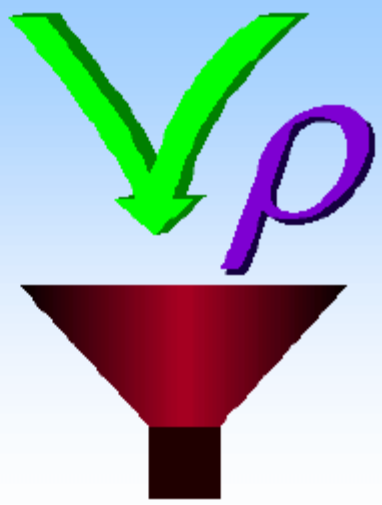
Duct Network Balance

Version 1.0

User's Manual



An automated template for use with Microsoft Excel 7 for Windows 95/Windows NT 4.0.

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1. Introducing the Duct Network Balance (DNB) Program

Duct Network Balance (DNB) automates the dust- or aerosol-control design practices described in the 1981 *Dust Control Design Manual*. The program calculates the parameters required to balance air flow into each entrance of a duct network exhaust system by providing the following information:

- Air flows and static pressures at test points for commissioning and troubleshooting the system.
- Entrance orifice sizes
- Performance specifications for determining fan speed and power requirements.

N O T E

DNB is designed for use with *Microsoft Excel 7 for Windows 95*/*Windows NT 4.0* on a Pentium II system. Do not use it with Excel 97 or later versions.

What Is DNB?

DNB is a custom Excel template for designing dust control systems. The template replaces the standard Excel menu items with the special functions required to calculate air flows, static pressure requirements, and orifice sizes for each branch of a dust or aerosol control system.

Basic DNB Definitions

DNB designs are stored as Excel workbooks, with each workbook containing related duct system design worksheets. The DNB design process begins when you enter data into the custom spreadsheet to create an initial, basic design. DNB uses specific terminology to describe the network balance system design.

- A *balance* is a worksheet of data and calculations for a single duct system design. To begin the design process, a user creates a new balance. The end result is that all branches of the system are balanced to deliver the design air flow. DNB calculations give you orifice sizes required to achieve the balance.
- A *base plan worksheet* is an initial system design (the first balance in a workbook) that can become the basis for a number of *options*, or alternative system designs.
- An *option* is a variation on a base plan system design. A base plan and its associated options make up a workbook of design alternatives that can be tested and evaluated in the process of creating the final design for construction.

The DNB Spreadsheet Screen

The user's view of DNB is not the standard Excel spreadsheet screen. A DNB balance screen is laid out so that its rows and columns correspond to the data cells of the Duct System Static Pressure worksheet in *Dust Control Design Manual*. It is an automated version of the worksheet used for hand calculations.

You enter data and make program selections using the DNB main menu (Figure 1) and a series of dialogs that guide you through the data entry, review, and verification process.

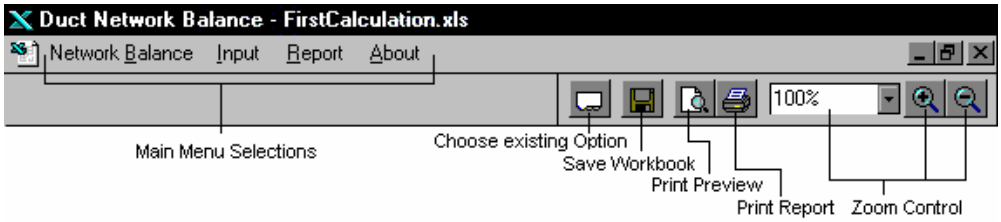

Figure 1

DNB has four main menu selections.

