3 SRP INITIAL SET-UP

Each SRP consists of a separate optical bench and two instrumentation modules (electronics and pneumatics). Modules are interfaced through the Peripheral Component Interconnect (PCI) control cards interface cable, to the PC, and SRP Control Program for Windows NT/2000/XP Version 4.4.1, Windows-based VisualBASIC™ software and allow for unattended tests runs. The new dual manifold sampling configuration allows the SRP and up to three guest instruments to be connected at any one time using the same sample and reference gas streams side-by-side.

SRP-10 with 3 guest instruments

3.1 Equipment and Supplies Needed

STOLabs PL-30^{o}C or 100^{o}C temperature source (Calibration suggested **once every two years**.)
STOLab calibrators have been in use from the very beginning of the O_3 program. Some operators have reported that their calibrator has been unchecked for several years. Because of the cost of recertification of a single calibrator, a comparison can be made to a recently certified calibrator. If the differences between the two calibrators are less than the established limits for the SRP then the calibrator can be used for another year. If it fails, it should be returned promptly to StowLab for repairs.

Voltmeter (Accurate to ±0.1 mV, **NIST traceable annually**)

Pressure standard (Druck DPI-705 or equivalent, Accurate to ±0.1 millibar (mb) **NIST traceable annually**)

Temperature standard (Accurate to ±0.1 °C, **NIST traceable annually**) NOTE: The StowLab is the calibration for the RTD that reads the temperature of the sample and is the most critical temperature measurement. The temperature of the heated blocks should be checked but stability of this temperature is more critical than accuracy, as well as the room temperature.
OPTIONAL Commercial O_3 calibrator (TEI 49C Calibrator) or SRP can generate O_3 to supplies each guest Zero Air System (Teledyne Model 701) or equivalent (0 - 20 SLPM @ 0 - 30 p.s.i., Dewpoint <20^{o}C

@ 10 LPM, <10°C @ 20 LPM, <-20°C up to 15 SLPM, <-10°C up to 20 SLPM, OUTPUT CONCENTRATIONS (MAX.): SO_2 NO NO_2 H_2S TRS O_3 < 0.5 ppb CO < 0.025 ppm, Hydrocarbons < 0.02 ppm. NOTE: There are, surprisingly, no NIST Standards for Zero Air and unless you have the trace ability to measure CO, CO2, NOX and HC it will be difficult to know if your system is working well. There are, however a couple of tests you can perform to see how your SRP is working with your Zero Air source. The first is to set your Ozone concentration to 1000 ppb and see how well it will stabilize, assuming all is well with your SRP. If it can hold that high concentration with a Standard Deviation of less than 0.7 for an indefinite period of time, then it is acceptable. Ozone instability of the high level Ozone can be an indication of minute pressure fluctuations in the Zero Air source. An additional pressure regulator between the Zero Air Source and the SRP may be needed. In addition, you can use a tank of Certified Zero Air for your SRP and then sample your Zero Air with the Sample Line. The Ozone concentration should be Zero.

NIST Specification for Zero Air http://www.nist.gov/calibrations/ozone-measurements.cfm

Air Supply: Minimum input pressure of 15 psig (34.7 psia, 239.2 kPa) of clean, dry air. Preferably, zero air containing no significant impurities, having less than 1 ppm (parts per million) total hydrocarbons by volume, and containing 20 - 21% oxygen. The NIST SRP has internal devices to control the amount of air required for operation. No external control is necessary. A zero air supply of 20 standard liters/min. (SLPM) will be adequate for most calibration work. These units are available through commercial suppliers of air monitoring equipment.

An SRP draws 2 SLPM into each cell (4 SLPM total), plus some excess is required in the sample and reference manifolds, and additional flow requirements for instruments under calibration.

