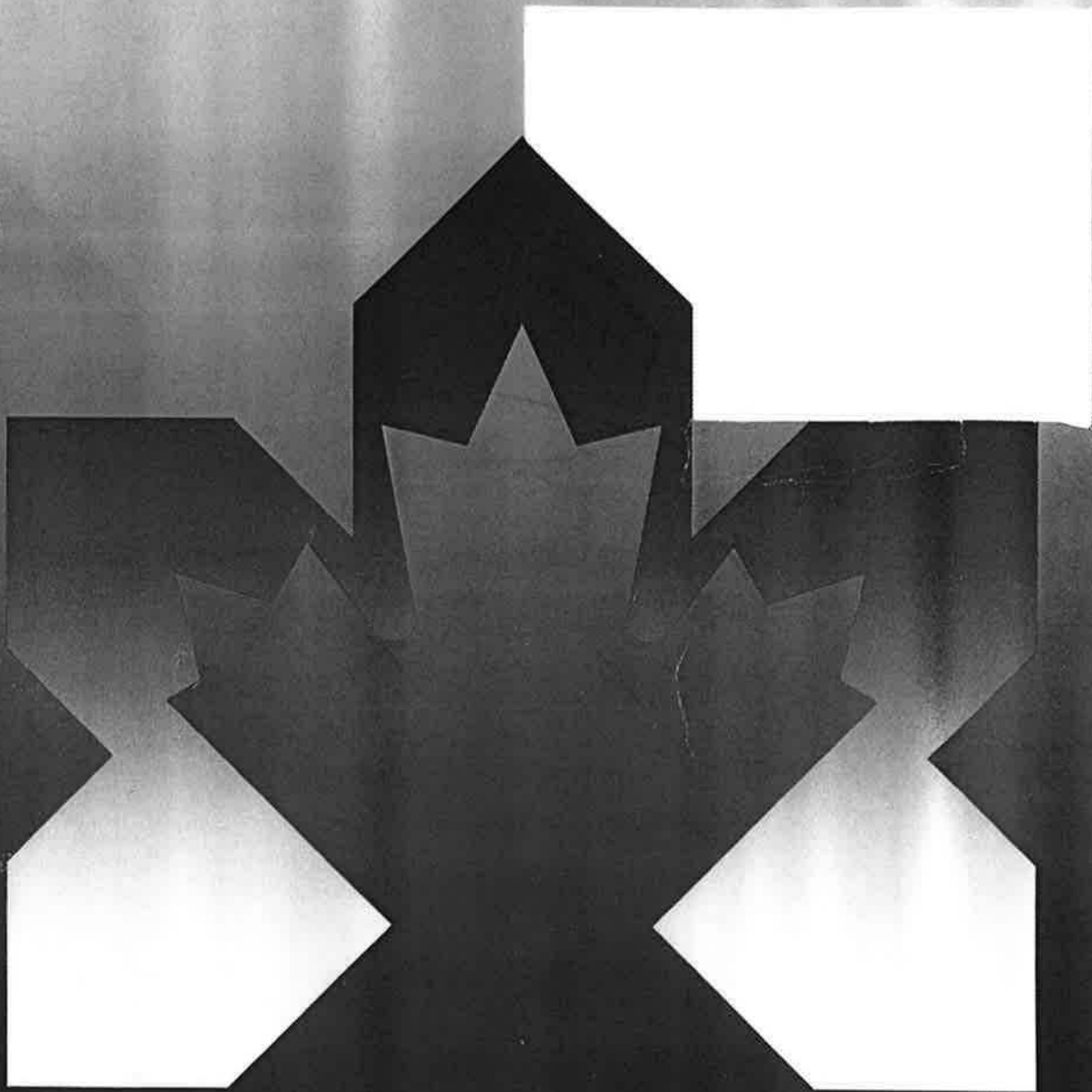


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2.4 Approach for Applying Simulation Tools

Two new approaches have been considered in this project to add the capabilities to CONAIR of simulating subslab venting systems, separations between the basement wall and backfill, and air barriers: modify PRESSU and MASTRA, and add them to CONAIR so all three programs run together; or develop an input file generator for CONAIR so it can also simulate airflows, pressures, radon fluxes, and radon concentrations in the soil.

In the first approach, PRESSU and MASTRA would have to be substantially modified, which would be difficult, because these programs are not written in a modular style. The sequential node method used in these programs is not directly compatible with the simultaneous one used in CONAIR. This difference would significantly complicate direct linking of these programs.

In the second approach, extending the capabilities of CONAIR does not involve PRESSU and MASTRA. Instead, a new program would be developed to generate input data for CONAIR. CONAIR already has the capability to solve airflow networks and to model convective and diffusive transport of radon through these networks. Thus, an input generator would only need to describe the soil surrounding a house as part of an airflow network already used to describe that house.

Specifically, the new program would define a three-dimensional grid, allocate and characterize nodes to discretely describe the soil, and determine flow resistances between these nodes based on soil permeability. The program would also characterize the radon production rate at each node and the diffusivity of radon between nodes.

The second approach is simpler than the first one, because it requires less programming effort. Modifications to existing computer code not developed in-house often require more time and effort to understand the structure of that code than that required to develop and test new code. Therefore, the second approach was used in this project.

2.3.2 Review of CONAIR

The CONAIR computer program (Wray 1990, Wray and Yuill 1990a, 1990b; Yuill and Wray 1989) is capable of simultaneously solving for room pressures, interzone airflows, HVAC system airflows, and flows across the building envelope, taking into account the effects of buoyancy, wind, and building features. It includes a wind flow model that can estimate the distribution of wind pressure coefficients on all four sides of a building, and that can account for the effects of terrain on the wind velocity profile. CONAIR also contains a model that accounts for two-way buoyancy-driven airflows in large openings such as doorways. The program calculates steady-state airflow rates on an hour-by-hour basis using hourly weather data such as wind velocity, wind direction, and outdoor temperature.

Time-varying or steady-state radon levels under the influence of these airflow rates can be predicted by the program. It simultaneously determines the concentrations at discrete points within the building. The program can model: steady-state and/or time-varying radon mass transport due to air movement (infiltration, exfiltration, interzone airflows, and HVAC system airflows); removal of radon from the air by radioactive transmutation; and steady-state or time-varying generation of radon. Provisions for simulating one-dimensional convection-diffusion processes are included in the program.

2.3.3 Review of PRESSU and MASTRA

PRESSU and MASTRA implement three-dimensional steady-state finite-difference models. PRESSU uses a sequential node method (Jeppson 1982), along with Darcy's law and the principle of conservation of mass, to predict the soil gas velocity and pressure fields in a heterogeneous soil region surrounding a basement. MASTRA uses the soil gas velocity field generated by PRESSU and a sequential node method, along with models of radon production and of convective and diffusive transport of radon, to predict radon concentrations and fluxes in the soil. MASTRA also predicts total soil gas infiltration and radon entry rates from the soil into the basement. These two programs can model basements that have a crack only at the basement wall/floor intersection. However, they cannot model subslab venting systems, separations between the basement wall and backfill, or air barriers in the soil.

studies of mitigation system types to gain an understanding of the general patterns of radon dynamics and of mitigation system performance. This enables better and cheaper mitigation systems to be developed.

2.3 Review of Existing Programs

2.3.1 Introduction

The work carried out in this project is the next step in a series of studies of radon mitigation system performance that have involved the development of three computer programs (Wray 1990, Yuill and Associates 1991). One program (CONAIR) models airflow and the movement of radon in multizone buildings (Wray and Yuill 1990a, Wray and Yuill 1990b). The other two programs (PRESSU and MASTRA) model the three-dimensional flow of air and the emanation and transport of radon in the soil surrounding these buildings (Loureiro 1987).

These programs have been linked in the past in a crude way (Wray 1990), which was adequate for the studies carried out. The results of a series of runs at several different pressures using the soil models were reduced to a flow equation and an equation for radon source strength. These equations were then added to the multizone model of the indoor space. This approach has been used to simulate air and radon transport in a conventional house, but it cannot be used to model houses with subslab venting systems. These systems introduce additional links between the indoor space and the soil, which require a coupled network solution of the soil and indoor space.

In the remainder of this Chapter, these programs are examined to determine their applicability to simultaneously simulating the airflows and radon levels in a house and in the heterogeneous soil surrounding its basement for three different radon mitigation systems (basement suction, subslab depressurization, and subslab pressurization). A new approach to simulating these systems is presented at the end of this Chapter.

2.2 Need for Simulation Tools

The impact of radon mitigation systems such as subslab venting on airflows and radon levels in buildings and in the soil surrounding them is too complex to predict without computer simulation. Although preliminary field monitoring of a Winnipeg test house has been carried out to study these interactions (Yuill and Associates 1991), the results of that work indicate more detailed monitoring is required if this approach is to be used to fully understand the variations in airflow patterns and radon levels caused by these systems. Unfortunately, that approach is prohibitively expensive and time consuming if even a few combinations of building type, system type, ventilation rates, and soil types are to be examined.

The analysis of airflows has significantly lagged the modelling of other building features, because of limited data, computational difficulties, and incompatible methods for analyzing different flows. This is particularly true of the combined building, soil, and HVAC system simulation. In the past, methods have been applied independently to analyze airflows in mechanical ventilation systems, to predict soil gas flow fields, and to estimate total infiltration and natural ventilation for the building. The predicted flows were then combined using crude superposition models intended to account for the non-linear interactions between these processes. Kiel and Wilson (1987) have shown that total ventilation is not well predicted by these superposition models due to the non-linear interactions between pressures and flows in the presence of natural and forced ventilation.

More sophisticated airflow models, such as multizone airflow and pollutant dispersal analysis computer programs, have been developed recently to treat the building and soil as a network. In these models, the rooms, soil, and outdoor environment are represented by nodes. Discrete airflow passages such as construction cracks, ducts, fans, doorways, and sections of the soil are represented by airflow elements that connect the nodes to one another. Flows within these elements are calculated using well-established relationships between airflow rate and element pressure differential to solve sequentially or simultaneously for the pressure at each node as a function of wind and stack effects and as a function of HVAC system operation.

Multizone simulation tools are far too complex to be applied to analyzing individual houses to develop their mitigation systems. Rather, they can be used in generic

2.0 PHASE 1 - AIR / RADON TRANSPORT SIMULATION TOOLS - A REVIEW

2.1 Introduction - Importance of the Research

Radon is a radioactive gas that is produced by the radioactive decay of radium. It is part of the decay chain of uranium-238, which is present in varying concentrations in most mineral materials. The precursors of radon are not a significant hazard, because they are solids that remain bound in the minerals where they are produced. Radon, however, is a noble gas, so it emanates from the radium-bearing minerals. In soil, radon can move through the pore spaces.

Houses draw radon from the soil due to stack effect (the tendency of warm air to rise) and due to wind effect (the alteration in indoor pressure caused by the flow of wind over and around a house). As a result, the radon concentration in a house can rise to a dangerous level. This does not happen in the atmosphere, because radon has a short half-life (3.8 days), which allows it to decay fast enough to keep the atmospheric concentration low.

Radon is our most serious indoor air pollution problem. According to the U.S. Environmental Protection Agency (EPA), radon-induced lung cancer kills about 20,000 Americans per year (Puskin and Nelson 1989), which is more than all other indoor air pollutants combined. This amount is probably proportionally as high in Canada.

Radon is also our most serious radiation problem. Well over half of the total radiation exposure of the Canadian population is due to the radioactive decay products of radon. Many thousands of Canadian homes expose their occupants to more radiation than is permitted in uranium mines or around nuclear reactors.

Radon mitigation systems are presently being installed in houses, and it has been found that they usually reduce radon levels substantially. However, more knowledge is needed to make it possible to design these systems with confidence that they will work, that their capital and operating costs will be minimized, and that their use will not cause other problems.

It is recommended that:

1. the finding regarding the potential of large separations between the basement wall and backfill to contribute to soil freezing be studied further through computer simulations of heat transfer and airflow in the soil, and
2. the finding about the relative performance of the mitigation system types be confirmed by experiments in test houses and by computer simulation for a wider range of configurations and soil types.

reduced by sealing the basement as tightly as possible before installing the subslab depressurization system, and then adjusting the subslab depressurization flow rate to provide just the amount of ventilation required to exclude entry of soil gas into the house.

With a large separation between the basement wall and the backfill and without the air barrier, most of the air removed by the subslab depressurization system passed through the separation, and not through the basement. Further research regarding the heat transfer around the footings is necessary to determine if the cold outdoor air drawn through the separation by this system could cause the soil to freeze under the footings and damage the foundation.

When the subslab depressurization system operated with a small separation or with a soil air barrier installed, the program predictions showed the simulated house was adequately ventilated according to CSA Standard F326.1-M1989 "Residential Mechanical Ventilation Requirements" and soil gas entry into the basement was excluded. With a large separation, this system did not adequately ventilate the house and soil gas entered the basement. Although the simulations predicted that the basement suction system also ventilated the house similarly for these same conditions, soil gas always entered the basement when this system operated. The predicted radon levels in the living room when this system operated were an order of magnitude greater than those when the subslab depressurization system operated. To reduce these levels with the basement suction system, the exhaust airflow rate from the basement would have to be increased to eliminate flow from the basement to the main floor. This increase would lead to unnecessary energy losses.

Program predictions also showed the subslab pressurization system did not adequately ventilate the house according to CSA Standard F326.1-M1989 and did not exclude soil gas entry from the basement under any conditions. The predicted indoor radon levels when this system operated were significantly higher than those when the subslab depressurization system operated. Most of the air exhausted from the main floor and supplied to the subslab region by this system was predicted to return to the main floor through the basement. This recirculation of exhaust air is not permitted by CSA Standard F326.1-M1989.

1.0 EXECUTIVE SUMMARY

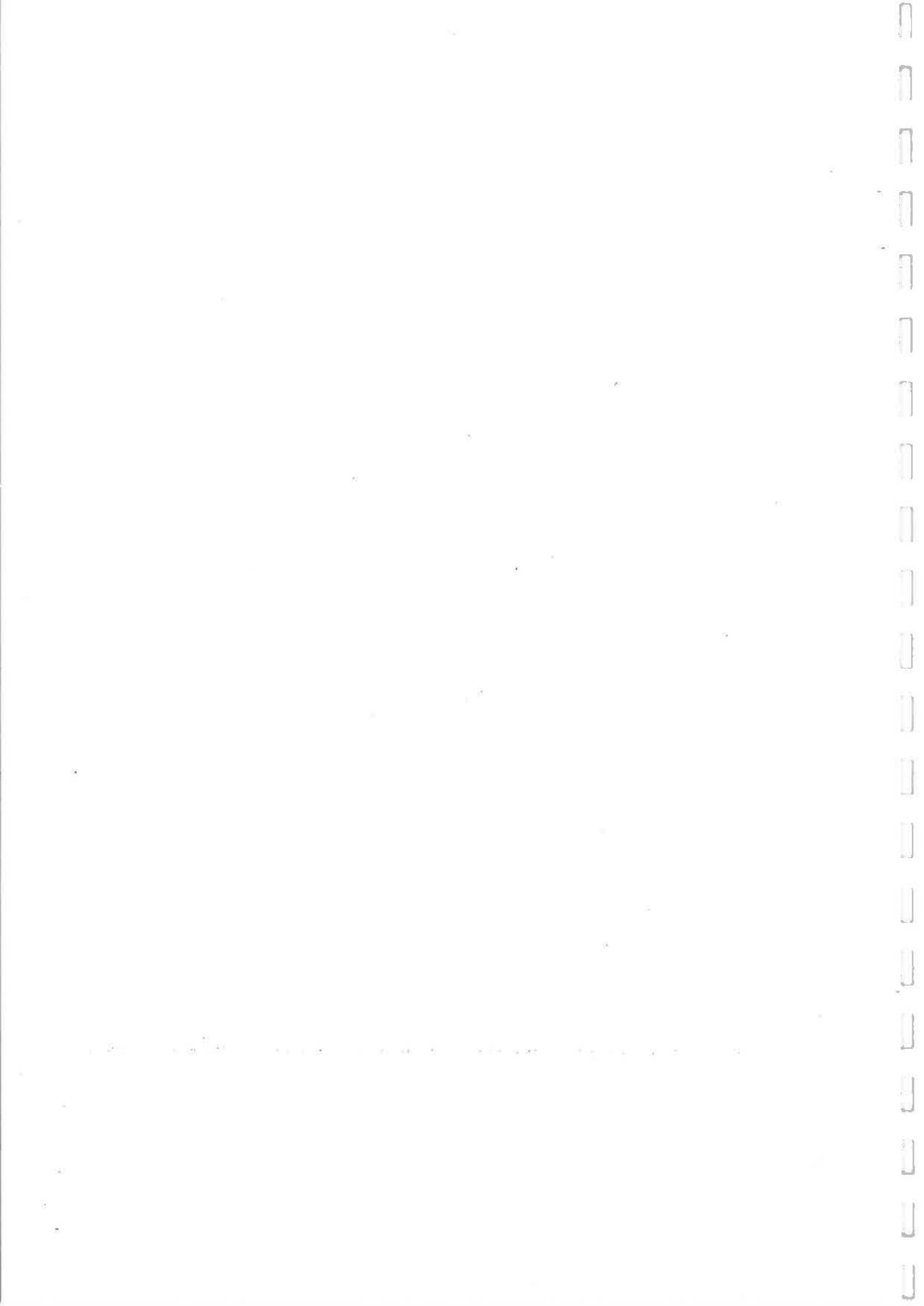
This project had the objectives of assessing the performance of subslab ventilation systems and of assessing their potential for creating foundation problems and for wasting energy. The approach taken to achieve these objectives was to use a computer program (CONAIR) to simulate the flow of air and radon through a house and the soil surrounding it for fifteen cases. These cases considered different combinations of three radon mitigation systems (subslab depressurization, subslab pressurization, and basement suction), a large and small separation width between the basement wall and backfill, a soil air barrier at grade level, and two subslab venting system flow rates.

One of the two most important findings was that indoor radon levels were always lower with subslab depressurization than with subslab pressurization or basement suction. For example, in the cases with a small separation width, a low subslab venting system flow rate, and no soil air barrier, the radon concentration on the main floor was 0.2 pCi/L with the subslab depressurization system. This concentration was the same as that outdoors, was 15 times lower than that with the basement suction system, and was 60 times lower than that with the subslab pressurization system.

The second important finding was that in cases with a small separation between the basement wall and the backfill, or in cases with an air barrier at grade covering the separation and backfill, most of the air exhausted by the subslab depressurization system from the subslab region originated in the basement, and not in the soil. Therefore, it is unlikely in these cases that cold outdoor air drawn through the soil by the subslab depressurization system could cause the soil to freeze under the footings and damage the foundation.

The air flowing from the basement into the subslab region could create two problems. It could depressurize the basement enough to cause furnace backdrafting, and it could withdraw enough air from the house to cause excessive inflow of cold outdoor air, thus wasting heating energy.

Radon mitigation contractors must be trained to avoid these two problems. Excessive depressurization can be avoided by testing the house for furnace backdrafting potential, and providing combustion air if necessary. Energy use can be



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séparation peut faire geler le sol sous les semelles et endommager les fondations.

Lorsque le système de dépressurisation sous la dalle fonctionne dans une maison où la séparation est petite ou pourvue d'un pare-air au sol, le programme indique que la maison en simulation est correctement ventilée, respecte la norme F326.1-M1989 de la CSA, intitulée «Ventilation des habitations», et empêche l'infiltration des gaz souterrains. Lorsque la séparation est grande, ce système n'arrive pas à ventiler la maison adéquatement et les gaz souterrains parviennent à s'infiltrer dans le sous-sol. Bien que les simulations révèlent que le système d'aspiration au sous-sol ventile tout autant la maison dans les mêmes conditions, il n'entrave pas l'infiltration des gaz souterrains dans le sous-sol. Les concentrations de radon prévues pour le salon à l'utilisation de ce système sont plus élevées par un ordre de grandeur que celles qui sont anticipées à l'emploi du système de dépressurisation. Pour que ces concentrations soient réduites avec le système d'aspiration au sous-sol, il faudrait que le débit de l'air extrait du sous-sol soit accru de manière à éliminer le mouvement d'air entre le sous-sol et le rez-de-chaussée. Cette augmentation entraînerait toutefois des pertes d'énergie inutiles.

Le programme montre également que le système de pressurisation sous la dalle ne réussit pas à ventiler la maison suffisamment pour respecter la norme F326.1-M1989 de la CSA et n'empêche jamais l'infiltration des gaz souterrains dans le sous-sol. Les concentrations intérieures de radon prévues à l'utilisation de ce système sont beaucoup plus élevées que lorsque le système de dépressurisation est employé. Le logiciel prévoit que la majeure partie de l'air extrait du rez-de-chaussée et amené sous la dalle par ce système retourne au rez-de-chaussée en passant par le sous-sol. Ce genre de recirculation de l'air extrait n'est pas permis par la norme F326.1-M1989.

Recommandations

1. Il faudra étudier davantage, au moyen de plus amples simulations informatiques du transfert de la chaleur et du mouvement de l'air dans le sol, l'observation selon laquelle une grande séparation entre le sous-sol et le remblai peut faire geler le sol.
2. La performance relative des divers systèmes de réduction des concentrations de radon devra être confirmée au moyen d'expériences dans des maisons d'essai ainsi que par simulation informatique pour un large éventail de configurations et de sols.

RÉSUMÉ

Cette étude a pour objectifs d'évaluer la performance d'installations de ventilation sous la dalle et de déterminer si elles peuvent entraîner des problèmes de fondations et un gaspillage d'énergie. À ces fins, le logiciel CONAIR est utilisé pour simuler le débit d'air et de radon passant dans une maison et le sol environnant. Quinze cas permettent d'étudier les différentes combinaisons de systèmes de réduction de la concentration du radon (dépressurisation sous la dalle, pressurisation sous la dalle et aspiration au sous-sol). En outre, ces cas servent à analyser l'efficacité d'une petite et d'une grande séparation entre le mur du sous-sol et le remblai, la pose d'un pare-air au niveau du sol et les débits de deux installations de ventilation sous la dalle.

L'étude révèle deux phénomènes d'importance : premièrement, les concentrations intérieures de radon sont toujours plus faibles en dépressurisation qu'en pressurisation sous la dalle ou qu'en aspiration au sous-sol. Par exemple, lorsque la séparation est petite, que le débit de l'installation de ventilation sous la dalle est faible et qu'il n'y a pas de pare-air au sol, la concentration de radon au rez-de-chaussée est de 0,2 pCi/L avec le système de dépressurisation sous la dalle. Cette concentration est la même que celle de l'extérieur, soit 15 fois moins que ce que l'on obtient avec le système à aspiration au sous-sol et 60 fois moins qu'avec le système de pressurisation sous la dalle.

Deuxièmement, lorsque la séparation entre le mur du sous-sol et le remblai est petite ou lorsqu'un pare-air au sol recouvre la séparation et le remblai, la plupart de l'air extrait sous la dalle par le système de dépressurisation provient du sous-sol et non du sol. Par conséquent, il est peu probable que, dans ces cas, l'air froid de l'extérieur entraîné dans le sol par le système de dépressurisation sous la dalle fasse geler le sol sous les semelles et endommage les fondations.

L'air qui va du sous-sol à la zone située sous la dalle pourrait créer deux problèmes. Il pourrait dépressuriser le sous-sol suffisamment pour entraîner le refoulement des gaz de combustion du générateur de chaleur et extraire assez d'air de la maison pour causer l'admission excessive d'air froid extérieur, gaspillant ainsi l'énergie consacrée au chauffage.

Les entrepreneurs spécialisés dans la réduction des concentrations de radon doivent être formés de manière à éviter ces deux problèmes. On peut pallier à la dépressurisation excessive en vérifiant si le générateur de chaleur de la maison présente des risques de refoulement et en assurant, au besoin, un apport d'air comburant. L'énergie utilisée peut être réduite en rendant le sous-sol le plus étanche possible avant d'installer le système de dépressurisation sous la dalle, puis en réglant le débit de dépressurisation de manière à fournir la quantité exacte de ventilation requise pour empêcher l'infiltration des gaz souterrains.

Lorsque la séparation entre le mur du sous-sol et le remblai est grande et qu'il n'y a pas de pare-air, la plupart de l'air extrait par le système de dépressurisation passe par cette séparation et non par le sous-sol. De plus amples recherches concernant le transfert de chaleur autour des semelles sont nécessaires pour déterminer si l'air froid extérieur aspiré de la sorte par la

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ACKNOWLEDGMENTS

This project was funded by the Canada Mortgage and Housing Corporation. The views expressed are those of the author and do not represent the official views of the Corporation. The Corporation accepts no responsibility for these views.

ABSTRACT

The project had the objectives of studying the effectiveness of subslab ventilation systems in reducing indoor radon levels, and of assessing their potentials for creating foundation problems, wasting energy, and creating troublesome or dangerous indoor depressurization. To achieve these objectives, a computer program was used to simulate the flow of air and radon through a house and the soil surrounding it for fifteen cases. These cases considered different combinations of three radon mitigation systems (subslab depressurization, subslab pressurization, and basement suction), a large and small separation width between the basement wall and backfill, a soil air barrier at grade level, and two subslab venting system flow rates.

Of the three systems, subslab depressurization always worked best. With a small separation between the basement wall and the backfill, or with the soil air barrier installed, most of the air removed by this system came from inside the basement, not from the soil. Therefore, cold air drawn through the soil by this system is unlikely to cause the soil to freeze under the footings and damage the foundation. However, this flow of air from the basement could depressurize the basement enough to cause furnace backdrafting, and could withdraw enough air from the house to cause excessive inflow of cold outside air, thus wasting heating energy.

Radon mitigation contractors must be trained to avoid these two problems. Excessive depressurization can be avoided by providing combustion air if testing the house indicates a potential for furnace backdrafting. Energy use can be reduced by sealing the basement as tightly as possible before installing the subslab depressurization system, and then adjusting that system's flow rate to provide just the ventilation required to exclude entry of soil gas into the house.

With a large separation between the basement wall and the backfill and without the air barrier, most of the air removed by the subslab depressurization system passed through the separation, and not through the basement. Further research regarding the heat transfer around the footings is necessary to determine if the cold outdoor air drawn through the separation by this system could cause the soil to freeze under the footings and damage the foundation.

Final Report for
CANADA MORTGAGE AND HOUSING CORPORATION

**Computer Simulation of the Transport of
Soil Gas, Indoor Air, and Atmospheric Air
into Subslab Venting Systems**

Prepared by:

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(File: 90341-105/V341003)

Peter Russell
CMHC Project Manager
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August 19, 1991

Yuill and Associates

Consulting Engineers

August 19, 1991

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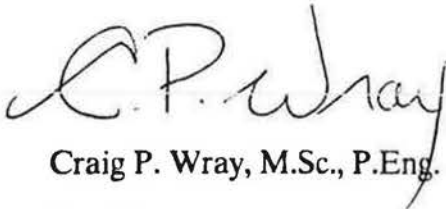
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Sincerely,

G.K. YUILL & ASSOCIATES (B.C.) LTD.



Craig P. Wray, M.Sc., P.Eng.

President

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Encl.

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3.0 PHASE 2 - PROGRAMMING AND VALIDATION

3.1 Program to Generate Input Files for CONAIR

3.1.1 Introduction

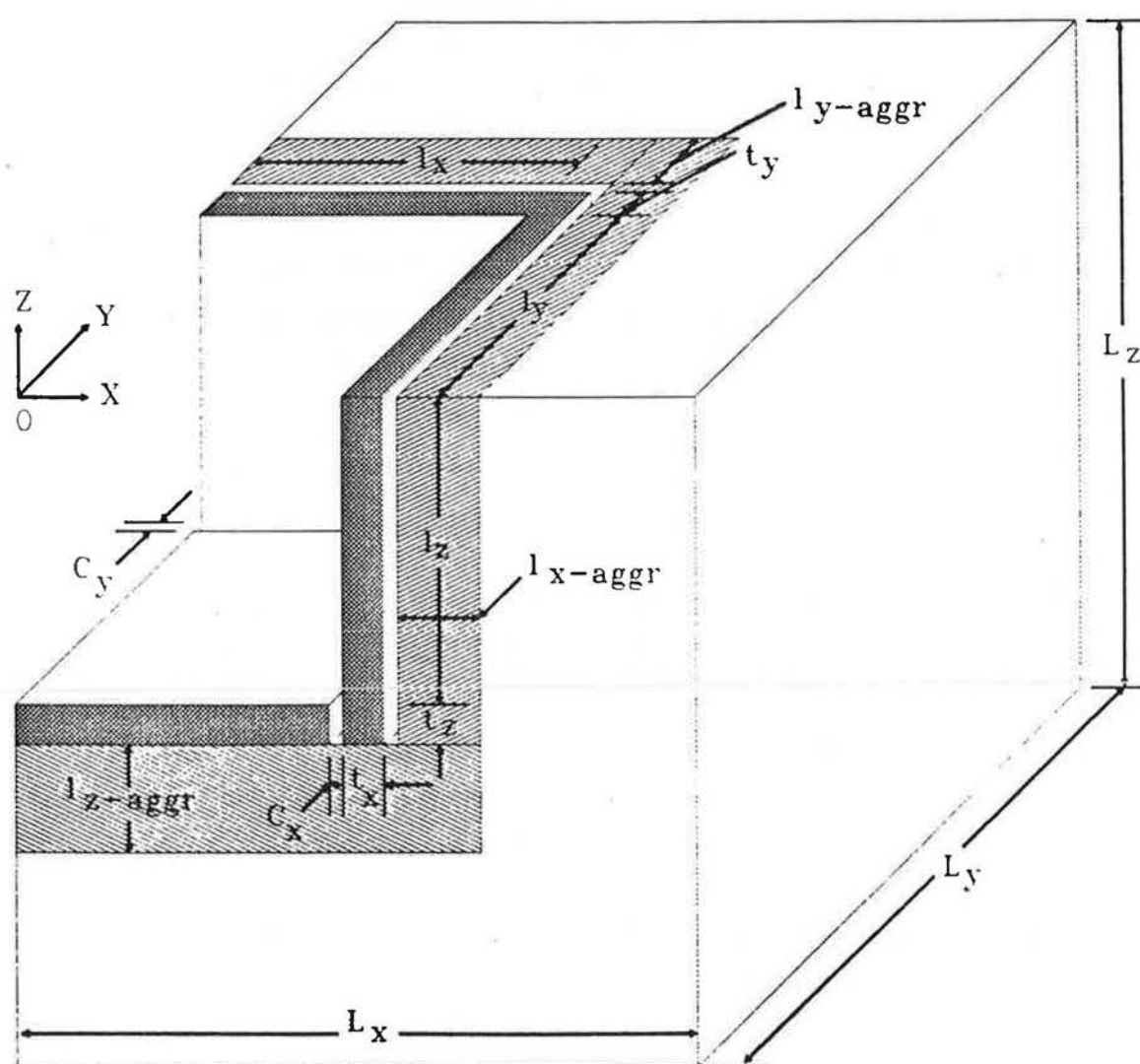
In this project, the soil was assumed to be a porous medium with no open channels or fractures. It was also assumed that: soil properties are constant and isotropic within each distinct region of the soil surrounding the basement; the soil gas in the pore spaces can be treated as a single-phase gaseous mixture of air and radon; and soil gas density was constant, so the soil gas was considered to be incompressible.

The geometrical configuration of the basement and surrounding soil for the house modelled in this project is shown in Figure 3.1. It is based on the configuration used by Loureiro (1987). Only one quarter of the soil surrounding the basement was modelled, because symmetry around the basement was assumed. Except for the surface of the soil at grade and the surface immediately below the basement floor perimeter crack, it was assumed there is no flow across boundaries of the quarter soil block.

Basement wall footings were not modelled, because it was assumed the subslab region and bottom of the backfill region are coupled and have flow resistances several orders of magnitude lower than the rest of the soil. Ignoring the footings is not expected to significantly affect the program predictions for the cases considered in this project. However, further research in a future project should be carried out to quantify the effect footings and drain tile systems have on program predictions.

The basement has dimensions of $2l_x$, $2l_y$, and l_z . The soil block has dimensions $2L_x$, $2L_y$, and L_z . Three different regions of aggregate soil material with thicknesses $l_{x\text{-aggr}}$, $l_{y\text{-aggr}}$, and $l_{z\text{-aggr}}$ in the x-, y-, and z-directions respectively are located just outside the basement. The basement walls have thicknesses of t_x and t_y respectively in the x- and y-directions. The floor has a thickness of t_z . Soil gas can enter the basement only through a crack located at the wall-floor interface. The crack width is C_x and C_y in the x- and y-directions respectively.

Figure 3.1. Basement and soil block geometrical configuration.



Note: Diagram is not to scale.

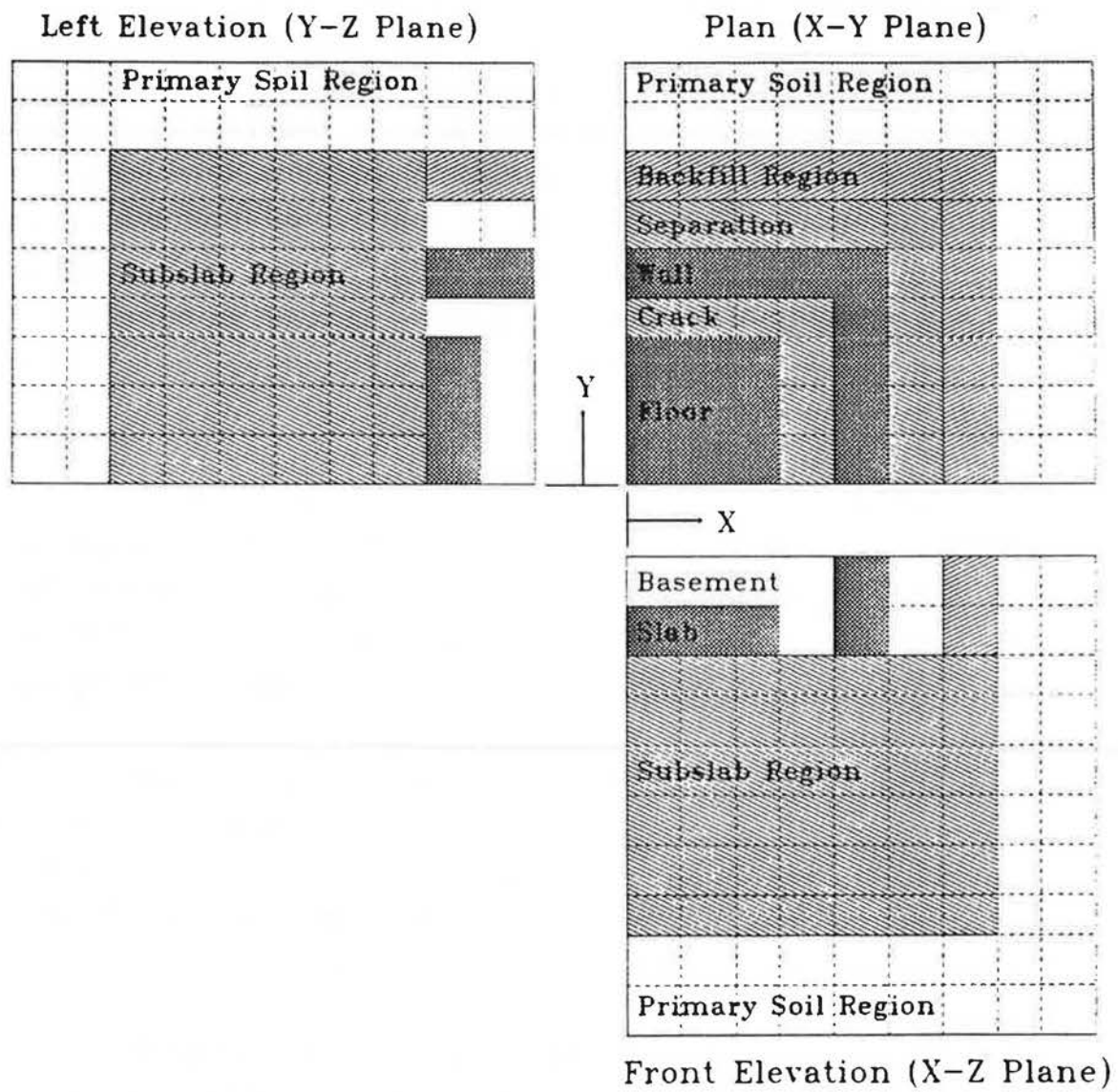
A single network was used to represent the house, the soil surrounding it, and the radon mitigation systems. Each room of the house was considered to be a single zone. To simulate soil gas flow and radon levels within the soil, the quarter soil block was divided into hundreds of nodes using a non-uniform three-dimensional grid. The method for defining the grid is similar to that used by Loureiro (1987). Each soil node was placed at the center of a different grid control volume.

Indoor nodes were connected with convective flow elements, while the soil nodes were connected by convective-diffusive flow elements. The house was coupled to the soil using convective-diffusive flow elements to represent the crack at the basement floor perimeter. Another set of convective-diffusive flow elements were used to represent the separation between the basement wall and backfill. The subslab radon mitigation systems were represented by constant-flow convective elements supplying air to or exhausting air from a node in the subslab region immediately beneath the center of the floor slab.

To use CONAIR, several parameters had to be specified for each node and/or flow element in each of the four distinct soil regions. These included the depth of each node below grade, the mass of air in the control volume surrounding each node, the radon generation rate for each node, the flow resistance to gas in each element, the radon diffusivity in each element, the length of each element, and the mass per unit length of each element. The manual calculation and specification of these parameters would be prone to error and too time consuming to carry out within the scope of this project. To solve this problem, a new computer program was developed by Yuill and Associates. The program subdivides the soil, determines the necessary parameters, and generates CONAIR input data files. The input file generator program is listed in Appendix A.

Using the new program, the soil block was subdivided into ten planes in the x-direction, ten planes in the y-direction, and eleven planes in the z-direction. Figure 3.2 shows the locations of these planes in the soil. The total network consisted of 787 nodes and 2143 elements, of which 778 nodes and 2100 elements were in the soil. Excerpts from a sample set of CONAIR input files generated using this program are listed in Appendix B. The entire files were not included, because they are too large. These excerpts illustrate the format of the input files.

Figure 3.2. Location of soil regions around basement.



Note: Diagram is not to scale.

3.1.2 Airflow Network Inputs

3.1.2.1 Soil Permeabilities and Flow Coefficients

Darcy's law (Wray 1990) and the fundamental principle of conservation of mass were assumed to govern the flow of gas through the soil. However, CONAIR does not contain a flow element based on Darcy's law. To model flow in the soil based on Darcy's law, the power law resistance element in CONAIR was used. For this element, the relationship between flow and pressure difference is based on that which is commonly used to represent leaks across a building envelope (Wray 1990). A flow exponent of 1.0 in the soil was assumed. Thus, the relationship between the flow coefficient and soil permeability was defined as:

$$C = k A (\rho)^{0.5} / (\mu l) \quad (3.1)$$

where

C = flow coefficient, $(\text{m}^3 \cdot \text{kg})^{0.5} / (\text{Pa} \cdot \text{s})$.

k = soil permeability, m^2 .

A = element cross-sectional area, m^2 .

ρ = soil gas density, kg/m^3 .

μ = soil gas dynamic viscosity, $\text{Pa} \cdot \text{s}$.

l = element length, m .

For the basement floor perimeter crack and for the separation between the basement wall and backfill, the same power law relationship was used, but the flow coefficients were defined differently. For these flow elements, it was assumed the flow was fully-developed and was similar to that between flat parallel plates (Loureiro 1987). Thus, assuming a flow exponent of 1.0, the flow coefficient for these elements was given by:

$$C = t^2 (\rho)^{0.5} A / (12 \mu l) \quad (3.2)$$

where

t = distance between parallel sides of crack or separation, m .

For elements with flows crossing interfaces between soil regions, an expression based on mass continuity was developed to evaluate the effective flow coefficient for these elements. The effective coefficient was calculated using the effective soil permeability, which is approximated by the weighted average of the soil permeabilities in each of the two regions, as follows (Loureiro 1987):

$$k_{\text{eff}} = (k_1 \cdot k_2) (l_1 + l_2) / ((l_1 \cdot k_2) + (l_2 \cdot k_1)) \quad (3.3)$$

where

- k_{eff} = effective soil permeability, m^2 .
- k_1 = soil permeability in region 1, m^2 .
- k_2 = soil permeability in region 2, m^2 .
- l_1 = length of element in region 1, m.
- l_2 = length of element in region 2, m.

The soil permeabilities used in this project for each region of the soil are described in detail in Section 4.1.2. The input file generator used those permeabilities along with the node locations to define the characteristics for each flow element in the soil.

3.1.3 Radon Transport Parameter Inputs

3.1.3.1 Production of Radon in Soil

It was assumed that production of radon occurred only in the soil. The rate at which radon enters pore spaces from soil particles was similar to that defined by Nazaroff et al. (1989):

$$S = (1.332 \times 10^{14}) f \rho_{\text{hos}} [^{226}\text{Ra}] R_{\text{n}_{\text{dec}}} (1-e) V \quad (3.4)$$

where

- S = production rate of radon into pore spaces, radon atoms/h.
- 1.332×10^{14} = conversion factor for Ci/s to atoms/h.
- f = radon emanation fraction, dimensionless.

ρ_{hos}	= soil particle density, kg/m ³ .
$[^{226}\text{Ra}]$	= radium-226 concentration in soil particles, Ci/kg.
$R_{\text{n}_{\text{dec}}}$	= radon decay constant, s ⁻¹ .
e	= soil porosity, dimensionless.
V	= soil control volume, m ³ .

The parameters required in Equation 3.4 to characterize radon production in the soil regions surrounding the basement are described in detail in Section 4.1.2. The input file generator used these parameters along with control volume sizes it calculated from grid control surface locations to determine radon production rates for each node in the soil.

3.1.3.2 Diffusion of Radon in Soil

Equation 3.4 defines the rate at which radon escapes from soil particles into pore spaces around the particles. However, it does not describe the transport of radon through the pore spaces into the basement, subslab venting system, or outdoor air. This transport is driven by convection and diffusion.

A general steady-state transport equation similar to the thermal conduction-convection equation is implemented in CONAIR to represent radon flow in an element from one node to another node (Axley 1988). In that equation, the diffusive mass transport rate is described relative to the convective mass transport rate, based on Fick's one-dimensional law of molecular diffusion. According to that law, the rate of diffusion in an element is dependent on the radon concentration gradient across the length of that element, and on the bulk diffusion coefficient for radon for that element. This diffusion coefficient relates the radon concentration gradient in an element to the flux density across the geometric cross-sectional area of that element (Nazaroff and Nero 1988).

The bulk diffusion coefficients used in this project for each region of the soil are described in more detail in Section 4.1.2. For convective-diffusive elements crossing interfaces between soil regions, an effective diffusion coefficient was determined using a relation similar to that described by Equation 3.3. Diffusion of radon through the concrete (other than through the crack) was assumed to be negligible.

The input file generator also determined the mass per unit length for each convective-diffusive flow element. This parameter was used in CONAIR to calculate a Peclet number and then an upwind factor for each element to maintain numerical stability for large Peclet numbers. The Peclet number is a measure of the importance of convection relative to diffusion. High Peclet numbers indicate convection is the dominant transport mechanism.

3.2 Porting CONAIR to a Mainframe Computer Environment

Normally, CONAIR is run on a microcomputer. However, the networks involved in these simulations required large amounts of memory. Six megabytes of memory (RAM) were required for each simulation. Each set of CONAIR input files was approximately 500,000 bytes in size. The set of output files from CONAIR for each simulation was of a similar magnitude. Execution times for running these large networks on a microcomputer were expected to be unacceptably long. Thus, the program was modified, recompiled, and run instead using a commercially-available IBM 3090 Model 150S mainframe computer.

