NFPA 2001 ENCLOSURE INTEGRITY TEST SOFTWARE USER'S MANUAL

For Infiltec Software LA.COM Dated 05/11/99

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VERSION 2.0

Using the Infiltec 2001 Hold Time / Leakage Analysis Software

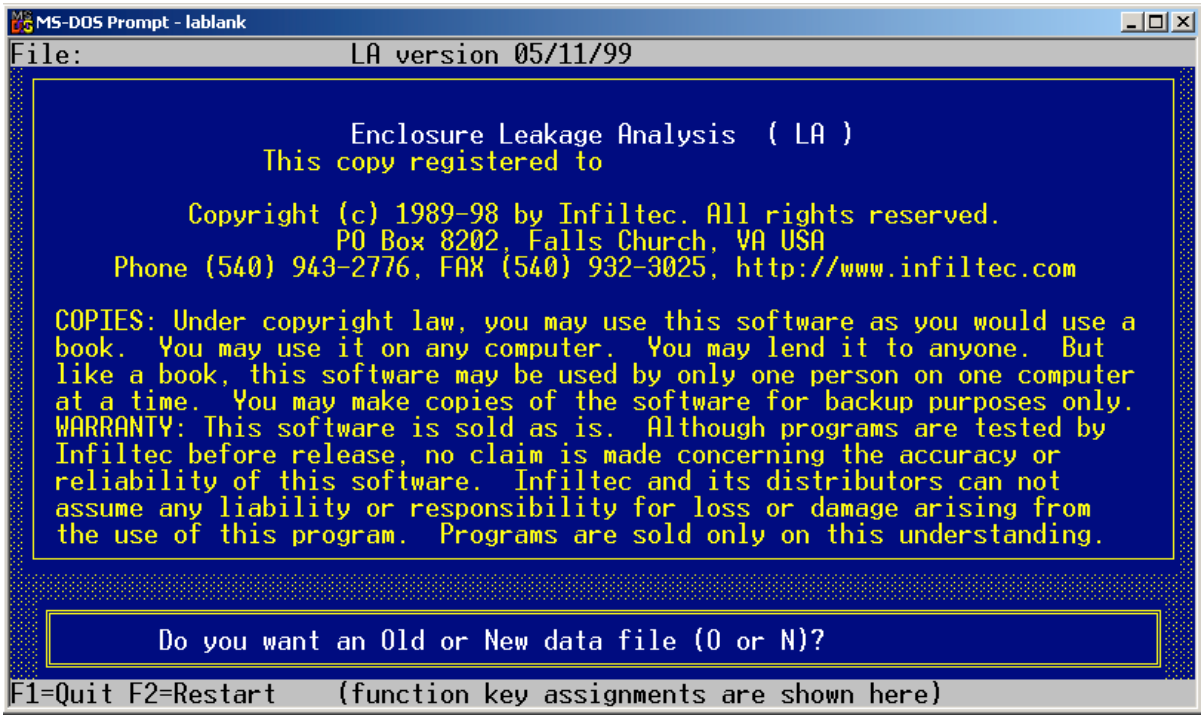
The Infiltec 2001 Hold Time/Leakage Analysis Program brings a new level of professionalism to your room integrity testing. The program runs most Windows or DOS compatible computers. A hard disk is not required; it can be run from a floppy disk or a flash drive.

The Infiltec 2001 Hold Time/Leakage Analysis Program was designed to be user friendly, It is easy to use and difficult to make serious errors that might make for a loss of data. The program follows a series of prompts that guide the user inputting all necessary data. If a mistake is made it is immediately visible on screen and correction is made by backspacing and overwriting the error. Likewise after completion of the test it easy to play "what if?". Would this room pass if the minimum hold height was lowered 6 inches?

The Infiltec 2001 Hold Time/Leakage Analysis Program produces a full page test summary report and a graph showing the predicted gas interface drop over a 20 minute time period. These reports can be printed as is, or incorporated into a word processor to produce a full report.

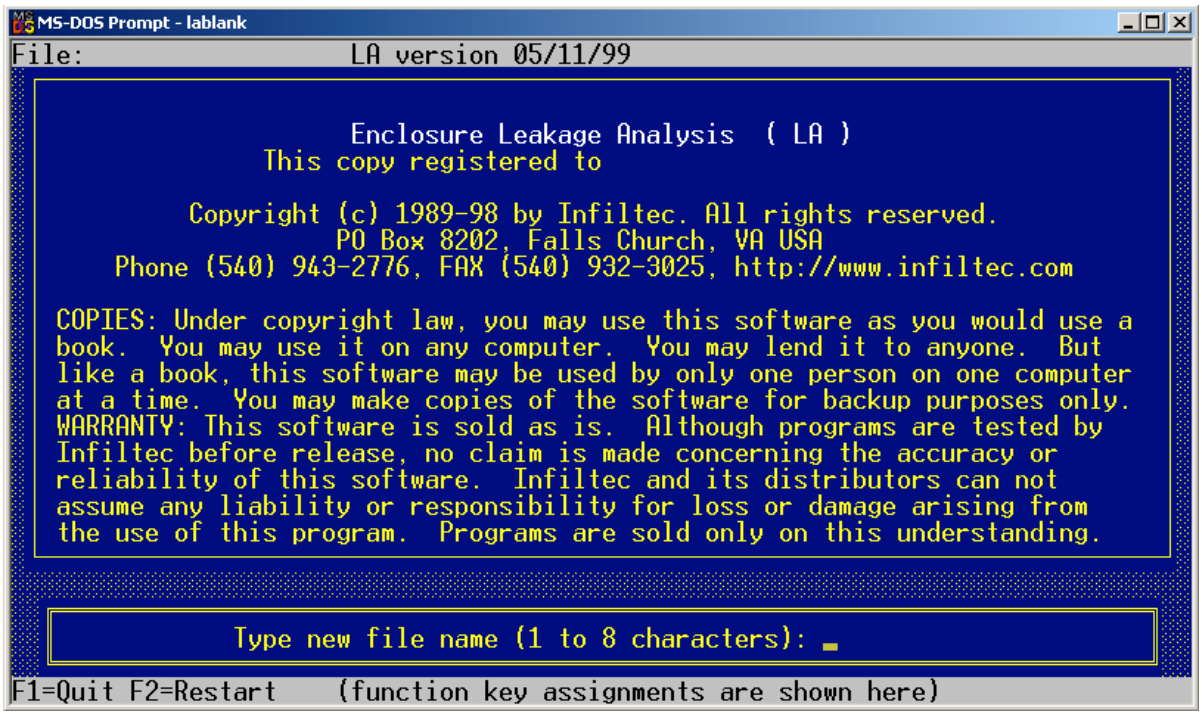
Starting the program:

