

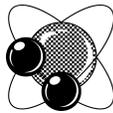
OPERATION AND MAINTENANCE MANUAL

**MINI TWO-PRESSURE
HUMIDITY GENERATOR
SERIES 1200**



MINI 1200 TWO-PRESSURE HUMIDITY GENERATOR

OPERATION AND MAINTENANCE MANUAL



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Printed 2018



Document Edition 10 ♦ June 2018

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Model 1200 Two-Pressure Two-Temperature Humidity Generator

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LIST OF REFERENCE DRAWINGS

DRAWING #	DRAWING TITLE
03D12901-----	Mechanical/Utility Layout
03D12902-1, -2, & -3-----	Component Location Diagram
03D12903-----	Electrical Box Layout Diagram
03S12904-----	Computer Control Schematic
03S12905-----	Main Power Schematic
03S12906-----	Heater/Pump/Solenoid Schematic
03S12907-----	Temperature Probe/Transducer Schematic
03S12908-----	Pneumatic System Schematic
03S12909-----	Heat Transfer Fluid Schematic
03D12910-----	Chamber Fluid Filling Instructions
05D12913-----	1200 Utility Cart Dimensions
06D12914-----	ACS1210 Mechanical / Utility Layout
06D12915-----	Generator & ACS1210 Placement Drawing
07D12916-----	EHC-10 Remote Calibration Assembly
ACS12030-----	ACS1210 Pneumatic Schematic
ACS12001_01-----	ACS1210 Electrical Schematic Low Voltage
ACS12001_02-----	ACS1210 Electrical Schematic High Voltage

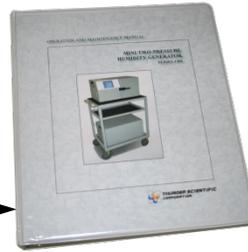
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1200 Item Check List

1. Certificate of Calibration (In Manual)

2. Operation and Maintenance Manual



3. HumiCalc[®] with Uncertainty Software Download



4. 4oz. Plastic Funnel



5. Chamber Overflow Cap



6. Chamber Port Foam Plug



7. Power Cable



8. Pressure Vent Cap



9. Stylus Ballpoint Pen



10. 1/4" MPT Air In Plug



11. Torx Driver, #10



12. Torx Screws, #10



1. **Optional Equipment** – Air compressor power cable

2. **ACS1210** – Air Compressor System Manual

3. **Air Hose** – On Air Box



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Para devolver productos que no desee, póngase en contacto con el sitio Web del fabricante mostrado en el producto, o con la oficina de ventas o distribuidor local.

Deutsch

Dieses Produkt stimmt mit den Kennzeichnungsanforderungen der WEEE-Richtlinie (2002/96/EC) überein. Das angebrachte Etikett weist darauf hin, dass dieses elektrische/elektronische Produkt nicht in Hausmüll entsorgt werden darf.

Produktkategorie: In Bezug auf die Gerätetypen in Anhang I der WEEE-Richtlinie ist dieses Produkt als Kategorie 9 "Überwachungs- und Kontrollinstrument" klassifiziert.



Nicht in Hausmüll entsorgen!

Zur Rückgabe von unerwünschten Produkten die auf dem Produkt angegebene Website des Herstellers oder die zuständige Verkaufsstelle bzw. den zuständigen Fachhändler konsultieren.

Italiano

Questo prodotto risponde ai requisiti sull'etichettatura stabiliti nella Direttiva RAEE (2002/96/CE). Il simbolo apposto indica che non si deve gettare questo prodotto elettrico o elettronico in un contenitore per rifiuti domestici.

Categoria del prodotto: con riferimento ai tipi di apparecchiature elencate nell'Allegato 1 della Direttiva RAEE, questo prodotto rientra nella categoria 9 "Strumenti di monitoraggio e di controllo".



Non gettare in un contenitore per rifiuti domestici.

Per restituire prodotti non desiderati, visitare il sito Web del produttore riportato sul prodotto o rivolgersi al distributore o all'ufficio vendite locale.

Português

Este produto está em conformidade com as exigências de rotulagem da Directiva WEEE (2002/96/EC). O rótulo afixado indica que o utilizador não deve deitar este produto eléctrico/electrónico fora juntamente com o lixo doméstico.

Categoria do produto: No que se refere aos tipos de equipamento listados no Anexo I da Directiva WEEE, este produto está classificado como produto da categoria 9, "Instrumentação de monitorização e controlo".



Não deite fora juntamente com o lixo doméstico!

Para devolver produtos indesejados, contacte o fabricante através do Website constante do produto ou contacte o seu representante de vendas ou distribuidor local.

Nederlands

Dit product voldoet aan de merktekenvereisten van de AEEA-richtlijn (2002/96/EG). Het aangebrachte merkteken duidt erop dat dit elektrische/elektronische product niet met het huishoudelijk afval mag worden afgevoerd.

Productcategorie: Met betrekking tot de apparatuurcategorieën van bijlage I van de AEEA-richtlijn, valt dit product onder categorie 9 'meet- en controle-instrumenten'.



Niet afvoeren met huishoudelijk afval!

Om ongewenste producten te retourneren, neemt u contact op met de website van de fabrikant die op het product staat vermeld, of met uw plaatselijke verkoopkantoor of distributeur.

Svenska

Denna produkt uppfyller märkningskraven enligt WEEE Directive (2002/96/EC). Märkningsetiketten anger att du inte får kassera denna elektriska/elektroniska produkt tillsammans med vanliga hushållssopor.

Produktkategori: Med hänvisning till utrustningstyperna i WEEE Directive Annex I, är denna produkt klassad som kategori 9 "Monitoring and Control Instrumentation" (Instrument för övervakning och styrning).



Får ej kasseras tillsammans med vanliga hushållssopor!

Returnera ej önskvärda produkter genom att gå till tillverkarens webbplats, vilken anges på produkten, eller till det lokala försäljningskontoret eller distributören.

Norsk

Dette produktet oppfyller bestemmelsene ifølge WEEE-direktiv (2002/96/EC) med krav til merking. Påsatt merke viser at det ikke er tillatt å kassere dette elektriske/elektroniske produktet sammen med husholdningsavfall.

Produktkategori: På grunnlag av utstyrstypene i WEEE-direktivet, vedlegg I, er dette produktet klassifisert i kategori 9, "Instrumentering for overvåking og kontroll".



Må ikke kastes sammen med husholdningsavfall!

Ved behov for returforsendelse av uønskede produkter må du gå til produsentens nettside som er angitt på produktet, eller du må kontakte det lokale salgskontoret eller den lokale forhandleren.

Section 1

GENERAL INFORMATION

1.1 INTRODUCTION

The 1200 humidity generating system produces known humidity values for instrument calibration and evaluation using the fundamental principle of the "two pressure" generator originally developed by NIST. The automatic features allow the 1200 to generate manually entered humidity and temperature set-points as well as multipoint profiles completely unattended while continuously recording and printing system data. Upon completion of a profile, usually in a few hours or the following day, the system shuts-down automatically.

Virtually all functions of the 1200 humidity generator are controlled automatically through the use of an embedded computer. Visual indications of system status are displayed in real time on the full color active matrix liquid crystal display. Operator interaction is through the integral touch panel or optional USB keyboard and mouse.

1.2 PRINCIPLE OF OPERATION

1.2.1 General Description

The Series 1200 humidity generation system is based on the two-pressure principle. This process involves saturating air or some other gas, such as nitrogen, with water vapor at a given temperature and pressure. The saturated high pressure gas flows through an expansion valve where it is isothermally reduced to test pressure (Figure 1-1). The indications of saturation temperature, saturation pressure, test temperature, and test pressure are then used in the determination of all hygrometric parameters such as %RH, Dew Point, PPM, etc. Humidity generation by this system does not depend upon measuring the amount of water vapor, but rather is dependent on the measurements of temperature and pressure alone. The precision of the system is determined by the accuracy of the temperature and pressure measurements, and on the constancy of them throughout.

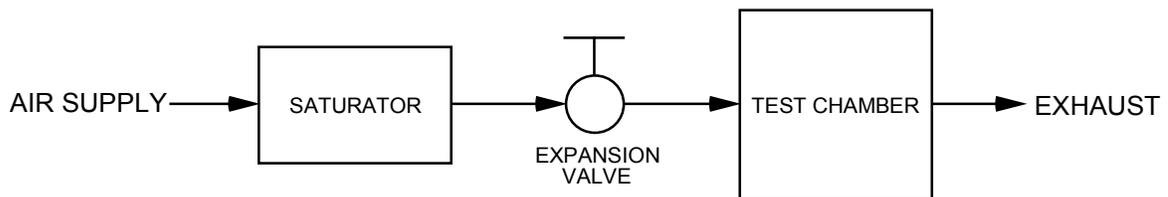


Figure 1-1

1.2.2 Humidity Formulas

The humidity (or water vapor content) of a gas may be expressed in a variety of ways. The humidity parameters available with the 1200, and the formulas used to derive them, will be expressed in terms of the two-pressure generator. While some basic understanding of humidity is helpful, thorough knowledge of the following formulas and their relationships to the 1200 is not a requirement for successful operation of the generator.

1.2.2.1 Saturation Vapor Pressure, e

Saturation Vapor Pressure (SVP) is the pressure exerted by water vapor alone when in equilibrium with pure ice or water, and is expressed as a function of temperature only.

Wexler's¹ formula for the saturation vapor pressure over water in the pure phase with Hardy's² adjusted coefficients for the ITS-90 temperature scale is as follows:

$$\ln e_w(T) = \sum_{i=0}^6 g_i T^{i-2} + g_7 \ln T \quad (1)$$

$$\begin{aligned} \text{where } g_0 &= -2.8365744 \times 10^3 \\ g_1 &= -6.028076559 \times 10^3 \\ g_2 &= 1.954263612 \times 10^1 \\ g_3 &= -2.737830188 \times 10^{-2} \\ g_4 &= 1.6261698 \times 10^{-5} \\ g_5 &= 7.0229056 \times 10^{-10} \\ g_6 &= -1.8680009 \times 10^{-13} \\ g_7 &= 2.7150305 \times 10^0 \end{aligned}$$

$$e_w(T) = \text{The saturation vapor pressure (in Pascals) at temperature, } T \text{ (in Kelvin) with respect to water.}$$

Hyland's&Wexler's³ formula for the saturation vapor pressure over ice in the pure phase with Hardy's² adjusted coefficients for the ITS-90 temperature scale is as follows:

$$\ln e_i(T) = \sum_{i=0}^4 k_i T^{i-2} + k_5 \ln T \quad (2)$$

$$\begin{aligned} \text{where } k_0 &= -5.8666426 \times 10^3 \\ k_1 &= 2.232870244 \times 10^1 \\ k_2 &= 1.39387003 \times 10^{-2} \\ k_3 &= -3.4262402 \times 10^{-5} \\ k_4 &= 2.7040955 \times 10^{-8} \\ k_5 &= 6.7063522 \times 10^{-1} \end{aligned}$$

$$e_i(T) = \text{The saturation vapor pressure (in Pascals) at temperature, } T \text{ (in Kelvin) with respect to ice.}$$

¹ Wexler, Arnold, "Vapor Pressure Formulation for Water in Range 0 to 100 °C. A Revision.", Journal of Research of the National Bureau of Standards - A. Physics and Chemistry, Vol. 80A, Nos. 5 and 6, September-December 1976, pp 775-785, Equation 18.

² R. Hardy, "ITS-90 Formulations for Vapor Pressure, Frost Point Temperature, Dew Point Temperature and Enhancement Factors in the Range - 100 to +100 °C", The Proceedings of the Third International Symposium on Humidity & Moisture, Teddington, England, April 1998

³ Hyland, Richard, and Wexler, Arnold, "Formulations of the Thermodynamic Properties of the Saturated Phases of H₂O from 173.15 K to 473.15 K", *Ashrae Transactions* 1983, Part 2A, pp 500-513, Equation 18

1.2.2.2 Enhancement Factor, f

The enhancement factor, f , corrects for the non-ideal behavior of a gas admixed with water vapor. The enhancement factor is a function of two independent variables; pressure, P , and temperature, T . A formula for calculation of the enhancement factor, when air is used as the carrier gas, at any given pressure and temperature above freezing is given by Greenspan⁴ as

$$f_w(T,P) = \exp \left[a \left(1 - \frac{e_w(T)}{P} \right) + b \left(\frac{P}{e_w(T)} - 1 \right) \right] \quad (3)$$

where P = the absolute pressure in Pascals, and
 $e_w(T)$ = the saturation vapor pressure (in Pascals) at temperature, T .

The two remaining variables, a and b , with Hardy's⁵ adjusted coefficients for the ITS-90 temperature scale are as follows:

$$a = \sum_{i=0}^3 A_i T^i$$

$$b = \exp \sum_{i=0}^3 B_i T^i$$

where $A_0 = 3.53624 \times 10^{-4}$
 $A_1 = 2.9328363 \times 10^{-5}$
 $A_2 = 2.6168979 \times 10^{-7}$
 $A_3 = 8.5813609 \times 10^{-9}$
 $B_0 = -1.07588 \times 10^1$
 $B_1 = 6.3268134 \times 10^{-2}$
 $B_2 = -2.5368934 \times 10^{-4}$
 $B_3 = 6.3405286 \times 10^{-7}$
 T = temperature of the gas in °C.

This formula for the enhancement factor is valid over the pressure range of the 1200 and over the temperature range of 0 to 100 °C.

When calculating enhancement factors for temperatures below freezing, the formula becomes

$$f_i(T,P) = \exp \left[a \left(1 - \frac{e_i(T)}{P} \right) + b \left(\frac{P}{e_i(T)} - 1 \right) \right] \quad (4)$$

where P = the absolute pressure in Pascals, and
 $e_i(T)$ = the saturation vapor pressure in Pascals at temperature, T .

⁴ Greenspan, Lewis, "Functional Equations for the Enhancement Factors of CO₂-Free Moist Air", *Journal of Research of the National Bureau of Standards - A. Physics and Chemistry*, Vol. 80A, No.1, January-February 1976, pp. 41-44

⁵ R. Hardy, "ITS-90 Formulations for Vapor Pressure, Frost Point Temperature, Dew Point Temperature and Enhancement Factors in the Range - 100 to +100 °C", *The Proceedings of the Third International Symposium on Humidity & Moisture*, Teddington, England, April 1998

Again the variables, a and b , with Hardy's⁶ adjusted coefficients for the ITS-90 temperature scale are as follows:

$$a = \sum_{i=0}^3 A_i T^i$$

$$\text{and } b = \exp \sum_{i=0}^3 B_i T^i$$

where

$$A_0 = 3.64449 \times 10^{-4}$$

$$A_1 = 2.9367585 \times 10^{-5}$$

$$A_2 = 4.8874766 \times 10^{-7}$$

$$A_3 = 4.3669918 \times 10^{-9}$$

$$B_0 = -1.07271 \times 10^1$$

$$B_1 = 7.6215115 \times 10^{-2}$$

$$B_2 = -1.7490155 \times 10^{-4}$$

$$B_3 = 2.4668279 \times 10^{-6}$$

$$T = \text{temperature of the gas in } ^\circ\text{C}.$$

1.2.2.3 Relative Humidity, %RH

Relative Humidity, %RH, is a percentage ratio of the amount of water vapor in a given gas mixture to the maximum amount physically allowable in the gas at the same temperature and pressure. In its strictest form, relative humidity is defined in terms of mole fractions and is given as

$$\%RH = \frac{X_v}{X_w} \Big|_{P,T} * 100$$

where X_v = the mole fraction of water vapor in a sample of moist air at a specific pressure, P , and temperature, T , and
 X_w = the mole fraction of water vapor which would exist in a sample of air if it were saturated with water vapor at the same pressure, P , and temperature, T , as the unsaturated sample X_v .

The mole fraction of water vapor in a sample of gas is given by

$$X = \frac{P_v}{P}$$

where P_v = the partial pressure of the gas which is exerted by the water vapor constituent alone, and
 P = the absolute (or total) pressure of the gas, which is also equal to the sum of the partial pressures exerted by the water vapor and dry air constituents.

⁶ R. Hardy, "ITS-90 Formulations for Vapor Pressure, Frost Point Temperature, Dew Point Temperature and Enhancement Factors in the Range - 100 to +100 °C", The Proceedings of the Third International Symposium on Humidity & Moisture, Teddington, England, April 1998

When a gas is fully saturated with water vapor, the partial pressure, P_V , exerted by the water vapor constituent is a known quantity, $e_w(T)$, and is termed "the saturation vapor pressure". Since, at saturation, $P_V = e_w(T)$, the mole fraction equation of a saturated gas may be written as

$$X = \frac{e_w(T)}{P}$$

where $e_w(T)$ = the saturation vapor pressure at temperature T , and is the partial pressure exerted by the water vapor constituent alone, and
 P = the absolute (or total) pressure of the gas.

The mole fraction of water vapor which would exist in a saturated gas sample at the chamber pressure, P_C , and chamber temperature, T_C , would be the quantity, X_W , which is needed to calculate the relative humidity relationship previously discussed. Here, the mole fraction, under saturated conditions, may be expressed by

$$X_W = \frac{e_w(T_C)}{P_C}$$

where $e_w(T_C)$ = the saturation vapor pressure at the chamber temperature, T_C , and
 P_C = the measured absolute pressure in the chamber expressed in the same units as $e_w(T_C)$.

The other quantity, X_V , required for the calculation of relative humidity, is that mole fraction of water vapor which actually exists in the air sample within the chamber at pressure P_C , and temperature T_C . If the chamber pressure, P_C , were used in the calculation of the mole fraction X_V , the expression would be

$$X_V = \frac{P_v}{P_C}$$

which would require direct measurement of the water vapor content, P_V . However, this requirement is eliminated by using the relationship

$$\frac{e_w(T_S)}{P_S} = \frac{P_v}{P_C}$$

where $e_w(T_S)$ = the saturation vapor pressure at the saturation temperature, T_S , and
 P_S = the measured absolute (or total) pressure at which the sample is saturated (the saturation pressure).

The basis for this relationship lies in the fact that the number of molecules of the constituents within a sample of gas remain constant regardless of the pressure or temperature, provided that the temperature or pressure applied does not cause a change in phase (i.e., gas to liquid).

Since the saturation vapor pressure, $e_w(T)$, is a well known function of the temperature alone, the total pressure at saturation, P_S , may be adjusted to any reasonable value to achieve the desired mole fraction of water vapor. Relying on this relationship, the mole fraction of water vapor entering the chamber (and at chamber temperature) may be written as that mole fraction of water vapor existing in the saturator at the saturation pressure and temperature.

Thus, by combination of the two previous expressions, the mole fraction of water vapor may be written as

$$X_V = \frac{e_w(T_S)}{P_s}$$

where $e_w(T_S)$ = the saturation vapor pressure at saturation temperature, T_S , and
 P_s = the measured absolute (or total) pressure at which the sample is saturated (the saturation pressure).

The relative humidity may now be expressed in terms of these other quantities by returning to the original definition and substituting in the appropriate expressions.

$$\begin{aligned} \%RH &= \frac{X_v}{X_w|_{P,T}} * 100 \\ &= \frac{\left(\frac{e_w(T_S)}{P_s} \right)}{\left(\frac{e_w(T_C)}{P_c} \right)} * 100 \end{aligned}$$

After rearrangement of terms, the relative humidity formula for ideal gas may then be expressed as

$$\%RH = \frac{e_w(T_S)}{e_w(T_C)} * \frac{P_c}{P_s} * 100 \quad (5)$$

where $e_w(T_S)$ = the saturation vapor pressure at saturation temperature, T_S
 $e_w(T_C)$ = the saturation vapor pressure at chamber temperature, T_C
 P_c = the absolute pressure in the chamber, and
 P_s = the absolute pressure in the saturator.

Any gas, when admixed with water vapor, exhibits non-ideal properties which affect the saturation vapor pressure, $e_w(T)$. The saturation vapor pressures, $e_w(T_S)$ and $e_w(T_C)$, in the relative humidity formula (5), must be replaced by their "effective" saturation vapor pressures which are related to the ideal SVP by

$$e_w'(P, T) = f_w(P, T) e_w(T)$$

where $e_w'(P, T)$ = the "effective saturation vapor pressure" at absolute pressure, P , and temperature, T , and
 $f_w(P, T)$ = the "enhancement factor for moist air" at pressure, P , and temperature, T .

The relative humidity formula, based on the *effective* saturation vapor pressures, is then written as

$$\%RH = \frac{e_w'(P_s, T_s)}{e_w'(P_c, T_c)} * \frac{P_c}{P_s} * 100$$

and, after making the appropriate substitutions, is expressed by

$$\%RH = \frac{f(T_s, P_s) * e(T_s) * P_c}{f(T_c, P_c) * e(T_c) * P_s} * 100 \quad (6)$$

- where $f(T_s, P_s)$ = the enhancement factor at saturation temperature, T_s , and saturation pressure, P_s
 $f(T_c, P_c)$ = the enhancement factor at the chamber temperature, T_c , and chamber pressure, P_c
 $e(T_s)$ = the SVP (e_j or e_w) at saturation temperature, T_s
 $e(T_c)$ = the SVP (e_j or e_w) at chamber temperature, T_c
 P_c = the absolute chamber pressure, P_c
 P_s = the absolute saturation pressure, P_s

It can now be seen by inspection of the relative humidity formula, expressed in its final form in equation 6, that known relative humidities may be accurately generated through precise measurement and control of pressure and temperature alone.

The 1200 generates a particular Relative Humidity by determining the saturation pressure, P_s , required (at saturation temperature, T_s) to establish the correct %RH at chamber temperature, T_c , and chamber pressure, P_c . Relative Humidity is dependent on both chamber temperature and chamber pressure.

The 1200 displays and generates %RH using saturation vapor pressure at the test chamber temperature, $e(T_c)$, computed with respect to water (equation 1) for test chamber temperatures above 0 °C, and with respect to ice (equation 2) for test chamber temperatures below 0 °C.

1.2.2.4 Frost Point

Frost point temperature, T_f , is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of ice or frost. For this reason, frost point is not applicable above freezing. In the two-pressure generator, frost point vapor pressure is derived from the formula

$$e_i(T_f) = \frac{f(T_s, P_s) * e(T_s) * P_c}{f(T_f, P_c) * P_s} \quad (7)$$

- where $f(T_s, P_s)$ = the enhancement factor at saturation temperature, T_s , and saturation pressure, P_s
 $f(T_f, P_c)$ = the enhancement factor at the frost point temperature, T_f , and test chamber pressure, P_c . (Since frost point is not known, this equation is solved by iteration.)
 $e(T_s)$ = the SVP (e_j or e_w) at saturation temperature, T_s
 P_c = the absolute test chamber (or test) pressure, P_c
 P_s = the absolute saturation pressure, P_s .

Then frost point temperature relative to that vapor pressure is solved for as the inverse of the SVP formula (see equation 2 section 1.2.2.1)

$$T_f = t | e_i(T_f) \quad (8)$$

where $e_i(T_f)$ = SVP over ice at the frost point temperature, T_f , obtained from equation 5.

The 1200 generates a particular frost point by determining the saturation pressure, P_S , required to establish the correct frost point vapor pressure (and ultimately the correct frost point temperature) at any given test chamber pressure, P_C . Frost point is independent of test chamber temperature.

1.2.2.5 Dew Point

Dew point temperature, T_d , is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of dew. Unlike frost point, dew point can exist both above and below freezing. In the two-pressure generator, dew point vapor pressure is derived from the formula

$$e_w(T_d) = \frac{f(T_s, P_s) * e(T_s) * P_c}{f(T_d, P_c) * P_s} \quad (9)$$

where $f(T_s, P_s)$ = the enhancement factor at saturation temperature, T_s , and saturation pressure, P_s

$f(T_d, P_c)$ = the enhancement factor at the dew point temperature, T_d , and test chamber pressure, P_c . (Since dew point is not known, this equation is solved by iteration.)

$e(T_s)$ = the SVP (e_i or e_w) at saturation temperature, T_s

P_c = the absolute test chamber (or test) pressure, P_c

P_s = the absolute saturation pressure, P_s .

Then dew point temperature relative to that vapor pressure is solved for as the inverse of the SVP formula (see equation 1 section 1.2.2.1)

$$T_d = t | e_w(T_d) \quad (10)$$

where $e_w(T_d)$ = SVP over water at the dew point temperature, T_d , obtained from equation 7.

The 1200 generates a particular dew point by determining the saturation pressure, P_S , required to establish the correct dew point vapor pressure (and ultimately the correct dew point temperature) at any given test chamber pressure, P_C . Dew point is independent of test chamber temperature.

1.2.2.6 Parts Per Million by Volume, PPM_V

PPM_V is a relationship between the number of molecules of water vapor to the number of molecules of dry gas in the mixture. In the two-pressure generator, it is expressed by the relationship

$$\text{PPM}_V = \frac{f(T_s, P_s) * e(T_s)}{P_s - f(T_s, P_s) * e(T_s)} * 10^6 \quad (11)$$

where $f(T_s, P_s)$ = the enhancement factor at saturation temperature, T_s , and saturation pressure, P_s
 $e(T_s)$ = the SVP (e_j or e_w) at saturation temperature, T_s
 P_s = the absolute saturation pressure, P_s .

The 1200 generates a particular PPM_V by determining the required saturation pressure, P_s , at any given value of saturation temperature, T_s . PPM_V is independent of test chamber pressure and test chamber temperature.

1.2.2.7 Parts Per Million by Weight, PPM_W

PPM_W is a relationship between the weight of the molecules of water vapor to those of the dry gas in the mixture. PPM_W is related to PPM_V by the formula

$$\text{PPM}_W = \frac{MW_w}{MW_a} * \text{PPM}_V \quad (12)$$

where MW_w = molecular weight of water (~ 18.02 g/mol)
 MW_a = molecular weight of air (~ 28.97 g/mol)
 PPM_V = Parts Per Million by Volume from equation 9.

Therefore PPM_W ~ 0.622 PPM_V. With the exception of the 0.622 scaling factor, PPM_W is generated in a manner identical to that of PPM_V. PPM_W is also independent of test chamber temperature and test chamber pressure.

1.3 SPECIFICATIONS

1.3.1 General

Relative Humidity Range:	10 to 95%
Relative Humidity Uncertainty: @ PcTc *	0.5%
Frost Point Temperature Range:	-18 to 0 °C
Dew Point Temperature Range:	-20 to 50 °C
Dew Point Uncertainty: *	0.1 °C
Chamber Temperature Range:	10 to 60 °C
Chamber Temperature Control Stability:	±0.04 °C
Chamber Temperature Uniformity: **	0.1 °C
Chamber Temperature Measurement Uncertainty: *	0.05 °C
Chamber Temperature Cooling Rate:	4 Minutes Per °C Average
Chamber Temperature Heating Rate:	2 Minutes Per °C Average
Saturation Pressure Range:	Ambient to 152 psiA
Saturation Pressure Uncertainty: *	0.08% of FS psiA
Test Chamber Pressure Range:	Ambient
Test Chamber Pressure Uncertainty: *	0.08% of FS psiA
Display Resolution:	0.01
Gas Type:	Air or Nitrogen
Gas Pressure Rating (MAWP):	175 psiG
Gas Flow Rate Range:	2 to 10 L/min
Gas Flow Rate Resolution:	0.01 L/min
Gas Flow Rate Uncertainty: *	1.0 L/min
Test Chamber Dimensions:	6" x 6" x 6" (152 mm x 152 mm x 152 mm)
Access Port:	Ø 1.688" (42.8 mm) located on right side
Physical Dimensions:	11.8" H x 24.1" W x 14.1" D (30.1 cm x 61.2 cm x 35.8 cm)
Dry Weight:	56 lbs. (25.40 Kg)
Wet Weight:	65 lbs. (29.48 Kg)
Utility Cart Dimensions:	33.0" H x 30.6" W x 20.0" D (83.8 cm x 77.7 cm x 50.8 cm)
Utility Cart Weight:	84 lbs. (38.10 Kg)

* Represents an expanded uncertainty using a coverage factor, k=2, at an approximate level of confidence of 95%.

** When operated within ±10 °C of ambient temperature.

1.3.2 Facility Requirements

1200 Humidity Generator	100-240 vac, 6 A, 50/60Hz
ACS1210 Air Compressor	100/100-115 vac, 10 A, 50/60Hz single phase
ACS1210 Air Compressor (optional)	220-240/230 vac, 6.3 A, 50/60Hz single phase
Gas Supply:	155-175 psiG @ 0.5 cfm (15 L/min)

1.3.3 Environmental

Operating Temperature:	15 to 30 °C
Storage Temperature:	0 to 50 °C
Humidity:	5 to 95% Non-condensing

1.4 COMPUTER / CONTROL SYSTEM

Reference Drawing 03S12904

1.4.1 General Description

The computer/control system of the 1200 humidity generator performs all control functions required in the humidity generation process. Temperature and pressure measurement and control, as well as displaying, printing, and storing of system parameters are all performed in real time. The computer/controller is made up of several main components, each with individual yet cooperative functions.

1.4.2 Computer System

The 1200 employs a Windows Embedded computer system, color TFT LCD touch panel display, and interfaces for USB and Ethernet. The computer controls all aspects of the humidity generation process (i.e., controlling temperatures, pressures, etc.) as well as performing all human interface functions of user input and information display. Typical windows functions are limited to provide a small embedded footprint and conserve disk space for data storage.

1.4.2.1 MCU Controller

The Main Computer Unit (MCU) used in the 1200 humidity generator is an embedded SBC running Windows XP Embedded OS and Thunder Scientifics' ControLog® for the Series 1200. The main computer unit supplies a CPU running at 400MHz or better, 1GB or larger solid state disk for program/data storage, a LCD interface for display connection, serial and parallel ports for system communication and control, and USB/Ethernet connections for user interfacing.

1.4.2.2 Thin Film Transistors Display (TFT)

The LCD display incorporated into the 1200 humidity generator is a backlit, touch sensitive, thin film transistor display (TFT). It is used for the purpose of user input and display of system information such as setpoints, measurements, and any other information pertinent to the operation of the 1200 humidity generator.

1.4.2.3 USB and Ethernet Interface

The 1200 humidity generator incorporates USB and Ethernet interfaces for communication. The USB port can be expanded with the use of a USB hub. A multitude of devices can be used, such as a keyboard, mouse, jump drive, or printer. Ethernet capabilities are provided to connect to local servers. This feature supports remote desktop operations, Ethernet printing, and file transfers. To connect to your network please refer to your IT personnel. All connections are standard Windows XP protocol.

1.5 ELECTRICAL SYSTEM

1.5.1 Power Distribution

Reference Drawing 03S12905

The 1200 requires 100/240 VAC 50/60 Hz at approximately 6 amps.

1.5.1.1 Power Supply - +24 VDC (DC1)

The +24 VDC power supply provides power for the pump, fans, stepper motors, solenoid valves, heaters, and the thermoelectric assembly.

1.5.1.2 Power Supply - +5/+12 VDC (DC2)

The +5/+12 VDC power supply provides power to the main computer (MCU), relay control board (RCB), and fan control board (FCB) as well as the analog voltage modules for temperature, pressure, and flow measurement.

1.5.2 System Control Blocks

1.5.2.1 Analog to Digital Converters

The temperature, flow, and pressure transducers are measured by the use of DGH Analog to Digital Converters. Each of these is discussed further in following sections.

1.5.2.2 Flow Valve

The Flow Valve (V1) is used to control system mass flow rate and is driven indirectly from the main computer. The stepper motor drive to this valve is powered by the +24 VDC supply (DC1).

1.5.2.3 Expansion Valve

The Expansion Valve (V2) is used to control saturation pressure and is driven indirectly from the main computer. The stepper motor drive to this valve is powered by the +24 VDC supply (DC1).

1.5.2.4 Thermoelectric Assembly

The Thermoelectric Assembly (TE) is used to control saturation temperature and is driven indirectly from the main computer. The thermoelectric assembly is powered by the +24 VDC supply (DC1).

1.5.3 Analog Inputs

Reference Drawings 03S12906, 03S12907

1.5.3.1 Temperature Measurement

Four 2K ohm thermistors are used for temperature measurement with continuous real time display by the main computer. All are easily removable for calibration.

	<u>Channel #</u>
1. Saturation Temperature (RTD0) (indication and control)	0
2. Presaturation Temperature (RTD1) (indication and control)	1
3. Expansion Valve Temperature (RTD2) (indication and control)	2
4. Test Chamber Temperature (RTD3) (indication only)	3

These thermistor temperatures are measured by a DGH analog to digital converter with a resolution of approximately ± 0.01 °C. Since the temperatures measured by the DGH are based on ideal R-T curves, further calibration of the temperature output is performed by the main computer prior to use or display (refer to 4.2.2 for calibration).

1.5.3.2 Mass Flow Transducer (T0)

The mass flow control system utilizes a thermal type Mass Flow Transducer (T0). Mass flow rate through the generator is settable from 1 to 10 L/min and is displayed in real time on the liquid crystal display (LCD).

