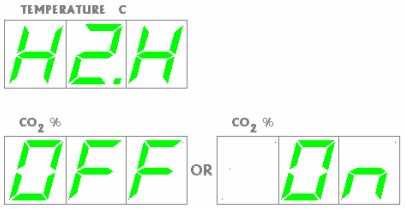
11. *N-Gas Tank 2 Valve*
    This function shows the current state of the N-Gas tank 2 valve. The CO_2 percent display will show “on” or “off” corresponding to the valve condition.



12. *Door Heater*
    This function shows the current state of the door heater. This function also allows the door heater to be turned on at different percentages (0,25,50,75,100) alternating with the “dor” indicator (function 2 - Safety relay should be "NO" to force heater output).



13. *RH Reservoir Heater*
    This function shows the current state of the RH reservoir heater. This function, indicated in the CO_2 percent display, allows the RH reservoir heater to be turned “on” or “off” corresponding to the heater condition.



14. *Air Inject Valve*
    This function shows the current state of the air inject valve. The CO_2 percent display will show “on” or “off” corresponding to the valve condition.

15. *Alarm Relay*
    This function shows the current state of the alarm relay. The CO_2 percent display will show “on” or “off” corresponding to the relay condition.

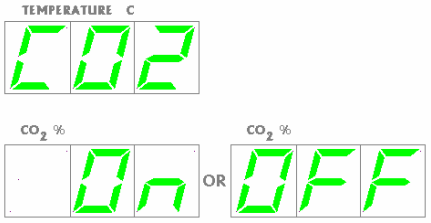
8.8.4 Option Configuration Parameters

			Range of Settings		
			Min	**Max**	**Current**
1.	C02	-CO_2 System Enable (**on**/off)	N/A	N/A	
2.	C.2t	-CO_2 Tank 2 Enable (on/**off**)	N/A	N/A	
3.	CAS	-CO_2 Auto Switch Back (on/**off**)	N/A	N/A	
4.	C.SC	-Closed Door CO_2 Zero/Span Calibration (on/**off**)			
5.	H20	-RH System Enable (on/**off**)	N/A	N/A	
6.	HC	-HC System Enable (**on**/off**)**	N/A	N/A	
7.	02	-O_2 System Enable (on/**off**)	N/A	N/A	
8.	n.t2	-N-Gas Tank 2 Enable (on/**off**)	N/A	N/A	
9.	nAS	-N-Gas Tank Switch Back Enable (on/**off**)	N/A	N/A	
10.	PAS	-Password (on/**off**)	N/A	N/A	
11.	C.2F	-CO_2 Display Delay (**on**/off)	N/A	N/A	
12.	Ar E	-Alarm Audible Enable (**on**/off)	N/A	N/A	
13.	At.0	-Auto Zero (**on**/off)	N/A	N/A	
14.	dor / dLY	-Door Delay Time (seconds/**45**)	2	240	
15.	C2.1 / dL.Y	-CO_2 Inject Delay Time (seconds/**50**)	2	240	
16.	n2.1 / dL.Y	-N-Gas Inject Delay Time (seconds/**40**)	2	240	
17.	H2.1 / dL.Y	-RH Inject Delay Time (seconds/**40**)	2	240	
18.	A ir / inJ	-Air Inject Time (seconds/**30**)	0	999	
19.	A ir / CYL	-Air Inject Cycle (minutes/**10**)	1	999	
20.	Prt / n in	-Print Frequency Time (minutes/**0**)	0	999	
21.	HC / inJ	-Maximum RH Inject Time (minutes/**20**)	10	40	
22.	HC / Cnt	-Maximum Number of RH Injections (qty/**10**)	5	20	
23.	CH.t / to	-Temperature Time Out (min/**360**)	1	999	
24.	Co2 / to	-CO_2 Time Out (min/**30**)	1	999	
25.	o2 / to	-O_2 Time Out (min/**30**)	1	999	
26.	H2o / to	-RH Time Out (optional) (min/**240**)	1	999	
27.	SAF / d iF	-Temp. Sensor Differential (°C/**6.0**)	0.5	20.0	
28.	CH.t / ALr	-Temp. Max. Above Setpoint (°C/**1.0**)	0.5	10.0	
29.	C02 / ALr	-CO_2 Max. Above Setpoint (%/**1.0**)	0.5	10.0	
30.	02 / ALr	-O_2 Max. Under Setpoint (%/**1.0**)	0.5	10.0	
31.	H20 / ALr	-RH Max. Above Setpoint (%/**5.0**)	0.5	20.0	

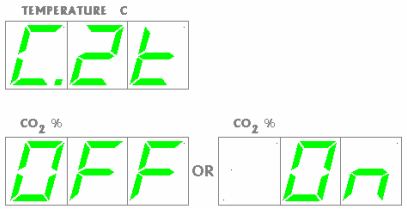
(Note: Default values are in **bold)** The column labeled **Current** is provided to record settings chosen if other than the default value listed. Once you have made your menu selection, you will remain within that menu selection until you exit the diagnostic mode. If another menu selection is desired, you must re-enter the diagnostic mode via the hidden key.

To exit the function parameters, press the hidden key (flag on NuAire logo). Following are descriptions of each control parameter.

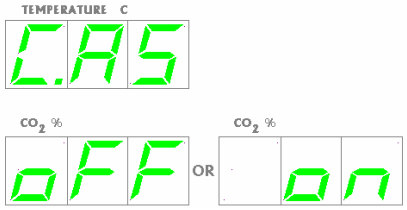
1. *CO_2 System Enable*
   This function will enable or disable the CO_2 system. The value display will show "on" or "off" corresponding to the current condition. In Run mode, the CO_2 percent display will indicate either the CO_2 percent when the system is on, or nothing when the system is off.



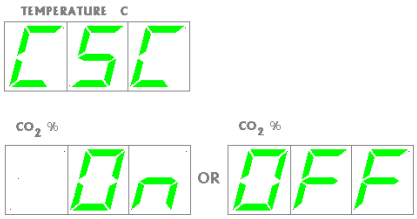
2. *CO_2 Tank 2 Enable (option)*
   This function will enable or disable the optional CO_2 tank 2 system. The value display will show "on" or "off" corresponding to the current condition.



3. *CO_2 Tank Switch Back (option)*
   Note function can only be enabled with CO_2 tank 2 option in use. Unit will automatically check tank 1 for gas pressure every 12 hours, and stay on Tank 1 if pressure is detected.

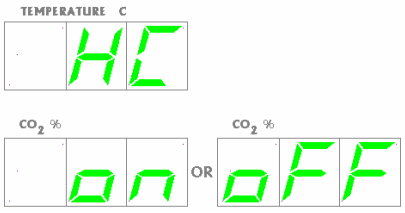


4. *Closed Door CO_2 Zero/Span Calibration*
   This option enables user to run zero & span calibration on the CO_2 sensor with out opening the Incubator door. (See section 9.4.2).

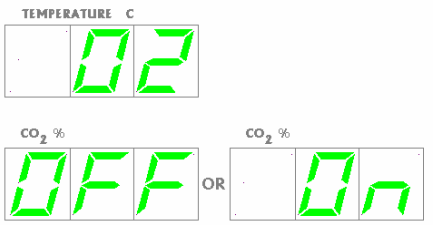


5. *RH System Enable (NU-4850 & NU-4950 only)*
   This function will enable or disable the optional RH system. The value display will show "on" or "off" corresponding to the current condition. In Run mode, the RH percent display will indicate either the RH percent when the system is on or blank when the system is off. At NU-4950 model, this option must be present in order to run O_2 system.

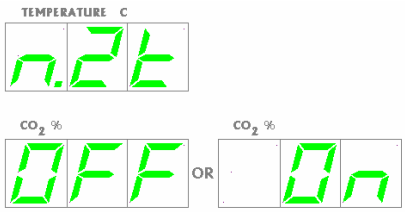
6. *Humidity Control Alarm Enable (4850 & 4950 only)*
   This function will enable or disable the optional RH system control fault detection and alarm. Display shows on or off. This function is automatically turned off when an O_2 setpoint of 5% or below is selected.



7. *O_2 System Enable (NU-4950 only)*
This function will enable or disable the optional O_2 system. The value display will show "on" or "off" corresponding to the current condition. In Run mode, the O_2 percent will indicate either the O_2 percent when the system is on or blank when the system is off. Default setpoint for O_2% is 21. At NU-4950, RH system must be present in order to run O_2 system.

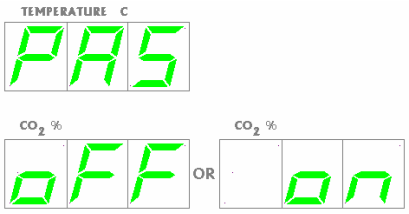


8. *N-Gas Tank 2 Enable (Option in NU-4950 model)*
This function will enable or disable the optional N-Gas tank 2 system. The value display will show "on" or "off" corresponding to the current condition.



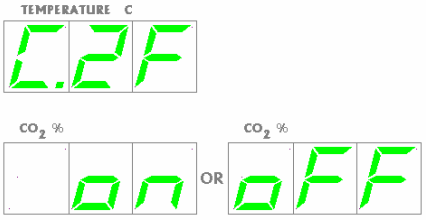
9. *N-Gas Tank Switch Back (option)*
Note function can only be enabled with N-Gas tank 2 option in use. Unit will automatically check tank 1 for gas pressure every 12 hours, and stay on Tank 1 if pressure is detected.

10. *Password*
This function allows users to disable/enable password to prevent unauthorized change of setpoint, using Up, Down and Select keys combination. Password requires three digits. If the password option is enabled, whenever 'SETUP' key is pressed, the password will be required. Every time the password option is disabled and re-enabled, the old password is cleared and new password will be required.
To set password:



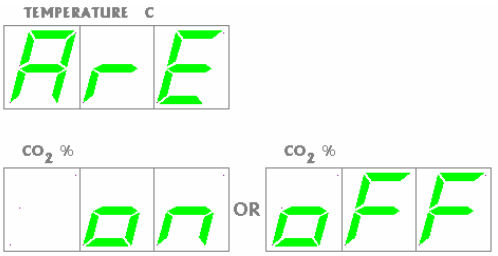
- Press Hidden key to enter option menu.
- Press ↑ to advance to "opt".
- Press [SEL] several times to advance to "Pass"
- Press ↑ to enable option, "ON".
- Press Hidden key twice to exit option menu
- Enter your password, when Front panel message displays 'Ent – Pas".
- Re- Enter your password, when Front panel message displays 'Pas – rEO'
- Press Run/setup key to Setup, then back to Run to set.

11. *CO_2 Display Delay*
This function delays the CO_2 display after a door opening for a period of fifteen minutes. This function will not inhibit the CO_2 alarm system.



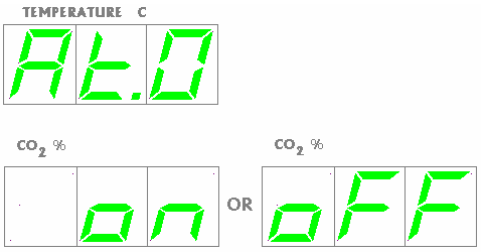
12. Audible Alarm Enable

This function will enable or disable the audible alarm ringback function. The value display will show "ON" or "OFF" corresponding to the current condition. If the function is "ON", the audible alarm will provide a ringback of the alarm condition. If the user pushes any key to silence the audible alarm, after 15 minutes of silence the audible alarm will return. If the function is "OFF", the ringback of the alarm condition will never come back after the user pushes a key to silence the audible alarm.



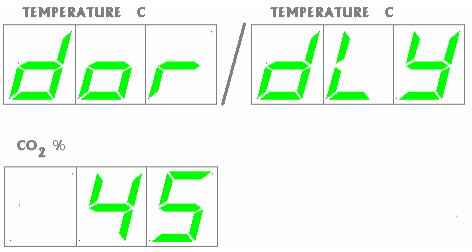
13. Auto Zero Enable

This function turns the CO_2 automatic zeroing routine on and off. Default on.



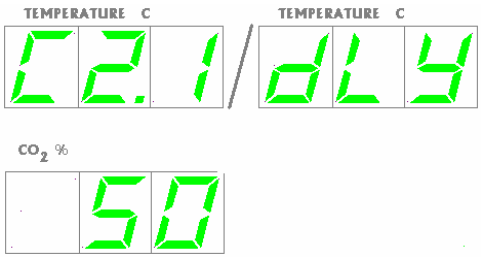
14. Door Delay Time

This value determines the time, in seconds, to turn on the door heater to a 100 percent duty cycle after opening, then closing the inner glass door. It also determines the amount of time gas and humidity injections are delayed after closing the inner glass door.



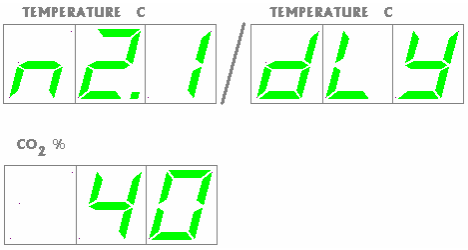
15. CO_2 Inject Delay Time

This value specifies the time, in seconds, for an injection of CO_2 to be measurable at the sensor. When CO_2 is injected into the chamber, the system delays until this period has elapsed before making a new control decision. In this manner tubing induced delays do not cause the CO_2 system to overshoot the control setpoint. The CO_2 inject delay time prevents CO_2 overshoot during the CO_2 inject process. This value is automatically reduced when the O_2 setpoint is reduced to achieve better recovery after a door opening. See section 8.7.1.1 for details.

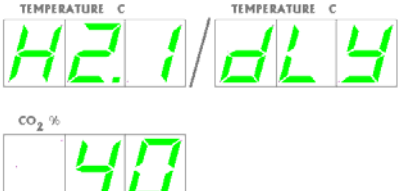


16. N-Gas Inject Delay Time (NU-4950)

This value specifies the time, in seconds, for an injection of N-Gas to be measurable at the sensor. When N-Gas is injected into the chamber, the system delays until this period has elapsed before making a new control decision. The N-Gas inject delay time prevents N-Gas overshoot during the N-Gas inject process. This value is automatically reduced when the O_2 setpoint is reduced to achieve better recovery after a door opening. See section 8.7.1.1 for details.



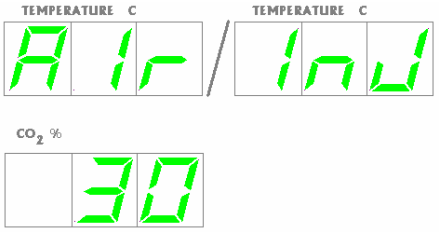
17. RH Inject Delay Time (NU-4850 & 4950)



This value specifies the time, in seconds, for an injection of RH to be measurable at the sensor. When RH is injected into the chamber, the system delays until this period has elapsed before making a new control decision. The RH inject delay time prevents RH overshoot during the RH inject process. This value is automatically reduced when the O_2 setpoint is reduced to achieve better recovery after a door opening. See section 8.7.1.1 for details.