1. If you saved the program into folder such as **C:\infiltec** then you can start the program from the DOS prompt **C:>** by typing **C:\infiltec\LA.COM.** (Note that from Windows you can get the DOS prompt from START, then RUN, then type CMD and press OK). The first screen is:

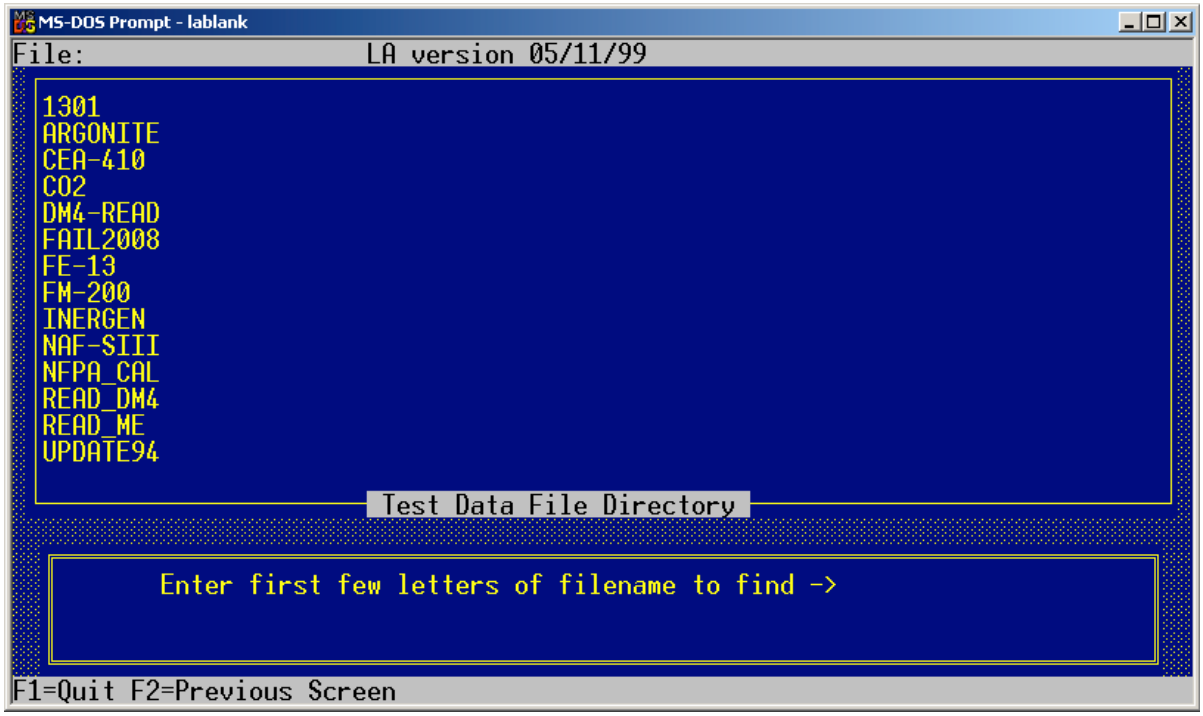


2. Type **N** (for New) and press ENTER if you are starting a new test, or type **O** (for Old) and press ENTER if you want to retrieve data from an old saved test.

3. If you type N you will be asked to type the new test file name in 1 to 8 characters with no spaces:



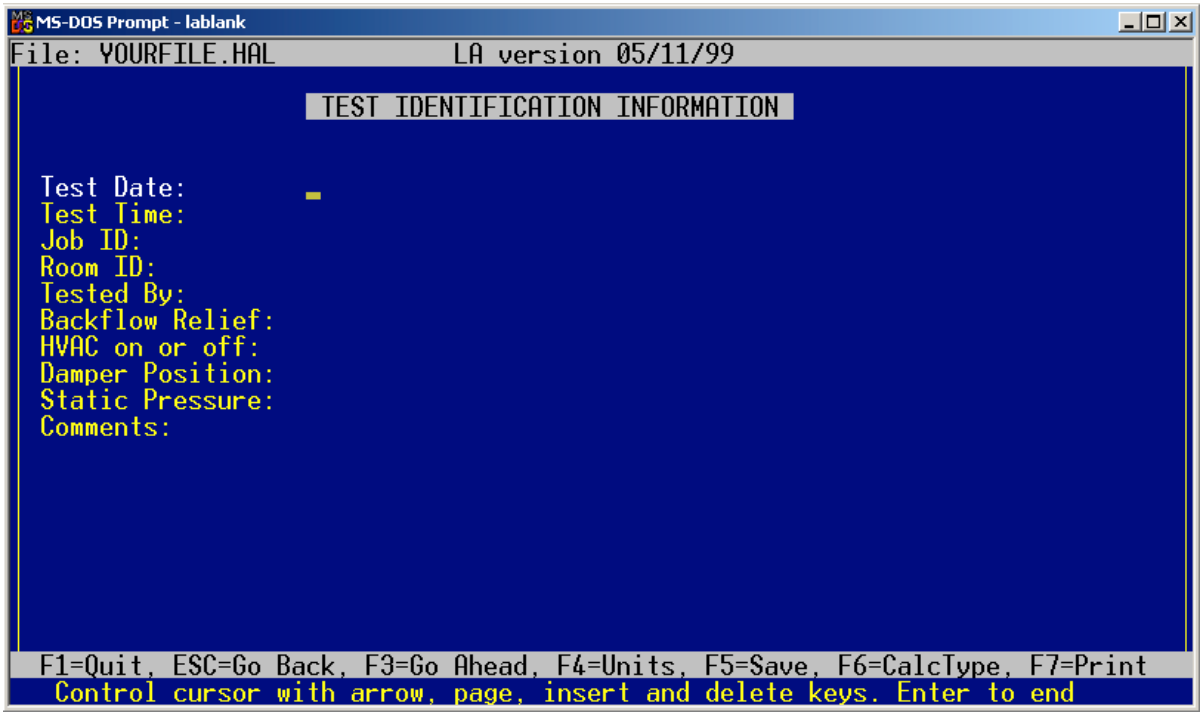
4. If you type **O** you will be shown a list of saved test files, and you will be asked to type the first few letters of file you want.



