## Instructions
## for

# Combustion Venting Safety Calculations

## Program "DTL"
## (Depressurization Tightness Limit)

*Solving for*

**$CFM_{50}$ DTL**

**Maximum CFM exhaust ventilation**

**Resulting negative pressure, $\Delta P$**

**November 2002 (V1.2)**

**Combustion Venting Safety: Depressurization Tightness Limits (DTL) Program**

This program, DTL (Depressurization Tightness Limits), includes three calculation procedures; you may solve for $CFM_{50}$, CFM or $\Delta P$. The primary purpose of this program is to allow you to determine if vented combustion appliances will vent properly from a house while all the appliances that exhaust air (bathroom and kitchen exhaust fans, clothes dryers, etc.) are operating. The is calculations are based on the equation:

$$CFM = (CFM_{50}/50^{Fx})(\Delta P^{Fx})$$

where:

CFM = total cubic feet per minute flow rate of actual mechanical exhaust from building;

$CFM_{50}$ = the tested blower door $CFM_{50}$ of the building;

$\Delta P$ = the pressure difference between the indoors and outdoors of the building in units of negative Pascals (enter as a positive value);

Fx = the flow exponent (slope of the leakage curve) of the tested building. The typical value for the flow exponent is 0.65. The typical range for the flow exponent is 0.5 to 1.0. A flow exponent of 0.5 characterizes a building with large leaks through which air flows in a turbulent fashion. A flow exponent of 1.0 characterizes a building with small leaks through which air flows in a laminar fashion. If you perform a single-point blower door test, use 0.65 as the flow exponent. If you perform a multi-point blower door test, you will know the flow exponent for the building in question. Use this specific flow exponent.

This program allows you to solve for $CFM_{50}$, CFM, and $\Delta P$. Solving for $CFM_{50}$ is the most often used routine. To solve for $CFM_{50}$ you must choose the $\Delta P$ target value to use. Many energy auditing and weatherization programs select a $\Delta P$ = -5 Pascals as the target pressure difference created by the operation of exhaust appliances. This is because common practice and testing has demonstrated that a negative pressure between indoor and outdoors of a greater negative magnitude than -5 Pascals (i.e., -6, -7, -8, etc.) will cause backdrafting of natural draft combustion appliances. On the other hand, if the combustion appliance zone (CAZ) contains only a natural draft water heater, it might be best to use a value of -2.

The tighter a weatherization crew makes a house (reduction of $CFM_{50}$), the greater the magnitude of the negative pressure created by a given total cfm of the exhaust appliances. Therefore, many weatherization programs use a depressurization tightness limit, DTL, to determine the limit to house tightening. This is done by solving for $CFM_{50}$. The depressurization tightness limit, DTL, is often used in combination with the Building Tightness Limit, BTL (see explanation of this program on page 2). DTL establishes a tightness limit for the sake of proper drafting of draft combustion appliances, while BTL establishes a tightness limit for the sake of acceptable indoor air quality for the occupants. When both of these tightness limits are established for a house, the larger of the two, expressed as $CFM_{50}$, should be used as the weatherization tightness limit. A third tightness limit to keep in mind is the Weatherization Cost-Effective Guideline (WCEG), another program in this software package. The explanation of WCEG begins on page 59.

The depressurization tightness limit calculation is not required if a house:

1) has no combustion appliances, such as an all-electric house
2) has only direct-vent (sealed-combustion) appliances. These appliances exhaust all their combustion air to the outdoors and receive all their combustion supply air from the outdoors through a dedicated pipe running from the outdoors directly to the appliance.

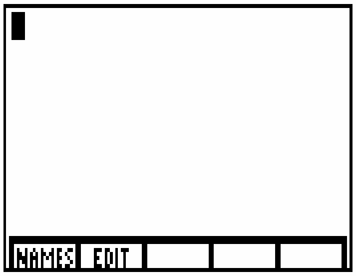
A gas-fired range/oven, or other unvented combustion appliance, is not affected by negative pressures in a house because it is not vented—or coupled—to the outdoors, so the indoor-outdoor pressure difference is irrelevant for unvented combustion appliances.

This program also includes a routine that allows you to solve for cfm, the sum of the actual exhaust rate for all exhaust appliances operating simultaneously. This method allows you to determine the maximum exhaust rate for a house with a given $CFM_{50}$ or a target $CFM_{50}$ tightness level. Again, you must select the target $\Delta P$ in units of Pascals. This is a helpful procedure if you are going to install any additional exhaust devices and wonder what cfm exhaust rate will create a negative pressure of a higher magnitude than your target $\Delta P$.