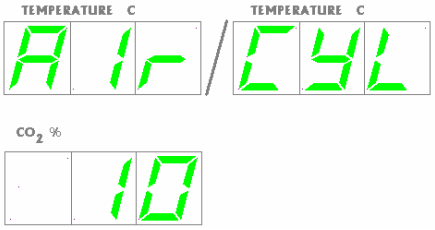
18. Air Inject Time

This value specifies the time, in seconds, for an injection of air into the chamber. Reduce this value to 0 for O_2 setpoint of 10% and below. See section 8.7.1.



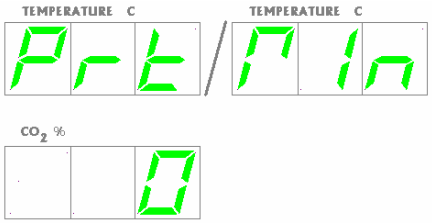
19. Air Inject Cycle Time

This value specifies the time, in minutes, of the frequency of the air inject cycle.



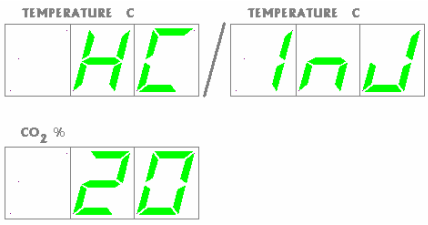
20. Print Frequency Time (Option)

This parameter specifies the frequency, in minutes, that lines are to be printed on a status report. If the frequency is specified as zero, no report will be printed.



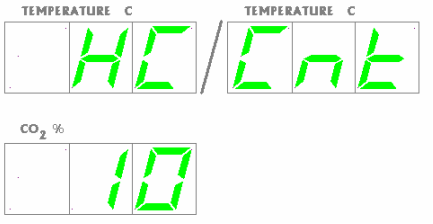
21. Maximum RH Inject Time

This parameter specifies the time after a door opening, in minutes, that the RH inject solenoid may remain continuously on after all controlled gases have recovered, without declaring an "HC" alarm. See Error Indicators and Troubleshooting Section 11 for details of alarm state.



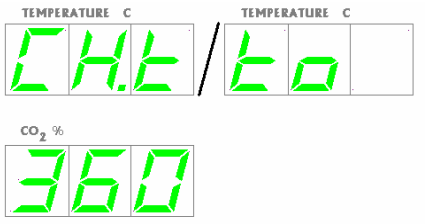
22. Maximum Number of RH Injections

This parameter specifies the number of times, after recovering to within 5% of setpoint, that the RH inject solenoid may cycle on and off before achieving setpoint, without declaring an "HC" alarm. See Error Indicators and Troubleshooting Section 11 for details of alarm state.



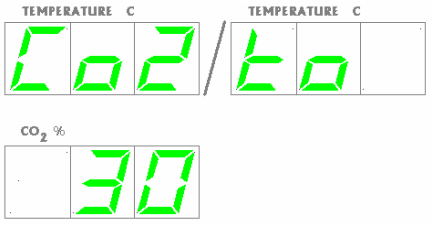
23. Temperature Time Out

This value determines the time, in minutes, for the temperature to achieve setpoint. If the temperature doesn't get to within 0.2° of setpoint within this time period, an alarm condition is declared.



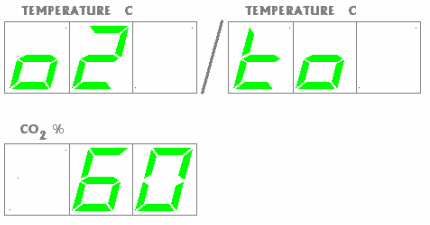
24. CO_2 Time Out

This value determines the time, in minutes, for the CO_2 percentage to achieve setpoint. If the CO_2 percentage doesn't get to within 0.2% of setpoint within this time period, an alarm condition is declared.



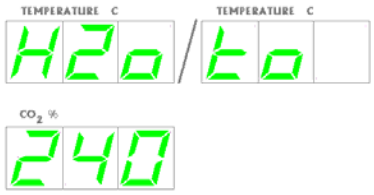
25. O_2 Time Out (NU-4950 Only)

This value determines the time, in minutes, for the O_2 percentage to achieve setpoint. If the O_2 percentage doesn't get to within 1.0% of setpoint within this time period, an alarm condition is declared.



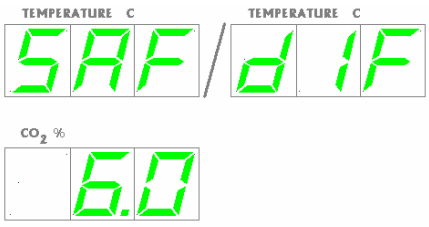
26. RH Time Out (NU-4850 & 4950)

This value determines the time, in minutes, for the RH percentage to achieve setpoint. If the RH percentage doesn't get to within 1.0% of setpoint within this time period, an alarm condition is declared. The timer for this alarm starts after the CO_2 and/or O_2 systems have recovered within to with in 0.2% of set-point if the system is active.



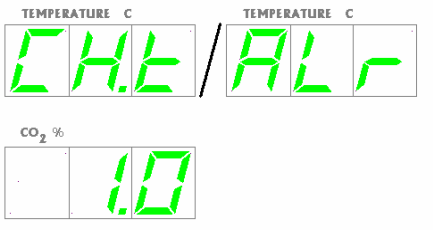
27. Temperature Sensor Differential

This value specifies a maximum differential, measured in temperature (°C) that the two temperature sensors may deviate from one another or from the last read value. If this differential is exceeded, a warning LED is shown and an alarm condition is declared. An alarm condition will cause the chamber to enter a safe condition where no power is enabled to any of the system output controls until the situation is rectified.



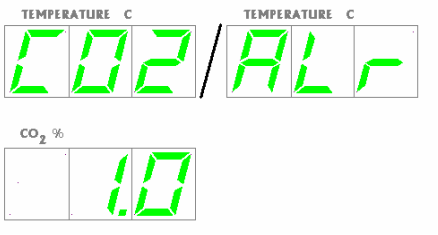
28. Temperature Maximum Above Setpoint

This value determines the maximum deviation, measured in temperature (°C), that the chamber is permitted above once the Incubator reaches the specified setpoint before an alarm condition is declared. An alarm condition will cause the chamber to enter a safe condition where no power is enabled to any of the system output controls until the situation is rectified.



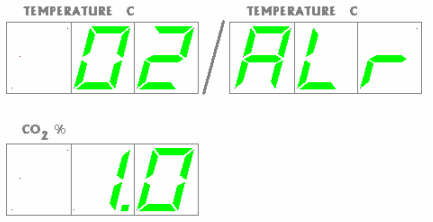
29. CO_2 Maximum Above Setpoint

This value determines the maximum deviation, measured in CO_2 percent (%), that the chamber is permitted above once the Incubator reaches the specified setpoint before an alarm condition is declared.



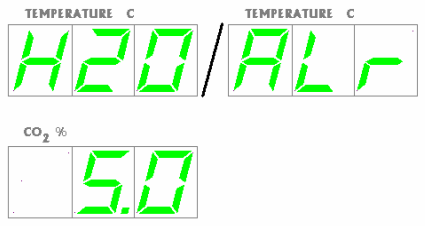
30. O_2 Maximum Under Setpoint (NU-4950)

This value determines the maximum deviation, measured in O_2 percent (%), that the chamber is permitted below once the Incubator reaches the specified setpoint before an alarm condition is declared.



31. RH Maximum Above Setpoint (NU-4850 & 4950)

This value determines the maximum deviation, measured in RH percent (%), that the chamber is permitted above once the Incubator reaches the specified setpoint before an alarm condition is declared.



8.8.5.1 Reset, Master

The master reset diagnosis function is the last effort to correct operational faults, which otherwise cannot be solved. By reloading the default configuration, the entire memory will be reset and **ALL CALIBRATION OFFSETS AND CONFIGURATION OPTIONS WILL BE LOST. ALL CURRENT RUN PARAMETERS WILL BE RESET TO DEFAULT VALUES.**

To perform a master reset, follow the steps below:

- Press and hold Hidden key for four seconds (in either Run or Setup mode), the temperature display will indicate the first menu "tst".
- Press ↑ key, temp. display will indicate "opt".
- Press ↑ key, temp. display will indicate "rst".
- Press [SEL] key two times to initiate the reset process. Once the master reset process is complete, the unit will reset into the Setup mode.

All calibration will need to be performed following a master reset. Default control parameters after master reset are 37 ^{o}C (temperature), and 5% (CO_2). For NU-4850, NU-4950 models, RH and O_2 systems need to be enabled by following below steps:

RH System enable:

- Press Hidden key to enter option menu.
- Press ↑ to advance to “opt”.
- Press [SEL] several times to advance to “H2O”
- Press ↓ to enable system, “ON”.
- Press Hidden key twice to exit option menu.
- Change default setpoint (90%) if necessary.

O_2 System enable:

- Press Hidden key to enter option menu.
- Press ↑ to advance to “opt”.
- Press [SEL] several times to advance to “O2”
- Press ↓ to enable system, “ON”.
- Press Hidden key twice to exit option menu.
- Change default setpoint (21%) if necessary

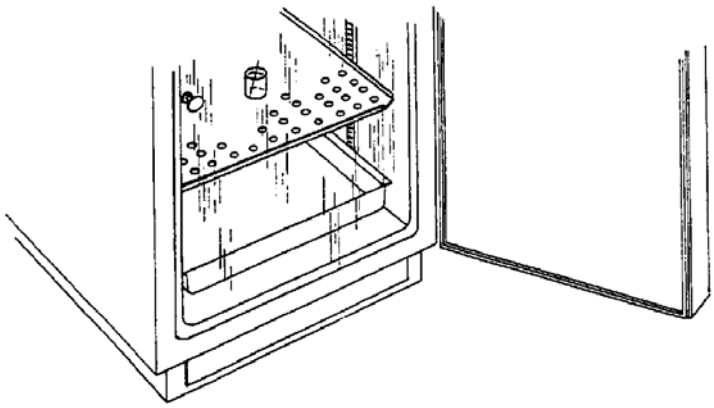
9.0 Calibration

Proper calibration of the US Autoflow involves four parameters: chamber temperature, door temperature, CO_2 sensor, humidity, and O_2 sensors (NU-4850, 4950). The first two, chamber and door temperature should be completed and stabilized before any CO_2/humidity/O_2 sensor calibration is performed. Below, each calibration procedure is described in detail. For the best results, follow the procedure carefully, and if the desired result is not achieved, try procedures again from the start.

9.1 Chamber Temperature Calibration

The US Autoflow's TEMPERATURE CALIBRATION MUST BE PERFORMED WITHIN 1°C OF THE PLANNED OPERATING TEMPERATURE. Normally, 37.0°C is the most common setpoint. To initiate the procedure, turn on the IR Autoflow via the power switch on the back panel. Press the run/setup key until the unit goes into setup mode to check the temperature value parameter for your planned operating temperature and change if necessary. Press the run/setup key again until the unit switches back to Run and let stabilize for 8 to 12 hours.

At the beginning of this procedure, set a mercury glass thermometer in a glass beaker filled with water resting on a shelf in the middle of the IR Autoflow chamber. Do not place the glass beaker on the bottom of the chamber because it will result in a slightly higher temperature due to the heater pan being located just below the chamber bottom. Placing the thermometer in a glass beaker on the middle shelf will give the most accurate results for calibration. Chamber should be humidified to avoid false low readings due to evaporation of water from the flask. An accurate digital thermometer with a type K thermo couple could also be used.



When the unit has stabilized at the operating temperature, perform the following calibration procedure.

- Make sure unit is in Run mode, green LED above the run/setup key should be on solid.
- Press [SEL] to indicate green LED next to temperature display.
- Press and hold ↑ key for four seconds, temperature display alternates between "Adj" and the current temperature.
- Press ↑ or ↓ key to indicate same temperature as thermometer.
- Press [SEL] key to complete calibration.

The chamber temperature calibration is complete. Let unit stabilize for 8 to 12 hours. If the chamber temperature (actual thermometer) still does not match the display, perform the above procedure again. In some cases it might be necessary to calibrate several times to achieve a stable condition due to ambient conditions of temperature and humidity within the laboratory.

9.2 Door Temperature Calibration

The Autoflow's inner glass door temperature calibration is best accomplished by running the Incubator 24 hours with the chamber humidified. Perform the following calibration sequence, if required. Open the Incubator door and look for general condensation. Some condensation on the glass door can be desirable as an indication of adequate humidity in the chamber. Typically, one to two inches of condensation in the corners of the glass door indicates a properly calibrated door heater. Typically, no condensation should form on the inner chamber next to the glass door. However, if calibration is required, simply perform the procedure as stated below. The door heater operates as a duty cycle percentage ON/OFF (0 is off, 100 is Full ON). Typically, 40 to 60 percent is the most effective duty cycle for the door heater in 22ºC ambient with a 37.0ºC set point. Default setting for the door is 45%.

CAUTION: Adjust the door heater duty cycle in small increments. A maximum adjustment of 5% at a time either up or down is recommended. If duty cycle is adjusted too high, it will cause condensation on the chamber walls and ceiling.

The following steps should be taken for setting these duty cycle percentages:

- Allow Incubator to stabilize at its given temperature and humidity level.
- In run mode, press "SEL" to indicate LED next to temperature display.
- Press and hold ▲ and ▼ keys simultaneously for three seconds. Temperature displays "dor" and the duty cycle percentage.
- Press ▲ or ▼ key to desired door duty cycle percentage. A maximum adjustment of 5% should be made at a time.
- Press "SEL" to set current value and return to run mode.

9.2.1 Door heater duty cycle automatic control

The door duty cycle is automatically reduced when the room temperature in the lab increases enough to allow the contribution from this heater to overheat the chamber. For example, if the door duty cycle is set up when the room temperature is 22ºC and the room temperature is allowed to increase to 27ºC. Less heat is required to keep the chamber at set point. If the chamber starts to overheat, the door duty cycle will be reduced at a rate of 1% per minute starting when the chamber temperature is 0.2ºC above set point. The duty cycle will continue to be reduced until the chamber temperature returns to set point. The duty cycle is continuously monitored and will be increased slowly again, as long as the chamber temperature does not go over the set point. If the room ambient reduces back to 22ºC, the door duty cycle will actually be returned to the original setting.