The flow transducer is powered by the +12 VDC power supply (DC2) and has an output of 0 to 5 VDC for a mass flow rate of 0 to 20 L/min. The flow transducer output is measured by a DGH analog to digital converter with a resolution better than ± 0.01 L. Further calibration of the mass flow output is performed by the main computer prior to use or display (refer to 4.2.2 for calibration).

1.5.3.3 System Pressure Transducer (T1)

The 0-155 psiA System Pressure Transducer (T1) is a micromachined silicon sensing element mounted within a high integrity pressure module constructed from stainless steel 316L. During humidity generation, this system pressure transducer normally monitors the saturation pressure but will switch via the pressure select solenoid valve (SOL5) to read chamber pressure (barometric) about once every 10 minutes. The system pressure transducer is powered by the +12 VDC power supply (DC2) and has an output of 0 to 5 VDC for a range of 0 to 155 psiA. This transducer is measured by a DGH analog to digital converter with a resolution of approximately ± 0.02 psiA. Further calibration of actual pressure values is performed by the main computer prior to use or display (refer to 4.2.2 for calibration).

1.5.3.4 Supply Pressure Transducer (T2)

The 0-200 psiG Supply Pressure Transducer (T2) is a micromachined silicon sensing element mounted within a high integrity pressure module constructed from stainless steel. This transducer is used to measure incoming supply pressure. The output of the transducer is 0 to 5 VDC for a range of 0 to 200 psiG. Transducer output is measured by a DGH analog to digital converter with a resolution of approximately ± 0.02 psiG. Further calibration to actual pressure values is performed by the main computer prior to use or display (refer to 4.2.2 for calibration).

1.5.3.5 Reservoir Level Monitor

The Reservoir Level Monitor, located on the Relay Control Board (RCB), is used by the main computer to measure reservoir distilled water level, which can be displayed on the LCD screen. When an empty indication occurs during RH generation, an audible alarm will sound accompanied by a warning message. An empty reservoir during start up forces a shutdown, accompanied by both audible and visual alarms.

1.5.3.6 Presaturator Level Monitor

The Presaturator Level Monitor, located on the Relay Control Board (RCB), is used by the main computer to monitor the presaturator distilled water level. When the distilled water level drops below the control point (i.e., presaturator empty) the main computer is signaled of this condition and the presaturator fill solenoid (SOL4) is activated allowing distilled water to flow into the presaturator until a full condition is obtained.

If the presaturator does not fill to the control point (i.e., reservoir empty) within approximately 5 minutes, the system will shut down.

1.5.4 Control Logic

Reference Drawing 03S12906

All control is performed digitally at a logic level of +5 VDC. Activation of all devices is accomplished by applying a high logic level to the control input of the associated solid state relay or other coupling device.

1.5.4.1 Air Supply Solenoid Valve

The Air Supply Solenoid Valve (SOL1) is activated (air on) by applying a high logic level to the gate of SSR1 (U6) on the Relay Control Board (RCB). Valve actuation voltage is +24 VDC.

1.5.4.2 Pressure Bleed Solenoid Valve

The Pressure Bleed Solenoid Valve (SOL3), when deactivated (normally open), vents system pressure during a SHUTDOWN or when electrical power is OFF. This valve is activated by applying a high logic level to the gate of SSR3 (U7) on the Relay Control Board (RCB). Valve actuation voltage is +24 VDC.

1.5.4.3 Pressure Select Solenoid Valve

The Pressure Select Solenoid Valve (SOL2) allows the System Pressure Transducer (T1) to measure the saturation pressure and the chamber (barometric) pressure when activated and deactivated respectively. This valve is activated by applying a high logic level to the gate of SSR2 (U11) on the Relay Control Board (RCB). Valve actuation voltage is +24 VDC.

1.5.4.4 Presaturator Heater

The Presaturator Heater (H1) is a resistive foil heating element. Activation is accomplished by applying a high logic level to the gate of SSR8 (U10,U14,U15) on the Relay Control Board (RCB). The presaturator heater is controlled through a PID driven pulse width modulated +24 VDC drive.

1.5.4.5 Presaturator Fill Solenoid Valve

The Presaturator Fill Solenoid Valve (SOL4) is activated by the main computer when it is determined that the water level in the presaturator has dropped below the control point. The presaturator fill solenoid valve, when activated, allows distilled water to flow into the presaturator until a full condition is obtained. If the presaturator does not fill to the control point (i.e., reservoir empty) within approximately 5 minutes, the system will shut down.

This valve is activated by applying a high logic level to the gate of SSR4 (U12) on the Relay Control Board (RCB). Valve actuation voltage is +24 VDC.

1.5.4.6 Expansion Valve Heaters

The Expansion Valve Heaters (H2 & H3), when activated, are used to warm the expansion valve body offsetting the cooling effects due to gas expansion. The heaters are activated by applying a high logic level to the gate of SSR7 (U9) on the Relay Control Board (RCB). The expansion valve heaters are controlled through a PID driven pulse width modulated +24 VDC drive.

1.5.4.7 Fluid Circulation Pump

The Fluid Circulation Pump (P1) is a magnetically coupled pump energized by applying a high logic level to the gate of SSR6 (U13) on the Relay Control Board (RCB). Pump voltage is +24 VDC.

1.5.4.8 Console Fans

The Console Fan Assembly (FAN) is made up of four (4) individual fans (F1-4). These are configured into two (2) banks: Bank one (1) contains three (3) fans (F1-3) and bank two (2) contains one (1) fan (F4). During idle powered up conditions, bank two (2) is used to cool the cabinet temperature when above about 30 °C. During system generation, both banks are enabled to keep the cabinet and the thermoelectric assembly cool. Bank one (1) is energized by applying a high logic level to the gate of U3 on the Fan Control Board (FCB). This is the same drive signal as used for the Fluid Circulation Pump (P1). Bank two (2) is energized by applying a high logic level to the gate of U2 on the Fan Control Board (FCB). These fans are powered by the +24 VDC supply (DC1).

1.6 PNEUMATIC SYSTEM

1.6.1 General Description

Reference Drawing 03S12908

The 1200's pneumatic system requires an air/gas supply that is clean, oil free, and should be capable of supplying a pressure of 155-175 psiG at a minimum flow rate of 0.5 cfm (15 L/min). A gas supply with a pressure dew point of 10 °C or less is recommended. The air supply is connected to a 1/4" FPT fitting located at the lower right rear of the console. From this point, air is admitted through the air supply solenoid valve (SOL1) to the air supply regulator (REG). Regulated pressure is then monitored by the supply pressure transducer (T2) and can be displayed on the LCD display. After regulation, the air passes through the mass flow meter (T0) to the flow control valve (V1). The flow control valve is an electromechanically actuated plug valve controlled by the main computer with feedback from the mass flow meter. Mass flow rates are user selectable and displayed on the LCD display.

From the flow control valve, the air flows to the presaturator (PSAT). The presaturator water temperature is maintained 10 to 20 °C warmer than saturation temperature so as to humidify the air stream to a water vapor content greater than saturation temperature conditions. This saturated air stream exits the presaturator and enters the saturator (SAT). As the air flows through the saturator it is cooled to saturation temperature and excess water vapor is condensed as the air establishes equilibrium with the chamber fluid thus achieving 100% saturation. Saturation pressure and saturation temperature are measured as the saturated air exits the saturator and flows to/through the expansion valve (V2).

The computer controlled expansion valve (V2) allows the saturated high pressure air to be reduced to chamber pressure by varying the orifice of the expansion valve from nearly closed to fully open depending upon the required saturation pressure. After expansion, the air enters the test chamber at the desired relative humidity with reference to the chamber temperature and pressure conditions. The air exits the test chamber through the exhaust port located at the bottom rear of the test chamber (as long as the chamber access port is sealed).

1.6.1.1 Reservoir

The reservoir (RES) is a pressure vessel constructed of 316 series stainless steel and holds approximately 0.75 liter of distilled water for the presaturator. This vessel is maintained at system pressure and, upon demand, supplies distilled water to the presaturator. Reservoir water level can be monitored on the LCD display in bar gauge form.

1.6.1.2 Presaturator

The presaturator (PSAT) is a vertical pressure vessel presenting a water surface to the incoming air stream. The presaturator is maintained at a temperature 10 to 20 °C warmer than the desired saturation temperature. Presaturator temperature is monitored using the Presaturator Temperature Probe (RTD1). Heating of the presaturator is accomplished by the Presaturator Heater (H1), a resistive foil heating element powered by the +24 VDC power supply using a PID driven pulse width modulated solid state control. The presaturator water level is controlled automatically via the presaturator level monitor and the main computer control of the presaturator fill solenoid valve (SOL4). This allows distilled water to flow from the reservoir (RES) maintaining a constant water level in the presaturator.

1.6.1.3 Saturator

The air stream is saturated with water vapor in a single pass "tube in shell" type heat exchanger and this assembly is called a "saturator" (SAT). The humidified air from the presaturator (PSAT), humidified to an absolute moisture content greater than saturation at saturation temperature, is made to flow through the saturator on the shell side of the heat exchanger. Temperature controlled chamber fluid flows through the saturator, in the opposite direction of the air, on the tube side of the heat exchanger. The presaturated air on the shell side is cooled to chamber fluid temperature as it flows through the saturator. Excess water vapor is condensed from the air stream as it establishes equilibrium with the chamber fluid, ensuring that the air stream is saturated. The "Saturation Pressure" (T1) and "Saturation Temperature" (RTD0) are monitored as the air exits the saturator. These measurements are used in the calculation and control of the desired humidity.

1.6.1.4 Expansion Valve

After exiting the saturator, the saturated high pressure air stream is reduced to chamber pressure through what is called an "expansion valve". The expansion valve (V2) is an electro-mechanically actuated plug valve, using feedback from the system pressure transducer. This valve is heated and thermally insulated to maintain the valve body above the dew point of the air stream.

1.7 FLUID SYSTEM

1.7.1 General Description

Reference Drawing 03S12909

The temperature control system utilizes distilled water as a heat transfer fluid. The fluid is circulated through the system at 2.5 gallons per minute by a magnetically coupled centrifugal pump (P1). In this closed loop system, conditioned fluid flows from the pump through the thermoelectric heat exchanger (TE), through the saturator assembly and then into the test chamber fluid shell. The fluid then exits the chamber fluid shell and returns to the pump inlet, completing the fluid circuit.

1.7.1.1 Temperature Conditioning

The 1200's heat transfer fluid is heated and cooled by a thermoelectric heat exchanger (TE) located in the main fluid path between the circulation pump and the saturator. Pulsed power to the thermoelectric element is switched using a solid state controller (TEC) that is driven by the PID output from the main computer using feedback from the saturator temperature measurement (RTD0).

Section 2

INSTALLATION

2.1 GENERAL

Preparations should be made to have adequate floor or bench space (if used without utility cart), a power source, and an air supply available at the location of operation if the system is to be used without the ACS1210 Air Compressor System.

2.2 FACILITIES REQUIRED

Reference Drawings 03D12901, 06D12914 & 06D12915

2.2.1 Floor or Bench Space

A minimum area of 2' x 3' of floor space or bench space (if used without utility cart) is required. This allows clearance for ventilation at the rear of the system and clearance for opening the door.

2.2.2 Electrical Power

1200 Humidity Generator	100-240 vac, 6 A, 50/60 Hz
ACS1210 Air Compressor	100/100-115 vac, 10 A, 50/60 Hz single phase
ACS1210 Air Compressor (optional)	220-240/230 vac, 6.3 A, 50/60 Hz single phase

2.2.3 Air Supply

The 1200 requires a gas supply that is of instrument quality, typically 5 micron or better particulate filtration, and oil free at a regulated pressure of 165-175 psiG and a pressure dew point of 10 °C or less. Regulated supply pressure lower than recommended is acceptable, but will limit the lowest humidity obtainable from the generator and will require an internal pressure regulator adjustment.

2.2.4 Distilled Water Supply

The 1200 Humidity Generator is shipped from the factory with the reservoir filled approximately 1/2 full. Approximately 0.75 liters of distilled water is required to fill an empty reservoir. Refer to Section 3.12.1 for filling procedure.

The system is shipped from the factory with the chamber fluid jacket **filled**. Refer to drawing 03D12901 for filling procedure and drawing 03D12902 for drain location.

2.3 PREPARATION

Reference Drawings 03D12901, 06D12914 & 06D12915

2.3.1 Generator and ACS1210 Placement

Place 1200 Humidity Generator on bench or on mobile cart per reference drawing 06D12915.

2.3.2 Chamber Overflow Cap Removal

The location of the chamber overflow cap is at the lower left rear corner of the system. **Remove Chamber Overflow Cap before system startup.** See figure 2-1.



Figure 2-1

2.3.3 Pressure Vent Cap Removal

The location of the pressure vent cap is at the lower right rear corner next to the system frame rail. After setting the system on the utility cart or workbench, rotate the system so as to see under the system and **remove Vent Cap before system startup.** See figure 2-2.

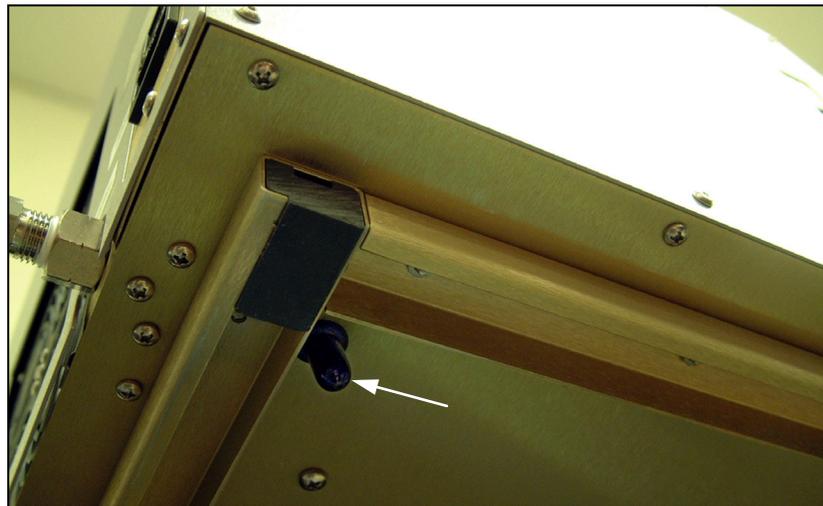


Figure 2-2

2.4 CONNECTIONS

Reference Drawing 03D12901

2.4.1 Air Supply

Connect a source of clean, oil free, instrument quality air to "AIR IN" connection on rear of system. The maximum working pressure is 175 psiG with a minimum flow rate of 0.5 cfm (15 L/min) and a pressure dew point not greater than 10 °C.

Position the "Air In" elbow at the five o'clock position while using a backup wrench on the system fitting. Tighten the Swagelok nut on hose 1/8 turn after finger tight. See figure 2-3.



Figure 2-3

If required, a 1/4" ID plastic hose may be inserted into the exhaust tubing and run to an area that a possible high humidity discharge will not harm. This line should not be longer than 8' and must slope away from the 1200 so all condensation is discharged. See figure 2-4.



Figure 2-4

2.4.2 AC Power

Connect power source per 2.2.2 to system using power cord supplied.

2.4.3 Utility Cart Connections

Reference Drawings 03D12901, 06D12914 & 06D12915

Connect the power cord from the power strip to power module of system then connect power strip main power cord to main power source. See figure 2-5.



Figure 2-5

2.5 INITIAL START-UP

Refer to Section 3 of the Operations Manual before using the 1200 for the first time. The system is ready for operation if all procedures in Section 2 have been completed.

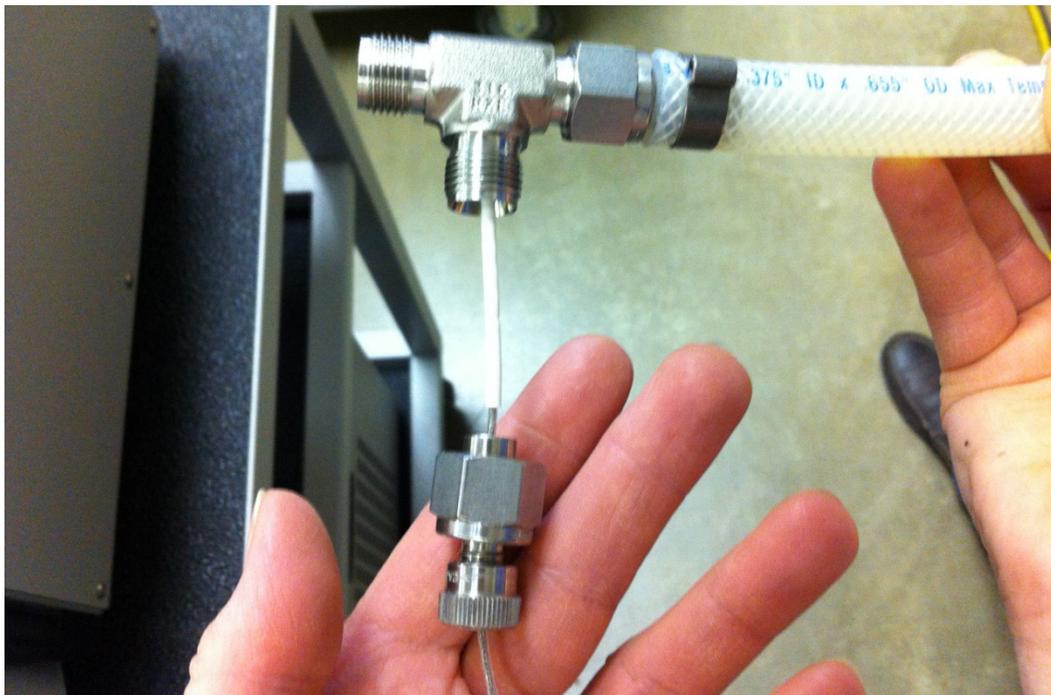
2.6 EXTERNAL HUMIDITY CALIBRATION FIXTURE INSTALLATION (Option)

Reference Drawing 07D12916

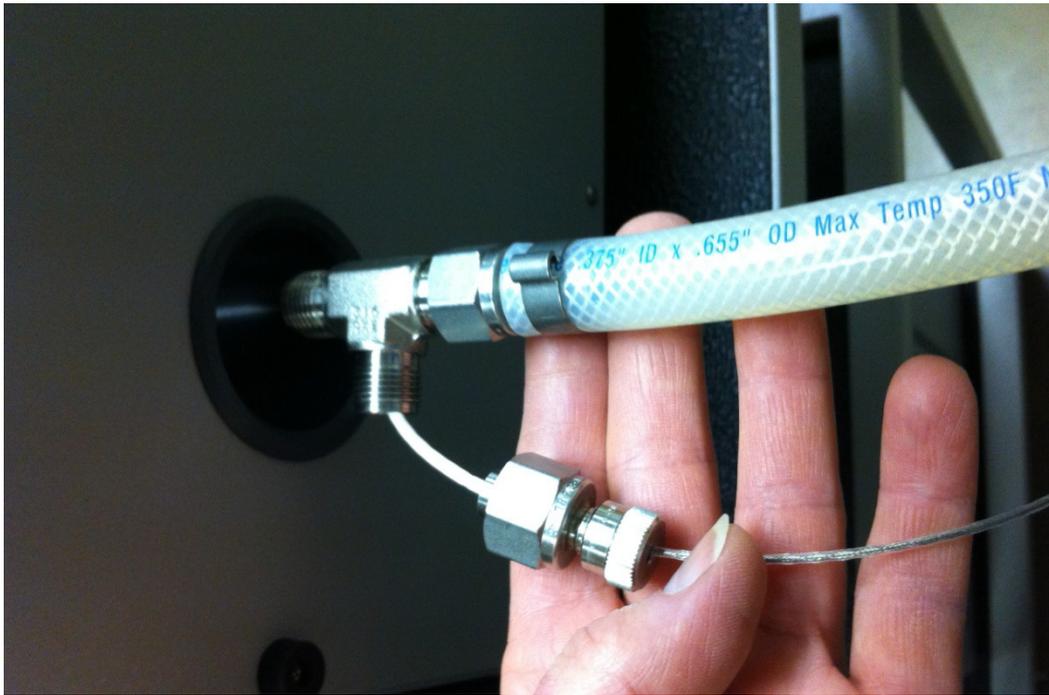
1. Unplug normal Chamber Temperature RTD.



2. Loosen knurled wire compression fitting. Using an 11/16" wrench decouple the wire compression fitting from the tee.



3. Insert assembly into access port as shown.



4. Make sure not to crimp the wires of the probe.



5. Connect the tee assembly to the fitting on 1200's inlet port. Reassemble the wire compression fitting to the tee assembly and tighten the knurled wire compression fitting just enough to keep the wire from sliding in the fitting. Align the red dots on connectors and push together.



6. Completed assembly.



7. Remote calibration assembly, shown clamped to a humidity probe.



Calibration coefficient installation for remote RTD

- 1) Refer to Section 4, paragraph 4.2.5. *Viewing the Current Calibration Coefficients* and paragraph 4.2.6 *Editing Calibration Coefficients* and review the editing procedure.
- 2) Power-up the 1200 and bring up the Calibration Coefficients window corresponding to the Chamber Temperature.
- 3) Refer to page 5 of the 1200's calibration report and install the temperature calibration coefficients exactly as shown for the remote RTD.
- 4) Close the *Editing Calibration Coefficients* window.

Section 3 OPERATION

3.1 GETTING STARTED

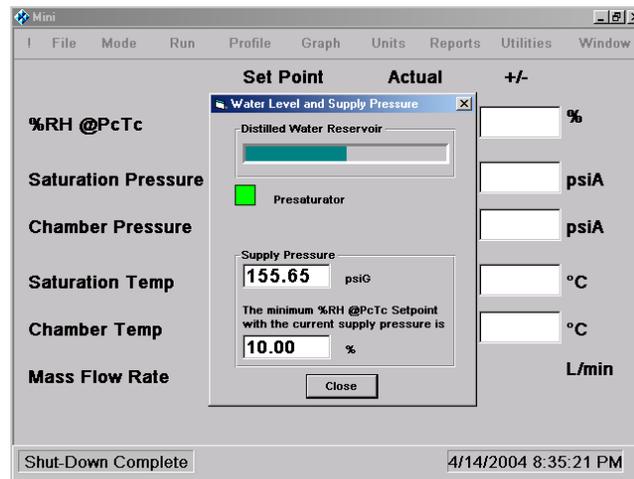
This section is intended to provide you with enough information to start up the generator and begin using it right away. By following along with the examples, you will become familiar with the basic operating procedures. Prior to continuing, ensure that installation and preparation has been completed (see sections *2.3 Preparation* and *2.4 Connections*).

3.1.1 Power Up:

- A) Verify power is connected. Press the 1200 Generator Power Switch to ON. Press the ACS1210 Air Compressor Power Switch to ON if applicable. If operating from facility air/gas system ensure any/all ON/OFF valves are open and verify supply pressure.
- B) The computer's bios will load followed by a Windows XP screen. A banner screen will appear while the 1200 program is initializing.



- C) At the end of the power-up sequence, the following screen appears:



If the "Reservoir" water level is at least 1/2 full, "Presaturator" indicator is green and "Supply Pressure" is adequate, click **Close**. If not, proceed to *Section 3.12 Water Level and Supply Pressure*.

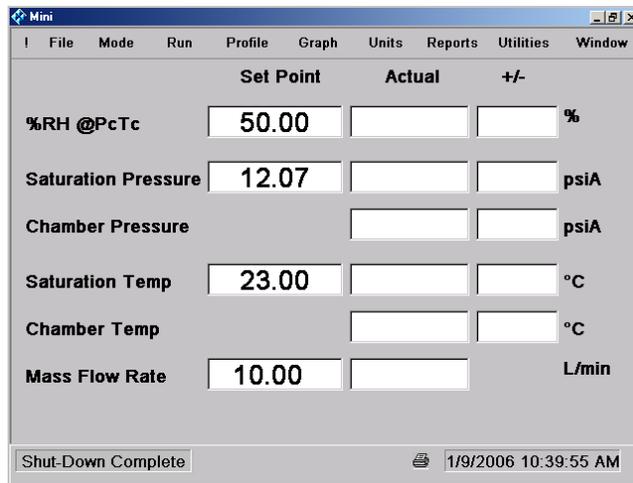
3.1.2 Initiating the Generate Mode

For our first trial run we will generate two different Relative Humidity points and then perform a system shutdown.

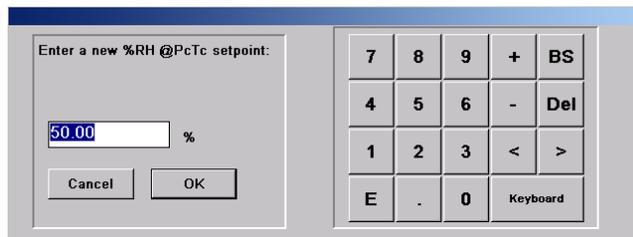
The first point we want to generate is 20% Relative Humidity with a 10 L/min flow rate at a test temperature of approximately 23 °C. First make sure the test chamber door is closed and the chamber access port plug is in place.

To start the Generate Mode:

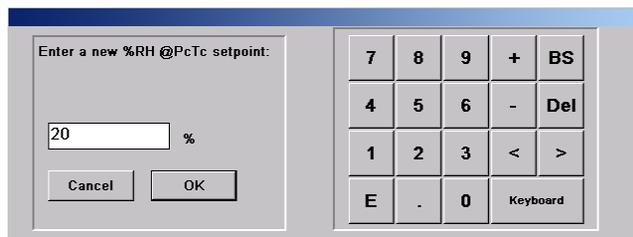
1. Using a stylus on the touch-screen or an optional mouse, click on the %RH Setpoint field of the Main Screen window.



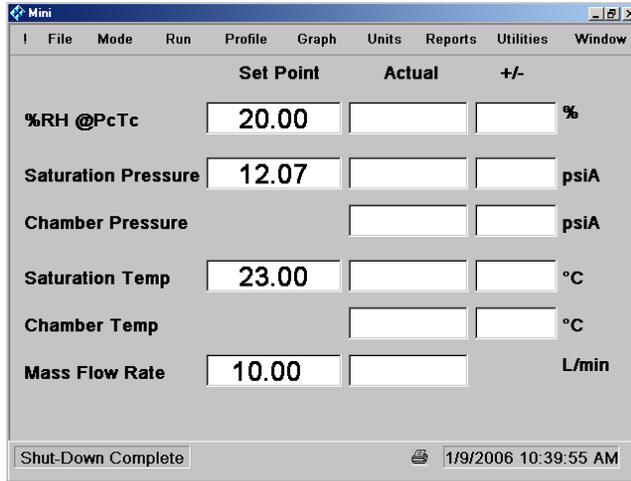
The following dialog box will appear:



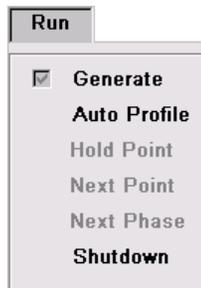
2. Using a stylus or mouse on the touch-screen keypad or an optional keyboard, enter a setpoint value of 20. Then click **OK**.



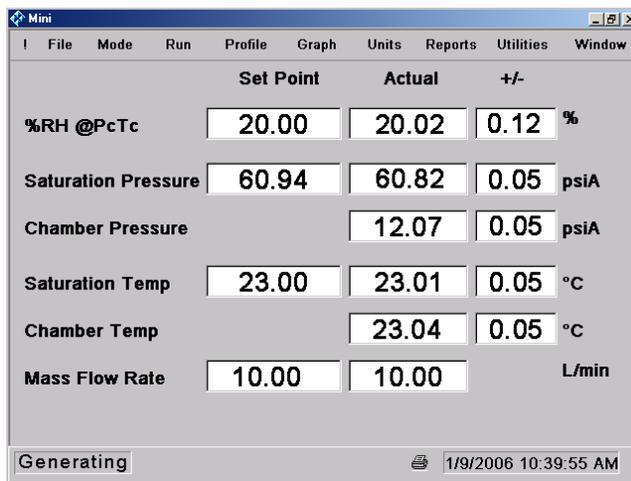
Notice that the %RH setpoint field updates to the new value. Since the setpoint values for flow rate and saturation temperature are already set to the correct values, there is no need to change them.



3. Select **Generate** from the **Run** drop-down menu.



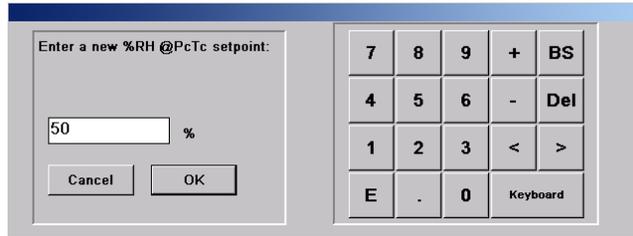
When the generate mode starts, all fields on the Main Screen will begin to update with current data. At this point, the generator will begin to control towards the mass flow, saturation pressure and saturation temp set points. Stabilization time of these control points will vary based on distance from the set points and distance of the set points from ambient conditions, as well as, any heat load placed in the chamber.



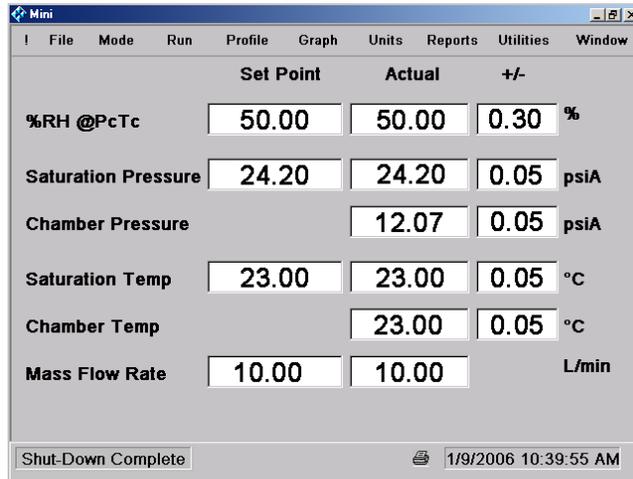
3.1.3 Changing the %RH Setpoint

Once the 1200 has become stable at 20% RH, we will change to a 50% Relative Humidity setpoint.

1. Click on the %RH setpoint field and enter 50 as the new set point.

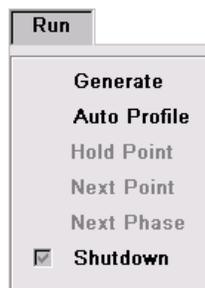


2. Click **OK** and allow the system to stabilize at the new %RH.

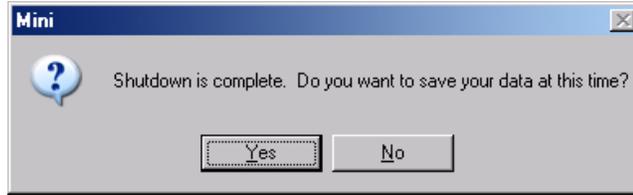


3.1.4 Shut Down

Now that we have completed our first trial run, select **Shutdown** from the **Run** drop-down menu.



Performing a shutdown causes the generator to disable control routines and vent the saturator pressure to ambient. Once the generator is shutdown, you will be asked if you would like to save the data that was stored during your trial run.



If you choose **Yes** and supply a valid file name the data will be stored to disk for later use.

3.1.5 Power Down

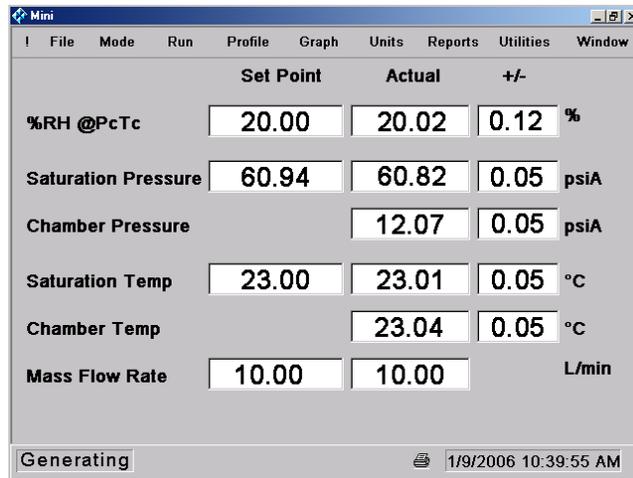
To properly power down the unit and prevent possible compact flash drive corruption the user must:

- A) Perform a Shut Down.
- B) Exit ControlLog using either the control box “X” or by selecting “Exit” from the file menu.
- C) Select “Shutdown” from the windows start menu.
- D) Wait until the computer shuts down. This is indicated by the LCD screen going completely black.
- E) Power off the unit by switching the 1200 Generator Power Switch to OFF.

3.2 WINDOWS

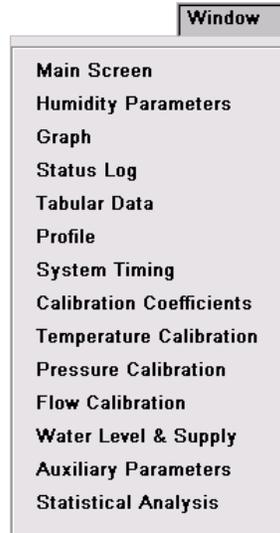
3.2.1 Main Screen

The Main Screen window contains all the control and measurement parameters critical to the operation of the humidity generator. Notice that each parameter consists of a brief title, unit of measurement, and the data values for Setpoint, Actual, and Error Estimate as applicable. The first line contains the active humidity control parameter (i.e. %RH@PcTc).