Finally, you can solve for $\Delta P$ in units of negative Pascals. If you know the sum of the actual cfm of exhaust appliances and the $CFM_{50}$ of the house, you can determine the resulting negative $\Delta P$ in Pascals. This routine helps you determine if the combustion appliances are in danger of backdrafting when all the exhaust fans are operating simultaneously.

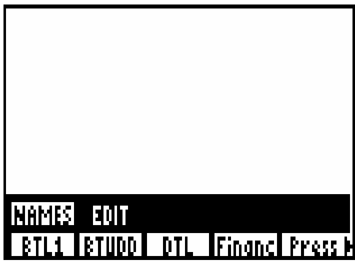
The value of Fx, the flow exponent, can significantly influence the answers to the three routines included in this program. If you know the value for Fx, use it. The only way you can determine this value for a particular house is by performing an multi-point blower door test (see page 83 of this instruction manual). Be aware that as a house is tightened, the Fx value changes because the size of the holes in the envelope is altered.

DTL-1



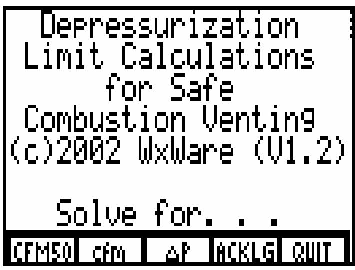

- Turn the TI-86 calculator on.
- Press **PRGM** (Programs).
- You will see this menu on the screen.
- Press **F1** for "NAMES."
- **NOTE:** It is best never to press "EDIT," **F2.**

DTL-2



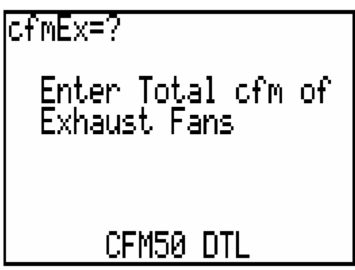

- You will see this menu and sub-menu on the screen.
- Press **F1, F2, F3, F4**, or **F5** for the program **DTL**. The menu key for this program will depend upon the number of programs loaded in the memory of your TI-86 calculator.
- "DTL" will appear at the cursor location.
- Press **ENTER**. **Note: The exact name of the program must appear at the cursor position, if it does not, you will receive an error message.**

DTL-3



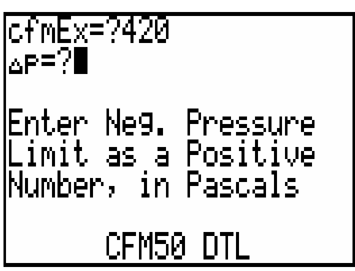

- You will see this menu on the screen. This is the main menu screen.
- Select **F1,** "CFM50," to solve for $CFM_{50}$ depressurization tightness limit.
- Select **F2,** "cfm," to solve for cfm exhaust limit of house exhaust appliances.
- Select **F3,** "ΔP," to solve for resulting ΔP from existing $CFM_{50}$ and exhaust cfm.
- Select **F4,** "ACKLG," to view program acknowledgements.
- Select **F5,** "QUIT," selection allows you to exit the program. Always exit the program by selecting **F5** from this menu; the decimal place is thereby set to "floating."

DTL-4




- Select **F1,** "CFM50," to solve for $CFM_{50}$ depressurization tightness limit.
- You will see this menu on the screen.
- Enter the actual, total cfm exhaust rate of all the exhaust appliances in the house. You may include appliances that are not yet installed, such as a dryer.
- For this example, assume the house has two bathroom exhaust fans at 50 cfm each, a kitchen range hood at 100 cfm, a workshop exhaust fan of 100 cfm, and a dryer to be installed of 120 cfm.
- Enter the total cfm of "420" and press **ENTER**.

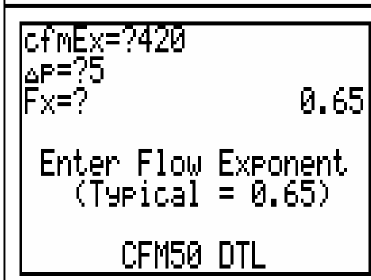
DTL-5




- Now you must enter the target ΔP in units of Pascals. This is the allowable difference between the indoor and outdoor pressure. You must choose this value for the safe operation of the natural draft combustion appliances. Most auditors for weatherization programs use a ΔP = -5 Pascals, plus or minus one. **This number is actually negative, but it is always entered as a positive number at this prompt.**
- Notice that there is an instructive comment on the screen under the prompt.
- Enter "5" and then press **ENTER**.