- **Network Balance**
  This drop-down menu selection includes the following items:

Menu Item	**Purpose**	**Discussion**
Create New Balance	Use this menu selection to create a new base plan	See **4. Working with Balances**
Choose Existing Option Create New Option Rename Option Delete Option	Use these menu selections to manage base plan variations.	See **8. Working with Options**
Save Save As	Use these items to save new and/or changed workbooks.	See **4. Working with Balances**
Duplicate to workbook	Use this menu selection to duplicate an option and save it to a blank workbook.	See **4. Working with Balances**
Update Administration data Change Defaults Change Filter Defaults	Use these items to change administrative and default data for a workbook	See **5. Setting Defaults**
Exit Balance	Use this item to exit DNB	

- **Input**
  This drop-down menu selection includes:

Menu Item	**Purpose**	**Discussion**
Node Numbers	Use this menu selection to start data entry for defining the nodes, or entry, exit, and test points, for the duct network's Branch Structure. You must define the nodes before you can enter branch data.	See **6. Defining Branch Structure**
Branch Data	Use this menu selection to start data entry for specifying detail data for a branch of the duct network. You enter branch data after you have defined the network's nodes.	See **7. Adding Branch Data**

- **Report**
  This drop-down menu selection includes:

Menu Item	Purpose	Discussion
View Reports	Use this menu selection to view DNB reports	See **9. Creating and Using Reports**
Print Reports	Use this menu selection to print DNB reports.	See **9. Creating and Using Reports**

DNB Inputs and Outputs

DNB requires the following inputs:

- A duct layout for the entire system that includes a node structure defining the start, test, and end points (nodes) for the network. (This is easily visualized by developing a flow diagram that shows air flow entries, junctions, and exits, test point locations, and air flow requirements.)
- Exhaust hood design, air flow and dimensional details identifying the cross-sectional area for each air flow path from the room into the dust control system. This data sets the basis for each individual air flow requirement.
- Ductwork component descriptions that include duct diameters, number and types of elbows, Ys, and other transitions, and duct lengths.

N O T E

DNB is designed to work with a maximum of 35 nodes, which is a sequence for any single air path, counting from an entrance through each node, to the filter, through the filter and fan and exhausting to atmosphere. The user may enter air entry nodes for as many as 256 separate air paths before DNB workbook capacity is exceeded.

DNB computes the parameters for balancing air flow into each entrance of a duct network exhaust system and provides the following information:

- Entrance orifice sizes.
- Design values for air flow and static pressure at all test points.
- Balance calculation and elbow summary.
- Fan speed and power requirements.

How DNB Works

To begin the design process, you create a base plan for the target system. The base plan begins with a network design that includes air flow diagrams and layout and dimensional data for the system's exhaust hood(s), duct(s), and component(s).

When you open the DNB template to create a new base plan worksheet, always save the base plan under a new file name. If you do not **Save As** a new file name, you write over the DNB template file named **Duct Balance 1.0.xls.**. This makes the template unusable and forces you to install a fresh copy.

Defaults

You define default values for typical design parameters used in DNB calculations. The default entries save time, but they can be overridden when necessary.

Branch Structure

You identify and number *nodes*, which are junctions, test points, and entrance/exit points on the air flow diagram. DNB uses the numbered nodes to model the sequence of connections, air velocity changes, and overall air flow within the duct network. A node system that is accurate and complete establishes a logic basis for the DNB calculations.

Branch Data

You enter the details of each section of duct which you have defined by the nodes of the Branch Structure. Duct diameters, lengths, construction type, elbow number and types, transition types, special losses, filters, and fans are entered through a variety of dialog boxes.

Entry Losses

Losses at the various entry points into the duct network are computed. DNB uses common entry coefficients to calculate entry losses for typical routine entrances; you must factor in design and dimensional data to compute entry losses for nonroutine entrances.

Please refer to **2. Getting Started with DNB**, for additional information about gathering and organizing the required input data.

Reports

DNB computes and outputs tables showing entrance orifice sizes, test pressures, and fan performance specs for the base plan system.

Velocity Critique

You can also constrain the design by specifying a conveying velocity range within which all air velocity in the system must fall. When you do this, DNB flags out-of-range data points. You can then choose to change the duct diameter to bring velocity into range or continue without changing. Then you save the worksheet as the base plan.

Options

After you have created and saved a base plan, DNB allows you to create, name, and input data for another option, or version of the network design. You can:

- Add new entrances and branches to the system
- Make design adjustments to optimize out-of-range velocities.
- Export an option to a fresh Workbook and re-use the system design in other locations.

The ability to create options allows you to take advantage of the program's "what-if" capability by comparing variations on the system and evaluating them before selecting the final design.