3.2.2 Calculated Humidity Parameters

Select Calculated **Humidity Parameters** from the **Window** drop-down menu.



The Calculated Humidity Parameters window contains calculated values of humidity based on the current system temperatures and pressures. An Error Estimate is given for each value. A check mark in front of any item indicates that the item will be included in printed data.

Page 1		Page 2	
	Actual	+/-	
✓ %RH @PcTc	19.97	0.24	%
✓ %RH @Pc	19.61	0.24	%
✓ Frost(Dew)Point	0.85	0.13	°C
✓ Dew Point	0.85	0.13	°C
✓ PPMv	-1.01 m	75.72	
PPMw	-1.63 m	47.09	
Grains/lb	34.463	0.330	
Absolute Humidity	4.7343 m	43.8 μ	g/l
Dry Air Density	0.96161	69.7 μ	g/l
Moist Air Density	0.96634	25.9 μ	g/l

%RH@PcTc

%RH@PcTc is calculated at test chamber pressure P_C and test chamber temperature T_C from saturation pressure P_S and saturation temperature T_S . Percent relative humidity is the ratio of the amount of water vapor in a given sample to the maximum amount possible at the same temperature and pressure.

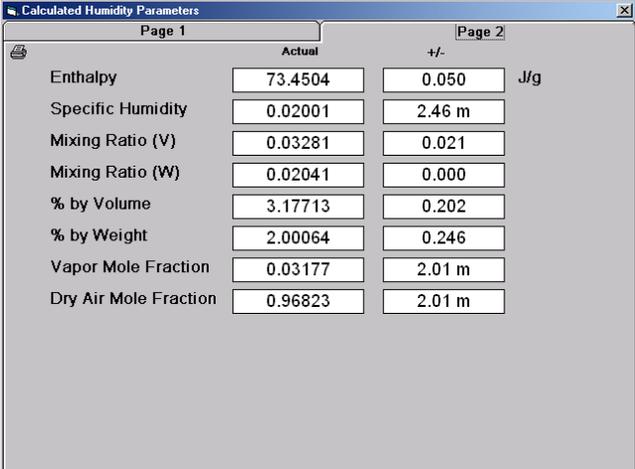
%RH@P _c	%RH@P _c is calculated at test chamber pressure P _c from saturation pressure P _s and saturation temperature T _s . Percent relative humidity is the ratio of the amount of water vapor in a given sample to the maximum amount possible at the same temperature and pressure. This mode ignores possible temperature differences between saturation and chamber.
Frost Point	Frost point temperature is calculated at test chamber pressure P _c from saturation temperature T _s and saturation pressure P _s . Frost point temperature is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of frost or ice and therefore only exists at values below 0.01 °C. When operating the system with indicated frost point above 0.01 °C, the values indicated are to be interpreted as dew point. However, frost point is not the same as dew point for values below freezing. Frost point is independent of test chamber temperature.
Dew Point	Dew point temperature is calculated at test chamber pressure P _c from saturation temperature T _s and saturation pressure P _s . Dew point temperature is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of dew. Generally, dew point exists at temperatures above freezing. However, in many instances dew point may actually exist at indicated values below freezing. It is important to note that dew point is not the same as frost point. Dew point is independent of test chamber temperature.
PPMv	Parts Per Million by Volume, PPMv, is calculated from saturation temperature T _s and saturation pressure P _s . PPMv is a ratio of the number of molecules of water vapor to the number of molecules of the other constituents in the gas. PPMv is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.
PPMw	Parts Per Million by Weight, PPMw, is calculated from saturation temperature T _s , saturation pressure P _s , and the molecular weight of the carrier gas. PPMw is a ratio of the weight of the water vapor in a sample to the weight of the remaining constituents in the gas. PPMw is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.
Grains/lb	Grains per pound is calculated from saturation temperature T _s , saturation pressure P _s and the molecular weight of the carrier gas. Grains per pound is a ratio of the weight, in grains (7000 grains = 1 pound), of water vapor to the weight in pounds of the other constituents in the gas. Grains/lb is pressure and temperature insensitive and is therefore independent of test chamber temperature and test chamber pressure.
Absolute Humidity	Absolute Humidity is calculated from saturation temperature T _s , saturation pressure P _s , test chamber temperature T _c and test chamber pressure P _c . Absolute Humidity is the weight of the water vapor per unit volume of humidified gas.

Dry Air Density

Partial Dry Air Density is calculated from saturation temperature T_S , saturation pressure P_S , test chamber temperature T_C and test chamber pressure P_C . Dry Air Density is the partial density in weight per unit volume of only the dry air portion of a moist air sample. In other words, if the water vapor were removed from a fixed volume of air the remaining dry air would exhibit this density.

Moist Air Density

Moist Air Density is calculated from saturation temperature T_S , saturation pressure P_S , test chamber temperature T_C and test chamber pressure P_C . Moist Air Density is the total weight per unit volume of a moist air sample. This density includes both the weight of the air and the weight of the water vapor.



	Actual	+/-	
Enthalpy	73.4504	0.050	J/g
Specific Humidity	0.02001	2.46 m	
Mixing Ratio (V)	0.03281	0.021	
Mixing Ratio (W)	0.02041	0.000	
% by Volume	3.17713	0.202	
% by Weight	2.00064	0.246	
Vapor Mole Fraction	0.03177	2.01 m	
Dry Air Mole Fraction	0.96823	2.01 m	

Enthalpy

Enthalpy is calculated from saturation temperature T_S , saturation pressure P_S , test chamber temperature T_C and test chamber pressure P_C . Enthalpy is a measure of the amount of energy required to change a gas from one temperature and/or humidity value to another. In application, enthalpy is not used as an absolute value, it is the difference in enthalpy between two distinct points which are of interest. The datum point which results in zero enthalpy was therefore arbitrarily chosen at a test temperature of 0 °C and 0 %RH. Applying enthalpy is a matter of computing the difference in enthalpy between two or more distinct data points.

Specific Humidity

Specific Humidity is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Specific humidity is a ratio of the weight of the water vapor to the total weight of the humidified gas. Specific humidity is independent of test chamber temperature.

Mixing Ratio (V)

Mixing Ratio by Volume is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Mixing Ratio by Volume is a ratio of the partial pressure of the water vapor to the partial pressure of the remaining constituents in the sample. Mixing Ratio by Volume is independent of test chamber temperature.

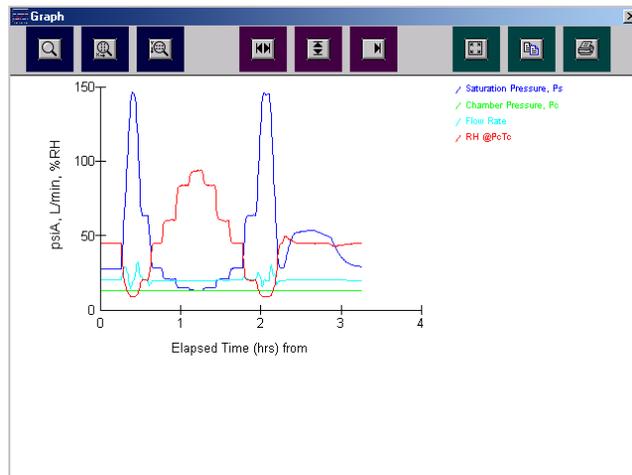
Mixing Ratio (W)

Mixing Ratio by Weight is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Mixing Ratio by Weight is a ratio of the weight of the water vapor to the weight of the remaining constituents in the sample. Mixing Ratio by Weight is independent of test chamber temperature.

% by Volume	Percent by Volume is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Percent by Volume is a ratio (expressed as a percentage) of the partial pressure of the water vapor to the total pressure of the sample. Percent by Volume is independent of test chamber temperature.
% by Weight	Percent by Weight is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Percent by Weight is a ratio (expressed as a percentage) of the weight of the water vapor to the total weight of the sample. Percent by Weight is independent of test chamber temperature.
Vapor Mole Fraction	Vapor Mole Fraction is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Vapor Mole Fraction is the mole fraction of water vapor in a sample.
Dry Air Mole Fraction	Dry Air Mole Fraction is calculated from saturation temperature T_S , saturation pressure P_S and test chamber pressure P_C . Dry Air Mole Fraction is the mole fraction of the dry air portion of a sample. The dry air portion is considered to be all constituents in a gas exclusive of the water vapor.

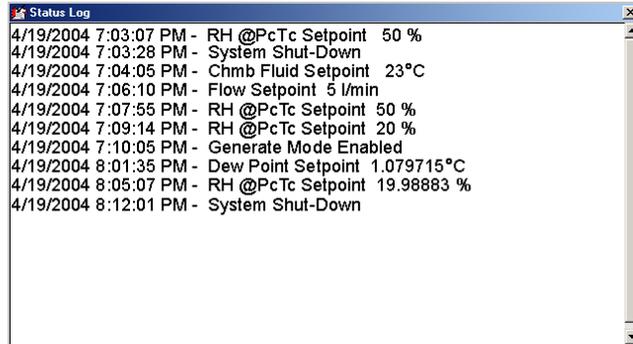
3.2.3 Graph

The Graph window is a powerful tool used to view previously generated data or to monitor the current data in real time using the strip chart feature. Use of the graph is fully explained in section 3.10 *Graphing*.



3.2.4 Status Log

The Status Log contains information about the system status, logging start times of operational modes, setpoint changes, and runtime errors due to communication or mechanical difficulties the generator encounters.



To print the contents of the status log, select **Print Status Log** from the **File** drop-down menu.

Should the status log become very large, the entire log may be cleared by selecting **Clear Status Log** from the **File** drop-down menu.

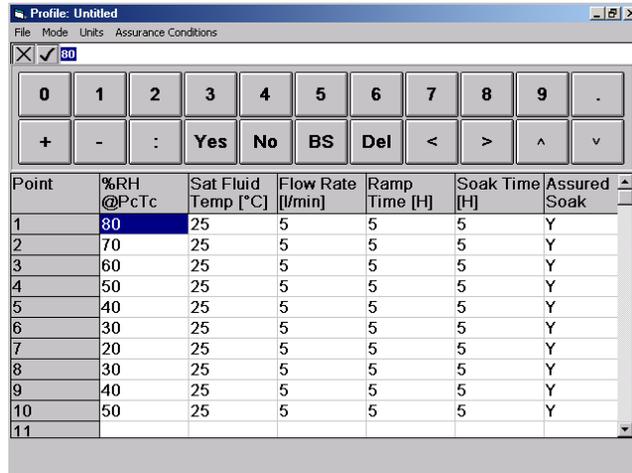
3.2.5 Tabular Data

The Tabular Data window contains a spreadsheet type view of actual system data including both system control parameters (Saturation Temperature, Saturation Pressure, Flow, etc.) and calculated humidity parameters (%RH, Frost Point, Dew Point, etc.) Tabular data is always stored in the system units selected. If the units are changed while in Generate mode the user is prompted to save the data and a new tabular data file is started. This is to maintain the consistency of units within the tabular data file. For a further discussion of the Tabular Data information, refer to section 3.8 *Data Storage & Retrieval*.

Elapsed Time [h]	Date/Time	Saturation Pressure, Ps [Pa]	Chamber Pressure, Pc [Pa]	Saturation Temperature, Ts [°C]	Chamber Temperature, Tc [°C]
1.111111E-03	10/29/2007	85173.1070	85036.2000	20.0265	20.0300
1.388889E-03	10/29/2007	85173.1070	85036.2000	20.0265	20.0220
1.694444E-02	10/29/2007	181497.9744	85036.2000	20.1465	20.1250
3.361111E-02	10/29/2007	258459.8419	85036.2000	20.0377	20.0310
5.027778E-02	10/29/2007	360282.7254	85036.2000	20.0156	20.0010
6.694444E-02	10/29/2007	460624.4743	85036.2000	20.0084	20.0070
8.361111E-02	10/29/2007	559589.4708	85173.1100	20.0033	20.0030
0.1002778	10/29/2007	575926.3213	85173.1100	20.0031	20.0020
0.1169444	10/29/2007	575994.3583	85173.1100	20.0008	20.0010
0.1336111	10/29/2007	576037.8391	85173.1100	20.0035	20.0030
0.1502778	10/29/2007	576044.2703	85173.1100	20.0001	20.0000
0.1669444	10/29/2007	576067.0470	85173.1100	20.0000	20.0000
0.1836111	10/29/2007	576054.5286	85173.1100	19.9988	19.9870
0.2002778	10/29/2007	576041.4122	85173.1100	20.0014	20.0020

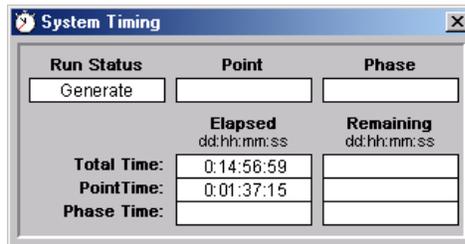
3.2.6 Profile

A Profile is a list of humidity, temperature, flow, and time parameters that are used during Automated Control of the 1200 Generator. The Profile essentially programs the computer/controller operations. The profile form stores this information.



3.2.7 System Timing

The System Timing window shows information about the current operating mode (Generate or Auto) and the timing associated with it, such as, the amount of run time elapsed at the current humidity conditions. This window may be viewed at any time by selecting **System Timing** from the **Window** drop-down menu.

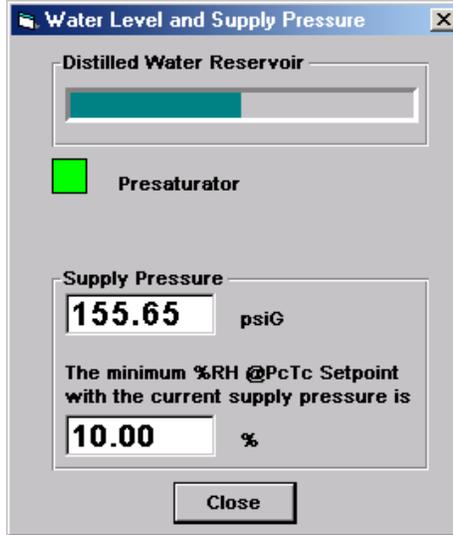


3.2.8 Calibration Coefficients

Calibration Coefficients for each of the temperature, pressure, and flow transducers may be viewed in the *Calibration Coefficients window*. The Calibration Coefficients window, along with windows for Temperature Calibration, Pressure Calibration, and Flow Calibration are discussed in detail in section 4.2 *Calibration*.

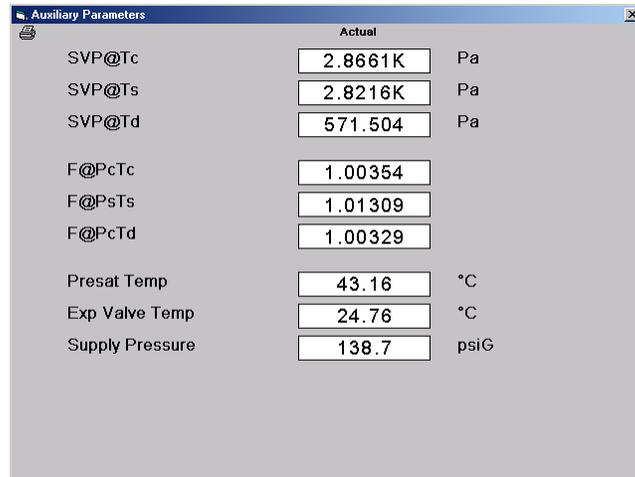
3.2.9 Water Level and Supply Pressure

The Water Level and Supply Pressure window is used to monitor the water levels in the reservoir and presaturator vessels, as well as indicate available supply pressure. For a further discussion of this window, refer to section 3.12 *Water Level and Supply Pressure*.



3.2.10 Auxiliary Parameters

The Auxiliary Parameters window contains values of vapor pressure and enhancement factors calculated from current system temperatures and pressures. Also displayed are current values for presaturator temperature, expansion valve temperature, and supply pressure. A check mark in front of any item indicates that the item will be included in printed data. This window may be shown at any time by selecting **Auxiliary Parameters** from the **Window** drop-down menu.



SVP@Tc

Saturation Vapor Pressure calculated at test chamber temperature, $e(T_C)$, is the maximum allowable vapor pressure in a sample of gas at that temperature. For $T_C \geq 0.01$ °C, vapor pressure is computed with respect to water. For $T_C < 0.01$ °C, vapor pressure is computed with respect to ice.

SVP@Ts	Saturation Vapor Pressure calculated at saturation temperature, $e(T_S)$, is the maximum allowable vapor pressure in a sample of gas at the saturation temperature. For $T_S \geq 0.01$ °C, $e(T_S)$ is computed with respect to water. For $T_S < 0.01$ °C, $e(T_S)$ is computed with respect to ice.
SVP@Td	Saturation Vapor Pressure calculated at dew point temperature, $e_w(T_d)$, with respect to water, is commonly referred to as the dew point vapor pressure. For $T_d < 0.01$ °C, this vapor pressure may also be computed at the frost point temperature T_f , with respect to ice. While $e_w(T_d)$ is vapor pressure with respect to water at the dew point temperature, and $e_i(T_f)$ is vapor pressure with respect to ice at frost point temperature, then for $T_d < 0.01$ °C, $e_w(T_d) = e_i(T_f)$ even though $T_d \neq T_f$.
F@PcTc	Enhancement Factor is calculated at test chamber pressure P_C and test chamber temperature T_C .
F@PsTs	Enhancement Factor is calculated at saturation pressure P_S and saturation temperature T_S .
F@PcTd	Enhancement Factor is calculated at test chamber pressure P_C and dew point temperature T_d .
Presat Temp	Temperature of the water in the presaturator.
Exp Valve Temp	Temperature of the gas after expansion as it exits the expansion valve.
Supply Pressure	Indicated pressure after internal pressure regulation.

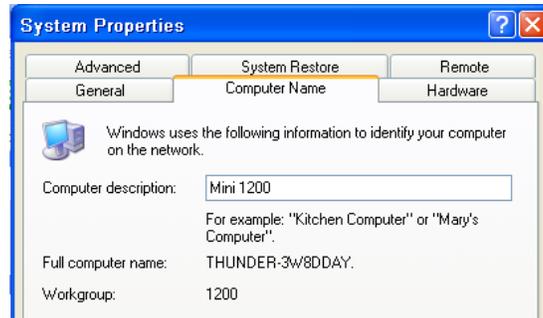
3.2.11 Remote Desktop Control

An Ethernet connection is required for file sharing.

The 1200 supports file sharing via a network to aid in data file transfer. By default the 1200 will be a member of the 1200 workgroup once connected to a network. To access the 1200 file sharing, browse your network from the any client Windows XP computer and locate the desired 1200 within the 1200 workgroup. To gain access to file sharing use the user name of "miniuser" with a password of "1200".



All 1200s will have a full computer name in the format of "Thunder-xxxxxxx". Where xxxxxx represents a unique set of alphanumeric characters. To determine the full computer name of a particular 1200 select > Start > Control Panel > Performance and Maintenance > System and select the "Computer Name" tab on the 1200.



3.3 GENERATING

The Generate Mode is used to generate gas of a desired humidity. In the generate mode, the gas flows through the presaturator, through the saturator at saturation temperature and pressure, and then to the test chamber and the devices under test at the test chamber temperature and pressure.

3.3.1 Initiating Generate

To operate the system in the Generate Mode:

- 1) Ensure chamber door is closed and latched.
- 2) Select **Generate** from the **Run** drop-down menu. When Generate is selected, the elapsed time counter (System Timing) resets and the humidity generation process begins. The 1200 will generate the values indicated in the setpoint column. The Generate menu item will now be checked indicating the generate process is active.
- 3) Change setpoints to desired values.
- 4) After operating in the Generate mode for a sufficient time, the system should be at the desired humidity. Check all instrumentation for stability and record a data point.
- 5) Adjust the humidity to the next desired setpoint. Ample time should be allowed for the system and instrumentation being calibrated to stabilize and equilibrate to the new value.

3.3.2 What Happens in Generate

When the system is placed into Generate mode, gas flows from the gas supply and flow control valve, through the presaturator, through the saturator, through the expansion valve and then to the test chamber. It then flows through the test chamber to the gas exhaust outlet.

The temperature of the fluid medium surrounding the chamber is controlled at the Saturation Temp setpoint. Since this fluid medium is common to the chamber and saturator, both the chamber and saturation temperatures converge toward this value.

3.3.3 Special Considerations in Generate

To prevent condensation on a cold device under test when transitioning upward in temperature, lower the humidity setpoint prior to changing the Saturation Temp setpoint. Since it is not always easy to remember which temperature direction causes this problem, the general rule of thumb is to make temperature transitions at low humidities only (below 20 %RH).

Since the generated Relative Humidity is relative to the measurement of the test chamber temperature, place the chamber temperature probe as close as possible to the humidity sensing element of the device under test.

Heat loads in the chamber will cause temperature gradients resulting in humidity gradients within the chamber. Keep heat loads to a minimum if possible.

Generate may be initiated regardless of the current operating mode. In other words the system may be freely switched to generate mode from either Auto Profile or Shutdown.

3.3.4 Chamber Fan

The Chamber Fan is an optional item, which provides a uniform distribution of air within the 1200's chamber. The Chamber Fan option is generally used when a circulated distribution of air above ambient temperature is desired. The chamber will experience a slight rise in temperature when the Chamber Fan is in use and should be considered when performing particular tests. By default the Chamber Fan is set to "OFF". To turn the Chamber Fan "ON", select the menu option "!" And select the **Chamber Fan** menu item.

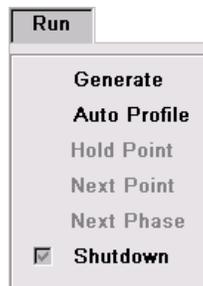


3.4 SHUTDOWN

The Shutdown mode is used to stop the system and place it in a depressurized and idle state.

3.4.1 Initiating a Shutdown

To shut the system down select **Shutdown** from the **Run** drop-down menu.



3.4.2 What Happens during Shutdown

A Shutdown causes all gas flow to stop, saturation pressure vents to ambient, and all other controls to stop. Following the shutdown sequence a prompt is displayed which allows saving of data if desired.

If the Shutdown was caused by a system malfunction, or the system discovered a malfunction during shutdown, then an entry is made to the Status Log indicating the nature of the error.

3.4.3 Special Considerations during Shutdown

A Shutdown, if followed later by a Generate or Auto Profile causes all system data to be reinitialized. Prior to reinitialization, an opportunity is provided via prompt to save any unsaved data. If the data was saved upon Shutdown, then no additional prompt is required and the data is automatically reinitialized.

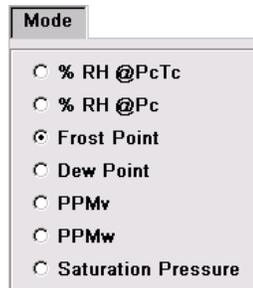
3.5 HUMIDITY CONTROL MODES

The generator may be operated in one of several possible Humidity Control modes:

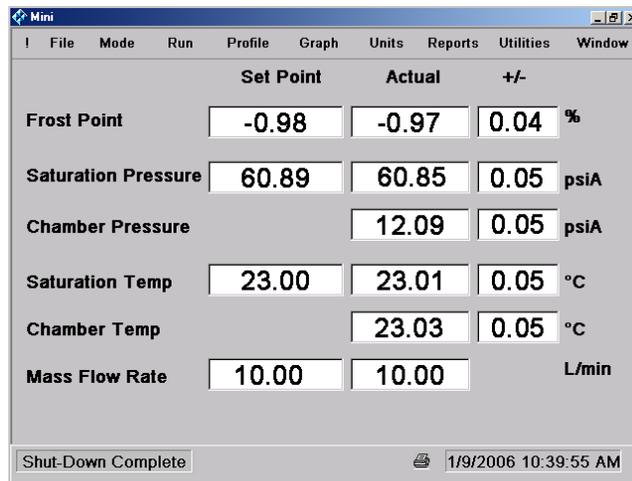
1. %RH@PcTc
2. %RH@Pc
3. Frost Point
4. Dew Point
5. PPMv
6. PPMw
7. Saturation Pressure

3.5.1 Changing the Humidity Control Mode

To select a new Humidity Control Mode, choose the desired mode from the **Mode** drop-down menu.



The Control Parameters window changes to reflect the new Humidity Control mode selected, and the setpoint value is changed to the equivalent of the previous humidity setpoint.



3.5.2 %RH @PcTc Control Mode

This control mode is the one most often used and is the power-up default mode of the generator. %RH@PcTc is controlled at a constant value by varying saturation pressure P_S to compensate for any changes in saturation temperature T_S , test chamber temperature T_C , or test chamber pressure P_C . While %RH@PcTc is held constant, all other humidity parameters may vary.

3.5.3 %RH @Pc Control Mode

%RH @Pc is controlled at a constant value by varying saturation pressure P_S to compensate for any changes in test chamber pressure P_C . While %RH @Pc is held constant other humidity parameters may vary.

3.5.4 Frost Point Control Mode

Frost point is controlled at a constant value by varying the saturation pressure P_S to compensate for changes in either saturation temperature T_S , or test chamber pressure P_C . While frost point is held constant other humidity parameters may vary. Frost point is independent of test chamber temperature.

3.5.5 Dew Point Control Mode

Dew point is controlled at a constant value by varying saturation pressure P_S to compensate for any changes in either saturation temperature T_S , or test chamber pressure P_C . While dew point is held constant, other humidity parameters may vary. Dew point control mode is valid both above and below 0°C. Dew point is independent of test temperature.

3.5.6 PPMv Control Mode

PPMv is controlled at a constant value by varying saturation pressure P_S to compensate for any changes in saturation temperature T_S . While PPMv is held constant other humidity parameters may vary. PPMv is independent of test chamber pressure and temperature.

3.5.7 PPMw Control Mode

PPMw is controlled at a constant value by varying saturation pressure P_S , to compensate for any changes in saturation temperature T_S . While PPMw is held constant other humidity parameters may vary. PPMw is independent of test chamber pressure and temperature.

3.5.8 Saturation Pressure Control Mode

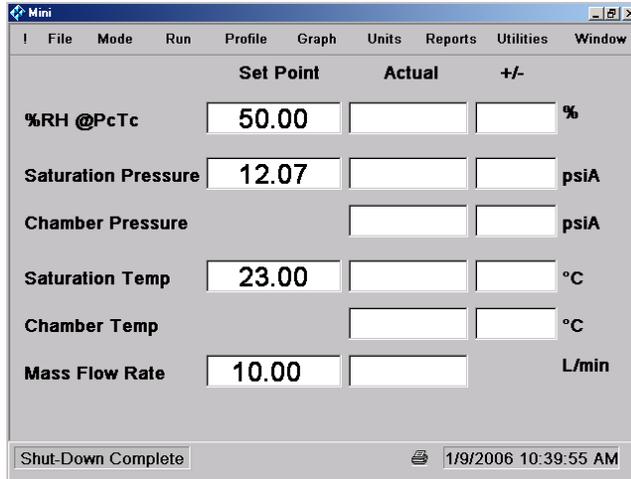
Saturation Pressure P_S , is controlled at a constant value independent of any other pressure, temperature, or humidity value. While saturation pressure is held constant some humidity parameters may vary.

3.6 SETPOINTS

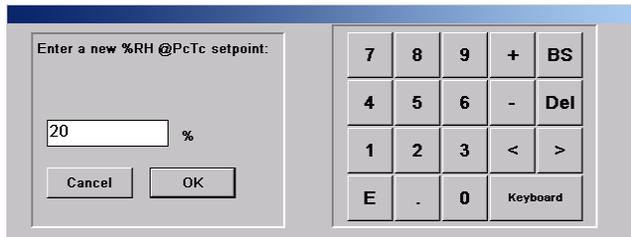
Setpoints, which may be changed, are listed in the **Set Pt** column of the Main Screen window. Editable setpoints in addition to the top listed humidity parameter include Saturation Temp and Mass Flow Rate. Note that Saturation Pressure is only editable when selected as the humidity control mode.

3.6.1 To Change Setpoints

1. Click once on the desired setpoint entry field.



2. A dialog box appears on the screen with the prompt **Enter a new %RH@PcTc setpoint:**



3. Using the touch-screen keypad or an optional keyboard, enter the desired value in the units indicated in the dialog box.
4. After entering the new value select **OK** or **Cancel** button. Selecting cancel will abort the setpoint entry procedure.
5. The value you entered should be displayed in the appropriate setpoint entry field.

3.6.2 What Happens When Changing Setpoints

Setpoints within legal limits are accepted. If an entry is invalid due either to mistakes in setpoint entry or out of range conditions, the computer will retain the original setpoint value.

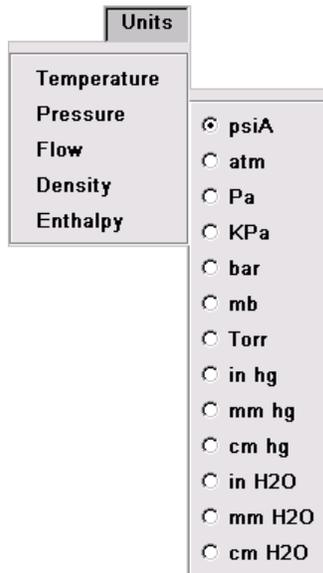
Editing the **Saturation Temp** setpoint sets the temperature of the fluid medium, which flows around and through the saturator and around the test chamber. Note that some instruments installed in the test chamber may generate a heat load and cause a temperature difference between the saturation temperature and the actual chamber temperature.

3.6.3 Special Considerations When Changing Setpoints

A Saturation Pressure setpoint may only be entered if saturation pressure is the current humidity control mode. In all other humidity control modes, saturation pressure setpoint is automatically determined by the computer in order to achieve the desired humidity output.

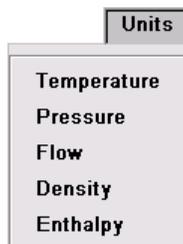
3.7 UNITS

The **Units** menu allows the operator to select desired engineering units for display, printing, and graphing purposes. The current engineering units are indicated with a selection mark .

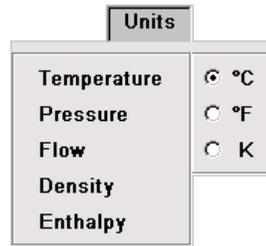


3.7.1 How To Change Units

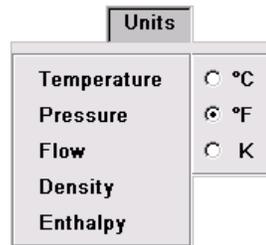
1. Pull down the **Units** menu.



2. Select the units type to change.



3. From the sub menu select the desired units.



4. A  will be placed in front of the currently selected units.

3.7.2 What Happens When Changing Units

1. The units label on the affected control and humidity parameter items update to reflect the new units selection.
2. All affected data values in the fields of the Main, Calculated Humidity Parameters and Auxiliary Parameters screens will update within a few seconds to reflect the change.
3. If a selected graph item is affected, changing units will update the y-axis values to reflect the change.

3.7.3 Special Considerations When Changing Units

Changing units may cause the values that are displayed to become very large or very small. In order to maintain significant digits, values are displayed in a modified scientific notation form.

$$\begin{aligned} M &= 10^6 \\ K &= 10^3 \\ m &= 10^{-3} \\ \mu &= 10^{-6} \\ n &= 10^{-9} \end{aligned}$$

This notation is only used for display and printing purposes, not for entry of data, set points or for data storage. For these cases, standard scientific notation (1.23E3, 1.23E-3, etc.) is used.

3.8 DATA STORAGE & RETRIEVAL

3.8.1 How the System Stores Data

The system stores system data and other calculated parameters to the tabular data window and a temporary data file named *c:\windows\thunder\sys.dat*. Tabular data is always stored in the system units selected. This data is also stored in the tabular data window for use by the 1200's graphing function.

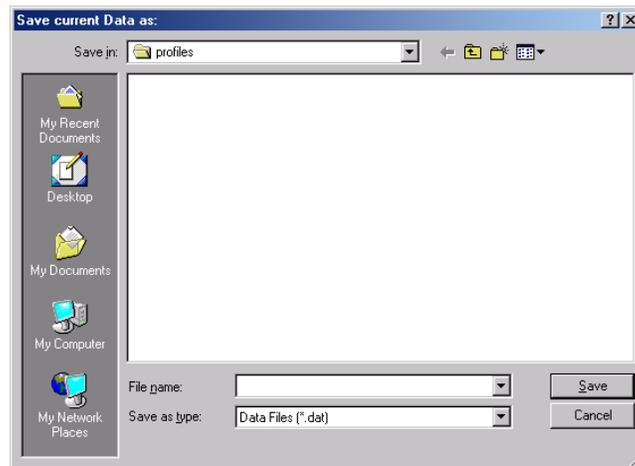
The items stored are dependent on the type of function the generator is performing. Both (generate, auto profile) modes store the system data consisting of elapsed time, date/time, and the measured system parameters. In generate and auto profile modes, the data stored will also include the calculated humidity parameters and some additional system parameters. In (temperature, pressure, and flow) calibration modes data and coefficients are stored to a separate calibration system file.