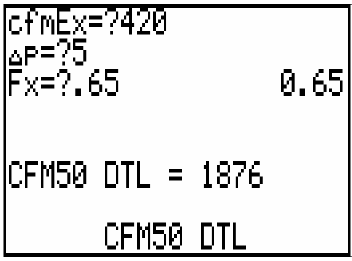
*This is very important!*

DTL-6



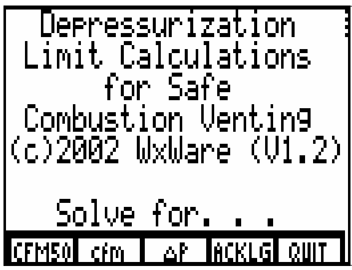

- Next you must enter the flow exponent, "Fx." This is the slope of the leakage curve of the house. There is a reminder value—0.65—to the right of the prompt for "Fx" as a reminder of the typical flow exponent value.
- If you know the actual flow exponent for the house as a result of conducting a multi-point blower door test, enter the actual value.
- Notice that "CFM50 DTL" appears at the bottom of the screen as a reminder of the routine on which you are working.
- For this example, enter ".65" and press **ENTER**.

DTL-7



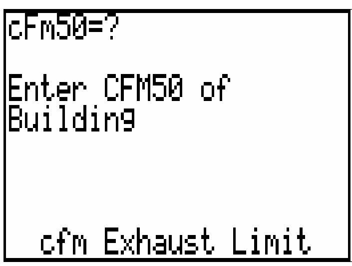

- With all three of the inputs entered, the CFM50 DTL answer of 1876 is displayed. Notice that the input values are displayed along with the answer.
- This $CFM_{50}$ depressurization tightness limit is the house tightness level that corresponds with a ΔP = -5, a cfm of exhaust appliances = 420, and a flow exponent of 0.65. The house should not be tightened to a lever below 1876 $CFM_{50}$.
- Press **ENTER** and we will try the next routine.

DTL-8



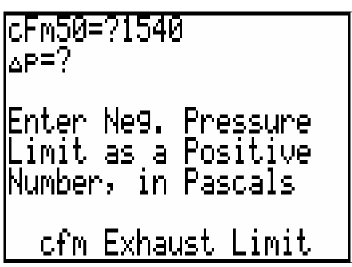

- Back to the home screen.
- Press **F2** for the "cfm" routine. This allows you to solve the cfm exhaust appliance limit for the house.

DTL-9




- At the bottom of the screen, notice the reminder of the routine on which you are working—"cfm Exhaust Limit."
- Enter the actual or the expected target of the house $CFM_{50}$.
- For this example, enter "1540" and press **ENTER.**

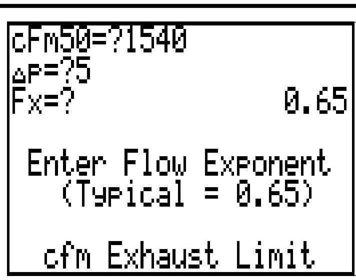
DTL-10




- Now you must enter the target ΔP in units of Pascals. This is the difference between the indoor and outdoor pressure allowable. You must choose this value for the safe operation of the combustion appliances. Many auditors for weatherization programs use a ΔP = -5 Pascals, plus or minus one. **This number is actually negative, but it is always entered as a positive number at this prompt.**
- Notice that there is an instructive comment on the screen under the prompt.
- For this example enter "5" and press **ENTER**.

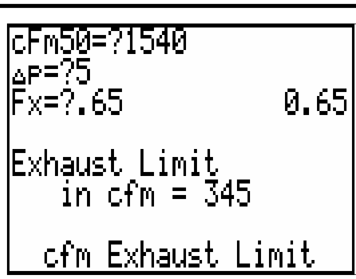
*This is very important!*

DTL-11



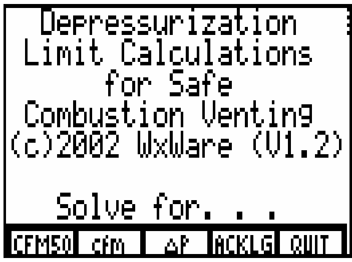

- Next you must enter the flow exponent, "Fx." This is the slope of the leakage curve of the house. There is a reminder value—0.65—to the right of the prompt for "Fx" as a reminder of the typical flow exponent value.
- If you know the actual flow exponent for the house as a result of conducting a multi-point blower door test, enter the actual value.
- For this example, enter ".65" and press **ENTER**.