CONAIR is written in FORTRAN. Several changes were made to this source code to allow it to be compiled and run on the mainframe computer. These changes included:

1. truncating file input and output record lengths,
2. replacing do case structures with if statements,
3. altering include file specifications,
4. altering file naming protocols,
5. altering interactive prompts, and
6. increasing maximum allowable numbers of nodes, elements, and element characteristics to permit simulations of the large networks.

In addition to these changes, a new feature was added to CONAIR. A multiplier for convective and diffusive flow through an element was added. The modification was necessary to correctly link the house sub-network with the soil sub-network, which included only a quarter of the soil surrounding the basement. For each element connecting the soil to the outdoors, or connecting the soil to the basement, a flow multiplier of four from the soil was specified.

Only steady-state simulations were carried out in this project, because budget constraints did not permit time-varying runs. The steady-state runs provide sufficient information for the purposes of this project. It should be noted that if time-varying runs had been carried out, they still would be significantly less expensive than monitoring.

3.3 Post-Processor Program

3.3.1 Introduction

As described in Section 3.2, CONAIR produces very large output files for the networks generated in this project. These output files include the pressure differential across each element, the flows through each element, the pressure at each node, and the radon concentration at each node. To analyze these data without summarizing them is impractical. However, summarizing these data manually would be prone to error and too time consuming to carry out within the scope of this project. To solve this problem, another new computer program was developed by Yuill and Associates to summarize CONAIR output files. A listing of the post-processor program is included in Appendix C. The summaries produced by this program are described in Sections 3.3.2 through 3.3.4.

3.3.2 Airflows Between House, Soil, and Outdoors

To summarize the predicted airflow data, the soil block was considered to be two single control volumes (separation and remaining soil space), and each room indoors was considered to be a separate control volume. Each control volume was enclosed by a control surface. The flows across these control surfaces were of five different types: infiltration (the flow of outdoor air into a control volume), exfiltration (the flow of air out of a control volume to the outdoors), exhaust (the constant fan-driven

flow of air out of a control volume to the outdoors), supply (the constant fan-driven flow of air from the outdoors into a control volume), and interzone (all other flows). Total flows of each type between connected pairs of control volumes were determined by the post-processor program using CONAIR output files as input. The post-processor program generated output files summarizing these data. The program also converted the mass flow rates predicted by CONAIR in units of kg/s to volumetric flow rates in units of L/s, using an air density corresponding to standard conditions (barometric pressure of 101,325 Pa and a temperature of 20°C). The format of the zonal airflow summaries is shown in Appendix D.

3.3.3 Pressures Indoors and Profiles in Soil

The pressures predicted by CONAIR are total pressures relative to the outdoor pressure at grade level. These total pressures are the sum of hydrostatic pressures and disturbance pressures. The hydrostatic pressure is a result of the mass of air at rest in the house, in the soil, and outdoors. The disturbance pressure at any node in the network is a result of pressure disturbances imposed at that node or at other nodes in the network. Thus, it is the disturbance pressures that are of primary interest in understanding how radon mitigation systems operate. Since the hydrostatic pressure is constant (independent of disturbance pressures), it can be eliminated, leaving only the disturbance pressure. The post-processor program carried out these calculations using CONAIR output files as input. The output files generated by the post-processor program include summaries of disturbance pressures for each room indoors, along with disturbance pressure fields in the soil surrounding the basement.

Appendix E shows the format of the disturbance pressure fields in the soil. Figure 3.2 illustrated the location of the soil regions around the basement. All vertical slices shown in Appendix E are in the x-z plane.

In the x-z planes shown in Appendix E, vertical slice Y=1 is at the center of the basement floor. Vertical slice Y=9 is at the outer limit of the soil block. Lines in each figure outline the different soil regions considered. Regions with asterisks represent concrete (basement wall and floor), which is impermeable to airflow and radon transport.

The perimeter crack is shown in vertical slices $Y=1$ through 3 at coordinates $X=4$ and $Z=2$, and in vertical slice $Y=4$ at coordinates $X=1$ through 4 and $Z=2$.

The separation between the basement wall and backfill is shown in vertical slices $Y=1$ through 5 at coordinates $X=6$ and $Z=1$ through 2, and in vertical slice $Y=6$ at coordinates $X=1$ through 6 and $Z=1$ through 2.

The backfill region is shown in vertical slices $Y=1$ through 6 at coordinates $X=7$ and $Z=1$ through 2, and in vertical slice $Y=7$ at coordinates $X=1$ through 7 and $Z=1$ through 2.

The subslab gravel region is shown in vertical slices $Y=1$ through 7 at coordinates $X=1$ through 7 and $Z=3$ through 8.

The subslab mitigation systems supplied air to or exhausted soil gas from coordinate $X=1$ and $Z=3$ in vertical slice $Y=1$.

3.3.4 Radon Concentrations Indoors and Profiles in Soil

The radon concentrations predicted by CONAIR are on an atomic number basis in units of radon atoms per unit mass of air. The more traditional unit for radon concentrations is pCi/L, which describes the activity concentration. Thus, the post-processor program converted the radon concentrations to units of pCi/L using an air density corresponding to standard conditions (barometric pressure of 101,325 Pa and a temperature of 20°C).

The output files generated by the post-processor program include summaries of radon concentrations indoors, the radon concentration at the subslab vent location, the average radon concentration at the bottom of the basement floor perimeter crack, along with radon concentration fields in the soil surrounding the basement. The format of the radon concentration fields is shown in Appendix F. The structure of these fields is the same as that presented for the disturbance pressure fields in Appendix E.

3.4 Program Validation

CONAIR has been validated by comparing its predictions with those of other available programs or solution techniques to determine whether the predictions of CONAIR are reliable.

AIRNET is one of the programs on which CONAIR is based. Walton (1989) has compared the predictions of AIRNET with those of ESPAIR (ABACUS 1986), which is a separate airflow analysis program included in the ESP building thermal analysis program. AIRNET and ESPAIR were used to solve a large airflow network that represents a four-storey building with six rooms, a hallway, an elevator shaft, and a stairwell on each floor. Both programs solved the same airflow and pressure fields, but AIRNET was significantly faster than ESPAIR (a factor of approximately 1000).

Walton also described 14 analytical validation tests he carried out to demonstrate the performance of AIRNET. In all cases, AIRNET predictions matched the analytical results. These cases were also analyzed using CONAIR. CONAIR's predictions were exactly the same as those of AIRNET.

CONAIR has also been validated through comparisons with four other airflow analysis programs. Three of these programs (SCAFA, LINEAR, and SIMLOOP) have been developed by Yuill and Associates (1990b). The fourth program was ASCOS (Klote and Fothergill 1983). The solution methods used in these programs vary. In the comparisons of the predictions of these five programs, the same case was run in each program. The case involved a five-storey building with an atrium, a zoned smoke control system, stairwell pressurization, and atrium exhaust. This building had 66 zones and 170 airflow paths. All programs predicted the same zone pressures, element pressure drops, and flows.

CONTAM 87, another program on which CONAIR is based, has been validated internally by NBS (Axley 1988) through one inter-program comparison and two comparisons of program predictions with measured data. In addition, the program has been externally validated by another inter-program comparison (Sparks 1988). For cases for which input data were available, CONAIR predictions were identical to those of CONTAM 87.

The input file generator program used for CONAIR is based on algorithms used in the computer programs PRESSU and MASTRA (Loureiro 1987). Loureiro carried out tests to determine whether the predictions of his programs behaved as expected. Several of these tests involved comparisons of program predictions for simple test cases with hand-calculated results obtained using the fundamental principle models described in his dissertation. He also carried out sensitivity studies to determine the effects of house size, disturbance pressure, crack width, soil permeability, soil porosity, and bulk diffusivity of radon in soil on the predictions of PRESSU and MASTRA. These sensitivity analyses indicated that the variations in program predictions exhibited the expected behavior. However, these results do not verify the accuracy of the programs.

Loureiro employed analytical techniques to test the subroutine used by the two programs that implements the widely accepted Thomas algorithm (Patankar 1980) for solving transport equations. In these tests, this subroutine was used to solve for heat flow in a one-dimensional bar and in a two-dimensional surface. The heat flow predictions generated using this subroutine agreed well with the results obtained analytically.

Validations of PRESSU and MASTRA have also been carried out by other researchers (Fisk et al. 1989). Exact analytical models (Mowris and Fisk 1988) have been used to check the predictions of Loureiro's programs for homogeneous soils, in the absence of diffusion. Excellent agreement was reported. Diffusion was neglected, because analytical models that include this phenomenon are not presently available.

CONAIR and the new input file generator program were also validated through a program-program comparison with PRESSU and MASTRA. A 600-node representation of a basement and heterogeneous soil block was specified in PRESSU. Based on the three-dimensional finite-difference grid generated by PRESSU, a CONAIR airflow network representation of the same soil block and basement was also developed using the input file generator program. The pressure and airflow rate predictions of CONAIR and PRESSU were identical. The concentration predictions of CONAIR and MASTRA were identical.

The output of the post-processor program was validated through comparisons of program predictions with hand-calculated results obtained using the algorithms implemented in the program. Perfect agreement was obtained.

4.0 PHASE 3 - COMPUTER SIMULATION OF SUBSLAB VENTING SYSTEMS

4.1 Input Data

4.1.1 House Characteristics

An unoccupied house located in Winnipeg, Manitoba was used as the basis for the simulations. This house is a one-storey bungalow having a floor area of approximately 100 m² (not including the basement), an Equivalent Leakage Area (ELA) of 154 cm² with all intentional openings sealed and excluding below-grade leaks, and a total volume of 446 m³. The walls of the house are of typical wood-frame construction, using studs 38 x 140 mm. The basement in this house is unfinished. The top of its poured concrete floor slab is 1.26 m below grade level. The slab is 75 mm thick and has dimensions of 7.5 m by 11.8 m. It has a lapped and caulked polyethylene moisture barrier underneath it. A layer of small-diameter gravel with a total thickness of 125 mm is located immediately beneath the moisture barrier. Subslab perforated piping connects the sump pit and drain tile system. The basement walls are poured concrete with a thickness of 200 mm. Heating for the house is provided by electric baseboard heaters.

The house is ventilated by a multi-port central exhaust fan that runs continuously. There are damper-controlled outdoor-air inlets in each room to provide replacement outdoor air for the air that is exhausted. The fan is capable of exhausting air from as many as six locations with a total design flow rate of 62 L/s. In the house, air is continually exhausted at a design flow rate of 17.5 L/s directly from each of the kitchen and the bathroom. To emulate a basement suction system, a duct from the exhaust fan was placed to exhaust air directly from the basement at a continuous design flow rate of 27 L/s. To emulate a subslab depressurization system, a duct was run from a penetration (diameter of 102 mm) through the slab to connect the above-mentioned piping and drain tile system to the exhaust fan. The design flow rate in that duct to the exhaust fan was 27 L/s. No air was exhausted directly from the basement in this case. Subslab pressurization was achieved by directing all of the exhaust air from the exhaust fan to the subslab region through a duct connected to the floor slab penetration. The design flow rate in that duct was 62 L/s. In this case, additional air was exhausted directly from the kitchen at a design flow rate of 27 L/s.

For the simulations, the house was divided into the following eight zones:

1. basement;
2. kitchen/dining room/living room;
3. hallway joining living room, bathroom, and bedrooms;
4. bathroom (sink area);
5. bathroom (tub area);
6. master bedroom;
7. bedroom 2; and
8. bedroom 3.

The kitchen, living room, and dining room of the simulated house were lumped together as one zone because there are no significant flow resistances between these regions.

Using the total ELA of the actual house, which was obtained from blower door tests (Yuill and Comeau 1989), using assumptions of leakage area distributions based on surface area, and using ASHRAE (1989) estimates of door and window component leakages, inputs were developed for the airflow analysis section of CONAIR to characterize the magnitude and location of unintentional leaks in the building envelope. The only leaks considered between zones were interior doorways, which were simulated as if the doors were wide open.

All windows and exterior doors were simulated in their closed position. Thus, the only source of natural ventilation in the house was infiltration and exfiltration driven by wind and stack effects through unintentional leaks in the house envelope and through the air inlets.

Each damper-controlled air inlet was modelled using empirical airflow data determined in tests carried out by Yuill and Associates (Yuill and Comeau 1989). The ELA of each air inlet in the fully-open position was 23.6 cm² and the flow exponent was 0.57. In the so-called "fully-closed" position, these tests indicated the ELA of the air inlet was reduced to 68% of that in the fully-open position. The air inlets were positioned so those in the living room were fully open, while those in the bedrooms were fully closed. These positions are typical of those that would be used during normal daytime occupancy.

The basement was assumed to be at a constant temperature of 20.00°C. Every other room in the house was assumed to be at a constant temperature of 20.15°C. The basement temperature was based on monitored data, whereas the temperatures in the remainder of the house were based on calibrated-modelling exercises (Yuill and Associates 1991). It was found that a slight temperature difference between the basement and main floor was required to explain flows of radon from the basement to the main floor. No monitored data were available to support the assumed main floor temperature.

For the wind model in CONAIR, the following information was input:

1. house height is 3.6 m from grade to the eaves, and
2. house is located in suburban terrain.

Wind pressure coefficients for the house were estimated using the model contained in CONAIR (Swami and Chandra 1988).

4.1.2 Foundation and Soil Characteristics

The dimensions used in this project to model the basement and surrounding soil as shown in Figure 3.1 were:

L_x :	14.450 m	L_y :	16.600 m	L_z :	11.460 m
l_{x-aggr} :	0.500 m	l_{y-aggr} :	0.500 m	l_{z-aggr} :	0.125 m
l_x :	3.745 m	l_y :	5.895 m	l_z :	1.260 m
t_x :	0.200 m	t_y :	0.200 m	t_z :	0.075 m
C_x :	0.005 m	C_y :	0.005 m		

The soil block was defined with silt in the primary soil region and with coarse sand beneath the floor slab. A looser-packed silt was specified in the backfill region, because the house is still relatively new. Over time, it is expected that the packing of the soil in this region will become similar to that in the primary region. These soil types are based only on observations at the building site, because field investigations

to determine the soil types or their physical properties were beyond the scope of the project.

No data or observations were available regarding the separation between the basement wall and backfill. Also, no literature was found describing the characteristics of this gap. However, consultations with foundation experts who have observed these gaps around houses in Winnipeg indicated:

1. the width of the gap varies seasonally, depending on the moisture content of the soil,
2. the maximum gap typically occurs during the period from July to September, when the soil is desiccated,
3. moisture from snow melting adjacent to heated foundations tends to cause local soil swelling, which closes the gap in winter months, (insulated foundations are expected to have larger gaps around them, because of reduced snow melting),
4. typically, the maximum gap for Winnipeg houses is approximately 20 mm wide at grade, and tapers to zero at a depth of approximately 1 m below grade,
5. in drought conditions when the soil is extremely desiccated, the maximum gap for Winnipeg houses is approximately 40 to 50 mm wide at grade, and tapers to zero at a depth of approximately 1.5 to 1.8 m below grade, and
6. the gaps around houses in Winnipeg normally extend to a depth below grade of 1.0 to 1.5 m, but can extend to as much as 2.0 to 2.5 m for houses in severely desiccated soil.

Based on these observations, it was assumed the separation was 1 mm wide for the winter conditions simulated in this project. The separation was assumed to have a constant width around the entire basement perimeter, and extended from grade to the top of the subslab gravel layer.

The permeabilities of the soils were assumed to be: $5 \times 10^{-8} \text{ m}^2$ for the sand, $2.5 \times 10^{-12} \text{ m}^2$ for the silt in the primary region, and $2.5 \times 10^{-11} \text{ m}^2$ for the silt in the backfill region. These values are based on values found in the literature (DSMA 1983, Sextro et al. 1987, Nazaroff and Nero 1988). A higher permeability was used for the backfill region to account for the looser packing in that region.

The porosities of the soils were assumed to be 0.4 for the sand and 0.5 for the silts. These values are based on values found in the literature (DSMA 1983, Nazaroff and Nero 1988, Nazaroff et al. 1989).

The soil particle density of all the soils was assumed to be 2650 kg/m^3 . Nazaroff and Nero (1988) state that this soil particle density is typical of most soils and that only rarely is the density outside the range of 2600 to 2800 kg/m^3 .

The ^{226}Ra concentrations of the soils were assumed to be $0.3 \times 10^{-9} \text{ Ci/kg}$ for the sand and $3.0 \times 10^{-9} \text{ Ci/kg}$ for the silts. These concentrations tend to increase with decreasing grain size (Nazaroff et al. 1989). Since the sand has large grain sizes, a value near the minimum found in the literature was used for the sand (Nero and Nazaroff 1984, Sextro et al. 1987, Nazaroff and Nero 1988). A higher concentration was used for the silts for two reasons. First, the silts have much smaller grain sizes than the sand. Second, calibrated-modelling exercises (Yuill and Associates 1991) indicated that high ^{226}Ra concentrations in the backfill and primary soil regions were necessary to explain the high soil radon concentrations measured.

The radon emanation fractions were assumed to be 0.20 for the sand and 0.35 for the silts. These fractions are based on the range of values listed in the literature. (Bruno 1983, Sextro et al. 1987, Nazaroff & Nero 1988). The emanation fraction for the silts is typical of most moist soils (DSMA 1983). A lower fraction was used for the sand, because it has a larger grain size. Emanation fractions tend to decrease with increasing grain size (Nazaroff et al. 1989).

The bulk radon diffusion coefficients were assumed to be $3.65 \times 10^{-7} \text{ m}^2/\text{s}$ for the sand and $3.5 \times 10^{-8} \text{ m}^2/\text{s}$ for the silts. These values are based on those found in the literature (Nazaroff 1988, Nazaroff and Nero 1988). A lower coefficient was used for the silts than for the sand, because the silts are assumed to be moister than the

sand. As the moisture content of a soil increases, the diffusion coefficient decreases as a function of the fourth power of the moisture content (Nazaroff and Nero 1988).

4.2 Meteorological Data and Outdoor Concentrations

All of the simulations were carried out using an average outdoor dry-bulb temperature of -23.5°C (Yuill and Associates 1991). Wind speed and direction data were not available. A wind speed of 11.5 km/h and a wind direction from the North was used.

A constant outdoor air pressure of 101,325 Pa was used for all of the simulations.

The variation of soil temperatures in the soil block were not measured or simulated, because that work was beyond the scope of this project. The feasibility of developing a linear approximation of the temperature variation in the soil using the average outdoor air temperature and the soil temperature measured in another project just outside the basement walls (Yuill and Associates 1991) was examined.

A review of long-term normal monthly average January outdoor temperatures and soil temperatures published by Environment Canada (1982, 1984) was carried out. This review showed that the variation in soil temperatures for undisturbed soil far away from buildings is not as large as would be expected if the soil temperature near the surface was considered to be the same as the outdoor air temperature. Outdoors, the long-term normal mean daily air temperature was -19.0°C . In the soil, the soil temperature was -5.0°C at a depth of 0.05 m, 1.2°C at a depth of 1.00 m, and 6.5°C at a depth of 3.00 m.

With the presence of a building in the soil, the temperature gradients become even more complex. Therefore, it is not practical to develop a linear approximation of the variation using only a single soil temperature. Further research should be carried out in a future project to determine the impact of soil temperatures on soil gas flows around foundations (and vice versa). Thus, the soil was assumed to be isothermal, with a temperature equal to the average soil temperature (7°C), which was measured just outside the basement walls at footing level.

The infiltration of radon in outdoor air can be a significant contribution to typical indoor levels, even though it is negligible at higher indoor levels. Radon concentrations in outdoor air are usually in the range of 0.1 to 0.4 pCi/L (Nazaroff and Nero 1988). In a survey of these concentrations in Manitoba, levels as high as 2.5 pCi/L were measured. However, some of the measurements were made just under the eaves of houses, where the detectors might have been exposed to radon-laden air exfiltrating from the house. Thus, a typical value of 0.2 pCi/L (Bodansky et al. 1989) was assumed for the cases simulated in this project.

4.3 Summary of Simulation Cases

Fifteen simulation cases were created using the input file generator developed in this project. Several parameters were varied in these cases to study the impact of radon mitigation system type, subslab venting system flow rate, basement wall-backfill separation width, and air barriers on airflow and radon concentration distributions in the house and in the soil.

The three radon mitigation systems considered were: basement suction, subslab depressurization, and subslab pressurization. The basement suction system was included as a reference for comparison with the subslab venting systems.

Two different sets of subslab ventilation system flow rates were considered. The reference set of flow rates were described in Section 4.1.1. The other set of flow rates corresponded to an exhaust fan with a 25% increase in total exhaust flow. This variation was intended to represent the effect of fan oversizing in radon mitigation systems. Flow rates lower than the reference rates were not considered, because these rates are likely to reduce the effectiveness of the radon mitigation systems, and are less likely to contribute to soil freezing than are the high rates.

Two different basement wall-backfill separation widths were considered. The reference separation width was 1 mm, as described in Section 4.1.2. The other separation width was 20 mm. This larger gap was selected to represent the average width of the maximum sized gap that is expected to occur around basements in Winnipeg.

In three of the fifteen cases, an air barrier at grade level was simulated. This air barrier was impermeable to airflow and radon transport. It covered the separation and the top of the backfill. A perfect seal between the air barrier and the basement wall to which it was attached was assumed.

Table 4.1 summarizes the variation of parameters in the fifteen cases simulated in this project using CONAIR.

Table 4.1. Summary of Cases Simulated.

Case	Basement Suction Flow [L/s]	Subslab Depress Flow [L/s]	Subslab Press Flow [L/s]	Total Exhaust Flow [L/s]	Separation Width [mm]	Air Barrier Installed
1	26.9	0.0	0.0	61.8	1	No
6	26.9	0.0	0.0	61.8	20	No
11	26.9	0.0	0.0	61.8	20	Yes
2	0.0	26.9	0.0	61.8	1	No
4	0.0	42.3	0.0	77.2	1	No
7	0.0	26.9	0.0	61.8	20	No
9	0.0	42.3	0.0	77.2	20	No
12	0.0	26.9	0.0	61.8	20	Yes
14	0.0	42.3	0.0	77.2	20	Yes
3	0.0	0.0	61.8	61.8	1	No
5	0.0	0.0	77.2	77.2	1	No
8	0.0	0.0	61.8	61.8	20	No
10	0.0	0.0	77.2	77.2	20	No
13	0.0	0.0	61.8	61.8	20	Yes
15	0.0	0.0	77.2	77.2	20	Yes

4.4 Simulation Results

4.4.1 Introduction

Tables 4.2 through 4.4 summarize the predicted infiltration, exfiltration, exhaust, supply, and interzone airflows across the house and soil control surfaces for each set of cases with the three different systems: basement suction, subslab depressurization, and subslab pressurization. Tables D.1 through D.15 in Appendix D summarize the predicted infiltration, exfiltration, exhaust, supply, and interzone airflows across the control surfaces for each zone for the fifteen cases that were simulated.

Figures E.1 through E.15 in Appendix E show the predicted disturbance pressure fields in the soil surrounding the basement for each of the fifteen cases. These figures also list the predicted disturbance pressures for each room of the house in each case. The format of these figures was described in Section 3.3.3.

Table 4.5 summarizes the predicted radon concentrations in the basement, living room, bathroom, and bedrooms for the fifteen cases simulated. It also lists the radon concentration at the subslab vent location beneath the basement floor and the average radon concentration at the bottom of the basement floor perimeter crack for each case.

Measured radon concentrations for the basement and living room of the actual house on which the simulated house is based are also included in Table 4.5 in three cases for comparison. These three cases represent conditions similar to those studied in the actual house (Yuill and Associates 1991). The other twelve cases involve changes to these three cases, which have not been studied in the actual house. Thus, the three cases for which measured data are available are called reference cases.

The predicted radon concentration fields in the soil are shown in Appendix F for each of the fifteen cases (Figures F.1 through F.15). The structure of these fields is the same as that presented for the disturbance pressure fields in Appendix E. These figures also list the predicted radon concentrations in each zone of the house in each case.

4.4.2 Basement Suction - Reference Case

In the reference basement suction case (Case 1), the predicted radon concentration in the basement was 6.9 pCi/L and in the living room was 3.1 pCi/L, as shown in Table 4.5. These levels are similar to those measured in the actual house: 8.1 pCi/L and 3.0 pCi/L respectively (Yuill and Associates 1991).

Predictions in Table D.1 show that there were large airflows from the basement to the living room for the reference basement suction case. This suggests the basement exhaust airflow rate should be increased to eliminate flows from the basement to the living room, so radon from the basement would not be transported to the main floor. However, the basement was only slightly under-ventilated in this case according to CSA Standard F326.1-M1989 (CSA 1989). Predictions for this case listed in Table D.1 show the basement received 8.6 L/s of outdoor air (even though the exhaust flow rate for the basement was 26.9 L/s). The standard calls for 10 L/s as a base flow rate for the basement. The remainder of the house was adequately ventilated based on the predicted airflows shown in Table D.1 and according to this standard.

Table 4.2 shows all of the air removed from the house in this case was by exhaust flows (not by exfiltration) and most of the flows into the house (61.8 L/s) were directly from the outdoors. Only 4% of the flows into the house were soil gas, which entered through the crack at the basement floor perimeter. Thus, the outdoor air change rate for the conditioned volume of this house was predicted to be 0.5 ach. This means that if CSA Standard F326.1-M1989 is assumed to define an acceptable level of energy loss caused by ventilation, increasing the exhaust airflow rate from the basement would lead to unacceptably high ventilative energy losses from the house. Furthermore, increasing this exhaust flow rate would lead to higher basement radon levels, because the basement would be depressurized further. In this case, Figure E.1 shows the basement depressurization was predicted to be 12.5 Pa.

Table 4.2 also shows that most (83%) of the soil gas entering the house flowed through the 1 mm wide separation between the basement wall and backfill, as expected. The flow resistance of this gap is significantly less than that for the rest of the soil. Figure F.1 illustrates the soil gas flow patterns further. The radon concentrations in the separation in this case were extremely low relative to those in the remainder of the soil space, due to the dilution effects of the outdoor air flowing

Table 4.2. Summary of predicted airflows across house and soil control surfaces - Basement suction.

				Total Flows Between Zones (L/s)		
	From	To	Comment	Case 1	Case 6	Case 11
In Flows	Outdoors	House	Infiltration	59.4	4.8	61.7
	Soil	House	Interzone	2.4	76.8	0.1
	Total Into House:			61.8	81.6	61.8
Out Flows	House	Soil	Interzone	0.0	0.0	0.0
	House	Outdoors	Exhaust	61.8	61.8	61.8
	House	Outdoors	Exfiltration	0.0	19.8	0.0
	House	Soil	Supply	0.0	0.0	0.0
	Total Out of House:			61.8	81.6	61.8
In Flows	Outdoors	Soil	Infiltration	0.4	0.0	0.1
	Outdoors	Separation	Infiltration	2.0	76.8	0.0
	House	Soil	Interzone	0.0	0.0	0.0
	House	Soil	Supply	0.0	0.0	0.0
	Total Into Soil:			2.4	76.8	0.1
Out Flows	Soil	House	Interzone	2.4	76.8	0.1
	Soil	Outdoors	Exhaust	0.0	0.0	0.0
	Separation	Outdoors	Exfiltration	0.0	0.0	0.0
	Total Out of Soil:			2.4	76.8	0.1

Table 4.3. Summary of predicted airflows across house and soil control surfaces - Subslab depressurization.

				Total Flow Between Zones (L/s)					
	From	To	Comment	Case 2	Case 4	Case 7	Case 9	Case 12	Case 14
In Flows	Outdoors	House	Infiltration	59.3	74.1	3.7	4.3	61.7	77.1
	Soil	House	Interzone	0.0	0.0	54.2	51.9	0.0	0.0
	Total Into House:			59.3	74.1	57.9	56.2	61.7	77.1
Out Flows	House	Soil	Interzone	24.4	39.2	0.0	0.0	26.8	42.2
	House	Outdoors	Exhaust	34.9	34.9	34.9	34.9	34.9	34.9
	House	Outdoors	Exfiltration	0.0	0.0	23.0	21.3	0.0	0.0
	House	Soil	Supply	0.0	0.0	0.0	0.0	0.0	0.0
	Total Out of House:			59.3	74.1	57.9	56.2	61.7	77.1
In Flows	Outdoors	Soil	Infiltration	0.4	0.5	0.0	0.0	0.1	0.1
	Outdoors	Separation	Infiltration	2.1	2.6	81.1	94.2	0.0	0.0
	House	Soil	Interzone	24.4	39.2	0.0	0.0	26.8	42.2
	House	Soil	Supply	0.0	0.0	0.0	0.0	0.0	0.0
	Total Into Soil:			26.9	42.3	81.1	94.2	26.9	42.3
Out Flows	Soil	House	Interzone	0.0	0.0	54.2	51.9	0.0	0.0
	Soil	Outdoors	Exhaust	26.9	42.3	26.9	42.3	26.9	42.3
	Separation	Outdoors	Exfiltration	0.0	0.0	0.0	0.0	0.0	0.0
	Total Out of Soil:			26.9	42.3	81.1	94.2	26.9	42.3

Table 4.4. Summary of predicted airflows across house and soil control surfaces - Subslab pressurization.

	From	To	Comment	Total Flow Between Zones (L/s)					
				Case 3	Case 5	Case 8	Case 10	Case 13	Case 15
In Flows	Outdoors	House	Infiltration	8.7	8.7	2.3	2.9	9.0	9.0
	Soil	House	Interzone	62.5	77.9	86.1	99.2	61.8	77.2
	Total Into House:			71.2	86.6	88.4	102.1	70.8	86.2
Out Flows	House	Soil	Interzone	0.0	0.0	0.0	0.0	0.0	0.0
	House	Outdoors	Exhaust	0.0	0.0	0.0	0.0	0.0	0.0
	House	Outdoors	Exfiltration	9.4	9.4	26.6	24.9	9.0	9.0
	House	Soil	Supply	61.8	77.2	61.8	77.2	61.8	77.2
	Total Out of House:			71.2	86.6	88.4	102.1	70.8	86.2
In Flows	Outdoors	Soil	Infiltration	0.1	0.1	0.0	0.0	0.0	0.0
	Outdoors	Separation	Infiltration	0.6	0.6	24.6	24.8	0.0	0.0
	House	Soil	Interzone	0.0	0.0	0.0	0.0	0.0	0.0
	House	Soil	Supply	61.8	77.2	61.8	77.2	61.8	77.2
	Total Into Soil:			62.5	77.9	86.4	102.0	61.8	77.2
Out Flows	Soil	House	Interzone	62.5	77.9	86.1	99.2	61.8	77.2
	Soil	Outdoors	Exhaust	0.0	0.0	0.0	0.0	0.0	0.0
	Separation	Outdoors	Exfiltration	0.0	0.0	0.3	2.8	0.0	0.0
	Total Out of Soil:			62.5	77.9	86.4	102.0	61.8	77.2

**Table 4.5. Summary of predicted and measured radon concentrations
indoors and in the soil beneath the basement floor.**

Radon Levels (pCi/L)									
Case	System Type ⁺	Basement (Pred ⁺⁺)	Basement (Meas ⁺⁺)	Living Room (Pred ⁺⁺)	Living Room (Meas ⁺⁺)	Bathroom (Pred ⁺⁺)	Bedrooms (Pred ⁺⁺)	Crack Bottom Average (Pred ⁺⁺)	Subslab Vent (Pred ⁺⁺)
1	Ref B	6.9	8.1	3.1	3.0	0.2	0.2 *	76.5	2018.8
6	B	1.1		1.0		1.0	1.0 *	0.9	756.6
11	B	6.1		2.7		0.2	0.2 *	1948.7	2029.9
2	Ref D	0.2	1.5	0.2	0.3	0.2	0.2 *	0.2	11.0
4	D	0.2		0.2		0.2	0.2 *	0.2	8.5
7	D	0.5		0.5		0.5	0.5 *	0.6	3.4
9	D	0.4		0.4		0.4	0.4 *	0.5	2.9
12	D	0.2		0.2		0.2	0.2 *	0.2	10.7
14	D	0.2		0.2		0.2	0.2 *	0.2	8.6
3	Ref P	14.0	3.9	13.1	2.2	12.9	12.6 **	43.4	13.1
5	P	13.8		13.1		12.9	12.6 **	40.5	13.0
8	P	2.3		2.3		2.3	2.3 *	2.0	2.3
10	P	2.3		2.3		2.3	2.2 *	2.0	2.3
13	P	11.5		10.7		10.5	10.3 **	15.2	10.7
15	P	11.6		11.0		10.8	10.5 **	14.6	10.9

* - B = Basement suction, D = Subslab depressurization, P = Subslab pressurization, Ref = Reference.

++ - Pred = Predicted, Meas = Measured.

* - Bedroom 2, bedroom 3, and master bedroom.

** - Bedroom 2 and master bedroom (Bedroom 3 concentration was 0.2 pCi/L).

Note: Outdoor radon concentration was 0.2 pCi/L.

through the gap. The radon concentrations in the backfill region were higher than those in the separation, but were still significantly lower than those in the remainder of the soil. This indicates that a large fraction of the outdoor air dilution flow through the soil outside of the separation was through the backfill. This behavior was expected, because the backfill was significantly more permeable (factor of ten) than the primary soil region.

4.4.3 Subslab Depressurization - Reference Case

Table 4.5 shows that the predicted basement and main floor radon levels with the reference subslab depressurization system (Case 2) were significantly reduced, in comparison to the basement suction reference system (Case 1). Throughout the house, the predicted levels were all slightly less than those outdoors (0.2 pCi/L). These low levels occurred, because no radon entered the basement from the soil, and because the radon from outdoors decayed as it entered the house.

Monitored data for the actual house operating with the subslab depressurization system have shown similar reductions in radon levels relative to the basement suction system (Yuill and Associates 1991). As Table 4.5 shows, the measured radon levels were 1.5 pCi/L in the basement and 0.3 pCi/L on the main floor when the subslab depressurization system was operating.

Table D.2 shows that for most rooms in the house, the predicted airflows in this case were similar to those for the basement suction case. This was expected, because the house operated under similar depressurizations in both cases, as shown in Figures E.1 and E.2. As for the reference basement suction case, the predicted ventilation airflows in this case conformed in general to the requirements of CSA Standard F326.1-M1989.

In this case however, the predicted flows between the basement and soil were significantly different. Instead of air flowing from the soil into the basement as predicted in the reference basement suction case, Table 4.3 shows that air flowed from the basement into the soil in this case (24.4 L/s). Of the 26.9 L/s of air exhausted from the soil, 91% was from the basement. The rest of the air exhausted from the soil (2.5 L/s) was due to leakage from outdoors through the separation and soil.

Table 4.3 indicates that most (84%) of the air leaking through the soil passed through the separation into the subslab region. However, in this case it is unlikely the low airflow rate through the separation (2.1 L/s) would contribute significantly to soil freezing near the basement footings.

The patterns of dilution airflow through the soil in this case were similar to those discussed for the reference basement suction case, as shown in Figures F.1 and F.2. However, Figure F.2 shows that the predicted radon concentrations in the subslab region when the reference subslab depressurization system was operating were slightly lower than those when the reference basement suction system was operating. For the reference subslab depressurization case, the predicted radon concentrations in the subslab region near the basement floor perimeter crack were similar to those indoors. Nearer to the point at which soil gas was exhausted from the subslab region, the predicted radon concentrations increased. These reductions in subslab radon concentrations were primarily due to the dilution airflows from the basement into the soil.

4.4.4 Subslab Pressurization- Reference Case

CONAIR predicted that the radon levels indoors increased when the reference subslab pressurization system operated (Case 3) compared to those when the reference subslab depressurization system operated (Case 2). This trend was also shown by the monitored data (Yuill and Associates 1991), which are included in Table 4.5. Table 4.5 shows that predicted radon levels were similar almost everywhere in the house when it operated with the reference subslab pressurization system. This behavior can be explained by the predicted airflow patterns in the soil and in the house.

The reference subslab pressurization system supplied air at a rate of 61.8 L/s from inside the house (living room and bathroom) to the soil. As Table 4.4 shows, almost all of this air then passed through the subslab region and back into the basement through the crack at the floor perimeter. It is not clear if 100% of the air supplied to the soil from the house reentered through this crack, because CONAIR predicted that a very small amount (5 mL/s) of soil gas flowed from the soil to outdoors, as shown in Table D.3.

Like the reference basement suction and subslab depressurization cases (Cases 1 and 2), there was a large flow from the basement to the living room with the reference subslab pressurization system. However in this case, the flow from the basement to the living room was significantly greater than in the other two cases, as shown in Tables D.2 and D.3 (73.2 L/s compared to 26.7 L/s). Also like the other two cases, there was no exfiltration of air from the basement in this case, even though the neutral pressure plane in the house moved below the level of the main floor ceiling with the increase in house pressure from -12.5 Pa to -5.2 Pa, as shown in Figures E.1, E.2, and E.3. Thus, most of the soil gas entering the basement (62.5 L/s) flowed from the basement through the doorway to the living room.

In the living room in this case, there was also some exfiltration, unlike in the other two cases. However, the exfiltration was predicted to be only 5% of the total airflow leaving the living room. A large fraction (57%) of the air leaving the living room was supplied directly to the soil. Another large fraction (29%) flowed into the hallway, from which most (77%) of the air was drawn into the bathroom and supplied directly to the soil. This meant that the subslab region, basement, living room, hallway, and bathroom acted like a duct system for soil gas flow. Some dilution of the soil gas occurred in the basement and in these rooms through infiltration of outside air. However, CONAIR predicted that only 12% of the airflows entering the house were from above grade. It is important to note CSA Standard F326.1-M1989 does not permit ventilation systems to recirculate air that is exhausted from the bathroom and kitchen. (The living room zone in this house included the kitchen and dining room).

Figure E.3 shows the reference subslab pressurization system did not pressurize the entire subslab region. As a result, the radon levels below the floor perimeter crack in this case were higher than those for the reference subslab depressurization case. To reduce the indoor radon levels when the subslab pressurization system operates, it appears that the balance of subslab pressurization flows from the subslab vent into the crack and to the outdoors through the soil must be altered so more subslab pressurization air flows to the outdoors than into the basement, and/or subslab radon levels must be lowered by increasing subslab pressurization airflows through the subslab region.

One method to change the balance of airflows in the subslab region is to seal the basement floor perimeter crack. However, if the sealants degrade over time, the flows through the crack will increase, which will result in increased indoor radon levels. An additional step should be to reduce the resistance to soil gas flow outside the basement between the subslab region and outdoors.

For the reference subslab pressurization system, Table 4.4 shows there was no flow directly from the subslab region to outdoors through the soil. Instead, 0.7 L/s of outdoor air flowed into the soil. As expected, most (86%) of this flow was through the separation, due to the low flow resistance of the separation compared to the rest of the soil. Decreasing this resistance to soil gas flow further would occur if the separation between the basement wall and backfill increased. This effect is examined in Section 4.4.5.

Increased subslab pressurization airflows would increase ventilative energy losses to the soil and outdoors, but these would be partially offset through reduced conduction heat losses through the basement floor slab and, to a limited extent, through the basement walls. Another significant drawback to increasing these flows is that a larger, more expensive fan would be required. This could cause unacceptable noise levels and could lead to excessive air velocities caused by increased airflows from the basement to the main floor. The effect of increasing subslab ventilation rates is discussed further in Section 4.4.7.

As Table 4.5 shows, the indoor radon levels predicted by CONAIR for the reference subslab pressurization case were significantly higher than those measured. The reason for these higher levels appears to be primarily due to simulating a different location for subslab pressurization (further from the floor crack). This meant that subslab pressurization airflows could not reach the subslab region near the crack to dilute radon levels, particularly at the corner of the basement as shown in Figure F.3. From the predictions, it appears that the airflows in the subslab region can be expected to be more sensitive to variations in permeability of that region and to the location of the subslab ducting for the reference subslab pressurization system than can those for the other two reference mitigation systems. Further research in a future project should be carried out to examine the sensitivity of these systems to different soils and to different subslab vent locations.

Table D.3 shows that the predicted airflows did not meet the requirements of CSA Standard F326.1-M1989 for the reference subslab pressurization case. The basement received only 37% of the required airflow, while the kitchen/living room/dining room combination received only 15% of the required airflow. The bedrooms were virtually unventilated relative to the standard's requirements. Of the three bedrooms, only bedroom 3 received ventilation, and that was only 7% of that required. Only the bathroom was adequately ventilated. The addition of another ventilation system incorporating a heat recovery device is necessary if this system is to meet the airflow requirements of CSA Standard F326.1-M1989 and is to avoid significant increases in ventilation energy losses.

It must be noted that if the central exhaust fan used in the subslab venting systems described in this project failed or was turned off, these systems could cause higher indoor radon levels than would otherwise occur if the systems were not present. The duct leading from the subslab region was connected to the indoor space through the fan. With no forced flow into or out of the subslab region through this duct, the duct would act to increase the area of leaks in the basement floor slab. Flow of radon-laden soil gas into the fan plenum could occur. This gas could then be delivered to the main floor without any dilution from outdoor air infiltrating into the basement. Although a backdraft damper could in theory obviate such a condition, it might be difficult in practice to design a low cost, low pressure drop damper that would be airtight when closed.

Without a backdraft damper, this failure scenario would always occur in the absence of fan-driven flow in a subslab pressurization system, unless outdoor air were used to pressurize the subslab region. However, the considerable potential for soil freezing and foundation damage in that mode of operation precludes that approach.

For subslab depressurization systems using ducts leading directly outdoors through a fan, and not connected to the indoor space, the lack of fan-driven flow would not be as significant a concern. In that case, the duct from the subslab vent could act as a passive stack, although the buoyancy-driven flows through this duct would be significantly lower than the flows driven by the fan.

4.4.5 Effect of Increased Separation Width

Compared to the reference cases (Cases 1 and 3), increasing the separation between the basement wall and backfill from 1 mm to 20 mm significantly reduced indoor radon levels when either the basement suction system or subslab pressurization system was operating (Cases 6 and 8 respectively), as shown in Table 4.5. In contrast, the increased separation caused a slight increase in these levels compared to the reference case (Case 2) when the subslab depressurization system operated (Case 7).

Table 4.2 shows there were significant increases in flow from the soil to the house for the case with basement suction and an increased separation, compared to the reference case. In the reference case (Case 1), the flow from the soil into the house was 2.4 L/s, which was 4% of the total flow into the house. The remainder of the flow into the house was infiltration of outdoor air (59.4 L/s). With the increased separation (Case 6), the flow from the soil into the house was 76.8 L/s, which was 94% of the total flow into the house (81.6 L/s). All of the flow from the soil into the house passed through the separation. The remainder of the flow into the house was infiltration of outdoor air (4.8 L/s).

This shift in flow magnitudes was due to the increased pressure in the house for the case with the increased separation and basement suction. Figures E.1 and E.6 show the house pressure increased from -12.5 Pa to -3.7 Pa when the separation increased from 1 mm to 20 mm. Since the exhaust flow rates did not change, this change in pressures can be entirely attributed to an increased leakage area of the house below grade. The leakage area increased, because the flow resistance in the separation was reduced.

The increased separation also increased flows from the soil to the basement in the case with an increased separation and subslab pressurization compared to the reference case, as shown in Table 4.4. In the reference case (Case 3), the flow into the house from the soil was 62.5 L/s, which was 88% of the total flow into the house (71.2 L/s). With the increased separation (Case 8), the flow into the house from the soil was 86.1 L/s, which was 97% of the total flow into the house (88.4 L/s). As in the case with basement suction and an increased separation, all of the flow from the soil into the house passed through the separation in this case.

Although the house pressure also increased in the case with an increased separation and subslab pressurization, as shown in Figures E.3 and E.6, the pressure increase (2.7 Pa) was diminished relative to that predicted for the cases with basement suction (8.8 Pa). The change in pressures caused by the increased separation was not as great in the case with subslab pressurization, because most of the flow from the soil into the house was due to pressurization of the subslab region through air supplied from the living room and bathroom. With the 1 mm separation, Table 4.4 shows the air supplied to the soil through the subslab vent was 99% of the total flow from the soil into the house (62.5 L/s). With the 20 mm separation, the air supplied to the soil was still a large fraction (72%) of the total flow from the soil into the house (86.4 L/s).