Who Should Use DNB?

The Duct Network System Balance program is designed specifically for users who have adequate training and experience with dust control system duct network design.

Engineering Experience

Before you attempt to use DNB for system design, it is strongly recommended that you have:

- Completed Section 8 (Duct Network and Balance) of the *Global Hygiene Engineering Training Manual*.
- Performed at least one system balance calculation by hand.

REQUIREMENT

You must be experienced with duct network system balancing, its concepts, and the required calculations. The recommended experience and training are **critical** to your understanding of the calculation process and essential for success with the DNB program.

The reliability of a dust control system is a function of its duct network design, which is affected strongly by various powder properties. DNB is not a substitute for good design; given the properties of the material collected, the program computes a balance whether the system is designed well or not. It is incumbent on the users to develop a reliable design, based on their experience and use of resources.

Basic Computer Experience

To use DNB efficiently, you must be:

- Familiar with the Windows 95/Windows NT 4.0 user interface. That means you must be able to identify the elements of a Windows desktop and understand how to use the mouse and keyboard to navigate screens and menus and to open, close, copy, and save files.
- Able to work with spreadsheets. You do not have to be an experienced Excel user, but you must understand the basic concepts of cells, rows, columns, worksheets, and workbooks (see **Appendix A. Understanding Excel as the Basis for DNB**).

4. Working with Balances

This section tells you how to:

- Use DNB to create a new base plan worksheet
- Make changes to an existing base plan worksheet
- Replace an existing base plan worksheet with a new one.

Prepare Your Data

Before you enter data into a DNB spreadsheet, you must have:

- A flow sheet illustrating air flow entries, junctions, start and end points (nodes), test point locations, and air flow requirements.
- Exhaust hood design, air flow, and dimensional details identifying the cross-sectional area of the air flow path from the room into the dust control duct.
- Duct layout (concept or final design) for the entire system, describing the ductwork components (duct diameters, number and types of elbows, Ys, and other transitions, and duct lengths.

Please read **3. Organizing your Data** before you start entering design data into a new balance.

To begin the design process in DNB, you create a new *balance*, or worksheet of data and calculations for a single duct system design. Each worksheet is part of a DNB workbook that contains at least one balance called a base plan.

A *base plan* is a worksheet of calculations for an initial system design (the first balance in a workbook) that can become the basis for a number of *options*, or alternative system designs.

An *option* is a variation on a base plan system design. A base plan and its associated options make up a workbook of design alternatives that can be tested and evaluated in the process of creating the final design for construction.

You can duplicate an option and save it to a blank workbook for use as the foundation for a similar base plan. See **Duplicate a Balance**, in this section for step-by-step instructions.

You can start a new base plan balance by opening a blank template (as described on the next page) or by selecting the **Create New Balance** menu item (as described in **Replace an Existing Balance**, in the last section of this chapter).

Create a New Balance from a Blank Template

You complete the **Administration - Dust Control System Balancing Process** dialog as the first step in creating a base plan balance in a blank template.

1. Double-click the DNB template icon to display the **Registration** dialog (Figure 2).
2. Complete the **Registration** dialog, as described in “Register DNB” on page 12.
   *The **Administration - Duct Control System Balancing Process** dialog (Figure 10) appears.*

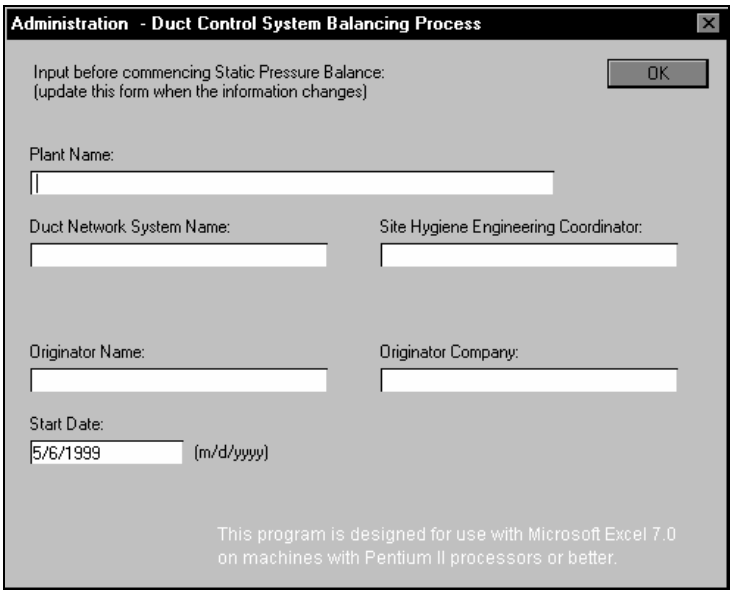

Figure 10.