3.2 SRP Initial Hardware Set-Up

3.2.1 Unpacking SRP-07 for Verification

- Carefully remove electronics module from the Starligh shipping container and place it on the bench top to be used for the SRP. Please note which container the electronics module is in because the foam is cut specifically for this module. If the case had been shipped from a low pressure region to a higher pressure region, it will be necessary to equlize the pressure from the case by opening the pressure relief valce on the front of the Starlight case.
- Carefully remove the pneumatics module from the Starlight shipping container and place it to the right of the electronics module leaving about 14 to15 inches between them. Please note which container the pneumatics module is in because the foam is cut specifically for this module. If the case had been shipped from a low pressure region to a higher pressure region, it will be necessary to equlize the pressure from the case by opening the pressure relief valce on the front of the Starlight case.
- Remove all miscellaneous items from the shipping container's center storage area and lay out on a table so specific items can be easily found.
- Carefully remove the optical bench from the optical bench shipping container and place upside down across the electronics and pneumatics modules resting on the optical bench pads, or a suitable table surface. SRP-07 has a Plexiglass plate attached to the bottom of the cell to keep all the fitting safely tucked away during shipping. Remove the screws and Plexiglass plate and set them to the side during operation.
- Carefully flip the optical bench over to the right side up position allowing the cables and lines to fall between the electronics and pneumatics modules. It is possible, but not recommended, to run the cell laying down on its side. Care needs to be taken not to bend the tubing too much and to place some for of vibration dampening under the cell.
- Find the 2 optical bench pads and place one on the back outside edge of both the electronics module and the pneumatics module to support the optical bench stand. This was the standard setup for earlier versions of the SRPs, however, many of the operators have acquired stands for their SRP and the visiting SRP-07. EPA RTP has also supplied an SRP stand that is different from the NIST Stand to many of the operators. An optional Optical Bench Stand can be purchased from NIST or you can make your own, just be sure to insulate the Optical Bench from any vibrations to the SRP modules.

3.2.2 Connecting Electronics Signal Cables

- Remove the cable ties holding the cables and Teflon lines and allow them to hang freely off the back.
- Connect the "J2", "J3", "pressure", and "temperature" cables to the rear of the electronics module. If the marking on the cable is unclear then look at the plug and count the number of pins in the socket and then look at J2 and J3 and find the corresponding number of pins and it should be a match. Never try to force a connector into place. Also, plug the ground wire into the Banana Socket on the back of this module.
- From the table where the other parts are, find the cables marked detector and "J1".

- Connect the “J1" cable from the rear of the electronics module to the rear of the pneumatics module.
- Connect the Detector cable, and the Scaler 1 and 2 cables from the rear of the electronics module to the SRP Detector module mounted on the right hand side of the optical bench.
- NOTE: This is for a new setup-Locate the Signal Distribution Module and Signal Distribution Ribbon Cable from the miscellaneous items.
- NOTE: This is for a new setup-Connect either end of the Signal Distribution Ribbon Cable to the 100 pin connector on the Signal Distribution Module labelled “COMPUTER”. **Make sure the white arrows on both connectors line up to each other.** WARNING: Plugging this cable in backward will create a shock hazard and potentially start a fire. All of the equipment should be powered down at this point.
- NOTE: The following stems are is for a new setup-Connect the other end of the Signal Distribution Ribbon Cable to the 100 pin connector on the PCI-DAS 1001 circuit board installed in the PC. **Make sure the white arrows on both connectors line up to each other.** If there is any doubt, contact the **O_3 SRP Laboratory Support** for additional help.
- Locate the 1.5 meter cable with the female 37 pin connector to a female 37 pin connector from among the miscellaneous items on the table supplied with SRP. NOTE: If not using the cable supplied with your instrument, make sure that the pin-out is straight through (*ie* pin 1 to pin1, pin 2 to pin 2, & so on.)
- Locate the “J4" cable assembly from the miscellaneous items on the table. NOTE: It is a common mistake to forget this cable. The symptoms of not having this cable in place will be loss of automatic control of the O_3 Mass flow Controller and Automatic Control of the Lamp % Power. If this has happened, you may need to shut down the software and reboot the computer and the SRP in order to regain full functionality.
- Locate the small blue junction box with the six sets of red and black banana jacks on top from the miscellaneous items on the table.
- Locate the cream colored connector box with three ports labeled “ANALOG”, for the guest SRP; this is the Analog/Computer/Digital Connector Box (ACD Box).
- Connect the female 37 pin cable to the male 37 pin port labeled “Analog” on the junction box. Connect the other end of this 1.5 meter cable to the blue junction box, where it is labeled “Digital”. . NOTE: If not using the cable supplied with your instrument, make sure that the pin-out is straight through (*ie* pin 1 to pin1, pin 2 to pin 2, & so on.)
- Connect the “J4" connector cable and “clip” it into the “Computer” port on the junction box. Connect the other end to the back of the computer in the slot configured with its port.
- Connect the female 37 pin “D” connector end to the Signal Distribution Module 37 pin “D” connector labelled “DIGITAL”.
- Connect the male 37 pin “D” connector end to the rear of the SRP Electronics Module labelled “Interface”.
- Connect Power Cable to rear of Electronics Module (100-120 VAC required).