The increased flows of soil gas into the basement did not increase indoor radon levels in the cases with basement suction or subslab pressurization, because the increased supply of outdoor air to the subslab region through the larger separation reduced radon concentrations in the subslab region, as shown in Figures F.1, F.3, F.6, and F.8.

These predictions indicate that reducing the flow resistance between the subslab region and outdoors increased the effectiveness of the subslab pressurization system in controlling indoor radon levels. However, maintaining an increased separation between the basement wall and backfill is impractical. A passive vent connecting the subslab region and outdoors could be used instead. Further research should be carried out in a future project to study this alternative.

As predicted for the basement suction and subslab pressurization systems, flows from the soil to the basement increased in the case of the subslab depressurization system with an increased separation compared to the reference case, as shown in Table 4.3. In the reference case (Case 2), there was no flow into the house from the soil. With the increased separation (Case 7), the flow into the house from the soil was 54.2 L/s, which was 94% of the total flow into the house (57.9 L/s). All of the flow from the soil into the house passed through the separation in this case, as it did in the other cases with an increased separation. Increases in house pressure similar to those predicted for the basement suction case with an increased separation were also predicted for this case, as shown in Figures E.1, E.2, E.6, and E.7.

The increased flows of soil gas into the house with the 20 mm separation and subslab depressurization increased indoor radon levels slightly, compared to the house with the same system and a 1 mm separation. Table 4.3 shows the flow through the separation increased significantly from 2.1 L/s to 81.1 L/s with the increased separation. Although the radon levels in the subslab region were no longer diluted with air from the basement for the case with the increased separation, the increased flow through the larger separation diluted these levels instead. However, because the dilution airflows passed through the soil region rather than through the house before reaching the subslab region, the radon concentration of the dilution air was slightly higher in the case with the increased separation. Table 4.5 shows the average radon concentration at the bottom of the basement floor perimeter crack increased from 0.2 pCi/L to 0.6 pCi/L with the increased separation.

Large flows of outdoor air through the separation when the subslab depressurization operates with a large separation are of significant concern. For basements with high insulation levels, heat loss from the basement could be insufficient to warm the air flowing through the separation to prevent soil freezing near the footings. The issue of combined conduction and convection heat transfer around basements should be investigated further in a future project.

Reducing the flow resistance between the subslab region and outdoors impaired the effectiveness of the subslab depressurization system in controlling indoor radon levels. In addition, the increased outdoor airflows through the separation could contribute to the problem of soil freezing. Thus, the separation between the basement wall and backfill should be minimized. Foundation experts consulted in this project indicated the separation can be reduced through watering of the soil near the foundation or by placing fibreglass batt insulation in the separation to impede airflow. These experts warned that incompressible materials such as soil should not be added to this separation to impede airflow, because subsequent soil swelling could increase the bearing pressure of the soil on the foundation. In some cases, the increased pressure could lead to foundation cracking, which would provide more leaks for radon-laden soil gas to enter the house. Another potential solution to decreasing the effect of the separation on subslab depressurization system performance is to place an air barrier in the soil to impede the flow of soil gas in the separation and/or in the backfill region. This approach is discussed in Section 4.4.6.

The increased separation altered indoor radon levels, but it also changed the amount of outdoor air supplied to the house for ventilation. For the basement suction and subslab depressurization cases with an increased separation, Tables D.6 and D.7 show the house no longer met the requirements of CSA Standard F326.1-M1989. The basement received 23% of the required airflow in the case with basement suction, and only 16% in the case with subslab depressurization. The kitchen/living room/dining room combination received only 8% of the required airflow in the basement suction case, and 7% in the subslab depressurization case. The bedrooms were completely unventilated. Only the bathroom was adequately ventilated. For the subslab pressurization case with an increased separation, Table D.8 shows the house still could not meet the requirements of CSA Standard F326.1-M1989.

It should be noted that the crack width at the basement wall-floor perimeter was 5 mm in this project. Smaller cracks, which have a higher flow resistance, are expected to reduce the effect on airflows of changing the separation width. However, further research in a future project is needed to quantify the effect of changes in the separation width with other crack widths.

4.4.6 Effect of Adding a Soil Air Barrier

Compared to the basement suction reference case (Case 1), placing an air barrier in the soil at grade level to cover the separation and backfill caused indoor radon concentrations to decrease slightly when this system operated (Case 11), as shown in Table 4.5.

In this case, Table 4.2 shows the air barrier had no effect on the total flow into or out of the house (61.8 L/s) compared to the reference case (Case 1). The barrier slightly reduced the flow of soil gas into the house in this case from 4% to 0.2% (0.1 L/s) of the total flow into the house. The remainder of the flow into the house was infiltration, which increased slightly from 59.4 L/s to 61.7 L/s. As Table D.11 shows, the house still met the requirements of CSA Standard F326.1-M1989 with the basement suction system and soil air barrier.

As Table 4.2 also shows, the flows of outdoor air into the soil were reduced from 2.4 L/s to 0.1 L/s by the air barrier in this case. All of this airflow passed through the

surface of the soil outside of the backfill, which has an order of magnitude higher flow resistance compared to the backfill.

Figures E.1 and E.11 show the house pressure decreased slightly from -12.5 Pa to -13.0 Pa. This change was entirely due to the increased flow resistance through the soil, which reduced the leakage area of the house.

The air barrier reduced dilution airflows to the subslab region, which caused the radon levels near the basement floor perimeter crack to increase significantly to the same order of magnitude as the undiluted levels far away from the basement in this case, as shown in Figures F.1 and F.11. However, the radon entry rates into the basement did not significantly increase, because the decreased flow of soil gas into the basement offset these increased subslab radon levels.

Indoor radon concentrations decreased slightly when the subslab pressurization system operated with the air barrier in the soil (Case 13), compared to the reference case (Case 3), as shown in Table 4.5.

A slight decrease in the total flow into or out of the house occurred for this case. Table 4.4 shows the air barrier reduced the total flow into the house from 71.2 L/s to 70.8 L/s compared to the reference case (Case 3). The barrier also slightly reduced the flow of soil gas into the house in this case from 88% to 87% of the total flow into the house. The remainder of the flow into the house was infiltration, which increased slightly from 8.7 L/s to 9.0 L/s. As Table D.13 shows, the house still could not meet the requirements of CSA Standard F326.1-M1989 with the subslab pressurization system and soil air barrier.

For this case, there were no flows of outdoor air into the soil. Thus, the only source of dilution air in the subslab region was that supplied from the house through the subslab vent. As in the case without the air barrier, almost all of this air reentered the house through the basement floor perimeter crack. The flow of dilution air out of the soil decreased insignificantly from 5 mL/s to 3 mL/s, as shown in Tables D.3 and D.13.

Figures E.3 and E.13 show the house pressure was relatively unaffected by the air barrier. The pressure was decreased slightly by 0.1 Pa from -5.2 Pa to -5.3 Pa. This

change was entirely due to the increased flow resistance through the soil, which reduced the leakage area of the house.

Only slight decreases in subslab radon levels were predicted in the case with the air barrier and subslab pressurization, as shown in Figures F.3 and F.13. The combination of similar flow patterns in the house and subslab region, and this decrease in subslab radon levels, explains why the indoor concentrations were relatively unchanged by the air barrier. Slight increases in radon levels occurred in the separation, and significant increases in these levels occurred in the backfill region in this case. However, the contribution of soil gas flows from these two regions to the radon entry rate into the basement is negligible.

With subslab depressurization (Case 12), the air barrier had no effect on indoor radon concentrations, compared to the reference case (Case 2).

The air barrier slightly increased the total flow into or out of the house for this case. Table 4.3 shows the total flow into the house increased from 59.3 L/s to 61.7 L/s compared to the reference case (Case 3). All of this flow into the house was infiltration. As Table D.12 shows, the house still met the requirements of CSA Standard F326.1-M1989 with the subslab depressurization system and soil air barrier.

In this case, the flow of soil gas out of the house increased by 10% from 24.4 L/s to 26.8 L/s, as shown in Table 4.3. As for the case with basement suction and the air barrier, the flows into the soil from outdoors were reduced in this case to 0.1 L/s. Thus, almost 100% of the air exhausted from the subslab region (26.9 L/s) originated in the house. This flow pattern eliminates the risk of soil freezing, if the integrity of the barrier can be maintained.

The air barrier had the same effect on house pressure when the subslab depressurization system operated, as when the basement suction system operated. In these cases, Figures E.2 and E.12 show the pressure indoors decreased by 0.5 Pa from -12.5 Pa to -13.0 Pa.

Subslab radon concentrations between the basement floor perimeter crack and the subslab vent decreased slightly with the addition of the air barrier in the case with subslab depressurization, as shown in Figures F.2 and F.12.

It appears from these simulations that the placement of a soil air barrier at grade is an effective means of enhancing the performance of subslab depressurization systems for the soils considered in this project. Also, although the issue of water drainage was not studied, it is expected this barrier would also help divert water away from the foundation, if the barrier were sloped away from the basement. Further research is needed to determine the effectiveness of soil air barriers in other soils with higher permeabilities outside the backfill. Research regarding the installation of these barriers and to determine if their integrity can be maintained is also required.

4.4.7 Effect of Increased Subslab Ventilation Rate

Conservative design of ventilation systems dictates that a factor of safety be applied when specifying the system flow rates. This approach results in oversized systems. To investigate the effect of these increased flow rates, the total flow rate of the central exhaust fan was increased by 25% from 61.8 L/s to 77.2 L/s. In the cases with subslab depressurization, the bathroom and living room exhaust flow rates were unchanged (34.9 L/s), but the flow through the subslab depressurization vent was increased by 57% from 26.9 L/s to 42.3 L/s. In the cases with subslab pressurization, all of the fan exhaust was directed through the subslab pressurization vent. Thus, the flow through that vent changed in the same manner as the total flow rate for the fan.

As Table 4.5 shows, radon concentrations indoors were slightly decreased (1%) when the subslab pressurization system operated with the higher flow rate in the case with a 1 mm separation (Case 5), compared to the reference case (Case 3). For this same system, but with the soil air barrier (Case 15), the radon levels indoors increased slightly (3%) in comparison to the reference case (Case 13). The higher subslab pressurization flow rates had no effect on indoor radon levels in the case with a 20 mm separation (Case 10), compared to the reference case (Case 8).

Increasing the subslab pressurization flow rate had no effect on house pressures or on the infiltration of outdoor air into the house in the cases with a 1 mm separation or with an air barrier, as shown in Figures E.3, E.5, E.13, and E.15, and in Table 4.4. The house still could not meet the requirements of CSA F326.1-M1989 in these cases, as shown in Tables D.5 and D.15.

In the case with a 20 mm separation, the increased subslab pressurization flow caused a slight increase in infiltration of outdoor air into the house from 2.3 L/s to 2.9 L/s, as Table 4.4 shows. The increased infiltration was due to a slight decrease in house pressure from -2.5 Pa to -2.8 Pa, as Figures E.8 and E.10 show. The increased subslab ventilation flow increased the pressure drop in the subslab region between the subslab vent and the basement floor perimeter crack. Although the quantity of outdoor air entering the house increased in this case, the house still did not meet the requirements of CSA F326.1-M1989, as shown in Table D.10.

Also with the 20 mm separation, Table 4.4 shows the increased subslab pressurization flow substantially increased the flow of soil gas from the subslab region through the larger separation to the outdoors from 0.3 L/s to 2.8 L/s. However, the increased flow through this separation was still only a small fraction (3%) of the total flow out of the subslab region. Most of this flow entered the house through the perimeter crack. There was no significant change in the flow of outdoor air into the separation in this case, and no flow of soil gas occurred in the soil outside the separation.

Figures F.3 and F.5 show there were slight decreases in radon levels beneath the basement floor between the subslab vent and the perimeter crack in the case with increased subslab pressurization flows and a 1 mm separation. There was a slight increase in these levels for the same system, but with the soil air barrier, as shown in Figures F.13 and F.15. The increased subslab pressurization flows had no effect on these radon levels in the case with the 20 mm separation, as shown in Figures F.8 and F.10.

Radon concentrations indoors were slightly decreased (0.1 pCi/L) when the subslab depressurization system operated with the higher flow rate in the case with a 20 mm separation (Case 9), as shown in Table 4.5 compared to the reference case (Case 7). For this same system, but with the smaller separation (Case 4), or with the soil air barrier (Case 14), the higher subslab depressurization flow rates had no effect on indoor radon levels, compared to the reference cases (Cases 2 and 12).

Increasing the subslab depressurization flow rate had a substantial effect on house pressures and on the infiltration of outdoor air into the house in the cases with a 1 mm separation or with an air barrier, as shown in Figures E.2, E.4, E.12, and E.14,

and in Table 4.3. With the 1 mm separation, the house pressure decreased from -12.5 Pa to -15.6 Pa. For the case with the air barrier, this pressure was reduced from -13.0 Pa to -16.3 Pa. Outdoor air infiltration above-grade increased by 25%, from 59.3 L/s to 74.1 L/s in the case with the smaller separation, and from 61.7 L/s to 77.1 L/s with the air barrier. The house in both these cases exceeded the requirements of CSA F326.1-M1989, as shown in Tables D.4 and D.14.

Large flows of air out of the basement, such as those occurring with the subslab depressurization systems described in this project, create two problems. The first of these is furnace backdrafting. In a relatively airtight house, the pressure reductions predicted for the basement could be enough to backdraft a furnace. Although radon levels indoors would be reduced, this could create another indoor air quality problem and, in some cases, could even lead to the production of carbon monoxide by the furnace due to an inadequate combustion air supply.

The second problem caused by the withdrawal of air from the basement is that of energy loss. Since most of the air exhausted from the subslab region was predicted to originate in the house, the high subslab exhaust flow rates will waste energy through excessive ventilation of the house. This loss would be offset somewhat by the warming of the basement floor and subslab region, which would reduce the heat loss through the floor. Further research in a future project should be carried out to quantify this phenomenon.

In the case with a 20 mm separation, the increased subslab depressurization flow caused a slight increase in infiltration of outdoor air into the house from 3.7 L/s to 4.3 L/s, as Table 4.3 shows. The increased infiltration was due to a slight decrease in house pressure from -3.2 Pa to -3.4 Pa, as Figures E.7 and E.9 show. The increased subslab ventilation flow increased the pressure drop in the subslab region between the subslab vent and the basement floor perimeter crack. Although the quantity of outdoor air entering the house increased in this case, the house still did not meet the requirements of CSA F326.1-M1989, as shown in Table D.9.

Also with the 20 mm separation, Table 4.3 shows the increased subslab depressurization flow slightly decreased the flow of soil gas into the house by 4% from 54.2 L/s to 51.9 L/s, but there was still no flow of indoor air from the basement into the subslab region with this large separation. In addition, Table 4.3 shows the

increased subslab ventilation substantially increased (16%) the flow of soil gas from outdoors into the subslab region through the larger separation from 81.1 L/s to 94.2 L/s. The increased flow through this separation will exacerbate the problem of soil freezing near the footings in this case. No flow of soil gas occurred in the soil outside the separation.

In the cases with increased subslab depressurization flows and with the smaller separation or the air barrier, Table 4.3 shows there were no significant changes in flows of outdoor air through the separation or soil into the subslab region. However, the magnitude of the increase in flow of indoor air through the subslab region was similar to that for the increase in flow in the subslab depressurization system in these two cases. Between 93% to 100% of the exhaust flow from the subslab region was from the basement in these cases.

Figures F.2, F.4, F.12 and F.14 show there were no significant changes in radon levels beneath the basement floor between the subslab vent and the perimeter crack in the cases with increased subslab depressurization flows and with a 1 mm separation or with an air barrier. There was a slight decrease in these levels for the same system, but with the larger separation, as shown in Figures F.7 and F.9.

5.0 CONCLUSIONS

1. Subslab depressurization systems were very successful at reducing indoor radon concentrations. For the conditions considered in this project, the simulations showed this system performed much better than the subslab pressurization or basement suction systems.
2. Most of the air removed from the subslab region beneath the house by the subslab depressurization system with a small separation between the basement wall and backfill or with a soil air barrier at grade level was drawn through the basement floor, instead of through the soil. This means that:
 - i) there is little danger of subslab depressurization systems causing soil to freeze under footings for these conditions, but
 - ii) airflows from the basement into the subslab region should be minimized to avoid excessive depressurization of the basement (leading to furnace backdrafting) and to avoid over-ventilating the house (leading to unnecessary heat loss).
3. With a large separation between the basement wall and backfill, most of the air removed from the subslab region beneath the house by the subslab depressurization system was drawn from outdoors through the separation, instead of through the soil or from the basement. This means that airflows through large separations should be minimized to avoid the potential freezing of soil near footings.

6.0 RECOMMENDATIONS

1. Further field tests and computer simulations should be carried out using different soils and for a wider range of configurations to confirm the conclusion that freezing of the soil under footings is not likely to be a problem. The project should also determine the impact of soil temperatures on soil gas flows around foundations (and vice versa) and should quantify the effect footings have on these flows.

The field tests should be carried out using a different test house surrounded by soil that is highly permeable to air, to create a worst case condition. The new test house should have thermocouples buried under the footings and around the house. It should also have a permanently installed subslab depressurization system. An identical house without subslab depressurization should also be tested and simulated for comparison.

The computer simulations should consider combined conduction and convection heat transfer in the soil. Convection heat transfer in the soil around basements has been ignored in the past. CONAIR can be adapted to carry out these analyses, since it already implements a transport equation that is similar to the thermal conduction-convection equation.

2. Subslab venting systems should not be ducted to the indoor space, to avoid the potential for increased radon entry rates in the event the system's fan is turned off or fails.
3. Air barriers should be used to impede airflows from outdoors through large separations between basement walls and the backfill. Incompressible materials such as soil should not be added to these separations if they were created by soil shrinkage. Swelling of the soil with the added material could increase soil bearing pressures, which could lead to foundation damage. Future work should evaluate the effectiveness of placing an air barrier at other locations, such as at the footing.
4. A radon mitigation contractor training program should be developed in Canada. This program should include a procedure for ensuring that radon

mitigation systems do not create furnace backdrafting problems, and a procedure for balancing the subslab depressurization flow rate to reduce or eliminate energy wastage due to over-ventilation of the house and/or of the surrounding soil. That procedure should include the following five steps, in the order listed here:

- a. Seal the basement floor as much as possible to reduce air leakage from the basement into the subslab region.
- b. Place a soil air barrier outside the foundation to reduce air leakage from outdoors into the subslab region, at least in the immediate region adjacent to the basement wall at grade where large separations could occur.
- c. Install and balance the subslab depressurization system so that system's exhaust flow rate is just sufficient to cause all parts of the subslab space immediately beneath the basement floor to be at a lower pressure than the basement under design conditions. If the addition of the subslab depressurization system causes the total ventilation rate for the house to exceed the requirements of CSA F326.1-M1989, and if further sealing of the basement floor is possible, then steps *a* and *c* should be repeated.
- d. Carry out backdrafting tests, and apply the formal procedure of CGSB Standard 51.71-M "Combustion Ventilation Requirements".
- e. Monitor the radon concentration in the house for at least two weeks. If the radon levels indoors are too high during this period, all of the steps should be repeated, with consideration given to extending the soil air barrier further from the foundation. If it is not possible to achieve further increases in flow resistance through the soil and basement floor, it may be necessary to increase and rebalance the subslab depressurization system exhaust flow rate to exclude soil gas entry into the house.

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APPENDIX A - INPUT FILE GENERATOR PROGRAM LISTING

FILE: L2IBM.FOR

C***** CONAIR INPUT FILE GENERATOR *****

C DEVELOPED BY: G.K. YUILL & ASSOCIATES (B.C.) LTD.
C IBM-PC VERSION - MARCH 26, 1991

```

      INTEGER NPTZ,NPTY,NPTX,I,J,K,TYPE,NCOUNT,TCOUNT,LCOUNT,NX1,
      +       NX2,NX3,NX4,NX5,NY1,NY2,NY3,NY4,NY5,NZ1,NZ2,NZ3,AMB,
      +       CLASS,NDNUM(2,10,10,12),STRT1,STRT2,STRT3,FIN1,FIN2,
      +       FIN3,BASNOD,SURNOD,TERR,YEAR,NZ1LOU,NZ2LOU,NZ3LOU

```

```

      INTEGER JDEF,JMIN,JMAX,JUNK,SIMP,
      +       WALSEP,FRMNOD,TONOD,SEPFLG,CRKFLG

```

```

      REAL RDEF,RMIN,RMAX,RUNK,SEPAR

```

```

      REAL*8 XPOS(15),YPOS(15),ZPOS(15),XSUM,GRDT,
      +       XBOUND(19),YBOUND(19),ZBOUND(19),YSUM,ZSUM,BASEP,
      +       WALLX,WALLY,WALLZ,ATMOS,PRES,TEMP,VOL,MASS1,VOLMAS,PORS,
      +       KXAG,KYAG,KZAG,KSOIL,STORE,CRKBOT,AIRT,BASET,
      +       BIGK(1000),C(1000),TBIGK,CT,CEE,INTFCE,HEYK

```

```

      REAL*8 AREA,MU,RHOS,DIST,SMALLK,EAVEHT,SLAB,STORE2,DIFF,
      +       DIF1,DIFX,DIFY,DIFZ,EMFRC1,EMFRCX,EMFRCY,EMFRCZ,BASEV,
      +       POROS1,POROSX,POROSY,POROSZ,RDCON1,RDCONX,RDCONY,RDCONZ,
      +       GENRAT,ST1,STX,STY,STZ,RDDEC,RHOA,RHOB,TOP,DIFAIR

```

```

      CHARACTER*14 COMMENT,LOCN

```

C DIFFUSIVITY IN OPEN AIR [m^2/h] (LOUREIRO - MASTRA 'DFAIR1')
DFAIR=0.0432
EXP = 1

```

      SIMP = 0
      JUNK = 999
      JDEF = SIMP
      JMIN = 0
      JMAX = 1

```

```

      CALL INTGET(' Enter SOIL element type: SIMP=1, CNDF=0',
      +       JDEF,JMIN,JMAX,JUNK,SIMP)

```

```

      WALSEP = 1
      JUNK = 999
      JDEF = WALSEP
      JMIN = 0
      JMAX = 1

```

```

      CALL INTGET(' Wall-soil SEPARATION?: YES=1, NO=0',
      +       JDEF,JMIN,JMAX,JUNK,WALSEP)

```

```

      SEPAR = 0.0
      IF (WALSEP.EQ.1) THEN
        SEPAR = 0.02
        RUNK = 999
        RDEF = SEPAR
        RMIN = 0.0
        RMAX = 0.05

```

```

      CALL RELGET(' Wall-soil SEPARATION (m):',
      +       RDEF,RMIN,RMAX,RUNK,SEPAR)

```

```

      END IF

```

```

      OPEN (2,FILE='L2.DAT',STATUS='UNKNOWN')
      OPEN (13,FILE='L2IN.DAT',STATUS='OLD')
      OPEN (3,FILE='LOUT1.OUT',STATUS='UNKNOWN')
      OPEN (4,FILE='LOUT2.OUT',STATUS='UNKNOWN')
      OPEN (5,FILE='LOUT3.OUT',STATUS='UNKNOWN')
      OPEN (8,FILE='FLOWSYS1.OUT',STATUS='UNKNOWN')
      OPEN (9,FILE='FLOWSYS2.OUT',STATUS='UNKNOWN')
      OPEN (10,FILE='FLOWELEM.OUT',STATUS='UNKNOWN')
      OPEN (11,FILE='KINELEM.OUT',STATUS='UNKNOWN')
      OPEN (12,FILE='STEADY.OUT',STATUS='UNKNOWN')

```

```

      REWIND(2)
      REWIND(13)

```

```

      WRITE (8,2507) 'FLOWSYS'
      WRITE (10,2508) 'FLOWELEM'
      WRITE (11,2507) 'KINELEM'

```

```

      WRITE (12,2506) 'STEADY'

```

C***** INPUT OF SUNDRY WEATHER AND TERRAIN DATA *****
C*****

```

      READ (2,1700) STRT1,STRT2,STRT3
      READ (2,1700) FIN1,FIN2,FIN3
      READ (2,1800) YEAR
      READ (2,1900) LOCN
      READ (2,2100) TERR
      READ (2,2200) EAVEHT

```

```

      WRITE (3,1700) STRT1,STRT2,STRT3
      WRITE (3,1700) FIN1,FIN2,FIN3
      WRITE (3,1800) YEAR
      WRITE (3,1900) LOCN
      WRITE (3,2100) TERR
      WRITE (3,2200) EAVEHT

```

C*****
C***** WRITE (6,*) 'BEGIN NODE PROCESSING...' *****

C THE GRID PARAMETERS ARE GENERATED BY PROGRAM "GRIDSUB", WHICH
C ASSUMES GRID POINTS ARE AT THE CENTER OF EACH GRID BLOCK.

```

C   TOTAL NUMBER OF GRID POINTS IN EACH DIRECTION
      READ (13,*) NPTX
      READ (13,*) NPTY
      READ (13,*) NPTZ

C   THE GRID POINT NUMBER AT EACH OF THE PHYSICAL BOUNDARIES
C   IN EACH DIRECTION
      READ (13,*) NX1,NX2,NX3,NX4,NX5,NY1,NY2,NY3,NY4,NY5,
      +      NZ1LOU,NZ2LOU,NZ3LOU

      IF (WALSEP.EQ.1) THEN
        NPTX=NPTX+1
        NX4=NX4+1
        NX5=NX5+1
        NPTY=NPTY+1
        NY4=NY4+1
        NY5=NY5+1
      END IF

      NZ1 = NPTZ - NZ2LOU
      NZ2 = NPTZ - NZ1LOU
      NZ3 = NZ3LOU

C   SOIL AIR PERMEABILITIES Units: m2.
      READ (13,*) KXAG,KYAG,KZAG,KSOIL

C   BASEMENT VOLUME Units: m3.
      READ (2,*) BASEV

C   BASEMENT FLOOR SLAB THICKNESS Units: m.
      READ (2,*) SLAB

C   BASEMENT AND OUTDOOR PRESSURES Units: Pa.
      READ (2,*) BASEP
      READ (2,*) ATMOS

C   AIR TEMPERATURES Units: Deg. C.
      READ (2,*) AIRT
      READ (2,*) GRDT
      READ (2,*) BASET

C   AIR DENSITIES Units: kg/m3.
      RHOA = 3.4838E-3 * 101325/(AIRT+273.15)
      RHOB = 3.4838E-3 * 101325/(BASET+273.15)
      RHOS = 3.4838E-3 * 101325/(GRDT+273.15)

C   SOIL GAS VISCOISITY Units: Pa*s.
      MU = GRDT*4.828E-8+1.71432E-5

      XSUM=0.0
      YSUM=0.0
      ZSUM=0.0

C   THE GRID X-BOUNDARY POSITIONS Units: m.
      DO 10 I=1,NPTX
        IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))) THEN
          XBOUND(I)=SEPAR
          XPOS(I)=XSUM+XBOUND(I)
        ELSE
          READ (13,*) XBOUND(I)
          XPOS(I)=XSUM+(XBOUND(I)/2.)
        END IF
        XSUM=XSUM+XBOUND(I)
      10 CONTINUE

C   THE GRID Y-BOUNDARY POSITIONS Units: m.
      DO 20 J=1,NPTY
        IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))) THEN
          YBOUND(J)=SEPAR
          YPOS(J)=YSUM+YBOUND(J)
        ELSE
          READ (13,*) YBOUND(J)
          YPOS(J)=YSUM+(YBOUND(J)/2.)
        END IF
        YSUM=YSUM+YBOUND(J)
      20 CONTINUE

C   THE GRID Z-BOUNDARY POSITIONS Units: m.
      DO 30 K=1,NPTZ
        READ (13,*) ZBOUND(K)
        ZPOS(K)=ZSUM+(ZBOUND(K)/2.)
        ZSUM=ZSUM+ZBOUND(K)
      30 CONTINUE

      DO 35 K=1,NPTZ
        ZPOS(K)=-ZSUM+ZPOS(K)
      35 CONTINUE

      WALLX=NX3
      WALLY=NY3
      WALLZ=NZ2

C   SOIL BULK RADON DIFFUSION COEFFICIENTS Units: m2/s.
      READ (2,*) DIF1
      READ (2,*) DIFX
      READ (2,*) DIFY
      READ (2,*) DIFZ

C   SOIL RADON EMANATION FRACTIONS Units: Dimensionless.
      READ (2,*) EMFRC1
      READ (2,*) EMFRCX
      READ (2,*) EMFRCY
      READ (2,*) EMFRCZ

C   SOIL PARTICLE DENSITIES Units: kg/m3.
      READ (2,*) RHOS1
      READ (2,*) RHOSX
      READ (2,*) RHOSY

```

```

      READ (2,*) RHOSZ
C     SOIL RADIUM CONCENTRATIONS Units: Ci/kg.
      READ (2,*) RDCON1
      READ (2,*) RDCONX
      READ (2,*) RDCONY
      READ (2,*) RDCONZ
C     SOIL POROSITIES Units: Dimensionless.
      READ (2,*) POROS1
      READ (2,*) POROSX
      READ (2,*) POROSY
      READ (2,*) POROSZ
C     RADON DECAY CONSTANT Units: h-1.
      READ (2,*) RDDEC
C     Convert diffusivities from m2/s to m2/h.
      DIF1 = DIF1*3600
      DIFX = DIFX*3600
      DIFY = DIFY*3600
      DIFZ = DIFZ*3600

      ST1 = EMFRC1*RDCON1*RHOS1*(1-POROS1)*3600*3.7E10
      STX = EMFRCX*RDCONX*RHOSX*(1-POROSX)*3600*3.7E10
      STY = EMFRY*RDCONY*RHOSY*(1-POROSY)*3600*3.7E10
      STZ = EMFRCZ*RDCONZ*RHOSZ*(1-POROSZ)*3600*3.7E10

      WRITE (11,3000) 'K=',1,'< Decay constant: Rn [h-1]'
      WRITE (11,3100) RDDEC,'< Loureiro, p.268'
      WRITE (11,2850) '<'

C***** WRITE NODE DATA TO OUTPUT FILE*****
C     OUTPUT TO FILE "LOUT1.OUT"
      NCOUNT = 0

      DO 40 K=1,NPTZ
        DO 50 J=1,NPTY
          DO 60 I=1,NPTX
            IF (I.LE.WALLX.AND.J.LE.WALLY.AND.K.GT.(WALLZ+1)) THEN
C     THESE NODES ARE IN THE BASEMENT
              GOTO 60
            ELSE
              NCOUNT = NCOUNT + 1
              AMB=0
              TYPE = 0
              PRES = 0
              TEMP=GRDT

              IF (K.EQ.WALLZ+1) THEN
                IF (I.LE.NX1.AND.J.LE.NY1) THEN
                  NCOUNT=NCOUNT-1
                  GOTO 60
                ELSE IF (I.LE.NX2.AND.J.LE.NY2) THEN
                  CRKBOT=(ZPOS(K)-ZBOUND(K))/2.
                  NDNUM(1,I,J,K) = NCOUNT
                  WRITE (3,1030) NCOUNT,TYPE,AMB,CRKBOT,TEMP,PRES,
                    + ' CRACK BOT'
                ELSE IF (I.LE.NX3.AND.J.LE.NY3) THEN
                  NCOUNT=NCOUNT-1
                  GOTO 60
                ELSE IF (I.LE.(NX3+1).AND.J.LE.(NY3+1)) THEN
                  IF (WALSEP.EQ.1) THEN
                    CRKBOT=(ZPOS(K)-ZBOUND(K))/2.
                    NDNUM(2,I,J,K) = NCOUNT
                    WRITE (3,1040) NCOUNT,TYPE,AMB,CRKBOT,TEMP,
                      + PRES,' WALSEP BOT'
                    NCOUNT=NCOUNT+1
                  END IF
                  NDNUM(1,I,J,K) = NCOUNT
                  WRITE (3,1000) NCOUNT,TYPE,AMB,ZPOS(K),TEMP,PRES,
                    + I,J,K
                ELSE
                  NDNUM(1,I,J,K) = NCOUNT
                  WRITE (3,1000) NCOUNT,TYPE,AMB,ZPOS(K),TEMP,PRES,
                    + I,J,K
                END IF
              ELSE
                NDNUM(1,I,J,K) = NCOUNT
                WRITE (3,1000) NCOUNT,TYPE,AMB,ZPOS(K),TEMP,PRES,I,J,K
              END IF
            END IF
          END IF
        CONTINUE
      CONTINUE
    CONTINUE
  40
  50
  60

      TYPE=0
      NCOUNT = NCOUNT + 1
      BASNOD=NCOUNT
      ZPOS(NPTZ+1) = ZPOS(NPTZ) + ZBOUND(NPTZ)/2.
      WRITE (3,1050) NCOUNT,AMB,TYPE,ZPOS(NPTZ+1),BASET,BASEP,
        - ' BASEMENT'

      TYPE=1
      NCOUNT = NCOUNT + 1
      SURNOD=NCOUNT
      WRITE (3,1060) NCOUNT,AMB,TYPE,ZPOS(NPTZ+1),AIRT,ATMOS,
        - ' OUTDOORS - SOIL SURFACE'

      WRITE(8,2700) 'N=',NCOUNT,' S=1 ID=URN TP=A'
      WRITE(8,2800) SURNOD,'BC=', 'C'
      WRITE(8,2850) '<'

C*****
      WRITE (6,*) 'BEGIN ELEMENT PROCESSING...'
C*****
C*****

```


C***** FIRST SET OF ELEMENTS (X-DIRECTION) *****
C*****

```

WRITE (11,3200) ' 1 I= 1 K=1'
WRITE (11,3300) NCOUNT, ' I=1, NCOUNT, ' GEN=1 K=1'

CLASS = 1
TCOUNT = 1
LCOUNT = 0
TOP = 0.0

DO 70 K=1,NPTZ
  DO 80 J=1,NPTY
    DO 90 I=1,NPTX
      PORS=-1.0
      VOL = XBOUND(I)*YBOUND(J)*ZBOUND(K)

      IF (K.EQ.WALLZ+1) THEN
        IF (I.GT.NX1.OR.J.GT.NY1) THEN
          IF (I.LE.NX2.AND.J.LE.NY2) THEN
            VOLMAS=XBOUND(I)*YBOUND(J)*0.000001*RHOS*1000.
            WRITE (9,2410) NDCUM(1,I,J,K), 'V=',VOLMAS,
              * '< CRACK BOT'
          END IF
        END IF
      END IF

      IF (I.LE.WALLX.AND.J.LE.WALLY.AND.K.GT.WALLZ) THEN
        GOTO 300
      END IF

      IF (I.EQ.NPTX) THEN
        PORS=POROS1
        GENRAT=ST1*VOL
        GOTO 200
      END IF
      COMMENT = 'X-DIRECTION'

      LCOUNT = LCOUNT +1
      SEPFLG=0

      IF (K.LE.NZ1) THEN
        SMALLK=KSOIL
        DIFF=DIF1
        PORS=POROS1
        GENRAT=ST1*VOL
      ELSE IF (K.LE.NZ2) THEN
        IF (I.LT.NX4) THEN
          IF (J.LE.NY4) THEN
            SMALLK=KZAG
            DIFF=DIFZ
            PORS=POROSZ
            GENRAT=STZ*VOL
          ELSE
            SMALLK=KSOIL
            DIFF=DIF1
            PORS=POROS1
            GENRAT=ST1*VOL
          END IF
        ELSE IF (I.EQ.NX4) THEN
          IF (J.LE.NY4) THEN
            SMALLK=INTFCE(KZAG,KSOIL,XBOUND(I),XBOUND(I+1))
            DIFF=INTFCE(DIFZ,DIF1,XBOUND(I),XBOUND(I+1))
            PORS=POROSZ
            GENRAT=STZ*VOL
          ELSE
            SMALLK=KSOIL
            DIFF=DIF1
            PORS=POROS1
            GENRAT=ST1*VOL
          END IF
        ELSE
          SMALLK=KSOIL
          DIFF=DIF1
          PORS=POROS1
          GENRAT=ST1*VOL
        END IF
      ELSE IF (K.GT.NZ2) THEN
        IF (I.LT.NX3) THEN
          IF (J.LE.NY4) THEN
            SMALLK=KYAG
            DIFF=DIFY
            PORS=POROSY
            IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))) THEN
              SEPFLG=2
              GENRAT=0.0
            ELSE
              GENRAT=STY*VOL
            END IF
          ELSE
            SMALLK=KSOIL
            DIFF=DIF1
            PORS=POROS1
            GENRAT=ST1*VOL
          END IF
        ELSE IF (I.EQ.NX3) THEN
          IF (J.LE.NY4) THEN
            SMALLK=INTFCE(KYAG,KXAG,XBOUND(I),XBOUND(I+1))
            DIFF=INTFCE(DIFY,DIFX,XBOUND(I),XBOUND(I+1))
            PORS=POROSY
            IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))) THEN
              SEPFLG=2
              GENRAT=0.0
            ELSE
              GENRAT=STY*VOL
            END IF
          ELSE
            SMALLK=KSOIL
            DIFF=DIF1
            PORS=POROS1
            GENRAT=ST1*VOL
          END IF
        ELSE
          SMALLK=KSOIL
          DIFF=DIF1
          PORS=POROS1
          GENRAT=ST1*VOL
        END IF
      ELSE
        SMALLK=KSOIL
        DIFF=DIF1
        PORS=POROS1
        GENRAT=ST1*VOL
      END IF
    END DO
  END DO
END DO

```

```

      PORS=POROS1
      SMALLK=KSOIL
      DIFF=DIF1
      GENRAT=ST1*VOL
    END IF
  ELSE IF (I.LT.NX4) THEN
    IF (J.LE.NY4) THEN
      SMALLK=KXAG
      DIFF=DIFX
      PORS=POROSX
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1)).AND.
        (J.LE.(NY3+1))) THEN
        SEPFLG=1
        DIFF=INTFCE(DIFAIR,DIFX,XBOUND(I),XBOUND(I+1))
        GENRAT=0.0
      ELSE
        GENRAT=STX*VOL
      END IF
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
      PORS=POROS1
      GENRAT=ST1*VOL
    END IF
  ELSE IF (I.EQ.NX4) THEN
    IF (J.LE.NY4) THEN
      SMALLK=INTFCE(KXAG,KSOIL,XBOUND(I),XBOUND(I+1))
      DIFF=INTFCE(DIFX,DIF1,XBOUND(I),XBOUND(I+1))
      PORS=POROSX
      GENRAT=STX*VOL
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
      PORS=POROS1
      GENRAT=ST1*VOL
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
    PORS=POROS1
    GENRAT=ST1*VOL
  END IF
END IF

AREA=YBOUND(J)*ZBOUND(K)
IF (SEPFLG.EQ.2) THEN
  DIFF=DIFAIR
  DIST=(XBOUND(I)+XBOUND(I+1))/2.
  TBIGK=(SEPAR**2*AREA)/(12.*DIST)
  CT=TBIGK*DSQRT(RHOS)/MU
  SEPFLG=0
ELSE IF (SEPFLG.EQ.1) THEN
  DIST=XBOUND(I+1)/2.
  CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
  TBIGK=HEYK(AREA,DIST,SMALLK)
  DIST=(XBOUND(I)+XBOUND(I+1))/2.
  SEPFLG=0
ELSE
  DIST=(XBOUND(I)+XBOUND(I+1))/2.
  CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
  TBIGK=HEYK(AREA,DIST,SMALLK)
  SEPFLG=0
END IF
MASSL=AREA*RHOS*1000.

C(1)=0.
BIGK(1)=0.
FRMNOD=NDNUM(1,I,J,K)
TONOD=NDNUM(1,I+1,J,K)
DO 95 TYPE=1,TCOUNT
  IF (CT.EQ.(TYPE).AND.TBIGK.EQ.BIGK(TYPE)) THEN
    WRITE (5,1100) LCOUNT,FRMNOD,0.,
      TONOD,0.,TYPE,0.,0.1,COMMENT
    WRITE (5,1600) 0,0,0
    IF (SIMP.EQ.1) THEN
      WRITE (10,2600) LCOUNT,'I=',FRMNOD,
        TONOD,'T=SIMP'
    ELSE
      WRITE (10,2650) LCOUNT,'I=',FRMNOD,
        TONOD,'T=CNDF M=',MASSL,' L=',DIST,
        ' D=',DIFF
    END IF
    GOTO 200
  END IF
95 CONTINUE
C(TCOUNT) = CT
BIGK(TCOUNT) = TBIGK
WRITE (4,1200) TCOUNT,CLASS,BIGK(TCOUNT),BIGK(TCOUNT),
  C(TCOUNT),EXP
WRITE (5,1100) LCOUNT,FRMNOD,0.,TONOD,
  0.,TCOUNT,0.,0.1,COMMENT
WRITE (5,1600) 0,0,0
IF (SIMP.EQ.1) THEN
  WRITE (10,2600) LCOUNT,'I=',FRMNOD,
    TONOD,'T=SIMP'
ELSE
  WRITE (10,2650) LCOUNT,'I=',FRMNOD,
    TONOD,'T=CNDF M=',MASSL,' L=',DIST,
    ' D=',DIFF
END IF

TCOUNT = TCOUNT + 1
C(TCOUNT)=0.
BIGK(TCOUNT)=0.

200 IF (WALSEP.EQ.1) THEN
  IF (K.GT.NZ2) THEN
    IF (K.EQ.WALLZ+1) THEN

```

```

      IF ((I.LE.(NX3+1)).AND.(J.LE.(NY3+1))) THEN
      IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(2,I,J,K),
      'CG=', GENRAT
      VOLMAS=XBOUND(I)*YBOUND(J)*0.000001*RHOS*1000.
      WRITE(9,2420) NDNUM(2,I,J,K), 'V=', VOLMAS,
      '< WALSEP BOT'
      END IF
    END IF
    IF (I.EQ.(NX3+1)).AND.(J.LT.(NY3+1)) THEN
    IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(1,I,J,K),
    'CG=', GENRAT
    VOLMAS=SEPAR*YBOUND(J)*ZBOUND(K)*RHOS*1000.
    WRITE(9,2420) NDNUM(1,I,J,K), 'V=', VOLMAS,
    '< WALL SID-X'
    ELSE IF ((I.LT.(NX3+1)).AND.(J.EQ.(NY3+1))) THEN
    IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(1,I,J,K),
    'CG=', GENRAT
    VOLMAS=XBOUND(I)*SEPAR*ZBOUND(K)*RHOS*1000.
    WRITE(9,2420) NDNUM(1,I,J,K), 'V=', VOLMAS,
    '< WALL SID-Y'
    ELSE IF ((I.EQ.(NX3+1)).AND.(J.LT.(NY3+1))) THEN
    IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(1,I,J,K),
    'CG=', GENRAT
    VOLMAS=SEPAR*SEPAR*ZBOUND(K)*RHOS*1000.
    WRITE(9,2420) NDNUM(1,I,J,K), 'V=', VOLMAS,
    '< WALL SID-XY'
    ELSE
    IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(1,I,J,K),
    'CG=', GENRAT
    VOLMAS=VOL*PORS*RHOS*1000.
    WRITE(9,2400) NDNUM(1,I,J,K), 'V=', VOLMAS, '< ', I,J,K
    END IF
  ELSE
  IF (GENRAT.NE.0.0) WRITE (12,2900) NDNUM(1,I,J,K),
  'CG=', GENRAT
  VOLMAS=VOL*PORS*RHOS*1000.
  WRITE(9,2400) NDNUM(1,I,J,K), 'V=', VOLMAS, '< ', I,J,K
  END IF
END IF
C***** SECOND SET OF ELEMENTS (Y-DIRECTION) *****
C*****
COMMENT = 'Y-DIRECTION'
IF (J.EQ.NPTY) THEN
  GOTO 300
END IF
LCOUNT = LCOUNT + 1
SEPFLG=0
IF (K.LE.NZ1) THEN
  SMALLK=KSOIL
  DIFF=DIF1
ELSE IF (K.LE.NZ2) THEN
  IF (J.LT.NY4) THEN
    IF (I.LE.NX4) THEN
      SMALLK=KZAG
      DIFF=DIF2
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.EQ.NY4) THEN
    IF (I.LE.NX4) THEN
      SMALLK=INTFCE(KZAG,KSOIL,YBOUND(J),YBOUND(J+1))
      DIFF=INTFCE(DIF2,DIF1,YBOUND(J),YBOUND(J+1))
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
  END IF
END IF
C (ELSE K.GT.NZ2)
ELSE
  IF (J.LT.NY3) THEN
    IF (I.LE.NX4) THEN
      SMALLK=KXAG
      DIFF=DIFX
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))) THEN
        SEPFLG=2
      END IF
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.LT.NY4) THEN
    IF (I.LE.NX3) THEN
      SMALLK=KYAG
      DIFF=DIFY
      IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))) THEN
        SEPFLG=1
        DIFF=INTFCE(DIFAIR,DIFY,YBOUND(J),YBOUND(J+1))
      END IF
    ELSE IF (I.LE.NX4) THEN
      SMALLK=KXAG
      DIFF=DIFX
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1)).AND.
      (J.EQ.(NY3+1))) THEN