For example, if you want the **FM-200** file, then type **FM** and press **ENTER**.

Press **Y** (for **YES)** if you are shown the file name that you want, or press **N** (for **NO)** if you want to see the next file that starts with the letters that you typed.

5. When you open up a new file, you will be shown a **TEST IDENTIFICATION INFORMATION** screen where you can start entering the basic information about your test or change information if you opened up an old file.



Note that none of the data on this page is used in the calculations. It provides information to identify the test, and the test conditions, so that the test can be reviewed in the future and possibly redone under the same conditions.

The fields **Test Date**, **Test Time**, **Job ID**, **Room ID**, and **Tested By** are self explanatory.

The following fields need some explanation:

Backflow Relief - This field is a reminder to be sure that air from air leaks in the room under test has a free path back to the fan from all sides of the room, and that there are no restrictions in the flow of air to or from the fan outside the room to be tested. A typical entry might be "*Opened hallway doors around the room and opened stairwell doors to floors above and below*."

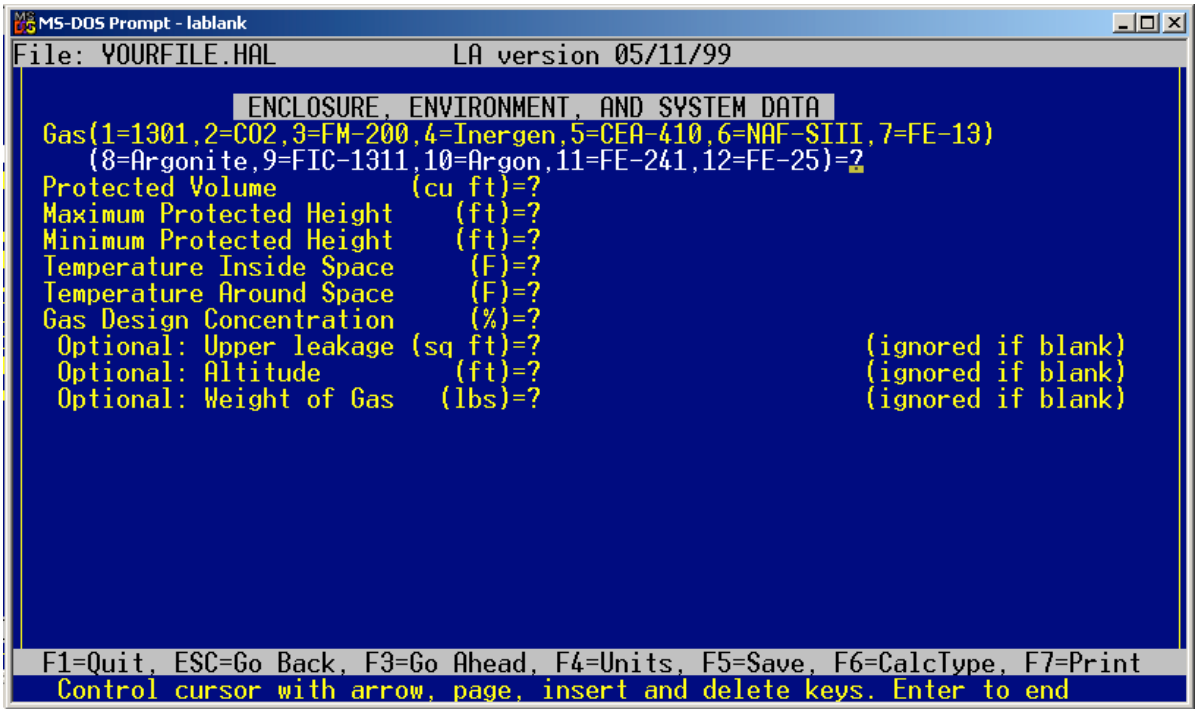
HVAC on or off - This field is a reminder to note if the HVAC systems were on or off during the test. The test should be done under the same conditions that would exist during an actual discharge. This means that if the building or local HVAC systems are tied to the fire alarm panel and are designed to shut down at discharge, then they should be shut down for the test. If they are not shut down, they may have an adverse effect on the static pressure which is an important part of the calculations later in the test.

Damper Position - This field is a reminder to check and note that all HVAC dampers are functioning and are in their closed, discharge position. Open or leaky dampers are a major cause of static pressure in the room that can push the fire protection agent out of the room faster than predicted by test calculations. A typical entry is *"All dampers were actuated by control panel and closed tightly*"

Static Pressure - Once the blower door frame and fan are set up and the fan is covered, the nylon cover will indicate if static pressure is present in the room under test. For this entry you should record if there is any static pressure and if it is positive pressurization (nylon cover blowing out of the tested zone) or negative depressurization (cover blowing in). A typical entry is *"Slight depressurization of the room appears to be caused by leaky damper in ceiling exhaust*".

Comments - Any appropriate comments may be made here concerning the test, such as temporary sealing that needs to be made permanent, or other deficiencies that need to be corrected. Some typical entries are:
"*Raised floor tiles pulled and floor/wall joint inspected and shown that there was no leakage*."
"*Wall inspection showed good sealing from the floor slab to the ceiling slab, even above the suspended ceiling*."

After completing your notes and comments continue to press the ENTER key until a new ENCLOSURE, ENVIRONMENT, AND SYSTEM DATA screen appears.



Gas - Enter the number for the suppression gas in the zone, i.e. 1 for Halon 1301, 3 for FM-200.

Protected Volume - This is the total volume of the protected zone. Make your own measurements, do not rely on "as built" drawings or drawings by others.

Maximum Protected Height - This is the maximum height of the zone.

Minimum Protected Height -This is the minimum height at which the suppression gas will be held for (normally) 10 minutes. The minimum protected height is set by the AHJ and/or is often the height of the highest hazard in the zone.