SRP-10 Electronics module (start-up)

Make sure that the three switches on the front of the pneumatics module are in the "off" position. At this point you can power on the NIST SRP. The front panel displays will show all or mostly E's (example EEEEEE). You may hear a high frequency sound coming from the Electronics Module for at least one minute, and then it should decrease. This is the PCI 2400 UV lamp power supply which has a one minute high power start mode.

3.2.3 Pneumatics Connection Setup

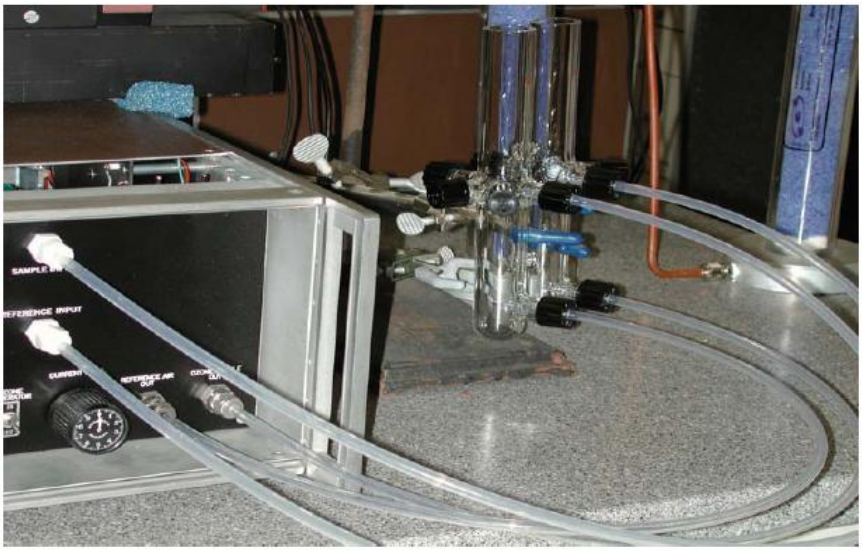
- Remove the caps and plugs from the Teflon tubing and the pneumatics module. Connect the Teflon lines labeled to "To 1" and "To 2" to the Teflon bulkhead connectors on the rear of the pneumatics module labeled "To Cell 1" and "To Cell 2". For the Teflon lines that are connected to stainless steel Swagelok fittings, make sure they are hand tightened plus a quarter inch turn with a wrench. For the Teflon lines that are connected to the Teflon Swagelok fittings, make sure they are hand tightened. (***Be careful not to strip the threads of the Teflon fittings***.) The cable tie markers attached to the Teflon lines sometimes break off. For this reason newer NIST SRPs are marked with one cable tie for cell 1, and two cable ties for cell 2. ***What if some or all the marking have fallen off? How do you identify Cell 1 and Cell 2 lines?*** If the SRP is set up properly, as you look at the Cell Block, the Temperature Block and Source should be to your left and the detector to you right. The Scalers are matched with the Cells, *ie* Scaler one is Cell one and Scaler 2 is Cell 2. Underneath the Cell Block to your left there are two Teflon lines coming out. The "To Cell One" is towards the front, closest to you and then "To Cell Two" is towards the back. Go ahead and connect "To Cell One" to the appropriate Teflon bulkhead fitting on the back. Then connect one of the SS fitting from the cells to the SS bulkhead labels 1, but only hand tighten. (It would be best if the O_3 and Reference were connected to the manifold at this time) Now watch the rotometer on the front panel for Cell 1 (the one to the left) and turn the sample pump on for just a moment and if the Rotometer jumps you got the correct connection. If the Rotometer jumps does not then switch to the other SS fitting from the cell and repeat. Rotometer 1 should now work. Connect the other Teflon and SS fittings accordingly and tighten.
- Connect the Teflon lines labeled "1" and "2" to the stainless steel bulkhead connectors on the rear of the pneumatics module labeled "From 1" and "From 2".
- Connect the laboratory supply of zero air to the stainless steel bulkhead connector labeled "Air In". It will be necessary to keep the pressure of this line between 20 and 25 psi. Zero Air Systems are yet to be fully evaluated in terms of proper SRP function. An adequate Zero Air Generator should be able to supply up to 30 liters per minute at 35 PSI. Most any brand-