The difference between the tabular data window and the temporary data file is the storage capacity. The tabular data window will contain only the most recent one thousand lines of data while the data file is only limited by the available space on the flash drive. The graph can only access data that is currently in the tabular data window.

The tabular data window and the temporary data file are cleared at the beginning of each new run (i.e. from a shutdown condition). The current data file can also be cleared by selecting **Clear Data...** from the **File** drop-down menu.

3.8.2 Saving the System Data

The user at any time may save a copy of the temporary data file to a data file for their own use. To save a copy of the current data file, select **Save Data as...** from the **File** drop-down menu. Enter an appropriate file path and name when prompted, then click **OK**.



Use the On-screen Keyboard to enter a file name. Click and hold on the upper bar of the keyboard to move it to other parts of the screen.

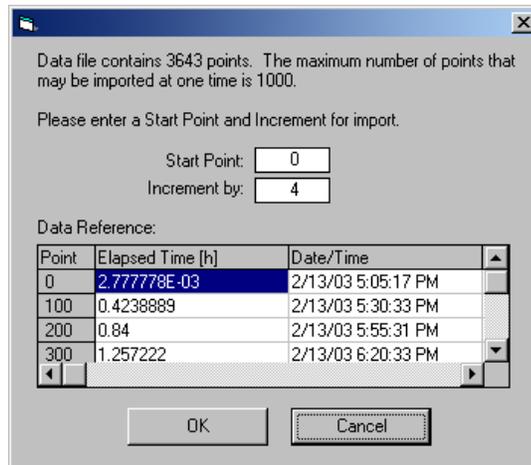


3.8.3 Retrieving Data from Previous Runs

Data that has been saved from a previous run may be imported for subsequent graphing functions. If the current data is important, save a copy of it prior to importing a new data set.

Note: Data may only be imported when the generator is shutdown (not running).

Select **Import Data...** from the **File** drop-down menu, then choose the file you wish to import. This data will replace the current data in the Tabular Data window. If the selected data file contains *more* than one thousand data lines, the following dialog box will appear:



By setting the start line and the increment of the import function you will reduce the data file to a more manageable size.

The data reference table given may be used to select a data range and will automatically calculate a corresponding data interval. Or, it may be used just as a reference for you to select an appropriate starting line, reading in each and every point up to the maximum allowed.

Any line, which exists within the given number of data lines, may be used as the start line.

A data interval of 1 will retrieve every point starting with the user selected start point.

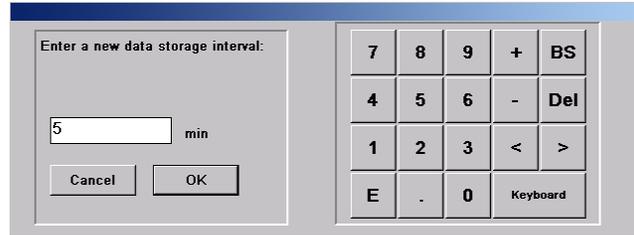
3.8.4 Data Storage Interval

Storing and maintaining data can become a very time consuming process. The more data that is stored in the tabular data window, the slower and less responsive the system will become. For this reason, some consideration should be given to the amount of data desired, the overall time span of the data (i.e. four hours, two days, possibly weeks), and ultimately the data interval.

The data interval determines when the data is stored and also when data will be printed. The 1200's default data interval for a generate mode is one minute. This is just a guideline. You, as the user, should decide what data storage interval best suits your needs.

3.8.4.1 Changing the Data Storage Interval

To change the data storage interval, select **Data Storage Interval** from the **File** drop-down menu. The following dialog box will appear.



Enter the new time interval in minutes and select **OK**.

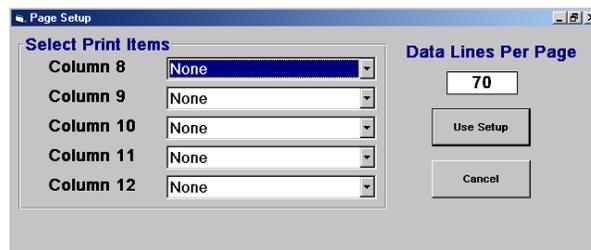
3.9 PRINTING

A printer may be connected to the USB connection. The printer is used for hardcopy output of system data and other parameters. While the 1200 generator is operating and enable printer is selected, data is captured on a timed interval basis and sent to the printer in a page at a time format only. Prior to enabling the printer, a Page Setup should be performed.

The system will buffer an entire page of data prior to sending it to the printer. When sending it to the printer, the standard Windows printer driver for the selected printer type is used, and all printing is handled by the Windows Print Manager. Printer drivers can be loaded via a USB Flash Drive connected to the USB Port and installed using the "New printer wizard" in the Windows XP Embedded printer section. Note that the operating system is of the embedded design and does not contain all features supported by a full installation. In some cases this limitation may prevent some drivers from being installed.

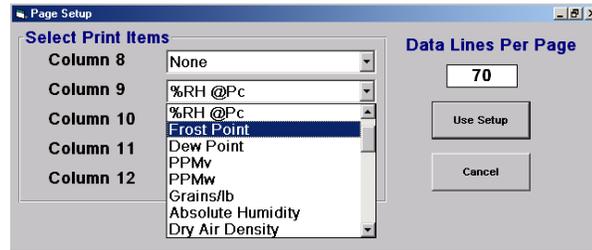
3.9.1 Page Setup

Printer operation and the data sent to it can be customized with Page Setup. Selecting **Page Setup...** from the **File** drop-down menu brings up the following dialog box:



Select Print Items:

Lines of data are printed in a column format. The first several columns are fixed by the system and include such things as Time, Date, Saturation Pressure, etc. The remaining columns of data on each page are user selectable and are shown on the Page Setup form. To select which data items will be sent to the printer in these later columns, choose the item from the drop-down menu which corresponds to the column in which the data should be printed.



Data Lines Per Page:

The number of data lines printed per page may also be changed. An entry of 60 would allow for one hour of printed data per page if the data storage interval is set to one minute (see section 3.8.4 *Data Storage Interval*). After all changes have been made to the Page Setup click the **OK** button, or click **Cancel** to abort any changes.

3.9.2 Enabling/Disabling the Printer

Selecting **Enable Printer** from the **File** drop-down menu causes measured system data to be sent to the print buffer until enough data has been collected to satisfy the page at a time interval (see section 3.8.4 *Data Storage Interval*). A ✓ appears in front of the menu item.

Selecting ✓ **Enable Printer**, from the **File** drop-down menu while the printer is enabled, disables further printer output and an end of page command will be sent which causes the page to be printed and ejected from the printer.

3.9.3 What Happens When the Printer is Enabled

The printer, when properly setup and enabled, prints data at user selectable page at a time intervals. A header is printed at the top of each page to indicate each columns selected parameter along with the parameter's units. If changes are made to the Page Setup or to the Units while the printer is enabled, the existing page will print and a new page will be started in order to reflect the changes.

3.9.4 Printing Immediate Data

Selecting **Print Now** from the **File** drop-down menu causes the system to immediately send one line of current data to the print buffer but nothing will be seen until enough data (number of lines entered in page setup) has been collected to print the entire page.

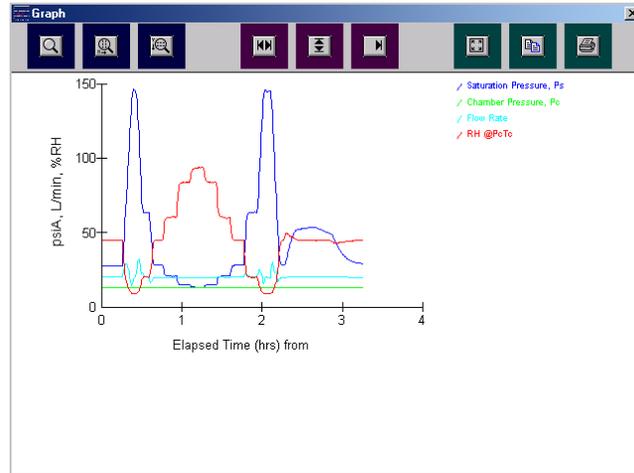
3.9.5 Special Considerations When Printing

Changing only the number of data lines per page will not force a new page and header to occur, however any other changes to the Page Setup will result in a new header if printing is currently enabled.

3.10 GRAPHING

The Graph window is a powerful tool used to view previously generated data or to monitor the generated data in real time using the strip chart feature.

Select **Graph** from the **Window** drop-down menu.



3.10.1 The Tool Bar



Zoom in

Turns the pointer into a cross hair zoom tool. Move the cross hair to the graph, then click and drag the cursor to create a box around the portion to zoom in on. The portion of the graph within the drag box will expand to fill the entire graph. The time and Y-axis limits update accordingly.



Zoom X

Turns the pointer into a cross hair zoom tool. Click on the graph and drag the cursor so that the portion of the X-axis (time axis) of interest is contained within the two vertical dashed zoom lines. The portion contained within this region will expand to fill the entire X-axis. The Y-axis remains unchanged.



Zoom Y

Turns the pointer into a cross hair zoom tool. Click on the graph and drag the cursor so that the portion of the Y-axis of interest is contained within the two horizontal dashed zoom lines. The portion contained within this region will expand to fill the entire Y-axis. The X-axis remains unchanged.



Fit X

Adjusts the left and right limits of the time axis to match the beginning and ending points of the stored data. This allows the parameters being graphed to fit within the left and right limits of the graph window. The X limits update accordingly.



Fit Y

Rescales the Y-axis in order to make the graphed data fit within the graph window. The Y limits update accordingly. The X-axis remains unchanged.



Current X

Shifts the graph so that the right edge of the graph is at the ending data point. The time span remains fixed.



Shrink to Fit

Adjusts the left, right, top and bottom limits on the graph axes so that entire data set of each selected item is contained within the boundaries of the graph.

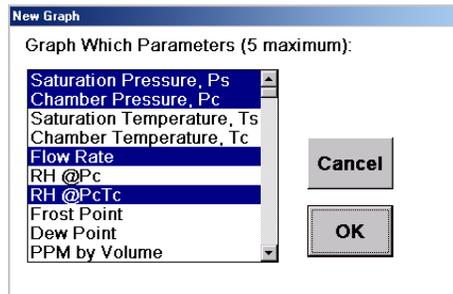


Print Graph

Causes the graph to maximize and a page size picture of the current graph to be sent to the printer. Once the graph has been sent to the printer the graph window returns to its previous size.

3.10.2 The Graph Menu

Select **New Graph...** from the **Graph** drop-down menu. A dialog box with a scrolling list of all available data will appear. The currently selected graph items will be highlighted.



Click **ON** or **Off** items to be graphed then click on the **OK** button allowing the graph to update, reflecting the changes. The source of the graph data is the tabular data window. Selecting the **Cancel** button will terminate the new graph operation and no changes will occur.

Time Span

Select **Time Span...** from the **Graph** drop-down menu.

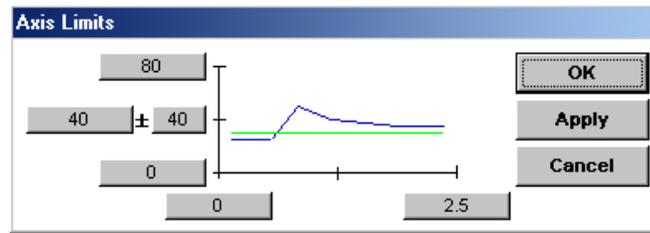
A dialog box appears asking you to enter a new X-axis time span. The X-axis is updated by maintaining the right time limit and adjusting the left time limit to reflect the specified time span.

Edit Axis limits

To edit the current axis limits either:

- a. Double click on the graph window, or
- b. Select **Edit Axis Limits...** from the **Graph** drop-down menu.

The following input box will appear.



Both the minimum and maximum limits for the X and Y axes may be changed. Another feature of the Edit Axis input box is the ability to set a mid point and span value for the Y axis.

Enable Strip Chart

In the strip chart mode, the rightmost time limit reflects the time of the last stored data point, while the leftmost time limit adjusts accordingly to keep a constant time span. Each time data is stored the strip chart is updated.

Selecting **Enable Strip Chart** from the **Graph** drop-down menu causes the graph to begin updating at regular time intervals (see section 3.8.4 *Data Storage Interval*). A ✓ appears in front of the menu item.

Selecting ✓ **Enable Strip Chart** from the **Graph** drop-down menu while the strip chart is enabled disables the graph from continuously updating.

Graph title

Select **Graph Title...** from the **Graph** drop-down menu. Enter the desired graph title into the dialog box that appears. Click **OK**.

Y- axis title

Select **Y-Axis Title...** from the **Graph** drop-down menu. Enter the new Y-axis title in the dialog box that appears. Click **OK**.

Show legend

Select **Show Legend** from the **Graph** drop-down menu. The legend appears on the graph window. A ✓ appears in front of the menu item. To hide the graph legend, select ✓ **Show Legend** again.

Edit Legend

Select **Edit Legend...** from the **Graph** drop-down menu. A dialog box appears, asking you to rename legend item 1. The current default name is already entered and highlighted. If you want to change the name, simply type in the new one. Select **OK** to update the change and/or go to the next legend item. You will be asked to accept or change each graph legend item. After changing the legend items you want to change, Select **Cancel** to exit the edit routine.

Show Grid

A grid may be placed on top of the currently graphed data to help clarify data values. Select **Show Grid** from the **Graph** drop-down menu. To remove the grid, select **Show Grid** again.

Show Markers

Markers may be placed on the graph lines to indicate the time each individual point was taken. Select **Show Markers** from the **Graph** drop-down menu. To remove the markers, select **Show Markers** again.

Print Graph

The **Print Graph** menu item responds exactly like the Print Graph button on the Graph Window's Toolbar (see section 3.10.1 *The Tool Bar*).

3.10.3 Graph Data

The graph works hand in hand with the tabular data window. While the generator is in operation, the tabular data window stores the most recent **one thousand data points**. If the data **exceeds** the maximum number of data points allowable, the data is still stored to the same temporary data file (*c:\windows\thunder\sys.dat*) but only the most recent data is available to the graph.

3.11 DIAGNOSTICS

While the system is continually self checking when running, a diagnostic test may be initiated when the system is shutdown. This is a useful feature to aid in the diagnosis of system failures, which cause system shutdowns.

3.11.1 Performing System Diagnostics

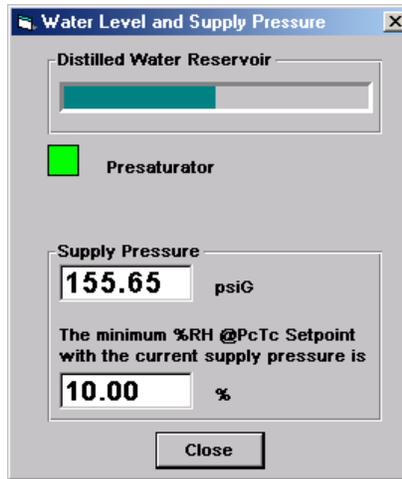
Diagnostics may only be performed while the system is shutdown and the Utilities menu is showing. To diagnose the system, select **Diagnostics** from the **Utilities** drop-down menu.

3.11.2 What Happens During Diagnostics

The system performs tests of the temperature probes, pressure transducers, limit switches, and digital inputs. Any problems encountered are logged to the status log and a message appears on the screen indicating the same.

3.12 WATER LEVEL and SUPPLY PRESSURE

The Water Level and Supply Pressure window is used to monitor the water level of the distilled water reservoir and presaturator as well as indicate available supply pressure.



3.12.1 Reservoir Water Level

The reservoir holds a supply of distilled water that is used for maintaining the proper water level in the presaturator. Prior to extended periods of generation or periods of high temperature and/or high humidity generation, it is a good idea to fill the reservoir. The reservoir level is displayed as a percentage of the vessel's total capacity.

To fill the reservoir:

- 1) Ensure that the generator is in a shutdown mode and that an adequate distilled water supply is available.
- 2) If not already showing, select **Water Level and Supply Pressure** from the **Window** drop-down menu.
- 3) Remove reservoir cap, attach funnel and begin filling reservoir with distilled water. While filling, the level gauge on the water level window updates continuously to reflect the present level.
- 4) Once the reservoir is 100 % full, stop filling, remove funnel and replace reservoir cap. **Do not overfill!**

3.12.2 Presaturator Water Level

The Presaturator distilled water level is maintained at a constant level by the computer. When the water level drops below the control point the computer signals a red condition. The computer will then activate solenoid SOL4, allowing distilled water into the presaturator until a green condition is indicated.

If the presaturator does not fill to the control point (i.e., reservoir empty) within approximately 5 minutes, the system will shut down and display an error message reflecting this problem.

3.12.3 Supply Pressure

Regulated air supply pressure is indicated in the **Water Level and Supply Pressure** window. The input pressure must be at least 5 psiG above the desired regulated supply pressure. The regulator adjustment is accessed through the left side panel.

Warning: Do NOT exceed 150 psiG

To adjust: Using an 11/32" socket wrench, rotate stem clockwise to increase pressure and counter-clockwise to decrease pressure while monitoring **Water Level and Supply Pressure** window.

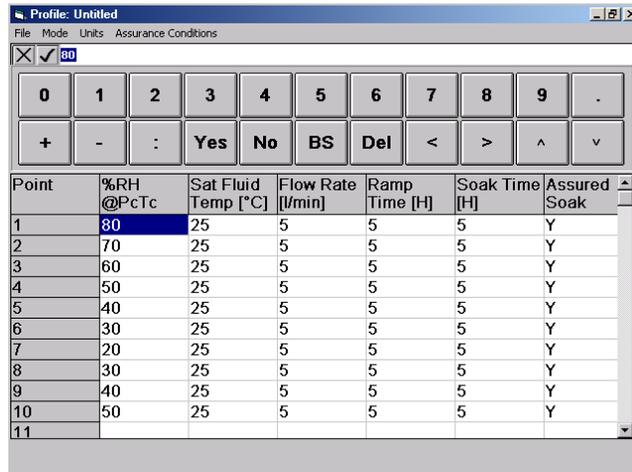
3.13 AUTO PROFILING

The Auto Profiling mode of operation is very similar to the Generate mode with the main exception being that profiling relies on a pre defined list of setpoints referred to as a Profile. The user configurable Profile is used as the program's road map. It defines which setpoint values to go to, at what rate to go from one setpoint to another, and how long to stay at a specific setpoint before moving on to the next one.

3.13.1 Entering a Profile

3.13.1.1 Showing the Profile in Memory

To show the Profile currently in memory, select **Profile** from the **Window** drop-down menu. The Profile is a list of humidity, temperature, flow, and time parameters that are used during Automated Control of the 1200 Generator. The Profile essentially programs the computer/controller operations. The profile form stores this information.



The screenshot shows a software window titled "Profile: Untitled" with a menu bar (File, Mode, Units, Assurance Conditions) and a toolbar. Below the toolbar is a numeric keypad with buttons for digits 0-9, a decimal point, and function keys (+, -, :, Yes, No, BS, Del, <, >, ^, v). The main area contains a table with 7 columns: Point, %RH @PcTc, Sat Fluid Temp [°C], Flow Rate [l/min], Ramp Time [H], Soak Time [H], and Assured Soak. The table has 11 rows, with the first row (Point 1) highlighted in blue and containing the value 80 in the %RH column.

Point	%RH @PcTc	Sat Fluid Temp [°C]	Flow Rate [l/min]	Ramp Time [H]	Soak Time [H]	Assured Soak
1	80	25	5	5	5	Y
2	70	25	5	5	5	Y
3	60	25	5	5	5	Y
4	50	25	5	5	5	Y
5	40	25	5	5	5	Y
6	30	25	5	5	5	Y
7	20	25	5	5	5	Y
8	30	25	5	5	5	Y
9	40	25	5	5	5	Y
10	50	25	5	5	5	Y
11						

The first column, next to the point numbers, contains values of humidity to generate and is titled at the top according to the currently selected profile control mode.

The *Sat Fluid Temp* column contains the Saturation Temperature setpoints and should be set to the desired Chamber Temperature. Temperature values are entered and displayed in the currently selected profile units.

The *Flow Rate* column contains values of system airflow, which the generator will operate at. Although not affecting the generated value of humidity, flow rate does affect the air exchange rate within the test chamber and the equilibration time of any instruments under test.

Ramp Time is the desired amount of time the 1200 should take to transition from one profile test point to another. Setting a Ramp Time of zero (0) instructs the 1200 to make the transition as quickly as possible. Zero (0) is the setting used for most applications.

Soak Time is the desired amount of time to generate at a particular profile point. The Soak Time required depends on the application, but should be at least 10 to 15 minutes, depending upon the humidity measurement devices being calibrated.

Assured Soak, if set to "Y", forces the system to wait until measured parameter values are within a specified tolerance and stability before the computer starts the Soak Phase. If "N" is set, the Soak Phase will start immediately when the Ramp Phase is over.

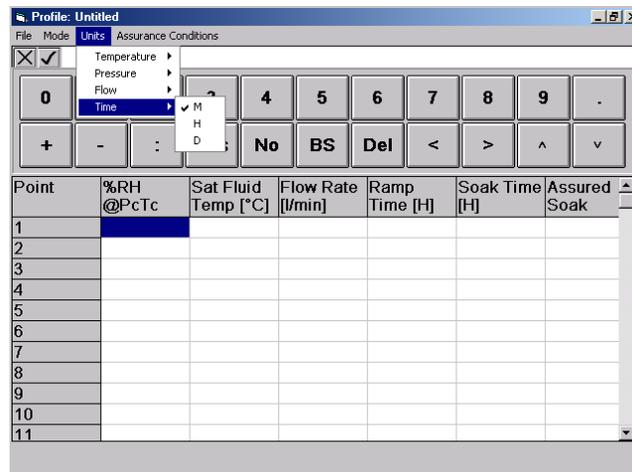
3.13.1.2 Entering a New Profile

To enter a new Profile Select **New Profile...** from the **Profile** drop-down menu. This clears the existing profile from memory.



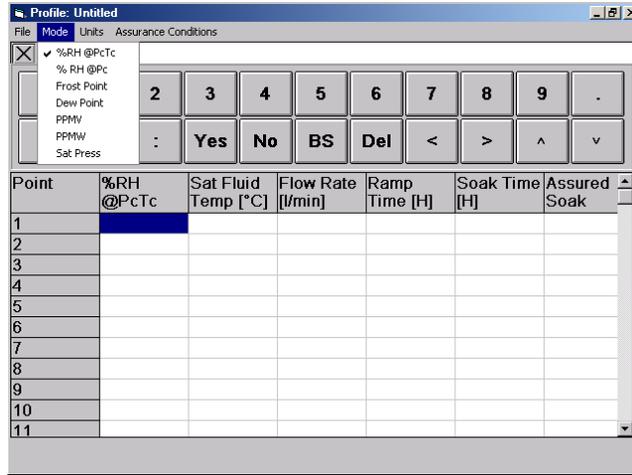
3.13.1.3 Setting the Profile Units

From the **Profile** drop-down menu, select **Units**. Another set of cascaded menus will appear from which you will choose the unit type to change. Please note the profile units are for use in entering the profile only and will not change the systems units upon start-up of an Auto Profile.



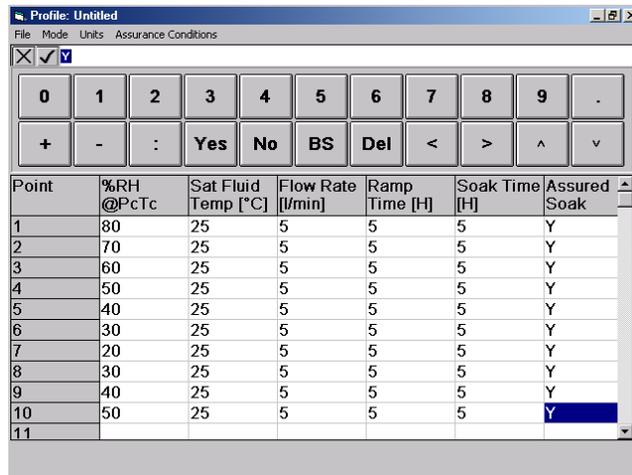
3.13.1.4 Setting the Profile Humidity Mode

From the **Profile** drop-down menu, select **Mode**. In the profile mode menu, select the desired control mode. Upon selection the new mode caption with its units will appear as the title of the humidity value.



3.13.1.5 Entering the Profile Data

Enter the required values of humidity, temp, flow, ramp time, soak time, and either a "Y" or "N" for assured soak. Selecting the check mark button on the profile window after each entered value advances the cursor to the next parameter for that point. An item that is left empty is a valid entry choice, but to be considered a valid profile point all items must be completed.



Each Profile entry is validated at time of entry as you are moving across the profile line. This validation is to assure that each entry is within system tolerances.

When moving from one line to another, the entire line is validated with respect to all other items contained on that profile line. Any invalid entry will cause a message box to appear and the value that may be causing the problem to be highlighted.

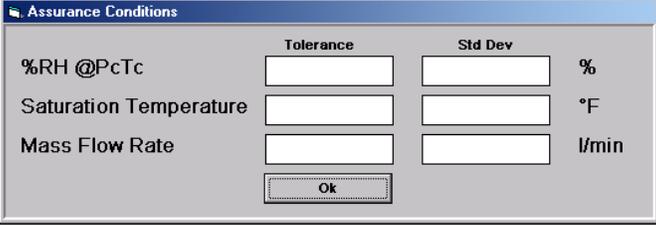
Enter the remaining profile points in the same manner. As the points are entered, the computer will predict the next value based on previous points entered. These predictions are often correct and will not require editing. To make corrections to an existing profile item, simply select and edit the data for that cell.

3.13.1.6 Setting the Assurance Conditions

One last task will conclude the profile entry process. If assured soak is to be used (any "Y" in the assured soak column), then the Assurance conditions must be set.

Assurance Conditions are user specified tolerances between setpoint and measured values. These tolerances must be met during the Assurance Phase before the Soak Phase begins.

To enter assurance tolerances, select **Assurance Conditions...** from the **Profile** drop-down menu. The following dialog box appears:



The dialog box titled "Assurance Conditions" contains a table with three rows and three columns. The columns are labeled "Tolerance" and "Std Dev" at the top, and units are listed on the right. The rows are for "%RH @PcTc", "Saturation Temperature", and "Mass Flow Rate". Each row has two empty input boxes. An "Ok" button is at the bottom center.

	Tolerance	Std Dev	
%RH @PcTc	<input type="text"/>	<input type="text"/>	%
Saturation Temperature	<input type="text"/>	<input type="text"/>	°F
Mass Flow Rate	<input type="text"/>	<input type="text"/>	l/min

Ok

For quicker Assurance times, increase the *Tolerance* and/or the *Std Dev* values. Tighter tolerances or standard deviations (smaller values) result in longer Assurance times. Setting these values too small could prevent assurance conditions from being met, therefore preventing the system from advancing to the next profile point. Although all parameters may be edited, only the humidity parameter of the currently selected control mode and the lower system parameter tolerance values will affect assurance conditions. A tolerance or standard deviation value left blank will always meet the assurance conditions

3.13.1.7 Historical Data

The historical data feature of the profile allows the user to retain a record of the generator's performance for long term comparison or repeatability analysis. When historical data is enabled, each point of a given profile will maintain a separate data file of the soak phase data collected for that point during the profile run. The data files have the same name as the profile itself, but the first point will have the suffix *.001*, the second point will have the suffix *.002*, etc. Each time this same profile is run, the new soak data is appended to the existing data in the appropriate historical files. These files are located in the same directory as the original profile.

To Enable the historical data feature select **Append to Historical Files** from the **Profile** drop-down menu. A ✓ appears in front of the menu item.

Selecting ✓ **Append to Historical Files** from the **Profile** drop-down menu while enabled, disables the historical files from being updated.

Like the assurance conditions, the historical data preference is saved with the profile but may be enabled or disabled at run time without affecting the name of the current profile.

3.13.1.8 Saving a Profile

Save a profile to disk by selecting **Save Profile** from the **Profile** drop-down menu. When asked, enter any standard path and filename then select **OK**. Once saved the Profile window title will indicate the new profile name. The existence of a profile path name on the Profile window title bar is an indication that the profile currently in memory matches the profile of the same name stored on disk. A profile window that is titled **Profile: Untitled** indicates that either the profile has not been saved, or does not exactly match the stored profile of the same name. This occurs if the profile points are edited after being saved. Profiles

are saved with all attributes such as control mode, engineering units, assurance conditions, historical data mode, etc..

3.13.1.9 Open an Existing Profile

To retrieve a profile from disk, select **Open Profile...** from the **Profile** drop-down menu. Choose an existing profile filename using the dialog box. When opened, the profile is verified and then loaded into memory. The previous profile is cleared from memory and the new profile is loaded with all attributes that it was saved with.

3.13.1.10 Printing a Profile

To print a copy of the profile in memory, select **Print Profile** from the **Profile** drop-down menu. It is best to save the profile to disk before printing so that the profile name will also be printed.

3.13.1.11 Saving a Profile as the Default

To make a specific profile the default, which loads automatically at power-up, save it as *c:\windows\thunder\profile.prf*.

3.13.2 Starting the Auto Profile

1. Check the Profile window to assure the profile exists in the system memory.
2. If the profile uses assurance conditions, verify assurance conditions are correctly specified.
3. Select **Auto Profile** from the **Run** drop-down menu.
4. Select the starting point from those listed in the dialog box, then click **OK**.

Point	%RH @PcT	Cham Fluid Temp	Flow Rate [l/min]	Ramp Time [H]	Soak Time [H]	Assurance Soak
1	20	23	5	0	1	N
2	50	23	5	0	1	N
3	80	23	5	0	1	N

The setpoints from the selected starting point will be entered into the appropriate setpoint fields of the Main Window and the generator will start-up in the same fashion as a normal generate mode.

3.13.2.1 Understanding *Phase* and *Point*

Each profile *point* consists of three distinct *phases*; Ramp, Assurance and Soak. Each phase accomplishes a specified task.

The Ramp phase is used to linearly transition from one *point's* setpoints to the next *point's* setpoints in a given amount of time.

The Assurance Phase forces the system to wait until measured parameters and setpoint values are within a specified tolerance and stability before the computer starts the Soak Phase.

The Soak Phase is the desired amount of time to generate the particular profile point before proceeding to the next point.

Examples of Ramp/Soak/Assured Soak Phase combinations:

Example 1:	Ramp Time	Soak Time	Assured Soak
	0	1	N

Example 1 causes the Soak phase to begin immediately at the start of the profile point, even though the 1200 may still be adjusting to the point. The next point will start after the 1 hour soak phase.

Example 2:	Ramp Time	Soak Time	Assured Soak
	0	1	Y

Example 2 causes the Assurance phase to begin immediately at the start of the profile point. The measured values are continually compared with the setpoint values until they agree to within a set tolerance and the measured values are stable to within the specified degree. Once assured (tolerances met) the Soak phase begins. Total time required for this point is variable and depends upon the amount of time that is required for assurance (dictated by tolerances). Total time for example 2 is elapsed assurance time plus 1 hour.

Example 3:	Ramp Time	Soak Time	Assured Soak
	.5	1	Y

The Ramp phase (Ramp Timer) begins at the start of the point. The system adjusts slowly toward the setpoint, taking 30 minutes. Once the Ramp Time has elapsed, Assurance starts and waits for tolerances to be met. When tolerances are met, the Soak phase begins and lasts 1 hour. Total time for example 3 is 30 minutes, plus elapsed Assurance time, plus 1 hour. Assurance time is a variable and depends on tolerances.

3.13.3 Manual Override of Profile

Although the system is operating automatically, some manual control is allowed using the **Hold Point**, **Next Phase** and **Next Point** menu items on the **Run** drop-down menu.

3.13.3.1 Holding the Profile

Selecting **Hold Point** from the **Run** drop-down menu stops the current "Remaining Time" timers, allowing these times to be effectively increased by the operator.

If the system is in an Assurance phase, the Hold Point will prevent the system from assuring and holds the profile at the current point.

To resume the profile point, select **Hold Point** again. This re-enables the timing functions and allows the profile to resume normal operation.

3.13.3.2 Advancing to the Next Phase

Selecting **Next Phase** from the **Run** drop-down menu manually duplicates the action which automatically occurs when a Remaining Ramp or Soak Time counter reaches zero (0), or when the assurance conditions are met. In other words, it causes Ramp Phase to proceed to the Assurance or Soak Phase, Assurance to proceed to Soak, or Soak to proceed to Ramp of the next profile point. This allows for early manual termination of any phase within a profile point.

3.13.3.3 Advancing to the Next Point

Selecting **Next Point** from the **Run** drop-down menu manually duplicates the action, which automatically occurs when the point time counter reaches zero (0).

3.13.4 Stopping an Auto Profile

A Shutdown may be performed at any time during a profile but will automatically occur when the last soak phase has been completed.