```

```

                SEPFLG=1
                DIFF=INTFCE(DIFAIR,DIFX,YBOUND(J),YBOUND(I+1))
            END IF
        ELSE
            SMALLK=KSOIL
            DIFF=DIF1
        END IF
    ELSE IF (J.EQ.NY4) THEN
        IF (I.LE.NX3) THEN
            SMALLK=INTFCE(KYAG,KSOIL,YBOUND(J),YBOUND(J+1))
            DIFF=INTFCE(DIFY,DIF1,YBOUND(J),YBOUND(J+1))
        ELSE IF (I.LE.NX4) THEN
            SMALLK=INTFCE(KKAG,KSOIL,YBOUND(J),YBOUND(J+1))
            DIFF=INTFCE(DIFX,DIF1,YBOUND(J),YBOUND(J+1))
        ELSE
            SMALLK=KSOIL
            DIFF=DIF1
        END IF
    ELSE
        SMALLK=KSOIL
        DIFF=DIF1
    END IF
END IF

AREA=XBOUND(I)*ZBOUND(K)
IF (SEPFLG.EQ.2) THEN
    DIFF=DIFAIR
    DIST=(YBOUND(J)+YBOUND(J+1))/2.
    TBIGK=(SEPAR**2*AREA)/(12.*DIST)
    CT=TBIGK*DSQRT(RHOS)/MU
    SEPFLG=0
ELSE IF (SEPFLG.EQ.1) THEN
    DIST=YBOUND(J+1)/2.
    CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
    TBIGK=HEYK(AREA,DIST,SMALLK)
    DIST=(YBOUND(J)+YBOUND(J+1))/2.
    SEPFLG=0
ELSE
    DIST=(YBOUND(J)+YBOUND(J+1))/2.
    CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
    TBIGK=HEYK(AREA,DIST,SMALLK)
    SEPFLG=0
END IF
MASSL = AREA*RHOS*1000.

DO 205 TYPE=1,TCOUNT
    IF (CT.EQ.C(TYPE).AND.TBIGK.EQ.BIGK(TYPE)) THEN
        WRITE (5,1100) LCOUNT,NDNUM(1,I,J,K),0.,
        NDNUM(1,I,J+1,K),0.,TYPE,0.,0,1,COMMENT
        WRITE (5,1600) 0,0,0
        IF (SIMP.EQ.1) THEN
            WRITE (10,2600) LCOUNT,'I=',NDNUM(1,I,J,K),
            NDNUM(1,I,J+1,K),'T=SIMP'
        ELSE
            WRITE (10,2650) LCOUNT,'I=',NDNUM(1,I,J,K),
            NDNUM(1,I,J+1,K),'T=CNDF M=',MASSL,'L=',DIST,
            'D=',DIFF
        END IF
        GOTO 300
    END IF
205 CONTINUE

C(TCOUNT) = CT
BIGK(TCOUNT) = TBIGK
WRITE (4,1200) TCOUNT,CLASS,BIGK(TCOUNT),BIGK(TCOUNT),
+ C(TCOUNT),EXP
+
WRITE (5,1100) LCOUNT,NDNUM(1,I,J,K),0.,NDNUM(1,I,J+1,K),
+ 0.,TCOUNT,0.,0,1,COMMENT
WRITE (5,1600) 0,0,0
IF (SIMP.EQ.1) THEN
    WRITE (10,2600) LCOUNT,'I=',NDNUM(1,I,J,K),
    NDNUM(1,I,J+1,K),'T=SIMP'
+ ELSE
    WRITE (10,2650) LCOUNT,'I=',NDNUM(1,I,J,K),
    NDNUM(1,I,J+1,K),'T=CNDF M=',MASSL,'L=',DIST,'D=',DIFF
+ END IF

TCOUNT = TCOUNT + 1
C(TCOUNT)=0.
BIGK(TCOUNT)=0.

C*****
C***** THIRD SET OF ELEMENTS (Z-DIRECTION) *****
C*****

300 CONTINUE
    COMMENT = 'Z-DIRECTION'

    SEPFLG=0
    CRKFLG=0
    LCOUNT = LCOUNT + 1

310 IF (K.EQ.NZ3) THEN
    IF (J.LE.NY3.AND.I.LE.NX3) THEN
        LCOUNT = LCOUNT - 1
        GOTO 400
    ELSE IF (I.LE.NX3) THEN
        IF (J.LE.NY4) THEN
            IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))
            + .AND.(SEPFLG.NE.3)) SEPFLG=2
            SMALLK=KYAG
            DIFF=DIFY
        ELSE
            SMALLK=KSOIL
            DIFF=DIF1
        END IF
    ELSE IF (I.LE.NX4) THEN

```

```

IF (J.LE.NY4) THEN
  IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1)).AND.
    (J.LE.(NY3+1)).AND.(SEPFLG.NE.3)) SEPFLG=2
  SMALLK=KXAG
  DIFF=DIFX
ELSE
  SMALLK=KSOIL
  DIFF=DIF1
END IF
ELSE
  SMALLK=KSOIL
  DIFF=DIF1
END IF

IF (SEPFLG.NE.3) THEN
  AREA=XBOUND(I)*YBOUND(J)
  DIST=(ZBOUND(K))/2.
  IF (SEPFLG.EQ.2) THEN
    DIFF=DIFAIR
    TBIGK=(SEPAR**2*AREA)/(12.*DIST)
    CT=TBIGK*DSQRT(RHOS)/MU
    SEPFLG=0
  ELSE
    CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
    TBIGK=HEYK(AREA,DIST,SMALLK)
    SEPFLG=0
  END IF
  COMMENT = 'SURFACE'
  FRMNO=NDNUM(1,I,J,K)
  TONOD=URNOD
  MASSL = AREA*RHOS*1000.
  GOTO 320
END IF
END IF

IF (K.LT.NZ1) THEN
  SMALLK=KSOIL
  DIFF=DIF1
ELSE IF (K.EQ.NZ1) THEN
  IF (J.LE.NY4) THEN
    IF (I.LE.NX4) THEN
      SMALLK=INTFCE(KZAG,KSOIL,ZBOUND(K+1),ZBOUND(K))
      DIFF=INTFCE(DIFZ,DIF1,ZBOUND(K+1),ZBOUND(K))
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
  END IF
ELSE IF (K.LT.NZ2) THEN
  IF (J.LE.NY4) THEN
    IF (I.LE.NX4) THEN
      SMALLK=KZAG
      DIFF=DIFZ
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
  END IF
ELSE IF (K.EQ.NZ2) THEN
  IF (I.LE.NX1.AND.J.LE.NY1) THEN
    LCOUNT = LCOUNT-1
    GOTO 400
  ELSE IF (J.LE.NY2) THEN
    IF (I.LE.NX2) THEN
      SMALLK=KZAG
      DIFF=DIFZ
      CRKFLG=1
    ELSE IF (I.LE.NX3) THEN
      LCOUNT=LCOUNT-1
      GOTO 400
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=1
      SMALLK=INTFCE(KXAG,KZAG,ZBOUND(K+1),ZBOUND(K))
      DIFF=INTFCE(DIFX,DIFZ,ZBOUND(K+1),ZBOUND(K))
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.LE.NY3) THEN
    IF (I.LE.NX3) THEN
      LCOUNT = LCOUNT-1
      GOTO 400
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=1
      SMALLK=INTFCE(KXAG,KZAG,ZBOUND(K+1),ZBOUND(K))
      DIFF=INTFCE(DIFX,DIFZ,ZBOUND(K+1),ZBOUND(K))
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.LE.NY4) THEN
    IF (I.LE.NX3) THEN
      IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=1
      SMALLK=INTFCE(KYAG,KZAG,ZBOUND(K+1),ZBOUND(K))
      DIFF=INTFCE(DIFY,DIFZ,ZBOUND(K+1),ZBOUND(K))
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.LE.(NX3+1)).AND.
        (J.EQ.(NY3+1)).AND.(SEPFLG.NE.3)) SEPFLG=1
      SMALLK=INTFCE(KXAG,KZAG,ZBOUND(K+1),ZBOUND(K))

```

```

      DIFF=INTFCE(DIFX,DIFZ,ZBOUND(K+1),ZBOUND(K))
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
  END IF
ELSE
  IF (I.LE.NX1.AND.J.LE.NY1) THEN
    LCOUNT = LCOUNT-1
    GOTO 400
  ELSE IF (J.LE.NY2) THEN
    IF (I.LE.NX2) THEN
      IF (I.LT.NX2) THEN
        T=YBOUND(J)
      ELSE
        T=XBOUND(I)
      END IF
      CRKFLG=2
    ELSE IF (I.LE.NX3) THEN
      LCOUNT=LCOUNT-1
      GOTO 400
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=2
      SMALLK=KXAG
      DIFF=DIFX
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.LE.NY3) THEN
    IF (I.LE.NX3) THEN
      LCOUNT = LCOUNT-1
      GOTO 400
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.EQ.(NX3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=2
      SMALLK=KXAG
      DIFF=DIFX
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE IF (J.LE.NY4) THEN
    IF (I.LE.NX3) THEN
      IF ((WALSEP.EQ.1).AND.(J.EQ.(NY3+1))
        .AND.(SEPFLG.NE.3)) SEPFLG=2
      SMALLK=KYAG
      DIFF=DIFY
    ELSE IF (I.LE.NX4) THEN
      IF ((WALSEP.EQ.1).AND.(I.LE.(NX3+1)).AND.
        (J.EQ.(NY3-1)).AND.(SEPFLG.NE.3)) SEPFLG=2
      SMALLK=KXAG
      DIFF=DIFX
    ELSE
      SMALLK=KSOIL
      DIFF=DIF1
    END IF
  ELSE
    SMALLK=KSOIL
    DIFF=DIF1
  END IF
END IF

AREA=XBOUND(I)*YBOUND(J)
MASSL = AREA*RHOS*1000.
IF ((CRKFLG.EQ.0).AND.(SEPFLG.EQ.0)) THEN
  FRMNOD=NDNUM(1,1,J,K)
  TONOD=NDNUM(1,1,J,K+1)
  DIST=(ZBOUND(K)+ZBOUND(K+1))/2.
  CT=CEE(AREA,DIST,RHOS,MU,SMALLK)
  TBIGK=HEYK(AREA,DIST,SMALLK)
ELSE IF (CRKFLG.EQ.1) THEN
C   SOIL TO CRACK ELEMENTS
  COMMENT = 'TO CRACK BOT'
  FRMNOD=NDNUM(1,1,J,K)
  TONOD=NDNUM(1,1,J,K+1)
  DIST=ZBOUND(K)/2.
  TBIGK=HEYK(AREA,DIST,KZAG)
  CT=CEE(AREA,DIST,RHOS,MU,KZAG)
  STORE=ZPOS(K+1)
  ZPOS(K+1) = CRKBOT
ELSE IF (CRKFLG.EQ.2) THEN
C   BASEMENT CRACK ELEMENTS
  COMMENT = 'BASEMENT'
  FRMNOD=NDNUM(1,1,J,K)
  TONOD=BASNOD
  TBIGK=(T**2*AREA)/(12.*SLAB)
  CT=TBIGK*DSORT(RHOS)/MU
  STORE=ZPOS(K+1)
  ZPOS(K+1) = CRKBOT+SLAB
  STORE2=ZPOS(K)
  ZPOS(K) = CRKBOT
  DIFF=DIFAIR
  DIST = SLAB
ELSE IF (SEPFLG.EQ.1) THEN
C   SOIL TO SEPARATION ELEMENTS
  COMMENT = 'TO SEP BOT'
  FRMNOD=NDNUM(1,1,J,K)
  TONOD=NDNUM(2,1,J,K+1)
  DIST=ZBOUND(K)/2.
  TBIGK=HEYK(AREA,DIST,KZAG)
  CT=CEE(AREA,DIST,RHOS,MU,KZAG)
  STORE=ZPOS(K+1)
  ZPOS(K+1) = CRKBOT

```

```

      SEPFLG=3
      ELSE IF (SEPFLG.EQ.2) THEN
C    SOIL-WALL SEPARATION ELEMENTS
      DIFF=DIFAIR
      FRMNOD=NDNUM(1,I,J,K)
      TONOD=NDNUM(1,I,J,K+1)
      DIST=(ZBOUND(K)+ZBOUND(K+1))/2.
      TBIGK=(SEPAR**2*AREA)/(12.*DIST)
      CT=TBIGK*DSQRT(RHOS)/MU
      SEPFLG=0
      ELSE IF (SEPFLG.EQ.3) THEN
C    SOIL-WALL SEPARATION ELEMENTS
      COMMENT = 'FROM SEP BOT'
      DIFF=DIFAIR
      FRMNOD=NDNUM(2,I,J,K+1)
      TONOD=NDNUM(1,I,J,K+1)
      DIST=ZBOUND(K+1)/2.
      TBIGK=(SEPAR**2*AREA)/(12.*DIST)
      CT=TBIGK*DSQRT(RHOS)/MU
      SEPFLG=0
    END IF
320  DO 305 TYPE=1,TCOUNT
      IF (CT.EQ.C(TYPE).AND.TBIGK.EQ.BIGK(TYPE)) THEN
      IF (COMMENT.EQ.'SURFACE') THEN
        WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,0.,TYPE,4.0,4,1,COMMENT
        IF (SIMP.EQ.1) THEN
+       WRITE (10,2600) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=SIMP'
        ELSE
+       WRITE (10,2650) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=CNDF M=',MASSL,'L=',
+       DIST,'D=',DIFF
        END IF
      ELSE
      IF (COMMENT.EQ.'BASEMENT') THEN
+       WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,TOP,TYPE,4.0,4,1,COMMENT
      ELSE
+       WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,TOP,TYPE,0.,0,1,COMMENT
      END IF
      IF (SIMP.EQ.1) THEN
+       WRITE (10,2600) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=SIMP'
      ELSE
+       WRITE (10,2650) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=CNDF M=',MASSL,'L=',
+       DIST,'D=',DIFF
      END IF
      END IF
      WRITE (5,1600) 0,0,0
      GOTO 400
305  CONTINUE
      C(TCOUNT) = CT
      BIGK(TCOUNT) = TBIGK
      WRITE (4,1200) TCOUNT,CLASS,BIGK(TCOUNT),BIGK(TCOUNT),
+      C(TCOUNT),EXP
      IF (COMMENT.EQ.'SURFACE') THEN
+       WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,0.,TCOUNT,4.0,4,1,COMMENT
      IF (SIMP.EQ.1) THEN
+       WRITE (10,2600) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=SIMP'
      ELSE
+       WRITE (10,2650) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=CNDF M=',MASSL,'L=',
+       DIST,'D=',DIFF
      END IF
      ELSE
      IF (COMMENT.EQ.'BASEMENT') THEN
+       WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,TOP,TCOUNT,4.0,4,1,COMMENT
      ELSE
+       WRITE (5,1100) LCOUNT,FRMNOD,0.,
+       TONOD,TOP,TCOUNT,0.,0,1,COMMENT
      END IF
      IF (SIMP.EQ.1) THEN
+       WRITE (10,2600) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=SIMP'
      ELSE
+       WRITE (10,2650) LCOUNT,'I=',FRMNOD,
+       TONOD,'T=CNDF M=',MASSL,'L=',
+       DIST,'D=',DIFF
      END IF
      END IF
      WRITE (5,1600) 0,0,0
      TCOUNT = TCOUNT + 1
      C(TCOUNT)=0.
      BIGK(TCOUNT)=0.
400  CONTINUE
      IF (SEPFLG.EQ.3) GOTO 310
90    CONTINUE
80    CONTINUE
70    CONTINUE
      WRITE (12,2900) SURNOD,'CG=',0.0
      VOLMAS=BASEV*RHO*1000.
      WRITE(9,2410) BASNOD,'V=',VOLMAS,'<  BASEMENT'
      VOLMAS=(100000000.)*RHO*1000.
      WRITE(9,2430) SURNOD,'V=',VOLMAS,'<  OUTDOORS - SOIL SURFACE'

```



```

WRITE (3,1300) 0
WRITE (4,1300) 0
WRITE (5,1300) 0

WRITE (9,2503) 'END'
WRITE (10,2503) 'END'
WRITE (11,2503) 'END'
WRITE (12,2503) 'END'
WRITE (12,2506) 'RETURN'

CLOSE (2)
CLOSE (3)
CLOSE (4)
CLOSE (5)
CLOSE (7)
CLOSE (8)
CLOSE (9)
CLOSE (10)
CLOSE (11)
CLOSE (12)

WRITE (6,*) 'END OF PROCESSING...WRITING INPUT FILES'

CALL AIRCON

C***** FORMAT STATEMENTS *****

1000 FORMAT (I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,3I3)
1030 FORMAT (I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,A11)
1040 FORMAT (I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,A12)
1050 FORMAT (I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,A10)
1060 FORMAT (I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,A25)
1100 FORMAT (I4,2X,I4,2X,F8.5,3X,I4,2X,F8.5,3X,I4,2X,F3.1,2X,I1,2X,
+      I1,3X,A12)
1200 FORMAT (I4,2X,I2,2X,E11.6E2,3X,E11.6E2,3X,E11.6E2,3X,F5.3)
1300 FORMAT (I1)
1500 FORMAT (A6)
1600 FORMAT (2X,I1,2X,F3.1)
1700 FORMAT (I1,1X,I1,1X,I1)
1800 FORMAT (I4)
1900 FORMAT (A14)
2100 FORMAT (2X,I1)
2200 FORMAT (F4.2)
2300 FORMAT (I3,4X,I3,4X,I3,4X,I4)
2400 FORMAT (3X,I3,2X,A2,E14.9E2,10X,A1,2X,I2,3X,I2,3X,I2)
2410 FORMAT (3X,I3,2X,A2,E14.9E2,10X,A12)
2420 FORMAT (3X,I3,2X,A2,E14.9E2,10X,A14)
2430 FORMAT (3X,I3,2X,A2,E14.9E2,10X,A27)
2503 FORMAT (A3)
2506 FORMAT (A6)
2507 FORMAT (A7)
2508 FORMAT (A8)
2600 FORMAT (3X,I4,2X,A2,I3,',',I3,1X,A6)
2650 FORMAT (3X,I4,2X,A2,I3,',',I3,1X,A9,E13.8E2,2(A3,E13.8E2))
2700 FORMAT (A2,I4,A18)
2800 FORMAT (2X,I4,1X,A3,A2)
2850 FORMAT (A1)
2900 FORMAT (I4,1X,A3,E17.12E2)
3000 FORMAT (A2,I1,5X,A30)
3100 FORMAT (F9.7,10X,A30)
3200 FORMAT (A22)
3300 FORMAT (I4,A3,I4,A11)

END

C----- INTFCE
DOUBLE PRECISION FUNCTION INTFCE(K1,K2,D1,D2)
REAL*8 K1,K2,D1,D2

IF ((K1.EQ.0.0D0).AND.(K2.EQ.0.0D0)) THEN
  INTFCE = 0.0D0
ELSE
  INTFCE = (K1*K2)/((K1*D2+K2*D1)/(D1+D2))
END IF

RETURN
END

C----- CEE
DOUBLE PRECISION FUNCTION CEE(AREA,DIST,RHO,MU,SMALLK)
REAL*8 AREA,DIST,RHO,MU,SMALLK

CEE = AREA*SMALLK*DSQRT(RHO)/(MU*DIST)

RETURN
END

C----- HEYK
DOUBLE PRECISION FUNCTION HEYK(AREA,DIST,SMALLK)
REAL*8 AREA,DIST,SMALLK

HEYK = AREA*SMALLK/DIST

RETURN
END

C----- AIRCON
SUBROUTINE AIRCON
C--SUB: AIRCON - Writes CONAIR input files.

INTEGER UNUM,STREND
CHARACTER*80 STRING
CHARACTER*1 LINE(80)

```

```

EQUIVALENCE (LINE(1),STRING)
LOGICAL WDEND

C *** Write AIRNET input file ***

OPEN(13,FILE='SOILA.INP',STATUS='UNKNOWN')

WDEND = .FALSE.
UNUM = 3
OPEN (3,FILE='LOUT1.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(13,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 4
OPEN (4,FILE='LOUT2.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(13,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 5
OPEN (5,FILE='LOUT3.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(13,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)
CLOSE(13)

C *** Write CONTAM input file ***

OPEN(14,FILE='SOILC.INP',STATUS='UNKNOWN')

WDEND = .FALSE.
UNUM = 8
OPEN (8,FILE='FLOWSYS1.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(14,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 9
OPEN (9,FILE='FLOWSYS2.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(14,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 10
OPEN (10,FILE='FLOWELEM.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(14,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 11
OPEN (11,FILE='KINELM.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(14,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)

WDEND = .FALSE.
UNUM = 12
OPEN (12,FILE='STEADY.OUT',STATUS='OLD')
REWIND(UNUM)
DO WHILE (.NOT.WDEND)
  CALL INREAD(UNUM,STRING,WDEND)
  STREND = LENTRM(STRING)
  IF (.NOT.WDEND) WRITE(14,900) (LINE(I),I=1,STREND)
END DO
CLOSE(UNUM)
CLOSE(14)

900 FORMAT(80A1)

RETURN
END

```

C----- INREAD

```

SUBROUTINE INREAD(UNUM,STRING,WEND)
C--SUB: INREAD - Reads STRING data from the source file defined
C----- in FNAME procedure.

```

```

      INTEGER UNUM
      CHARACTER*80 STRING
      LOGICAL WEND

      Read(UNIT=UNUM,FMT=900,ERR=5,END=10) STRING
900  FORMAT(A)
      Return

      5  Continue
      10 WEND = .TRUE.
      RETURN
      END

```

```

C-----LENTRM

```

```

FUNCTION LENTRM(STRING)
C--FUN:LENTRM - DETERMINES LENGTH OF TRIMMED STRING - A STRING WITH
C              TRAILING BLANKS REMOVED

```

```

C              LENTOT : THE TOTAL LENGTH OF THE STRING
C              LENTRM : THE LENGTH OF THE TRIMMED STRING
C-----

```

```

      CHARACTER STRING*80
      INTEGER LENTOT, LENTRM

      LENTOT = LEN(STRING)

      DO 10 I=LENTOT,1,-1
        IF(STRING(I:I).NE.' ') GO TO 20
      10 CONTINUE

      20 LENTRM = I

      RETURN
      END

```

```

      INCLUDE 'UTILL2.FOR'

```

FILE: UTILL2.FOR

```

C      SUBROUTINE ERROR(MSG,SEVR)
C      DESCRIPTION *****
C      Simple error message writer with fatal error termination.
C      DECLARATIONS *****
C      Input:
C      MSG - message to be printed.
C      SEVR - error severity code.
C      COMMON /UNITS/ U8,U9,U10
C      INTEGER U8,U9,U10
C      INTEGER SEVR
C      INTEGER I
C      CHARACTER*(*) MSG
C      CHARACTER*15 SEVER(0:3)
C      CODE *****
C      DATA SEVER / '*** NOTE ***', '*** WARNING ***',
C      '*** SEVERE ***', '*** FATAL ***' /
C      I = MAX(SEVR,0)
C      I = MIN(I,3)
C      WRITE(6,*) SEVER(I)
C      WRITE(U9,*) SEVER(I)
C      WRITE(6,*) MSG
C      WRITE(U9,*) MSG
C      IF(SEVR.GE.3) STOP
C      RETURN
C      END
C      SUBROUTINE ERROR2(MSG1,MSG2,SEVR)
C      DESCRIPTION *****
C      Simple error message writer (2 messages) with fatal termination.
C      DECLARATIONS *****
C      Input:
C      MSG1 - first message to be printed.
C      MSG2 - second message to be printed.
C      SEVR - error severity code.
C      COMMON /UNITS/ U8,U9,U10
C      INTEGER U8,U9,U10
C      INTEGER SEVR
C      INTEGER I
C      CHARACTER*(*) MSG1,MSG2
C      CHARACTER*15 SEVER(0:3)
C      CODE *****
C      DATA SEVER / '*** NOTE ***', '*** WARNING ***',
C      '*** SEVERE ***', '*** FATAL ***' /
C      I = MAX(SEVR,0)
C      I = MIN(I,3)
C      WRITE(6,*) SEVER(I)
C      WRITE(U9,*) SEVER(I)
C      WRITE(6,*) MSG1,MSG2
C      WRITE(U9,*) MSG1,MSG2
C      IF(SEVR.GE.3) STOP
C      RETURN
C      END
C      SUBROUTINE GETSTR(UIN,A,NUE)
C      DESCRIPTION *****
C      Get character data from batch input file. On CDC computers,
C      an empty record is considered an end-of-file.
C      DECLARATIONS *****
C      Input:
C      UIN - unit number of input file.
C      Output:
C      A - user input (character string).
C      NUE - (0 = no input).
C      INTEGER UIN
C      INTEGER NUE, I, L
C      CHARACTER A*(*)
C      CHARACTER*4 UNITNR
C      CODE *****
C      NUE = 1
C      READ(UNIT=UIN,FMT=901,END=10) A
C      GO TO 999
C      End-of-file.
C      10 NUE = 0
C      I = UIN
C      CALL INTDIS(I,UNITNR,1)
C      CALL ERROR2('End-of-file on UNIT ',UNITNR(1:L),2)
C      901 FORMAT(A)
C      999 RETURN
C      END
C      SUBROUTINE GETWRD(STRING,K,WORD)
C      DESCRIPTION *****

```

```

C
C      Get next "WORD" from the "STRING" of characters.
C      Words are separated by blanks or commas:  WORD,WORD,WORD  or
C      WORD WORD WORD  or  WORD, WORD, WORD  are all valid.
C
C      DECLARATIONS *****
C
C      Input/Output:
C      K      - current position in "STRING".
C      Local:
C      LS     - maximum length of "STRING".
C      L      - current position in "WORD".
C      LW     - maximum length of "WORD".
C
C      COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      INTEGER K, LS, L, LW
C      CHARACTER*(*) WORD, STRING
C      CHARACTER*1 A
C
C      CODE *****
C
C      WORD = ' '
C      LS = LEN(STRING)
C      LW = LEN(WORD)
C      L = 0
C
C      Skip blanks before the word.
C 10 CONTINUE
C      K = K+1
C      IF(K.GT.LS) GO TO 30
C      A = STRING(K:K)
C      IF(A.EQ.',') GO TO 10
C      IF(A.EQ.' ') GO TO 999
C      Copy "WORD" from "STRING".
C 20 CONTINUE
C      Copy character from "STRING" to "WORD".
C      L = L+1
C      IF(L.GT.LW) GO TO 40
C      WORD(L:L) = A
C
C      Find separator in "STRING".
C      K = K+1
C      IF(K.GT.LS) GO TO 50
C      A = STRING(K:K)
C      IF(A.EQ.',') GO TO 999
C      IF(A.EQ.' ') GO TO 999
C      GO TO 20
C
C 30 CALL ERROR('Did not find expected value',2)
C      GO TO 60
C 40 CALL ERROR('Word too long (parameter WRDLEN too short)',2)
C      GO TO 60
C 50 CALL ERROR('Did not find end of word (blank or comma)',2)
C 60 CONTINUE
C      WRITE(6,*) STRING
C      WRITE(U9,*) STRING
C      CALL ERROR('Could not process the input line listed above',3)
C 999 CONTINUE
C      RETURN
C      END
C      INTEGER FUNCTION INTCON(ANUM,EFLAG)
C
C      DESCRIPTION *****
C
C      Convert character string "ANUM" to an integer.
C      The limiting values for short integers are +/- 32759;
C      for long integers +/- 2147483649.
C
C      DECLARATIONS *****
C
C      INTEGER EFLAG, I, J, MINUS
C      CHARACTER ANUM*(*), TEST*13
C
C      COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      CODE *****
C
C      DATA TEST / ' +-0123456789' /
C      INTCON = 0
C      MINUS = 1
C      DO 40 J=1,LEN(ANUM)
C      I = INDEX(TEST,ANUM(J:J))
C      IF(I.GT.3) GO TO 10
C      GO TO(50,30,20), I
C      GO TO 60
C 10 IF(INTCON.GE.3276) GO TO 70
C      INTCON = INTCON*10+(I-4)
C      GO TO 40
C 20 MINUS = -1
C 30 IF(J.NE.1) GO TO 60
C 40 CONTINUE
C 50 CONTINUE
C      INTCON = MINUS*INTCON
C      EFLAG = 0
C      GO TO 999
C
C      Error messages.
C 60 CALL ERROR2('Invalid integer (INTCON): ',ANUM,2)
C      GO TO 80
C 70 CALL ERROR2('Too many digits (INTCON): ',ANUM,2)
C 80 EFLAG = 1
C 999 RETURN
C      END
C      SUBROUTINE INTDIS(I,ANUM,L)
C

```

```

C      DESCRIPTION *****
CCCC      Convert integer I to character string ANUM(1:L) for display.
C      DECLARATIONS *****
          INTEGER K, L, M, N, NN
          INTEGER I
          CHARACTER*(*) ANUM
          CHARACTER*10 DISP
C
C      CODE *****
          DATA DISP / '0123456789' /
          IF(I.GE.0) THEN
              L = 0
          ELSE
              L = 1
          END IF
          N = ABS(I)
          K = LEN(ANUM)
10      CONTINUE
          IF(N.LT.10) THEN
              M = N
              N = 0
          ELSE
              NN = N/10
              M = N-10*NN
              N = NN
          END IF
          IF(K.LE.L) CALL ERROR('String variable too short (INTDIS)',3)
          ANUM(K:K) = DISP(M+1:M+1)
          K = K+1
          IF(N.GT.0) GO TO 10
          N = LEN(ANUM)
          IF(L.EQ.1) ANUM(L:L) = '-'
20      CONTINUE
          L = L+1
          K = K+1
          ANUM(L:L) = ANUM(K:K)
          IF(K.LT.N) GO TO 20
          RETURN
          END
          SUBROUTINE INTGET(MSG,IDEF,IMIN,IMAX,IUNK,I)
C
C      DESCRIPTION *****
          Interactive input processor for a short integer value.
          Print message plus minimum, maximum, and default values.
          Read user input; treat carriage return as default value.
C
C      DECLARATIONS *****
          Input:
          MSG      - message to be printed.
          IDEF     - default value.
          IMIN     - minimum value.
          IMAX     - maximum value.
          IUNK     - undefined value.
          Output:
          I         - integer value (possibly INTEGER).
          Local:
          NUE      - (0 = no user input).
          EFLAG    - 1 indicates improper integer.
          ANUM     - user input character string.
C
          INTEGER I, IDEF, IMIN, IMAX, IUNK
          INTEGER LD, LN, LX, J, EFLAG, NUE
          CHARACTER*(*) MSG
          CHARACTER*20 ANUM, CD, CN, CX
C
C      CODE *****
          J = 0
          IF(IMIN.EQ.IUNK) J = J+1
          IF(IMAX.EQ.IUNK) J = J+2
          IF(IDEF.EQ.IUNK) J = J+4
          CALL INTDIS(IDEF,CD,LD)
          CALL INTDIS(IMIN,CN,LN)
          CALL INTDIS(IMAX,CX,LX)
C
C      Print message and read user entry.
10      CONTINUE
          IF(MSG.NE.' ') WRITE(6,901) ' ',MSG,' '
          GO TO (11,12,13,14,15,16,17), J
          WRITE(6,*) '[MIN = ',CN(1:LN),', MAX = ',CX(1:LX),
             & ' default = ',CD(1:LD),'] '
          GO TO 17
11      WRITE(6,*) '[MAX = ',CX(1:LX),', DEFAULT = ',CD(1:LD),'] '
          GO TO 17
12      WRITE(6,*) '[MIN = ',CN(1:LN),', DEFAULT = ',CD(1:LD),'] '
          GO TO 17
13      WRITE(6,*) '[DEFAULT = ',CD(1:LD),'] '
          GO TO 17
14      WRITE(6,*) '[MIN = ',CN(1:LN),', MAX = ',CX(1:LX),'] '
          GO TO 17
15      WRITE(6,*) '[MAX = ',CX(1:LX),'] '
          GO TO 17
16      WRITE(6,*) '[MIN = ',CN(1:LN),'] '
          GO TO 17
17      CONTINUE
          CALL STRGET(ANUM,NUE)
          IF(NUE.EQ.0) GO TO 30
C
C      Decode and test user entry.
          I = INTCON(ANUM,EFLAG)
          IF(EFLAG.EQ.1) GO TO 10
          IF(IMIN.EQ.IUNK) GO TO 20
          IF(I.GE.IMIN) GO TO 20
          WRITE(6,*) 'NUMBER TOO SMALL'

```

```

GO TO 10
20 CONTINUE
IF(IMAX.EQ.IUNK) GO TO 999
IF(I.LE.IMAX) GO TO 999
WRITE(6,*) 'NUMBER TOO LARGE'
GO TO 10
30 CONTINUE
IF(IDEF.EQ.IUNK) GO TO 10
I = IDEF
C 901 FORMAT(A,$)
901 FORMAT(A)
C
999 RETURN
END
INTEGER FUNCTION LENSTR(A)

DESCRIPTION *****
Determine the location of the last non-blank character in "A".
DECLARATIONS *****
CHARACTER*(*) A
INTEGER I

CODE *****
DO 10 I=LEN(A),1,-1
  IF(A(I:I).NE.' ') GO TO 20
10 CONTINUE
I = 0
20 LENSTR = I
RETURN
END
INTEGER FUNCTION NOYES(MSG)

DESCRIPTION *****
Obtain a YES or NO response from the user; 0 = no, 1 = yes.
To be called from an interactive program with the
unit numbers for the interaction input and output files.
Be careful with the length of the integer variables.
DECLARATIONS *****
Input:
MSG - Message to user.
Local:
NUE - (0 = no user entry).
CHARACTER*(*) MSG
CHARACTER*1 A
INTEGER NUE

CODE *****
10 WRITE(6,901) ' ',MSG,' (Y/N)? '
CALL STRGET(A,NUE)
IF(A.EQ.'Y' .OR. A.EQ.'y') GO TO 20
IF(A.EQ.'N' .OR. A.EQ.'n') GO TO 30
WRITE(6,*) ' VALID RESPONSES ARE: Y OR Y FOR YES, N OR N FOR NO.'
GO TO 10
20 NOYES = 1
GO TO 999
30 NOYES = 0
C 901 FORMAT(A,$)
901 FORMAT(A)
999 RETURN
END
SUBROUTINE OPENFL(U,FNM,ACC,RL,FOR,STA,MSG,NUE)

DESCRIPTION *****
Open a file; to be called from an interactive program with the
unit numbers for the interaction input and output files.
For use with named files (status cannot = SCRATCH).
Be careful with the length of the integer variables.
DECLARATIONS *****
Input:
U - unit number of file to be opened.
FNM - name of file (supplied by user).
ACC - access ('SEQUENTIAL' or 'DIRECT').
RL - record length (for direct access files only).
FOR - format ('FORMATTED' or 'UNFORMATTED').
STA - status ('NEW' or 'OLD' or 'UNKNOWN').
MSG - message to user.
Local:
NUE - (0 = no user entry).
INTEGER U, RL, IOS
INTEGER NUE
CHARACTER*(*) FNM, ACC, FOR, STA, MSG

CODE *****
10 CONTINUE
WRITE(6,901) ' ',MSG,' '
CALL STRGET(FNM,NUE)
IF(NUE.EQ.0) GO TO 100
IF(ACC.EQ.'SEQUENTIAL') THEN
  OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,FORM=FOR,STATUS=STA,
  IOSTAT=IOS,ERR=20,RECL=1000)
ELSE
  OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,RECL=RL,FORM=FOR,STATUS=STA,
  IOSTAT=IOS,ERR=20)
ENDIF

```



```

C      GO TO 999                      Failed to open file.
20 CONTINUE
WRITE(6,*) ' COULD NOT OPEN FILE NAMED: ', FNM
WRITE(6,*) ' FORTRAN I/O STATUS: ', IOS, ' (SEE FORTRAN MANUAL)'
IF(STA.EQ.'NEW') THEN
  WRITE(6,*) ' EXPECTED THE NAME OF A NEW FILE.'
ELSE IF(STA.EQ.'OLD') THEN
  WRITE(6,*) ' EXPECTED THE NAME OF AN EXISTING FILE.'
ENDIF
WRITE(6,*) ' TRY AGAIN. ENTER REVISED FILE NAME.'
WRITE(6,*) ' {TO STOP PROGRAM EXECUTION, PRESS ONLY ENTER}'
WRITE(6,*)
GO TO 10

C      User termination.
100 STOP 'User Termination'

C
C 901 FORMAT(A,$)
901 FORMAT(A)
999 RETURN
END
SUBROUTINE OPNCTL(U,FNM,ACC,RL,FOR,STA,MSG)
C
C DESCRIPTION *****
C
C Open a data file containing airflow element control values.
C For use with named files (status cannot = SCRATCH).
C Be careful with the length of the integer variables.
C
C DECLARATIONS *****
C
C Input:
C U      - unit number of file to be opened.
C FNM     - name of file (supplied by user).
C ACC     - access {'SEQUENTIAL' or 'DIRECT'}.
C RL      - record length (for direct access files only).
C FOR     - format {'FORMATTED' or 'UNFORMATTED'}.
C STA     - status {'NEW' or 'OLD' or 'UNKNOWN'}.
C MSG     - message to user.
C Local:
C NUE     - (0 = no user entry).
C
C      INTEGER U, RL, IOS
C      INTEGER NUE
C      CHARACTER*(*) FNM, ACC, FOR, STA, MSG
C
C CODE *****
C
C FNM='AFE.CTL'
10 CONTINUE
IF(ACC.EQ.'SEQUENTIAL') THEN
  OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,FORM=FOR,STATUS=STA,
    IOSTAT=IOS,ERR=20,RECL=1000)
ELSE
  OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,RECL=RL,FORM=FOR,STATUS=STA,
    IOSTAT=IOS,ERR=20)
ENDIF
GO TO 999
C      Failed to open file.
20 CONTINUE
WRITE(6,*) ' COULD NOT OPEN FILE NAMED: ', FNM
WRITE(6,*) ' FORTRAN I/O STATUS: ', IOS, ' (SEE FORTRAN MANUAL)'
IF(STA.EQ.'NEW') THEN
  WRITE(6,*) ' EXPECTED THE NAME OF A NEW FILE.'
ELSE IF(STA.EQ.'OLD') THEN
  WRITE(6,*) ' EXPECTED THE NAME OF AN EXISTING FILE.'
ENDIF
WRITE(6,*) ' TRY AGAIN. ENTER REVISED FILE NAME.'
WRITE(6,*) ' {TO STOP PROGRAM EXECUTION, PRESS ONLY ENTER}'
WRITE(6,*)
WRITE(6,901) ' ', MSG, ' '
CALL STRGET(FNM,NUE)
IF(NUE.EQ.0) GO TO 100
GO TO 10

C      User termination.
100 STOP 'User Termination'

C
C 901 FORMAT(A,$)
901 FORMAT(A)
999 RETURN
END
REAL FUNCTION RELCON(ANUM,EFLAG)
C
C DESCRIPTION *****
C
C Convert character string "ANUM" to a real number.
C
C DECLARATIONS *****
C
C COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      INTEGER EFLAG, I, J, MINUS
C      REAL MULT, RNUM
C      LOGICAL D, E
C      CHARACTER ANUM*(*), TEST*16
C
C CODE *****
C
C DATA TEST / 'eE.-+ 0123456789' /
RELCON = 0.0
MINUS = 1
MULT = 1.
RNUM = 0.0
D = .FALSE.
E = .FALSE.
C
C      Process each character until a blank.