named Zero Air generator should work well. A note should be mentioned here about the commonly used AADCO 737 Zero Air Generator. During the scrubbing process it alternately will scrub out the O2 and N2 and then re-mix them alternately. This process causes the O_3 concentration to alternate high and then low. Therefore when generating high O_3 concentration you could end up with undesired stability issues. The solution to this is an optional part from AADCO called a Mixer/Receiver that will remix the O2 and N2 at stable concentrations. A check that can be done to verify your Zero air supply would be to buy a tank of zero air and set up a purge line directly to the manifold and replace either the "reference in" or the "O_3 in" and then run some zero readings from the two different sources. If you get an unusually high or low Zero then there is an issue. If the Zero looks good, then it is good. NIST is looking into a test method for qualifying Zero Air Systems but it is not yet available.

- Locate the glass Dual External Manifold and remove it from plastic bag.
- Using a 3-finger laboratory clamp and mounting pole with stand, mount the Dual External Manifold and place near SRP Pneumatics Module.

Dual External Manifold Set-Up

Connect the main SRP to the dual external manifold (Reference side and Sample side).



Note: All connections between the SRP, O_3 standard, or candidate transfer standard under evaluation, need to be made through Teflon tubing (¼" Outer Diameter and 0.2" Inner Diameter) using the shortest length that is possible (preferably less than one meter of all equal lengths).

- Locate the Teflon Sample lines and remove them from their plastic bag(s).
- Connect the Sample line with the Stainless Steel (SS) knurled nut and Teflon Ferrules to the " SAMPLE OUT" SS bulkhead fitting on the SRP Pneumatics Module Front Panel. ***Make sure the ferrules are still in place before attaching***.
- Connect the other end of this sample out line to the bottom input fitting on the Dual External Manifold labelled "S" to provide the sample gas.