Note: If it is known that the lab room temperature where the Incubator is installed will vary significantly. (For example, the heating or air conditioning is shut off after work hours or there is no air conditioning and the room has large temperature swings.) The door duty cycle should be set up in the lower temperature expected in the lab. Then the door heater will automatically be adjusted to avoid over temperature conditions in the chamber when the room temperature rises. In this case the chamber should be monitored for condensation regularly. If the chamber walls and ceiling start to get excessive condensation, the door heater duty cycle setting will need to be reduced. Do not adjust the duty cycle setting by more than 5% at a time.

9.3 Setting Air Injections

If there is still some undesired condensation in the chamber when the door heater is set for the desired result, the air injections can be adjusted. There is a control for length of the air injection labeled, Air Inject Time, and the frequency that air is injected called, Air Inject Cycle. These controls are described in more detail in the "Opt" menu. The default is 30-second injections every 10 minutes. Start by increasing the length of the injection by a few seconds at a time then increase the frequency if needed. The target would be to look at seconds of injection per hour of operation. See section 9.6 if you are reducing the level of O_2 in the chamber with the O_2 system.

9.4 CO_2 Calibration

The Autoflow infrared CO_2 sensor may be calibrated using one of three techniques: CO_2 control, CO_2 sensor and CO_2 injection calibration. The CO_2 control and CO_2 injection calibration procedure are easily performed on the front panel similar to the temperature offset requiring no tools. The CO_2 sensor internal procedure is more in depth requiring approximately 15 minutes to perform.

9.4.1 CO_2 Control Calibration

CO_2 Control Calibration can be performed anytime an independent measurement doesn't correlate to the front panel display. However, this calibration SHOULD NOT BE PERFORMED MORE THAN ONCE PER WEEK. Sensor calibration should be performed if an independent measurement doesn't match the display within ±0.3 percent within one week after a sensor calibration. Before doing the following calibration, check and change, if necessary, the Incubator in-line filter found within the control center and the CO_2 gas line filter found outside the back of the Incubator.

When unit has stabilized at the operational temperature and CO_2 percentage, take an independent measurement and, if necessary, perform the following:

- In run mode press "SEL" to indicate LED next to CO_2 percent display.
- Press and hold ▲ key, CO_2 display alternates between "ADJ" and the CO_2 percentage.
- Press both ▲ and ▼ keys simultaneously, (clears all previous offsets).
- Use an independent instrument to determine actual CO_2 percentage (compare the display CO_2 value to the independent measurement). If these two readings have a difference of less than 1.0 percent, proceed to the next step in this routine. (See * **Note** below) If the difference is greater than 1.0 percent, proceed to CO_2 sensor zero/span calibration.
- Press ▲ or ▼ key to indicate same CO_2 percentage as the independent measurement.
- Press "SEL" to set current value and exit calibration.

***Note**: When the display value is more that 0.3% different from the measured value, offset display 1/2 the difference measured. Allow the Incubator to stabilize back to set point, then measure the CO_2 in the chamber again. Offset the display again if necessary.

9.4.2 CO_2 Sensor Calibration (Zero/Span)

There are 2 sensor (zero/span) calibration routines available to the lab professional. The first option is the "open door" routine involving opening the outer and inner door to zero the sensor. This routine also automatically calibrates to the CO_2 injection rate during the injection for the span portion of the sensor calibration. It is recommended that this routine be used during the initial setup of the Incubator, if the set point of the system is changed or if other changes are made on the Incubator affecting the CO_2 system. The second option is a "closed door" routine. This routine allows calibration of the sensor with out opening the door avoiding undue exposure to the cultures that may be in process. This routine injects "fresh air" into the detector head of the sensor to calibrate zero. The chamber air is then allowed back into the detector head to calibrate the gas span that is detected. The closed-door routine option is activated through the Options menu and must be turned off to use the open door routine.

<u>OPEN DOOR CO_2 SENSOR CALIBRATION ROUTINE</u>
(Default CO_2 calibration routine):
Zero calibration

- Make sure unit is in Run mode, the green LED above the run/setup key should be on and not blinking.
- Press the "SEL" key to indicate the LED next to the CO_2 display.
- Open the inner and outer doors then push the ▼ until "dor" appears in the temperature display: When "dor" starts flashing after 90 seconds close the doors. **CAUTION: Do not fan inner door when open for evacuating CO_2 from the chamber. If the door switch is activated it will cause the calibration routine to prematurely advance, then user would have to rerun calibration.**
- Display shows old value if other than zero then zeros out.

Note: If the value in the display is greater than 0.2 prior to the display zeroing, run the calibration routine again to ensure a proper zero was achieved.

The CO_2 display will show the following in order:
Span Calibration
"INJ" alternating w/value: Shows right after the door is closed from the zero calibration. The unit injects CO_2 targeting the selected set point.
"DLY" alternating w/value: Shows for 90 seconds to indicate the delay to give CO_2 time to mix in chamber.
"SPn" alternating w/value: Indicates the span value shown in the display is ready for verification. Measure chamber CO_2 at sample port on the front panel with an independent instrument. Change display value to match this measurement using "▲▼".

Press Run/Setup key to switch to set up then back to Run to lock in value and go back to normal running mode.

Note: The CaL inject rate is automatically calculated from the CO_2 injection made during the span calibration making it unnecessary to run the separate "CAL InJection" calibration. The injection is dependent on the proper gas pressure and factory set flow rate. Any changes in either will result in a change to the value reached during this injection.

CLOSED DOOR SENSOR CALIBRATION ROUTINE
(Default "OFF" see section 8.8.1.2 item 4):
Activating the routine

- Press logo key until tSt flashes in display then press ▲ to select the OPt menu.
- Press "SEL" until C.SC appears in the display.
- Press the ▲to turn this option on and shut off the open door routine.
- Press the logo key to return to run.

Note: Turning off this routine will reactivate the "open door" calibration routine.

Zero Calibration

- Make sure unit is in Run mode, the green LED above the run/setup key should be on and not blinking.
- Press the "SEL" key to indicate the LED next to the CO_2 display.
- Press the ▼ until "ZEr/value" alternate in the display: Air is being pumped through the sensor to confirm the sensor zero value. After 45 seconds the display is automatically zeroed and the span portion of the routine is started.

Note: If the value in the display is greater than 0.2 prior to the display zeroing, the zeroing portion of the routine should be run again. The current routine can be aborted by pressing "SEL". Press "SEL" again to select the CO_2 display to restart the routine.

The CO_2 display will show the following in order:
Span Calibration
"DLY" alternating w/value: Shows for 90 seconds to indicate the delay to give CO_2 from the chamber time to reenter the detector head and get an accurate reading.
"SPn" alternating w/value: Indicates the span value shown in the display is ready for verification. Measure chamber CO_2 at sample port on the front panel with an independent instrument. Change display value to match this measurement using either "▲▼".

Press run/setup key to switch to Setup then back to Run to lock in value and go back to normal running mode. Allow unit to run and stabilize for a minimum of 2 hours then, check calibration with an independent instrument. Compare the display CO_2 percent to your independent measurement. If these two readings have a difference greater than 0.3%, repeat above procedure. If these two readings have a difference of less than 0.3%, perform the CO_2 control calibration procedure in Section 9.4.1.

Note: When the span measurement is greater than the setpoint, open the door briefly to remove excess CO_2.

9.4.3 CO_2 Injection Calibration

The CO_2 injection calibration can be performed separately from zero/span calibration to optimize the gas injection time required to recover the CO_2 level to set point after a door opening. The recovery time should be as minimal as possible with virtually no overshoot. CO_2 injection calibration is required to be performed only after a CO_2 sensor closed door calibration. CO_2 injection calibration should also be performed anytime the CO_2 supply pressure to the Incubator is changed, or if the CO_2 flow control valve on the back panel is disturbed.

The following steps should be taken for the CO_2 injection calibration:

- Press "SEL" to indicate LED next to CO_2 percent display.
- Press and hold ▲and ▼ keys simultaneously for three seconds. "CAL" and current indicated CO_2% will blink.
- Open door for at least 1 minute to evacuate the CO_2 from the chamber. The value on the display should be below 1% before closing the door to continue the routine
- Press and hold ▲ and ▼ keys simultaneously again to start auto calibration procedure.
- Observe display, which will indicate the following sequence:
    a) dLY - Wait for door delay, prior inject delay, temp. in range.
    b) INJ - Inject CO_2 for fixed time period according to the set point
    c) dLY - Wait for post inject diffusion.
    d) End - Done with Calibration
- Press "SEL" to set current value and exit calibration.
- If necessary, open glass door to vent excess gas.

9.4.4 CO_2 System Auto Zero Calibration Function

This Incubator is programmed to automatically check and adjust the zero calibration of the CO_2 sensor. HEPA filtered room air is pumped through the sensor detector cell for 2 minutes. The CO_2 reading is checked at this time. If it 0.5% or less different than the current zero the sensor will use the new value as zero. When the value is greater than $\pm$ 0.5%, the auto zero routine is aborted and an ACF alarm is sounded. See Section 11.0 on Trouble Shooting for responses to this alarm.

The auto zero routine is scheduled to be initiated 12 hours after the Incubator is turned on and then every 24 hours thereafter. This timing is structured to run the auto zero routine daily at a time that would be considered "off hours". The timer for this routine can be reset at any time by simply turning the Incubator off then back on. Power failures will reset the timer.

This routine is essentially transparent to the operation of the Incubator and the factory supplied options like the chart recorder or the printer outputs while it is running. After the routine is done the CO_2 level will be reduced by about 0.2% to 1.0% depending on the amount of air that has be injected to perform the routine. The routine can run as long as 7 minutes because it will try to perform the zero function up to 5 times before declaring an “ACF” alarm. If any calibrations are attempted during this routine "SLF" shows in the display and the calibration is inhibited until the routine is complete. An independent monitoring system will record a minor shift in CO_2, O_2, RH and temperature during the routine. This happens because the air injected into the sensor, during the purge and while the sensor is performing the zero function, is passed into the chamber.
This routine compensates for minor shifts in zero due to electronic drift. Regularly scheduled checks of the calibration by an independent instrument must still be performed.

To abort the Auto Zero routine open the inner glass door and close it again.

9.5 Relative Humidity Calibration (NU-4850, NU-4950)

9.5.1 Relative humidity calibration can be performed anytime if the relative humidity option has been installed. The relative humidity sensor can be calibrated from a known source of humidity within the Incubator chamber. Typically, the water pan is used because it has a known minimum humidity level of 96 percent after 12 hours.

Calibrating the Incubator with a water pan (included with the Incubator):
To prepare the Incubator for calibration, perform the following steps:

- Be sure the relative humidity option is turned on. See Section 8.8.5 if it is not.
- With the mode switch in run, press "SEL" until the LED next to the humidity display is lit.
- Press and hold both ↑ and ↓ until the humidity display alternates showing "rH" then the current humidity level it detects. This indicates that the humidity option is in calibration mode.
- Place the water pan into one of the lower shelf sliding racks and fill it about half way up with single distilled water, **NO PURER THAN 1 MEGAOHM**.
- Let Incubator stabilize for 10 to 12 hours at the chosen temperature and CO_2 setpoints.

When unit is stabilized at the operational temperature, CO_2 percentage and water pan in place, perform the following calibration procedure:

- Press [SEL] until the LED next to the humidity display is lit.
- Press the ↑ until the display starts alternating between "bl" and the RH percentage.
- Press ↑ or ↓ to indicate the same RH% as the reading on the independent hygrometer.
- Press [SEL] key to complete calibration.
- Press [SEL] until the LED next to the humidity display is lit.
- Press both ↑ and ↓ key until the display stops flashing and shows only the humidity value. This takes the option out of calibration mode and puts it back into operation mode.
- Open the door for at least 15 seconds and close it again to allow the system to inject humidity with the new calibration. Remove the water pan while the door is open.

Allow at least a couple of hours for the Incubator to stabilize. Recheck the calibration with the hygrometer.

NOTE: Over time, some condensation can be expected in the chamber at a 95% RH setpoint.

9.5.2 Selecting a set-point <u>Recommended Maximum - 90%</u>

The Relative Humidity control system provides humidity in a significantly different manner than the water pan method. The water pan is limited to bringing the chamber humidity level to saturation and no further because the chamber air and the water are at the same temperature.

The Control system injects humidity at a temperature averaging 70ºC to reach a set-point determined by the lab professional's requirement. The ability maintain this set point is determined by how accurately the humidity sensor is calibrated during setup of the Incubator and, the ability of the sensor to maintain that calibration referred to as its accuracy. These are the two predominant factors that will govern how high of a set-point is chosen.
Accuracy of calibration:
The hygrometer used to calibrate the Incubator sensor will have a tolerance that is specified by the manufacturer of the instrument. The tolerance of accurate hygrometers is usually about +\- 2% at this humidity level. This means that when 90% is read on the instrument the actual relative humidity percentage can be 92%. When the sensor accuracy of <u>+</u>3% (see section **3.4**) is taken into account the actual humidity can reach 95%. This is very close to saturation but is still does not exceed the ability of the sensor to control the humidity. Any set-point chosen above 90% can lead to the actual relative humidity reaching saturation before the system set-point is achieved.

For example a 92% set-point is chosen. The actual chamber humidity can reach saturation (96%) before the sensor tells the Incubator that the set-point has been reached. This causes the system to continue to inject humidity into the chamber that will condense out since the humidity level is already at saturation. Eventually the system will go into an HC alarm (see sections **8.2 & 8.8.4 no's 20 &21**) and the humidity system will switch to a passive mode avoiding too much condensation. This alarm will then have to be cleared and the relative humidity system will have to be checked for calibration.

Maintaining 91 to 95% set-points (if required):

Calibrating to minimize Condensation

Wait for at least one day after performing the initial calibration. When rechecking the calibration, take into account the rated accuracy of the hygrometer being used for the calibration. If it has a tolerance, of ±2% or more, the relative humidity with a reading of 95% could actually be 97% or higher. Visually inspecting the chamber will help get an acceptable relative humidity level and avoids excessive condensation on the chamber walls. If condensation is forming on the chamber walls or if they are starting to fog up, this would indicate that the RH is higher than 95% (see Note 1). Recalibrate the display up 1 or 2%, depending on how much condensation has formed. Open the door for at least 15 seconds. This is a good time to dry up any condensation that formed in the chamber. Close the door and let the chamber stabilize again. Recheck with the hygrometer to ensure the chamber relative humidity is in an acceptable range. For example, if the setpoint is 95%, a hygrometer reading of 92.0% to 95% should be acceptable. Again, actual relative humidity above 95% or higher will produce some condensation in the chamber. The air inject duration and frequency (section **8.8.4** no's 17 & 18) are set to help control condensation at these higher set points. These are user settable see Note 1c for further instruction.