Temperature Inside Space - This is the air temperature in the protected zone when you are doing this test.

Temperature Around Space - This is the air temperature outside the protected zone. This is the temperature of air which would enter the zone through any leakage. It is not necessarily the "outside" temperature unless the majority of the walls of the zone are outside walls.

Gas Design Concentration - This is the concentration of the suppression gas in the zone at the completion of discharge. This is taken from the design drawings or from the Optional weight of gas calculation below

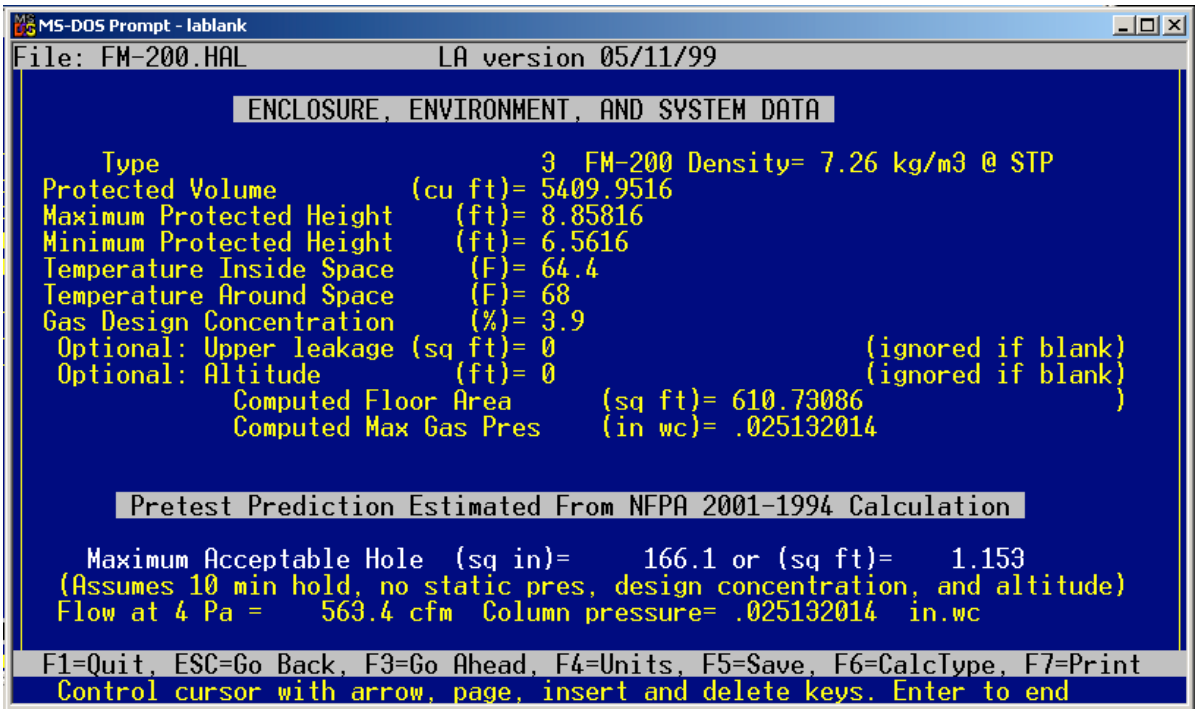
Optional: Upper Leakage - see NFPA 2001 appendix 3, page I6.

Optional: Altitude - If the test site is at an unusually high altitude, the altitude may be entered here.

Optional: Weight of Gas - If the total weight of the gas to be discharged is entered here, the program will calculate the % of gas concentration. This is a useful check on the suppression gas design for the zone and may be used above as the Gas Design Concentration. This % is not automatically used by the program and must be manually inserted above.

Note: By pressing F4 (Units), you may change back and forth between metric and imperial units: feet to Meters, Farenheit to Centigrade, Cubic Feet per Minute to Liters per Second, inches Water Column to Pascals. This may be done at any time.

After completing the above entries the program will calculate the following:



This screen shows sample data for a FM-200 protected enclosure. The data is used to compute:

Computed Floor Area is computed from (protected volume) / (maximum protected height)

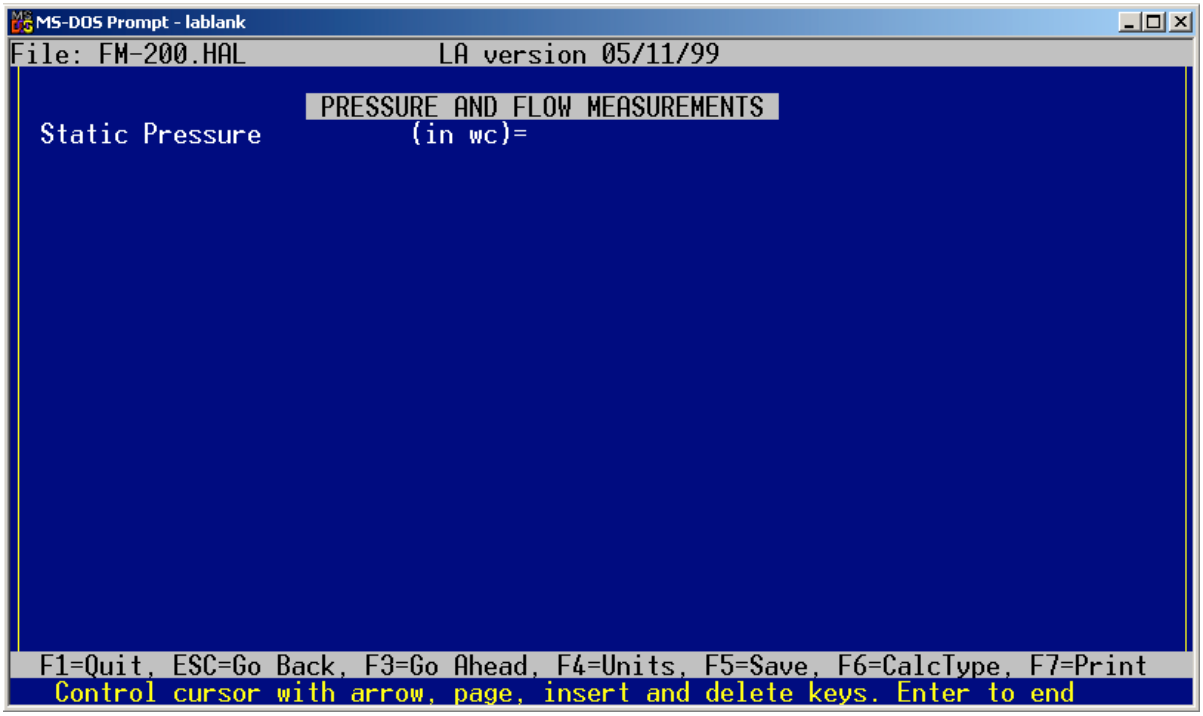
Computed Max Gas Pressure is the column weight of the gas/air mixture at the floor of the enclosure, and this determines the target test pressure for the zone that will be used to set the acceptable blower door pressurization and depressurization values.