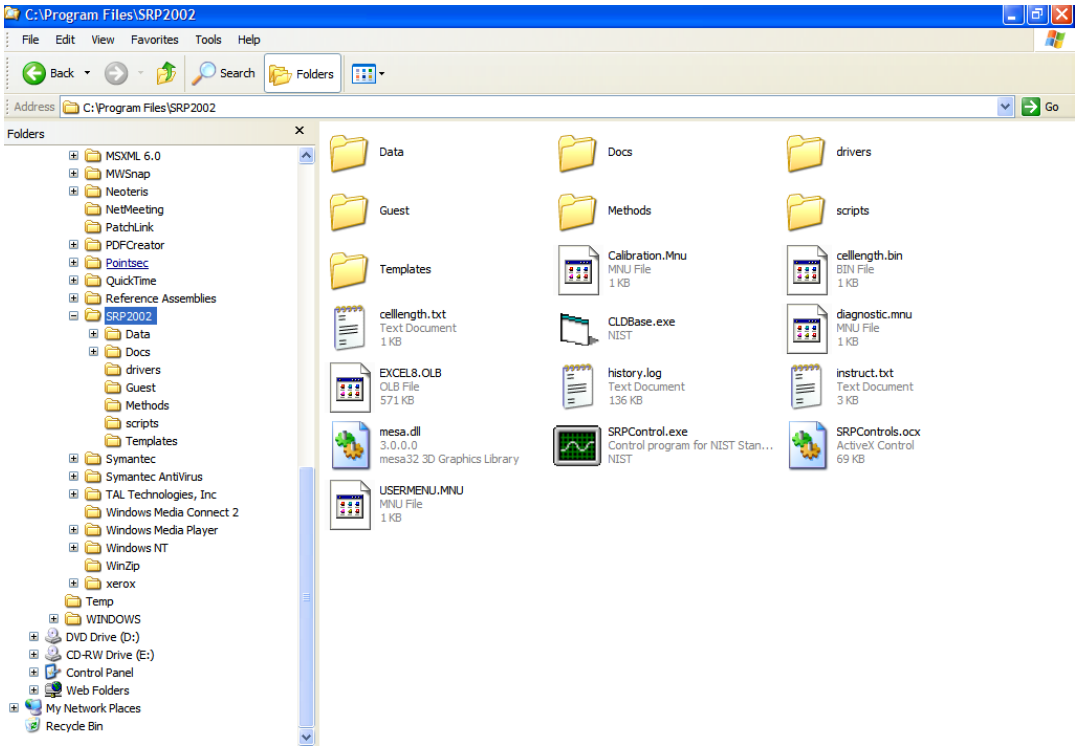
- Connect the Sample line with the Teflon nut and ferrules to the "SAMPLE INPUT" Teflon bulkhead fitting on the SRP Pneumatics Module Front Panel. ***Make sure the ferrules are still in place before attaching***. ***Be careful not to strip the threads of the Teflon fittings***.
- Connect the other end of this sample input line to any of the four fittings on the Dual External Manifold labelled "S".
- Locate the Teflon Reference lines and remove them from their plastic bag(s).
- Connect the Reference line with the Stainless Steel (SS) knurled nut and Teflon Ferrules to the "REFERENCE AIR OUT" SS bulkhead fitting on the SRP Pneumatics Module Front Panel. ***Make sure the ferrules are still in place before attaching***.
- Connect the other end of this reference out line to the bottom input fitting on the Dual External Manifold labelled "R" to provide the reference gas.
- Connect the Reference line with the Teflon nut and ferrules to the "REFERENCE INPUT" Teflon bulkhead fitting on the SRP Pneumatics Module Front Panel. ***Make sure the ferrules are still in place before attaching***. ***Be careful not to strip the threads of the Teflon fittings***.
- Connect the other end of this reference input line to any of the four fittings on the Dual External Manifold labelled "R".
- Clean, dry air at 20 to 25 pounds per square inch gas (psig) needs to be supplied to the rear of the SRP pneumatics module. The critical (flow limiting) orifice inside the SRP pneumatic module has been designed to provide approximately 7 to 9 Liters per minute (LPM) of zero air to the zero air dual external manifold reference "R" inlet. The "inlet" on the reference side of the dual manifold is the lower outlet.
- Remember that when the solenoid valves (A and B) are off and the pump is on, each line (sample and reference) draws 2 LPM from the zero air source, for a total of 4 LPM per SRP.
- When conducting Level 2 verifications, approximately 2 LPM of zero air will be needed for each guest instrument, along with 1 LPM of excess. Verify that the SRP supply air is greater than the sum of all the guest instruments to prevent room air from being drawn into the manifold. Check with a stopcock attached to a flow meter to make sure there is adequate venting at the top of the glass dual external manifold. Note: At end of run, or when the valves are off, more air is needed in the reference manifold.
- Check to see if power supply for mass flow controller of about 15 V is met. The actual flow from the MFC can be read from the black and red jacks on the back of the Pneumonic Module. This is a 0 to 10 LPM MFC and the voltage output is 0 to 5 Volts. Therefore a flow of about 6 LPM would be about 3.0 Volts. This MFC has been observed to work as low as 5.0 psig but it is not advised to run that low as this may severely limit the Reference Air in.

3.2.4 SRP Warm-Up Time

If not previously completed, plug in the power cable and place the power switch on the electronics module in the "on" position. Allow the SRP an initial warm-up time period of at least four hours for the system to become fully stable. Normally the SRP would be left on after the initial setup with the modules kept in idle mode (all pump module switches in "off" position) until needed for a Level 2 verification or any routine system characteristics data checks.

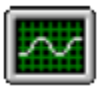
3.3 SRP Initial Software Control Program Setup

NIST software Version 4.4.1 of the SRP Control Program should already be loaded on PC within program files directory under Windows as SRP2002 directory which includes the following sub-directories Data, Docs, drivers, Guest, Methods, scripts, and Templates.



3.3.1 Save Shortcut to SRPControl.exe Program

Save shortcut to program either to the desktop or start menu line to allow easy start-up of the operating system.