Monitoring the Calibration:

Since the sensor's accuracy is ±3%, it is important to check the chamber and inner door for condensation at regular intervals for set-points above 90%. If an undesirable level of condensation is observed or the condensation appears to be increasing, the RH system should be recalibrated and the door opened to allow the new calibration to take effect. Wipe the condensation off the chamber and/or the inner door while the door is opened. This might not happen right after the initial calibration. Remember the accuracy of the sensor/system is its ability to maintain the calibration applied to it.

Notes:

1. If the relative humidity level measures less than 95% with an independent hygrometer and there is still condensation forming on the chamber walls, one of the following may be the problem.

    a. The door heater duty cycle may be set too high. Follow the instructions in Section 9.2 to reduce it. Remember to adjust the door heat in small increments up or down. A change of 5% at a time would be a maximum change recommended.

    b. Is the Incubator installed near an air supply duct or in moving air? Diffuse the air supply duct so that it doesn't blow on the Incubator or block the moving air. The Incubator needs an environment that will allow it to dissipate heat evenly.

    c. Change the air inject cycle as described in Section 8.8.4 (option configuration parameters) This will aid in reducing the condensation. It is recommended to increase the length of the injections in small increments (a few seconds) at a time.

2. The moisture from Cell culture media in unsealed containers will affect the humidity in the chamber. The greater the number of unsealed containers of media in the chamber the greater the effect becomes and can cause humidity alarms if humidity levels are pushed above the RH set-point.
3. Cell culture media/container temperature is another factor in dealing with chamber humidity and temperature. Depending on the amount of culture media, temperature and/or humidity may go into alarm until the media stabilizes at the chamber set points.

9.6 Oxygen Sensor Calibration (NU-4950)

When unit has stabilized at the operational temperature, CO_2%, and RH%, take an O_2 measurement with an independent instrument and, if necessary, perform the following: If a Fyrite instrument is used, **BE SURE TO READ THE O_2 FYRITE OPERATING AND SAFETY INSTRUCTIONS FOR PROPER O_2 MEASUREMENTS AND SAFETY CONSIDERATIONS.**

- Press mode switch to Run.
- Press [SEL] to indicate green LED next to O_2 display.
- Press and hold one ↑ key for four seconds, O_2 display alternates between "ADJ" and the O_2 percentage.
- Press ↑ or ↓ key to indicate same as the independently measured O_2 value.
- Press [SEL] key to complete calibration.

O_2 System Operation Notes:

1. This system is designed to reduce the oxygen content in the chamber. Since air injections cause an increase the oxygen content you will want to reduce them as your O_2 setpoint is reduced.
   a. Air is injected to control condensation in the chamber that can be generated by the high Relative Humidity that is sustained. The nitrogen used to reduce the oxygen content in the chamber is a dryer gas than the air and will control the condensation effectively.

O_2 Setpoints	Recommended Air Injection Settings
20.7% (ambient) - 11%	30 sec/10 min default down to 5 sec/10 min
10% to 2% (min setpoint)	no air injections (set air inject time to 0)

2. The nitrogen used to displace the oxygen volume in the chamber is very dry and will slow down or inhibit the RH in the chamber.
   a. Setpoints above 10%: The sensor calibration portion of the HC alarm can be adjusted for more and longer injections of O_2. See section 8.8.4 items labeled “HC/InJ” & “HC/Cnt”.
   b. Shut off the HC system for setpoints 10% and below. See section 8.8.4 item labeled “HC”.

3. Chamber RH at setpoints of 10% and below: Since the nitrogen is a very dry gas the following steps will aid in maintaining the RH level in the chamber. The water pan supplied with the Incubator for calibrating the RH system can be used to boost the chamber RH level for settings of 90% or higher.

10.0 Maintaining Your US Autoflow

US Autoflow Chamber
The chamber maintenance is up to the discretion of the owner and the extent of cleanliness and sterility desired. The shelves and bracket supports are all removable and autoclavable. The interior should be wiped down with an appropriate disinfectant such as 70% ISOPROPYL ALCOHOL or equivalent. **DO NOT USE ANY CHLORINATED OR HALOGEN MATERIALS IN THE CHAMBER. SUCH MATERIAL IS HARMFUL TO THE POLISHED STAINLESS STEEL.** *The humidity pan should also be sterilized and the water changed regularly to assure sterility. A small amount of copper sulfate may be added to the humidity pan to inhibit bacterial growth.*

US Autoflow Water-Jacket
The water-jacket requires no anti-bacterial agents. The US Autoflow already incorporates a copper tube producing copper sulfate which eliminates bacterial growth within the water-jacket. **DO NOT USE ANY CHLORINATED OR HALOGEN MATERIALS IN THE WATER-JACKET.**

Filter Maintenance:
P/N X-980385 (50 mm Disk, Uni-directional In-Line, Dry)

- **CO_2 Supply***
  The CO_2 Supply Filter should be replaced every fifth empty CO_2 tank or when the filter is visibly discolored (yellow-brown).

- **O_2 Supply***
  The O_2 Supply Filter should be replaced every fifth empty O_2 tank or when the filter is visibly discolored (yellow-brown).

- **Air Inlet***
  The Air Inlet Filter is located on the pack panel. The purpose of the filter is to cleanse the room air, which is drawn into the chamber via the pump during the air inject cycles, assuring the proper amount of oxygen is available to the cultures. The air inlet filter should be replaced every three to six months, or when visibly discolored.

P/N X-980398-02 (Capsule, Uni-Directional In-Line, Wet)

- **Air Pump Filter**
  The CO_2 Sensor Filter should be replaced EVERY TWO YEARS to assure optimum performance. A visual check should be performed during CO_2 sensor calibration to assure filter integrity. Remove sensor housing cover to perform visual check. Outlet port is on flat top side.

P/N X-980366 (50 mm Disk, Uni-directional In-Line, Wet)

- **CO_2 Sensor***
  Should be changed when discolored (yellow brown). Is plumbed to the CO_2 sensor and can be inspected when the cover is removed to check the air pump filter. This filter has a green dot to distinguish it from the "dry" filter.

***Note**: The word "IN" on the outer ring of the body indicates the inlet side of the filter and should be installed toward the gas supply.

RH Reservoir

THE RH RESERVOIR REQUIRES NO ANTI-BACTERIAL AGENTS. The RH Reservoir is filled using single distilled water, **NO PURER THAN 1 MEGAOHM. DO NOT USE ANY CHLORINATED OR HALOGEN MATERIALS IN THE RH RESERVOIR.** The reservoir is under slight pressure, which can disrupt filling it. To refill, press run/setup key until control system goes into "SETUP" and remove the fill cap. Wait a minute for the pressure to bleed off and fill reservoir. After filling, replace fill cap and press run/setup key until the control system returns to "RUN".

RH Sensor Care and Cleaning

CAUTION: Do not spray cleaner / disinfectant directly on the filter cap or the sensor (inside the filter housing under the filter cap). Some cleaners may damage this sensor.

NOTE: If the sensor (inside of the housing) is exposed to any type of liquid it will not function properly until it is dry again. Any method other than air drying might also damage the sensor.

Remove sensor from chamber during a gas process decontamination. Plug the mounting hole for the sensor during the procedure.

RECOMMENDED:
Wipe the outside of sensor housing with a cloth or swab, dampened in liquid disinfectant and immediately dry thoroughly. Reminder – do not use chlorinated or halogenated cleaners.

Sensor mounted in chamber

Sensor Filter Cap

10.1 Shutting down the Incubator

Prior to shutting down the Incubator open the inner and outer doors and remove the water pan. Leave doors open for at least 5 minutes prior to shutting it off. This will purge the chamber, circulating system and the sensors of humidity that could condense and cause faulty readings when the Incubator is turned back on. Be sure to empty the water pan prior to putting it back into the chamber if the Incubator is going to be shut off for any length of time.

10.2 Chemical Decontamination of the Incubator Chamber

To chemically decontaminate NuAire Incubators, users may use the traditional formaldehyde, Vapor based Hydrogen Peroxide, or Chlorine Dioxide. All three of the chemicals are compatible to all parts within NuAire Incubators.

NOTE: As stated previously, the chamber and components can also be wiped down with a 70% solution of Isopropyl Alcohol for cleaning and decontamination.

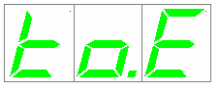
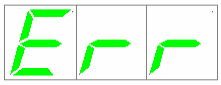
11.0 Error Indicators & Troubleshooting

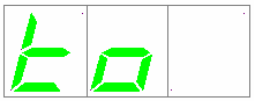
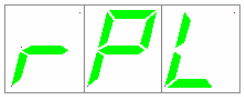
Step 1 NOTE ALL ERROR INDICATORS. When the Incubator is running, any and all red or yellow LEDs indicate an error. Pressing any key will silence the audible alarm for 15 minutes.

Step 2 CLEAR ERROR INDICATORS. Error indicators can be cleared by pressing the mode key to Setup and back to Run.

Step 3 MONITOR REOCCURRENCE OF ERROR INDICATORS. If reoccurrence of the error indicator is immediate or daily, use guide on next page to correct the situation.

Error Indicator Troubleshooting Guide

DISPLAYED ERROR CODE	CODE DESCRIPTION	CHECKS & CORRECTIONS
Temperature System		
	-Temperature over setpoint normal mode	1. Check temperature sensor calibration 2. Faulty TRIAC, replace control board 3. Door heater duty cycle too high, reduce 4. Door switch is faulty or out of position
	-Temperature time out error during normal running	1. Check temperature sensor calibration 2. Replace fuse 3. Faulty TRIAC, replace control board 4. Faulty chamber heater contact NuAire Technical Service 5. Door heater duty cycle needs to be increased with a high temperature set-point in a low ambient temperature
	-Sensor temperature (differential) error normal running. Occurs when difference between sensors exceeds 4°C	1. Check temperature sensor calibration 2. Check connection on control board 3. One or both temp sensors faulty, replace
CO_2 System		
	- CO_2 over setpoint	1. Perform CO_2 sensor calibration open door 2. Check injection solenoid for leaking valve 3. Check sensor and disk filter for condensation
	- CO_2 time out error	1. Check CO_2 gas supply - inline gas filters, CO_2 gas tank pressure, CO_2 sensor function 2. Run Cal Inj. Calibration (see Section 9.3.3) 3. Check/replace CO_2 gas supply tanks 4. Check for leaks in chamber - inner door gasket 5. Check for leaks in air pump and hosing
	- CO_2 tank switch occurrence	1. Press mode key to “SETUP” and back to RUN to reset alarm
	- Cal inject calibration failed. Not enough increase in the CO_2 reading after gas was injected	1. Check gas supply then run calibration again 2. Call NuAire Technical Services if error persists
	- Auto zero failure. The value for zero generated by the routine is greater than 0.5%. This is an alert only and does not affect the operation of the CO_2 system	1. Zero span calibrate the CO_2 sensor 2. Check ambient CO_2 level. Ventilate area if level exceeds normal limits 3. Check air inject system function 4. Check for plugged filter 5. Contact NuAire Tech. Service if problem persists

RH Percent		
	- RH over setpoint	1. Check for other sources of humidity in the chamber, i.e. excessive condensation and remove. 2. Check inject valve for leaking. 3. Check the shuttle valve and replace if faulty. 4. Perform RH sensor calibration.
	- RH time out error	1. Check RH reservoir for water level and water pan if used for low O_2 setpoints. 2. Check the shuttle valve and replace if faulty. 3. Perform sensor calibration.
	- Humdity Control Alarm Calibration or other over injection issue: The duration of the humidity injection was too long or there were too many injections of humidity causing this alarm. The evaporator tank heater is shut off then, after drying out and cool down period a continuous humidity injection is resumed to maintain a near 90% humidified condition in the chamber until the alarm is addressed. When the tank heater is turned off the resevoir light on the control label will light up. It will stay lit until the tank is back up to operational temperature of 60 to 70 deg. C.	1. Calibrate sensor (see section 9.4) 2. Check RH tank heater for function 3. Check RH reservoir float switch for function 4. If condensation is not a problem the acceptable length & number of injections can be increased by accessing the "Opt" (Option) menu. 5. If nuisance alarms persist, this position of the HC alarm can be turned off in the "OPt" menu
	Failed sensor signal issue: The alarm sounds immediately in this condition. When the alarm is cleared it will alarm again immediately in this condition.	1. Check for loose or broken connection 2. RH sensor is wet, let dry out and check for function. 3. RH sensor is faulty and needs replacement.
O2 Percent		
	- O_2 under setpoint	1. Perform O_2 sensor calibration 2. Replace sensor 3. Check inject valve for leaking
	- O_2 time out error	1. Perform O_2 sensor calibration 2. Check N_2 gas supply tanks
	- N_2 tank switch occurrence	1. Check N_2 gas supply tanks
	- O_2 sensor fuel cell low output signal	1. Replace O_2 sensor 2. Calibrate O_2 sensor to adjust output reading until new sensor is replaced 3. Calibrate O_2 system when new sensor is installed

Memory Chip Fault		
Err / CrC	- Corrupted memory data read at start-up	1. Turn Incubator off and back on. 2. If CrC message persists, push "NUAIRE" button to reset. All systems will require recalibration 3. Continuation of 2, refer to Section 9. If CrC still persists, call NuAire Technical Service.
Err / E2P	- Set up information read failure	1. Turn Incubator off then on again. If error indicator continues, replace main control board. If error indicator is cleared, recalibrate Incubator temperature and CO_2 control.
Err InP	- Data write to EEProm chip failure	1. Occurs when the checksum read of manually or automatically input data fails at the time of the input. Input data will be active in volatile memory but will be lost if power to the Incubator is interrupted. Contact NuAire Technical Service to replace control board.
Power Supply Errors		
Err / P 12	+ 12 VDC power supply failure	Replace power supply
Err / - 12	- 12 VDC power supply failure	
General Indicators		
DOOR AJAR LED	- Inner glass door is not closed or magnetic switch needs a position adjustment	1. Close and latch inner glass door. 2. Adjust switch position to align it with the disk magnet on the glass door hinge by loosening acorn nut on the cable clip. 3. Check door switch, if faulty, replace.
SLF	- Self diagnostic move	1. Indicates Incubator is performing self diagnostic task - Calibration can be performed when task is completed.
dLY	- When performing on off set calibration DLY shows in display and the value will not change	1. Indicates the Incubator is busy with an automatic function like an air injection. Then display can be changed when the function is complete. This usually takes a few seconds CO_2 control is in delay for one of the following reasons: A. Power interruption just occurred. Will resume CO_2 within 1-minute. B. Chamber temperature is not within 2.0°C of Setpoint. Cannot bypass. 2. Shows for 1 minute in CO_2 display after a menu exit.
LOW WATER	- Low water level in water jacket - Faulty level indicator switch	1. Fill jacket until light goes out 2. Replace level indicator switch
RH RESERVOIR (Option)	- Low water in RH reservoir - Heater shut off by AC alarm - Faulty Level Switch - Faulty evaporator tank heater	1. Fill reservoir 2. See "HC Alarm" in this section 3. Replace level switch 4. Replace heater

BLINKING DISPLAY	- Interruption of power	1. Press any key to stop blinking displays.
CONDENSATION EXCESSIVE (Humidity pan in place)	- Glass door, gasket or front wall of chamber wet.	1. Increase door heater duty cycles. See section 9.2 for detailed instructions.
	- Back wall bottom and top walls	1. Decrease door heater duty cycle. See section 9.2 for detailed instructions.
CONDENSATION PERSISTS AFTER DOOR DUTY CYCLE IS ADJUSTED		1. Increase air injections, increasing duration first, recommended in 20 second intervals
EXCESS VIBRATION		1. Check for and remove the block of shipping foam from under the air pump. 2. Turn Incubator off. If vibration persists it is not caused by the Incubator.