```

```

DO 80 J=1,LEN(ANUM)
  I = INDEX(TEST,ANUM(J:J))
  IF(I-6) 10,100,20
10  GO TO (70,70,30,40,60), I
  GO TO 120
C      Add digit to number.
20  RNUM = RNUM*10+(I-7)
  IF(D) MULT = MULT*10.
  GO TO 80
C      Note decimal point.
30  IF(D .OR. E) GO TO 120
  D = .TRUE.
  GO TO 80
C      Note minus sign.
40  IF(J.EQ.1) GO TO 50
  IF(ANUM(J-1:J-1).EQ.'E') GO TO 50
  IF(ANUM(J-1:J-1).EQ.'e') GO TO 50
  GO TO 120
50  MINUS = -1
  GO TO 80
C      Note plus sign.
60  IF(J.EQ.1) GO TO 80
  IF(ANUM(J-1:J-1).EQ.'E') GO TO 80
  IF(ANUM(J-1:J-1).EQ.'e') GO TO 80
  GO TO 120
C      Begin exponent.
70  IF(I.EQ.0) GO TO 120
  IF(E) GO TO 120
  RELCON = REAL(RNUM*MINUS)/MULT
  MINUS = 1
  RNUM = 0.0
  D = .FALSE.
  E = .TRUE.
80  CONTINUE
C      Finish calculation of number.
100 EFLAG = 0
  IF(E) GO TO 110
  RELCON = REAL(RNUM*MINUS)/MULT
  GO TO 999
110 RELCON = RELCON*10.** (RNUM*MINUS)
  GO TO 999
C      Error messages.
120 CALL ERROR2('Invalid number (RELCON): ',ANUM,2)
  EFLAG = 1
999 RETURN
END
SUBROUTINE RELDIS(R,M,ANUM,L)
  DESCRIPTION *****
  Convert real R to character string ANUM(1:L) for display.
  DECLARATIONS *****
  Input:
    R - real (single precision) number.
    M - number of significant digits in result.
  Output:
    ANUM - character string with number beginning at 1.
    L - last position of number in ANUM. [ANUM(1:L)]
  Local:
    LFC - position of first character in ANUM.
    LDEC - position of decimal point in ANUM.
    LEXP - position of "E" in ANUM.
    LSIG - position of last significant digit in ANUM.
    EXPT - value of the exponent in ANUM.
    DECML - .TRUE. if decimal point has been written.

  INTEGER M
  INTEGER L, LFC, LDEC, LEXP, LSIG, EXPT, I, EFLAG
  LOGICAL DECML
  REAL R
  CHARACTER(*) ANUM
  CHARACTER*10 FORM

  CODE *****
  IF(LEN(ANUM).LT.30) CALL ERROR('Short string (RELDIS)',3)
  I = M-1
  CALL INTDIS(I,ANUM,L)
  FORM = '(1PE30. '//ANUM(1:L)//')'
  WRITE(ANUM,FMT=FORM) R
  I = 0
10  I = I+1
  IF(ANUM(I:I).EQ.' ') GO TO 10
  LFC = I
12  I = I+1
  IF(ANUM(I:I).NE.' ') GO TO 12
  LDEC = I
14  I = I+1
  IF(ANUM(I:I).NE.'E') GO TO 14
  LEXP = I
16  I = I-1
  IF(ANUM(I:I).EQ.'0') GO TO 16
  LSIG = I
  EXPT = INTCON(ANUM(LEXP+1:30),EFLAG)
  IF(EXPT.LT.-4) GO TO 30
  IF(EXPT.GE.M+3) GO TO 30
C      Display number in normal format.
  DECML = .FALSE.
  L = 0
  IF(ANUM(LFC:LFC).EQ.'-') THEN
    L = L+1
    ANUM(L:L) = '-'
  END IF
  IF(EXPT.LT.0) THEN
    L = L+1
    ANUM(L:L) = '0'

```

```

      L = L+1
      ANUM(L:L) = '.'
      DECML = .TRUE.
    END IF
20  CONTINUE
    EXPT = EXPT+1
    IF(EXPT.GE.0) GO TO 22
    L = L+1
    ANUM(L:L) = '0'
    GO TO 20
22  CONTINUE
    L = L+1
    ANUM(L:L) = ANUM(LDEC-1:LDEC-1)
    I = LDEC+1
24  CONTINUE
    EXPT = EXPT-1
    IF(EXPT.LE.0) THEN
      L = L+1
      ANUM(L:L) = '.'
      DECML = .TRUE.
    END IF
    IF(1.GT.LSIG) THEN
      IF(DECML) GO TO 999
      L = L+1
      ANUM(L:L) = '0'
    ELSE
      L = L+1
      ANUM(L:L) = ANUM(I:I)
      I = I+1
    END IF
    GO TO 24
C      Display number in exponential format.
30  CONTINUE
    L = 0
    DO 32 I=LFC,LSIG
      L = L+1
      ANUM(L:L) = ANUM(I:I)
32  CONTINUE
    DO 34 I=LEXP,30
      L = L+1
      ANUM(L:L) = ANUM(I:I)
34  CONTINUE
C
999  RETURN
    END
    SUBROUTINE RELGET(MSG,RDEF,RMIN,RMAX,RUNK,R)
C
C      DESCRIPTION *****
C
C      Interactive input processor for a real value.
C      Print message plus minimum, maximum, and default values.
C      Read user input; treat carriage return as default value.
C
C      DECLARATIONS *****
C
C      Input:
C      MSG      - message to be printed.
C      RDEF     - default value.
C      RMIN     - minimum value.
C      RMAX     - maximum value.
C      RUNK     - undefined value.
C
C      Output:
C      R        - real value.
C
C      Local:
C      NUE      - (0 = no user input).
C      EFLAG    - 1 indicates improper real.
C      ANUM     - user input character string.
C
C      INTEGER I, LD, LN, LX, EFLAG, NUE
C      REAL    R, RDEF, RMIN, RMAX, RUNK
C      CHARACTER*(*) MSG
C      CHARACTER*20 ANUM
C      CHARACTER*30 CD, CN, CX
C
C      CODE *****
C
C      I = 0
C      IF(RMIN.EQ.RUNK) I = I+1
C      IF(RMAX.EQ.RUNK) I = I+2
C      IF(RDEF.EQ.RUNK) I = I+4
C      CALL RELDIS(RDEF,6,CD,LD)
C      CALL RELDIS(RMIN,6,CN,LN)
C      CALL RELDIS(RMAX,6,CX,LX)
C      Print message and read user entry.
10  CONTINUE
    IF(MSG.NE.' ') WRITE(6,901) ' ',MSG,' '
C 901 FORMAT(A,$)
901  FORMAT(A)
    GO TO (11,12,13,14,15,16,17), I
    WRITE(6,*) ' [MIN = ',CN(1:LN), ' MAX = ',CX(1:LX),
      - ' default = ',CD(1:LD),'] '
    GO TO 17
11  WRITE(6,*) ' [MAX = ',CX(1:LX), ' DEFAULT = ',CD(1:LD),'] '
    GO TO 17
12  WRITE(6,*) ' [MIN = ',CN(1:LN), ' DEFAULT = ',CD(1:LD),'] '
    GO TO 17
13  WRITE(6,*) ' [DEFAULT = ',CD(1:LD),'] '
    GO TO 17
14  WRITE(6,*) ' [MIN = ',CN(1:LN), ' MAX = ',CX(1:LX),'] '
    GO TO 17
15  WRITE(6,*) ' [MAX = ',CX(1:LX),'] '
    GO TO 17
16  WRITE(6,*) ' [MIN = ',CN(1:LN),'] '
    GO TO 17
17  CONTINUE
    CALL STRGET(ANUM,NUE)
    IF(NUE.EQ.0) GO TO 30
C      Decode and test user entry.

```

```

      R = RELCON(ANUM,EFLAG)
      IF(EFLAG.EQ.1) GO TO 10
      IF(RMIN.EQ.RUNK) GO TO 20
      IF(R.GE.RMIN) GO TO 20
      WRITE(6,*) 'NUMBER TOO SMALL'
      GO TO 10
20    CONTINUE
      IF(RMAX.EQ.RUNK) GO TO 999
      IF(R.LE.RMAX) GO TO 999
      WRITE(6,*) 'NUMBER TOO LARGE'
      GO TO 10
30    CONTINUE
      IF(RDEF.EQ.RUNK) GO TO 10
      R = RDEF
C
999  RETURN
      END
      SUBROUTINE STRGET(A,NUE)
C
C      DESCRIPTION *****
C
C      Get character data from interactive input file. This is a likely
C      place for machine dependencies: On CDC computers, an empty record
C      is considered an end-of-file.
C
C      DECLARATIONS *****
C
C      Output:
C      A      - user input (character string).
C      NUE     - (0 = no user input).
C
C      COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      INTEGER NUE
C      CHARACTER A(*)
C
C      CODE *****
C
C      NUE = 1
C      READ(*,FMT=901) A
C
C      IF(A.EQ.' ') NUE = 0      Test for no user input.
901  FORMAT(A)
999  RETURN
      END

```

FILE: GETDAT.FOR

```

C$NOAR
C      COMMON /UNITS/ U8,U9,U10
      INTEGER U8,U9,U10
C      COMMON /AF1/ FIRST,CTLEnd
      LOGICAL FIRST,CTLEnd

      COMMON /SDY/ STDYRPT
      LOGICAL STDYRPT

      COMMON /LST/ LIST
      INTEGER LIST,NUE,NZST,NFTST,NFEST,NHBSMT,NHOUT,NSBSMT,NSOUT
      INTEGER JUNK,JDEF,JMIN,JMAX

      CHARACTER*20 FILENM, FLNMIN
C      Open files.
      U8 = 0
      U9 = 1
      U10 = 2

      JUNK = 999
      NUE = 1
      LIST = 0
      FIRST = .TRUE.
      CTLEnd = .FALSE.
      STDYRPT = .FALSE.
1111 CALL OPENFL(U8,FILENM,'SEQUENTIAL',IOS,'FORMATTED','OLD',
-      ' ENTER NAME OF AIRFLOW CHARACTERISTICS INPUT FILE: ',
-      NUE)
      FLNMIN = FILENM
      JDEF = LIST
      JMIN = 0
      JMAX = 4
C      CALL INTGET(' Enter airflow data OUTPUT CONTROL parameter',
C      JDEF,JMIN,JMAX,JUNK,LIST)
      JDEF = 1
      JMIN = 1
      JMAX = 25000
      CALL INTGET(' Enter HOUSE network BASEMENT NODE number',
-      JDEF,JMIN,JMAX,JUNK,NHBSMT)
      JDEF = 9
      JMIN = 1
      JMAX = 25000
      CALL INTGET(' Enter HOUSE network OUTDOOR NODE number',
-      JDEF,JMIN,JMAX,JUNK,NHOUT)
      JDEF = 779
      JMIN = 1
      JMAX = 25000
      CALL INTGET(' Enter SOIL network BASEMENT NODE number',
-      JDEF,JMIN,JMAX,JUNK,NSBSMT)
      JDEF = 780
      JMIN = 1
      JMAX = 25000
      CALL INTGET(' Enter SOIL network OUTDOOR NODE number',
-      JDEF,JMIN,JMAX,JUNK,NSOUT)
      JDEF = 781
      JMIN = 1
      JMAX = 25000
      CALL INTGET(' Enter NEW starting NODE number',
-      JDEF,JMIN,JMAX,JUNK,NZST)
      JDEF = 609
      JMIN = 1
      JMAX = 5000
      CALL INTGET(' Enter NEW starting CHARACTERISTIC number',
-      JDEF,JMIN,JMAX,JUNK,NFTST)
      JDEF = 2101
      JMIN = 1
      JMAX = 50000
      CALL INTGET(' Enter NEW starting ELEMENT number',
-      JDEF,JMIN,JMAX,JUNK,NFEST)
C      If (LIST.GE.1) then
      CALL FILEINF(IRCDEF,'RECFM','F','LRECL',132,'BLKSIZE',132)
      CALL OPENFL(U9,FILENM,'SEQUENTIAL',IOS,'FORMATTED','NEW',
-      ' ENTER NAME OF AIRFLOW DATA OUTPUT FILE: ',
-      NUE)
      write(U9,900) FLNMIN
      write(U9,901) FILENM
      End if

      OPEN (3,FILE='LOUT1.OUT',STATUS='UNKNOWN')
      OPEN (4,FILE='LOUT2.OUT',STATUS='UNKNOWN')
      OPEN (5,FILE='LOUT3.OUT',STATUS='UNKNOWN')
      OPEN (10,FILE='FLOWELEM.OUT',STATUS='UNKNOWN')
      CALL WEATHER
      CALL GETDAT(NHBSMT,NHOUT,NSBSMT,NSOUT,NZST,NFTST,NFEST)
      WRITE (3,1300) 0
      WRITE (4,1300) 0
      WRITE (5,1300) 0
      CLOSE(3)
      CLOSE(4)
      CLOSE(5)
      CLOSE(10)

      If (LIST.GE.1) CLOSE(U9)
      CLOSE(U8)
      FIRST = .TRUE.

900 FORMAT(//,'INPUT DATA FILE : ',A20,/)
901 FORMAT('OUTPUT DATA FILE: ',A20,/)
1300 FORMAT(I1)

```

End

```

C===== WEATHER
SUBROUTINE Weather
C-----
C----- Developed by Craig Wray *****
C January 1989

C-----
C--0.0 DATA SPECIFICATIONS & COMMON STORAGE
C-----
C$INCLUDE WTHR.INC
C$INCLUDE WTHRD.INC
COMMON /AF1/ FIRST,CTLEnd
LOGICAL FIRST,CTLEnd
C
REAL RELCON
INTEGER INTCON,Year
INTEGER J, K, FLAG
CHARACTER*160 STRING
CHARACTER*80 WORD

COMMON /UNITS/ U8,U9,U10
C
INTEGER U8,U9,U10
C
Character CNM*6,Xtn*3,YNM*2
CHARACTER*1 ANL

C-----
C--1.0 NAME INPUT FILE
C-----
READ(U8,900) STRING
K = 0
CALL GETWRD(STRING,K,WORD)
StMon = INTCON(WORD,FLAG)
CALL GETWRD(STRING,K,WORD)
StDay = INTCON(WORD,FLAG)
CALL GETWRD(STRING,K,WORD)
StHr = INTCON(WORD,FLAG)

READ(U8,900) STRING
K = 0
CALL GETWRD(STRING,K,WORD)
EndMon = INTCON(WORD,FLAG)
CALL GETWRD(STRING,K,WORD)
EndDay = INTCON(WORD,FLAG)
CALL GETWRD(STRING,K,WORD)
EndHr = INTCON(WORD,FLAG)

Read(u8,50) Yr
Read(u8,100) City

WRITE (3,1700) STMON,STDAY,STHF
WRITE (3,1700) ENDMON,ENDDAY,ENDHR
WRITE (3,1800) YR
WRITE (3,1900) CITY

50 Format(A4)
100 Format(A20)
900 Format(A)
1700 Format(I2,1X,I2,1X,I2)
1800 Format(A4)
1900 Format(A14)

RETURN
END

C----- GETDAT
SUBROUTINE GETDAT(NHBSMT,NBOUT,NSBSMT,NSOUT,NZST,NFTST,NFEST)
C
C DESCRIPTION *****
C
C Read the airflow data file.
C
C DECLARATIONS *****
C
NAPP - Number of airflow element parameters stored.
C Airflow element data
C INTEGER MAXAFE
C PARAMETER (MAXAFE = 3200)
C
COMMON /AFEDAT/ AFELNK(2,MAXAFE),AFEHT(2,MAXAFE),AFEPT(2,MAXAFE),
- AFECTL(MAXAFE),AzM(MAXAFE),ETYPE(MAXAFE),
- TCls,BBt
C
INTEGER AFELNK,AFEPT,ETYPE,TCls
REAL AFEHT,AFECTL,AzM,BBt
C
COMMON /CTLAFE/ NoCtl(MAXAFE),CtlS1(MAXAFE,2),Ctl1(MAXAFE,2)
INTEGER NoCtl,CtlS1
Real Ctl1
C
Airflow element parameters
C INTEGER MAXAFT
C PARAMETER (MAXAFT = 650)
C INTEGER MAXAFP
C PARAMETER (MAXAFP = 3300)
C
COMMON /AFEPAR/ AFENDX(MAXAFT),AFEPAR(MAXAFP),AFTMAP(MAXAFT)
C

```

```

      INTEGER AFENDX,AFTMAP
      REAL AFEPAR
C
COMMON /LST/ LIST
COMMON /CONTRL/ PB,ACNVG1,ACNVG2,ACNVG3,AMAXIT,DPMAX,
      NOINIT,NAFET,NAFE,NZON
C
      INTEGER LIST, AMAXIT, NOINIT, NAFET
      INTEGER NAFE,NZON
      REAL PB, ACNVG1, ACNVG2, ACNVG3, DPMAX
C
COMMON /UNITS/ U8,U9,U10
C
      INTEGER U8,U9,U10
C
      Zone (airflow node) data
      INTEGER MAXZON
      PARAMETER (MAXZON = 1000)
C
COMMON /ZONL/ZTYPE(MAXZON),PZ(MAXZON),TZ(MAXZON),HZ(MAXZON),
      ATYPE(MAXZON),ZONMAP(MAXZON)
C
      INTEGER ZTYPE,ATYPE,ZONMAP
      DOUBLE PRECISION PZ
      REAL HZ, TZ
C
      REAL RELCON
      INTEGER INTCON,J,MI,MOUT
      INTEGER I, K, M, N, FLAG, NAFF, R
      CHARACTER*160 STRING
      CHARACTER*80 WORD,COMMENT
      INTEGER JUNK,JDEF,JMIN,JMAX
      INTEGER NZST,NFTST,NFEST,NHBSMT,NHOUT,NSBSMT,NSOUT
C$INCLUDE WTHRD.INC
C
C CODE *****
C
      NAFF = 0
      NAFET = 0
      NAFE = 0
      NZON = 0
      JUNK = 999
C
C ***** Read building site terrain class and building height.
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      TCls = INTCON(WORD,FLAG)
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      BHT = RELCON(WORD,FLAG)
      WRITE (3,2100) TCls
      WRITE (3,2200) BHT
      IF(LIST.GE.3) WRITE(U9,907) TCls
C
C ***** Read zone data:
C      type(ambient,known press.), height, temperature, pressure.
      IF(LIST.GE.3) WRITE(U9,901)
C
      NZON=NZST-1
      CONTINUE
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      I = INTCON(WORD,FLAG)
      IF (I.EQ.NHBSMT) THEN
        ZONMAP(I)=NSBSMT
        GO TO 10
      END IF
      IF (I.EQ.NHOUT) THEN
        ZONMAP(I)=NSOUT
        GO TO 10
      END IF
      IF (I.LE.0) GO TO 20
      NZON = NZON+1
      ZONMAP(I)=NZON
      IF(NZON.GT.MAXZON) CALL ERROR(' Parameter MAXZON too small',3)
      CALL GETWRD(STRING,K,WORD)
      E = INTCON(WORD,FLAG)
      ATYPE(NZON) = E
      CALL GETWRD(STRING,K,WORD)
      N = INTCON(WORD,FLAG)
      ZTYPE(NZON) = N
      CALL GETWRD(STRING,K,WORD)
      HZ(NZON) = RELCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      TZ(NZON) = RELCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      PZ(NZON) = RELCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      COMMENT = WORD
      WRITE(3,1000) NZON,ATYPE(NZON),ZTYPE(NZON),
      HZ(NZON),TZ(NZON),PZ(NZON),COMMENT
      IF(LIST.GE.3) WRITE(U9,902) NZON,ATYPE(NZON),ZTYPE(NZON),
      HZ(NZON),TZ(NZON),PZ(NZON)
      GO TO 10
20 CONTINUE
C
C ***** Read airflow element parameters:
      IF(LIST.GE.3) WRITE(U9,903)
      NAFET=NFTST-1
30 CONTINUE

```

```

C          Read first line.
READ(U8,900) STRING
IF(LIST.GE.3) WRITE(U9,904) STRING
K = 0
CALL GETWRD(String,K,WORD)
I = INTCON(WORD,FLAG)
IF(I.LE.0) GO TO 100
NAFET = NAFET+1
IF(NAFET.GT.MAXAFT) CALL ERROR(' Parameter MAXAFT too small',3)
AFTMAP(I) = NAFET
CALL GETWRD(String,K,WORD)
I = INTCON(WORD,FLAG)
IF(NAFP+10.GT.MAXAFP)
-   CALL ERROR(' Parameter MAXAFP too small',3)
NAFP = NAFP+1
AFENDX(NAFET) = NAFP
AFEPAR(NAFP) = I
M = NAFP
MI = M

C          Read remaining data.
IF (I.EQ.0) THEN
  CALL GETWR1(String,K,WORD)
  COMMENT = WORD
  WRITE (4,1200) NAFET,I,COMMENT
C          Power law resistance.
DO 32 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
32  AFEPAR(M) = RELCON(WORD,FLAG)
  CALL GETWR1(String,K,WORD)
  COMMENT = WORD
  WRITE (4,1210) NAFET,I,(AFEPAR(MOUT),MOUT=(MI+1),M),
-   COMMENT
ELSE IF(I.EQ.1) THEN
  Duct element.
DO 35 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
35  AFEPAR(M) = RELCON(WORD,FLAG)
  READ(U8,900) STRING
  IF(LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 36 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
36  AFEPAR(M) = RELCON(WORD,FLAG)
  M = M+1
  AFEPAR(M) = AFEPAR(NAFP+4)/AFEPAR(NAFP+2)
  M = M+1
  AFEPAR(M) = AFEPAR(NAFP+1)/AFEPAR(NAFP+2)
  M = M+1
  AFEPAR(M) = 1.14 - 0.868589*LOG(AFEPAR(NAFP+9))
  M = M+1
  AFEPAR(M) = AFEPAR(NAFP+11)
ELSE IF(I.EQ.3) THEN
  Doorway element.
DO 41 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
41  AFEPAR(M) = RELCON(WORD,FLAG)
  CALL GETWR1(String,K,WORD)
  COMMENT = WORD
  WRITE (4,1230) NAFET,I,(AFEPAR(MOUT),MOUT=(MI+1),M),
-   COMMENT
  MI = M+1
  READ(U8,900) STRING
  IF(LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 42 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
42  AFEPAR(M) = RELCON(WORD,FLAG)
  WRITE (4,1235) (AFEPAR(MOUT),MOUT=MI,M)
C          Constant flow rate.
ELSE IF(I.EQ.4) THEN
  CALL GETWRD(String,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
  CALL GETWR1(String,K,WORD)
  COMMENT = WORD
  WRITE (4,1240) NAFET,I,(AFEPAR(MOUT),MOUT=(MI+1),M),
-   COMMENT
C          Detailed fan element.
ELSE IF(I.EQ.5) THEN
  DO 44 N=1,4
  CALL GETWRD(String,K,WORD)
  M = M+1
44  AFEPAR(M) = RELCON(WORD,FLAG)
  READ(U8,900) STRING
  IF(LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 45 N=1,6
  CALL GETWRD(String,K,WORD)
  M = M+1
45  AFEPAR(M) = RELCON(WORD,FLAG)
DO 46 N=1,AFEPAR(NAFP+9)
  READ(U8,900) STRING
  IF(LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 46 J=1,5
  CALL GETWRD(String,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
46  CONTINUE
ELSE IF(I.EQ.6) THEN
  Constant power fan element.
  CALL GETWRD(String,K,WORD)

```



```

      M = M+1
      AFEPAR(M) = RELCON(WORD,FLAG)
      ELSE IF(1.EQ.7) THEN
C          Multirange resistance.
          DO 51 N=1,4
              CALL GETWRD(String,K,WORD)
              M = M+1
          51      AFEPAR(M) = RELCON(WORD,FLAG)
              DO 52 N=1,AFEPAR(NAFF+2)
                  READ(U8,900) STRING
                  IF(LIST.GE.3) WRITE(U9,904) STRING
                  K = 0
                  DO 52 J=1,3
                      CALL GETWRD(String,K,WORD)
                      M = M+1
                      AFEPAR(M) = RELCON(WORD,FLAG)
          52      CONTINUE
C          ELSE IF(1.EQ.8) THEN
              Variable resistance.
          DO 54 N=1,4
              CALL GETWRD(String,K,WORD)
              M = M+1
          54      AFEPAR(M) = RELCON(WORD,FLAG)
              CALL GETWR1(String,K,WORD)
              COMMENT = WORD
              WRITE (4,1280) NAFET,I,(AFEPAR(MOUT),MOUT=(MI+1),M),
                  COMMENT
              MI = M+1
              READ(U8,900) STRING
              IF(LIST.GE.3) WRITE(U9,904) STRING
              K = 0
              DO 55 N=1,2
                  CALL GETWRD(String,K,WORD)
                  M = M+1
          55      AFEPAR(M) = RELCON(WORD,FLAG)
                  WRITE (4,1282) (AFEPAR(MOUT),MOUT=MI,M)
                  MI = M+1
                  READ(U8,900) STRING
                  IF(LIST.GE.3) WRITE(U9,904) STRING
                  K = 0
                  DO 56 N=1,4
                      CALL GETWRD(String,K,WORD)
                      M = M+1
          56      AFEPAR(M) = RELCON(WORD,FLAG)
                  WRITE (4,1284) (AFEPAR(MOUT),MOUT=MI,M)
C          ELSE
              Element type error.
              IF ((LIST.LT.3) .AND. (LIST.GE.1)) WRITE(U9,904) STRING
              CALL ERROR(' Invalid airflow element type',2)
              M = M+1
              AFEPAR(M)=0.0
              END IF
              NAFF = M
              IF(NAFF.GT.MAXAFP)
                  CALL ERROR(' Parameter MAXAFP too small',3)
              GO TO 30
          100 CONTINUE
              IF(LIST.GE.4) CALL DUMPVI('AFENDX:',AFENDX,NAFET,U9)
              IF(LIST.GE.4) CALL DUMPVR('AFEPAR:',AFEPAR,NAFF,U9)

C ***** Read airflow element data:
C          link 1, height 1, link 2, height 2,
C          pointer to parameters, surface azimuth,
C          #ctl intervals, ctl times, ctl values.
          IF(LIST.GE.3) WRITE(U9,905)
          NAFE=NFEST-1
          CONTINUE
          READ(U8,900) STRING
          K = 0
          CALL GETWRD(String,K,WORD)
          I = INTCON(WORD,FLAG)
          IF(1.LE.0) GO TO 120
          NAFE = NAFE+1
          IF(NAFE.GT.MAXAFE) CALL ERROR(' Parameter MAXAFE too small',3)
          CALL GETWRD(String,K,WORD)
          AFELNK(1,NAFE) = ZONMAP(INTCON(WORD,FLAG))
          CALL GETWRD(String,K,WORD)
          AFEHT(1,NAFE) = RELCON(WORD,FLAG)
          CALL GETWRD(String,K,WORD)
          AFELNK(2,NAFE) = ZONMAP(INTCON(WORD,FLAG))
          CALL GETWRD(String,K,WORD)
          AFEHT(2,NAFE) = RELCON(WORD,FLAG)
          CALL GETWRD(String,K,WORD)
          AFEPTR(NAFE) = INTCON(WORD,FLAG)
          AFEPTR(NAFE) = AFTMAP(AFEPTR(NAFE))
          CALL GETWRD(String,K,WORD)
          Azm(NAFE) = RELCON(WORD,FLAG)
          CALL GETWRD(String,K,WORD)
          ETYPE(NAFE) = INTCON(WORD,FLAG)
C 890723
          CALL GETWRD(String,K,WORD)
          Noctl(NAFE) = INTCON(WORD,FLAG)
          J=0
          CALL GETWR1(String,K,WORD)
          COMMENT = WORD
          DO 150 I=1,Noctl(NAFE)
              If (MOD(J,6).EQ.0) then
                  READ(U8,900) STRING
                  K = 0
                  End if
                  CALL GETWRD(String,K,WORD)
                  CtlS1(NAFE,I) = INTCON(WORD,FLAG)
                  CALL GETWRD(String,K,WORD)
                  CtlI(NAFE,I) = RELCON(WORD,FLAG)
                  J=J+1
          150      Continue
                  I=Noctl(NAFE)+1

```

```

CtLS1(NAFE,I)=24
IF(LIST.GE.3) WRITE(U9,906) NAFE,AFELNK(1,NAFE),AFEHT(1,NAFE),
- AFELNK(2,NAFE),AFEHT(2,NAFE),AFEPTR(NAFE),
- AZM(NAFE),ETYPE(NAFE),NOCTL(NAFE)
IF(LIST.GE.3) WRITE(U9,908) (CtLS1(NAFE,I),
- Ct11(NAFE,I),I=1,NOCTL(NAFE))
WRITE(5,1100) NAFE,AFELNK(1,NAFE),AFEHT(1,NAFE),
- AFELNK(2,NAFE),AFEHT(2,NAFE),AFEPTR(NAFE),
- AZM(NAFE),ETYPE(NAFE),NOCTL(NAFE),COMMENT
WRITE(5,1600) (CtLS1(NAFE,I),Ct11(NAFE,I),I=1,NOCTL(NAFE))
WRITE(10,4000) NAFE,AFELNK(1,NAFE),AFELNK(2,NAFE),COMMENT
GO TO 110
120 CONTINUE

900 FORMAT(A)
901 FORMAT(/,8X,'N AMB TYP HZ TZ PZ')
902 FORMAT(' ZON:',3I4,2F8.3,P9.0)
903 FORMAT(/,8X,'I parameters')
904 FORMAT(' AFP:',A)
905 FORMAT(/,8X,'I N H1 M H2 T AZM TYP',
- ' NOCTL',/,TIME:CTL')
906 FORMAT(' AFE:',2I4,F8.3,I4,F8.3,I4,F12.5,I4,I6)
907 FORMAT(' TCLA:',I4)
908 FORMAT(24(I6,F6.3/))
1000 FORMAT(I4,3X,I1,3X,I1,3X,F8.5,3X,F13.8,3X,F6.2,T62,A40)
1100 FORMAT(I4,2X,I4,2X,F8.5,2X,I4,2X,F8.5,2X,I4,2X,F5.1,2X,I1,2X,
- I1,2X,A40)
1200 FORMAT(I4,1X,I2,T62,A40)
1210 FORMAT(I4,2X,I2,2X,3(E11.6E2,3X),F5.3,T62,A40)
1230 FORMAT(I4,2X,I2,2X,2(E11.6E2,3X),6X,F5.3,3X,F5.3,T62,A40)
1235 FORMAT(7X,3(8X,F6.4),2X,F6.4)
1240 FORMAT(I4,2X,I2,2X,E12.6E2,T62,A40)
1280 FORMAT(I4,2X,I2,2X,3(E11.6E2,3X),F5.3,T62,A40)
1282 FORMAT(15X,F6.4,8X,F6.4)
1284 FORMAT(7X,3(8X,F6.4),2X,F6.4)
1300 FORMAT(I1)
1500 FORMAT(A6)
1600 FORMAT(24(2X,I2,2X,F4.2))
1700 FORMAT(I1,1X,I1,1X,I1)
1800 FORMAT(I4)
1900 FORMAT(A14)
2100 FORMAT(2X,I1)
2200 FORMAT(F4.2)
2300 FORMAT(I3,4X,I3,4X,I3,4X,I4)
2400 FORMAT(3X,I3,2X,A2,E14.9E2,10X,A1,2X,I2,3X,I2,3X,I2)
2503 FORMAT(A3)
2506 FORMAT(A6)
2507 FORMAT(A7)
2508 FORMAT(A8)
2600 FORMAT(3X,I4,2X,A2,I3,',',I3,1X,A6)
2650 FORMAT(3X,I4,2X,A2,I3,',',I3,1X,A9,E13.8E2,2(A3,E13.8E2))
2700 FORMAT(A2,I4,A18)
2800 FORMAT(2X,I4,1X,A3,A2)
2850 FORMAT(A1)
2900 FORMAT(I4,1X,A3,E17.12E2)
3000 FORMAT(A2,I1,5X,A30)
3100 FORMAT(F9.7,10X,A30)
3200 FORMAT(A22)
3300 FORMAT(I4,A3,I4,A11)
4000 FORMAT(I5,' I=',I4,',',I4,',',I4,' T=SIMP ',A40)
RETURN
END

```

```

C----- DUMPVD
SUBROUTINE DUMPVD(S,V,N,UOUT)
C
C DESCRIPTION *****
C
C Print the contents of the double precision "V" vector.
C
C DECLARATIONS *****
C
C INTEGER UOUT
C INTEGER N, I
C REAL*8 V(*)
C CHARACTER*(*) S
C
C CODE *****
C
C WRITE(UOUT,901) S
C WRITE(UOUT,902) (V(I),I=1,N)
C11 WRITE(UOUT,901)
C901 FORMAT(1X,A)
C902 FORMAT(1X,1P,5E15.7)
C
C RETURN
C
C END

```

```

C----- DUMPVI
SUBROUTINE DUMPVI(S,V,N,UOUT)
C
C DESCRIPTION *****
C
C PRINT THE CONTENTS OF THE INTEGER*4 "V" VECTOR.
C
C DECLARATIONS *****
C
C INTEGER UOUT
C INTEGER N, I, V(*)
C CHARACTER*(*) S
C
C CODE *****

```

```

C      WRITE(UOUT,901) S
      WRITE(UOUT,902) {V(I),I=1,N)
C11   WRITE(UOUT,901)
      901 FORMAT(1X,A)
      902 FORMAT(1X,10I6)
C      RETURN
      END

```

```

C----- DUMPVR
C      SUBROUTINE DUMPVR(S,V,N,UOUT)
C      DESCRIPTION *****
C      Print the contents of the real "V" vector.
C      DECLARATIONS *****
C      INTEGER UOUT
C      INTEGER N, I
C      REAL V(*)
C      CHARACTER*(*) S
C      CODE *****
C      WRITE(UOUT,901) S
C      WRITE(UOUT,902) {V(I),I=1,N)
C11   WRITE(UOUT,901)
      901 FORMAT(1X,A)
      902 FORMAT(1X,1P,5E15.7)
C      RETURN
      END

```

```

C$INCLUDE UTILGET.INC

```

FILE: UTILGET.INC

```

SUBROUTINE ERROR(MSG,SEVR)
DESCRIPTION *****
Simple error message writer with fatal error termination.
DECLARATIONS *****
Input:
MSG - message to be printed.
SEVR - error severity code.
COMMON /UNITS/ U8,U9,U10
      INTEGER U8,U9,U10
      INTEGER SEVR
      INTEGER I
      CHARACTER*(*) MSG
      CHARACTER*16 SEVER(0:3)
CODE *****
DATA SEVER / ' *** NOTE *** ', ' *** WARNING *** ',
             ' *** SEVERE *** ', ' *** FATAL *** ' /
I = MAX(SEVR,0)
I = MIN(I,3)
WRITE(6,*) SEVER(I)
WRITE(U9,*) SEVER(I)
WRITE(6,*) MSG
WRITE(U9,*) MSG
IF(SEVR.GE.3) STOP
RETURN
END
SUBROUTINE ERROR2(MSG1,MSG2,SEVR)
DESCRIPTION *****
Simple error message writer (2 messages) with fatal termination.
DECLARATIONS *****
Input:
MSG1 - first message to be printed.
MSG2 - second message to be printed.
SEVR - error severity code.
COMMON /UNITS/ U8,U9,U10
      INTEGER U8,U9,U10
      INTEGER SEVR
      INTEGER I
      CHARACTER*(*) MSG1, MSG2
      CHARACTER*16 SEVER(0:3)
CODE *****
DATA SEVER / ' *** NOTE *** ', ' *** WARNING *** ',
             ' *** SEVERE *** ', ' *** FATAL *** ' /
I = MAX(SEVR,0)
I = MIN(I,3)
WRITE(6,*) SEVER(I)
WRITE(U9,*) SEVER(I)
WRITE(6,*) MSG1,MSG2
WRITE(U9,*) MSG1,MSG2
IF(SEVR.GE.3) STOP
RETURN
END
SUBROUTINE GETSTR(UIN,A,NUE)
DESCRIPTION *****
Get character data from batch input file. On CDC computers,
an empty record is considered an end-of-file.
DECLARATIONS *****
Input:
UIN - unit number of input file.
Output:
A - user input (character string).
NUE - (0 = no input).
      INTEGER UIN
      INTEGER NUE, I, L
      CHARACTER A*(*)
      CHARACTER*4 UNITNR
CODE *****
NUE = 1
READ(UNIT=UIN,FMT=901,END=10) A
GO TO 999
      End-of-file.
10 NUE = 0
I = UIN
CALL INTDIS(I,UNITNR,L)
CALL ERROR2('End-of-file on UNIT ',UNITNR(1:L),2)
901 FORMAT(A)
999 RETURN
END
SUBROUTINE GETWRD(STRING,K,WORD)
DESCRIPTION *****

```

```

C
C      Get next "WORD" from the "STRING" of characters.
C      Words are separated by blanks or commas:  WORD,WORD,WORD  or
C      WORD WORD WORD  or  WORD, WORD, WORD  are all valid.
C
C      DECLARATIONS *****
C
C      Input/Output:
C      K      - current position in "STRING".
C      Local:
C      LS     - maximum length of "STRING".
C      L      - current position in "WORD".
C      LW     - maximum length of "WORD".
C
C      COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      INTEGER K, LS, L, LW
C      CHARACTER*(*) WORD, STRING
C      CHARACTER*1 A
C
C      CODE *****
C
C      WORD = ' '
C      LS = LEN(STRING)
C      LW = LEN(WORD)
C      L = 0
C
C      10 CONTINUE      Skip blanks before the word.
C      K = K+1
C      IF(K.GT.LS) GO TO 30
C      A = STRING(K:K)
C      IF(A.EQ.' ') GO TO 10
C      IF(A.EQ.',') GO TO 999
C
C      20 CONTINUE      Copy "WORD" from "STRING".
C      Copy character from "STRING" to "WORD".
C      L = L+1
C      IF(L.GT.LW) GO TO 40
C      WORD(L:L) = A
C
C      Find separator in "STRING".
C      K = K+1
C      IF(K.GT.LS) GO TO 50
C      A = STRING(K:K)
C      IF(A.EQ.' ') GO TO 999
C      IF(A.EQ.',') GO TO 999
C      GO TO 20
C
C      30 CALL ERROR(' Did not find expected value',2)
C      GO TO 60
C      40 CALL ERROR(' Word too long (parameter WRDLEN too short)',2)
C      GO TO 60
C      50 CALL ERROR(' Did not find end of word (blank or comma)',2)
C      60 CONTINUE
C      WRITE(6,*) STRING
C      WRITE(U9,*) STRING
C      CALL ERROR(' Could not process the input line listed above',3)
C      999 CONTINUE
C      RETURN
C      END
C      SUBROUTINE GETWR1(STRING,K,WORD)
C
C      DESCRIPTION *****
C
C      Get next "WORD" from the "STRING" of characters.
C      Words are separated by blanks and/or commas:  WORD,WORD,WORD.
C
C      DECLARATIONS *****
C
C      Input/Output:
C      K      - current position in "STRING".
C      Local:
C      LS     - maximum length of "STRING".
C      L      - current position in "WORD".
C      LW     - maximum length of "WORD".
C
C      COMMON /UNITS/ U8,U9,U10
C
C      INTEGER U8,U9,U10
C
C      INTEGER K, LS, L, LW
C      CHARACTER*(*) WORD, STRING
C      CHARACTER*1 A1
C      CHARACTER*2 A
C
C      CODE *****
C
C      WORD = ' '
C      LS = LEN(STRING)
C      LW = LEN(WORD)
C      L = 0
C
C      10 CONTINUE      Skip blanks before the word.
C      K = K+1
C      IF(K.GT.LS) GO TO 30
C      A1 = STRING(K:K)
C      IF(A1.EQ.' ') GO TO 10
C      IF(A1.EQ.',') GO TO 999
C
C      Copy "WORD" from "STRING".
C      A=STRING(K-1:K)
C      20 CONTINUE      Copy character from "STRING" to "WORD".
C      L = L+2
C      IF(L.GT.LW) GO TO 40
C      WORD(L-1:L) = A
C
C      Find separator in "STRING".

```

```

K = K+2
IF(K.GT.LS) GO TO 50
A = STRING(K-1:K)
IF(A.EQ.' ') GO TO 999
IF(A.EQ.', ') GO TO 999
GO TO 20

C
30 CALL ERROR(' Did not find expected value',2)
GO TO 60
40 CALL ERROR(' Word too long (parameter WRDLEN too short)',2)
GO TO 60
50 CALL ERROR(' Did not find end of word (blank or comma)',2)
60 CONTINUE
WRITE(6,*) STRING
WRITE(U9,*) STRING
CALL ERROR(' Could not process the input line listed above',3)
999 CONTINUE
RETURN
END
INTEGER FUNCTION INTCON(ANUM,EFLAG)

DESCRIPTION *****
Convert character string "ANUM" to an integer.
The limiting values for short integers are +/- 32759;
for long integers +/- 2147483649.

DECLARATIONS *****
INTEGER EFLAG, I, J, MINUS
CHARACTER ANUM*(*) , TEST*13

COMMON /UNITS/ U8,U9,U10

INTEGER U8,U9,U10

CODE *****
DATA TEST / ' +-0123456789' /
INTCON = 0
MINUS = 1
DO 40 J=1,LEN(ANUM)
I = INDEX(TEST,ANUM(J:J))
IF(I.GT.3) GO TO 10
GO TO(50,30,20), I
GO TO 60
10 IF(INTCON.GE.3276) GO TO 70
INTCON = INTCON*10+(I-4)
GO TO 40
20 MINUS = -1
30 IF(J.NE.1) GO TO 60
40 CONTINUE
50 CONTINUE
INTCON = MINUS*INTCON
EFLAG = 0
GO TO 999

Error messages.
60 CALL ERROR2(' Invalid integer (INTCON): ',ANUM,2)
GO TO 60
70 CALL ERROR2(' Too many digits (INTCON): ',ANUM,2)
80 EFLAG = 1
999 RETURN
END
SUBROUTINE INTDIS(I,ANUM,L)

DESCRIPTION *****
Convert integer I to character string ANUM(1:L) for display.

DECLARATIONS *****
INTEGER K, L, M, N, NN
INTEGER I
CHARACTER*(*) ANUM
CHARACTER*10 DISP

CODE *****
DATA DISP / '0123456789' /
IF(I.GE.0) THEN
L = 0
ELSE
L = 1
END IF
N = ABS(I)
K = LEN(ANUM)
10 CONTINUE
IF(N.LT.10) THEN
M = N
N = 0
ELSE
NN = N/10
M = N-10*NN
N = NN
END IF
IF(K.LE.L) CALL ERROR(' String variable too short (INTDIS)',3)
ANUM(K:K) = DISP(M+1:M+1)
K = K-1
IF(N.GT.0) GO TO 10
N = LEN(ANUM)
IF(L.EQ.1) ANUM(L:L) = '-'
20 CONTINUE
L = L+1
K = K+1
ANUM(L:L) = ANUM(K:K)
IF(K.LT.N) GO TO 20

```



```

DECLARATIONS *****
Input:
MSG      - Message to user.
Local:
NUE      - (0 = no user entry).

CHARACTER*(*) MSG
CHARACTER*1 A
INTEGER NUE

CODE *****
10 WRITE(6,901) ' ',MSG,' (Y/N)? '
   CALL STRGET(A,NUE)
   IF(A.EQ.'Y' .OR. A.EQ.'y') GO TO 20
   IF(A.EQ.'N' .OR. A.EQ.'n') GO TO 30
   WRITE(6,*) ' Valid responses are: Y or y for YES, N or n for NO.'
   GO TO 10
20 NOYES = 1
   GO TO 999
30 NOYES = 0
901 FORMAT(A,$)
901 FORMAT(A)
999 RETURN
END
SUBROUTINE OPENFL(U,FNM,ACC,RL,FOR,STA,MSG,NUE)

DESCRIPTION *****
Open a file; to be called from an interactive program with the
unit numbers for the interaction input and output files.
For use with named files (status cannot = SCRATCH).
Be careful with the length of the integer variables.

DECLARATIONS *****
Input:
U        - unit number of file to be opened.
FNM      - name of file (supplied by user).
ACC      - access ('SEQUENTIAL' or 'DIRECT').
RL       - record length (for direct access files only).
FOR      - format ('FORMATTED' or 'UNFORMATTED').
STA      - status ('NEW' or 'OLD' or 'UNKNOWN').
MSG      - message to user.
Local:
NUE      - (0 = no user entry).

INTEGER U, RL, IOS
INTEGER NUE
CHARACTER*(*) FNM, ACC, FOR, STA, MSG
CHARACTER*80 FNMO

CODE *****
10 CONTINUE
   WRITE(6,901) MSG
   CALL STRGET(FNM,NUE)
   IF(NUE.EQ.0) GO TO 100
   FNMO=FNM
   FNM=FNMC
   IF(ACC.EQ.'SEQUENTIAL') THEN
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,FORM=FOR,STATUS=STA,
          IOSTAT=IOS,ERR=20)
   ELSE
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,RECL=RL,FORM=FOR,STATUS=STA,
          IOSTAT=IOS,ERR=20)
   ENDIF
   GO TO 999
C      Failed to open file.
20 CONTINUE
   WRITE(6,*) ' Could not open file named: ',FNM
   WRITE(6,*) ' FORTRAN I/O status: ',IOS,' (See FORTRAN manual)'
   IF(STA.EQ.'NEW') THEN
     WRITE(6,*) ' Expected the name of a new file.'
   ELSE IF(STA.EQ.'OLD') THEN
     WRITE(6,*) ' Expected the name of an existing file.'
   ENDIF
   WRITE(6,*) ' Try again. Enter revised file name.'
   WRITE(6,*) ' {To stop program execution, press only ENTER}'
   WRITE(6,*)
   GO TO 10
C      User termination.
100 STOP 'User Termination'
901 FORMAT(A,$)
901 FORMAT(A)
999 RETURN
END
SUBROUTINE OPNCTL(U,FNM,ACC,RL,FOR,STA,MSG)

DESCRIPTION *****
Open a data file containing airflow element control values.
For use with named files (status cannot = SCRATCH).
Be careful with the length of the integer variables.

DECLARATIONS *****
Input:
U        - unit number of file to be opened.
FNM      - name of file (supplied by user).
ACC      - access ('SEQUENTIAL' or 'DIRECT').
RL       - record length (for direct access files only).
FOR      - format ('FORMATTED' or 'UNFORMATTED').
STA      - status ('NEW' or 'OLD' or 'UNKNOWN').
MSG      - message to user.