System Shutdown is performed by the computer and consists of the following actions:

1. Flow and Expansion valves close.
2. Pressure Vent valve opens.
3. All control is disabled.
4. User is asked to save data.

Another way to exit the Auto Profile is to switch from Auto Profile to Generate. The current setpoints for Saturation Pressure, Saturation Temperature and Flow are used to control the system at its current humidity control mode point.

3.13.5 Special Considerations While Auto Profiling

Auto Profiling may be initiated from either a Generate or Shutdown condition.

3.14 REPORTS

ControLog can create custom reports containing generator and user supplied data for up to eight individual instruments. Data may be collected for as few or as many points as desired. Data collected is placed into a set of temporary files for later use by the Report Editor. Data is written into these temporary files in the following format:

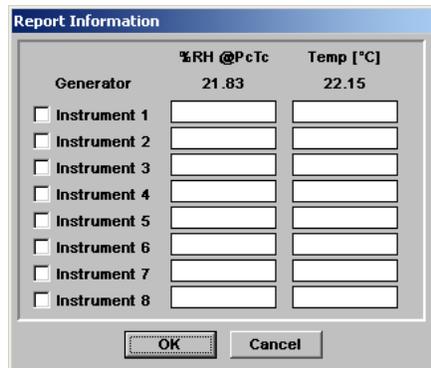
Gen Date/Time		Temp Mode	Unit	1200 Data		Instr Data		Correction	
-----		-----	-----	Hum	Temp	Hum	Temp	Hum	Temp
06Dec03 12:48		%RH	C	90.01	21.005	90.27	21.062	-.27	-.062
06Dec03 13:25		%RH	C	84.99	21.010	85.35	21.050	-.35	-.050
06Dec03 13:52		%RH	C	70.00	21.000	70.24	21.045	-.24	-.045

Each data entry into a temporary file is time and date stamped, and includes the generated humidity mode and temperature units. The corresponding instantaneous value of the generated humidity and temperature is included along with the humidity and temperature that the user enters for the instrument under test. Also included are calculated correction values, which are computed as the difference between the generated values and those, entered for the test instrument. There is a separate temporary file created for each of the eight test instruments.

3.14.1 Collecting Report Data

To collect system and instrument data:

1. Assure both the generator and your instruments are stable at the desired point.
2. Select **Save Data Point Now...** from the **Reports** drop-down menu. In the dialog box that appears, the current generated humidity and temperature have already been supplied.



- Click on the data entry field, which corresponds to the instrument data you wish to supply. Enter the data, taking note of both the humidity mode and units.

Generator	%RH @PcTc	Temp [°C]
Generator	19.99	25.05
<input checked="" type="checkbox"/> Instrument 1	20.0	25.0
<input type="checkbox"/> Instrument 2		
<input type="checkbox"/> Instrument 3		
<input type="checkbox"/> Instrument 4		
<input type="checkbox"/> Instrument 5		
<input type="checkbox"/> Instrument 6		
<input type="checkbox"/> Instrument 7		
<input type="checkbox"/> Instrument 8		

- Once you have entered all of your data for each of the instruments, Click **OK**. Data will be appended to a temporary data file for each of the selected instruments.
- Repeat steps 3 through 4 at each humidity/temperature point that requires instrument data to be entered.
- When the run is complete, and all of the test instrument data has been collected, use the Report Editor to edit, print, and save the instrument reports (see section 3.11.3 *The Report Editor*).

3.14.2 Clearing Report Data

To start collecting data to a new temporary report data storage file, it is necessary to clear the current temporary data storage file or restart ControlLog.

To clear report data storage files:

- Select **Clear Report Data...** from the **Reports** drop-down menu. The following dialog box will appear.

- Select the desired range for the data files to clear and click **OK**.

3.14.3 The Report Editor

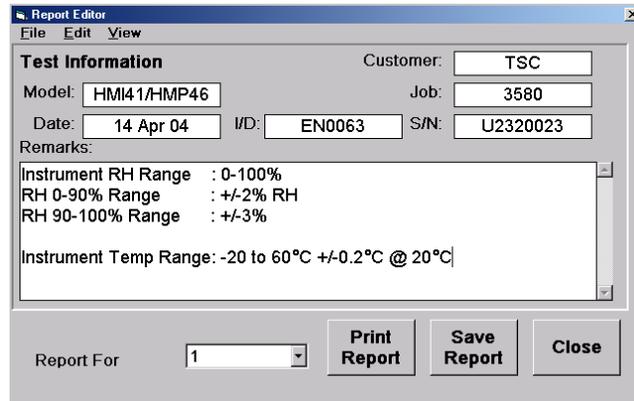
The Report Editor allows for customized report generation showing test instrument performance data. Once the data has been collected (see section 3.14.1 *Collecting Report Data*), the Report Editor is used to preview, edit, print, and save completed reports for each instrument under test.

3.14.3.1 Creating, Printing, and Saving a Report

Each report consists of a Header, Test Information, Data, and a Footer section. Each of these elements are editable prior to printing and/or saving the report. The Header, Test Information, and Footer sections are completely customizable and may be saved in their customized forms for later recall and inclusion in future reports.

To create, print, and save a report:

1. Select **Report Editor...** from the **Reports** drop-down menu. The Report Editor appears.



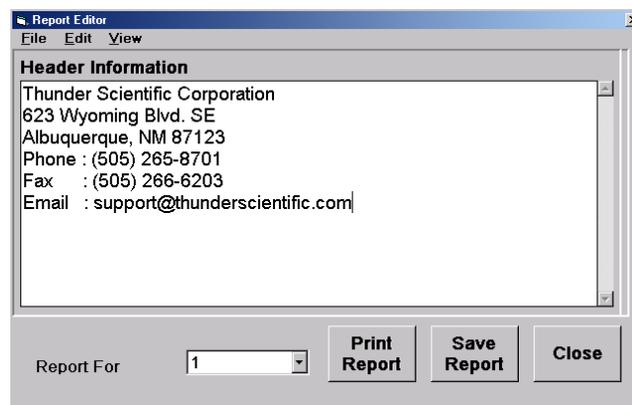
2. Select **Header** from the **View** drop-down menu. Load, edit, or save the header information as needed (see section 3.14.3.2 *Editing the Header*).
3. Select **Footer** from the **View** drop-down menu. Load, edit, or save the footer information as needed (see section 3.14.3.3 *Editing the Footer*).
4. If not already showing, select **Test Information** from the **View** drop-down menu. Load, edit, or save the test information as needed (see section 3.14.3.4 *Editing the Test Information*).
5. Select **Data** from the **View** drop-down menu to bring up the data screen.
6. From the **Report for Instrument:** box at the bottom of the screen, select an instrument number. The previously collected data for the selected instrument appears on the screen.
7. Edit the data if needed (see section 3.14.3.5 *Editing the Data*).
8. Click **Print Report** to print a report for the instrument selected using all of the information (header, footer, data, etc.) as currently edited.
9. Click **Save Report** to save the report to a text file. A dialog box appears asking for the destination filename.
10. Enter a valid filename and click **OK**, or click **Cancel** to abort the file save process. Saved reports are stored as standard text files, and may be imported into a word processor or text editor program for viewing or further editing at a later date.
11. Repeat steps 2 through 9 as needed for each of the instruments requiring reports.

3.14.3.2 Editing the Header

The report header is printed at the top of each report and should contain fixed information such as Company Name, Address, etc. Several report headers may be created and saved for use with different types of report styles. For example, a different header would most likely be used when printing a report on letterhead rather than on plain paper. The header information on the screen at the time of printing or saving a report is the information that is used for that report.

Editing a report header:

1. If not already in the Report Editor, select **Report Editor...** from the **Reports** drop-down menu.
2. If the Header window is not visible, select **Header** from the Report Editor's **View** drop-down menu.



3. Using normal text editing procedures, edit the header text as needed. Add blank lines (using the *Return* key) at the top of the header to shift the entire report downward as needed. The header can be centered visually using spaces to the left of each line.

Saving a report header:

1. Once edited, save the header for later recall by selecting **Header...** from the **Save** sub menu of the Report Editor's **File** menu.
2. From the dialog box that appears, enter an appropriate header filename. Use a *.hdr* suffix when naming header files. This makes it easier to distinguish them from other types of files when recalling them later.

Recalling a previously stored report header:

1. Select **Header...** from the **Open** sub menu of the Report Editor's **File** menu. A list of any previously created header files is displayed (files with a *.hdr* suffix).
2. Select a header file from the list, or enter a valid filename in the dialog box that appears. Click **OK** to load the header selected, or click **Cancel** to abort the load process and retain the current header information.

Saving a default report header:

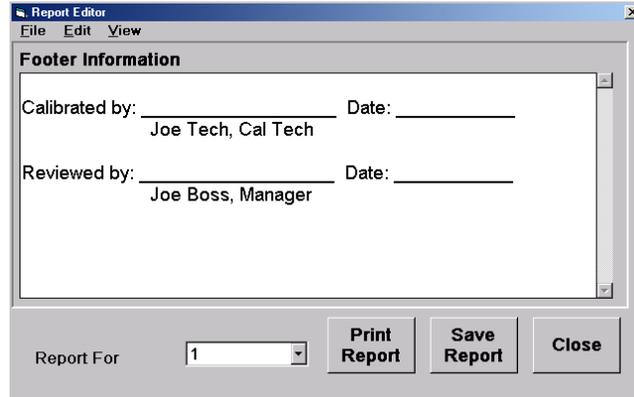
To make a header the default header, save it as `c:\windows\thunder\header.hdr`.

3.14.3.3 Editing the Footer

The report footer is printed at the bottom of each report and should contain fixed information such as technician name, signature and date lines, etc. Several report footers may be created and saved for use by different technicians. The footer information on the screen at the time of printing or saving a report is the information that is used for that report.

Editing a report footer:

1. If not already in the Report Editor, select **Report Editor...** from the **Reports** drop-down menu.
2. If the Footer window is not visible, select **Footer** from the Report Editor's **View** drop-down menu.



3. Using normal text editing procedures, edit the footer text as needed.

Saving a report footer:

1. Once edited, save the footer for later recall by selecting **Footer...** from the **Save** sub menu of the Report Editor's **File** menu.
2. From the dialog box that appears, enter an appropriate footer filename. Use a `.ftr` suffix when naming footer files. This makes it easier to distinguish them from other types of files when recalling them later.

Recalling a previously stored report footer:

1. Select **Footer...** from the **Open** sub menu of the Report Editor's **File** menu. A list of any previously created footer files is displayed (files with a `.ftr` suffix).
2. Select a footer file from the list, or enter a valid filename in the dialog box that appears. Click **OK** to load the footer selected, or click **Cancel** to abort the load process and retain the current footer information.

Saving a default report footer:

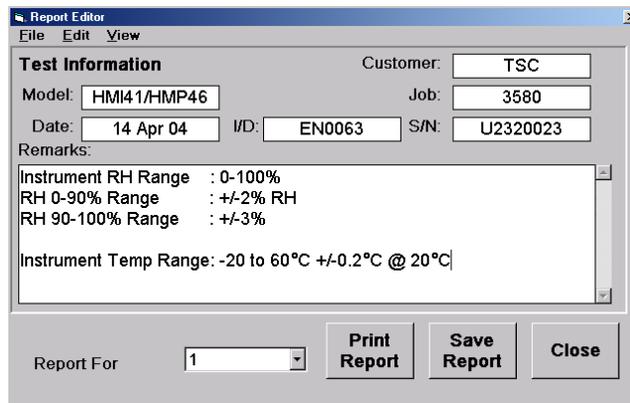
Create the report footer and save it as `c:\windows\thunder\footer.ftr`.

3.14.3.4 Editing the Test Information

The test information is printed immediately after the header of each report and should contain fixed information such as serial number, model number, etc. specific to the instrument under test. Since test information is device specific, several test information files may be created and stored for later recall. The test information on the screen at the time of printing or saving is the information that is used for that report.

Editing the test information:

1. If not already in the Report Editor, select **Report Editor...** from the **Reports** drop-down menu.
2. If the Test Information window is not visible, select **Test Information** from the Report Editor's **View** drop-down menu. The Test Information window appears.



3. Using normal text editing procedures, edit the remarks area of the test information section as needed.
4. Using normal data entry procedures, edit any or all fixed data items such as Serial Number, Model Number, etc. If an entry is left blank, then neither the title nor the entry will appear on the report.
5. To change the titles of the fixed data items, hold the *Ctrl* key and click directly on the title itself. You will be prompted for a new title for that item.

Saving the test information:

1. Once edited, save the test information for later recall by selecting **Test Information...** from the **Save** sub menu of the Report Editor's **File** menu.
2. From the dialog box that appears, enter an appropriate Test Information filename. Use a `.msc` suffix when naming test information files. This makes it easier to distinguish them from other types of files when recalling them later.

Recalling previously stored test information:

1. Select **Test Information...** from the **Open** sub menu of the Report Editor's **File** menu. A list of any previously created test information files is displayed (files with a *.msc* suffix).
2. Select a test information file from the list, or enter a valid filename in the dialog box that appears. Click **OK** to load the test information selected, or click **Cancel** to abort the load process and retain the current test information.

Saving the default test information

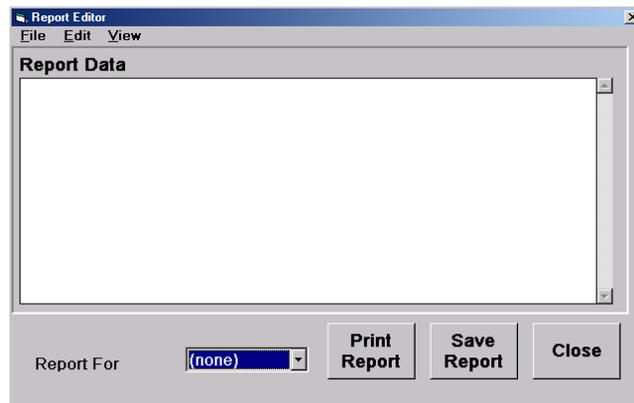
To make the current test information the default, create the report footer and save it as *c:\windows\thunder\misc.msc*.

3.14.3.5 Editing the Data

The report data is printed immediately following the test information and contains previously collected data for the specified instrument. Prior to printing or saving the report, the data may be viewed and edited. The data as it is on the screen at the time of printing or saving a report is the data that is used for that report.

Selecting the test instrument data:

1. If not already in the Report Editor, select **Report Editor...** from the **Reports** drop-down menu.
2. If the Data window is not visible, select **Data** from the Report Editor's **View** drop-down menu. The Data window appears.



3. From the **Report for Instrument:** box at the bottom of the screen, select an instrument number. The previously stored data for the selected instrument appears on the screen.

Editing the data:

Prior to printing or saving, the data text can be edited as needed using normal text editing procedures.

3.15 STATISTICAL ANALYSIS

The Statistical Analysis window provides a method to monitor the stability of the generator. The statistical mean and standard deviation are calculated for each of the parameters listed and are updated and displayed continuously in real time.

The screenshot shows a software window titled "Statistical Analysis" with a "Sample Size" menu. The window is divided into three pages: Page1, Page2, and Page3. Page2 is active and displays a table with two columns: "Mean" and "StdDev". The table lists seven parameters with their respective units. Each parameter has two empty input boxes for Mean and StdDev values.

	Mean	StdDev	
Sat Pressure	<input type="text"/>	<input type="text"/>	psia
Chmb Pressure	<input type="text"/>	<input type="text"/>	psia
Saturation Temp	<input type="text"/>	<input type="text"/>	°C
Chamber Temp	<input type="text"/>	<input type="text"/>	°C
Mass Flow Rate	<input type="text"/>	<input type="text"/>	l/min
%RH @PcTc	<input type="text"/>	<input type="text"/>	%
%RH @Pc	<input type="text"/>	<input type="text"/>	%

Both the mean and standard deviation are computed from a fixed size moving data set, which contains only the most recent data.

To change the size of the data set, click on the **Sample Size** menu. A dialog box appears prompting for a new data set size. Click the Page 2 and Page 3 tabs to reveal the rest of the statistical data.

Section 4

CALIBRATION AND MAINTENANCE

4.1 GENERAL

The Model 1200 requires little periodic maintenance. Following the proper operating procedures as given in this manual will help assure trouble-free operation of this system.

4.2 CALIBRATION

Proper calibration of the temperature and pressure transducers is critical to the accuracy of the generated humidity. Each time a transducer is calibrated its current calibration coefficients and calibration data are stored to disk. Calibration of the system requires the following support equipment:

- 1) **Temperature** - 10 to 60 °C:
 - A) Precision temperature bath of specified range with a liquid medium, and stability of ± 0.01 °C or better. Less stable baths may require the use of a thermal block.
 - B) Reference thermometer of specified range with resolution and accuracy of ± 0.05 °C or better.

- 2) **Pressure** - ambient to 152 psiA and 0 to 150 psiG:
 - A) Static gas pressure source with a stability of ± 0.01 % of range or better.
 - B) Reference pressure gage/controller with resolution and accuracy of $\pm 0.08\%$ of full scale or better.

- 3) **Flow** - 0 to 10 standard liters/min:
 - A) Reference flow meter with resolution and accuracy of ± 2 % of range or better.

4.2.1 Temperature Calibration

This temperature calibration procedure is used in conjunction with a precision temperature bath and precision temperature reference. Using the temperature bath to generate three known temperatures and a precision temperature reference for measurement, coefficients (ZERO, SPAN, LINEARITY) are calculated automatically by the computer and used to update the system calibration. Calibration reports may also be printed for each of the temperature probes at the conclusion of the calibration sequence.

Equipment Required:

1. Precision Temperature Bath (per section 4.2).
2. Reference thermometer (per section 4.2).
3. Torx T10 driver for removal of covers.

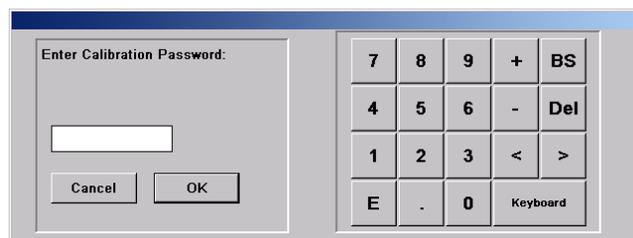
Calibration Procedure:

Reference Drawing 03D12902

- 1) Perform a shutdown, exit the 1200 ControlLog program, shutdown Windows operating system, switch power OFF, and remove power cord.
- 2) Remove the top/rear console cover.
- 3) Remove RTD's from system:
 - (A) Saturation Temperature RTD0 - Uncoil cable and pull probe out from its location.
 - (B) Presaturator Temperature RTD1 - Uncoil cable and pull probe out from its location.
 - (C) Expansion Valve Temperature RTD2 - Remove insulation from probe location, loosen and pull back clamping nut, remove probe by pulling on rubber restraint (do not pull probe by the cable), uncoil cable and pull excess cable through the grommet (towards the probe location).
 - (D) Chamber Temperature RTD3 - Remove insulation around probe feed through, uncoil cable, pull rubber cable restraint (inside chamber) loose and pull all excess probe cable into the chamber, then feed probe and cable through the chamber access port.
- 4) Couple all RTD probes together along with the temperature reference using small rubber bands and then insert probes with reference into the precision temperature bath.
- 5) Connect power and start the 1200's ControlLog program.

CAUTION!
DO NOT ENABLE TEMPERATURE CONTROL
WITH RTD's REMOVED FROM SYSTEM.

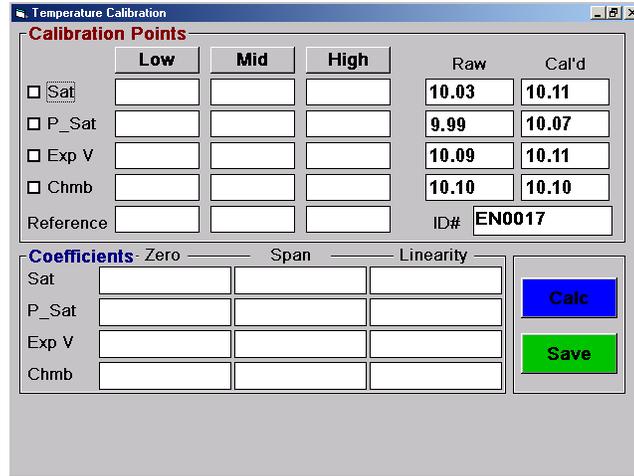
- 6) For temperature units other than °C, select the desired temperature units for calibration from the **Units** drop-down menu. Once calibration has begun, the units must not be changed again until calibration is complete.
- 7) Select **Temperature Calibration** from the **Window** drop-down menu. The system then asks for a Calibration Password.



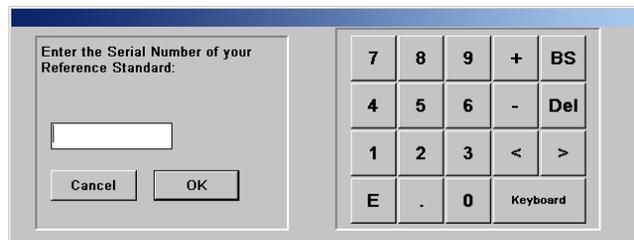
The image shows a software dialog box titled "Enter Calibration Password:". On the left side, there is a text input field, a "Cancel" button, and an "OK" button. On the right side, there is a numeric keypad with the following layout:

7	8	9	+	BS
4	5	6	-	Del
1	2	3	<	>
E	.	0	Keyboard	

- 8) Enter the Calibration Password (found at the back of the manual) and click the **OK** button. The Temperature Calibration form appears with continuous real time readings of all RTD's. (Without the password, the calibration screen is in read only mode.)



- 9) Using the **check boxes** at the left of the temperature calibration window, **select the probes to be calibrated**. Then click on the ID# box and enter an identification number for your reference thermometer. The reference thermometer identification number will then appear on the calibration records when saved.



Click the Keyboard button and the On-screen Keyboard will appear if alpha characters are required in identification number.



- 10) Using the temperature bath, generate a temperature near the low end of the 1200's temperature range of 10 °C. Once the readings are stable, click the **Low** button.

- 11) Enter the value of the reference thermometer (in current system units), then click **OK**.

Calibration Points					
	Low	Mid	High	Raw	Cal'd
<input checked="" type="checkbox"/> Sat	10.03			10.03	10.11
<input checked="" type="checkbox"/> P_Sat	9.99			9.99	10.07
<input checked="" type="checkbox"/> Exp V	10.09			10.09	10.11
<input checked="" type="checkbox"/> Chmb	10.10			10.10	10.10
Reference	10.079				
				ID#	EN0017

Coefficients			
	Zero	Span	Linearity
Sat			
P_Sat			
Exp V			
Chmb			

Buttons: **Calc** (blue), **Save** (green)

The stored values from the Raw column are placed into the Low column of the selected probes and the reference temperature is placed into its corresponding column.

Note - Clicking a Low, Mid, or High button again allows the previous point of each RTD to be over-written with the most current measured value. The reference thermometer value will also be over-written with the new value entered.

- 12) Generate a temperature near the center of the 1200's temperature range. Once the readings are stable, click the **Mid** button and enter the temperature reading from the reference thermometer in the correct units. Note the placement of the temperature values in the appropriate columns.
- 13) Generate a temperature at the upper end of the 1200's temperature range. Once the readings are stable, click the **High** button and enter the temperature reading from the reference thermometer in the correct units.
- 14) When all three temperature points have been entered, click the **Calc** button. New calibration coefficients will be calculated and displayed in the appropriate Zero, Span, and Linearity columns of the selected probes.

Calibration Points					
	Low	Mid	High	Raw	Cal'd
<input checked="" type="checkbox"/> Sat	10.03	34.91	59.85	59.85	60.02
<input checked="" type="checkbox"/> P_Sat	9.99	34.86	59.78	59.87	60.02
<input checked="" type="checkbox"/> Exp V	10.09	34.97	59.91	59.91	60.02
<input checked="" type="checkbox"/> Chmb	10.10	35.01	59.97	59.96	60.02
Reference	10.079	35.017	60.024		
				ID#	EN0017

Coefficients			
	Zero	Span	Linearity
Sat	5.131214E-02	1.000270E+00	2.974667E-05
P_Sat	7.328073E-02	1.001076E+00	2.977499E-05
Exp V	-8.703923E-03	1.000266E+00	2.974667E-05
Chmb	-3.704328E-03	9.986977E-01	3.776062E-05

Buttons: **Calc** (blue), **Save** (green)

- 15) Click **Save** to store and update the system with the new coefficients and data.
- 16) Set the bath to different temperatures within the temperature range to view the values in the **Cal'd** column (As Left Data).
- 17) When finished, close the Temperature Calibration window, exit the 1200's program, shutdown Windows operating system, switch power OFF and remove the power cord.
- 18) Reinstall all probes. Ensure that RTD0 and RTD1 probes are completely inserted. Ensure that RTD2's probe tip is against the rubber restraint (not inserted too deep). Reinstall all foam insulation that was removed from around the RTD's.
- 19) Replace the top/rear console cover.

4.2.2 System Pressure Transducer Calibration

The calibration procedure given here is for the Sat/Chmb pressure transducer calibration. This calibration is critical to the accuracy of the 1200 and is used in all of the humidity calculations.

This procedure is used in conjunction with an adjustable pressure reference. Using the pressure reference to generate three known pressures, coefficients (ZERO, SPAN, LINEARITY) are then calculated automatically by the computer and used to update the system calibration. A calibration report may be printed for the pressure transducer at the conclusion of the calibration sequence.

Equipment Required:

1. Torx T10 driver (included with system).
2. 7/16" & 9/16" wrenches

Calibration Procedure:

Reference Drawing 03D12902

- 1) For safety purposes, perform a shutdown, exit the 1200 ControLog program, shutdown Windows operating system, switch power OFF, and remove power cord. Remove the top/rear access cover.

CAUTION!
ALL SYSTEM PRESSURE MUST BE
VENTED BEFORE PROCEEDING.

- 2) Using the appropriate tools, mechanically disconnect the pressure transducer from the 1200 leaving it electrically connected to the system. Connect the transducer to the pressure reference.
- 3) Restore power and restart the 1200 ControLog program.

CAUTION!
DO NOT ENABLE HUMIDITY GENERATION WITH
PRESSURE TRANSDUCER DISCONNECTED.

- 4) For pressure units other than psiA, select the desired pressure units for calibration from the **Units** drop-down menu. Once calibration has begun, the units should not be changed again until calibration is complete.
- 5) Select **Pressure Calibration** from the **Window** drop-down menu. The system then asks for a Calibration Password.

Enter Calibration Password:

Cancel OK

7	8	9	+	BS
4	5	6	-	Del
1	2	3	<	>
E	.	0	Keyboard	

- 6) Enter the Calibration Password (found at the back of the manual) and click the **OK** button. The Pressure Calibration form appears with continuous real time readings of the pressure transducers. (Without the password, the calibration screen is in read only mode.)

Pressure Calibration

Calibration Points

	Low	Mid	High	Raw	Cal'd
<input checked="" type="checkbox"/> Sat / Chmb				0.4742	14.7000
<input type="checkbox"/> Supply				0.0000	0.0000

Reference: [] [] [] ID#: EN0037

Coefficients Transducers

	Zero	Span	Linearity
System			
Supply			

Calc Save

- 7) Using the **check boxes** on the left of the calibration window, **select the Sat/Chmb transducer** to be calibrated. Click on the ID# box and enter an identification number for your pressure reference. The identification number will then appear on the calibration records when printed.

Enter the Serial Number of your Reference Standard:

Cancel OK

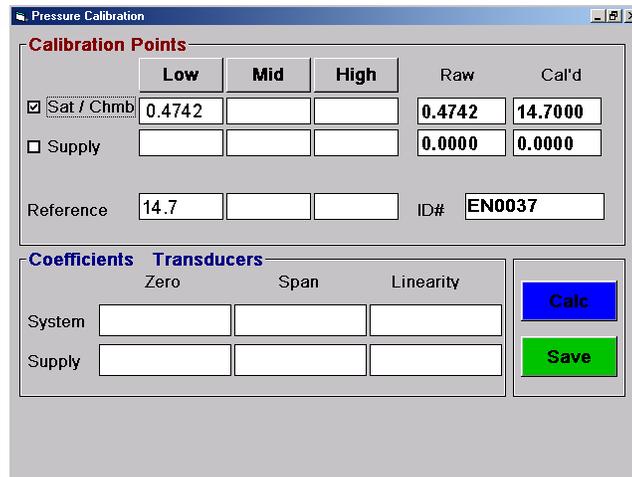
7	8	9	+	BS
4	5	6	-	Del
1	2	3	<	>
E	.	0	Keyboard	

Click the Keyboard button and the On-screen Keyboard will appear if alpha characters are required in identification number.



- 8) Pressurize the transducer to approximately 15 psiA or use ambient absolute pressure. Allow the selected transducer and the pressure reference to stabilize. Once the readings are stable, click the **Low** button.

Note - This transducer is operated at or above ambient pressure, requiring calibration between ambient and full scale only. There is no need for below ambient testing or calibration.



- 9) Enter the value of the pressure reference (absolute pressure, in the current system units), then click **OK**.

The stored values from the Raw column are placed into the Low column of the selected transducer, and the pressure reference is placed into its corresponding column.

Note - Clicking a Low, Mid, or High button again allows the previous point to be over-written with the most current measured value. The pressure reference value will also be over-written with the new value entered.

- 10) Pressurize the transducer to 75 psiA or a pressure near the center of the operating pressure range of the transducer. Once the readings are stable, click the **Mid** button and enter the pressure reading from the pressure reference in the correct units. Note the placement of the pressure values in the appropriate columns.
- 11) Pressurize the transducer to 152 psiA or a pressure near the upper end of the operating pressure range of the transducer. Once the readings are stable, click the **High** button and enter the pressure reading from the pressure reference in the correct units.

- When all three pressure points have been entered, click the **Calc** button. New calibration coefficients will be calculated and displayed in the appropriate Zero, Span, and Linearity columns of the calibrated transducer.

Calibration Points					
	Low	Mid	High	Raw	Cal'd
<input checked="" type="checkbox"/> Sat / Chmb	0.4742	2.4194	4.904	4.904	152.00
<input type="checkbox"/> Supply				0.0000	0.0000
Reference	14.7	75	152	ID#	EN0037

Coefficients Transducers			
	Zero	Span	Linearity
System	7.443486E-02	2.968501E+01	2.348472E-02
Supply			

- Click **Save** to store and update the system with the new coefficients and data.
- Set the pressure reference to various pressures within the operating pressure range of the transducer to view the calibrated values (As Left Data) in the **Cal'd** column. (For information on printing a Calibration Report refer to section 4.2.7 *Printing Calibration Records*.)
- When finished, close the pressure calibration window, exit the 1200 ControlLog program and switch power OFF. Remove the power cord.
- Reinstall the pressure transducer and tighten Swagelok nut 1/8 turn past finger tight. Replace the console cover.

4.2.3 Supply Pressure Transducer Calibration

Although calibration procedures are given here for supply pressure transducer calibration, its measurement is **not critical** to the accuracy of the 1200 and is only used in the calculation of the lowest humidity setpoint capability.

This procedure should be used in conjunction with an adjustable pressure reference. Using the pressure reference to generate three known pressures, coefficients (ZERO, SPAN, LINEARITY) are then calculated automatically by the computer and used to update the system calibration. A calibration report may be printed for the pressure transducer at the conclusion of the calibration sequence.

Calibration Procedure:

Reference Drawing 03D12902

- Perform a shutdown, exit the 1200 ControlLog program, shutdown Windows operating system, switch power OFF and remove power cord. Disconnect air/gas supply from system.
- Remove the top/rear and front covers to access the supply pressure transducer.

CAUTION!
AIR/GAS SUPPLY MUST BE DISCONNECTED
BEFORE PROCEEDING!

- 3) Using the appropriate tools, mechanically disconnect the supply pressure transducer from the 1200 leaving it electrically connected to the system. Connect the transducer to the pressure reference.
- 4) Restore power and restart the 1200 ControLog program.

CAUTION!
DO NOT ENABLE SYSTEM CONTROL WITH
PRESSURE TRANSDUCER REMOVED FROM
SYSTEM.

- 5) For pressure units other than psiG, select the desired pressure units for calibration from the **Units** drop-down menu. Once calibration has begun, the units should not be changed again until calibration is complete.
- 6) Select **Pressure Calibration** from the **Window** drop-down menu. The system then asks for a Calibration Password.

- 7) Enter the Calibration Password (found at the back of the manual) and click the **OK** button. The Pressure Calibration form appears with continuous real time readings of the pressure transducers. (Without the password, the calibration screen is in read only mode.)

		Low	Mid	High	Raw	Cal'd
<input type="checkbox"/> Sat / Chmb					0.4742	14.700
<input checked="" type="checkbox"/> Supply					0.0000	0.0000
Reference				ID#	EN0037	

		Zero	Span	Linearity
System				
Supply				

- 8) On the Pressure Calibration window, click the **check box** to the left of **Supply** to select the supply pressure transducer for calibration.