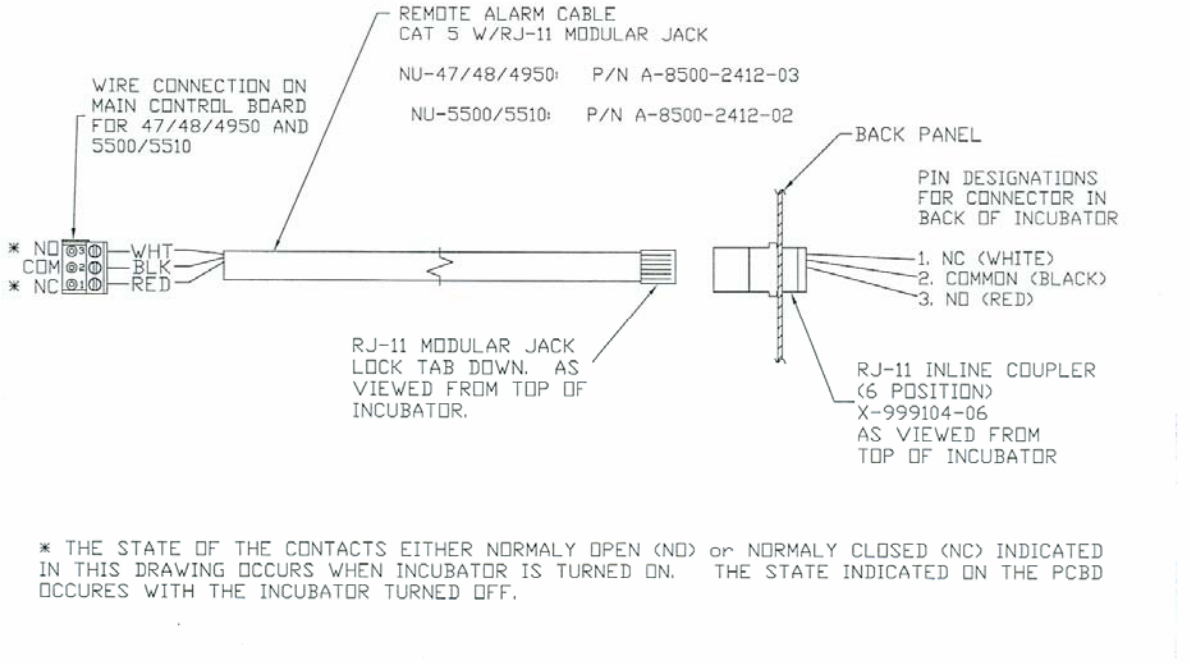
For further assistance, call NuAire Customer Service at 1-800-328-3352 or (763) 553-1270 USA.

12.0 Remote Alarm Contacts

The NuAire US Autoflow provides a set of relay contacts to monitor alarm via RJ-11 phone type connection on the back of the unit. The remote alarm contacts provide N.C, N.O outputs and ground.

The alarm contact points do not distinguish between a CO_2 or temperature (or RH, or O_2) alarm. Each alarm will produce a contact to the alarm system whenever abnormal condition, as well as power interruption occurs.

To reset alarm contacts, press run/setup key to setup, then back to Run.



13.0 Electrical/Environmental Requirements

13.1 Electrical

		START UP POWER (WATTS)	RUNNING POWER (WATTS)
NU-4750, 4850, 4950 D	100V, 50/60Hz, 1 Phase, 6 Amps	550	250
*NU-4750, 4850, 4950	115V, 60Hz, 1 Phase, 5 Amps	550	250
NU-4750, 4850, 4950 G	220V, 60Hz, 1 Phase, 3 Amps	550	250
**NU-4750, 4850, 4950 E	230V, 50Hz, 1 Phase, 3 Amps	550	250

**UL/UL-C Listed*
***CE Certified*

13.2 Operational Performance - Indoor Use Only

Environment Temperature Range: 60°F-85°F (15°C - 30°C)
Environment Humidity: 20% - 60% Relative Humidity
Environment Altitude: 6562 feet (2000 meters) Maximum

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.

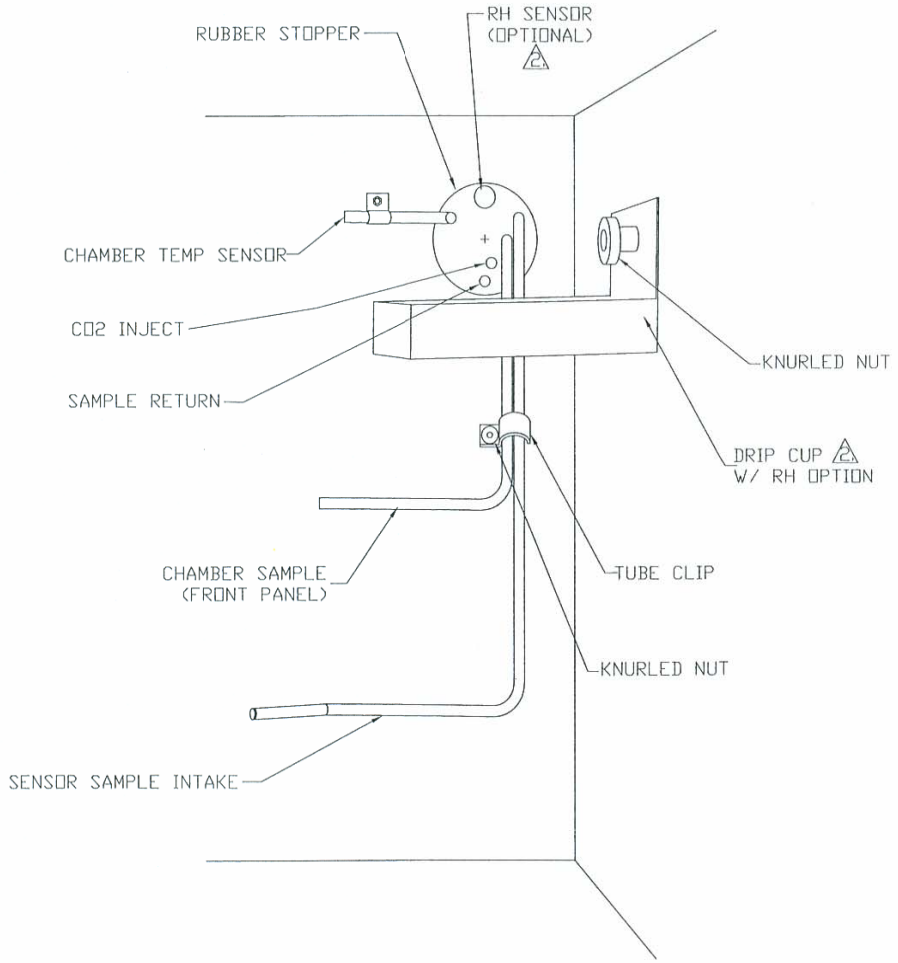
13.7 EMC Performance (classified for light industrial)

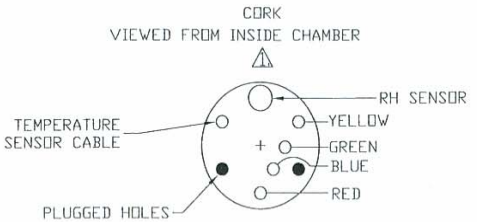
Conducted Emissions: CISPR 11, Class B & EN55011
Radiated Emission: CISPR 11, Class B & EN55011
Radiated Immunity: EN50082-1, IEC 801-3, Level 2
ESD Immunity: EN50082-1, IEC 801-2, Level 2
EFT/BURST Immunity: EN50082-1, IEC 801-4, Level 2

(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.

13.8 Heat Rejection: 14 BTU/Min

REV	ECO	DESCRIPTION	DATE	DFTM	CHKD
A	8972	RELEASE TO PRODUCTION	10/05/04	KF	KCK





1 YELLOW: SENSOR SAMPLE INTAKE
GREEN: CHAMBER SAMPLE-FRONT PANEL
BLUE: CO2 INJECT
RED: SENSOR SAMPLE RETURN / RH INJECT

NOTE: 1 NOTED COLOR CODE CORRESPONDS WITH COLORED BANDS ON HOSES CONNECTED TO CHAMBER TUBING.

2 NU-4850 & NU-4950 ONLY

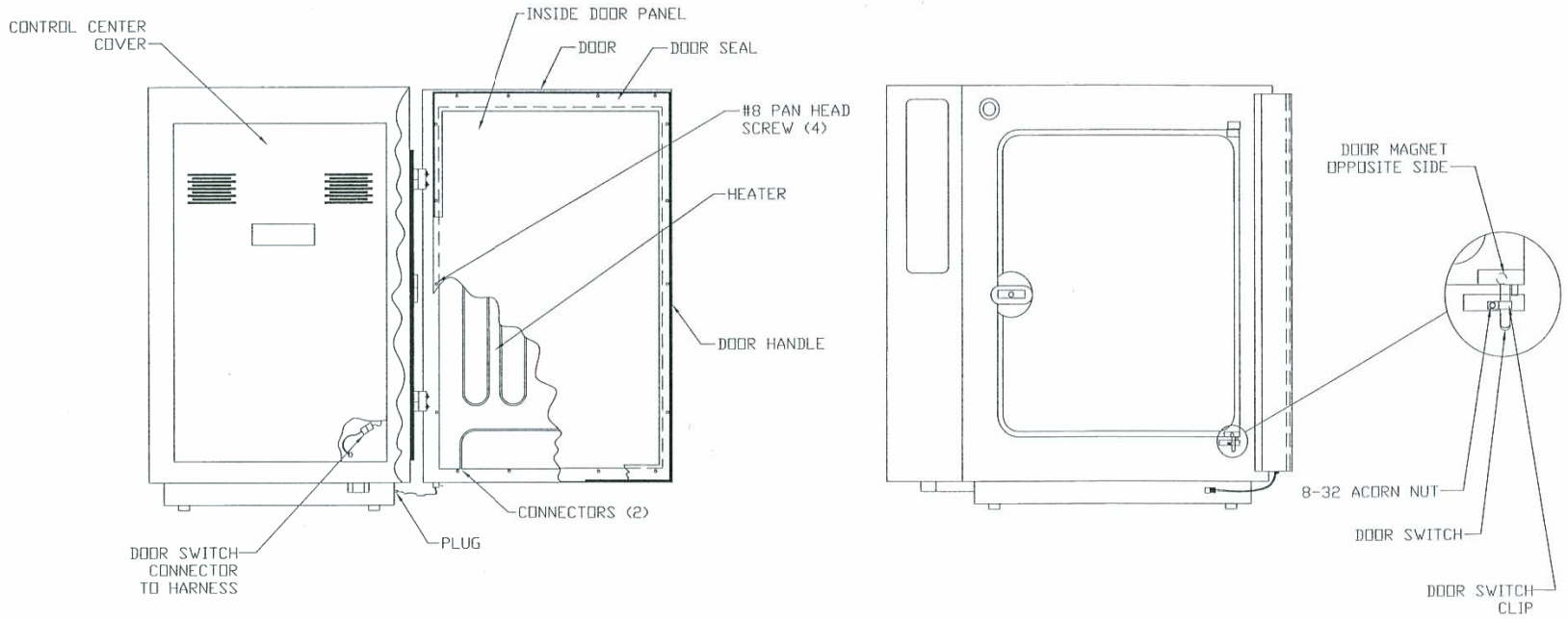
ORIGINAL

DATE	10/5/04
DFTM	KF
CHKD	KCK

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
-TOLERANCES-
DECIMALS ±.032
ANGLES ±2°

TITLE: CHAMBER TUBING ASSEMBLY 8500
MATERIAL: AS NOTED
NUMBER: BCD-10405 A
DO NOT SCALE DRAWING
SHEET 1 OF 1

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
A	8972	RELEASE TO PRODUCTION	10/06/04	KF	KCK



DOOR SWITCH
REPLACEMENT PROCEDURE

1. DISCONNECT ALL ELECTRICAL POWER.
2. REMOVE DOOR SWITCH CLIP (1) 8/32 ACORN NUT.
3. PULL SWITCH AWAY FROM DOOR HINGE AREA.
4. OPEN CONTROL CENTER COVER.
5. LOCATE & DISCONNECT DOOR SWITCH AND PULL OUT OF HOLE.
6. STRING NEW DOOR SWITCH THRU HOLE IN THE CONTROL CENTER.
7. INSTALL NEW DOOR SWITCH REVERSING THE ABOVE STEPS. NOTE COLOR CODE. (NOTE. CHECK DOOR SWITCH OPERATION SO, THE DOOR SWITCH IS ACTIVATED BY THE MAGNET.)