```



```

C Local:
C NUC - (0 = no user entry).
C
C      INTEGER U, RL, IOS
C      INTEGER NUC
C      CHARACTER*(*) FNM, ACC, FOR, STA, MSG
C
C      CODE *****
C      FNM='AFE CTL'
10  CONTINUE
C      IF (ACC.EQ.'SEQUENTIAL') THEN
C        OPEN(UNIT=U, FILE=FNM, ACCESS=ACC, FORM=FOR, STATUS=STA,
C          -   IOSTAT=IOS, ERR=20)
C      ELSE
C        OPEN(UNIT=U, FILE=FNM, ACCESS=ACC, RECL=RL, FORM=FOR, STATUS=STA,
C          -   IOSTAT=IOS, ERR=20)
C      ENDIF
C      GO TO 999
C
C      Failed to open file.
20  CONTINUE
C      WRITE(6,*) ' Could not open file named: ', FNM
C      WRITE(6,*) ' FORTRAN I/O status: ', IOS, ' (See FORTRAN manual)'
C      IF (STA.EQ.'NEW') THEN
C        WRITE(6,*) ' Expected the name of a new file.'
C      ELSE IF (STA.EQ.'OLD') THEN
C        WRITE(6,*) ' Expected the name of an existing file.'
C      ENDIF
C      WRITE(6,*) ' Try again. Enter revised file name.'
C      WRITE(6,*) ' {To stop program execution, press only ENTER}'
C      WRITE(6,*) ' MSG
C      CALL STRGET(FNM, NUC)
C      IF (NUC.EQ.0) GO TO 100
C      GO TO 10
C
C      User termination.
100 STOP 'User Termination'
C
C 901 FORMAT(A,$)
C 901 FORMAT(A)
999 RETURN
END
REAL FUNCTION RELCON(ANUM, EFLAG)
C
C      DESCRIPTION *****
C      Convert character string "ANUM" to a real number.
C
C      DECLARATIONS *****
C      COMMON /UNITS/ U8, U9, U10
C
C      INTEGER U8, U9, U10, MINUS
C
C      INTEGER EFLAG, I, J
C      REAL MULT, RNUM
C      LOGICAL D, E
C      CHARACTER ANUM*(*), TEST*16
C
C      CODE *****
C
C      DATA TEST / 'eE.-+ 0123456789' /
C      RELCON = 0.0
C      MINUS = 1
C      MULT = 1.
C      RNUM = 0.0
C      D = .FALSE.
C      E = .FALSE.
C
C      Process each character until a blank.
C      DO 80 J=1, LEN(ANUM)
C        I = INDEX(TEST, ANUM(J:J))
10      IF (I-6) 10, 100, 20
C        GO TO (70, 70, 30, 40, 60), I
C        GO TO 120
C
C        Add digit to number.
20      RNUM = RNUM*10 + (I-7)
C        IF (D) MULT = MULT*10.
C        GO TO 80
C
C        Note decimal point.
30      IF (D .OR. E) GO TO 120
C        D = .TRUE.
C        GO TO 80
C
C        Note minus sign.
40      IF (J.EQ.1) GO TO 50
C        IF (ANUM(J-1:J-1).EQ.'E') GO TO 50
C        IF (ANUM(J-1:J-1).EQ.'e') GO TO 50
C        GO TO 120
50      MINUS = -1
C        GO TO 80
C
C        Note plus sign.
60      IF (J.EQ.1) GO TO 80
C        IF (ANUM(J-1:J-1).EQ.'E') GO TO 80
C        IF (ANUM(J-1:J-1).EQ.'e') GO TO 80
C        GO TO 120
C
C        Begin exponent.
70      IF (I.EQ.0) GO TO 120
C        IF (E) GO TO 120
C        RELCON = REAL(RNUM*MINUS)/MULT
C        MINUS = 1
C        RNUM = 0.0
C        D = .FALSE.
C        E = .TRUE.
80      CONTINUE
C
C      Finish calculation of number.
100 EFLAG = 0
C      IF (E) GO TO 110
C      RELCON = REAL(RNUM*MINUS)/MULT
C      GO TO 999

```

```

110 RELCON = RELCON*10.** (RNUM*MINUS)
GO TO 999
C      Error messages.
120 CALL ERROR2(' Invalid number (RELCON): ',ANUM,2)
EFLAG = 1
999 RETURN
END
SUBROUTINE RELDIS(R,M,ANUM,L)
C      DESCRIPTION *****
C      Convert real R to character string ANUM(1:L) for display.
C      DECLARATIONS *****
C
C      Input:
C      R      - real (single precision) number.
C      M      - number of significant digits in result.
C      Output:
C      ANUM    - character string with number beginning at 1.
C      L      - last position of number in ANUM. {ANUM(1:L)}
C      Local:
C      LFC    - position of first character in ANUM.
C      LDEC   - position of decimal point in ANUM.
C      LEXP   - position of "E" in ANUM.
C      LSIG   - position of last significant digit in ANUM.
C      EXPT   - value of the exponent in ANUM.
C      DECML  - .TRUE. if decimal point has been written.
C
C      INTEGER M
C      INTEGER L, LFC, LDEC, LEXP, LSIG, EXPT, I, EFLAG
C      LOGICAL DECML
C      REAL R
C      CHARACTER*(*) ANUM
C      CHARACTER*10 FORM
C
C      CODE *****
C
C      IF (LEN(ANUM).LT.30) CALL ERROR(' Short string (RELDIS)',3)
C      I = M-1
C      CALL INTDIS(I,ANUM,L)
C      FORM = '(1PE30. '//ANUM(1:L)//')'
C      WRITE(ANUM,FMT=FORM) R
C      I = 0
10    I = I+1
C      IF (ANUM(I:I).EQ.' ') GO TO 10
C      LFC = I
12    I = I+1
C      IF (ANUM(I:I).NE.'.') GO TO 12
C      LDEC = I
14    I = I+1
C      IF (ANUM(I:I).NE.'E') GO TO 14
C      LEXP = I
16    I = I+1
C      IF (ANUM(I:I).EQ.'0') GO TO 16
C      LSIG = I
C      EXPT = INTCON(ANUM(LEXP+1:30),EFLAG)
C      IF (EXPT.LT.-4) GO TO 30
C      IF (EXPT.GE.M+3) GO TO 30
C      Display number in normal format.
C      DECML = .FALSE.
C      L = 0
C      IF (ANUM(LFC:LFC).EQ.'-') THEN
C        L = L+1
C        ANUM(L:L) = '-'
C      END IF
C      IF (EXPT.LT.0) THEN
C        L = L+1
C        ANUM(L:L) = '0'
C        L = L+1
C        ANUM(L:L) = '.'
C        DECML = .TRUE.
C      END IF
20    CONTINUE
C      EXPT = EXPT+1
C      IF (EXPT.GE.0) GO TO 22
C      L = L+1
C      ANUM(L:L) = '0'
C      GO TO 20
22    CONTINUE
C      L = L+1
C      ANUM(L:L) = ANUM(LDEC-1:LDEC-1)
C      I = LDEC+1
24    CONTINUE
C      EXPT = EXPT-1
C      IF (EXPT.EQ.0) THEN
C        L = L+1
C        ANUM(L:L) = '.'
C        DECML = .TRUE.
C      END IF
C      IF (I.GT.LSIG) THEN
C        IF (DECML) GO TO 999
C        L = L+1
C        ANUM(L:L) = '0'
C      ELSE
C        L = L+1
C        ANUM(L:L) = ANUM(I:I)
C        I = I+1
C      END IF
C      GO TO 24
C      Display number in exponential format.
C
30    CONTINUE
C      L = 0
C      DO 32 I=LFC,LSIG
C        L = L+1
C        ANUM(L:L) = ANUM(I:I)
32    CONTINUE
C      DO 34 I=LEXP,30

```



```

C
NUE = 1
READ(5,FMT=901) A
C
IF(A.EQ.' ') NUE = 0
901 FORMAT(A)
999 RETURN
END
Test for no user input.

```

FILE: WTHR.INC

COMMON /WTHR1/CITY, INNAME, YR
CHARACTER CITY*20, INNAME*16, YR*4

- COMMON /WTHR2/DAYS, FRSTDY, FRSTER, LASTDY, LASTER, HOURS,
1, STMON, STDAY, STER, ENDMON, ENDDAY, ENDR, X
- INTEGER DAYS, FRSTDY, FRSTER, LASTDY, LASTER, HOURS, 1, STMON,
StDay, StHr, EndMon, EndDay, EndHr, X

FILE: GRIDGEN.FOR

BASED ON PRESSU PROGRAM DEVELOPED BY CELSO LOUREIRO (1987)

PROGRAM GRIDGEN

C ... SPECIFICATION OF THE LOCAL SCALARS

```

IMPLICIT REAL*8 (A-H,O-Z)
IMPLICIT INTEGER (I-N)
REAL*8 DELTAP,RNLAMB,DIFFO,VISCO
REAL*8 LX1,LX2,LX3,LX4,LY1,LY2,LY3,LY4,LZ1,LZ2
REAL*8 LXAG,LYAG,LZAG
REAL*8 LX1DIM,LX2DIM,LX3DIM,LX4DIM
REAL*8 LY1DIM,LY2DIM,LY3DIM,LY4DIM,LZ1DIM,LZ2DIM
REAL*8 PERM0,PERM1,PERMX,PERMY,PERMZ
REAL*8 TOL,WCONV,PCONV
REAL*8 LENGTH,VOLUME,HEIGHT,VELO
REAL*8 KXCRACK,YKCRACK,LESS1,XLESS2,YLESS2,LCRACK
REAL*8 SUM,ZR

```

C ... SPECIFICATION OF THE LOCAL INTEGERS

```

INTEGER NX1,NX2,NX3,NX4,NY1,NY2,NY3,NY4,NZ1,NZ2
INTEGER I1,I2,I3,I4,J1,J2,J3,J4,K1,K2
INTEGER NXAG,NYAG,NZAG,IAG,JAG,KAG
INTEGER I,J,K,I1,J1,K1
INTEGER ITEXMAX,ITER,SZ
INTEGER NV,NH,NVA,NVB,VPRINT(8),HPRINT(8)

```

C ... SPECIFICATION OF THE LOCAL ARRAYS

C LOCAL VECTORS

```

PARAMETER (SZ=35)
REAL*8 CVX(SZ),CVY(SZ),CVZ(SZ),LX(SZ),LY(SZ),LZ(SZ)
COMMON I1,I2,I3,I4,J1,J2,J3,J4,K1,K2

```

C ... LIST OF THE SUBROUTINES USED WITH THIS PROGRAM

```

C PREOUT ...OUTPUT ROUTINE
C PMENU ...MENU ROUTINE

```

C*****

C STEP#2 : ASSIGN PARAMETER VALUES

C ... REAL DATA

```

PARAMETER (ZR=0.0)
DATA DELTAP /5.0D+0/
DATA RNLAMB,VISCO /2.098D-6,1.8D-5/
DATA DIFFO /1.0D-6/
DATA PERM0,PERM1 /1.0D-12,2.5D-12/
DATA PERMX,PERMY,PERMZ /2.5D-11,2.5D-11,5.0D-8/
DATA HEIGHT /3.0D+0/
DATA LX1,LX2,LX3,LX4,LXAG /3.75D+0,5.0D-3,2.0D-1,10.0D+0,5.0D-1/
DATA LY1,LY2,LYAG /5.90D+0,5.0D-3,5.0D-1/
DATA LZ1,LZ2,LZAG /1.26D+0,10.0D+0,1.25D-1/
DATA TOL /1.0D-6/
DATA PCONV,WCONV /0.0,0.0/

```

C ... INTEGER DATA

```

DATA ITER/0/
DATA ITEXMAX/500/

DATA NX1,NX2,NX3,NX4,NXAG/3,1,1,2,1/
DATA NY1,NY2,NYAG /3,1,1/
DATA NZ1,NZ2,NZAG/2,2,1/

```

C *** CHANGE PARAMETERS ? ***

```

OPEN(7,FILE='GRDGEN.OUT',STATUS='UNKNOWN')
OPEN(8,FILE='L2IN.DAT',STATUS='UNKNOWN')
CALL PMENU(DELTAP,PERM0,PERM1,PERMX,PERMY,PERMZ,
* LX1,LX2,LX3,LX4,LXAG,LY1,LY2,LYAG,LZ1,LZ2,LZAG,
* NX1,NX2,NX3,NX4,NXAG,NY1,NY2,NYAG,NZ1,NZ2,NZAG,
* TOL,ITEXMAX,NV,NH,NVA,NVB,VPRINT,HPRINT)

```

```

LX1=LX1-LX2
LY1=LY1-LY2
LY3=LX3
LY4=LX4
LZ1=LZ1+LX3-1.25D-1

```

```

NY3=NX3
NY4=NX4

```

```

I1 = NX1
I2 = I1 + NX2
I3 = I2 + NX3
IAG= I3 + NXAG
I4 = IAG+ NX4
J1 = NY1
J2 = J1 + NY2
J3 = J2 + NY3
JAG= J3 + NYAG
J4 = JAG+ NY4
K1 = NZ1
KAG= K1 + NZAG + 5
K2 = KAG+ NZ2

```

C ... TEST IF THE GRID IS ASSIGNED APPROPRIATELY.

```

IF(NX1.LT.(NX3+2))THEN

```

```

      WRITE(6,7000)
      WRITE(7,7000)

      STOP
    ELSEIF((I4+2).GT.SZ.OR.(J4+2).GT.SZ.OR.(K2+2).GT.SZ)THEN
      WRITE(6,7100){SZ-2}
      WRITE(7,7100){SZ-2}
      STOP
    ENDIF

C*****
C   STEP #3 : CALCULATION OF SOME OF THE CONSTANTS USED IN THE
C             DIMENSIONLESS EXPRESSIONS.

XKCRAK = ((LX2)**2)/(12.*VISCO*LX3)
YKCRAK = ((LY2)**2)/(12.*VISCO*LY3)
LENGTH = DSORT(DIFFO/RNLAMB)
LCRAK=LX3/LENGTH
VELO = DSORT(DIFFO*RNLAMB)
LESS1 = (PERMO*DELTAP)/(VISCO*DIFFO)
XLESS2 = {XKCRAK*DELTAP}/VELO
YLESS2 = {YKCRAK*DELTAP}/VELO
VOLUME = 4.0*(HEIGHT*(LZ1-LX3))*(LX1+LX2)*(LY1+LY2)

C*****
C   STEP #4 : CALCULATION OF THE DIMENSIONLESS SIZE OF ALL C.V.
C   ... THE SIZES OF THE C.V.FACES ARE DISTRIBUTED IN EACH SEGMENT
C           FOLLOWING AN EQUATION OF A CIRCLE. (SEE APPENDIX)
C   ... ALL THESE VALUES ARE STORED IN ONE-DIMENSIONAL ARRAYS WHERE
C           THE FIRST AND THE LAST POSITIONS ARE MADE EQUAL TO ZERO.

LX1DIM = LX1/LENGTH
LX2DIM = LX2/LENGTH
LX3DIM = LX3/LENGTH
LX4DIM = LX4/LENGTH
LY1DIM = LY1/LENGTH
LY2DIM = LY2/LENGTH
LY3DIM = LY3/LENGTH
LY4DIM = LY4/LENGTH
LZ1DIM = LZ1/LENGTH
LZ2DIM = LZ2/LENGTH

C   ... SOME REAL VARIABLES ARE DEFINED HERE TO SUBSTITUTE THE
C   INTEGER VARIABLES NX1, NX2, etc. IN THE FOLLOWING
C   CALCULATIONS.

RX1=NX1 - NX3
RX2=NX2
RX3=NX3
RX4=NX4
RXAG = NXAG
RY1=NY1 - NY3
RY2=NY2
RY3=NY3
RY4=NY4
RYAG = NYAG
RZ1=NZ1
RZ2=NZ2
RZAG = NZAG

C   ... CALCULATION FOR THE X-DIRECTION
C   UNDER THE BASEMENT (FAR FROM THE CRACK)...

SUM = 0.0
DO 10 II=1,(NX1-NX3)/2.
  I=II+1
  RI=II
  CVX(I)={ (LX1DIM-LX3DIM)/2. }*(1.0-DSQRT(1.-(2.*RI/RX1)**2))-SUM
  CVX(I1-NX3+2-II)=CVX(I)
  SUM=SUM+CVX(I)
10 CONTINUE

C   UNDER THE BASEMENT (NEAR THE CRACK)...

SUM=0.0
DO 15 II=1,NX3
  I=NX3+2-II
  RI=II
  CVX(NX1-NX3+I)=LX3DIM*(1.-DSQRT(1.-(RI/RX3)**2))-SUM
  SUM=SUM+CVX(NX1-NX3+I)
15 CONTINUE

C   UNDER THE CRACK...

IF (NX2.EQ.1)THEN
  CVX(I2+1)=LX2DIM
ELSE
  SUM = 0.0
  DO 20 II = 1,NX2/2
    I=II+1
    RI=II
    CVX(I1+I)={LX2DIM/2. }*(1.-DSQRT(1.-(2.*RI/RX2)**2))-SUM
    CVX(I2+2-II)=CVX(I1+I)
    SUM=SUM+CVX(I1+I)
  20 CONTINUE
ENDIF

C   UNDER THE WALL...

SUM = 0.0
DO 25 II=1,NX3
  I=II+1
  RI=II

```

```

      CVX(I2+I)=LX3DIM*(1.-DSQRT(1.-(RI/RX3)**2))-SUM
      SUM=SUM+CVX(I2+I)
25  CONTINUE
C    WITHIN X-AGGREGATE...
      IF(NXAG.NE.0)THEN
        SUM=0.0
        DO 27 II=1,NXAG
          I=II+1
          RI=II
          CVX(I3+I)=(LXAG/LENGTH)*(1.-DSQRT(1.-(RI/RXAG)**2))-SUM
          SUM=SUM+CVX(I3+I)
27  CONTINUE
        ENDIF
C    WITHIN SOIL...
      SUM = 0.0
      DO 30 II=1,NX4/2
        I=II+1
        RI=II
        CVX(IAG+I)=(LX4DIM/2.)*(1.-DSQRT(1.-(2.*RI/RX4)**2))-SUM
        CVX(I4+2-II)=CVX(IAG+I)
        SUM=SUM+CVX(IAG+I)
30  CONTINUE
C    ... CALCULATION FOR THE Y-DIRECTION
C    UNDER THE BASEMENT (FAR FROM THE CRACK)...
      SUM = 0.0
      DO 35 JJ=1,(NY1-NY3)/2
        J=JJ+1
        RJ=JJ
        CVY(J)=((LY1DIM-LY3DIM)/2.)*(1.-DSQRT(1.-(2.*RJ/RX1)**2))-SUM
        CVY(J1-NY3+2-JJ)=CVY(J)
        SUM=SUM+CVY(J)
35  CONTINUE
C    UNDER THE BASEMENT (NEAR THE CRACK)...
      SUM=0.0
      DO 40 JJ=1,NY3
        J=NY3+2-JJ
        RJ=JJ
        CVY(NY1-NY3+J)=LY3DIM*(1.-DSQRT(1.-(RJ/RX3)**2))-SUM
        SUM=SUM+CVY(NY1-NY3+J)
40  CONTINUE
C    UNDER THE CRACK...
      IF (NY2.EQ.1) THEN
        CVY(J2+1)=LY2DIM
      ELSE
        SUM = 0.0
        DO 45 JJ=1,NY2/2
          J=JJ+1
          RJ=JJ
          CVY(J1+J)=(LY2DIM/2.)*(1.-DSQRT(1.-(2.*RJ/RX2)**2))-SUM
          CVY(J2+2-JJ)=CVY(J1+J)
          SUM=SUM+CVY(J1+J)
45  CONTINUE
        ENDIF
C    UNDER THE WALL...
      SUM = 0.0
      DO 50 JJ=1,NY3
        J=JJ+1
        RJ=JJ
        CVY(J2+J)=LY3DIM*(1.-DSQRT(1.-(RJ/RX3)**2))-SUM
        SUM=SUM+CVY(J2+J)
50  CONTINUE
C    WITHIN THE Y-AGGREGATE...
      IF(NYAG.NE.0)THEN
        SUM=0.0
        DO 52 JJ=1,NYAG
          J=JJ+1
          RJ=JJ
          CVY(J3+J)=(LYAG/LENGTH)*(1.-DSQRT(1.-(RJ/RXAG)**2))-SUM
          SUM=SUM+CVY(J3+J)
52  CONTINUE
        ENDIF
C    WITHIN THE SOIL...
      SUM = 0.0
      DO 55 JJ=1,NY4/2
        J=JJ+1
        RJ=JJ
        CVY(JAG+J)=(LY4DIM/2.)*(1.-DSQRT(1.-(2.*RJ/RX4)**2))-SUM
        CVY(J4+2-JJ)=CVY(JAG+J)
        SUM=SUM+CVY(JAG+J)
55  CONTINUE
C    ... CALCULATION FOR THE Z-DIRECTION
C    ABOVE THE BASEMENT...
      SUM = 0.0
      DO 60 KK=1,NZ1/2
        K=KK+1
        RK=KK
        CVZ(K)=(LZ1DIM/2.)*(1.-DSQRT(1.-(2.*RK/RZ1)**2))-SUM
        CVZ(K1+2-KK)=CVZ(K)

```



```

60      SUM=SUM+CVZ(K)
      CONTINUE
C      AT THE MIDDLE LAYERS...
C      (NOTE THAT THE SIZE OF THE FIRST MIDDLE LAYER IS EQUAL TO THE
C      AVERAGE OF THE CRACK WIDTHS AT THE X-LINE AND Y-LINE.)

      CVZ(K1+2)=(LX2DIM+LY2DIM)/2.
      CVZ(K1+3)=CVZ(K1+2)
      CVZ(K1+4)=CVZ(K1+2)*2.
      CVZ(K1+5)=CVZ(K1+2)*4.
      CVZ(K1+6)=CVZ(K1+2)*8.
C      WITHIN THE Z-AGGREGATE...
      IF(NZAG.NE.0)THEN
        SUM=0.0
        DO 62 KK=1,NZAG
          K=KK+1
          RK=KK
          CVZ(K1+5+K)={ (LZAG/LENGTH) - 16.*CVZ(K1+2) } *
          * { 1.-DSQRT(1.-(RK/RZAG)**2) } -SUM
          SUM=SUM+CVZ(K1+5+K)
62      CONTINUE
      ENDIF
C      WITHIN THE SOIL...
      SUM = 0.0
      DO 65 KK=1,NZ2/2
        K=KK+1
        RK=KK
        CVZ(KAG+K)={ (LZ2DIM/2.) * (1.-DSQRT(1.-(2.*RK/RZ2)**2) ) } -SUM
        CVZ(K2+2-KK)=CVZ(KAG+K)
        SUM=SUM+CVZ(KAG+K)
65      CONTINUE
C      ... ASSIGN THE VALUE ZERO FOR THE EXTREMITIES OF THESE ARRAYS
      CVX(1) = 0.0
      CVX(I4+2) = 0.0
      CVY(1) = 0.0
      CVY(J4+2) = 0.0
      CVZ(1) = 0.0
      CVZ(K2+2) = 0.0
C      ... ASSIGN VALUES FOR THE ARRAYS LX(I), LY(J), AND LZ(K)
      LX(1)=0.0
      DO 70 I=2,I4+2
        LX(I)=LX(I-1)+LENGTH*CVX(I)
70      CONTINUE
      LY(1)=0.0
      DO 75 J=2,J4+2
        LY(J)=LY(J-1)+LENGTH*CVY(J)
75      CONTINUE
      LZ(1)=0.0
      DO 80 K=2,K2+2
        LZ(K)=LZ(K-1)+LENGTH*CVZ(K)
80      CONTINUE
C*****
C      STEP #14 :          *** OUTPUT ***
C      ... PRINT ALL CONSTANTS AND CALCULATED PARAMETERS
      WRITE(7,5200)
      WRITE(7,5300)TOL,PCONV,WCONV
      WRITE(7,5400)ITEMAX,ITER
      WRITE(7,5500)
      WRITE(7,5600)DELTAP,RNLAMB,VISCO,DIFFO,
      * PERMO,PERM1,PERMX,PERMY,PERMZ
      WRITE(7,5700)
      WRITE(7,5800)HEIGHT,VOLUME,LX1,LX2,LX3,LX4,LXAG,
      * LY1,LY2,LY3,LY4,LYAG,LZ1,LZ2,LZAG
      WRITE(7,5900)
      WRITE(7,6000)NX1,NX2,NX3,NX4,NXAG,
      * NY1,NY2,NY3,NY4,NYAG,NZ1,NZ2,NZAG
      WRITE(7,6100)
      WRITE(7,6200)I1,I2,I3,IAG,I4,J1,J2,J3,JAG,J4,K1,KAG,K2
      WRITE(8,*) I4
      WRITE(8,*) J4
      WRITE(8,*) K2
      WRITE(8,*)
      WRITE(8,*) I1
      WRITE(8,*) I2
      WRITE(8,*) I3
      WRITE(8,*) IAG
      WRITE(8,*) I4
      WRITE(8,*)
      WRITE(8,*) J1
      WRITE(8,*) J2
      WRITE(8,*) J3
      WRITE(8,*) JAG
      WRITE(8,*) J4
      WRITE(8,*)
      WRITE(8,*) K1
      WRITE(8,*) KAG
      WRITE(8,*) K2
      WRITE(8,*)
      WRITE(8,*) PERMX
      WRITE(8,*) PERMY
      WRITE(8,*) PERMZ
      WRITE(8,*) PERM1

```

```

C *****
C      STEP #16 :  LIST OF VARIABLES
C
C      *** SCALARS ***
C
C      VARIABLE      UNITS      DESCRIPTION

```

C	DELTA	[Pa]	Delta pressure applied at the crack;
C	RNLAMB	[1/s]	Radioactive decay constant of Rn-222;
C	DIFFO	[m ² /s]	Bulk diffusivity of radon in soil;
C	VISCO	[Kg/m.s]	Dynamic viscosity of air;
C	PERM0	[m ²]	Characteristic permeability of soil;
C	PERM1	[m ²]	Permeability of soil;
C	PERMX	[m ²]	Permeability of x-aggregate;
C	PERMY	[m ²]	Permeability of y-aggregate;
C	PERMZ	[m ²]	Permeability of z-aggregate;
C	LX1	[m]	X-dimension of basement;
C	LX2	[m]	X-dimension of crack;
C	LX3	[m]	X-dimension under vertical wall;
C	LX4	[m]	X-dimension of soil after aggregate;
C	LXAG	[m]	X-dimension of aggregate;
C	LY1	[m]	Y-dimension of basement;
C	LY2	[m]	Y-dimension of crack;
C	LY3	[m]	Y-dimension under vertical wall;
C	LY4	[m]	Y-dimension of soil after aggregate;
C	LYAG	[m]	Y-dimension of aggregate;
C	LZ1	[m]	Z-dimension above basement;
C	LZ2	[m]	Z-dimension below aggregate;
C	LZAG	[m]	Z-dimension of aggregate;
C	TOL	[dim.less]	Tolerance criteria;
C	WCONV	[dim.less]	Difference between WCRACK and WSOIL;
C	PCONV	[dim.less]	Difference between PRES and PRESA;
C	WPROB	[dim.less]	A particular value of the velocity WSOIL;
C	LENGTH	[m]	Characteristic length;
C	VOLUME	[m ³]	Total internal volume of the house;
C	HEIGHT	[m]	Height of the house;
C	VELC	[m/s]	Characteristic velocity;
C	LESS1	[dim.less]	Constant used in the calculation of the gas velocity through the soil matrix;
C	XLESS2	[dim.less]	Constant used in the calculation of the gas velocity through the crack parallel to the y-axis;
C	YLESS2	[dim.less]	Constant used in the calculation of the gas velocity through the crack parallel to the x-axis;
C	XKCRACK	[m ² .s/Kg]	Constant used in the calculation of the gas velocity through the crack parallel to the y-axis;
C	YKCRACK	[m ² .s/Kg]	Constant used in the calculation of the gas velocity through the crack parallel to the x-axis;
C	LCRACK	[dim.less]	Depth of the crack;
C	SUM		Dummy variable;
C	ZR		Parameter equal to zero;
C	FLAG		Character variable, used to orient the printout.
C	*** INTEGERS ***		
C	VARIABLE	DESCRIPTION	
C	I1	X-direction :	Order of the last node under the basement;
C	NX1	X-direction :	Number of nodes under the basement;
C	NX2	X-direction :	Number of nodes under the crack;
C	NX3	X-direction :	Number of nodes under vertical wall;
C	NX4	X-direction :	Number of nodes beyond aggregate;
C	NXAG	X-direction :	Number of nodes in the aggregate;
C	NY1	Y-direction :	Number of nodes under the basement;
C	NY2	Y-direction :	Number of nodes under the crack;
C	NY3	Y-direction :	Number of nodes under vertical wall;
C	NY4	Y-direction :	Number of nodes beyond aggregate;
C	NYAG	Y-direction :	Number of nodes in the aggregate;
C	NZ1	Z-direction :	Number of nodes above the basement;
C	NZ2	Z-direction :	Number of nodes under the aggregate;
C	NZAG	Z-direction :	Number of nodes in the aggregate;
C	I1	X-direct.:	Order of the last node under the basement;
C	I2	X-direct.:	Order of the last node under the crack;
C	I3	X-direct.:	Order of the last node under wall;
C	IAG	X-direct.:	Order of the last node within aggregate;
C	I4	X-direct.:	Order of the last node in the soil;
C	J1	Y-direct.:	Order of the last node under the basement;
C	J2	Y-direct.:	Order of the last node under the crack;
C	J3	Y-direct.:	Order of the last node under wall;
C	JAG	Y-direct.:	Order of the last node within aggregate;
C	J4	Y-direct.:	Order of the last node in the soil;
C	K1	Z-direct.:	Order of the last node above basement;
C	KAG	Z-direct.:	Order of the last node within aggregate;
C	K2	Z-direct.:	Order of the last node in the soil;
C	KMID		Order of the first layer below the basement;
C	NDUMB		Dummy variable;
C	ITEMAX		Maximum number of iterations;
C	ITER		Actual number of iterations;
C	SZ		Parameter that specifies the dimension of the arrays;
C	NV		
C	NH		
C	NVA		
C	NVB		
C	VPRINT(8)		
C	HPRINT(8)		
C	These integer parameters orient the output;		

```

C      *** ARRAYS ***
C      VARIABLE      UNITS      DESCRIPTION
C      CVX(SZ)      [dim.less]  X-direction : Size of the C.Va.
C      CVY(SZ)      [dim.less]  Y-direction : Size of the C.Va.
C      CVZ(SZ)      [dim.less]  Z-direction : Size of the C.Va.
C      LX(SZ)      [m]          X-direct.: Distance from C.V to origin;
C      LY(SZ)      [m]          Y-direct.: Distance from C.V to origin;
C      LZ(SZ)      [m]          Z-direct.: Distance from C.V to origin;
C      A(SZ)
C      B(SZ)
C      C(SZ)      These vectors are used in the subroutine TRIDIM.
C      D(SZ)
C      VEC(SZ)
C      *** MATRICES ***
C      VARIABLE      UNITS      DESCRIPTION
C      WCRACK(SZ,SZ) [dim.less]  Gas velocity through the crack;
C      WSOIL(SZ,SZ)  [dim.less]  Gas velocity through the soil/crack;
C      PRES(SZ,SZ,SZ) [dim.less]  Pressure distribution in the soil;
C      PRESA(SZ,SZ,SZ) [dim.less]  Pressure distribution in the soil;
C      PERM(SZ,SZ,SZ) [dim.less]  Soil permeability distribution;
C      AE(SZ,SZ,SZ)  [dim.less]
C      AW(SZ,SZ,SZ)  [dim.less]
C      AN(SZ,SZ,SZ)  [dim.less]
C      AS(SZ,SZ,SZ)  [dim.less]  Discretization coefficients.
C      AT(SZ,SZ,SZ)  [dim.less]
C      AB(SZ,SZ,SZ)  [dim.less]
C      AP(SZ,SZ,SZ)  [dim.less]
C      *****
C      CLOSE(7)
C      CLOSE(5)
C      END
C      INCLUDE 'GRDSUB.FOR'

```

FILE: GRDSUB.FOR

BASED ON PRESSU PROGRAM DEVELOPED BY CELSO LOUREIRO (1987)

```

C*****
C          *** GRDSUB ***
C          (SUBROUTINES CALLED FROM GRIDGEN)
C*****
C          ***SUBROUTINE PMENU***
C          ... OBJECTIVE : TO HANDLE THE MENU FOR THE PROGRAM GRDGEN
C
C          SUBROUTINE PMENU(DELTA,PERM0,PERM1,PERMX,PERMY,PERMZ,
C          *          LX1,LX2,LX3,LX4,LXAG,LY1,LY2,LYAG,LZ1,LZ2,LZAG,
C          *          NX1,NX2,NX3,NX4,NXAG,NY1,NY2,NYAG,NZ1,NZ2,NZAG,
C          *          TOL,ITEMAX,NV,NH,NVA,NVB,VPRINT,HPRINT)
C
C          IMPLICIT REAL*8 (A-H,O-Z)
C          IMPLICIT INTEGER (I-N)
C          REAL*8 DELTA,PERM0,PERM1,PERMX,PERMY,PERMZ,TOL
C          REAL*8 LX1,LX2,LX3,LX4,LXAG,LY1,LY2,LYAG,LZ1,LZ2,LZAG
C          INTEGER ITEMAX,NX1,NX2,NX3,NX4,NXAG,NY1,NY2,NYAG,NZ1,NZ2,NZAG
C          INTEGER NV,NH,NVA,NVB,VPRINT(8),HPRINT(8)
C          CHARACTER MENU1*1,MENU2*2,MENU3*3
C
C          Z1 = DELTA
C          Z2 = PERM0
C          Z3 = PERM1
C          Z4 = PERMX
C          Z5 = PERMY
C          Z6 = PERMZ
C          Z7 = LX1
C          Z8 = LX2
C          Z9 = LX3
C          Z10 = LX4
C          Z11 = LXAG
C          Z12 = LY1
C          Z13 = LY2
C          Z14 = LYAG
C          Z15 = LZ1
C          Z16 = LZ2
C          Z17 = LZAG
C          Z18 = TOL
C
C          I1 = ITEMAX
C          I2 = NX1
C          I3 = NX2
C          I4 = NX3
C          I5 = NX4
C          I6 = NXAG
C          I7 = NY1
C          I8 = NY2
C          I9 = NYAG
C          I10 = NZ1
C          I11 = NZ2
C          I12 = NZAG
C
C          1 DELTA= Z1
C            PERM0 = Z2
C            PERM1 = Z3
C            PERMX = Z4
C            PERMY = Z5
C            PERMZ = Z6
C            LX1 = Z7
C            LX2 = Z8
C            LX3 = Z9
C            LX4 = Z10
C            LXAG = Z11
C            LY1 = Z12
C            LY2 = Z13
C            LYAG = Z14
C            LZ1 = Z15
C            LZ2 = Z16
C            LZAG = Z17
C            TOL = Z18
C
C            ITEMAX= I1
C            NX1 = I2
C            NX2 = I3
C            NX3 = I4
C            NX4 = I5
C            NXAG = I6
C            NY1 = I7
C            NY2 = I8
C            NYAG = I9
C            NZ1 = I10
C            NZ2 = I11
C            NZAG = I12
C
C          *** PRINT THE FIRST MENU
C
C          10 WRITE(6,6000)
C             WRITE(6,6010) PERM1,PERMX,PERMY,PERMZ,
C             *          LX1,LX2,LX3,LX4,LXAG,LY1,LY2,LX3,LX4,LYAG,LZ1,LZ2,LZAG
C             *          WRITE(6,6015)NX1,NX2,NX3,NX4,NXAG,NY1,NY2,NX3,NX4,NYAG,
C             *          NZ1,NZ2,NZAG
C             WRITE(6,6020)
C
C          20 READ(5,5000)MENU1
C             IF(MENU1.EQ.'R')THEN
C               N1 = NY1
C               N2 = N1 + NY2
C               N3 = N2 + NX3
C               NAG = N3 + NYAG
C               N4 = NAG + NX4

```

```

      NV = 0
      NH = 0
      NVA = 1
      NVB = N2
      GO TO 300
    ELSEIF (MENU1.EQ.'C') THEN
      GO TO 30
    ELSEIF (MENU1.EQ.'X') THEN
      GO TO 910
    ELSE
      GO TO 20
    ENDIF
C    *** PRINT MENU #2 ***
30  WRITE(6,6030)
    WRITE(6,6000)
40  READ(5,5000)MENU1
    IF (MENU1.EQ.'P') THEN
      GO TO 40
    ELSEIF (MENU1.EQ.'K') THEN
      GO TO 60
    ELSEIF (MENU1.EQ.'T') THEN
      GO TO 40
    ELSEIF (MENU1.EQ.'I') THEN
      GO TO 40
    ELSEIF (MENU1.EQ.'L') THEN
      GO TO 90
    ELSEIF (MENU1.EQ.'G') THEN
      GO TO 190
    ELSEIF (MENU1.EQ.'S') THEN
      GO TO 1
    ELSEIF (MENU1.EQ.'X') THEN
      GO TO 10
    ELSE
      GO TO 40
    ENDIF
C    READ NEW PARAMETERS
50  WRITE(6,6050)DELTAP
    READ(5,5010)DELTAP
    GO TO 30
C    *** PRINT MENU-K ***
60  WRITE(6,6060)PERM1,PERMX,PERMY,PERMZ
    WRITE(6,6000)
62  READ(5,5002)MENU2
    IF (MENU2.EQ.'K1') THEN
      GO TO 64
    ELSEIF (MENU2.EQ.'KX') THEN
      GO TO 65
    ELSEIF (MENU2.EQ.'KY') THEN
      GO TO 66
    ELSEIF (MENU2.EQ.'KZ') THEN
      GO TO 67
    ELSEIF (MENU2.EQ.'S') THEN
      GO TO 1
    ELSEIF (MENU2.EQ.'X') THEN
      GO TO 10
    ELSE
      GO TO 62
    ENDIF
C    READ NEW PARAMETERS FOR MENU-K
64  WRITE(6,6064)PERM1
    READ(5,5010)PERM1
    PERM0=PERM1
    GO TO 60
65  WRITE(6,6065)PERMX
    READ(5,5010)PERMX
    GO TO 60
66  WRITE(6,6066)PERMY
    READ(5,5010)PERMY
    GO TO 60
67  WRITE(6,6067)PERMZ
    READ(5,5010)PERMZ
    GO TO 60
70  WRITE(6,6070)TOL
    READ(5,5010)TOL
    GO TO 30
80  WRITE(6,6080)ITEMAX
    READ(5,5030)ITEMAX
    GO TO 30
C    *** PRINT MENU #3 ***
90  WRITE(6,6090)LX1,LX2,LX3,LX4,LXAG,LY1,LY2,LYAG,LZ1,LZ2,LZAG
    WRITE(6,6000)
100 READ(5,5005)MENU3
    IF (MENU3.EQ.'LX1') THEN
      GO TO 110
    ELSEIF (MENU3.EQ.'LX2') THEN
      GO TO 120
    ELSEIF (MENU3.EQ.'LX3') THEN
      GO TO 130
    ELSEIF (MENU3.EQ.'LX4') THEN
      GO TO 140
    ELSEIF (MENU3.EQ.'LXA') THEN
      GO TO 145
    ELSEIF (MENU3.EQ.'LY1') THEN

```

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        GO TO 150
    ELSEIF(MENU3.EQ.'LY2')THEN
        GO TO 155
    ELSEIF(MENU3.EQ.'LYA')THEN
        GO TO 157
    ELSEIF(MENU3.EQ.'LZ1')THEN
        GO TO 160
    ELSEIF(MENU3.EQ.'LZ2')THEN
        GO TO 170
    ELSEIF(MENU3.EQ.'LZA')THEN
        GO TO 175
    ELSEIF(MENU3.EQ.'S')THEN
        GO TO 1
    ELSEIF(MENU3.EQ.'X')THEN
        GO TO 10
    ELSE
        GO TO 100
    ENDIF

C    READ NEW PARAMETERS FOR MENU #3

110  WRITE(6,6110)LX1
      READ(5,5010)LX1
      GO TO 90
120  WRITE(6,6120)LX2
      READ(5,5010)LX2
      GO TO 90
130  WRITE(6,6130)LX3
      READ(5,5010)LX3
      GO TO 90
140  WRITE(6,6140)LX4
      READ(5,5010)LX4
      GO TO 90
145  WRITE(6,6145)LXAG
      READ(5,5010)LXAG
      GO TO 90
150  WRITE(6,6150)LY1
      READ(5,5010)LY1
      GO TO 90
155  WRITE(6,6155)LY2
      READ(5,5010)LY2
      GO TO 90
157  WRITE(6,6157)LYAG
      READ(5,5010)LYAG
      GO TO 90
160  WRITE(6,6160)LZ1
      READ(5,5010)LZ1
      GO TO 90
170  WRITE(6,6170)LZ2
      READ(5,5010)LZ2
      GO TO 90
175  WRITE(6,6175)LZAG
      READ(5,5010)LZAG
      GO TO 90

C    *** PRINT MENU #4 ***

190  WRITE(6,6190)NX1,NX2,NX3,NX4,NXAG,NY1,NY2,NYAG,NZ1,NZ2,NZAG
      WRITE(6,6000)

200  READ(5,5005)MENU3
      IF(MENU3.EQ.'NX1')THEN
          GO TO 210
      ELSEIF(MENU3.EQ.'NX2')THEN
          GO TO 220
      ELSEIF(MENU3.EQ.'NX3')THEN
          GO TO 230
      ELSEIF(MENU3.EQ.'NX4')THEN
          GO TO 240
      ELSEIF(MENU3.EQ.'NXA')THEN
          GO TO 245
      ELSEIF(MENU3.EQ.'NY1')THEN
          GO TO 250
      ELSEIF(MENU3.EQ.'NY2')THEN
          GO TO 255
      ELSEIF(MENU3.EQ.'NYA')THEN
          GO TO 257
      ELSEIF(MENU3.EQ.'NZ1')THEN
          GO TO 260
      ELSEIF(MENU3.EQ.'NZ2')THEN
          GO TO 270
      ELSEIF(MENU3.EQ.'NZA')THEN
          GO TO 275
      ELSEIF(MENU3.EQ.'S')THEN
          GO TO 1
      ELSEIF(MENU3.EQ.'X')THEN
          GO TO 10
      ELSE
          GO TO 200
      ENDIF

C    READ NEW PARAMETERS FOR MENU #4

210  WRITE(6,6210)NX1
      READ(5,5020)NX1
      GO TO 190
220  WRITE(6,6220)NX2
      READ(5,5020)NX2
      GO TO 190
230  WRITE(6,6230)NX3
      READ(5,5020)NX3
      GO TO 190
240  WRITE(6,6240)NX4
      READ(5,5020)NX4
      GO TO 190
245  WRITE(6,6245)NXAG
      READ(5,5020)NXAG
      GO TO 190

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250 WRITE(6,6250)NY1
    READ(5,5020)NY1
    GO TO 190
255 WRITE(6,6255)NY2
    READ(5,5020)NY2
    GO TO 190
257 WRITE(6,6257)NYAG
    READ(5,5020)NYAG
    GO TO 190
260 WRITE(6,6260)NZ1
    READ(5,5020)NZ1
    GO TO 190
270 WRITE(6,6270)NZ2
    READ(5,5020)NZ2
    GO TO 190
275 WRITE(6,6275)NZAG
    READ(5,5020)NZAG
    GO TO 190

C    *** OUTPUT MENU ***

300 CONTINUE
    WRITE(6,6000)

    WRITE(6,6340)N1,N2,N3,NAG,N4

360 READ(5,5000)MENU1
    IF(MENU1.EQ.'R')THEN
        GO TO 900
    ELSEIF(MENU1.EQ.'C')THEN
        GO TO 360
    ELSEIF(MENU1.EQ.'P')THEN
        GO TO 360
    ELSEIF(MENU1.EQ.'S')THEN
        GO TO 360
    ELSEIF(MENU1.EQ.'X')THEN
        GO TO 910
    ELSE
        GO TO 360
    ENDIF