3. Type the requested information in each field, pressing TAB to move forward, to the next field or SHIFT-TAB to move backward, to the previous field.
   - In the **Plant Name** box, type the name of the plant where the duct network is located.
   - In the **Duct Network System Name** box, type a name for the duct system to be designed.
   - In the **Site Hygiene Engineering Coordinator** box, type the name of the Site Hygiene Engineering Coordinator who will receive the completed calculations after system startup.
   - In the **Originator Name** box, type the originator’s name.
   - In the **Originator Company** box, type the name of the originating company.
   - In the **Start Date** box, accept the date displayed by typing nothing *or* type a different start date.

4. Click OK. *The dialog closes, and the* ***Duct Control Network Balancing Process*** *dialog (Figure 11) appears.*

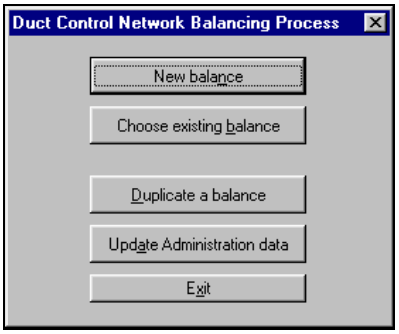

Figure 11.

5. Click **New balance.** *DNB displays a dialog asking "Do you want to start a new balance?*
6. Click **Yes**. *The* ***Units of Measure*** *dialog (Figure 20) appears. Completing this dialog is the first step in setting the defaults for your new balance, as described in* ***5. Setting Defaults****.*

Make Changes to an Existing Balance

After you have created a base plan (as described in the previous section, “Create a New Balance from a Blank Template”**)**, saved it (as described in “Save the Whole Workbook” in **2. Getting Started with DNB**), and exited DNB, you can open the program and edit the entries in your base plan by following these steps:

1. Double-click the icon for the existing DNB file (FirstBalance.xls, for example). *The **Administration - Duct Control System Balancing Process** dialog (Figure 10) appears.*
2. Enter any required administrative data changes in the appropriate fields; then click OK. *The dialog closes, and the **Duct Control Network Balancing Process** dialog (Figure 11) appears.*
3. Click **Choose an Existing Balance**. *The **Choose an Option** dialog (Figure 54) appears.*

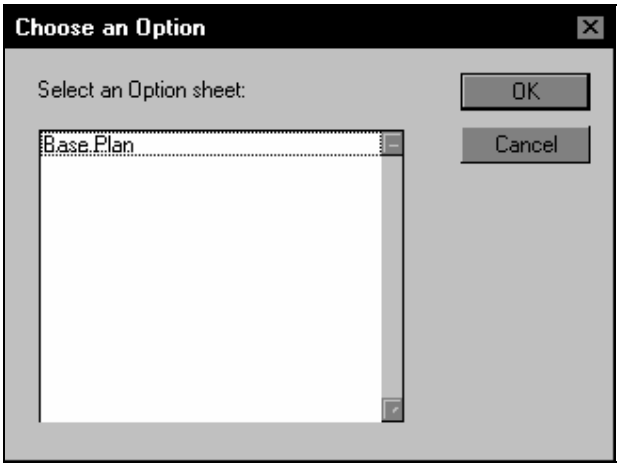

Figure 12.