DOOR HEATER
REPLACEMENT PROCEDURE

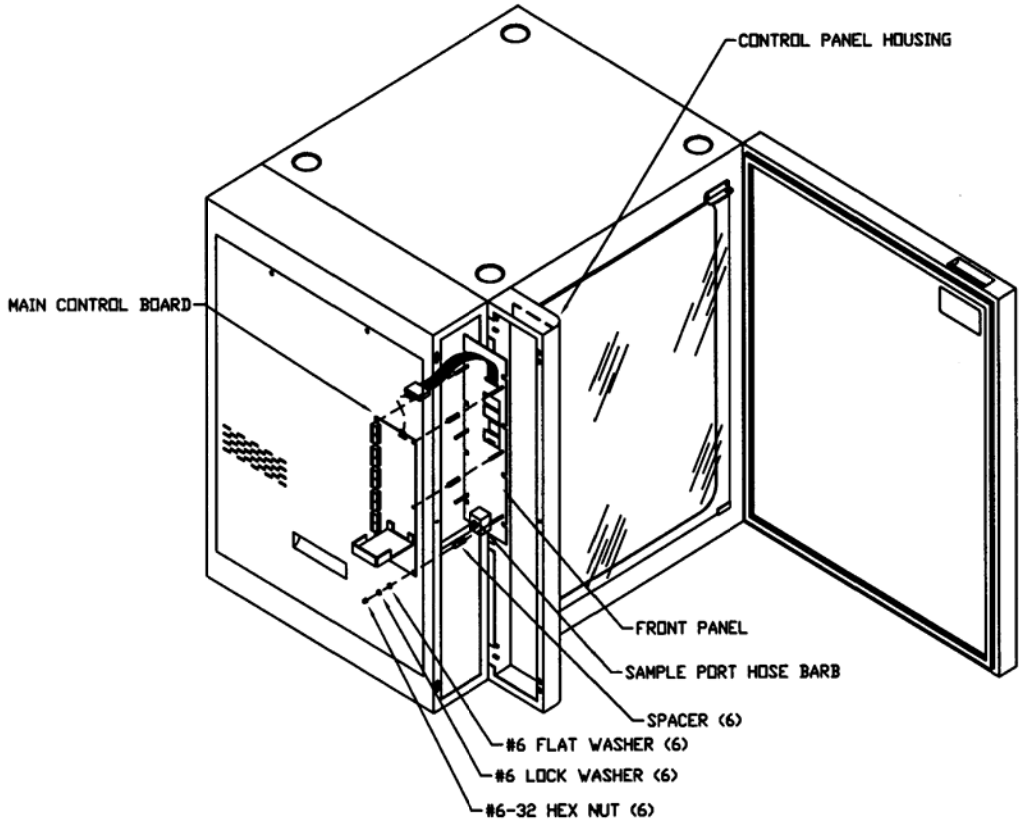
1. DISCONNECT ALL ELECTRICAL POWER.
2. REMOVE (10) #8 PAN HEAD SCREWS LOCATED UNDER THE DOOR SEAL.
3. REMOVE DOOR PANEL W/SEAL. MOVING SLOWLY AWAY FROM DOOR EXPOSING WIRES.
4. CUT BUTT SPLICE CONNECTORS FROM DOOR HEATER, NOTE COLOR CODE.
5. REMOVE DOOR HEATER.
   -PULL OFF DOOR HEATER AND REPLACE.
   -NOTE, SILICON RTV MUST BE APPLIED TO CORNERS OF HEATERS.
6. REPLACE DOOR HEATER REVERSING THE ABOVE STEPS.

ORIGINAL

DOOR HEATER AND SWITCH ASSEMBLY

DFTM	KF	10/06/04	CHKD	KCK	SHEET 1 OF 1
DRAWING NUMBER	BCD-10407				A

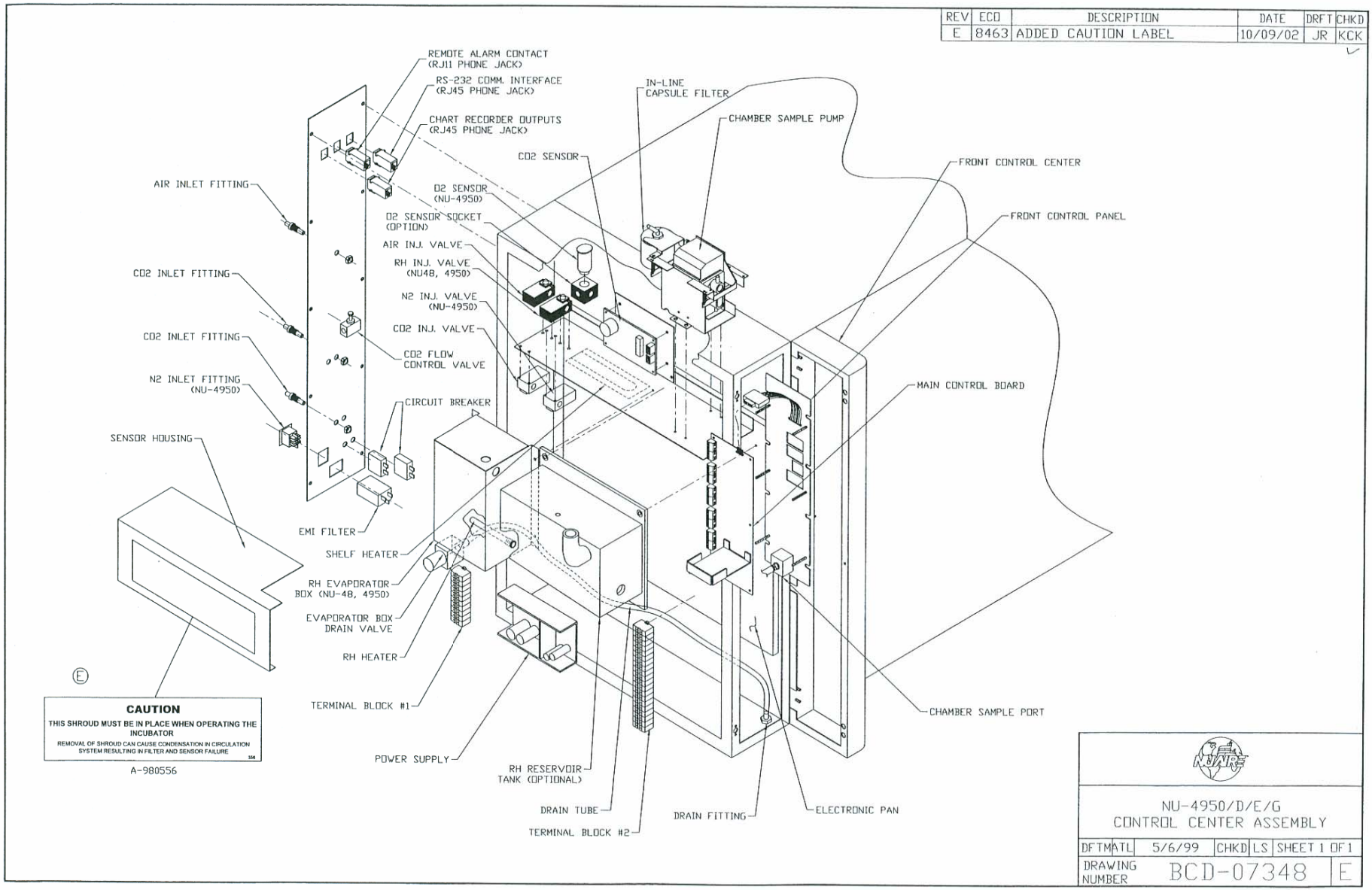
REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
A	7634	RELEASED TO PRODUCTION	5/25/99	ATL	DB



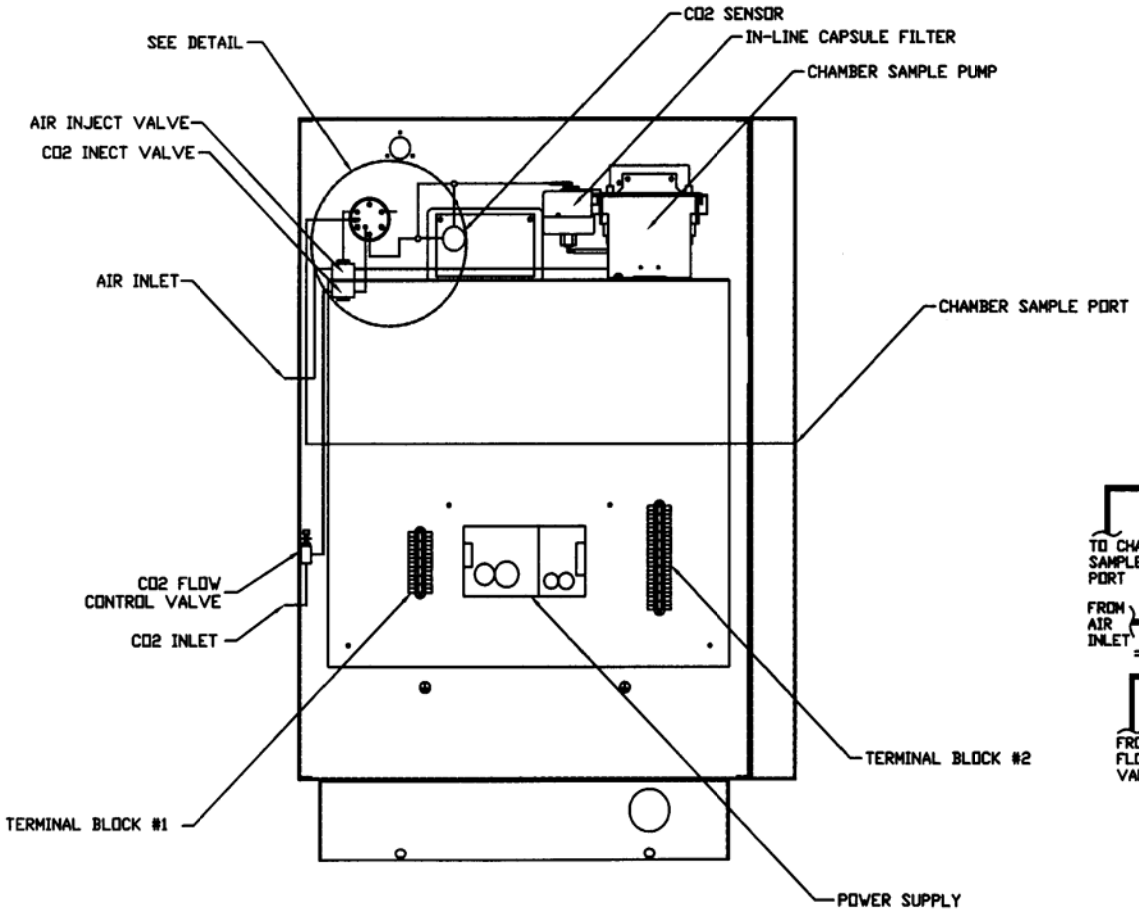
PROCEDURE:
1. DISCONNECT ALL ELECTRICAL POWER.
2. OPEN INCUBATOR FRONT DOOR.
3. PLACE HANDS ON OUTSIDE EDGE (TOP & BOTTOM) OF CONTROL PANEL HOUSING AND PULL OPEN.
4. DISCONNECT FRONT PANEL CONNECTORS.
5. SEPARATE MAIN CONTROL BOARD BY REMOVING #6-32 LOCKNUTS AND SPACERS.
6. REMOVE FRONT PANEL BY REMOVING (8) #6-32 HEXNUTS, FLAT WASHERS AND LOCK WASHERS.
7. TO INSTALL NEW FRONT PANEL REVERSE ABOVE STEPS.

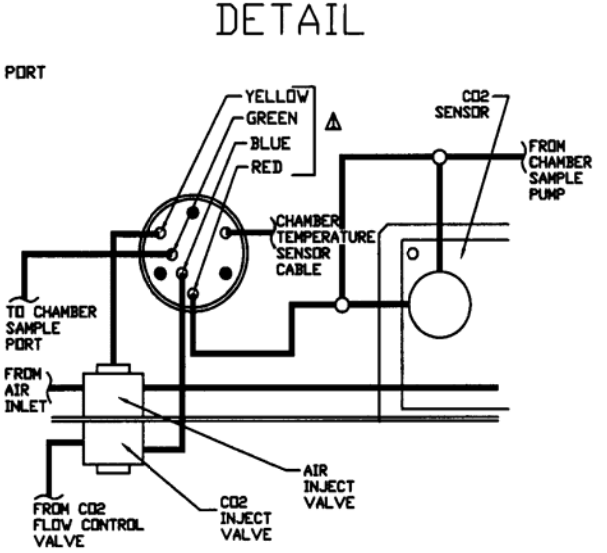
NU-4750, 4850, 4950/D/E/G
FRONT PANEL ASSEMBLY

DFTM ATL	5/6/99	CHKD	DB	SHEET 1 OF 1
DRAWING NUMBER	BCD-07346			A


REV | ECO | DESCRIPTION | DATE | DRFT | CHKD
E | 8463 | ADDED CAUTION LABEL | 10/09/02 | JR | KCK
REMOTE ALARM CONTACT (RJ11 PHONE JACK)
RS-232 COMM. INTERFACE (RJ45 PHONE JACK)
CHART RECORDER OUTPUTS (RJ45 PHONE JACK)
AIR INLET FITTING
CO2 INLET FITTING
CO2 INLET FITTING
N2 INLET FITTING (NU-4950)
SENSOR HOUSING
EMI FILTER
CIRCUIT BREAKER
CO2 FLOW CONTROL VALVE
O2 SENSOR (NU-4950)
O2 SENSOR SOCKET (OPTION)
AIR INJ. VALVE
RH INJ. VALVE (NU48, 4950)
N2 INJ. VALVE (NU-4950)
CO2 INJ. VALVE
CO2 SENSOR
IN-LINE CAPSULE FILTER
CHAMBER SAMPLE PUMP
FRONT CONTROL CENTER
FRONT CONTROL PANEL
MAIN CONTROL BOARD
CHAMBER SAMPLE PORT
SHELF HEATER
RH EVAPORATOR BOX (NU-48, 4950)
EVAPORATOR BOX DRAIN VALVE
RH HEATER
TERMINAL BLOCK #1
POWER SUPPLY
RH RESERVOIR TANK (OPTIONAL)
DRAIN TUBE
TERMINAL BLOCK #2
DRAIN FITTING
ELECTRONIC PAN
Ⓔ
CAUTION
THIS SHROUD MUST BE IN PLACE WHEN OPERATING THE INCUBATOR
REMOVAL OF SHROUD CAN CAUSE CONDENSATION IN CIRCULATION SYSTEM RESULTING IN FILTER AND SENSOR FAILURE
356
A-980556
NU-4950/D/E/G
CONTROL CENTER ASSEMBLY
DFTMATL 5/6/99 CHKD LS SHEET 1 OF 1
DRAWING NUMBER BCD-07348 E

REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
C	8158	UPDATED CONTROL VALVE LOC.	11/13/01	JR	KCK