- 9) With **no** pressure applied, click the **Low** button. Enter a reference pressure of 0 psiG.
- 10) Pressurize the supply pressure transducer to approximately 75 psiG or a pressure near the center of the operating pressure range of the supply pressure transducer.
- 11) Monitor the pressure calibration window for a stable reading. Once the reading is stable, click the **Mid** button and enter the pressure reading from the pressure reference.
- 12) Pressurize the supply pressure transducer to approximately 150 psiG or a pressure near the upper end of the operating pressure range of the supply pressure transducer.
- 13) Monitor the pressure calibration window for a stable reading. Once the reading is stable, click the **High** button and enter the pressure reading from the pressure reference.
- 14) Once the low, mid, and high readings have all been taken, click the **Calc** button. The coefficients will be calculated and placed in the supply pressure transducer's Zero, Span, and Linearity section of the window.

Calibration Points					
	Low	Mid	High	Raw	Cal'd
<input type="checkbox"/> Sat / Chmb				0.4742	14.7000
<input checked="" type="checkbox"/> Supply	0.0000	1.8750	3.7500	3.750	150.000
Reference	0	75	150	ID#	EN0037

Coefficients Transducers			
	Zero	Span	Linearity
System			
Supply	0.000000E+00	1.010299E+02	-5718678E-01

- 15) To save the coefficients, click the **Save** button. The coefficients are then updated and saved to disk.
- 16) Set the pressure reference to various pressures within the operated pressure range of the supply pressure transducer to view the calibrated values (As Left Data) in the **Cal'd** column. (For information on printing a Calibration Report refer to section 4.2.7 *Printing Calibration Records*.)
- 17) When finished, close the pressure calibration window, exit the 1200 ControlLog program, shutdown Windows operating system, and switch power OFF. Remove the power cord.
- 18) Reinstall the supply pressure transducer and tighten 1/2 turn past finger tight. Ensure transducer is it electrically connected to the system. Replace the top/rear and front covers. Reconnect air/gas supply and connect power.

4.2.4 Flow Meter Calibration

The flow measurement, while indicated on the screen, is not critical to the accuracy of the generated humidity and is not used in the humidity calculations. Therefore, flow calibration requirements depend upon the needs of the user. Also, since the use of the Flow Calibration window is very similar to that of Temperature Calibration, only abbreviated instructions are given here. For more detailed understanding of the Calibration window usage, refer to section 4.2.1 *Temperature Calibration*.

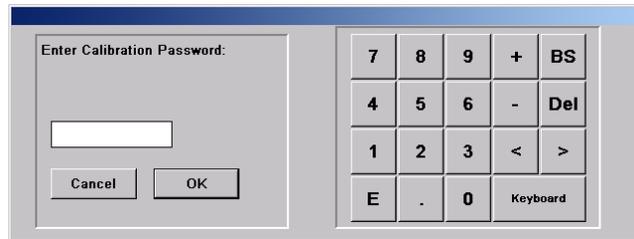
Equipment Required:

1. Reference flow meter (per section 4.2).

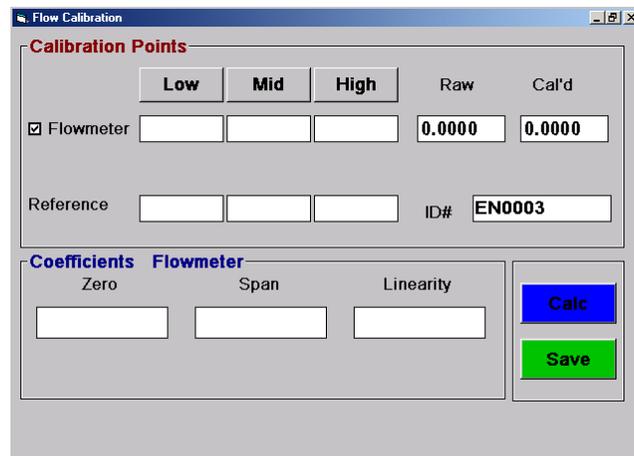
Calibration Procedure:

Reference Drawing 03D12902

- 1) Connect a reference flowmeter to the test chamber inlet (inside the test chamber).
- 2) Using the **Units** drop-down menu, select the desired flow units for calibration. Once calibration has begun, the units must not be changed again until calibration is complete.
- 3) Select **Flow Calibration** from the **Window** drop-down menu. The system then asks for a Calibration Password.



- 1) Enter the Calibration Password (found at the back of the manual) and click the **OK** button. The Flow Calibration screen appears and the flow readings begin updating. (Without the password, the calibration screen is in read only mode.)



- 5) Click on the **check box** at the left of the Flow Calibration window to **select the flowmeter for calibration**. If desired, enter an ID# for the reference flowmeter.
- 6) With **no** flow through the system, click the **Low** button once the reading is stable. Enter a reference flow of 0.

The screenshot shows the 'Flow Calibration' window. Under the 'Calibration Points' section, there are three buttons: 'Low', 'Mid', and 'High'. To the right of these buttons are two columns: 'Raw' and 'Cal'd'. Below this, there is a checked checkbox for 'Flowmeter' followed by three input fields (0.0000, an empty field, and another empty field). To the right of these are two more input fields, both containing '0.0000'. Below that, there is a 'Reference' section with three input fields (0, an empty field, and another empty field) and an 'ID#' field containing 'EN0003'. The bottom section is titled 'Coefficients Flowmeter' and has three input fields for 'Zero', 'Span', and 'Linearity', all of which are empty. To the right of these fields are two buttons: 'Calc' (blue) and 'Save' (green).

- 7) Minimize the flow calibration window and start the system by selecting **Generate** from the **Run** drop-down menu.
- 8) From the Main Screen, change the flow setpoint to mid range (the equivalent of 5 L/m) keeping in mind the previously set units.
- 9) Again select **Flow Calibration** from the **Window** drop-down menu and monitor for a stable flow reading at mid range. Once stable, click the **Mid** button. Enter the reference flowmeter measurement in the proper units.
- 10) Minimize the flow calibration window and change the flow setpoint to full range (the equivalent of 10 L/m) keeping in mind the units.
- 11) Again select **Flow Calibration** from the **Window** drop-down menu and monitor for a stable flow reading at full range. Once stable, click the **High** button. Enter the reference flowmeter measurement in the proper units.
- 12) Once the low, mid, and high readings have all been taken, click the **Calc** button. The coefficients will be calculated and placed in the Zero, Span, and Linearity section of the window.

The screenshot shows the 'Flow Calibration' window after the calibration process. Under the 'Calibration Points' section, the 'Low', 'Mid', and 'High' buttons are present. The 'Flowmeter' checkbox is checked. The 'Raw' and 'Cal'd' values are now 0.0097 and 0.0388. The 'Reference' section has three input fields containing 0, 5.041, and 9.8. The 'ID#' field still contains 'EN0003'. The 'Coefficients' section now has calculated values: 'Zero' is -3.910326E-02, 'Span' is 4.080492E+00, and 'Linearity' is -8.036870E-03. The 'Calc' and 'Save' buttons are still visible.

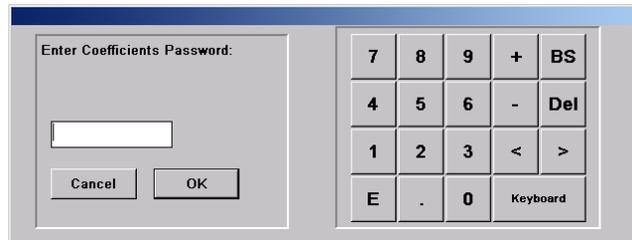
- 13) To save the coefficients, click the **Save** button. The coefficients are updated and saved to disk.
- 14) Verify the flow calibration at different flow rates against the reference flowmeter.

4.2.5 Viewing the Current Calibration Coefficients

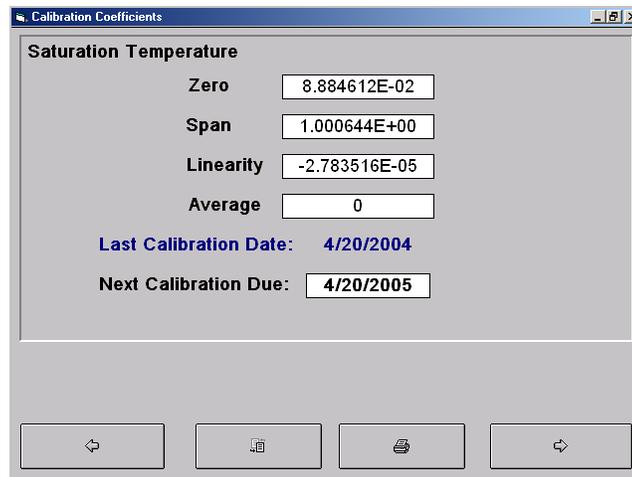
Calibration coefficients and corresponding data are available for viewing at any time.

To view the calibration coefficients and data:

- 1) Select **Calibration Coefficients** from the **Window** drop-down menu. The system then asks for a Coefficients Password.



- 2) Enter the Coefficients Password (found at the back of the manual) and click the **OK** button. The Calibration Coefficients window appears. (Without the password, the coefficients are in read only mode.)



The Tool Bar



Navigation buttons allow viewing each of the transducers in succession in either direction.



Toggles displayed information between calibration coefficients and actual calibration data.

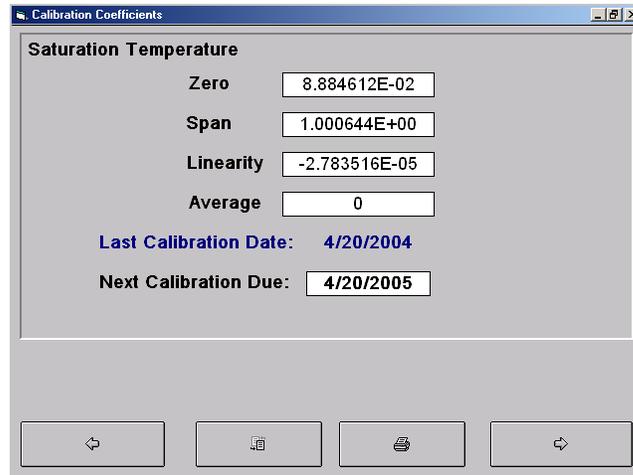


Prints the calibration record for the currently displayed transducer. You may optionally print *ALL* transducer reports at once if desired. (Refer to section 4.2.7 *Printing Calibration Records*)

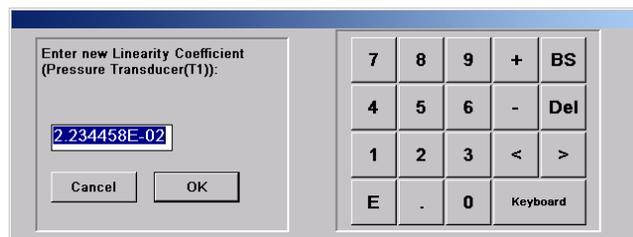
4.2.6 Editing Calibration Coefficients

Calibration Coefficients may be edited from the Calibration Coefficients window. To edit coefficients:

- 1) Bring up the Calibration Coefficients window corresponding to the transducer that is to be edited. Reference section 4.2.5 *Viewing the Current Calibration Coefficients*.



- 2) Click on the number that you want to change. The program asks for a new value.



- 3) Enter the new number, then click **OK**. Any changes made are updated to disk immediately.

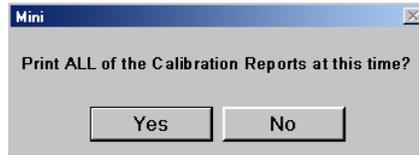
The *Zero*, *Span*, and *Linearity* affect the actual transducer calibration. Ensure you understand the significance of each prior to changing them.

Average determines the amount of filtering applied to the displayed transducer readings. An average of 10 is typical, 0 results in no filtering, and 100 would be excessive.

To change the calibration interval which is used to compute the *Next Calibration Due* date, edit the Next Calibration Due date box with a date relative to the Last Calibration Date. For example, a Next Calibration Due of 10/20/04 and a Last Calibration Date of 10/20/03 results in a one year calibration interval. The next time that the transducer is calibrated, the calibration dates will update using the existing time difference between Last and Next calibration dates.

4.2.7 Printing Calibration Records

- 1) Bring up the Calibration Coefficients window with the coefficients or data for the transducer you want to print. Reference section 4.2.5 *Viewing the Current Calibration Coefficients*.
- 2) Click the Print Icon at the bottom of the window. The following prompt appears.



- 3) Selecting **Yes** causes reports for *all* of the transducers to be printed. Selecting **No** prints only the report for the current transducer shown on the Calibration Coefficients window.

4.3 ROUTINE MAINTENANCE

4.3.1 Chamber Fluid Level

Interval: Yearly

- 1) Ensure system is near 23 °C (ambient temperature) and perform shutdown.
- 2) Exit program, shut down computer and remove power.
- 3) Remove top/rear cover.
- 4) Locate Chamber Fill cap (above chamber) and remove slowly.
- 5) Add distilled water until small plastic overflow tank is ½ full.
- 6) Replace Chamber Fill cap, see figure 4-1.
- 7) Replace top/rear cover.
- 8) Reconnect power.



Figure 4-1

4.3.2 Pre-saturator water change

Interval: Yearly

- 1) Power up system and ensure reservoir is full or fill with distilled water.
- 2) Exit program, shut down computer and remove power.
- 3) Locate presaturator drain. Bottom right rear of system, (looking from the front of the unit). Refer to figure 4-2.
- 4) Using 7/16" nut driver, remove drain cap and drain presaturator (approximately 200 ml).
- 5) Replace presaturator drain cap (tighten 1/8 turn max after finger tight).

- 6) Restore power and restart the 1200 ControlLog program. Allow presaturator to fill.
- 7) Top off reservoir with distilled water.
- 8) Operate system if desired or perform shutdown, exit program, and shut down computer.

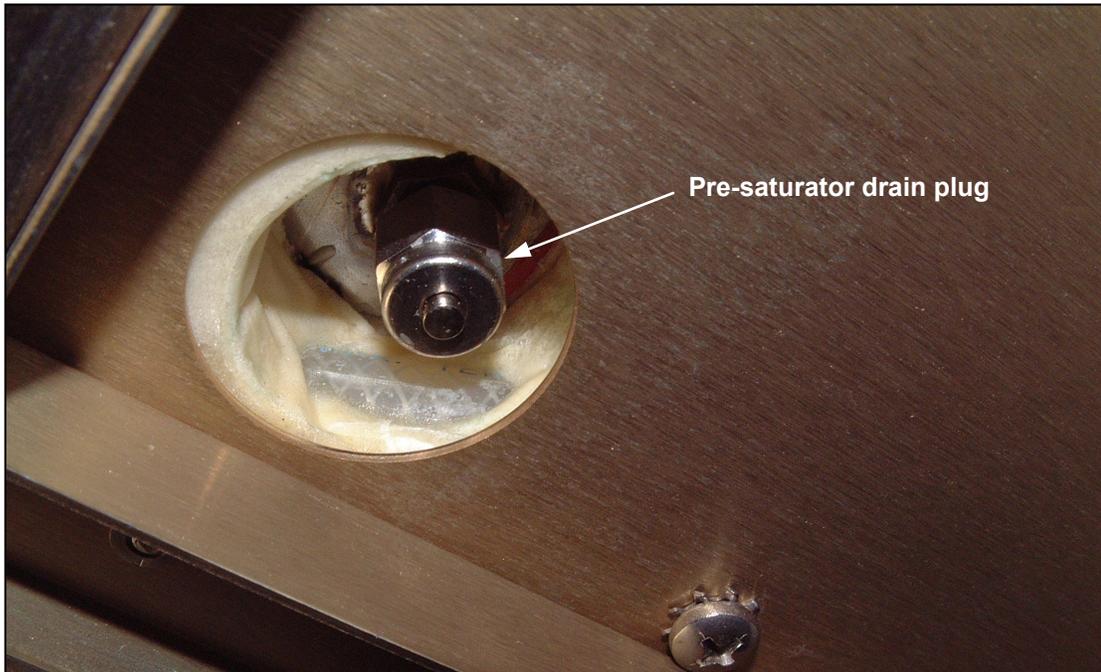


Figure 4-2

4.3.3 Cleaning thermoelectric unit and fan grill

Interval: Yearly

- 1) Remove power.
- 2) Remove top/rear cover.
- 3) Locate console thermoelectric unit and fan assembly (rear of unit).
- 4) Clean dust/lint build up on air intakes, thermoelectric heat-sink, and fan grills as necessary.
- 5) Replace top/rear cover.
- 6) Reconnect power.

4.3.4 Data Backup

Interval: After each calibration

It is recommended to perform a periodic backup on any user generated files such as data files, profiles, report files and especially calibration coefficients.

It is recommended to make a complete backup of the following directories:

- 1) C:\Program Files\Thunder Scientific\sysfiles
- 2) C:\Program Files\Thunder Scientific\datfiles

Warning: the user has full control as to where to save data and the above directory may not be the location they choose.

- 3) C:\Program Files\Thunder Scientific\profiles
- 4) C:\Program Files\Thunder Scientific\rptfiles

4.4 ERROR CODES and TROUBLE SHOOTING

<u>ERROR CODE</u>	<u>DESCRIPTION</u>
1	Supply Pressure Low
2	Reservoir Water Empty
4	Temperature Limit Exceeded (measured)
8	Presaturator Water Empty
16	Pressure Transducer (T1) Malfunction
32	Supply Pressure Transducer (T2) Malfunction
64	Valve Positioning Error

Error 1 - Supply Pressure Low

This indicates a supply pressure that is too low to generate the desired relative humidity (i.e., compressor fluctuations or malfunction). The computer will calculate the minimum humidity that can be generated and will adjust to that point.

If supply pressure remains low, check the operation of your air compressor. If your air compressor checks OK, inspect all facility supply line valves, filters, and regulators. If all facility components check OK, inspect supply input solenoid valve SOL1 for proper operation. Check the supply pressure transducer for proper operation and for proper calibration coefficients.

Error 2 - Reservoir Water Empty

If the reservoir level drops to empty during operation, the computer signals the operator.

Error 4 - Temperature Limit Exceeded

This error indicates that a measured value from one of the RTD's is outside allowable limits. If after 20 seconds, the error still exists, the system will shutdown automatically. **Diagnostics** may be initiated from the **Utilities** menu. 0 = Open and 111.11 = Short.

Error 8 - Presaturator Water Empty

This indicates that the presaturator has been unsuccessfully attempting to fill for an appreciable amount of time, causing an automatic system shutdown.

Error 16 - Pressure Transducer (T1)

This error indicates that the measured output of transducer T1 is either 10% greater than its full range or less than 10 psiA. The most likely cause is transducer malfunction. Pressure readings may be monitored at ambient pressure conditions by selecting **Pressure Calibration** from the **Window** drop-down menu.

Error 32 - Supply Pressure Transducer (T2)

This error indicates that the measured output of transducer T2 is either 10% greater than its full range or less than 0 psiG. The most likely cause is transducer malfunction. Pressure readings may be monitored at ambient pressure conditions by selecting **Pressure Calibration** from the **Window** drop-down menu.

Error 64 - Valve Positioning Error (Flow or Expansion)

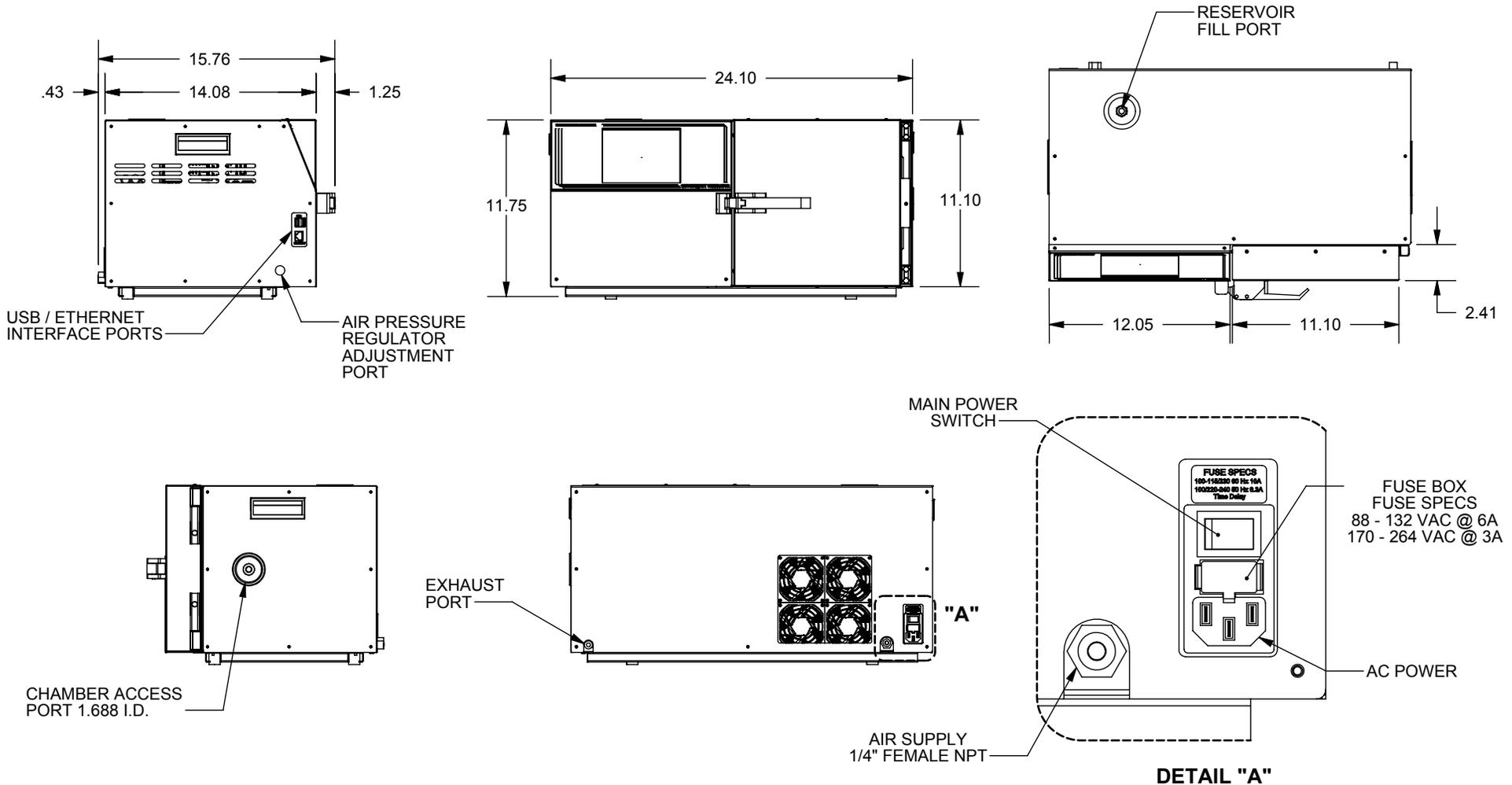
This error indicates either a malfunction occurred while attempting to "home" one of the stepper driven valves or that the Flow Valve V1 has hit a maximum open position. Possible stepper motor malfunction has occurred, or in the case of the maximum open position a wet flow meter.

Section 5

PARTS LISTS

Find #	Qty.	Description	Part Number
DC1	1	Power Supply, 24VDC	SP-500-24
DC2	1	Power Supply, +5/+12VDC	PD65A
DGHB	1	Board, DGH Interface Assembly	D03A12045
DGH1	1	Module, Thermistor Input	D5451
DGH2	1	Module, 4 Ch Analog to Digital	D5131
F1-4	4	Fan, Console	CR0824UB
FCB	1	Board, Fan Control	D03A12048
FUSE1	1	Fuse, 3A or 6A	FS3A or GDC-6.3A
H1	1	Heater, Foil (150W)	D03M12201
H2	1	Heater, Foil (22.0 ohm)	HK5161
H3	1	Heater, Foil (7.8 ohm)	HK5537
LCD	1	Display, 6.4" VGA TFT LCD	MINI-LCD2
LL1	1	Probe, Reservoir Liquid Level	D03A12041
LL2	1	Probe, PreSat Liquid Level	D03A12040
MCU	1	Unit, Main Computer	PCM9562
P1	1	Pump, Fluid	P893-10
PSAT	1	Presaturator	D03A12022
RCB	1	Board, Relay Control	D03A12038
REG	1	Regulator, Air Pressure	R72G2AKRMG
RES	1	Reservoir	D03A12009
RTD0-3	4	Sensor, Temperature	MINIPROBE
RV1	1	Valve, Relief	S4C-150
S1	1	Switch, Power	PEM-1205
SOL1	1	Valve, Solenoid	K243012
SOL2	1	Valve, Solenoid	K243040
SOL3	1	Valve, Solenoid	K243070
SOL4	1	Valve, Solenoid	K243016
T0	1	Transducer, Flow	EFM5700
T1	1	Transducer, System Pressure	PMP5014
T2	1	Transducer, Supply Pressure	S209
TE	1	Unit, Thermal Electric Cooling	TE-LC3606
TEC	1	Controller, Thermal Electric	TC-24-25RS232
TS	1	Screen, Touch	TSF-64-CC-120
TSC	1	Controller, Touch Screen	N16B-0558
UEB	1	Board, USB/Ethernet Interface	D03A12039
V1	1	Valve, Flow Assembly	D03A12031
V2	1	Valve, Expansion Assembly	D03A12033

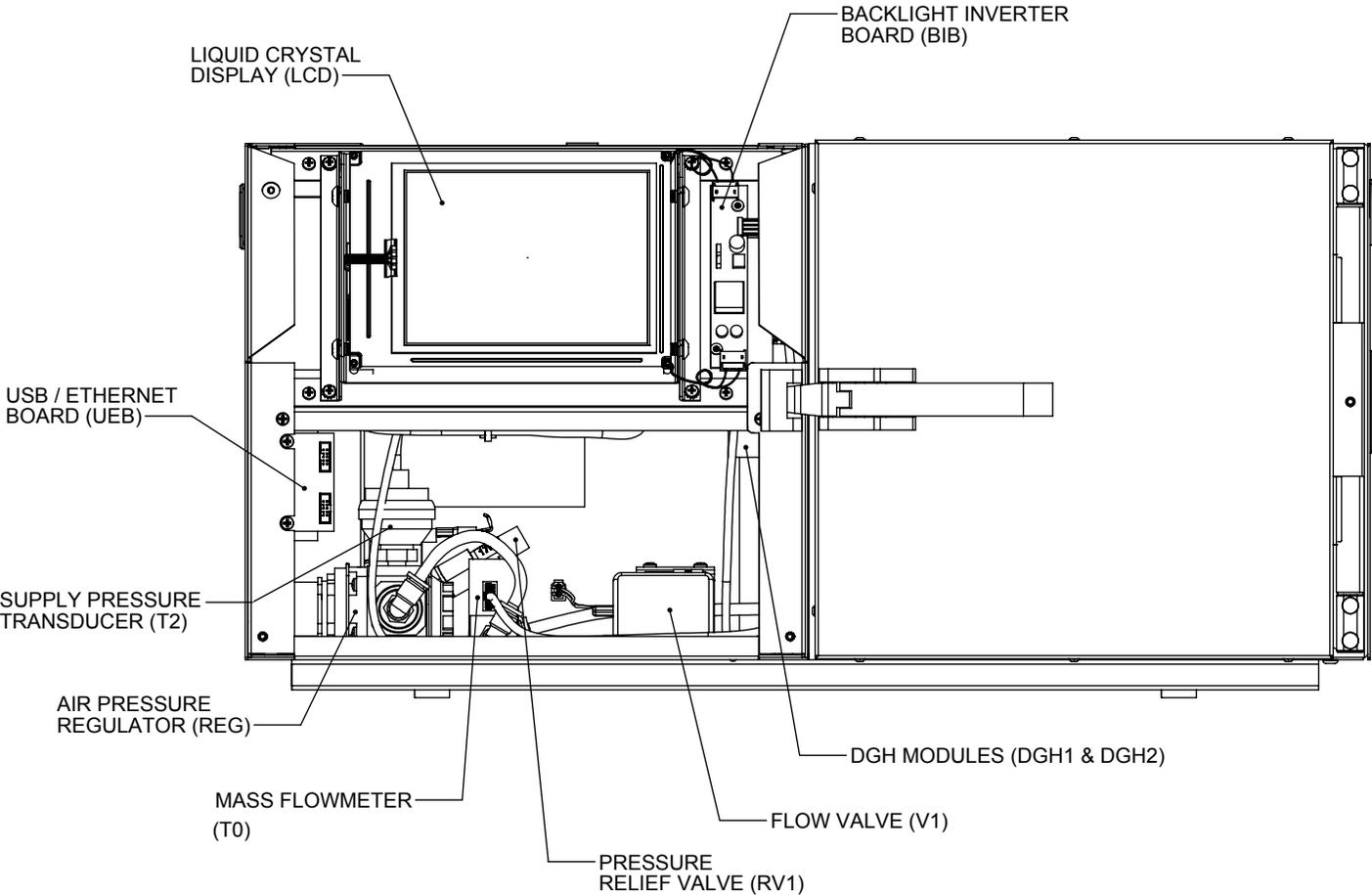
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DWF	A	Drawn to SW	5/14/2012	



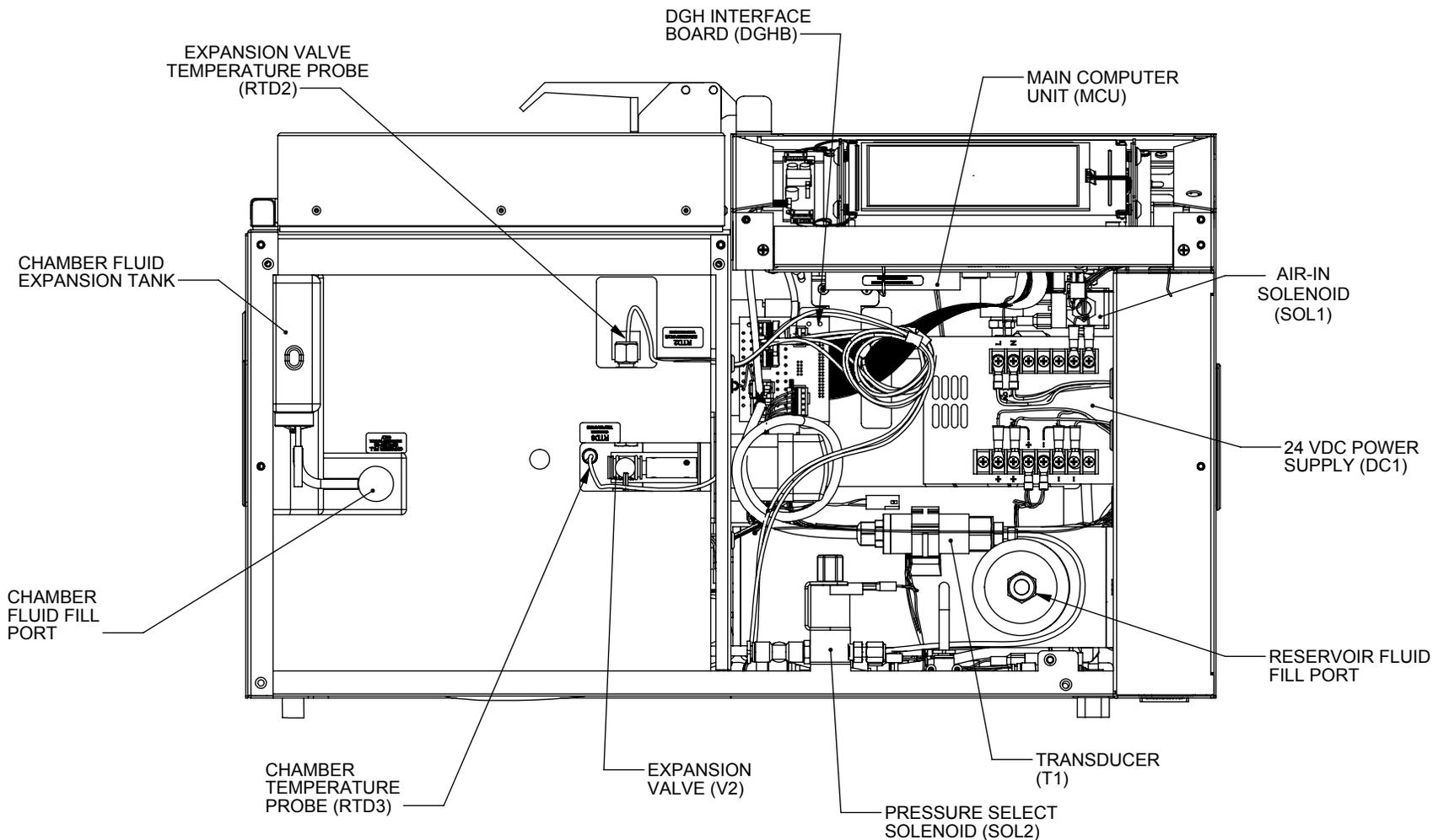
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					Mechanical / Utility Layout		
	1200	TOLERANCES .XXX ±.010 / ±.50° UNLESS NOTED OTHERWISE		DRAWN SANCHEZ 3/18/2004 CHECKED <i>MG</i> 3/30/2004 ISSUED <i>DWF</i> 3/30/2004	SIZE A SCALE 1 : 10	DWG. NO. 03D12901 WT. 61.49	REV A SHEET 1 OF 1