Pretest Prediction Estimated From NFPA 2001-1994 Calculation gives you information on what to expect before the test is done.

Maximum Acceptable Hole is the largest net hole size in the enclosure which will still hold the gas concentration for 10 minutes at the selected minimum protected height.

1. This is a very useful calculation and can be done at any time, even prior to the test in your office.
2. The maximum acceptable hole size can be used as a guide to building contractors as a reference to indicate how tight a enclosure must be sealed.
3. It also gives the installer and/or the A.HJ an advanced indication of the limits of acceptable/unacceptable leakage.

Press ENTER to go on to next PRESSURE AND FLOW MEASUREMENT screen.



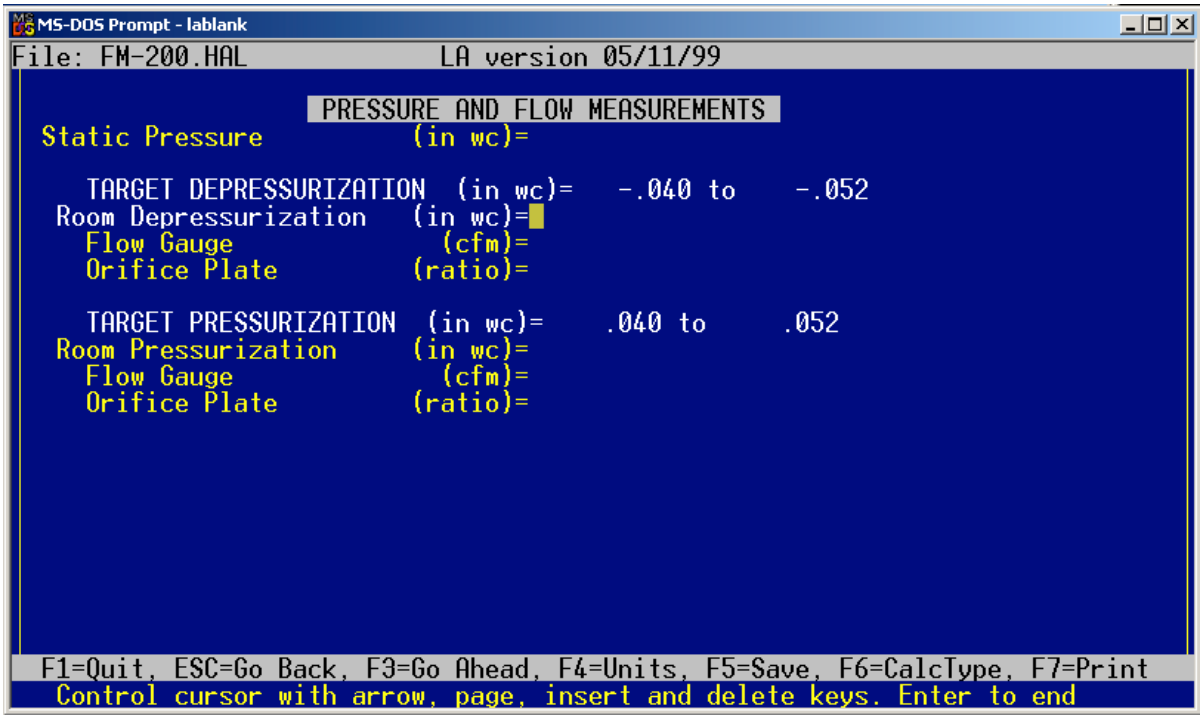
Install the blower door now for the static pressure measurement:

1. install the door frame in the enclosure door,
2. placed the E3 fan into the elastic hole in the door panel,
3. connect the fan speed control to the fan and to electrical power, and
4. connect the DM4 digital micro-manometer top left (signal port for INSIDE-OUTSIDE PRESSURE) brass tubing fitting to tubing going through the door panel and extending outside beyond the flow of the fan.
5. The DM4 digital micro-manometer bottom left (reference port for INSIDE-OUTSIDE PRESSURE) brass tubing fitting should be open and not connected to any tubing.
6. It is not necessary to connect any tubing to the FLOW PRESSURE brass tubing fittings.

STATIC PRESSURE MEASUREMENT

Seal the door by covering the fan opening or plugging all holes in low flow plate to seal the fan. Do not turn fan on. The nylon cover on the Infiltec door frame will now indicate immediately the presence of static pressure by moving into or out of the enclosure.

1. Measure the magnitude static pressure by turning on the DM4 micro-manometer and reading the pressure on the left side of the display. The DM4 time averaging is usually set to 1 or 2 seconds.
2. Define + "Positive" static pressure as when the pressure inside the enclosure is greater than outside the zone. The nylon door frame cover balloons out of the enclosure. This may not be the sign that the DM4 micro-manometer displays because the DM4 may be set up either inside or outside the enclosure for this test, which changes the sign on the DM4.
3. Define - "Negative" static pressure as when the pressure inside the enclosure is less than outside pressure. The nylon door frame cover is sucked into the enclosure. This may not be the sign that the DM4 micro-manometer displays because the DM4 may be set up either inside or outside the enclosure for this test, which changes the sign on the DM4.
4. If there is static pressure either negative or positive, the source should be determined and eliminated if possible. Ideally the static pressure should be very small, less than one Pascal.
5. If static pressure can not be totally eliminated, it should be measured and entered in the computer with proper sign.
6. The absolute value of pressure cannot exceed 25% of mixed gas column pressure. If higher pressures exist they must be permanently eliminated, i.e. tie in alarm system to shut down building air handlers.
7. After entering static pressure with the sign from the door cover movement, press ENTER