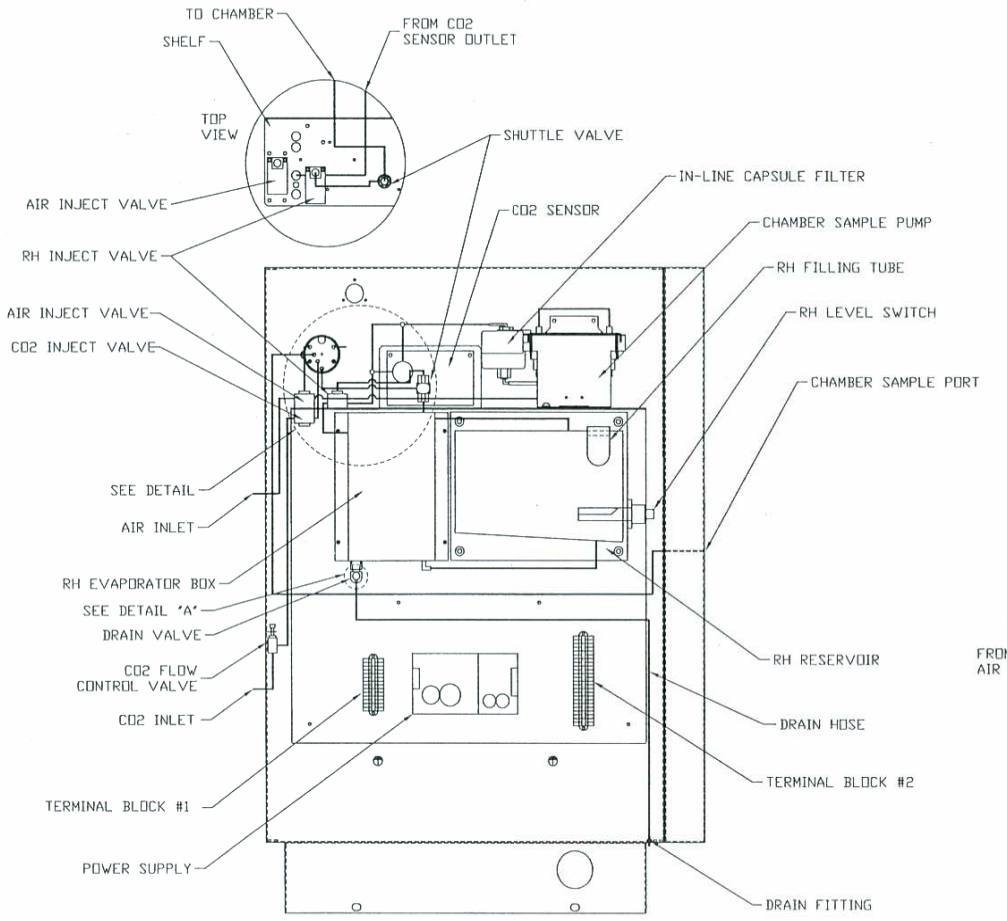


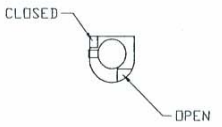
⚠ REFERS TO COLOR OF BAND ON HOSE.

NU-4750/D/E/G
ELEC. & TUBING CONNECTION

DFTMATL	5/7/99	CHKD	JR	SHEET 1 OF 1
DRAWING NUMBER	BCD-07349			C

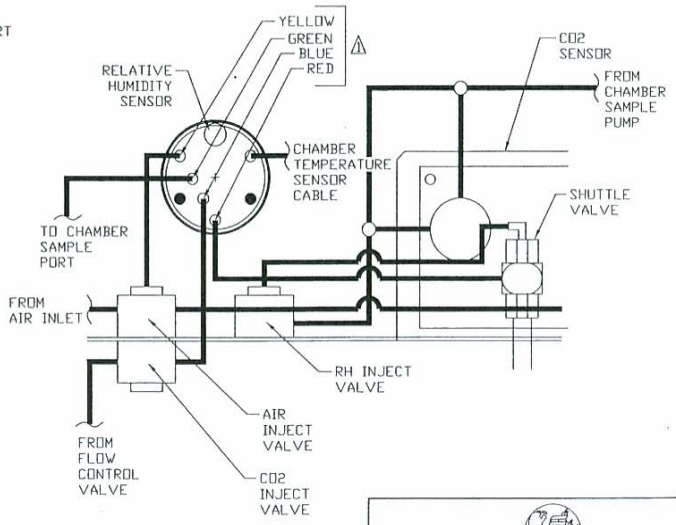
REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
D	8429	ADDED DRAIN HOSE AND FITTING	8/22/02	JR	KCK





DETAIL A

DETAIL

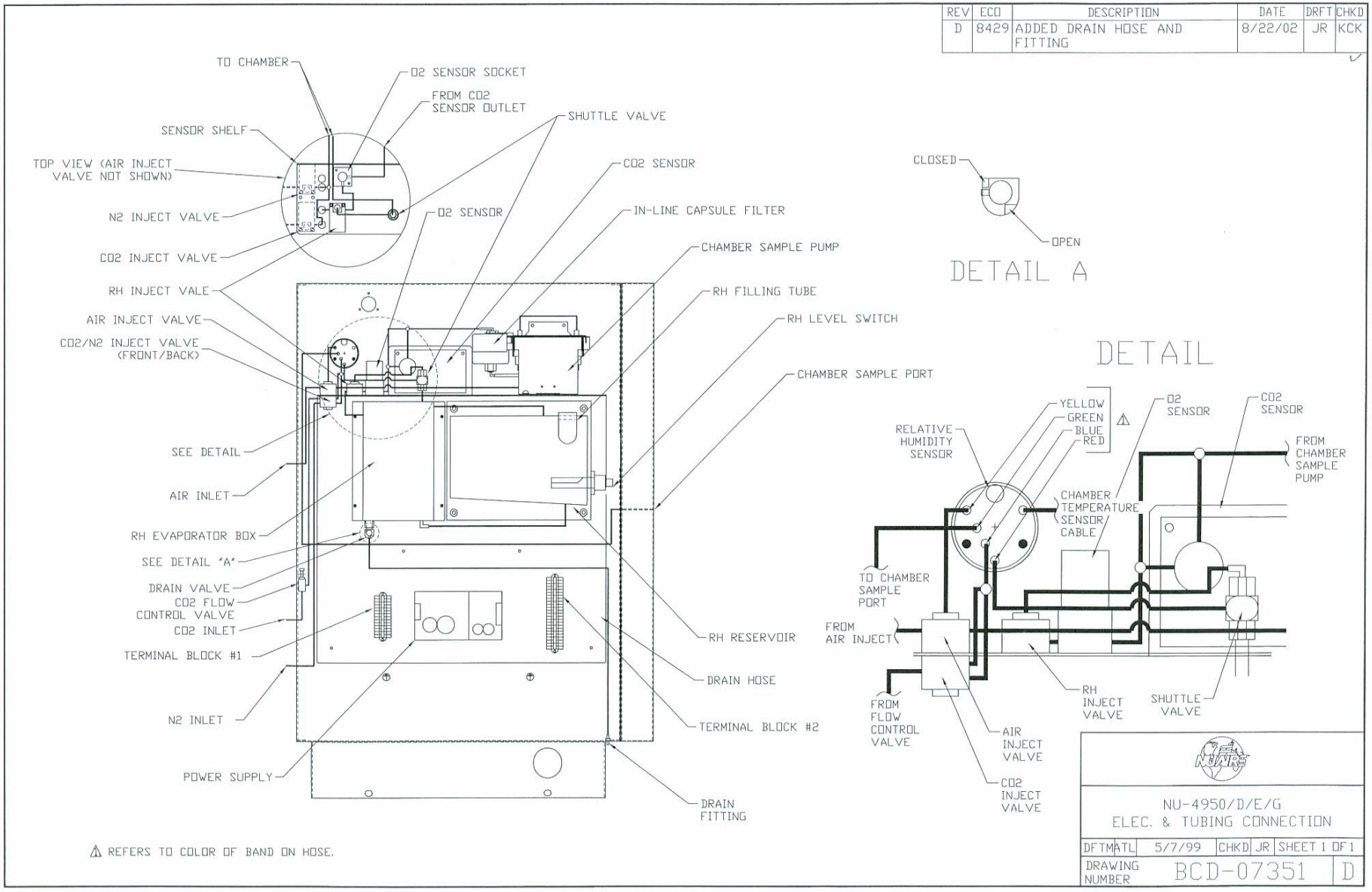


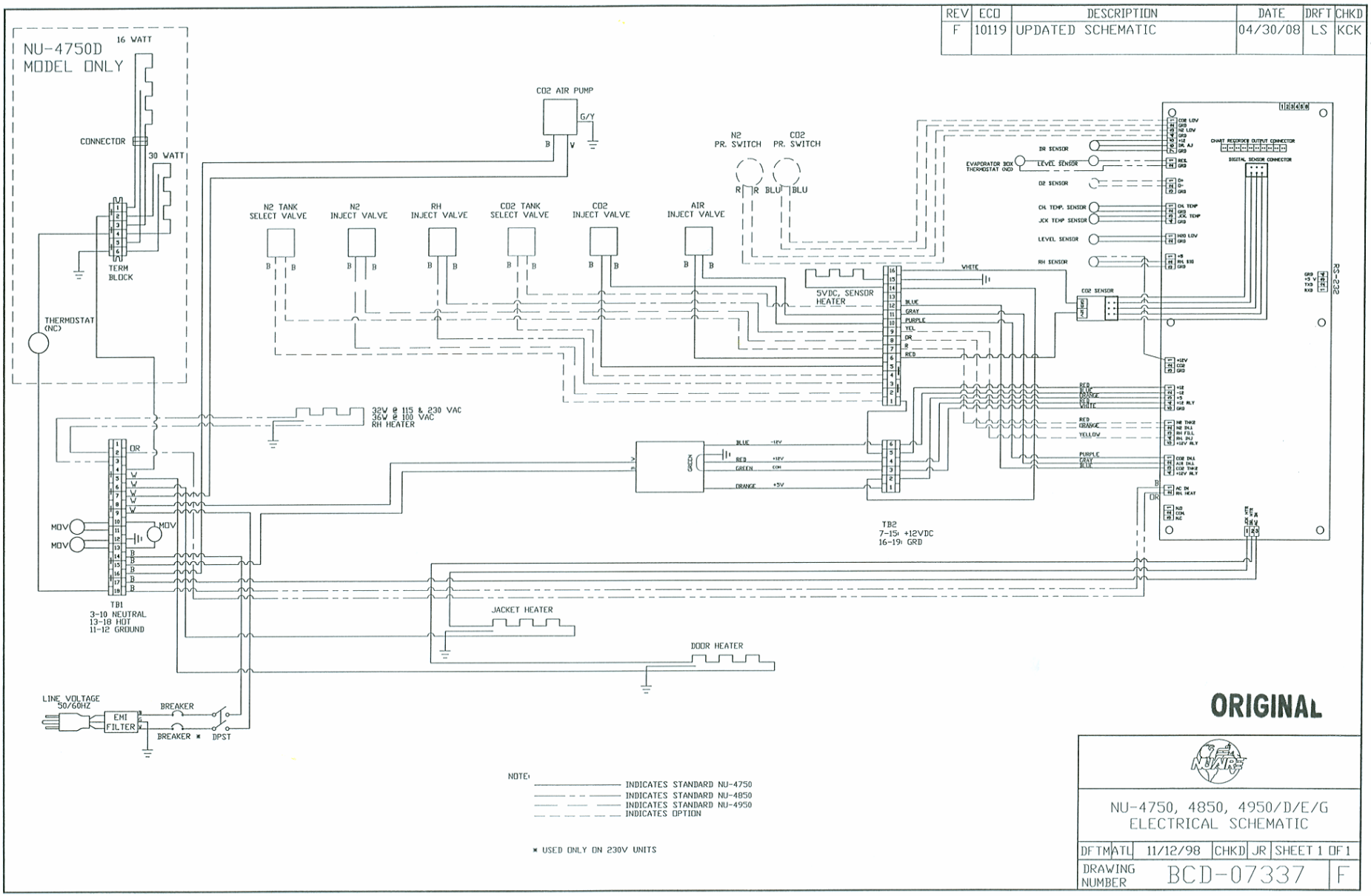
1. REFERS TO COLOR OF BAND ON HOSE.

NU-4850/D/E/G
ELEC. & TUBING CONNECTION

DFTMATL	5/7/99	CHKD	JR	SHEET 1 OF 1

DRAWING NUMBER BCD-07350 D


REV | ECO | DESCRIPTION | DATE | DRFT | CHKD
D | 8429 | ADDED DRAIN HOSE AND FITTING | 8/22/02 | JR | KCK
TO CHAMBER
O2 SENSOR SOCKET
FROM CO2 SENSOR OUTLET
SHUTTLE VALVE
SENSOR SHELF
TOP VIEW (AIR INJECT VALVE NOT SHOWN)
CO2 SENSOR
N2 INJECT VALVE
O2 SENSOR
IN-LINE CAPSULE FILTER
CO2 INJECT VALVE
CHAMBER SAMPLE PUMP
RH INJECT VALE
RH FILLING TUBE
AIR INJECT VALVE
RH LEVEL SWITCH
CO2/N2 INJECT VALVE (FRONT/BACK)
CHAMBER SAMPLE PORT
SEE DETAIL
AIR INLET
RH EVAPORATOR BOX
SEE DETAIL "A"
DRAIN VALVE
CO2 FLOW CONTROL VALVE
CO2 INLET
TERMINAL BLOCK #1
RH RESERVOIR
DRAIN HOSE
N2 INLET
TERMINAL BLOCK #2
POWER SUPPLY
DRAIN FITTING
⚠ REFERS TO COLOR OF BAND ON HOSE.
CLOSED
OPEN
DETAIL A
DETAIL
YELLOW
GREEN
BLUE
RED
⚠
O2 SENSOR
CO2 SENSOR
RELATIVE HUMIDITY SENSOR
FROM CHAMBER SAMPLE PUMP
CHAMBER TEMPERATURE SENSOR CABLE
TO CHAMBER SAMPLE PORT
FROM AIR INJECT
RH INJECT VALVE
SHUTTLE VALVE
FROM FLOW CONTROL VALVE
AIR INJECT VALVE
CO2 INJECT VALVE
NU-4950/D/E/G
ELEC. & TUBING CONNECTION
DFTMATL | 5/7/99 | CHKD | JR | SHEET 1 OF 1
DRAWING NUMBER | BCD-07351 | D