REVISIONS				
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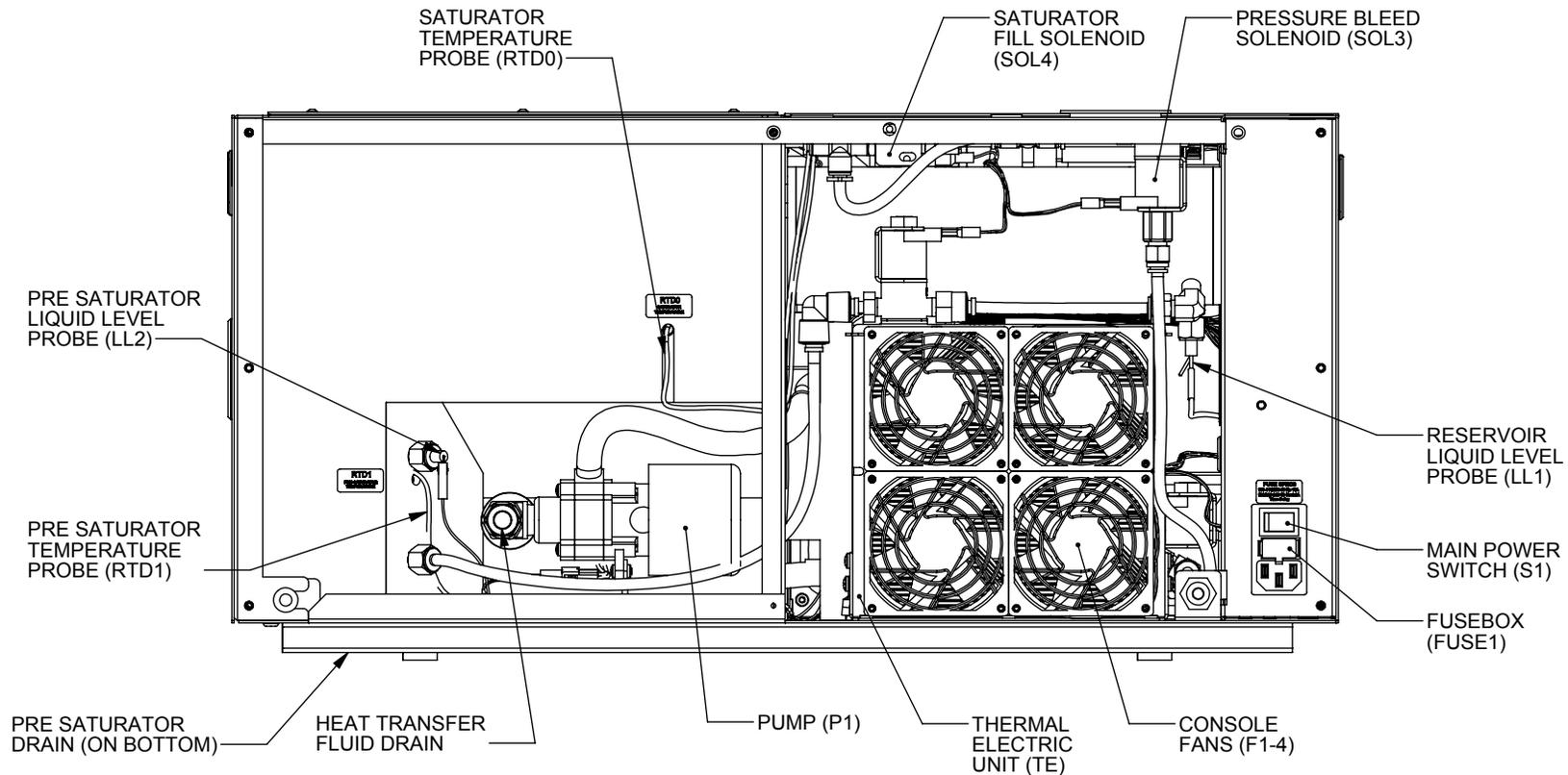
Note: Not Used After 11-24-2014



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					Component Location Diagram		
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NEXT ASSY	USED ON			SCALE 1 : 4	WT. 61.61	SHEET 1 OF 3	
APPLICATION							

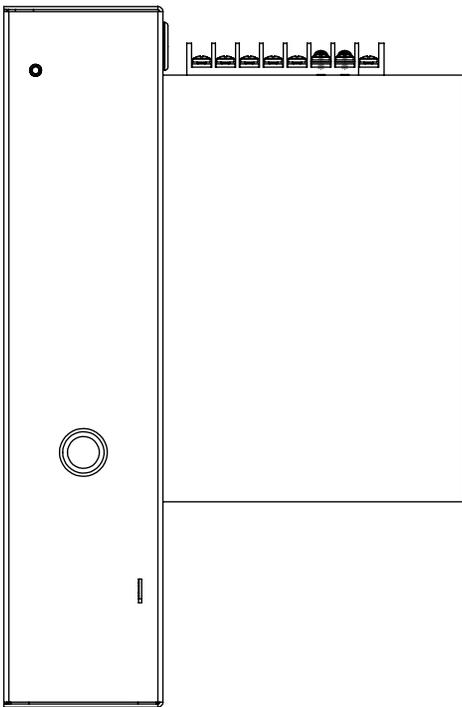
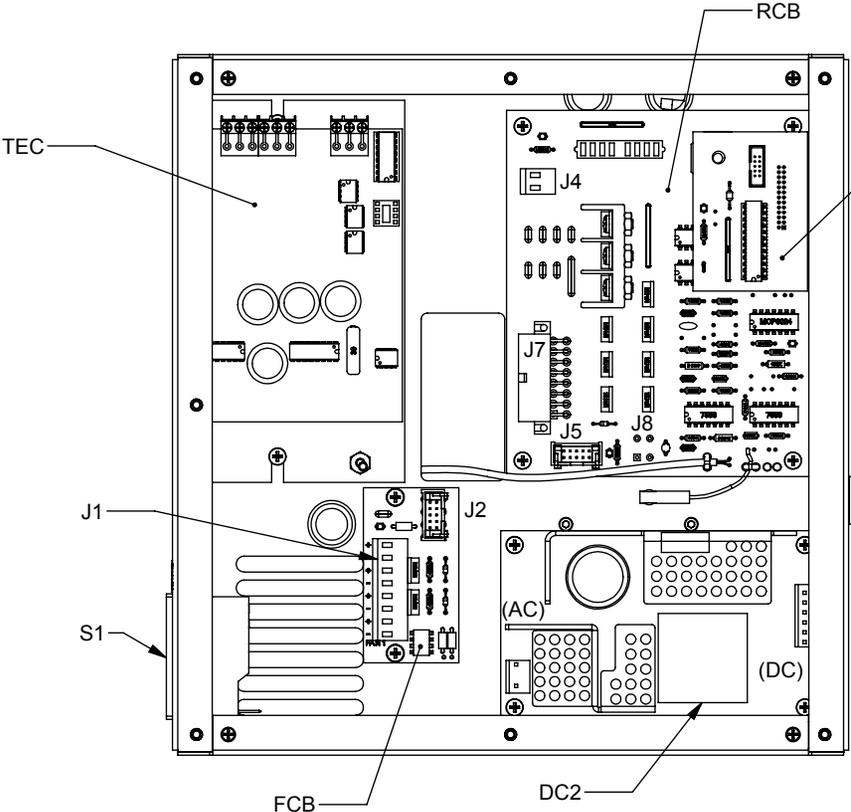
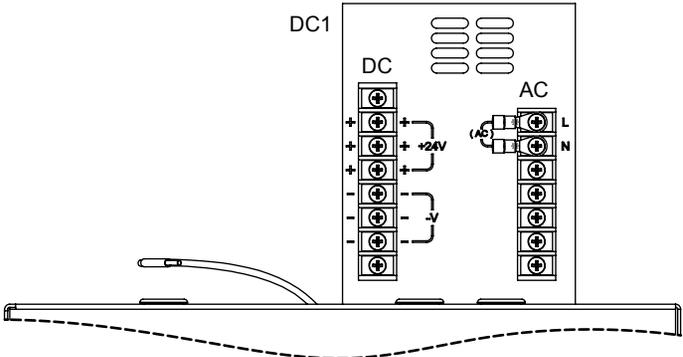


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					Component Location Diagram		
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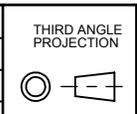


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APPLICATION		UNLESS NOTED OTHERWISE	ISSUED	<i>LMF</i>	3/30/2004	SCALE: 1 : 4		WT. 61.61
						SHEET 3 OF 3		

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Added URIB - Drawn to SW	5/17/2012	<i>[Signature]</i>



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APPLICATION	

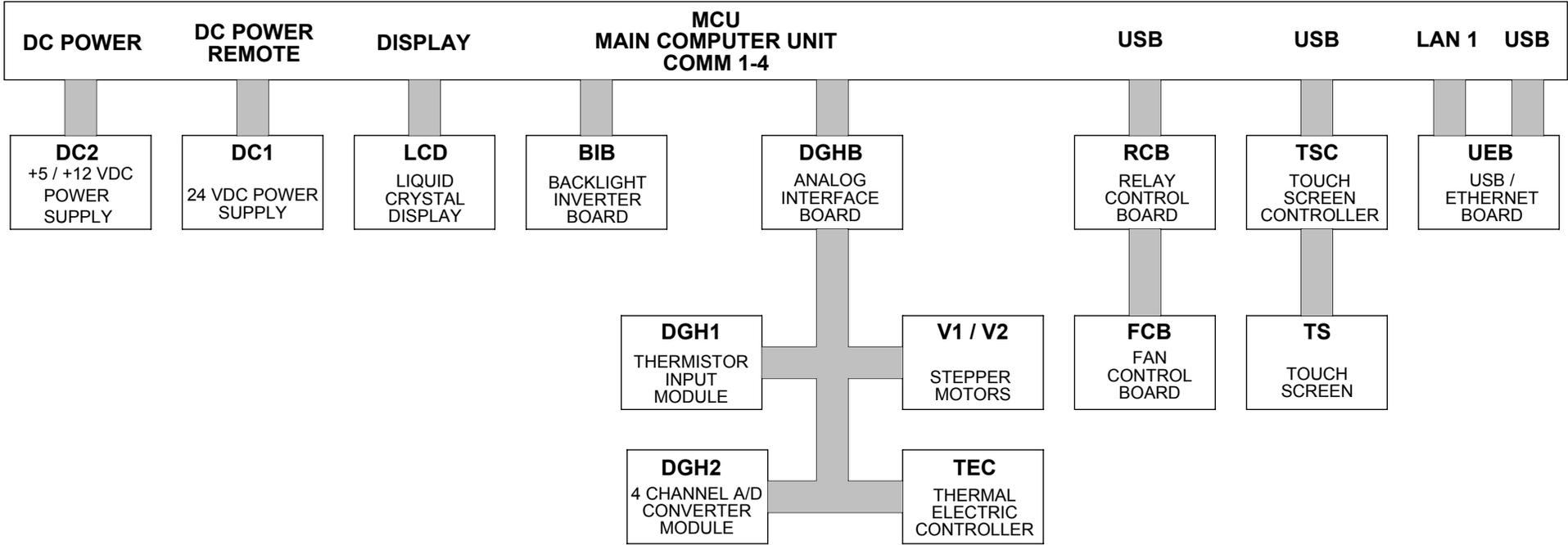


TOLERANCES
 .XXX ±.010
 / ±.50°
 UNLESS NOTED OTHERWISE

PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		
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ISSUED	<i>[Signature]</i>	3/30/2004

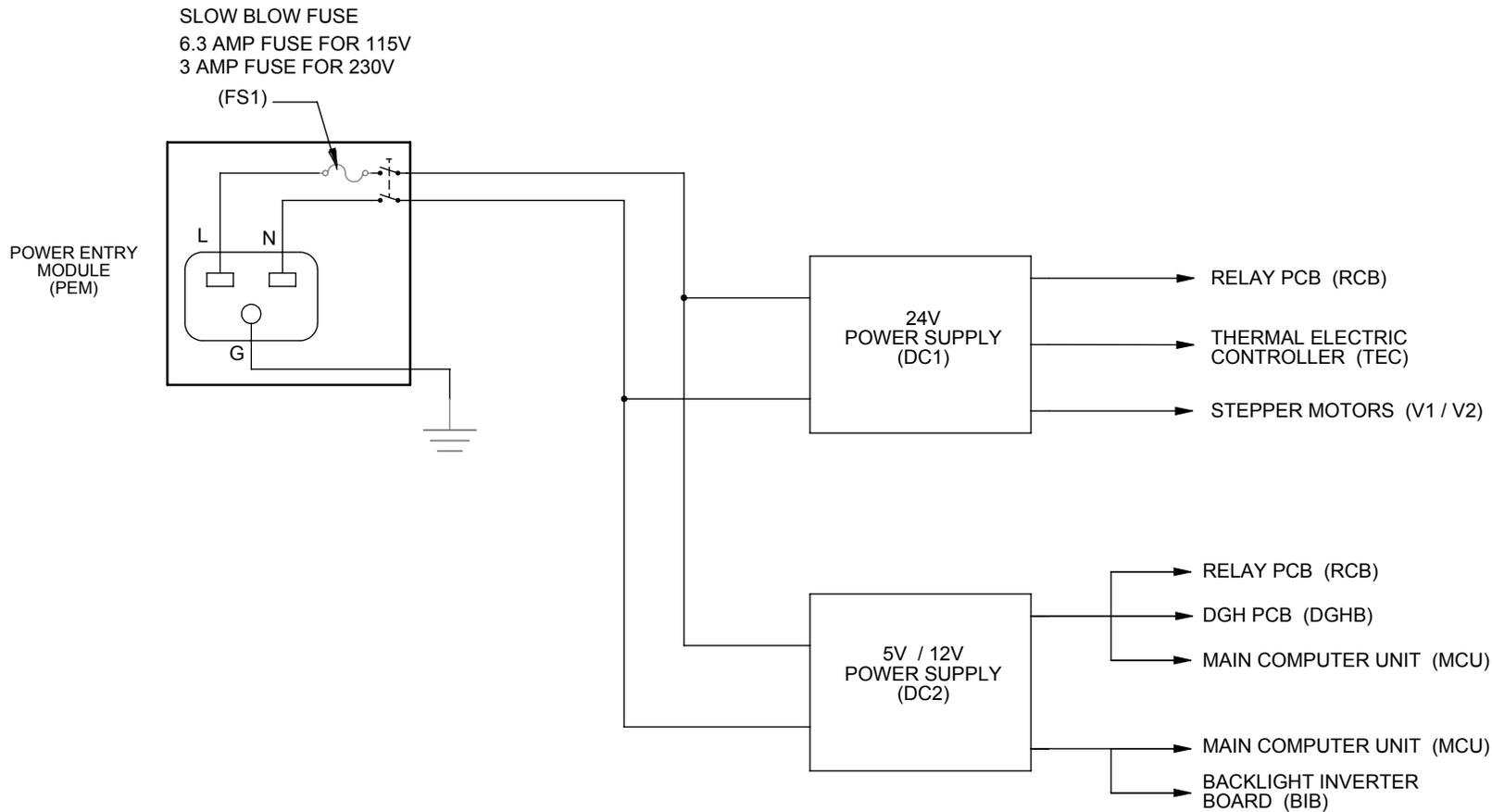
Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123		
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REVISIONS				
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DWF	A	Added V1 & V2 Module - Drawn to SW - Added USB	9/27/2010	<i>MJK</i>



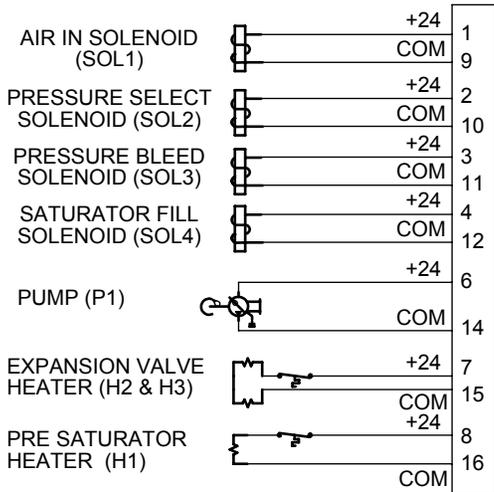
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					Computer Control Schematic		
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		.XXX ±.010	CHECKED	<i>MJK</i>	3/30/2004		DWG. NO.
		UNLESS NOTED OTHERWISE	ISSUED	<i>AMF</i>	3/30/2004		REV
NEXT ASSY		USED ON			3/30/2004		A
APPLICATION						SCALE	WT.
						SHEET 1 OF 1	

REVISIONS				
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DWF	A	Corrected Switch Diagram - Drawn to SW	9/13/2011	<i>MJE</i>

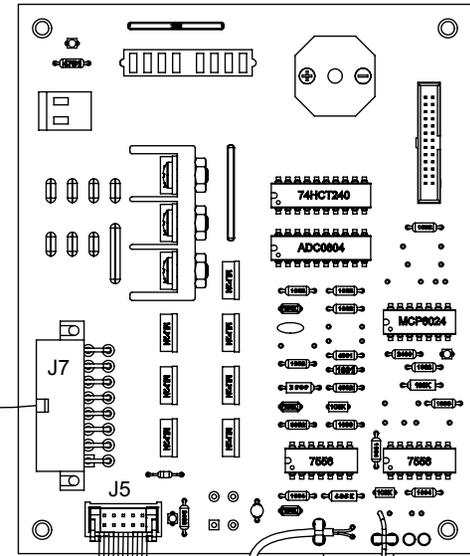


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					Main Power Schematic		
	1200	TOLERANCES .XX ±.010 ±.50° UNLESS NOTED OTHERWISE		DRAWN SANCHEZ 7/14/2005 CHECKED <i>BB</i> 7/14/2005 ISSUED <i>AMF</i> 2/7/2006	SIZE A SCALE N/A	DWG. NO. 03S12905 WT. N/A	REV A SHEET 1 OF 1
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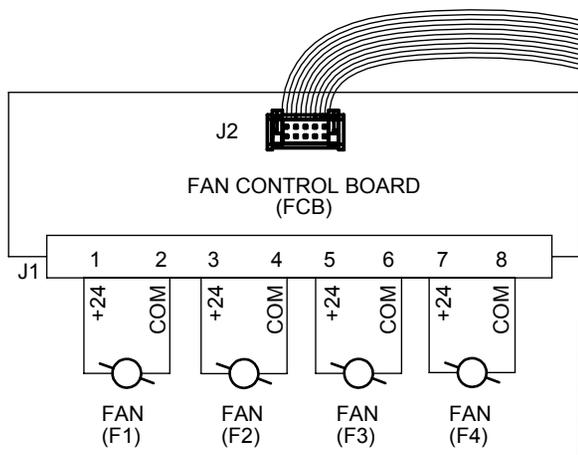
REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Drawn to SW	5/18/2012	



RELAY CONTROL BOARD (RCB)



RESERVOIR LIQUID LEVEL PROBE (LL1)
 PRE SATURATOR LIQUID LEVEL PROBE (LL2)



	1200
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION

PROPRIETARY NOTICE
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TOLERANCES
 .XXX ±.010
 / ±.50°
 UNLESS NOTED OTHERWISE

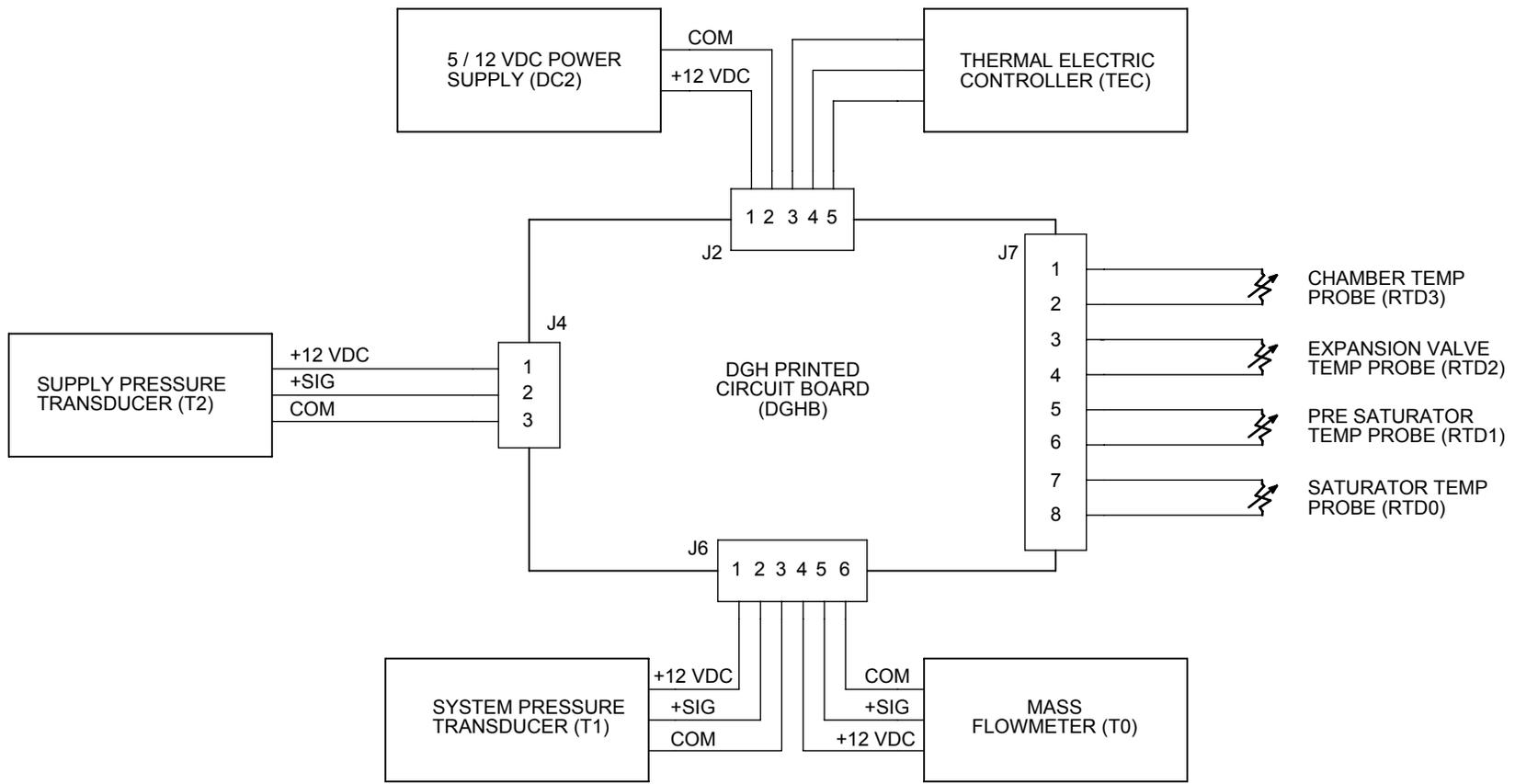
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CHECKED	<i>MG</i>	3/30/2004
ISSUED	<i>DMF</i>	3/30/2004

Thunder Scientific Corporation
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Heater / Pump / Solenoid Schematic

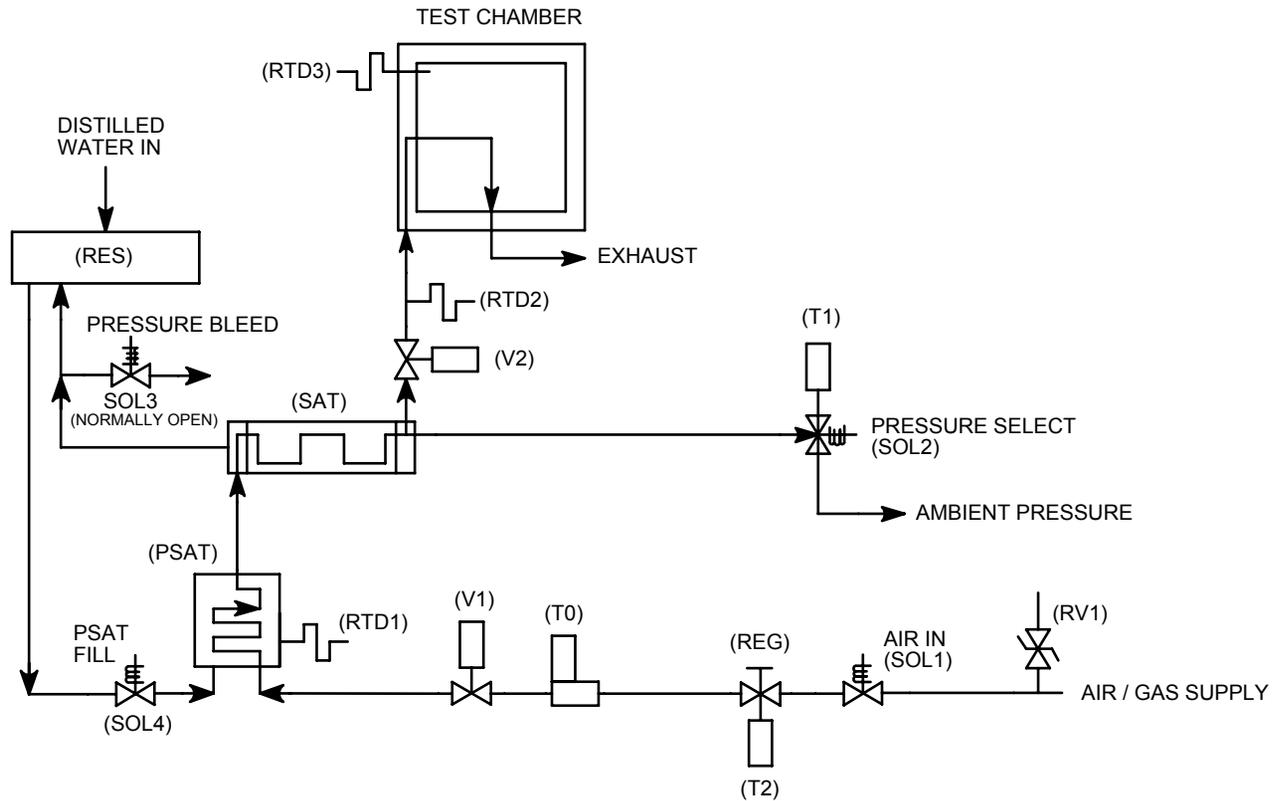
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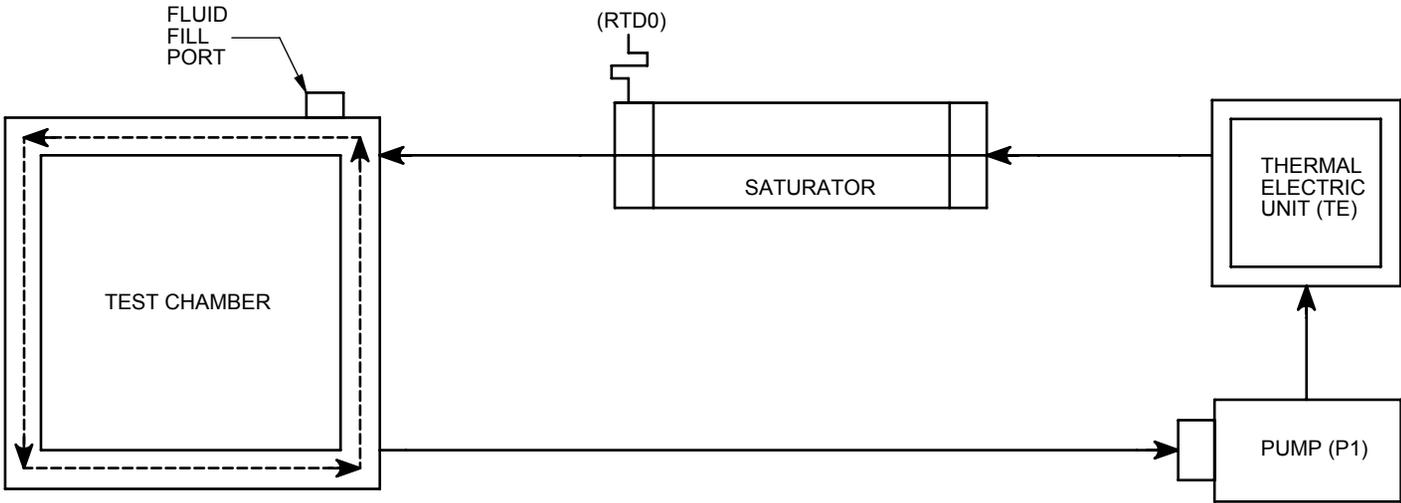
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			TOLERANCES .XXX ±.010 / ±.50° UNLESS NOTED OTHERWISE		DRAWN SANCHEZ 3/24/2004 CHECKED <i>MG</i> 3/30/2004 ISSUED <i>DWF</i> 3/30/2004	Temp Probe/Transducer Schematic	
NEXT ASSY	USED ON	1200			SIZE A	DWG. NO. 03S12907	REV A
APPLICATION					SCALE NTS	WT.	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Drawn to SW	5/21/2012	



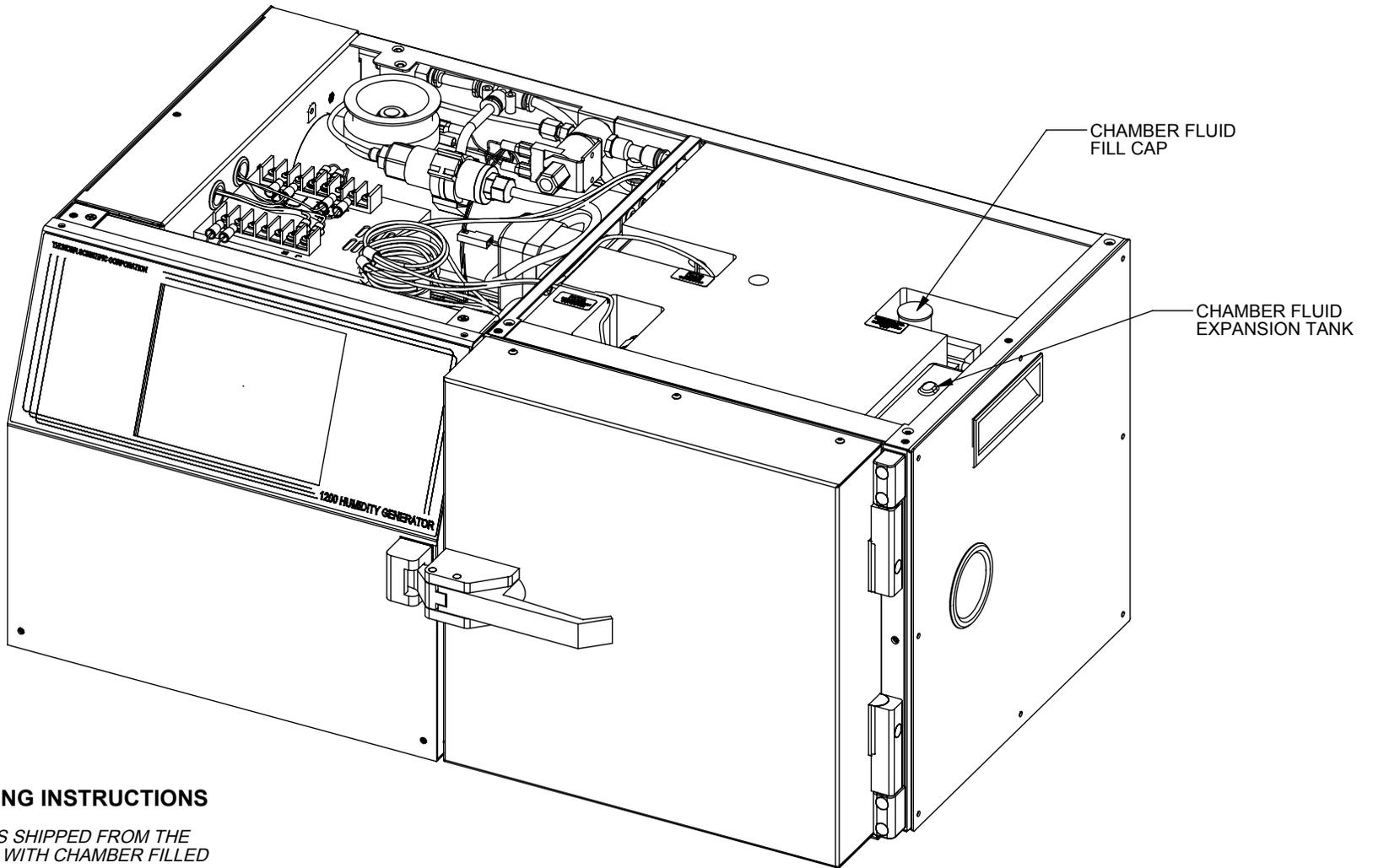
		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123		
					Pneumatic System Schematic		
1200		TOLERANCES .XXX ±.010 / ±.50° UNLESS NOTED OTHERWISE		DRAWN FISCHER 2/17/2004 CHECKED <i>MG</i> 3/30/2004 ISSUED <i>DWF</i> 3/30/2004	SIZE A SCALE NTS	DWG. NO. 03S12908 WT.	REV A SHEET 1 OF 1
NEXT ASSY	USED ON	APPLICATION					

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Drawn to SW	5/21/2012	



		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123		
					Heat Transfer Fluid Schematic		
	1200	TOLERANCES .XXX ±.010 ±.50° UNLESS NOTED OTHERWISE		DRAWN FISCHER 2/17/2004 CHECKED <i>MG</i> 3/30/2004 ISSUED <i>DMF</i> 3/30/2004	SIZE A DWG. NO. 03S12909 SCALE NTS	WT. REV A	SHEET 1 OF 1
NEXT ASSY	USED ON	APPLICATION					

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Drawn to SW	5/21/2012	



CHAMBER FILLING INSTRUCTIONS

NOTE: SYSTEM IS SHIPPED FROM THE FACTORY WITH CHAMBER FILLED

THE 1200 REQUIRES APPROXIMATELY 1 GALLON OF DISTILLED WATER AS A HEAT TRANSFER FLUID.