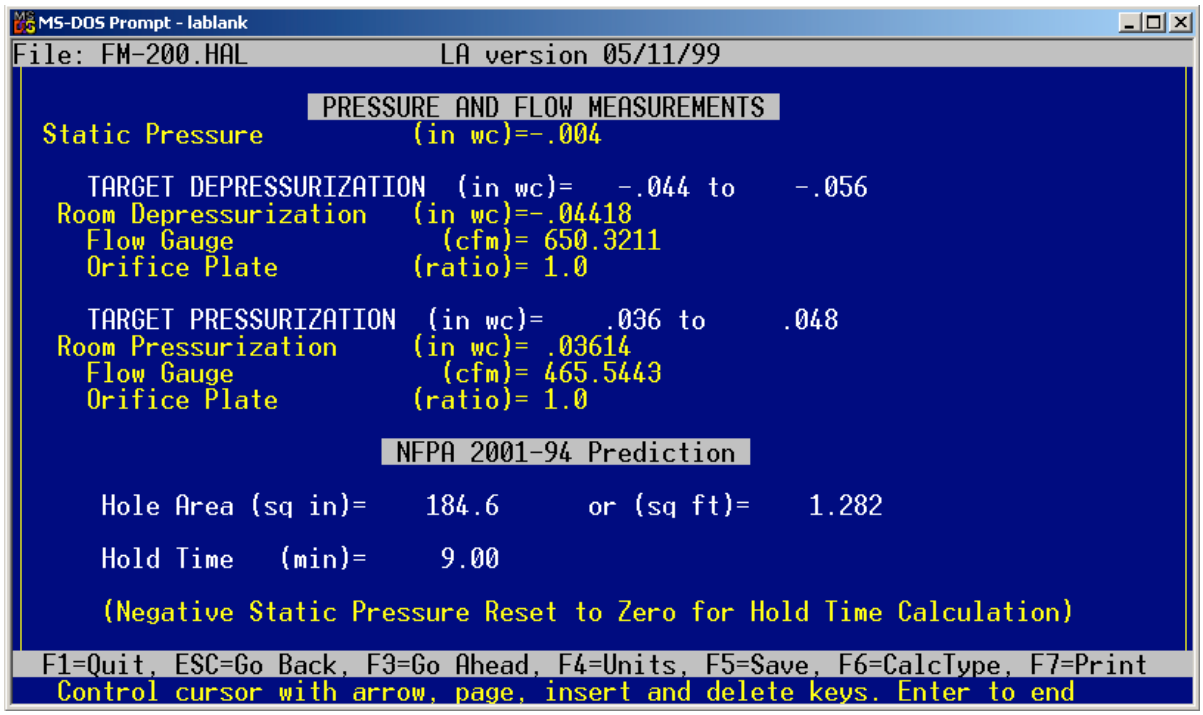
TARGET DEPRESSURIZATION – For depressurization the fan must be set up to blow air out of the enclosure under test. This will suck the door fabric into the room. The allowable range of depressurization (in this case it is –.040 to -.052 inches of water column) is computed by the standard calculations from the gas data, room dimensions and environmental conditions.

1. **Room Depressurization** – turn on the fan and increase the flow until the pressure is within the range of the target is reached. The press the HOLD key on the DM4 so that the pressure and flow can be recorded. Be sure that the LOW FLOW key on the DM4 is set to the low flow plate configuration on the fan (open fan, 7 holes open, etc.) Enter the pressure into the program, without any sign. If the static pressure is too large, then you will get an error message that the test can not be conducted until the static pressure is reduced. Note that the sign of the pressure reading on your DM4 digital micro-manometer will not always be the same as shown above because it varies depending on whether you have the DM4 inside or outside of the room. As long as the fan is blowing out of the room and the fabric is being pushed into the room, you should ignore the sign on the room pressure and just enter the pressure magnitude.
2. **Flow Gauge** – Enter the flow reading from the DM4 or analog flow gauge. If you are using metric units, you can convert from the metric DM4 flow of m3/h to L/s by multiplying m3/h times 0.267 (e.g. 1 m3/h = 0.267 L/s)
3. **Orifice Plate** – if you are using the Infiltec E3 blower door with the digital DM4 micro-manometer, this should always be set to 1.0. Older models of the Infiltec E3 or R2 blower doors with Magnahelic analog pressure gauges have factors of their low flow plates that should be entered here.

TARGET PRESSURIZATION – For pressurization, the fan must be set up to blow air into the enclosure under test. This will push the door fabric out of the room. The allowable range of pressurization (in this case it is +.040 to +.052 inches of water column) is computed by the standard calculations from the gas data, room dimensions and environmental conditions.

4. **Room Pressurization** – turn on the fan and increase the flow until the pressure is within the range of the target is reached. The press the HOLD key on the DM4 so that the pressure and flow can be recorded. Be sure that the LOW FLOW key on the DM4 is set to the low flow plate configuration on the fan (open fan, 7 holes open, etc.) Enter the pressure on this line, without any sign. If the static pressure is too large, then you will get an error message that the test can not be conducted until the static pressure is reduced. Note that the sign of the pressure reading on your DM4 digital micro-manometer will not always be the same as shown above because if varies depending on whether the DM4 is mounted inside or outside of the room. As long as the fan is blowing into the room and the fabric is being pushed out of the room, you should ignore the sign on the room pressure and just enter the magnitude.
5. **Flow Gauge** – Enter the flow reading from the DM4 or analog flow gauge. If you are using metric units, you can convert from the metric DM4 flow of m3/h to L/s by multiplying m3/h times 0.267 (eg. 1 m3/h = 0.267 L/s)
6. **Orifice Plate** – if you are using the Infiltec E3 blower door with the digital DM4 micro-manometer, this should always be set to 1.0. Older models of the Infiltec E3 or R2 blower doors with Magnahelic analog pressure gauges have factors of their low flow plates that should be entered here.