DTL-12



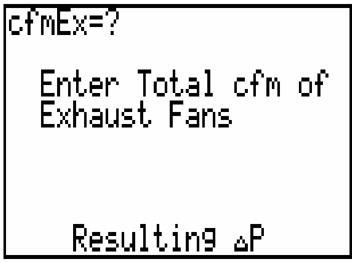

- With all three of the inputs entered, the "cfm Exhaust Limit" answer of 345 is displayed. Notice that the input values are displayed along with the output.
- This cfm exhaust limit corresponds with a ΔP = -5, a $CFM_{50}$ of 1540, and a flow exponent of 0.65. This house should not have exhaust fans installed with a total cfm greater than 345.
- Press **ENTER** and we will try the next routine.

DTL1-13



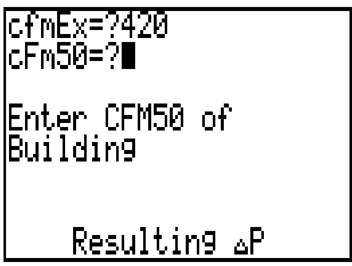

- Back to the home screen.
- Press **F3** for the “ΔP” routine. This allows you to solve for the resulting ΔP, the difference in Pascals of pressure between the indoors and outdoors of the house. You can quickly determine whether the vented combustion appliances in a house are likely to backdraft.

DTL-14



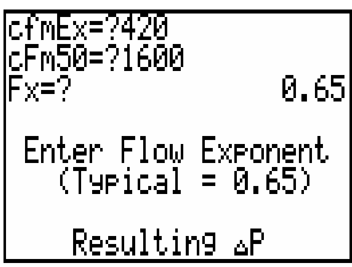

- Enter the actual, total cfm exhaust rate of all the exhaust appliances in the house. You may include appliances that are not yet installed, such as a dryer.
- For this example, assume the house has two bathroom exhaust fans at 50 cfm each, a kitchen range hood at 100 cfm, a workshop exhaust fan of 100 cfm, and a dryer to be installed of 120 cfm.
- At the bottom of the screen, notice the reminder of the routine on which you are working—”Resulting ΔP.”
- Enter the total cfm of “420” and press **ENTER**.

DTL-15



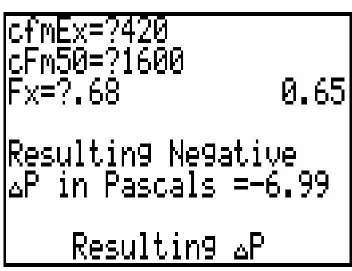

- Enter the actual or the expected target of the house $CFM_{50}$.
- For this example, enter “1600” and press **ENTER.**
- Notice that there is a instructive comment on the screen under the prompt line.

DTL-16



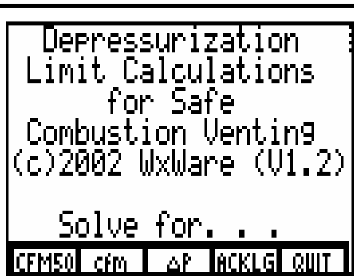

- Next you must enter the flow exponent, “Fx.” This is the slope of the leakage curve of the house. There is a reminder value—0.65—to the right of the prompt for “Fx” as a reminder of the typical flow exponent value.
- If you know the actual flow exponent for the house as a result of conducting a multi-point blower door test, enter the actual value.
- For this example, enter “.68” and press **ENTER**.

DTL-17




- With all three of the inputs entered, the “Resulting ΔP” answer of –6.99 is displayed. Notice that the input values are displayed along with the output.
- This resulting ΔP” corresponds with a cfm exhaust rate of 420, a $CFM_{50}$ of 1600, and a flow exponent of 0.68. When the exhaust appliances are operating in this house, they are likely to interfere with the proper venting of natural draft appliances.
- Press **ENTER**.

DTL-18




- Once again, back to the home screen.
- Press **F4** for “ACKLG” (acknowledgements).

DTL1-19


- This is the first of three acknowledgements screens.
- Press **ENTER**.

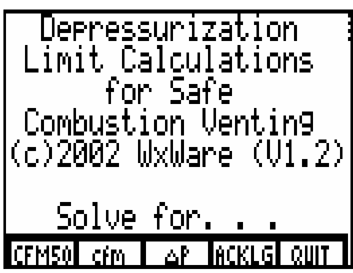
DTL-20


- This is the second of three acknowledgements screens.
- Press **ENTER**.

DTL-21


- This is the third of three acknowledgements screens.
- Press **ENTER**.

DTL-22




- Back again to the home screen.
- Press **F5** for "QUIT."
- Always exit any program by pressing "QUIT." This resets the decimal place to floating for the proper operation of the TI-86.

DTL-23


You will now see this display. You have now properly exited from the DTL program.

DTL-24

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