Select:  SRPControl.exc (green icon) found on the PC screen either located on the desktop or placed in the menu bar. Double clicking on icon will load the software program that controls the NIST SRP and up to three guest instruments. The guest instruments may be another SRP, have analog signal output, serial port communications, or require manual entry of the O_3 data. The program is capable of verifying the guest instruments with the primary SRP using the SRP internal O_3 generator, or a guest instrument's O_3 generator (not recommended). It is also

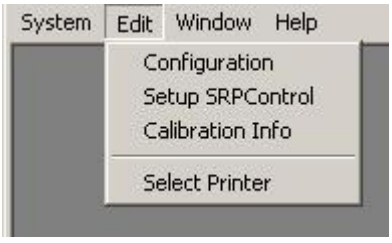
possible to setup the program to run verifications unattended, even linking different verification methods such that lengthy verifications may be performed overnight. Verification results are reported through a Microsoft Excel™ spreadsheet, and printed on a windows compatible printer. Currently all of the operators are using Excel™ 2003. The Agency standard is Excel™ 2007. This has created some issues with some of the operators. The solution may be to go into the template and then select File Save As and Create a new name for the template and to tell it to save as Excel™ 2003 and then to use this as your template, however this has not yet been tested or verified. In addition, the program is capable of being controlled by a remote computer connected to a network, or reporting results over the network to another computer (*see Appendix B).*

During routine operation of the SRP, various types of O_3 transfer standards will be interfaced with the SRP. Regardless of the configurations that will be used, there needs to be sufficient flows of both zero air and sample supplied to each photometer. Consult Section 3.2.3 in this document for further guidance regarding these interface and flow requirements.

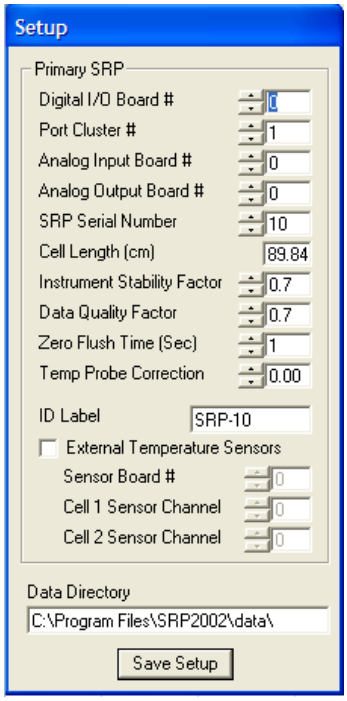
3.3.2 Using the "Standard Reference Photometer", software will allow for manual or automatic O_3 generator settings. For computer-controlled settings, make sure that the pneumatics module has been adjusted so that the switches are set appropriately. For example, for automatic settings, "Automatic" should be switched to "ON" for the O_3 generator settings to be selected by the computer automatically or "Automatic" should be switched to "ON" for the O_3 flow settings to be selected by the computer automatically. For manual settings, the switch should be placed in the "OFF" setting then pneumatic front panel Current Level knob dial in manual setting (normally not used).

3.3.3 Initial Setup of the Primary SRP Control Software:

The program must be initially setup prior for operation with the primary SRP through select *Edit* main menu and then drop down menu to "***Edit/Setup SRPControl***" menu option as shown below.



This option brings up the setup panel where you may input the various options that control how this program functions.



The Primary SRP settings can be seen in the image above, and they are described below:

Digital I/O Board #: The number assigned in *InstaCal* for the digital I/O board, usually the PCI-PIO1001/2

Port Cluster #. The port cluster (1 through 4) used for this SRP. This is set to 1 when using the PCI-PIO1001/2

Analog Input Board #: The number assigned in *InstaCal* for the analog input board, usually the PCI-PIO1001/2

Analog Output Board #: The number assigned in *InstaCal* for the analog output board, usually the PCI-PIO1001/2

SRP Serial Number: The serial number of the main SRP, this is found on the brass panel on the photometer

Cell Length(cm): Shows the cell length for this SRP. This is not user editable.

Instrument Stability Factor: The maximum standard deviation (in ppb) of four readings that will indicate that the O_3 concentration is stable. Data acquisition will not start until this factor is met. ***Set 0.7 for SRP***.

Data Quality Factor: The maximum standard deviation (in ppb) allowable during actual data acquisition. Data acquisition will restart if this factor is not met. ***Set 0.7 for SRP***

Zero Flush Time (Sec): The time in seconds the program will wait after the O_3 generator is set to zero.

ID Label: The label that will be used to identify this instrument in reports and in the control program.

Other Settings:

Data Directory: The path of the directory where the Excel™ "Calibration Reports" will be saved.

Enable Network Socket: Enables the data socket routines in the control program. Do not enable unless you intent to use the network features of this program.