REV	ECO	DESCRIPTION	DATE	DRFT	CHKD
F	10119	UPDATED SCHEMATIC	04/30/08	LS	KCK

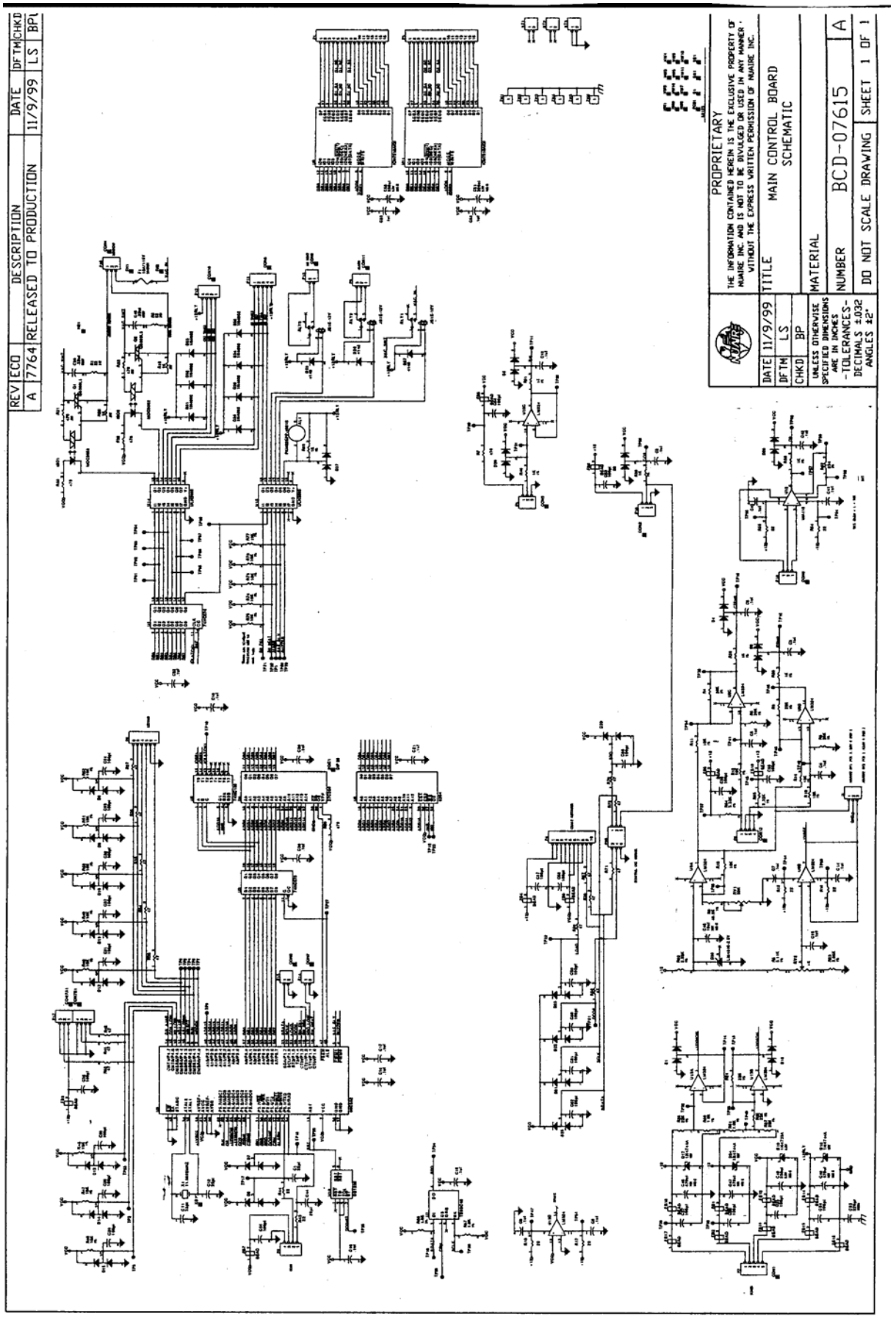
KC

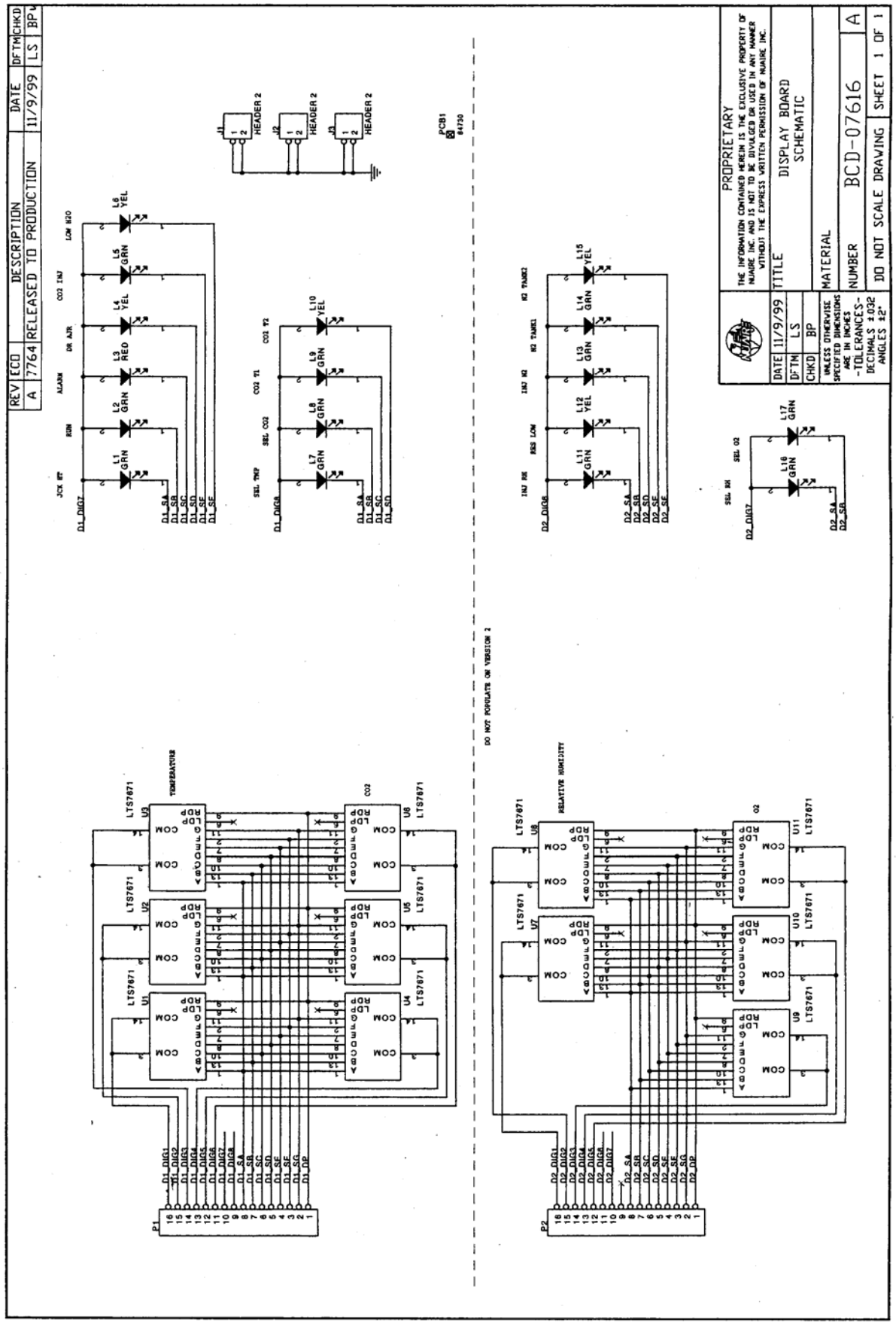
ORIGINAL

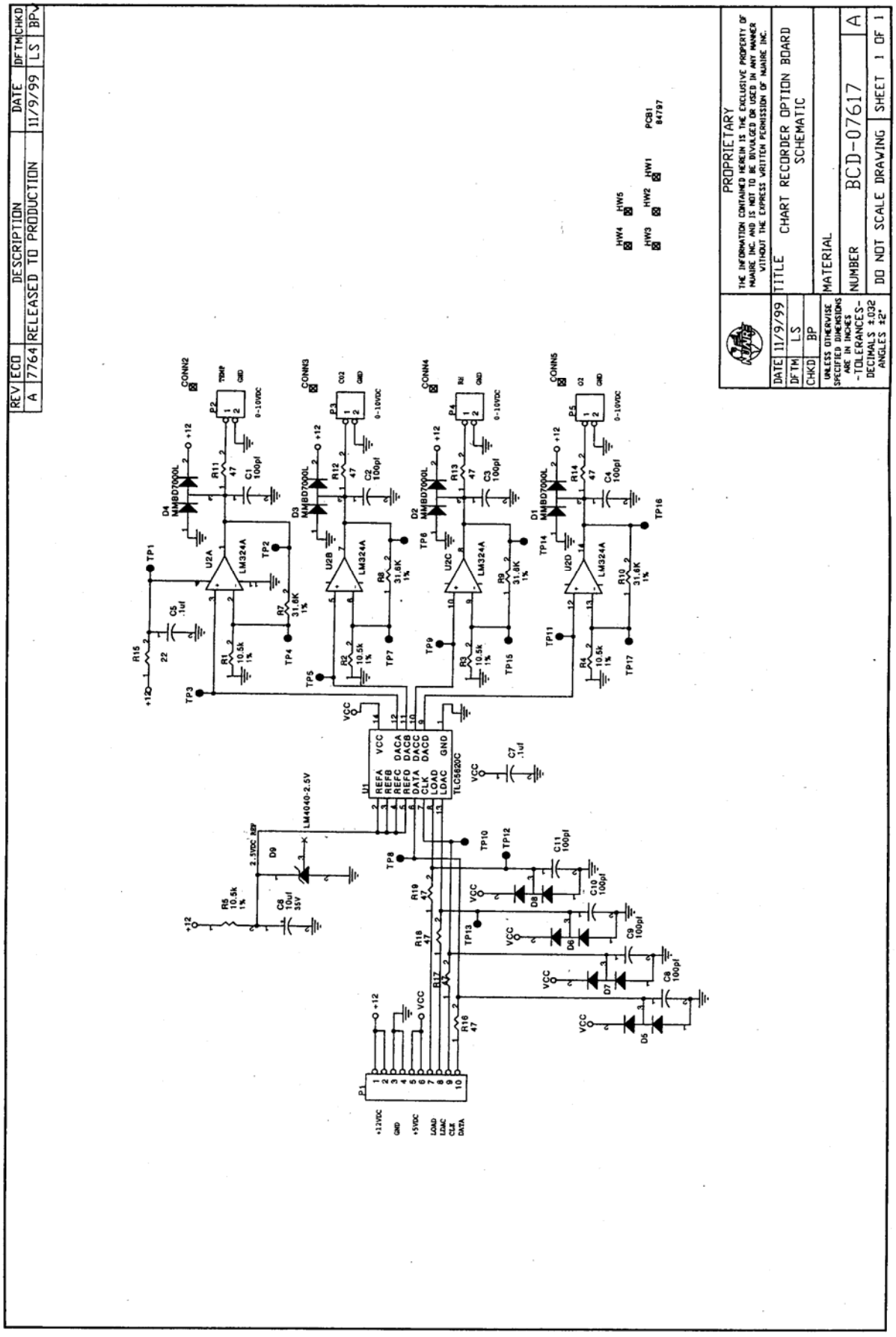
NU-4750, 4850, 4950/D/E/G
ELECTRICAL SCHEMATIC

DFTMATL	11/12/98	CHKD	JR	SHEET 1 OF 1

DRAWING NUMBER BCD-07337 F


REV ECO DESCRIPTION DATE DFTM CHKD
A 7764 RELEASED TO PRODUCTION 11/9/99 LS BP
PROPRIETARY
THE INFORMATION CONTAINED HEREIN IS THE EXCLUSIVE PROPERTY OF NUAIRE INC. AND IS NOT TO BE DIVULGED OR USED IN ANY MANNER WITHOUT THE EXPRESS WRITTEN PERMISSION OF NUAIRE INC.
DATE 11/9/99
DFTM LS
CHKD BP
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
-TOLERANCES-
DECIMALS ±.032
ANGLES ±2°
TITLE
MAIN CONTROL BOARD
SCHEMATIC
MATERIAL
NUMBER BCD-07615 A
DO NOT SCALE DRAWING SHEET 1 OF 1


REV ECO DESCRIPTION DATE DFTM CHKD
A 7764 RELEASED TO PRODUCTION 11/9/99 LS BP
PROPRIETARY
THE INFORMATION CONTAINED HEREIN IS THE EXCLUSIVE PROPERTY OF NUAIRE INC. AND IS NOT TO BE DIVULGED OR USED IN ANY MANNER WITHOUT THE EXPRESS WRITTEN PERMISSION OF NUAIRE INC.
DATE 11/9/99
DFTM LS
CHKD BP
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES -TOLERANCES- DECIMALS ±.032 ANGLES ±2°
TITLE DISPLAY BOARD SCHEMATIC
MATERIAL
NUMBER BCD-07616 A
DO NOT SCALE DRAWING SHEET 1 OF 1
DO NOT POPULATE ON VERSION 2
HEADER 2
LTS7671
TEMPERATURE
RELATIVE HUMIDITY
CO2
P1
P2


REV ECO DESCRIPTION DATE DFTM CHKD
A 7764 RELEASED TO PRODUCTION 11/9/99 LS BP
PROPRIETARY
THE INFORMATION CONTAINED HEREIN IS THE EXCLUSIVE PROPERTY OF NUAIRE INC. AND IS NOT TO BE DIVULGED OR USED IN ANY MANNER WITHOUT THE EXPRESS WRITTEN PERMISSION OF NUAIRE INC.
DATE 11/9/99
DFTM LS
CHKD BP
TITLE CHART RECORDER OPTION BOARD SCHEMATIC
MATERIAL
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES -TOLERANCES- DECIMALS ±.032 ANGLES ±2°
NUMBER BCD-07617 A
DO NOT SCALE DRAWING SHEET 1 OF 1
CONN2
CONN3
CONN4
CONN5
D1 MMBD7000L
D2 MMBD7000L
D3 MMBD7000L
D4 MMBD7000L
U1 TLC5620C
U2A LM324A
U2B LM324A
U2C LM324A
U2D LM324A
D9 LM4040-2.5V
P1 +12VDC GND +5VDC LOAD LDAC CLK DATA
P2 TEMP 0-10VDC
P3 CO2 0-10VDC
P4 RH 0-10VDC
P5 O2 0-10VDC
HW1 HW2 HW3 HW4 HW5
PCB1 847/97