365 NV = 0
    NH = 0
    NVA = 1
    NVB = N2
    GO TO 300

C    *** MENU - CHANGE VERTICAL CROSS-SECTIONAL VIEWS ***

400 WRITE(6,6000)
    WRITE(6,6400)NVA,NVB
    WRITE(6,6000)

410 READ(5,5000)MENU1
    IF(MENU1.EQ.'A')THEN
        GO TO 420
    ELSEIF(MENU1.EQ.'B')THEN
        GO TO 430
    ELSEIF(MENU1.EQ.'S')THEN
        GO TO 440
    ELSEIF(MENU1.EQ.'X')THEN
        GO TO 300
    ELSE
        GO TO 410
    ENDIF

420 WRITE(6,6420)NVA
421 READ(5,5020)NVA
    IF(NVA.GE.N4)THEN
        GO TO 421
    ENDIF
    GO TO 400

430 WRITE(6,6430)NVB
431 READ(5,5020)NVB
    IF(NVB.GT.N4.OR.NVB.LT.NVA)THEN
        GO TO 431
    ENDIF
    GO TO 400

440 NVA=1
    NVB=N2
    GO TO 400

C    *** MENU - CHANGE PRINTOUT SELECTION ***

500 WRITE(6,6000)
    IF(NV.EQ.0)THEN
        WRITE(6,6500)
    ELSE
        WRITE(6,6510)NV,(VPRINT(I),I=1,NV)
    ENDIF
    IF(NH.EQ.0)THEN
        WRITE(6,6520)
    ELSE
        WRITE(6,6530)NH,(HPRINT(I),I=1,NH)
        WRITE(6,6535)
    ENDIF

540 READ(5,5000)MENU1
    IF(MENU1.EQ.'V')THEN
        GO TO 550
    ELSEIF(MENU1.EQ.'H')THEN
        GO TO 560
    ELSEIF(MENU1.EQ.'S')THEN
        GO TO 570
    ELSEIF(MENU1.EQ.'X')THEN
        GO TO 300

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ELSE
  GO TO 540
ENDIF
550 WRITE(6,6550)NV
  READ(5,5020)NV
  IF(NV.GT.8)THEN
    NV=8
  ELSEIF(NV.EQ.0)THEN
    GO TO 500
  ENDIF
  WRITE(6,6551)
  DO 555 I=1,NV
556   READ(5,5020)VPRINT(I)
    IF(VPRINT(I).GT.N4)THEN
      GO TO 556
    ENDIF
555  CONTINUE
    GO TO 500

560 WRITE(6,6560)NH
  READ(5,5020)NH
  IF(NH.GT.8)THEN
    NH=8
  ELSEIF(NH.EQ.0)THEN
    GO TO 500
  ENDIF
  WRITE(6,6561)
  DO 565 I=1,NH
566   READ(5,5020)HPRINT(I)
    IF(HPRINT(I).GT.(NZ1+NZ2+NZAG))THEN
      GO TO 566
    ENDIF
565  CONTINUE
    GO TO 500

570 NV=0
  NH=0
  GO TO 500

C   *** WRITE THE EXIT STATEMENTS

900 WRITE(6,6900)
  RETURN

910 WRITE(6,6910)
  STOP

C   *** FORMAT STATEMENTS ***

C   ...READ FORMATS

5000 FORMAT(A1)
5002 FORMAT(A2)
5005 FORMAT(A3)
5010 FORMAT(D8.1)
5020 FORMAT(I2)
5030 FORMAT(I3)

C   ...WRITE FORMATS

6000 FORMAT(72,' ',)
6010 FORMAT(23X,'THESE ARE THE INPUT PARAMETERS: ',/,
  *10X,'PERM1 = ',D13.6,2X,'m2] = Soil permeability',/,
  *10X,'PERMX = ',D13.6,2X,'m2] = X-Aggregate permeability',/,
  *10X,'PERMY = ',D13.6,2X,'m2] = Y-Aggregate permeability',/,
  *10X,'PERMZ = ',D13.6,2X,'m2] = Z-Aggregate permeability',/,/,
  *20X,'*** GEOMETRICAL PARAMETERS ***',/,
  *3X,'LX1 = ',F7.4,2X,'LX2 = ',F7.4,2X,'LX3 = ',F7.4,/,
  *2X,'LX4 = ',F7.4,2X,'LXAG = ',F7.4,/,/,
  *3X,'LY1 = ',F7.4,2X,'LY2 = ',F7.4,2X,'LY3 = ',F7.4,/,
  *2X,'LY4 = ',F7.4,2X,'LYAG = ',F7.4,/,/,
  *3X,'LZ1 = ',F7.4,32X,'LZ2 = ',F7.4,2X,'LZAG = ',F7.4,/)
6015 FORMAT(23X,'*** GRID PARAMETERS ***',/,
  *3X,'NX1 = ',I2,7X,'NX2 = ',I2,7X,'NX3 = ',I2,/,
  *7X,'NX4 = ',I2,7X,'NXAG = ',I2,/,/,
  *3X,'NY1 = ',I2,7X,'NY2 = ',I2,7X,'NY3 = ',I2,/,
  *7X,'NY4 = ',I2,7X,'NYAG = ',I2,/,/,
  *3X,'NZ1 = ',I2,37X,'NZ2 = ',I2,7X,'NZAG = ',I2,/)
6020 FORMAT(25X,'*** MAIN MENU ***',/,
  *15X,'R - RUN GRDGEN WITH THESE PARAMETERS:',/,
  *15X,'C - CHANGE INPUT PARAMETERS:',/,
  *15X,'X - STOP AND EXIT. '),/,
6030 FORMAT(20X,'*** MENU #2 : CHANGE INPUT PARAMETERS ***',/,
  *10X,'K - PERMEABILITY',/,
  *10X,'L - GEOMETRICAL PARAMETERS',/,
  *10X,'G - GRID PARAMETERS',/,
  *10X,'S - SELECT THE DEFAULT PARAMETERS',/,
  *10X,'X - EXIT TO THE MAIN MENU',/,),
6050 FORMAT(42X,'DELTA P = ',F4.2,/,1X,'ENTER NEW VALUE:'),
6060 FORMAT(20X,'*** MENU-K : CHANGE PERMEABILITY ***',/,/,
  *10X,'K1 = ',D13.6,2X,'m2] = Soil permeability',/,
  *10X,'KX = ',D13.6,2X,'m2] = X-Aggregate permeability',/,
  *10X,'KY = ',D13.6,2X,'m2] = Y-Aggregate permeability',/,
  *10X,'KZ = ',D13.6,2X,'m2] = Z-Aggregate permeability',/,/,/,
  *20X,'*** OTHER OPTIONS ***',/,/,
  *10X,'S - SELECT THE DEFAULT VALUES',/,/,
  *10X,'X - EXIT TO THE MAIN MENU',/,),
6064 FORMAT(13X,'PERM1 = ',D13.6,/,1X,'ENTER NEW VALUE:'),
6065 FORMAT(13X,'PERMX = ',D13.6,/,1X,'ENTER NEW VALUE:'),
6066 FORMAT(13X,'PERMY = ',D13.6,/,1X,'ENTER NEW VALUE:'),
6067 FORMAT(13X,'PERMZ = ',D13.6,/,1X,'ENTER NEW VALUE:'),
6070 FORMAT(13X,'TOL = ',D13.6,/,1X,'ENTER NEW VALUE:'),
6080 FORMAT(13X,'ITEMAX = ',I3,/,1X,'ENTER NEW VALUE (FORMAT I3):'),
6090 FORMAT(20X,'*** MENU#3 : CHANGE GEOMETRICAL DIMENSIONS ***',/,
  *10X,'IN THE X-DIRECTION: ',/,
  *15X,'LX1 = ',F7.4,/,1X,'[m] = Under the basement;',/,/,
  *15X,'LX2 = ',F7.4,/,1X,'[m] = Crack size;',/,/,

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*15X, LX3 = 'F7.4', [m] = Under vertical wall;,,,
*15X, LX4 = 'F7.4', [m] = Within block soil;,,,
*15X, LXAG = 'F7.4', [m] = Aggregate;,,,
*10X, IN THE Y-DIRECTION:,,,
*15X, LY1 = 'F7.4', [m] = Under the basement;,,,
*15X, LY2 = 'F7.4', [m] = Crack size;,,,
*15X, LYAG = 'F7.4', [m] = Aggregate;,,,
*10X, IN THE Z-DIRECTION:,,,
*15X, LZ1 = 'F7.4', [m] = Above the basement;,,,
*15X, LZ2 = 'F7.4', [m] = Underneath the basement;,,,
*15X, LZAG = 'F7.4', [m] = Aggregate;,,,
*10X, OTHER OPTIONS:,,,
*15X, S - SELECT THE DEFAULT VALUES;,,,
*15X, X - EXIT TO THE MAIN MENU;,,,
6110 FORMAT(' ', LX1 = 'D13.6', ENTER NEW VALUE: ')
6120 FORMAT(' ', LX2 = 'D13.6', ENTER NEW VALUE: ')
6130 FORMAT(' ', LX3 = 'D13.6', ENTER NEW VALUE: ')
6140 FORMAT(' ', LX4 = 'D13.6', ENTER NEW VALUE: ')
6145 FORMAT(' ', LXAG = 'D13.6', ENTER NEW VALUE: ')
6150 FORMAT(' ', LY1 = 'D13.6', ENTER NEW VALUE: ')
6155 FORMAT(' ', LY2 = 'D13.6', ENTER NEW VALUE: ')
6157 FORMAT(' ', LYAG = 'D13.6', ENTER NEW VALUE: ')
6160 FORMAT(' ', LZ1 = 'D13.6', ENTER NEW VALUE: ')
6170 FORMAT(' ', LZ2 = 'D13.6', ENTER NEW VALUE: ')
6175 FORMAT(' ', LZAG = 'D13.6', ENTER NEW VALUE: ')
6190 FORMAT(' ', 20X, '*** MENU#4 : CHANGE THE GRID PARAMETERS ***',
*10X, IN THE X-DIRECTION:,,,
*15X, NX1 = 'I2', [m] = Under the basement;,,,
*15X, NX2 = 'I2', [m] = Under the crack;,,,
*15X, NX3 = 'I2', [m] = Under vertical wall;,,,
*15X, NX4 = 'I2', [m] = Within block soil;,,,
*15X, NXAG = 'I2', [m] = Within aggregate;,,,
*10X, IN THE Y-DIRECTION:,,,
*15X, NY1 = 'I2', [m] = Under the basement;,,,
*15X, NY2 = 'I2', [m] = Under the crack;,,,
*15X, NYAG = 'I2', [m] = Within aggregate;,,,
*10X, IN THE Z-DIRECTION:,,,
*15X, NZ1 = 'I2', [m] = Above the basement;,,,
*15X, NZ2 = 'I2', [m] = Within block soil;,,,
*15X, NZAG = 'I2', [m] = Within aggregate;,,,
*10X, OTHER OPTIONS:,,,
*15X, S - SELECT THE DEFAULT VALUES;,,,
*15X, X - EXIT TO THE MAIN MENU;,,,
6210 FORMAT(' ', NX1 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6220 FORMAT(' ', NX2 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6230 FORMAT(' ', NX3 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6240 FORMAT(' ', NX4 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6245 FORMAT(' ', NXAG = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6250 FORMAT(' ', NY1 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6255 FORMAT(' ', NY2 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6257 FORMAT(' ', NYAG = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6260 FORMAT(' ', NZ1 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6270 FORMAT(' ', NZ2 = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6275 FORMAT(' ', NZAG = 'I2', ENTER NEW VALUE: (FORMAT(I2),))
6300 FORMAT(' ', 20X, '*** THIS IS THE OUTPUT MENU ***',,,,
* 20X, '- VERTICAL CROSS-SECTIONAL VIEWS -',,,,
* 12X, 'FIRST VERTICAL CROSS-SECTIONAL VIEW: NODE = ', I2, ,,,
* 12X, 'SECOND VERTICAL CROSS-SECTIONAL VIEW: NODE = ', I2, ,,,
* 12X, '- PRINTOUT SELECTION -',,,,
6310 FORMAT(' ', 11X, 'ANY PRINTOUT AT ALL (Y/N)? : N', ,,,)
6320 FORMAT(' ', 11X, 'ANY PRINTOUT AT ALL (Y/N)? : Y', ,,,)
* 12X, 'AT WHICH CROSS-SECTIONS (MAXIMUM OF 8)?', ,,,
* 12X, 'VERTICAL = ', 8(I2, ', '), ,,,)
6325 FORMAT(' ', 11X, 'ANY PRINTOUT AT ALL (Y/N)? : Y', ,,,)
* 12X, 'AT WHICH CROSS-SECTIONS (MAXIMUM OF 8)?', ,,,
* 12X, 'HORIZONTAL = ', 8(I2, ', '), ,,,)
6330 FORMAT(' ', 11X, 'HORIZONTAL = ', 8(I2, ', '), ,,,)
6340 FORMAT(' ', 9X, 'NOTE: N1 = ', I2, ' = LAST NODE UNDER BASEMENT',,,,
* 16X, 'N2 = ', I2, ' = LAST NODE UNDER THE CRACK',,,,
* 16X, 'N3 = ', I2, ' = LAST NODE UNDER THE WALL',,,,
* 16X, 'NAG = ', I2, ' = LAST NODE IN Y-AGGREGATE',,,,
* 16X, 'N4 = ', I2, ' = LAST NODE WITHIN THE SOIL',,,,
* 10X, '*** MENU ***',,,,
* 14X, 'R - RUN GRDGEN WITH THIS OUTPUT CONFIGURATION;,,,
* 14X, 'X - STOP AND EXIT.',,,,
6400 FORMAT(' ', 14X, '*** CHANGE VERTICAL CROSS-SECTIONAL VIEWS ***',,,,
* 16X, 'A - N1 = ', I2, ' = NODE OF THE FIRST VERTICAL VIEW;,,,
* 16X, 'B - N2 = ', I2, ' = NODE OF THE SECOND VERTICAL VIEW;,,,
* 16X, 'S - SELECT THE DEFAULT VALUES FOR THESE PARAMETERS;,,,
* 16X, 'X - GO TO THE MAIN OUTPUT MENU.',,,,)
6500 FORMAT(' ', 16X, '*** MENU - CHANGE PRINTOUT SELECTION ***',,,,
* 10X, 'VERTICAL CROSS SECTIONS :',,,,
* 15X, 'NUMBER : (MAXIMUM OF 8) = NONE;', ,,,)
6510 FORMAT(' ', 16X, '*** MENU - CHANGE PRINTOUT SELECTION ***',,,,
* 10X, 'VERTICAL CROSS SECTIONS :',,,,
* 15X, 'NUMBER : (MAXIMUM OF 8) = ', I2, ,,,
* 15X, 'NODE LOCATION = ', 8(I2, ', '), ,,,)
6520 FORMAT(' ', 10X, 'HORIZONTAL CROSS-SECTIONS:',,,,
* 15X, 'NUMBER : (MAXIMUM OF 8) = NONE;', ,,,)
* 15X, 'V - CHANGE VERTICAL SECTIONS',,,,
* 15X, 'H - CHANGE HORIZONTAL SECTIONS',,,,
* 15X, 'S - SELECT DEFAULT OF THESE PARAMETERS',,,,
* 15X, 'X - GO TO THE OUTPUT MENU',,,,)
6530 FORMAT(' ', 10X, 'HORIZONTAL CROSS-SECTIONS:',,,,
* 15X, 'NUMBER : (MAXIMUM OF 8) = ', I2, ,,,
* 15X, 'NODE LOCATION = ', 8(I2, ', '), ,,,)
6535 FORMAT(' ', 15X, 'V - CHANGE VERTICAL SECTIONS',,,,

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*          15X,'H - CHANGE HORIZONTAL SECTIONS',/,/,
*          15X,'S - SELECT DEFAULT OF THESE PARAMETERS',/,
*          15X,'X - GO TO THE OUTPUT MENU',/,/)

6420 FORMAT(' ', 'THE FIRST VERTICAL VIEW IS = ', I2, /,
           ' ', 'ENTER NEW VALUE (FORMAT I2) : ', /)
6430 FORMAT(' ', 'THE SECOND VERTICAL VIEW IS = ', I2, /,
           ' ', 'ENTER NEW VALUE (FORMAT I2) : ', /)

6550 FORMAT(' ', 'THE NUMBER OF VERTICAL SECTIONS IS = ', I2, /,
           ' ', 'ENTER NEW VALUE (FORMAT I2) : ', /)
6551 FORMAT(' ', 'ENTER THE VERTICAL SECTIONS (FORMAT I2) : ', /)

6560 FORMAT(' ', 'THE NUMBER OF HORIZONTAL SECTIONS IS = ', I2, /,
           ' ', 'ENTER NEW VALUE (FORMAT I2) : ', /)
6561 FORMAT(' ', 'ENTER THE HORIZONTAL SECTIONS (FORMAT I2) : ', /)

6900 FORMAT(' ', /, /, /, ' EXECUTION OF GRDGEN BEGINS ...', /, /)
6910 FORMAT(' ', /, /, /, ' EXECUTION OF GRDGEN INTERRUPTED...', /, /)

END

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APPENDIX B - SAMPLE SET OF CONAIR INPUT FILES - EXCERPTS

3	1	.252360E-11	.252360E-11	.162046E-06	1.000	
4	1	.360900E-10	.360900E-10	.231743E-05	1.000	
5	1	.347256E-09	.347256E-09	.222982E-04	1.000	
6	1	.877963E-12	.877963E-12	.563762E-07	1.000	
7	1	.284750E-12	.284750E-12	.182845E-07	1.000	
8	1	.219491E-13	.219491E-13	.140940E-08	1.000	
9	1	.711875E-14	.711875E-14	.457112E-09	1.000	
10	1	.354167E-09	.354167E-09	.227419E-04	1.000	
...						
605	1	.187266E-10	.187266E-10	.120248E-05	1.000	
606	1	.187266E-09	.187266E-09	.120248E-04	1.000	
607	1	.190100E-08	.190100E-08	.158000E-03	0.680	Zone 1 E. Window Top/Bottom Resistances
608	1	.574600E-08	.574600E-08	.366200E-03	0.680	Zone 1 Sill Resistances
609	3	.305500E-02	.305500E-02	1.431	0.500	Zone 1/Zone 2 Interior Door
		0.0001	2.0700	0.8000	0.6110	
610	1	.471700E-08	.471700E-08	.315200E-03	0.680	Zone 2 S. Window Top/Bottom Resistances
611	1	.182100E-07	.182100E-07	.879800E-03	0.680	Zone 2 E. Window Top/Bottom Resistances
612	1	.107600E-07	.107600E-07	.589800E-03	0.680	S. Exterior Door Top/Bottom Resistances
613	1	.147600E-08	.147600E-07	.749900E-03	0.680	N. Exterior Door Top/Bottom Resistances
614	8	.547900E-07	.547900E-07	.172600E-02	0.570	LAFSWs with Controlled Resistances
		0.0000	1.0000	0.0000	0.0000	
		0.0000	1.0000	1.884	0.500	
615	3	.474200E-02	.474200E-02	0.8900	0.6110	Zone 3 Entrance (Door)
		0.0001	2.4400	0.324	0.500	
616	3	.269700E-02	.269700E-02	0.7500	0.6110	Bedroom/Bathroom Interior Doors
		0.0001	2.0400	.203700E-03	0.680	
617	1	.265600E-08	.265600E-08	1.302	0.500	Zone 4 N. Window Top/Bottom Resistances
618	3	.262700E-02	.262700E-02	0.7300	0.6110	Zone 5/Zone 6 Passage (Door)
		0.0001	2.0600	.460100E-03	0.680	
619	1	.775900E-08	.775900E-08	.305800E-03	0.680	Zone 7 W. Window Top/Bottom Resistances
620	1	.453200E-08	.453200E-08			Zone 8 W. Window Top/Bottom Resistances
621	4	-.210009E-01				Zone 2/6 Constant Flow Intake (37 cfm)
622	4	-.324015E-01				Constant Flow Intake (57 cfm)
623	4	0.744034E-01				Fan Constant Flow Exhaust (131 cfm)
624	0					Door Two-Way Flow Null Element
...						
0	1	.00000	2	.00000	1	X-DIRECTION
0	2	.00000	10	.00000	2	Y-DIRECTION
0	3	.00000	82	.00000	3	Z-DIRECTION
0	4	.00000	3	.00000	4	X-DIRECTION
0	5	.00000	11	.00000	2	Y-DIRECTION
0	6	.00000	83	.00000	3	Z-DIRECTION
0	7	.00000	4	.00000	5	X-DIRECTION
0	8	.00000	12	.00000	6	Y-DIRECTION
0	9	.00000	84	.00000	7	Z-DIRECTION
0	10	.00000	5	.00000	5	X-DIRECTION
...						
1582	571	.00000	572	.00000	443	X-DIRECTION
1583	571	.00000	580	.00000	446	Y-DIRECTION
1584	571	.00000	649	.00000	509	TO CRACK BOT
1585	572	.00000	573	.00000	448	X-DIRECTION
1586	572	.00000	581	.00000	444	Y-DIRECTION
1587	573	.00000	574	.00000	449	X-DIRECTION
1588	573	.00000	582	.00000	450	Y-DIRECTION
1589	573	.00000	650	.00000	510	TO SEP BOT
1590	650	.00000	651	.00000	511	FROM SEP BOT
1591	574	.00000	575	.00000	452	X-DIRECTION
1592	574	.00000	583	.00000	453	Y-DIRECTION
1593	574	.00000	652	.00000	512	Z-DIRECTION
1594	575	.00000	576	.00000	9	X-DIRECTION
1595	575	.00000	584	.00000	8	Y-DIRECTION
1596	575	.00000	653	.00000	513	Z-DIRECTION
1597	576	.00000	585	.00000	8	Y-DIRECTION
1598	576	.00000	654	.00000	513	Z-DIRECTION
1599	577	.00000	578	.00000	439	X-DIRECTION
1600	577	.00000	586	.00000	456	Y-DIRECTION
1601	578	.00000	579	.00000	442	X-DIRECTION

0	0								
1602	578	.00000	587	.00000	456	.0	0	1	Y-DIRECTION
0	0								
1603	579	.00000	580	.00000	443	.0	0	1	X-DIRECTION
0	0								
1604	579	.00000	588	.00000	457	.0	0	1	Y-DIRECTION
0	0								
1605	580	.00000	581	.00000	443	.0	0	1	X-DIRECTION
0	0								
1606	580	.00000	589	.00000	458	.0	0	1	Y-DIRECTION
0	0								
1607	580	.00000	655	.00000	509	.0	0	1	TO CRACK BOT
0	0								
1608	581	.00000	582	.00000	448	.0	0	1	X-DIRECTION
0	0								
1609	581	.00000	590	.00000	457	.0	0	1	Y-DIRECTION
0	0								
1610	582	.00000	583	.00000	449	.0	0	1	X-DIRECTION
0	0								
1611	582	.00000	591	.00000	459	.0	0	1	Y-DIRECTION
0	0								
1612	582	.00000	656	.00000	510	.0	0	1	TO SEP BOT
0	0								
1613	656	.00000	657	.00000	511	.0	0	1	FROM SEP BOT
0	0								
1614	583	.00000	584	.00000	452	.0	0	1	X-DIRECTION
0	0								
1615	583	.00000	592	.00000	460	.0	0	1	Y-DIRECTION
0	0								
1616	583	.00000	658	.00000	512	.0	0	1	Z-DIRECTION
0	0								
1617	584	.00000	585	.00000	9	.0	0	1	X-DIRECTION
0	0								
1618	584	.00000	593	.00000	22	.0	0	1	Y-DIRECTION
0	0								
1619	584	.00000	659	.00000	513	.0	0	1	Z-DIRECTION
0	0								
1620	585	.00000	594	.00000	22	.0	0	1	Y-DIRECTION
0	0								
1621	585	.00000	660	.00000	513	.0	0	1	Z-DIRECTION
0	0								
1622	586	.00000	587	.00000	461	.0	0	1	X-DIRECTION
0	0								
1623	586	.00000	595	.00000	462	.0	0	1	Y-DIRECTION
0	0								
1624	587	.00000	588	.00000	464	.0	0	1	X-DIRECTION
0	0								
1625	587	.00000	596	.00000	462	.0	0	1	Y-DIRECTION
0	0								
1626	588	.00000	589	.00000	465	.0	0	1	X-DIRECTION
0	0								
1627	588	.00000	597	.00000	465	.0	0	1	Y-DIRECTION
0	0								
1628	589	.00000	590	.00000	465	.0	0	1	X-DIRECTION
0	0								
1629	589	.00000	598	.00000	467	.0	0	1	Y-DIRECTION
0	0								
1630	589	.00000	661	.00000	514	.0	0	1	TO CRACK BOT
0	0								
1631	590	.00000	591	.00000	469	.0	0	1	X-DIRECTION
0	0								
1632	590	.00000	599	.00000	465	.0	0	1	Y-DIRECTION
0	0								
1633	591	.00000	592	.00000	470	.0	0	1	X-DIRECTION
0	0								
1634	591	.00000	600	.00000	471	.0	0	1	Y-DIRECTION
0	0								
1635	591	.00000	662	.00000	515	.0	0	1	TO SEP BOT
0	0								
1636	662	.00000	663	.00000	516	.0	0	1	FROM SEP BOT
0	0								
1637	592	.00000	593	.00000	473	.0	0	1	X-DIRECTION
0	0								
1638	592	.00000	601	.00000	474	.0	0	1	Y-DIRECTION
0	0								
1639	592	.00000	664	.00000	517	.0	0	1	Z-DIRECTION
0	0								
1640	593	.00000	594	.00000	33	.0	0	1	X-DIRECTION
0	0								
1641	593	.00000	602	.00000	32	.0	0	1	Y-DIRECTION
0	0								
1642	593	.00000	665	.00000	518	.0	0	1	Z-DIRECTION
0	0								
1643	594	.00000	603	.00000	32	.0	0	1	Y-DIRECTION
0	0								
1644	594	.00000	666	.00000	518	.0	0	1	Z-DIRECTION
0	0								
1645	595	.00000	596	.00000	477	.0	0	1	X-DIRECTION
0	0								
1646	595	.00000	604	.00000	462	.0	0	1	Y-DIRECTION
0	0								
1647	595	.00000	667	.00000	519	.0	0	1	TO CRACK BOT
0	0								
1648	596	.00000	597	.00000	479	.0	0	1	X-DIRECTION
0	0								
1649	596	.00000	605	.00000	462	.0	0	1	Y-DIRECTION
0	0								
1650	596	.00000	668	.00000	519	.0	0	1	TO CRACK BOT
0	0								
1651	597	.00000	598	.00000	467	.0	0	1	X-DIRECTION
0	0								
1652	597	.00000	606	.00000	465	.0	0	1	Y-DIRECTION

0	0								
1653	597	.00000	669	.00000	514	.0	0	1	TO CRACK BOT
0	0								
1654	598	.00000	599	.00000	467	.0	0	1	X-DIRECTION
0	0								
1655	598	.00000	607	.00000	467	.0	0	1	Y-DIRECTION
0	0								
1656	598	.00000	670	.00000	520	.0	0	1	TO CRACK BOT
0	0								
1657	599	.00000	600	.00000	481	.0	0	1	X-DIRECTION
0	0								
1658	599	.00000	608	.00000	465	.0	0	1	Y-DIRECTION
0	0								
1659	600	.00000	601	.00000	482	.0	0	1	X-DIRECTION
0	0								
1660	600	.00000	609	.00000	471	.0	0	1	Y-DIRECTION
0	0								
1661	600	.00000	671	.00000	521	.0	0	1	TO SEP BOT
0	0								
1662	671	.00000	672	.00000	522	.0	0	1	FROM SEP BOT
0	0								
1663	601	.00000	602	.00000	484	.0	0	1	X-DIRECTION
0	0								
1664	601	.00000	610	.00000	474	.0	0	1	Y-DIRECTION
0	0								
1665	601	.00000	673	.00000	523	.0	0	1	Z-DIRECTION
0	0								
1666	602	.00000	603	.00000	46	.0	0	1	X-DIRECTION
0	0								
1667	602	.00000	611	.00000	32	.0	0	1	Y-DIRECTION
0	0								
1668	602	.00000	674	.00000	524	.0	0	1	Z-DIRECTION
0	0								
1669	603	.00000	612	.00000	32	.0	0	1	Y-DIRECTION
0	0								
1670	603	.00000	675	.00000	524	.0	0	1	Z-DIRECTION
0	0								
1671	604	.00000	605	.00000	461	.0	0	1	X-DIRECTION
0	0								
1672	604	.00000	613	.00000	487	.0	0	1	Y-DIRECTION
0	0								
1673	605	.00000	606	.00000	464	.0	0	1	X-DIRECTION
0	0								
1674	605	.00000	614	.00000	487	.0	0	1	Y-DIRECTION
0	0								
1675	606	.00000	607	.00000	465	.0	0	1	X-DIRECTION
0	0								
1676	606	.00000	615	.00000	469	.0	0	1	Y-DIRECTION
0	0								
1677	607	.00000	608	.00000	465	.0	0	1	X-DIRECTION
0	0								
1678	607	.00000	616	.00000	481	.0	0	1	Y-DIRECTION
0	0								
1679	608	.00000	609	.00000	469	.0	0	1	X-DIRECTION
0	0								
1680	608	.00000	617	.00000	469	.0	0	1	Y-DIRECTION
0	0								
1681	609	.00000	610	.00000	470	.0	0	1	X-DIRECTION
0	0								
1682	609	.00000	618	.00000	488	.0	0	1	Y-DIRECTION
0	0								
1683	609	.00000	676	.00000	515	.0	0	1	TO SEP BOT
0	0								
1684	676	.00000	677	.00000	516	.0	0	1	FROM SEP BOT
0	0								
1685	610	.00000	611	.00000	473	.0	0	1	X-DIRECTION
0	0								
1686	610	.00000	619	.00000	489	.0	0	1	Y-DIRECTION
0	0								
1687	610	.00000	678	.00000	517	.0	0	1	Z-DIRECTION
0	0								
1688	611	.00000	612	.00000	33	.0	0	1	X-DIRECTION
0	0								
1689	611	.00000	620	.00000	47	.0	0	1	Y-DIRECTION
0	0								
1690	611	.00000	679	.00000	518	.0	0	1	Z-DIRECTION
0	0								
1691	612	.00000	621	.00000	47	.0	0	1	Y-DIRECTION
0	0								
1692	612	.00000	680	.00000	518	.0	0	1	Z-DIRECTION
0	0								
1693	613	.00000	614	.00000	490	.0	0	1	X-DIRECTION
0	0								
1694	613	.00000	622	.00000	491	.0	0	1	Y-DIRECTION
0	0								
1695	613	.00000	681	.00000	525	.0	0	1	TO SEP BOT
0	0								
1696	681	.00000	682	.00000	526	.0	0	1	FROM SEP BOT
0	0								
1697	614	.00000	615	.00000	493	.0	0	1	X-DIRECTION
0	0								
1698	614	.00000	623	.00000	491	.0	0	1	Y-DIRECTION
0	0								
1699	614	.00000	683	.00000	525	.0	0	1	TO SEP BOT
0	0								
1700	683	.00000	684	.00000	526	.0	0	1	FROM SEP BOT
0	0								
1701	615	.00000	616	.00000	471	.0	0	1	X-DIRECTION
0	0								
1702	615	.00000	624	.00000	470	.0	0	1	Y-DIRECTION
0	0								
1703	615	.00000	685	.00000	515	.0	0	1	TO SEP BOT

1704	0	.0	.00000	685	.00000	516	.0	0	1	FROM SEP BOT
1705	0	.0	.00000	616	.00000	471	.0	0	1	X-DIRECTION
1706	0	.0	.00000	616	.00000	482	.0	0	1	Y-DIRECTION
1707	0	.0	.00000	616	.00000	521	.0	0	1	TO SEP BOT
1708	0	.0	.00000	687	.00000	522	.0	0	1	FROM SEP BOT
1709	0	.0	.00000	617	.00000	488	.0	0	1	X-DIRECTION
1710	0	.0	.00000	617	.00000	470	.0	0	1	Y-DIRECTION
1711	0	.0	.00000	617	.00000	515	.0	0	1	TO SEP BOT
1712	0	.0	.00000	689	.00000	516	.0	0	1	FROM SEP BOT
1713	0	.0	.00000	618	.00000	494	.0	0	1	X-DIRECTION
1714	0	.0	.00000	618	.00000	494	.0	0	1	Y-DIRECTION
1715	0	.0	.00000	618	.00000	527	.0	0	1	TO SEP BOT
1716	0	.0	.00000	691	.00000	528	.0	0	1	FROM SEP BOT
1717	0	.0	.00000	619	.00000	496	.0	0	1	X-DIRECTION
1718	0	.0	.00000	619	.00000	497	.0	0	1	Y-DIRECTION
1719	0	.0	.00000	619	.00000	529	.0	0	1	Z-DIRECTION
1791	0	.0	.00000	647	.00000	52	.0	0	1	X-DIRECTION
1792	0	.0	.00000	647	.00000	535	.0	0	1	Z-DIRECTION
1793	0	.0	.00000	648	.00000	535	.0	0	1	Z-DIRECTION
1794	0	.0	.00000	649	.00000	536	4.0	4	1	BASEMENT
1795	0	.0	.00000	651	.00000	537	.0	0	1	X-DIRECTION
1796	0	.0	.00000	651	.00000	538	.0	0	1	Y-DIRECTION
1797	0	.0	.00000	651	.00000	539	.0	0	1	Z-DIRECTION
1798	0	.0	.00000	652	.00000	540	.0	0	1	X-DIRECTION
1799	0	.0	.00000	652	.00000	541	.0	0	1	Y-DIRECTION
1800	0	.0	.00000	652	.00000	542	.0	0	1	Z-DIRECTION
1801	0	.0	.00000	653	.00000	543	.0	0	1	X-DIRECTION
1802	0	.0	.00000	653	.00000	544	.0	0	1	Y-DIRECTION
1803	0	.0	.00000	653	.00000	545	.0	0	1	Z-DIRECTION
1804	0	.0	.00000	654	.00000	544	.0	0	1	Y-DIRECTION
1805	0	.0	.00000	654	.00000	545	.0	0	1	Z-DIRECTION
1806	0	.0	.00000	655	.00000	536	4.0	4	1	BASEMENT
1807	0	.0	.00000	657	.00000	537	.0	0	1	X-DIRECTION
1808	0	.0	.00000	657	.00000	546	.0	0	1	Y-DIRECTION
1809	0	.0	.00000	657	.00000	539	.0	0	1	Z-DIRECTION
1810	0	.0	.00000	658	.00000	540	.0	0	1	X-DIRECTION
1811	0	.0	.00000	658	.00000	547	.0	0	1	Y-DIRECTION
1812	0	.0	.00000	658	.00000	542	.0	0	1	Z-DIRECTION
1813	0	.0	.00000	659	.00000	543	.0	0	1	X-DIRECTION
1814	0	.0	.00000	659	.00000	548	.0	0	1	Y-DIRECTION
1815	0	.0	.00000	659	.00000	545	.0	0	1	Z-DIRECTION
1816	0	.0	.00000	660	.00000	548	.0	0	1	Y-DIRECTION
1817	0	.0	.00000	660	.00000	545	.0	0	1	Z-DIRECTION
1818	0	.0	.00000	661	.00000	549	4.0	4	1	BASEMENT
1819	0	.0	.00000	663	.00000	550	.0	0	1	X-DIRECTION
1820	0	.0	.00000	663	.00000	551	.0	0	1	Y-DIRECTION
1821	0	.0	.00000	663	.00000	552	.0	0	1	Z-DIRECTION
1822	0	.0	.00000	664	.00000	553	.0	0	1	X-DIRECTION
1823	0	.0	.00000	664	.00000	554	.0	0	1	Y-DIRECTION

0	.0								
1824	.664	.00000	732	.00000	555	.0	0	1	Z-DIRECTION
0	.0								
1825	.665	.00000	666	.00000	556	.0	0	1	X-DIRECTION
0	.0								
1826	.665	.00000	674	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1827	.665	.00000	733	.00000	558	.0	0	1	Z-DIRECTION
0	.0								
1828	.666	.00000	675	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1829	.666	.00000	734	.00000	558	.0	0	1	Z-DIRECTION
0	.0								
1830	.667	.00000	779	.00000	559	4.0	4	1	BASEMENT
0	.0								
1831	.668	.00000	779	.00000	559	4.0	4	1	BASEMENT
0	.0								
1832	.669	.00000	779	.00000	549	4.0	4	1	BASEMENT
0	.0								
1833	.670	.00000	779	.00000	560	4.0	4	1	BASEMENT
0	.0								
1834	.672	.00000	673	.00000	561	.0	0	1	X-DIRECTION
0	.0								
1835	.672	.00000	677	.00000	551	.0	0	1	Y-DIRECTION
0	.0								
1836	.672	.00000	735	.00000	562	.0	0	1	Z-DIRECTION
0	.0								
1837	.673	.00000	674	.00000	563	.0	0	1	X-DIRECTION
0	.0								
1838	.673	.00000	678	.00000	554	.0	0	1	Y-DIRECTION
0	.0								
1839	.673	.00000	736	.00000	564	.0	0	1	Z-DIRECTION
0	.0								
.	.								
.	.								
.	.								
1951	.723	.00000	724	.00000	537	.0	0	1	X-DIRECTION
0	.0								
1952	.723	.00000	727	.00000	538	.0	0	1	Y-DIRECTION
0	.0								
1953	.723	.00000	780	.00000	511	4.0	4	1	SURFACE
0	.0								
1954	.724	.00000	725	.00000	540	.0	0	1	X-DIRECTION
0	.0								
1955	.724	.00000	728	.00000	541	.0	0	1	Y-DIRECTION
0	.0								
1956	.724	.00000	780	.00000	595	4.0	4	1	SURFACE
0	.0								
1957	.725	.00000	726	.00000	543	.0	0	1	X-DIRECTION
0	.0								
1958	.725	.00000	729	.00000	544	.0	0	1	Y-DIRECTION
0	.0								
1959	.725	.00000	780	.00000	596	4.0	4	1	SURFACE
0	.0								
1960	.726	.00000	730	.00000	544	.0	0	1	Y-DIRECTION
0	.0								
1961	.726	.00000	780	.00000	596	4.0	4	1	SURFACE
0	.0								
1962	.727	.00000	728	.00000	537	.0	0	1	X-DIRECTION
0	.0								
1963	.727	.00000	731	.00000	546	.0	0	1	Y-DIRECTION
0	.0								
1964	.727	.00000	780	.00000	511	4.0	4	1	SURFACE
0	.0								
1965	.728	.00000	729	.00000	540	.0	0	1	X-DIRECTION
0	.0								
1966	.728	.00000	732	.00000	547	.0	0	1	Y-DIRECTION
0	.0								
1967	.728	.00000	780	.00000	595	4.0	4	1	SURFACE
0	.0								
1968	.729	.00000	730	.00000	543	.0	0	1	X-DIRECTION
0	.0								
1969	.729	.00000	733	.00000	548	.0	0	1	Y-DIRECTION
0	.0								
1970	.729	.00000	780	.00000	596	4.0	4	1	SURFACE
0	.0								
1971	.730	.00000	734	.00000	548	.0	0	1	Y-DIRECTION
0	.0								
1972	.730	.00000	780	.00000	596	4.0	4	1	SURFACE
0	.0								
1973	.731	.00000	732	.00000	550	.0	0	1	X-DIRECTION
0	.0								
1974	.731	.00000	735	.00000	551	.0	0	1	Y-DIRECTION
0	.0								
1975	.731	.00000	780	.00000	516	4.0	4	1	SURFACE
0	.0								
1976	.732	.00000	733	.00000	553	.0	0	1	X-DIRECTION
0	.0								
1977	.732	.00000	736	.00000	554	.0	0	1	Y-DIRECTION
0	.0								
1978	.732	.00000	780	.00000	597	4.0	4	1	SURFACE
0	.0								
1979	.733	.00000	734	.00000	556	.0	0	1	X-DIRECTION
0	.0								
1980	.733	.00000	737	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1981	.733	.00000	780	.00000	598	4.0	4	1	SURFACE
0	.0								
1982	.734	.00000	738	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1983	.734	.00000	780	.00000	598	4.0	4	1	SURFACE

0	.0								
1984	735	.00000	736	.00000	561	.0	0	1	X-DIRECTION
0	.0								
1985	735	.00000	739	.00000	551	.0	0	1	Y-DIRECTION
0	.0								
1986	735	.00000	780	.00000	522	4.0	4	1	SURFACE
0	.0								
1987	736	.00000	737	.00000	563	.0	0	1	X-DIRECTION
0	.0								
1988	736	.00000	740	.00000	554	.0	0	1	Y-DIRECTION
0	.0								
1989	736	.00000	780	.00000	599	4.0	4	1	SURFACE
0	.0								
1990	737	.00000	738	.00000	565	.0	0	1	X-DIRECTION
0	.0								
1991	737	.00000	741	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1992	737	.00000	780	.00000	600	4.0	4	1	SURFACE
0	.0								
1993	738	.00000	742	.00000	557	.0	0	1	Y-DIRECTION
0	.0								
1994	738	.00000	780	.00000	600	4.0	4	1	SURFACE
0	.0								
1995	739	.00000	740	.00000	550	.0	0	1	X-DIRECTION
0	.0								
1996	739	.00000	748	.00000	567	.0	0	1	Y-DIRECTION
0	.0								
1997	739	.00000	780	.00000	516	4.0	4	1	SURFACE
0	.0								
1998	740	.00000	741	.00000	553	.0	0	1	X-DIRECTION
0	.0								
1999	740	.00000	749	.00000	568	.0	0	1	Y-DIRECTION
0	.0								
2000	740	.00000	780	.00000	597	4.0	4	1	SURFACE
0	.0								
2001	741	.00000	742	.00000	556	.0	0	1	X-DIRECTION
0	.0								
2002	741	.00000	750	.00000	568	.0	0	1	Y-DIRECTION
0	.0								
2003	741	.00000	780	.00000	598	4.0	4	1	SURFACE
0	.0								
2004	742	.00000	751	.00000	568	.0	0	1	Y-DIRECTION
0	.0								
2005	742	.00000	780	.00000	598	4.0	4	1	SURFACE
0	.0								
2006	743	.00000	744	.00000	569	.0	0	1	X-DIRECTION
0	.0								
2007	743	.00000	752	.00000	570	.0	0	1	Y-DIRECTION
0	.0								
2008	743	.00000	780	.00000	526	4.0	4	1	SURFACE
0	.0								
2009	744	.00000	745	.00000	572	.0	0	1	X-DIRECTION
0	.0								
2010	744	.00000	753	.00000	570	.0	0	1	Y-DIRECTION
0	.0								
2011	744	.00000	780	.00000	526	4.0	4	1	SURFACE
0	.0								
2012	745	.00000	746	.00000	551	.0	0	1	X-DIRECTION
0	.0								
2013	745	.00000	754	.00000	550	.0	0	1	Y-DIRECTION
0	.0								
2014	745	.00000	780	.00000	516	4.0	4	1	SURFACE
0	.0								
2015	746	.00000	747	.00000	551	.0	0	1	X-DIRECTION
0	.0								
2016	746	.00000	755	.00000	561	.0	0	1	Y-DIRECTION
0	.0								
2017	746	.00000	780	.00000	522	4.0	4	1	SURFACE
0	.0								
2018	747	.00000	748	.00000	573	.0	0	1	X-DIRECTION
0	.0								
2019	747	.00000	756	.00000	550	.0	0	1	Y-DIRECTION
0	.0								
2020	747	.00000	780	.00000	516	4.0	4	1	SURFACE
0	.0								
2021	748	.00000	749	.00000	574	.0	0	1	X-DIRECTION
0	.0								
2022	748	.00000	757	.00000	574	.0	0	1	Y-DIRECTION
0	.0								
2023	748	.00000	780	.00000	528	4.0	4	1	SURFACE
0	.0								
2024	749	.00000	750	.00000	576	.0	0	1	X-DIRECTION
0	.0								
2025	749	.00000	758	.00000	577	.0	0	1	Y-DIRECTION
0	.0								
2026	749	.00000	780	.00000	601	4.0	4	1	SURFACE
0	.0								
2027	750	.00000	751	.00000	579	.0	0	1	X-DIRECTION
0	.0								
2028	750	.00000	759	.00000	577	.0	0	1	Y-DIRECTION
0	.0								
2029	750	.00000	780	.00000	602	4.0	4	1	SURFACE
0	.0								
2030	751	.00000	760	.00000	577	.0	0	1	Y-DIRECTION
0	.0								
2031	751	.00000	780	.00000	602	4.0	4	1	SURFACE
0	.0								
2032	752	.00000	753	.00000	581	.0	0	1	X-DIRECTION
0	.0								
2033	752	.00000	761	.00000	582	.0	0	1	Y-DIRECTION
0	.0								
2034	752	.00000	780	.00000	603	4.0	4	1	SURFACE