After you enter the pressurization and depressurization data, you will see these calculations:

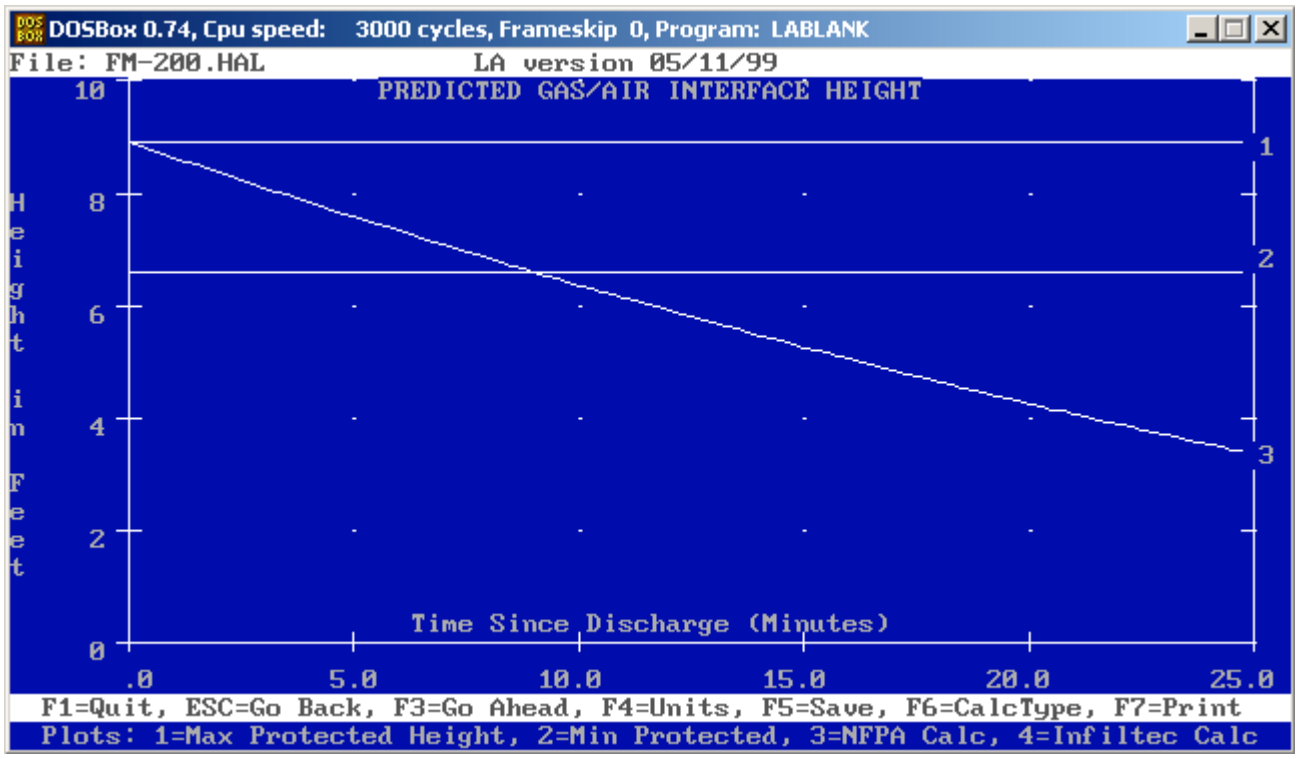


Hole Area is the NFPA 2001-94 based calculation of the net hole size of the leaks in the enclosure. This will give you an idea of how much leakage is distributed over the surface of the enclosure. Small enclosures are typically much harder to seal to pass a test because a leakage of a only few square inches or centimeters may be required to pass the enclosure integrity test.

Hold Time is the time required for the mixed gas in the enclosure to leak below the minimum protected height. This is generally required to be at least 10 minutes for the enclosure to be considered tight enough to pass the enclosure integrity test. However, the NFPA 2001 Standard does not specify 10 minutes as mandatory, and it leaves the hold time specification up to the persons supervising the test.

The last screen is a graph of the mixed gas height versus time after discharge. This graph page may not work on Windows XP, Vista, or 7. Please save your data by pressing your keyboard function key F7 before going to this graph page to make sure you can recover the data you have entered if the graph does not display. One way to make the graph display on any Windows PC is to use the program DosBox that is designed to run older DOS programs like LA.COM. You can download a free copy of this program at www.dosbox.com. You can then run LA.COM within DosBox and the graph will display correctly.

Press ENTER again to display a plot of hold height vs time:



Evaluating the Test Results

If the enclosure did not pass the required hold time (generally 10 minutes), but the hold time was close, say 9.9 minutes, you may have to do more sealing on the enclosure and retest, or you might ask the AHJ if the minimum protected height could be lowered slightly, say 6 inches. The possibility of changing the minimum protected height will generally depend on height the materials to be protected in the enclosure.

If the AHJ agrees to lowering the minimum protected height, then use the ESC key to go back to the ENCLOSURE, ENVIROMENT AND SYSTEM DATA screen, change the minimum protected height entry, and then use F3 to go forward to the NFPA 2001-1994 Prediction screen. If the calculations now show the enclosure has a hold time over 10 minutes, then the door fan test does not need to be redone and no extra sealing needs to be done in this case.

It is easy and fast to play "what if' with the Infiltec 2001 Hold Time / Leakage Analysis Program.

If the enclosure passed or if no further corrections can be made, then at this time save your data.

Saving your data:

Your data can be saved to disk at any time. At a minimum we suggest s saving your data after completing the entry of the ENCLOSURE, ENVIRONMENT, AND SYSTEM DATA screen.

Save the data by pressing function key **F5** and answering the question:

Save this data to disk file (Y or N)?

Press **Y** (for **Yes**) or **N** (for **No**)

If this was a retest and you used an existing file you will be asked:

Overwrite old file or Create new tile (O or C)?

If you select **O** (for **Overwrite**) your new data will be substituted for your old data, the file name will be unchanged.

If you select **C** (for **Create**) you will be asked for a new file name.

Type new name (1 to 8 characters) ->?

Type in new data file name. We suggest using name related to first test, i.e.. navytst2, fstnbnk2, comprmt2, etc. Then press ENTER. The new name of your file will appear in the upper left-hand carrier of screen like this:

File: navytst2.HAL

Printing your report:

On any screen of the program, you can print a report of all the data on that page and previous pages, by pressing function key F7 on your PC keyboard. If you want the report to contain all the data from the program, you must go to the last screen of the program.