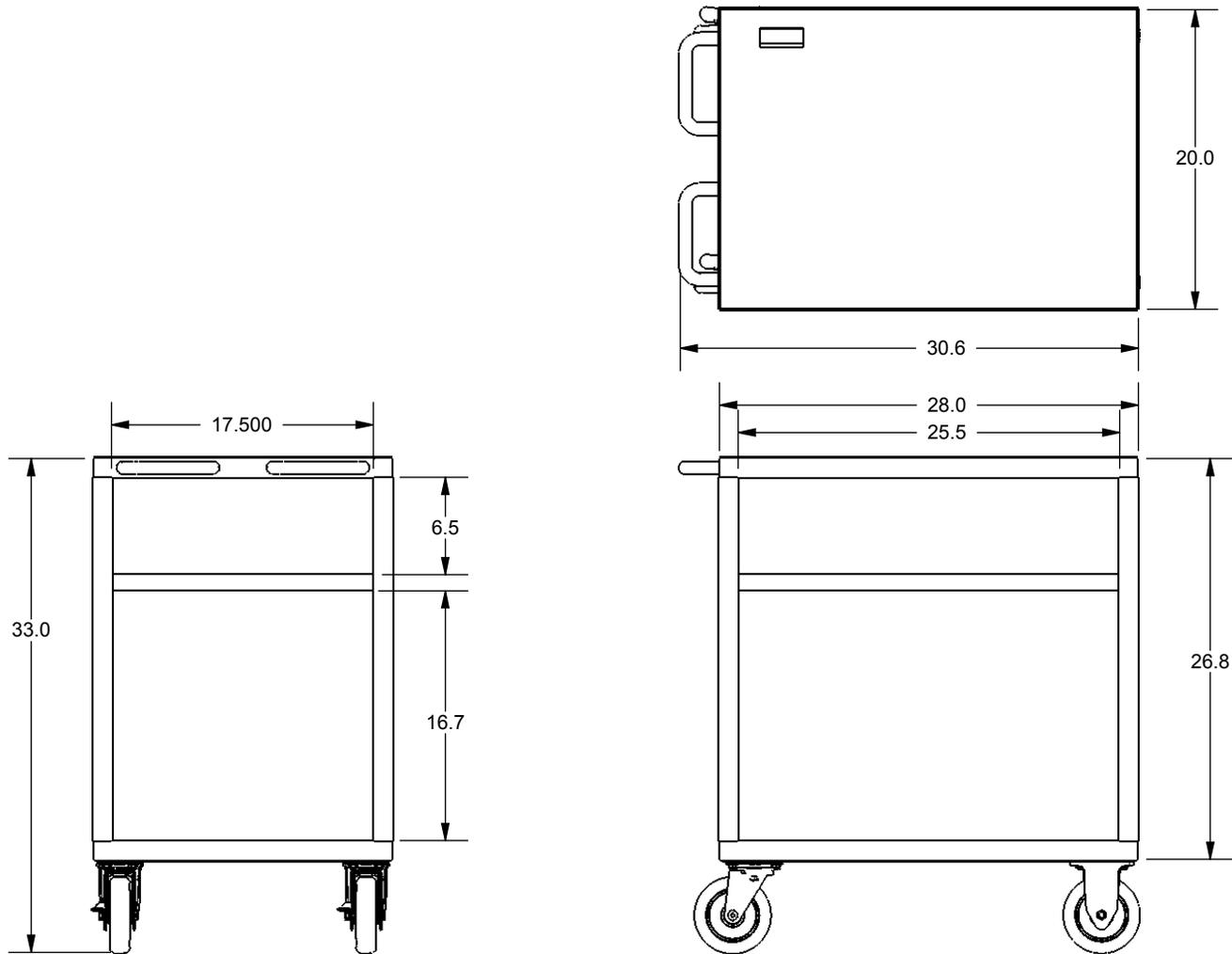
1. REMOVE TOP / REAR COVER
2. REMOVE CHAMBER FLUID FILL CAP
3. FILL WITH DISTILLED WATER TO BOTTOM OF FILL PORT.
4. REPLACE CHAMBER FLUID FILL CAP
5. REPLACE TOP / REAR COVER

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					Chamber Fluid Fill Instructions			
	1200	TOLERANCES	DRAWN	SANCHEZ	3/30/2004	SIZE	DWG. NO.	REV
NEXT ASSY	USED ON	.XXX ±.010	CHECKED		3/30/2004	A	03D12910	A
APPLICATION		UNLESS NOTED OTHERWISE	ISSUED		3/30/2004	SCALE 1 : 4	WT. 61.53	SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2009
3. ALL UNITS ARE INCHES U.N.O.

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
DWF	A	Drawn to SW	6/3/2014	

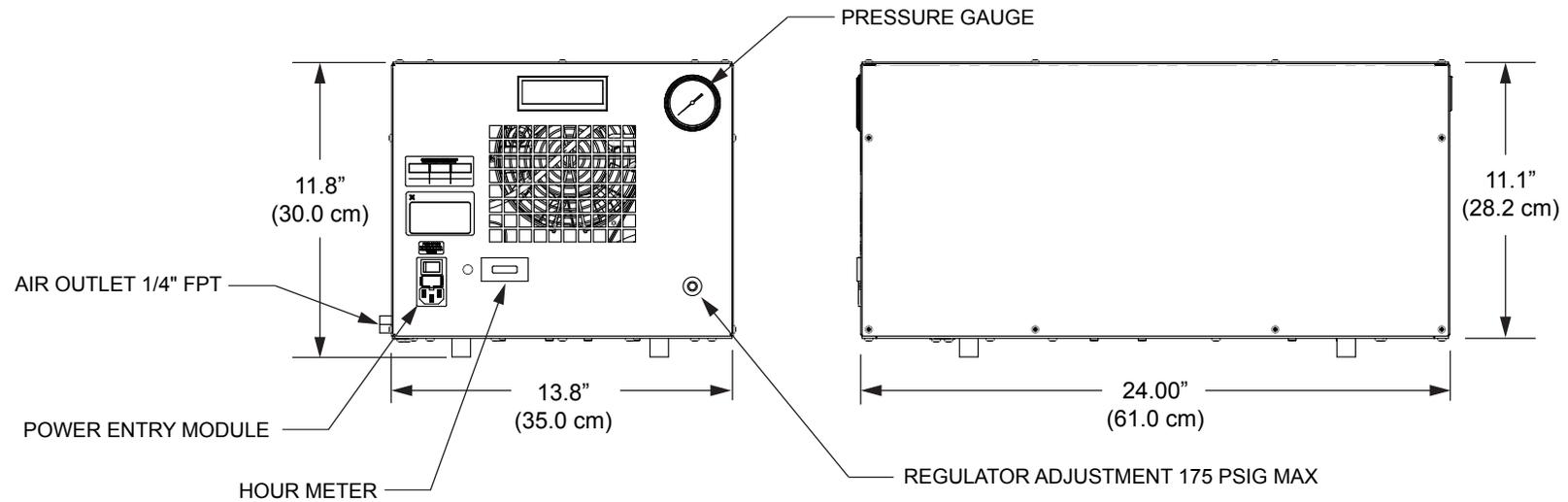
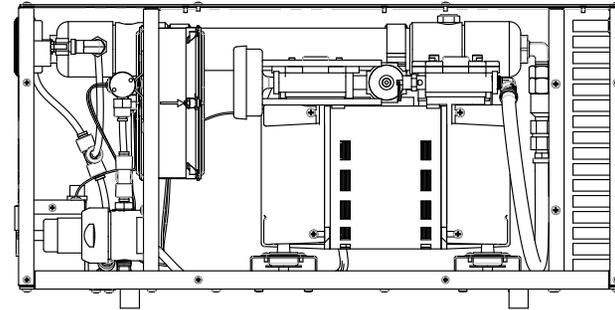


		THIRD ANGLE PROJECTION	PROPRIETARY NOTICE THIS DRAWING AND INFORMATION CONTAINED WITHIN IS PROPRIETARY TO THUNDER SCIENTIFIC AND CANNOT BE COPIED OR REPRODUCED WITHOUT SPECIFIC WRITTEN PERMISSION		Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123		
					1200 Cart Dimensions		
	1200	TOLERANCES .XXX ±.010 / ±.50° UNLESS NOTED OTHERWISE		DRAWN Sanchez 8/7/2006 CHECKED 11/9/2006 ISSUED 11/9/2006	SIZE A SCALE: 1 : 12	DWG. NO. 05D12913 WT. 74.95	REV A SHEET 1 OF 1
NEXT ASSY	USED ON	APPLICATION					

NOTES:

1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2009

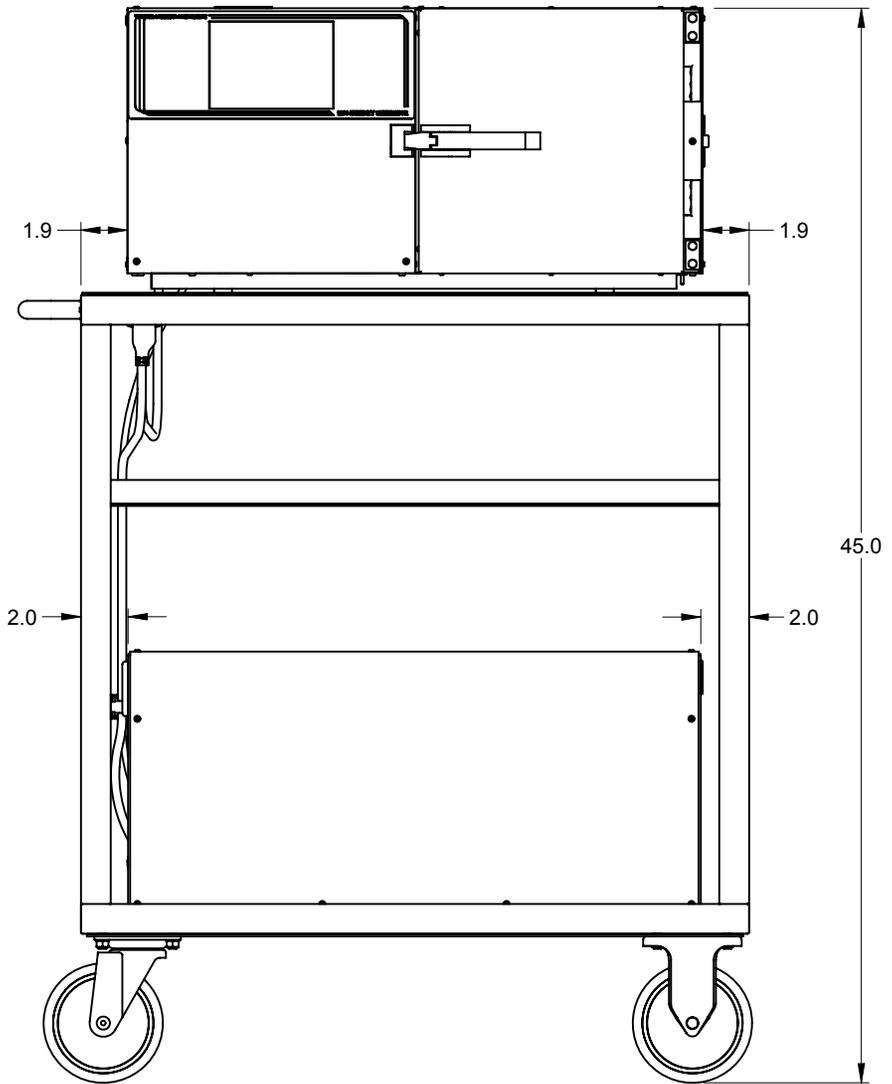
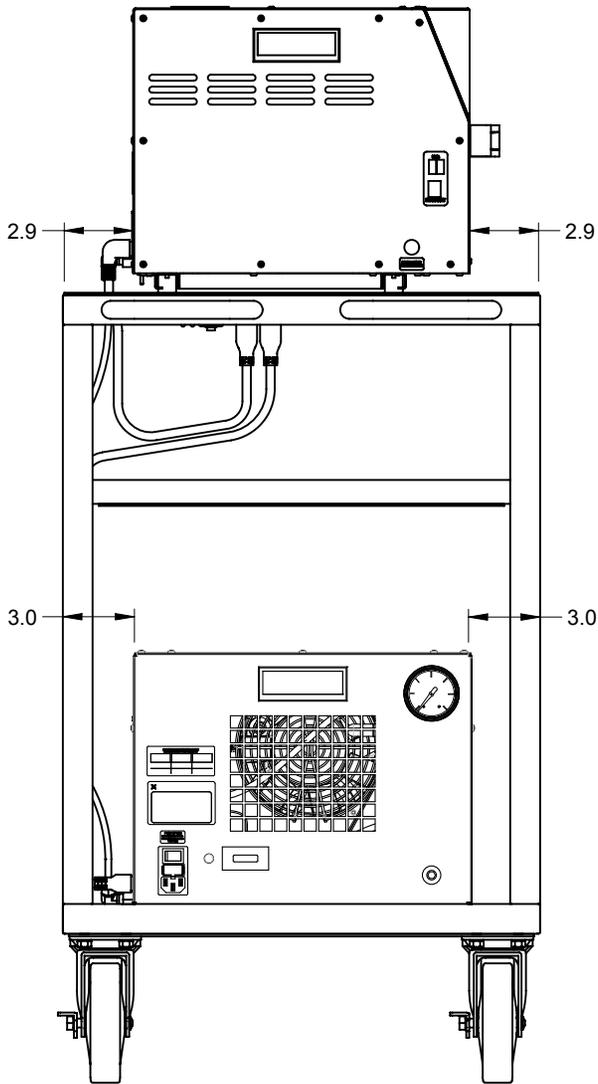
REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED



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			TOLERANCES .XXX ±.010 / ±.50° UNLESS NOTED OTHERWISE		DRAWN FURRY 4/7/2014 CHECKED <i>JB</i> 4/11/2014 ISSUED <i>DuF</i> 4/11/2014	ACS1210 Mechanical Utility Layout	
NEXT ASSY	USED ON		SIZE A DWG. NO. 06D12914 SCALE N/A	REV A WT. N/A	SHEET 1 OF 1		
APPLICATION							

FOR DETAILED ASSEMBLY INSTRUCTIONS REFER TO:

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED



NOTES :

1. INTERPRET DRAWING PER ASME Y14.100-2004
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. ALL UNITS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

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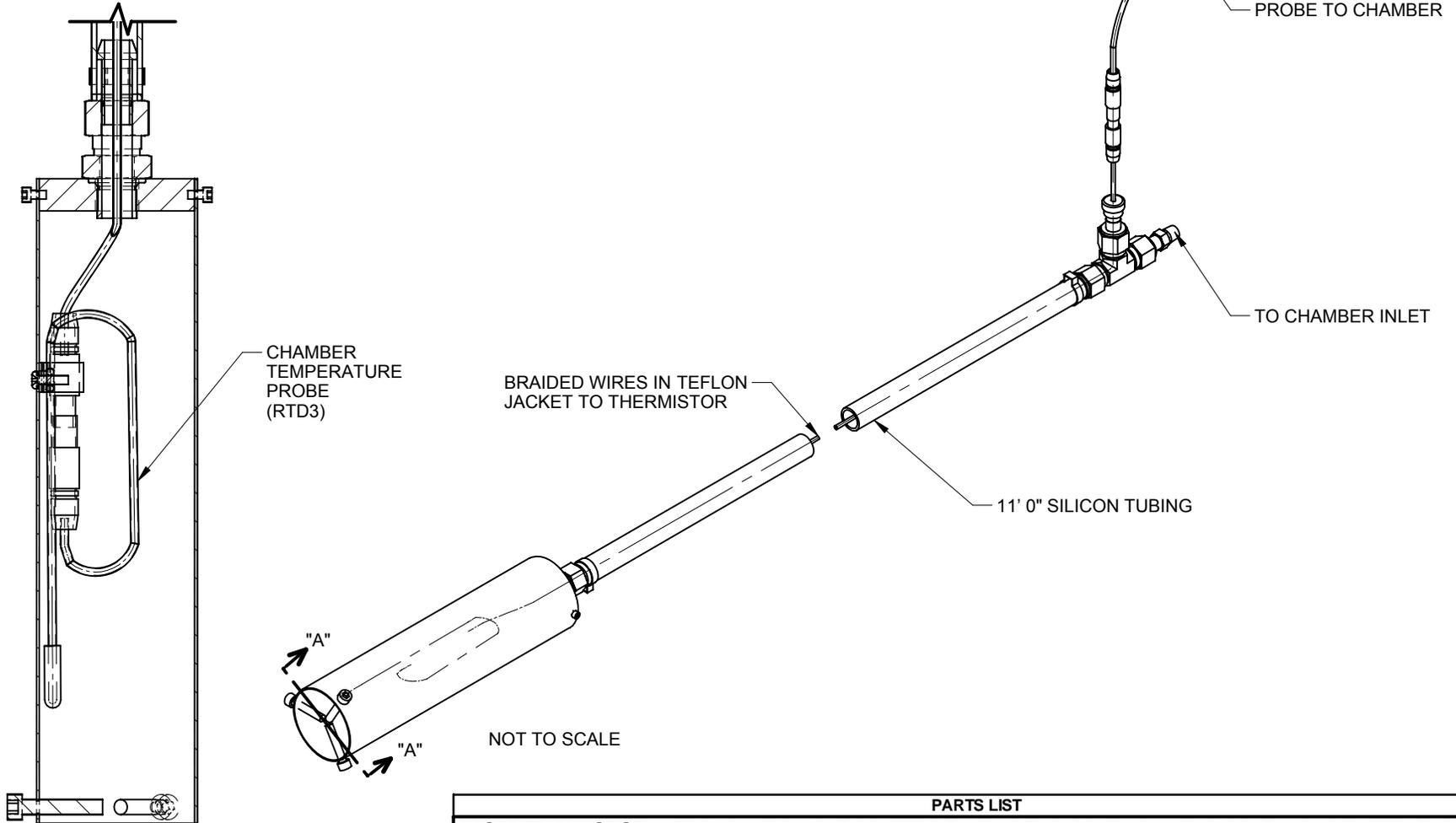
		TOLERANCES .X ± .015 .XX ± .010 .XXX ± .005 / ±/-.050° <small>UNLESS OTHERWISE SPECIFIED</small>	PRODUCTION DESIGNATION	THIRD ANGLE PROJECTION	Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123-3198
NEXT ASSY	USED ON		DRAWN Sanchez	DATE '06/11/09	
APPLICATION	FINISH	TREATMENT	CHECKED <i>BB</i>	'06/11/10	DWG SIZE A DWG NO. 06D12915 REV A
			ISSUED <i>LMF</i>	'06/11/10	SCALE 1 : 8 WEIGHT SHEET 1 OF 1

NOTES :

1. INTERPRET DRAWING PER ASME Y14.100-2004
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994
3. INTERPRET WELDS PER AWS A2.4:2007
4. ALL UNITS ARE IN INCHES UNLESS OTHERWISE SPECIFIED
5. REMOVE ALL BURRS AND SHARP EDGES
6. TREATMENT :
7. FINISH :
8. OPTION CODE EHC = EXTERNAL HUMIDITY CALIBRATION ACCESSORY

FOR DETAILED ASSEMBLY INSTRUCTIONS REFER TO: NONE

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED



SECTION "A"- "A"

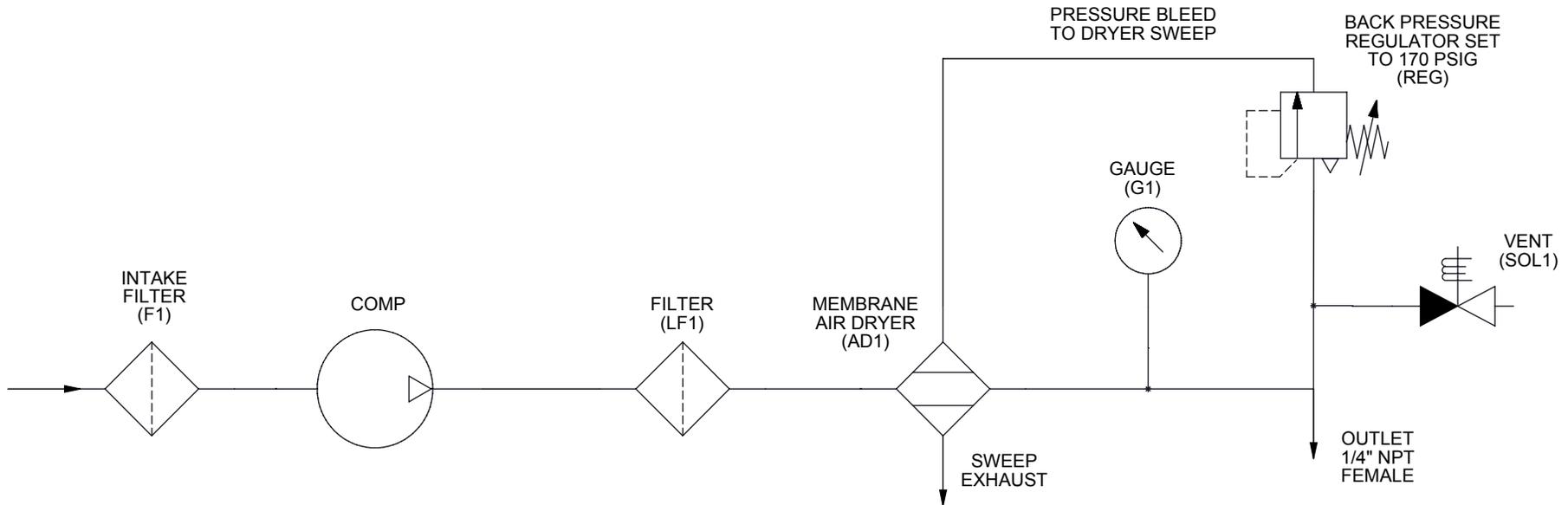
PARTS LIST									
PROPRIETARY NOTICE: This Drawing and Information Contained Within is Proprietary to Thunder Scientific and cannot be Copied or Reproduced without Written Permission									
07A12061	1200-EHC								
NEXT ASSY	USED ON								
APPLICATION	FINISH								

TOLERANCES	PRODUCTION DESIGNATION	THIRD ANGLE PROJECTION	Thunder Scientific Corporation
.X ± .015	NONE		623 Wyoming S.E. Albuquerque, NM 87123-3198
.XX ± .010	DRAWN Furry		EHC-10 Remote Calibration Assembly
.XXX ± .005	CHECKED BB		DWG NO. 07D12916
	ISSUED MWF		REV
			SCALE 1:4
			WEIGHT
			SHEET 1 OF 1

NOTES:

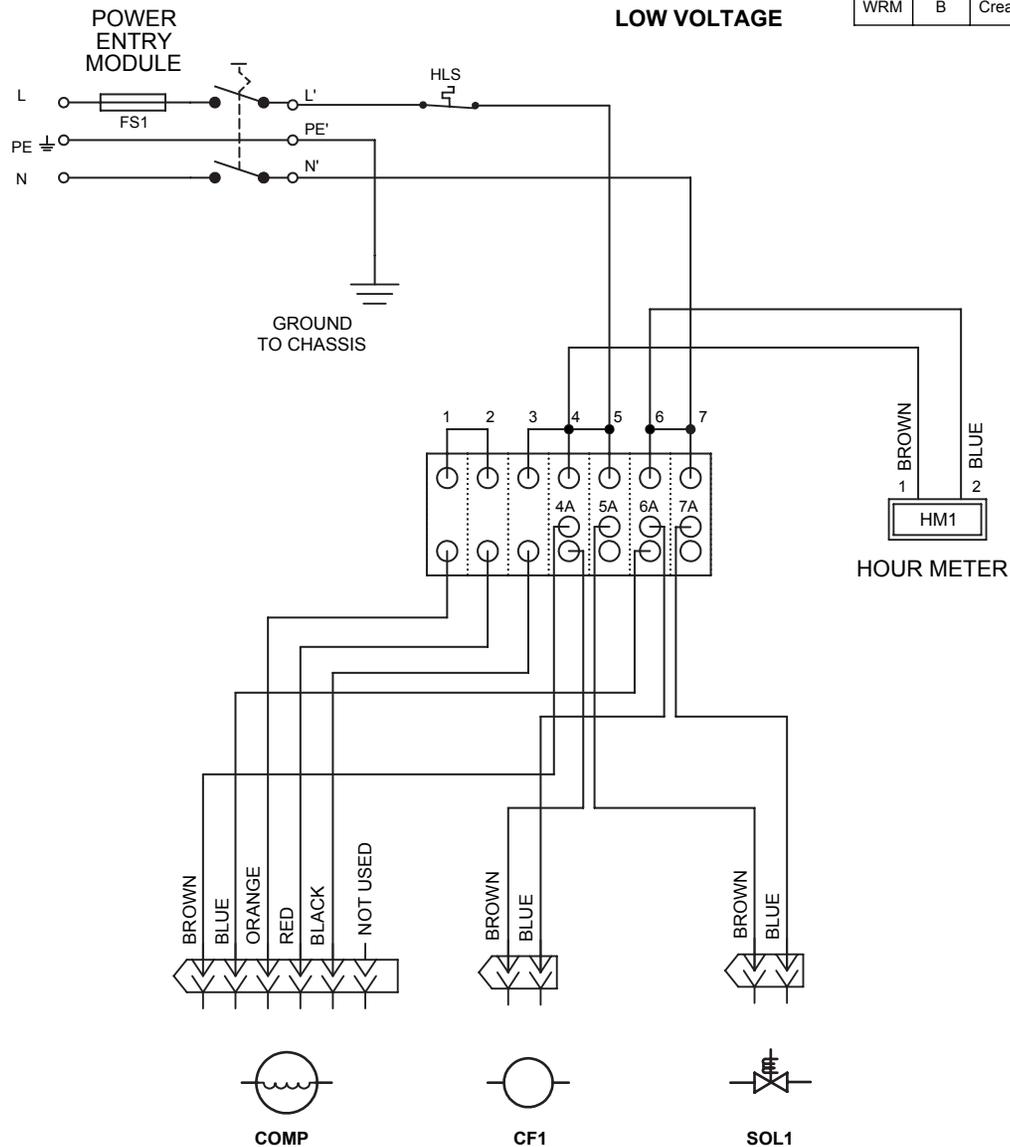
1. INTERPRET DRAWING PER ASME Y14.100-2013
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5-2009

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED



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		TOLERANCES .XXX ±.010 ∠ ±.50° UNLESS NOTED OTHERWISE	DRAWN	FURRY	4/10/2014		SIZE A	DWG. NO. ACS12030	REV -		
NEXT ASSY	USED ON		CHECKED	<i>ZB</i>	4/11/2014						
APPLICATION			ISSUED	<i>Duf</i>	4/11/2014		SCALE	N/A	WT.	N/A	SHEET 1 OF 1

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
WRM	B	Created Seperate 110V Drawing	11/23/2015	Duf



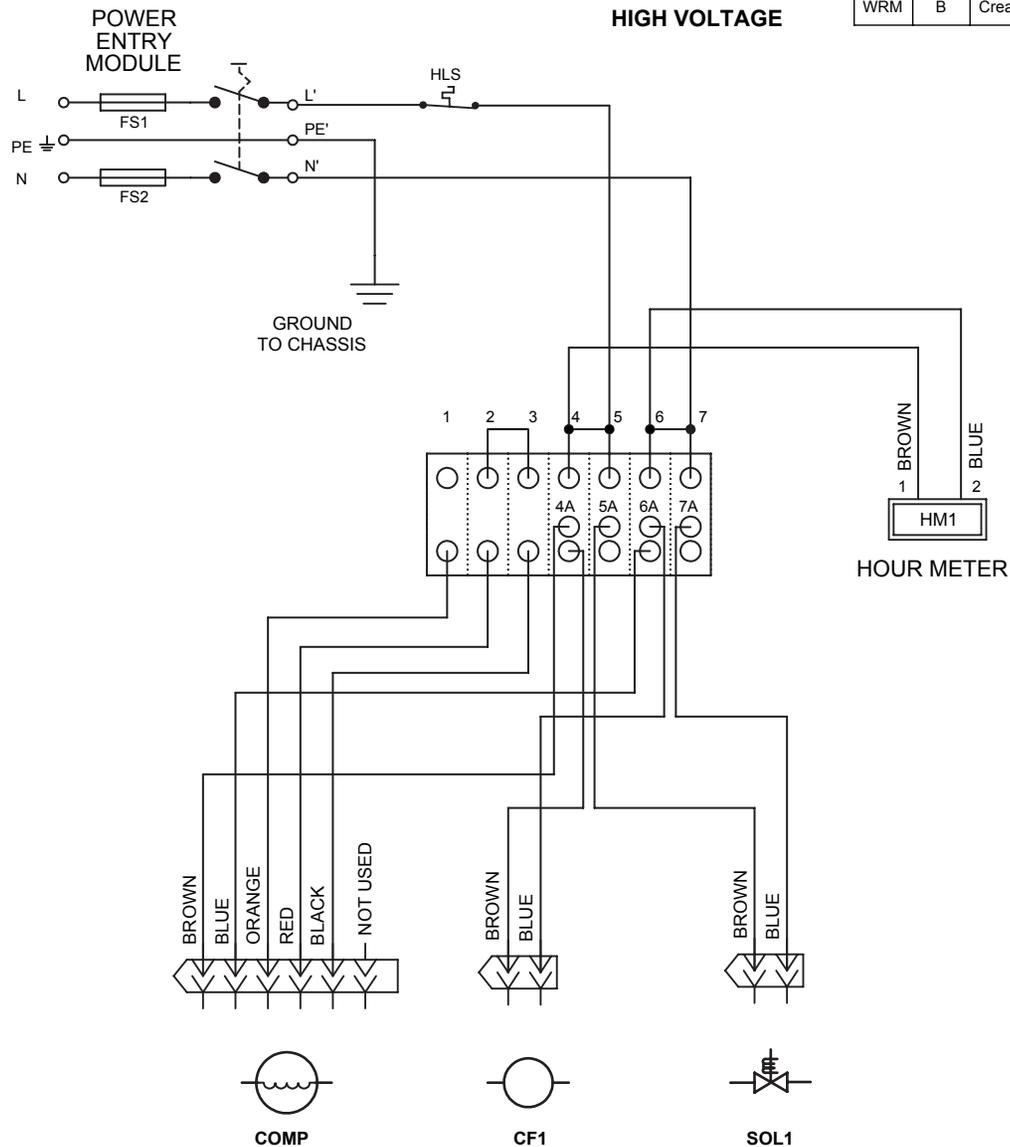
	1210
NEXT ASSY	USED ON
APPLICATION	

THIRD ANGLE PROJECTION
TOLERANCES
.XXX ±.010
UNLESS NOTED OTHERWISE

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DRAWN FURRY	4/10/2014
CHECKED <i>BF</i>	4/11/2014
ISSUED	4/11/2014

Thunder Scientific Corporation			
623 Wyoming S.E. Albuquerque, NM 87123			
ACS1210 Electrical Schematic 110			
SIZE A	DWG. NO. ACS12001_01	REV B	
SCALE N/A	WT. N/A	SHEET 1 OF 1	

REVISIONS				
DWN	REV.	DESCRIPTION	DATE	APPROVED
WRM	B	Created Seperate 220V Drawing	12/07/2015	Duf



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					ACS1210 Electrical Schematic 220	
1210		TOLERANCES	DRAWN FURRY	4/10/2014	SIZE A	DWG. NO. ACS12001_02
NEXT ASSY	USED ON	.XXX ±.010	CHECKED BF	4/11/2014	SCALE N/A	WT. N/A
APPLICATION		UNLESS NOTED OTHERWISE	ISSUED	4/11/2014	REV B	SHEET 1 OF 1

System Authorization Code:

[1200]

This code was designed to prevent unauthorized personnel access to the calibration coefficients.

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