4. Click to highlight the balance that must be edited, and click OK. *A **Duct Network Balance** spreadsheet (Figure 13) appears for the selected balance.*

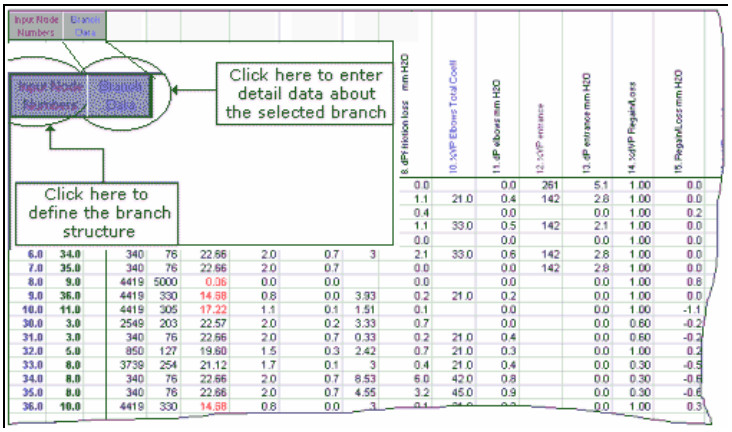

Figure 13.

To Insert or Remove a Branch

1. Click to select a row (branch); the added branch will be inserted in front of the selected branch.
2. Click **Input Node Numbers**. *The first **Ductwork Branch Structure** dialog (Node Input form, Figure 14) appears.*

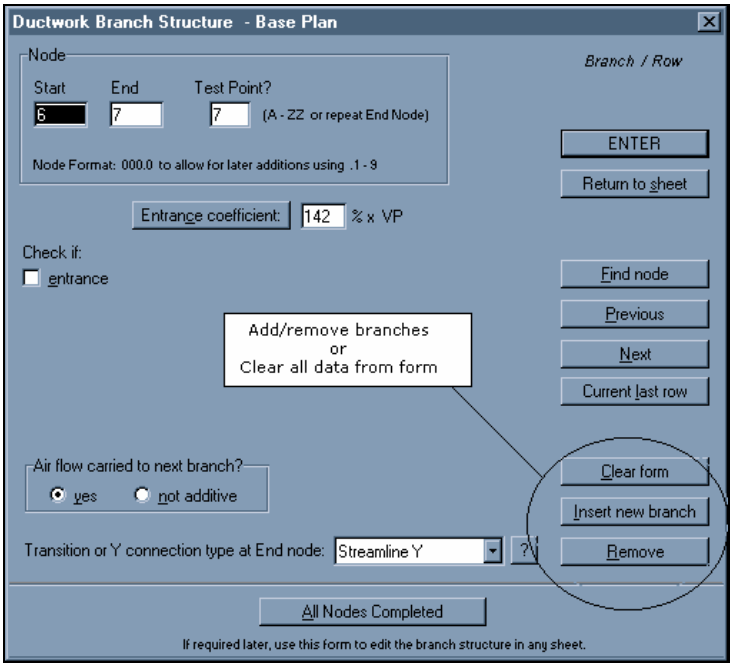

Figure 14.

3. Click the **Insert new branch** button to add a branch. *DNB displays a new Node Input form for the branch inserted in front of the selected branch.*
   - Complete the Node Input form for the new branch.
   - Click ENTER to save the branch and your entered data.

   or

4. Click the **Remove** button to remove the selected branch. *The Node Input form closes and the DNB worksheet appears, with the selected row/branch deleted.*

To Edit Node Numbers, Air Flow, or Ending Transitions

1. Click a cell in the row to select a row to be changed; then click **Input Node Numbers**. *The first **Ductwork Branch Structure** dialog appears, with the **Start Node** highlighted.*
2. Click to highlight the field to be changed, and make the required correction(s) in the highlighted field.
3. Repeat Step 2 until you have made all required changes; then click ENTER to close the dialog and save your changes.
4. Repeat Steps 1-3 for each row where a node number, air flow, or transition type must be edited.

To Edit Duct, Elbow, or Other Branch Data

1. Click to select a row to be changed; then click **Add Branch Data**. *The second **Ductwork Branch Structure** dialog (Branch Data form) appears.*.
2. Click to highlight the field to be changed, and make the required correction(s) in the highlighted field.
3. Repeat Step 2 until you have made all required changes; then click ENTER to close the dialog and save your changes.
4. Repeat Steps 1-3 for each row where an entry must be edited.