IMPORTANT NOTE: Since this is a DOS program, printing only works reliably in Windows 95 and 98. If you are using Windows XP or Vista or 7, then you should not print to a printer in this program. Instead you should print to a text file that you can print later using a Windows word processor.

To start printing, press the F7 function key on your keyboard and you will see the following message:

Send Output to Printer or Disk file (P or D)?

To print to a printer under DOS or Windows 95 or 98, then press **P** (for **Printer**), and you will then be asked to confirm that the printer is ready.

Press any key when printer is ready

Press any key and the report will he sent to your printer (LPT). Additional copies may be printed in the same way.

If you do not have a printer available, or you are using Windows XP, Vista or 7, then you may simply save the report data in a text disk file by pressing **D** (for **Disk file**). You will get a message to name your disk file:

Enter name of disk file to write to →

You should enter the name in 1 to 8 characters with no spaces, and press ENTER to save the test report. The report will be saved in the same directory that the LA.COM program is saved in. The print test file is a standard ASCII file which can be read by virtually any word processor program (or from DOS if may be printed by using the DOS command: “type filename > prn”).

To make file easy to find later, we suggest using present file name with P suffix, 1 .e. navytst2.p, fstntbnk2.p, comprn2.p, etc.

Here is a sample test report that was made from the example FM-200 test file and saved as a disk printer file:

```
                ENCLOSURE INTEGRITY TEST REPORT


                 TEST IDENTIFICATION INFORMATION

Disk Data File:   FM-200.HAL
Program:          INFILTEC LA version 05/11/99
Registered Owner

Test Date:        Test case for FM-200 gas
Test Time:        using NFPA 12A test case data.
Room ID:          the parameters in the example
Tested By:        that follows were taken
Backflow Relief:  from the NFPA 12A-1992
HVAC on or off:   Standard Appendix B
Damper Position:  on Integrity Testing for
Static Pressure:  Halon 1301 Total Flooding
Comments:         Fire Suppression Systems.
                  Note that there 12A was not
                  specifically written or tested
                  to deal with gases other than
                  halon 1301.

           ENCLOSURE, ENVIRONMENT, AND SYSTEM DATA

Gas                            =   FM-200 Density= 7.26 kg/m3 @ STP
Protected Volume         (cu ft)= 5409.9516
```

```
Maximum Protected Height    (ft)= 8.85816
Minimum Protected Height    (ft)= 6.5616
Temperature Inside Space     (F)= 64.4
Temperature Around Space     (F)= 68
Gas Design Concentration     (%)= 3.9
 Optional: Upper leakage (sq ft)= 0

Computed Floor Area      (sq ft)= 610.73086
Computed Max Gas Pres    (in wc)= .025132014

                 PRETEST PREDICTION FOR 10 MIN HOLD

 Pretest Prediction Estimated From NFPA 2001-1994 Calculation
Maximum Acceptable Hole  (sq in)= 166.0797936 or (sq ft)= 1.1533319

                    PRESSURE AND FLOW MEASUREMENTS

Static Pressure          (in wc)=-4.016E-03
 Room Depressurization   (in wc)=-.04418
   Flow Gauge              (cfm)= 650.3211
   Orifice Plate         (ratio)= 1.0
 Room Pressurization     (in wc)= .03614
   Flow Gauge              (cfm)= 465.5443
   Orifice Plate         (ratio)= 1.0

                     GAS RETENTION PREDICTIONS

 NFPA 2001-94 Prediction of 1/2 Concentration Interface
Hole Area (sq in)= 184.6873728      or (sq ft)= 1.2825512
Hold Time   (min)= 8.992816
                  PREDICTED GAS/AIR INTERFACE HEIGHT
     10.00 +---------+---------+---------+---------+---------+
           |                                                   |
           |                                                   |
           ++==================================================
           | +++                                               |
      8.00 +    +++                                            +
           |       ++++                                        |
H          |           +++                                     |
e          |              +++                                  |
i          -------------------++++-----------------------------
g     6.00 +                      +++                          +
h          |                         ++++                      |
t          |                             ++++                  |
           |                                 ++++              |
i          |                                     ++++          |
n     4.00 +                                         ++++     +
           |                                             +++++|
F          |                                                  |
e          |                                                  |
e          |                                                  |
t     2.00 +                                                  +
           |                                                  |
           |                                                  |
           |                                                  |
           |                                                  |
       .00 +---------+---------+---------+---------+---------+
           0         5        10        15        20        25
                     Time Since Discharge (Minutes)

 Plots: = is Maximum Protected Height, - is Minimum Protected,
        + is NFPA Calculation
```

You can change the font of this report in your word processor, but the formatting may change if you use a proportionally spaced font like “Times Roman” instead of a mono spaced font like “Courier” that is shown above.

Exiting the program:

If you have completed your test and are ready to pack up, exit the program pressing the F1 key. You will then be asked

Save data to disk before quitting (Y or N)?

It is probably a good idea to save the data one more times unless you have been playing "what if:'" and do not want your changes to be made permanent.

If you type **N** (for **No)** then the program will exit to the DOS prompt

If you type **Y** (for **Yes)** then you will get the message:

Overwrite old file or Create new file (O or C)?

If you type **O** (for **Overwrite)** then the program will save the file with the old name and exit to the DOS prompt.

If you type **C** (for **Create)** then the program will ask for a new file name with 1 to 8 characters:

Type new name (1 to 8 characters) →?

After you enter the new name and press ENTER, the program will save the new data file, and then return you to a DOS prompt.

The Infiltec door fan testing equipment, software and instruction manuals have been designed, built, calibrated, and written in accordance to the NFPA 2001, 1994 Appendix B Enclosure Integrity Procedure by the Infiltec Division of Saum Enterprises, Inc. However it is the responsibility of the company (individual) conducting the enclosure integrity test and the authority having jurisdiction supervising the test to assure all tests are conducted in full compliance with the NFPA procedure. Infiltec does not assume any responsibility or liability for any errors or omissions nor assumes any responsibility or liability for the passage of a discharge test and for maintaining the specified concentration for the predicted time in case of an actual emergency.