2035	.0	.0	.00000	754	.00000	584	.0	0	1	X-DIRECTION
2036	.0	.0	.00000	762	.00000	582	.0	0	1	Y-DIRECTION
2037	.0	.0	.00000	780	.00000	603	4.0	4	1	SURFACE
2038	.0	.0	.00000	755	.00000	554	.0	0	1	X-DIRECTION
2039	.0	.0	.00000	763	.00000	553	.0	0	1	Y-DIRECTION
2040	.0	.0	.00000	780	.00000	597	4.0	4	1	SURFACE
2041	.0	.0	.00000	756	.00000	554	.0	0	1	X-DIRECTION
2042	.0	.0	.00000	764	.00000	563	.0	0	1	Y-DIRECTION
2043	.0	.0	.00000	780	.00000	599	4.0	4	1	SURFACE
2044	.0	.0	.00000	757	.00000	568	.0	0	1	X-DIRECTION
2045	.0	.0	.00000	765	.00000	553	.0	0	1	Y-DIRECTION
2046	.0	.0	.00000	780	.00000	597	4.0	4	1	SURFACE
2047	.0	.0	.00000	758	.00000	577	.0	0	1	X-DIRECTION
2048	.0	.0	.00000	766	.00000	576	.0	0	1	Y-DIRECTION
2049	.0	.0	.00000	780	.00000	601	4.0	4	1	SURFACE
2050	.0	.0	.00000	759	.00000	585	.0	0	1	X-DIRECTION
2051	.0	.0	.00000	767	.00000	585	.0	0	1	Y-DIRECTION
2052	.0	.0	.00000	780	.00000	604	4.0	4	1	SURFACE
2053	.0	.0	.00000	760	.00000	587	.0	0	1	X-DIRECTION
2054	.0	.0	.00000	768	.00000	588	.0	0	1	Y-DIRECTION
2055	.0	.0	.00000	780	.00000	605	4.0	4	1	SURFACE
2056	.0	.0	.00000	769	.00000	588	.0	0	1	Y-DIRECTION
2057	.0	.0	.00000	780	.00000	605	4.0	4	1	SURFACE
2058	.0	.0	.00000	762	.00000	590	.0	0	1	X-DIRECTION
2059	.0	.0	.00000	770	.00000	591	.0	0	1	Y-DIRECTION
2060	.0	.0	.00000	780	.00000	603	4.0	4	1	SURFACE
2061	.0	.0	.00000	763	.00000	592	.0	0	1	X-DIRECTION
2062	.0	.0	.00000	771	.00000	591	.0	0	1	Y-DIRECTION
2063	.0	.0	.00000	780	.00000	603	4.0	4	1	SURFACE
2064	.0	.0	.00000	764	.00000	557	.0	0	1	X-DIRECTION
2065	.0	.0	.00000	772	.00000	556	.0	0	1	Y-DIRECTION
2066	.0	.0	.00000	780	.00000	598	4.0	4	1	SURFACE
2067	.0	.0	.00000	765	.00000	557	.0	0	1	X-DIRECTION
2068	.0	.0	.00000	773	.00000	565	.0	0	1	Y-DIRECTION
2069	.0	.0	.00000	780	.00000	600	4.0	4	1	SURFACE
2070	.0	.0	.00000	766	.00000	568	.0	0	1	X-DIRECTION
2071	.0	.0	.00000	774	.00000	556	.0	0	1	Y-DIRECTION
2072	.0	.0	.00000	780	.00000	598	4.0	4	1	SURFACE
2073	.0	.0	.00000	767	.00000	577	.0	0	1	X-DIRECTION
2074	.0	.0	.00000	775	.00000	579	.0	0	1	Y-DIRECTION
2075	.0	.0	.00000	780	.00000	602	4.0	4	1	SURFACE
2076	.0	.0	.00000	768	.00000	588	.0	0	1	X-DIRECTION
2077	.0	.0	.00000	776	.00000	587	.0	0	1	Y-DIRECTION
2078	.0	.0	.00000	780	.00000	605	4.0	4	1	SURFACE
2079	.0	.0	.00000	769	.00000	593	.0	0	1	X-DIRECTION
2080	.0	.0	.00000	777	.00000	593	.0	0	1	Y-DIRECTION
2081	.0	.0	.00000	780	.00000	606	4.0	4	1	SURFACE
2082	.0	.0	.00000	778	.00000	593	.0	0	1	Y-DIRECTION
2083	.0	.0	.00000	780	.00000	606	4.0	4	1	SURFACE
2084	.0	.0	.00000	771	.00000	590	.0	0	1	X-DIRECTION
2085	.0	.0	.00000	780	.00000	603	4.0	4	1	SURFACE

2086	0	0	771	.00000	772	.00000	592	.0	0	1	X-DIRECTION
2087	0	0	771	.00000	780	.00000	603	4.0	4	1	SURFACE
2088	0	0	772	.00000	773	.00000	557	.0	0	1	X-DIRECTION
2089	0	0	772	.00000	780	.00000	598	4.0	4	1	SURFACE
2090	0	0	773	.00000	774	.00000	557	.0	0	1	X-DIRECTION
2091	0	0	773	.00000	780	.00000	600	4.0	4	1	SURFACE
2092	0	0	774	.00000	775	.00000	568	.0	0	1	X-DIRECTION
2093	0	0	774	.00000	780	.00000	598	4.0	4	1	SURFACE
2094	0	0	775	.00000	776	.00000	577	.0	0	1	X-DIRECTION
2095	0	0	775	.00000	780	.00000	602	4.0	4	1	SURFACE
2096	0	0	776	.00000	777	.00000	588	.0	0	1	X-DIRECTION
2097	0	0	776	.00000	780	.00000	605	4.0	4	1	SURFACE
2098	0	0	777	.00000	778	.00000	593	.0	0	1	X-DIRECTION
2099	0	0	777	.00000	780	.00000	606	4.0	4	1	SURFACE
2100	0	0	778	.00000	780	.00000	606	4.0	4	1	SURFACE
2101	0	0.00	780	1.00000	779	1.00000	607	90.0	1	1	Lower E. Window Top
2102	0	0.00	780	0.06000	779	0.06000	607	90.0	1	1	Lower E. Window Bottom
2103	0	0.00	780	1.00000	779	1.00000	608	0.0	1	1	N. Sill Crack
2104	0	0.00	780	1.00000	779	1.00000	608	90.0	1	1	E. Sill Crack
2105	0	0.00	780	1.00000	779	1.00000	608	180.0	1	1	S. Sill Crack
2106	0	0.00	780	1.00000	779	1.00000	608	270.0	1	1	W. Sill Crack
2107	0	0.00	779	-1.26000	781	-3.73000	609	0.0	0	1	Basement Door
2108	0	0.00	779	-1.26000	781	-3.73000	624	0.0	0	1	Basement Door
2109	0	0.00	780	3.37000	781	0.89000	610	180.0	1	1	S. Window Top
2110	0	0.00	780	2.53000	781	0.05000	610	180.0	1	1	S. Window Bottom
2111	0	0.00	780	3.37000	781	0.89000	611	90.0	1	1	Upper E. Window Top
2112	0	0.00	780	1.54000	781	-0.94000	611	90.0	1	1	Upper E. Window Bottom
2113	0	0.00	780	2.54000	781	0.06000	612	180.0	1	1	S. Exterior Door Top
2114	0	0.00	780	0.46000	781	-2.02000	612	180.0	1	1	S. Exterior Door Bottom
2115	0	0.00	780	2.93000	781	0.46000	613	0.0	1	1	N. Exterior Door Top
2116	0	0.00	780	0.85000	781	-1.63000	613	0.0	1	1	N. Exterior Door Bottom
2117	0	1.00	780	1.54000	781	0.84000	614	90.0	1	1	N.E. LAFSW
2118	0	1.00	780	1.54000	781	0.84000	614	90.0	1	1	S.E. LAFSW
2119	0	0.00	781	-1.24000	782	-1.24000	615	0.0	0	1	Hall Entrance
2120	0	0.00	781	-1.24000	782	-1.24000	624	0.0	0	1	Hall Entrance
2121	0	0.00	782	-1.24000	783	-1.24000	616	0.0	0	1	Bedroom 3 Door
2122	0	0.00	782	-1.24000	783	-1.24000	624	0.0	0	1	Bedroom 3 Door
2123	0	0.00	780	3.37000	783	0.89000	617	0.0	1	1	N. Window Top
2124	0	0.00	780	2.53000	783	0.05000	617	0.0	1	1	N. Window Bottom
2125	0	0.00	780	2.53000	783	0.84000	614	0.0	1	1	N. LAFSW
2126	0	0.68	782	-1.24000	784	-1.24000	616	0.0	0	1	Bathroom Door (Sink)
2127	0	0.00	782	-1.24000	784	-1.24000	624	0.0	0	1	Bathroom Door (Sink)
2128	0	0.00	784	-1.24000	785	-1.24000	618	0.0	0	1	Bathroom Door (Tub)
2129	0	0.00	784	-1.24000	785	-1.24000	624	0.0	0	1	Bathroom Door (Tub)
2130	0	0.00	782	-1.24000	786	-1.24000	616	0.0	0	1	Master Bedroom Door
2131	0	0.00	782	-1.24000	786	-1.24000	624	0.0	0	1	Master Bedroom Door
2132	0	0.00	780	3.29000	786	0.81000	619	270.0	1	1	S.W. Window Top
2133	0	0.00	780	2.48000	786	0.00000	619	270.0	1	1	S.W. Window Bottom
2134	0	0.00	780	2.48000	786	0.76000	614	270.0	1	1	S.W. LAFSW
2135	0	0.68	780	2.48000	786	0.76000	614	270.0	1	1	S.W. LAFSW
2136	0	0.68	782	-1.24000	787	-1.24000	616	0.0	0	1	Bedroom 2 Door

FILE: CASE01C.INP

SAMPLE CONAIR CONTAMINANT DISPERSAL INPUT FILE

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* CONTAMINANT INPUT FILE - CASE 1
* Basement Suction System, 1 mm separation, no soil air barrier.
* 114 Payment, Winnipeg, Manitoba
* Units: nuclei/g, m, hr
* Airflow = [g/hr]
* Concentration = [nuclei/g·Air]
* Generation Rate = [nuclei/hr]

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FLOWSYS

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N= 787 S=1 ID=URN TP=A
780 BC= C

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<
1 V=.158989774E+05 < 1 1 1
2 V=.158989774E+05 < 2 1 1
3 V=.179396078E+04 < 3 1 1
4 V=.448490196E+02 < 4 1 1
5 V=.179396078E+04 < 5 1 1
6 V=.896980434E+01 < 6 1 1
7 V=.448490196E+04 < 7 1 1
8 V=.448490196E+05 < 8 1 1
9 V=.448490196E+05 < 9 1 1
10 V=.158989774E+05 < 1 2 1

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...
641 V=.279174319E+02 < 2 9 8
642 V=.315006283E+01 < 3 9 8
643 V=.787515708E-01 < 4 9 8
644 V=.315006283E+01 < 5 9 8
645 V=.157503149E-01 < 6 9 8
646 V=.787515708E-01 < 7 9 8
647 V=.787515708E-02 < 8 9 8
648 V=.787515708E-02 < 9 9 8
649 V=.179396078E-04 < CRACK BOT
650 V=.358792173E-05 < WALSEP BOT
651 V=.239493776E+01 < WALL SID-X
652 V=.598734412E+03 < 7 1 9
653 V=.598734412E+04 < 8 1 9
654 V=.598734412E+04 < 9 1 9
655 V=.179396078E-04 < CRACK BOT
656 V=.358792173E-05 < WALSEP BOT
657 V=.239493776E+01 < WALL SID-X
658 V=.598734412E+03 < 7 2 9
659 V=.598734412E+04 < 8 2 9
660 V=.598734412E+04 < 9 2 9
661 V=.126002513E-05 < CRACK BOT
662 V=.252005038E-06 < WALSEP BOT
663 V=.168213363E+00 < WALL SID-X
664 V=.420533388E-02 < 7 3 9
665 V=.420533388E+03 < 8 3 9
666 V=.420533388E+03 < 9 3 9
667 V=.111669727E-04 < CRACK BOT
668 V=.111669727E-04 < CRACK BOT
669 V=.126002513E-05 < CRACK BOT
670 V=.315006283E-07 < CRACK BOT
671 V=.630012595E-08 < WALSEP BOT
672 V=.420533408E-02 < WALL SID-X
673 V=.105133347E+01 < 7 4 9
674 V=.105133347E+02 < 8 4 9
675 V=.105133347E+02 < 9 4 9
676 V=.252005038E-06 < WALSEP BOT
677 V=.168213363E+00 < WALL SID-X
678 V=.420533388E+02 < 7 5 9
679 V=.420533388E+03 < 8 5 9
680 V=.420533388E+03 < 9 5 9
681 V=.223339465E-05 < WALSEP BOT
682 V=.149079093E+01 < WALL SID-Y
683 V=.223339465E-05 < WALSEP BOT
684 V=.149079093E+01 < WALL SID-Y
685 V=.252005038E-06 < WALSEP BOT
686 V=.168213363E+00 < WALL SID-Y
687 V=.630012595E-08 < WALSEP BOT
688 V=.420533408E-02 < WALL SID-Y
689 V=.252005038E-06 < WALSEP BOT
690 V=.168213363E+00 < WALL SID-Y
691 V=.126002525E-08 < WALSEP BOT
692 V=.841066856E-03 < WALL SID-XY
693 V=.210266704E+00 < 7 6 9
694 V=.210266704E+01 < 8 6 9
695 V=.210266704E+01 < 9 6 9
696 V=.372697715E+03 < 1 7 9
697 V=.372697715E+03 < 2 7 9
698 V=.420533388E+02 < 3 7 9
699 V=.105133347E+01 < 4 7 9
700 V=.420533388E+02 < 5 7 9

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720 V=.105133347E+04 < 7 9 9
721 V=.105133347E+05 < 8 9 9
722 V=.105133347E+05 < 9 9 9
723 V=.239493776E+01 < WALL SID-X
724 V=.598734412E+03 < 7 1 10
725 V=.598734412E+04 < 8 1 10
726 V=.598734412E+04 < 9 1 10

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727 V=.239493776E+01 < WALL SID-X
728 V=.598734412E+03 < 7 2 10
729 V=.598734412E+04 < 8 2 10
730 V=.598734412E+04 < 9 2 10
731 V=.168213363E+00 < WALL SID-X
732 V=.420533388E+02 < 7 3 10
733 V=.420533388E+03 < 8 3 10
734 V=.420533388E+03 < 9 3 10
735 V=.420533408E-02 < WALL SID-X
736 V=.105133347E+01 < 7 4 10
737 V=.105133347E+02 < 8 4 10
738 V=.105133347E+02 < 9 4 10
739 V=.168213363E+00 < WALL SID-X
740 V=.420533388E+02 < 7 5 10
741 V=.420533388E+03 < 8 5 10
742 V=.420533388E+03 < 9 5 10
743 V=.149079093E+01 < WALL SID-Y
744 V=.149079093E+01 < WALL SID-Y
745 V=.168213363E+00 < WALL SID-Y
746 V=.420533408E-02 < WALL SID-Y
747 V=.168213363E+00 < WALL SID-Y
748 V=.841066856E-03 < WALL SID-XY
749 V=.210266704E+00 < 7 6 10
750 V=.210266704E+01 < 8 6 10
751 V=.210266704E+01 < 9 6 10
752 V=.372697715E+03 < 1 7 10
753 V=.372697715E+03 < 2 7 10
754 V=.420533388E+02 < 3 7 10
755 V=.105133347E+01 < 4 7 10

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777 V=.105133347E+05 < 8 9 10
778 V=.105133347E+05 < 9 9 10
779 V=.249053969E+06 < BASEMENT
780 V=.141396372E+12 < OUTDOORS - SOIL SURFACE
781 V=.162561.11 < Kitchen/Dining/Living Room (135.07 m^3 @ 20.15 C)
782 V=.9387.55 < Hallway (7.80 m^3 @ 20.15 C)
783 V=.23480.92 < Bedroom 3 (19.51 m^3 @ 20.15 C)
784 V=.9544.01 < Bathroom (Sink) (7.93 m^3 @ 20.15 C)
785 V=.7728.68 < Bathroom (Tub) (6.42 m^3 @ 20.15 C)
786 V=.47804.30 < Master Bedroom (39.72 m^3 @ 20.15 C)
787 V=.27921.95 < Bedroom 2 (23.20 m^3 @ 20.15 C)

END
FLOWELEM
1 I= 1, 2 T=CNDF M=.17939608E+05 L=.17725000E+01 D=.12600000E-03
2 I= 1, 10 T=CNDF M=.11166973E+05 L=.28475000E+01 D=.12600000E-03
3 I= 1, 82 T=CNDF M=.63595910E+04 L=.50000000E+01 D=.12600000E-03
4 I= 2, 3 T=CNDF M=.17939608E+05 L=.98625000E+00 D=.12600000E-03
5 I= 2, 11 T=CNDF M=.11166973E+05 L=.28475000E+01 D=.12600000E-03
6 I= 2, 83 T=CNDF M=.63595910E+04 L=.50000000E+01 D=.12600000E-03
7 I= 3, 4 T=CNDF M=.17939608E+05 L=.10250000E+00 D=.12600000E-03
8 I= 3, 12 T=CNDF M=.12600251E+04 L=.28475000E+01 D=.12600000E-03
9 I= 3, 84 T=CNDF M=.71758431E+03 L=.50000000E+01 D=.12600000E-03
10 I= 4, 5 T=CNDF M=.17939608E+05 L=.10250000E+00 D=.12600000E-03

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2097 I=776, 780 T=CNDF M=.31500628E+04 L=.33375000E+00 D=.12600000E-03
2098 I=777, 778 T=CNDF M=.42053339E+04 L=.50000000E+01 D=.12600000E-03
2099 I=777, 780 T=CNDF M=.31500628E+05 L=.33375000E+00 D=.12600000E-03
2100 I=778, 780 T=CNDF M=.31500628E+05 L=.33375000E+00 D=.12600000E-03
2101 I= 780, 779 T=SIMP Lower E. Window Top
2102 I= 780, 779 T=SIMP Lower E. Window Bottom
2103 I= 780, 779 T=SIMP N. Sill Crack
2104 I= 780, 779 T=SIMP E. Sill Crack
2105 I= 780, 779 T=SIMP S. Sill Crack
2106 I= 780, 779 T=SIMP W. Sill Crack
2107 I= 779, 781 T=SIMP Basement Door
2108 I= 779, 781 T=SIMP Basement Door
2109 I= 780, 781 T=SIMP S. Window Top
2110 I= 780, 781 T=SIMP S. Window Bottom
2111 I= 780, 781 T=SIMP Upper E. Window Top
2112 I= 780, 781 T=SIMP Upper E. Window Bottom
2113 I= 780, 781 T=SIMP S. Exterior Door Top
2114 I= 780, 781 T=SIMP S. Exterior Door Bottom
2115 I= 780, 781 T=SIMP N. Exterior Door Top
2116 I= 780, 781 T=SIMP N. Exterior Door Bottom
2117 I= 780, 781 T=SIMP N.E. LAFSW
2118 I= 780, 781 T=SIMP S.E. LAFSW
2119 I= 781, 782 T=SIMP Hall Entrance
2120 I= 781, 782 T=SIMP Hall Entrance
2121 I= 782, 783 T=SIMP Bedroom 3 Door
2122 I= 782, 783 T=SIMP Bedroom 3 Door
2123 I= 780, 783 T=SIMP N. Window Top
2124 I= 780, 783 T=SIMP N. Window Bottom
2125 I= 780, 783 T=SIMP N. LAFSW
2126 I= 782, 784 T=SIMP Bathroom Door (Sink)
2127 I= 782, 784 T=SIMP Bathroom Door (Sink)
2128 I= 784, 785 T=SIMP Bathroom Door (Tub)
2129 I= 784, 785 T=SIMP Bathroom Door (Tub)
2130 I= 782, 786 T=SIMP Master Bedroom Door
2131 I= 782, 786 T=SIMP Master Bedroom Door
2132 I= 780, 786 T=SIMP S.W. Window Top
2133 I= 780, 786 T=SIMP S.W. Window Bottom
2134 I= 780, 786 T=SIMP S.W. LAFSW
2135 I= 780, 786 T=SIMP S.W. LAFSW
2136 I= 782, 787 T=SIMP Bedroom 2 Door
2137 I= 782, 787 T=SIMP Bedroom 2 Door
2138 I= 780, 787 T=SIMP N.W. Window Top

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2139 I= 780, 787 T=SIMP N.W. Window Bottom
2140 I= 780, 787 T=SIMP N.W. LAFSW
2141 I= 780, 781 T=SIMP Kitchen Exhausts
2142 I= 780, 779 T=SIMP Basement Exhaust
2143 I= 780, 785 T=SIMP Bathroom Exhausts
END
KINELEM
K=1 < Decay constant: Rn [h-1]
< .0075528 < Loureiro, p.268
< 1 I= 1 K=1
787 I= 787 GEN=1 K=1
END
STEADY
1 CG=.467659086621E+10
2 CG=.467659086621E+10
3 CG=.527683031448E+09
4 CG=.131920757862E+08
5 CG=.527683031448E+09
6 CG=.263841528256E+07
7 CG=.131920757862E+10
8 CG=.131920757862E+11
9 CG=.131920757862E+11
10 CG=.467659086621E+10
.
.
.
770 CG=.1096268447113E+10
771 CG=.1096268447113E+10
772 CG=.123697427038E+09
773 CG=.309243567596E+07
774 CG=.123697427038E+09
775 CG=.618487164568E+06
776 CG=.309243567596E+09
777 CG=.309243567596E+10
778 CG=.309243567596E+10
780 CG=2939 < Outdoor Rn222 Concentration (Constant 0.2 pCi/L)
END
RETURN

```


APPENDIX C - POST-PROCESSOR PROGRAM LISTING

FILE: PST.BAT

```
SET 18=POST15.
CALL GET CASE15
POST
CALL DUMP CASE15
```

FILE: GET.BAT

```
COPY ..\..\RUNS\%1\%1A.INP
COPY ..\..\RUNS\%1\%1A.OUT
COPY ..\..\RUNS\%1\%1C.STD
```

FILE: DUMP.BAT

```
COPY %17.SUM ..\..\RUNS\%1\*.SUM
COPY %17.PRS ..\..\RUNS\%1\*.PRS
COPY %17.VPC ..\..\RUNS\%1\*.VPC
DEL %17.*
```

FILE: POST.FOR

```
C      MAIN PROGRAM
      CHARACTER*20 FLNOUT
      CALL GDAT(FLNOUT)
      CALL VPIC1
      CALL VPIC2(FLNOUT)
      END
C$INCLUDE GDAT.FOR
C$INCLUDE VPIC1.FOR
C$INCLUDE VPIC2.FOR
```

FILE: GDAT.FOR

```

SUBROUTINE GDAT(FLNOUT)
COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
INTEGER U8,U9,U10,NSBSMT,NSOUT

COMMON /AF1/ FIRST,CTLEnd
LOGICAL FIRST,CTLEnd

COMMON /LST/ LIST
INTEGER LIST,NUE
INTEGER JUNK,JDEF,JMIN,JMAX

CHARACTER*20 FILENM, FLNMIN, FLNOUT

C          Open files.
U8 = 0
U9 = 1
U10 = 2

JUNK = 999
NUE = 1
LIST = 0
FIRST = .TRUE.
CTLEnd = .FALSE.
1111 CONTINUE
CALL OPENFL(U8,FILENM,'SEQUENTIAL',IOS,'FORMATTED','OLD',
-      ' Enter AIRFLOW INPUT file name (*A.INP): ',
-      NUE)
FLNMIN = FILENM
JDEF = LIST
JMIN = 0
JMAX = 4
CALL INTGET(' Enter OUTPUT CONTROL parameter',
-      JDEF,JMIN,JMAX,JUNK,LIST)
IF (LIST.GE.1) THEN
CALL OPENFL(U9,FILENM,'SEQUENTIAL',IOS,'FORMATTED','NEW',
-      ' Enter INTERMEDIATE DATA file name (*A.ITD): ',
-      NUE)
write(U9,900) FLNMIN
write(U9,901) FILENM
END IF
CALL GTDAT1

WRITE(*,*)
CALL OPENFL(U10,FILENM,'SEQUENTIAL',IOS,'FORMATTED','OLD',
-      ' Enter AIRFLOW OUTPUT file name (*A.OUT): ',
-      NUE)
JDEF = 779
JMIN = 1
JMAX = 25000
CALL INTGET(' Enter BASEMENT NODE number',
-      JDEF,JMIN,JMAX,JUNK,NSBSMT)
JDEF = 780
JMIN = 1
JMAX = 25000
CALL INTGET(' Enter OUTDOOR NODE number',
-      JDEF,JMIN,JMAX,JUNK,NSOUT)
WRITE(*,*)
CALL GTDAT2(FILENM,FLNOUT)

Close(3)
If (LIST.GE.1) CLOSE(U9)
CLOSE(U8)
CLOSE(U10)
FIRST = .TRUE.
WRITE(*,*)
C      If (NUE.GT.0) Goto 1111
900 FORMAT(' INPUT DATA FILE : ',A20,/)
901 FORMAT(' OUTPUT DATA FILE: ',A20,/)

RETURN
End

C----- GTDAT1
SUBROUTINE GTDAT1
DESCRIPTION *****
Read the airflow INPUT data file.
DECLARATIONS *****
NAFF - Number of airflow element parameters stored.
Airflow element data
INTEGER MAXAFE
PARAMETER (MAXAFE = 2200)

COMMON /AFEDAT/ AFELNK(2,MAXAFE),AFEHT(2,MAXAFE),AFEPTR(MAXAFE),
-      AFECTL(MAXAFE),AFLOW(2,MAXAFE),DP(MAXAFE),
-      PW(MAXAFE),PS(MAXAFE),AzM(MAXAFE),ETYPE(MAXAFE),
-      TCls,BHt

C      INTEGER AFELNK,AFEPTR,ETYPE,TCls
REAL AFEHT,AFECTL,PW,PS,AzM,BHt
REAL*8 DP,AFLOW

COMMON /CTLAFT/ NoCtl(MAXAFE),CtlS1(MAXAFE,5),Ctl1(MAXAFE,4)
INTEGER NoCtl,CtlS1
Real Ctl1

C      Airflow element parameters
INTEGER MAXAFT
PARAMETER (MAXAFT = 700)

```

```

      INTEGER MAXAFP
      PARAMETER (MAXAFP = 4200)
C
      COMMON /AFEPAR/ AFENDX(MAXAFP), AFEPAR(MAXAFP)
C
      INTEGER AFENDX
      REAL AFEPAR
C
      COMMON /LST/ LIST
      COMMON /CONTRL/ PB, ACNVG1, ACNVG2, ACNVG3, AMAXIT, DPMAX,
      NOINIT, NAFET, NAFE, NZON
C
      INTEGER LIST, AMAXIT, NOINIT, NAFET
      INTEGER NAFE, NZON
      REAL PB, ACNVG1, ACNVG2, ACNVG3, DPMAX
C
      COMMON /UNITS/ U8, U9, U10, NSBSMT, NSOUT
      INTEGER U8, U9, U10, NSBSMT, NSOUT
C
      Zone (airflow node) data
      INTEGER MAXZON
      PARAMETER (MAXZON = 1000)
C
      COMMON /ZONL/ZTYPE(MAXZON), PZ(MAXZON), TZ(MAXZON), HZ(MAXZON),
      RHOZ(MAXZON), SORTDZ(MAXZON), VISCZ(MAXZON),
      SUMAF(MAXZON), ATYPE(MAXZON)
C
      INTEGER ZTYPE, ATYPE
      DOUBLE PRECISION PZ, RHOZ, SORTDZ, VISCZ, SUMAF
      REAL HZ, TZ
C
      REAL RELCON
      INTEGER INTCON, I, J
      INTEGER K, M, N, FLAG, NAFF, E
      CHARACTER*80 STRING
      CHARACTER*40 WORD
C
      COMMON /WTHR1/CITY, INNAME, YR
      CHARACTER CITY*20, INNAME*16, YR*4
C
      COMMON /WTHR2/DAYS, FRSTDY, FRSTHR, LASTDY, LASTHR, HOURS,
      I, STMON, STDAY, STHR, ENDMON, ENDDAY, ENDDR, X
      INTEGER DAYS, FRSTDY, FRSTHR, LASTDY, LASTHR, HOURS, STMON,
      STDAY, STHR, EndMon, EndDay, EndHr, X
C
      CODE *****
C
      NAFF = 0
      NAFET = 0
      NAFE = 0
      NZON = 0
C--NAME WEATHER DATA INPUT FILE
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING, K, WORD)
      STMON = INTCON(WORD, FLAG)
      CALL GETWRD(STRING, K, WORD)
      STDAY = INTCON(WORD, FLAG)
      CALL GETWRD(STRING, K, WORD)
      STHR = INTCON(WORD, FLAG)
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING, K, WORD)
      EndMon = INTCON(WORD, FLAG)
      CALL GETWRD(STRING, K, WORD)
      EndDay = INTCON(WORD, FLAG)
      CALL GETWRD(STRING, K, WORD)
      EndHr = INTCON(WORD, FLAG)
      Read(U8,950) Yr
      Read(U8,951) City
      950 Format(A4)
      951 Format(A20)
C
      Read building site terrain class and building height.
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING, K, WORD)
      TC18 = INTCON(WORD, FLAG)
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING, K, WORD)
      BHT = RELCON(WORD, FLAG)
      IF(LIST.GE.3) WRITE(U9,907) TC18
C
      Read zone data:
      type(ambient, known press.), height, temperature, pressure.
C
      IF(LIST.GE.3) WRITE(U9,901)
      10 CONTINUE
      READ(U8,900) STRING
      K = 0
      CALL GETWRD(STRING, K, WORD)
      I = INTCON(WORD, FLAG)
      IF (I.LE.0) GO TO 20
      NZON = NZON+1
      IF(NZON.GT.MAXZON) CALL ERROR(' Parameter MAXZON too small',3)
      IF(I.NE.NZON) CALL ERROR(' Zone data out of sequence',3)
      CALL GETWRD(STRING, K, WORD)
      E = INTCON(WORD, FLAG)
      ATYPE(NZON) = E
      CALL GETWRD(STRING, K, WORD)
      N = INTCON(WORD, FLAG)
      ZTYPE(NZON) = N
      CALL GETWRD(STRING, K, WORD)
      HZ(NZON) = RELCON(WORD, FLAG)
      CALL GETWRD(STRING, K, WORD)

```



```

TZ(NZON) = RELCON(WORD,FLAG)
IF (ATYPE(NZON) .EQ. 1) TZ(NZON) = ODBT
PZ(NZON) = 0.0
IF (N.EQ.1) THEN
  CALL GETWRD(STRING,K,WORD)
  PZ(NZON) = RELCON(WORD,FLAG)
END IF
IF (LIST.GE.3) WRITE(U9,902) NZON,ATYPE(NZON),ZTYPE(NZON),
  HZ(NZON),TZ(NZON),PZ(NZON)
GO TO 10
20 CONTINUE
C      Read airflow element parameters:
IF (LIST.GE.3) WRITE(U9,903)
30 CONTINUE
C      Read first line.
READ(U8,900) STRING
IF (LIST.GE.3) WRITE(U9,904) STRING
K = 0
CALL GETWRD(STRING,K,WORD)
I = INTCON(WORD,FLAG)
IF (I.LE.0) GO TO 100
NAFET = NAFET+1
IF (NAFET.GT.MAXAFT) CALL ERROR(' Parameter MAXAFT too small',3)
IF (I.NE.NAFET)
  CALL ERROR(' AF parameter data out of sequence',3)
CALL GETWRD(STRING,K,WORD)
I = INTCON(WORD,FLAG)
IF (NAFP+10.GT.MAXAFP)
  CALL ERROR(' Parameter MAXAFP too small',3)
NAFP = NAFP+1
AFENDX(NAFET) = NAFP
AFEPAR(NAFP) = I
M = NAFP
C      Read remaining data.
IF (I.EQ.1) THEN
C      Power law resistance.
DO 32 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
32 ELSE IF (I.EQ.2) THEN
C      Duct element.
DO 35 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
35 READ(U8,900) STRING
  IF (LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 36 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
36 M = M+1
  AFEPAR(M) = AFEPAR(NAFP+4)/AFEPAR(NAFP+2)
  M = M+1
  AFEPAR(M) = AFEPAR(NAFP+1)/AFEPAR(NAFP+2)
  M = M+1
  AFEPAR(M) = 1.14 - 0.868589*LOG(AFEPAR(NAFP+9))
  M = M+1
  AFEPAR(M) = AFEPAR(NAFP+11)
ELSE IF (I.EQ.3) THEN
C      Doorway element.
DO 41 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
41 READ(U8,900) STRING
  IF (LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 42 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
42 ELSE IF (I.EQ.4) THEN
C      Constant flow rate.
CALL GETWRD(STRING,K,WORD)
M = M+1
AFEPAR(M) = RELCON(WORD,FLAG)
ELSE IF (I.EQ.5) THEN
C      Detailed fan element.
DO 44 N=1,4
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
44 READ(U8,900) STRING
  IF (LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 45 N=1,6
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
45 DO 45 N=1,AFEPAR(NAFP+9)
  READ(U8,900) STRING
  IF (LIST.GE.3) WRITE(U9,904) STRING
  K = 0
DO 46 J=1,5
  CALL GETWRD(STRING,K,WORD)
  M = M+1
  AFEPAR(M) = RELCON(WORD,FLAG)
46 CONTINUE
ELSE IF (I.EQ.6) THEN
C      Constant power fan element.
CALL GETWRD(STRING,K,WORD)
M = M+1
AFEPAR(M) = RELCON(WORD,FLAG)
ELSE IF (I.EQ.7) THEN
C      Multirange resistance.

```

```

DO 51 N=1,4
CALL GETWRD (STRING,K,WORD)
M = M+1
51 AFEPAR(M) = RELCON(WORD,FLAG)
DO 52 N=1,AFEPAR(NAFP+2)
READ(U8,900) STRING
IF(LIST.GE.3) WRITE(U9,904) STRING
K = 0
DO 52 J=1,3
CALL GETWRD (STRING,K,WORD)
M = M+1
52 AFEPAR(M) = RELCON(WORD,FLAG)
CONTINUE
ELSE IF(I.EQ.8) THEN      Variable resistance.
C DO 54 N=1,4
CALL GETWRD (STRING,K,WORD)
M = M+1
54 AFEPAR(M) = RELCON(WORD,FLAG)
READ(U8,900) STRING
IF(LIST.GE.3) WRITE(U9,904) STRING
K = 0
DO 55 N=1,2
CALL GETWRD (STRING,K,WORD)
M = M+1
55 AFEPAR(M) = RELCON(WORD,FLAG)
READ(U8,900) STRING
IF(LIST.GE.3) WRITE(U9,904) STRING
K = 0
DO 56 N=1,4
CALL GETWRD (STRING,K,WORD)
M = M+1
56 AFEPAR(M) = RELCON(WORD,FLAG)
M = M+1
AFEPAR(M)=0.0
END IF
NAFP = M
IF(NAFP.GT.MAXAFP)
CALL ERROR(' Parameter MAXAFP too small',3)
GO TO 30
100 CONTINUE
IF(LIST.GE.4) CALL DUMPVI('AFENDX:',AFENDX,NAFP,U9)
IF(LIST.GE.4) CALL DUMPVR('AFEPAR:',AFEPAR,NAFP,U9)
C C C C C      Read airflow element data:
C              link 1, height 1, link 2, height 2,
C              pointer to parameters, surface azimuth,
C              #ctl intervals, ctl times, ctl values.
IF(LIST.GE.3) WRITE(U9,905)
110 CONTINUE
READ(U8,900) STRING
K = 0
CALL GETWRD (STRING,K,WORD)
I = INTCON(WORD,FLAG)
IF(I.LE.0) GO TO 120
NAFE = NAFE+1
IF(NAFE.GT.MAXAFE) CALL ERROR(' Parameter MAXAFE too small',3)
IF(I.NE.NAFE) CALL ERROR(' AFE data out of sequence',3)
CALL GETWRD (STRING,K,WORD)
AFELNK(1,NAFE) = INTCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
AFEHT(1,NAFE) = RELCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
AFELNK(2,NAFE) = INTCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
AFEHT(2,NAFE) = RELCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
AFEPTR(NAFE) = INTCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
AZM(NAFE) = RELCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
ETYP(NAFE) = INTCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
NOCTL(NAFE) = INTCON(WORD,FLAG)
J=0
DO 150 I=1,NOCTL(NAFE)
IF (MOD(J,6).EQ.0) THEN
READ(U8,900) STRING
K = 0
End if
CALL GETWRD (STRING,K,WORD)
CTLS1(NAFE,I) = INTCON(WORD,FLAG)
CALL GETWRD (STRING,K,WORD)
CTI1(NAFE,I) = RELCON(WORD,FLAG)
J=J+1
150 CONTINUE
I=NOCTL(NAFE)+1
CTLS1(NAFE,I)=24
IF(LIST.GE.3) WRITE(U9,906) NAFE,AFELNK(1,NAFE),AFEHT(1,NAFE),
AFELNK(2,NAFE),AFEHT(2,NAFE),AFEPTR(NAFE),
AZM(NAFE),ETYP(NAFE),NOCTL(NAFE)
IF(LIST.GE.3) WRITE(U9,908) (CTLS1(NAFE,I)
CTI1(NAFE,I),I=1,NOCTL(NAFE))
GO TO 110
120 CONTINUE
900 FORMAT(A)
901 FORMAT(/,8X,'N AMB TYP HZ TZ PZ')
902 FORMAT(/,ZON:',3I4,2F8.3,F9.0)
903 FORMAT(/,10X,'1 parameters')
904 FORMAT(/,AFP:
905 FORMAT(/,8X,'I N H1 M H2 T AZM TYP',
NOCTL',/,TIME CTL')
906 FORMAT(' AFE:',2I4,F8.5,I4,F8.3,I4,F12.5,I4,I6)
907 FORMAT(' TCIs:',I4)
908 FORMAT(24(I6,F6.3))
RETURN
END

```

```

C----- GTDAT2
SUBROUTINE GTDAT2(FILNIN,FLNOUT)
C
C DESCRIPTION *****
C Read the airflow OUTPUT data file.
C
C DECLARATIONS *****
C
C NAFF - Number of airflow element parameters stored.
C Airflow element data
C   INTEGER MAXAFE
C   PARAMETER (MAXAFE = 2200)
C
C   COMMON /AFEDAT/ AFELNK(2,MAXAFE),AFEHT(2,MAXAFE),AFEPTR(MAXAFE),
C   -             AFECTL(MAXAFE),AFLOW(2,MAXAFE),DP(MAXAFE),
C   -             PW(MAXAFE),PS(MAXAFE),AzM(MAXAFE),ETYPE(MAXAFE),
C   -             TCls,BHt
C
C   INTEGER AFELNK,AFEPTR,ETYPE,TCls
C   REAL AFEHT,AFECTL,PW,PS,AzM,BHt
C   REAL*8 DP,AFLOW
C
C   COMMON /CTLAPE/ NoCtl(MAXAFE),CtlS1(MAXAFE,5),Ctl1(MAXAFE,4)
C   INTEGER NoCtl,CtlS1
C   Real Ctl1
C
C Airflow element parameters
C   INTEGER MAXAFT
C   PARAMETER (MAXAFT = 700)
C   INTEGER MAXAFP
C   PARAMETER (MAXAFP = 4200)
C
C   COMMON /AFEPAR/ AFENDX(MAXAFT),AFEPAR(MAXAFP)
C
C   INTEGER AFENDX
C   REAL AFEPAR
C
C   COMMON /LST/ LIST
C   COMMON /CONTRL/ PB,ACNVG1,ACNVG2,ACNVG3,AMAXIT,DPMAX,
C   -             NOINIT,NAFET,NAFE,NZON
C
C   INTEGER LIST,AMAXIT,NOINIT,NAFET
C   INTEGER NAFE,NZON
C   REAL PB,ACNVG1,ACNVG2,ACNVG3,DPMAX
C
C   COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
C   INTEGER U8,U9,U10,NSBSMT,NSOUT
C
C Zone (airflow node) data
C   INTEGER MAXZON
C   PARAMETER (MAXZON = 1000)
C
C   COMMON /ZONL/ZTYPE(MAXZON),PZ(MAXZON),TZ(MAXZON),HZ(MAXZON),
C   -             RHOZ(MAXZON),SQRTDZ(MAXZON),VISCZ(MAXZON),
C   -             SUMAF(MAXZON),ATYPE(MAXZON)
C
C   INTEGER ZTYPE,ATYPE
C   DOUBLE PRECISION PZ,RHOZ,SQRTDZ,VISCZ,SUMAF
C   REAL HZ,TZ
C
C   REAL RELCON
C   INTEGER INTCON,I,J
C   INTEGER K,M,N,FLAG,NAFF,E
C   CHARACTER*60 STRING
C   CHARACTER*40 WORD
C
C   COMMON /WTHR1/CITY,INNAME,YR
C   CHARACTER CITY*20,INNAME*16,YR*4
C
C   COMMON /WTHR2/DAYS,FRSTDY,FRSTHR,LASTDY,LASTHR,HOURS,
C   -             STMON,STDAY,STHR,ENDMON,ENDDAY,ENDHR,X
C   INTEGER DAYS,FRSTDY,FRSTHR,LASTDY,LASTHR,HOURS,STMON,
C   -             STDay,StHr,EndMon,EndDay,EndHr,X
C
C   REAL NODFLO(11,11,5),DIMPRS,FLNTM(2),STDRHO,FM
C   INTEGER ITYPE,LASTND,SEPNOD,FRNOD,TONOD,NUE
C   CHARACTER*20 FILENM,FILNIN,FLNOUT
C   CHARACTER*14 ZONAME(11),FLOTYP(5)
C   DATA ZONAME /'BASEMENT','OUTDOORS','LIVING ROOM',
C   +             'HALLWAY','BEDROOM 3','BATH (SINK)',
C   +             'BATH (TUB)','MASTER BEDROOM','BEDROOM 2',
C   +             'SEPARATION','SOIL',
C   +             FLOTYP /'INFILTRATION','EXFILTRATION','SUPPLY',
C   +             'EXHAUST','INTERZONE'/
C
C CODE *****
C
C   NUE = 1
C   LASTND=NZON-NSBSMT+3
C   SEPNOD=LASTND-1
C   PB=101325
C   DO 30 N=1, LASTND
C     SUMAF(N) = 0.0
C     DO 31 M=1, LASTND
C       DO 32 J=1,5
C         NODFLO(N,M,J)=0.0
C       32 CONTINUE
C     31 CONTINUE
C   30 CONTINUE
C   STDRHO=0.0034838*PB/(273.15+20)
C
C Compute zone air properties.
C   DO 10 N=1,NZON
C     RHOZ(N) = 0.0034838*PB/(TZ(N)+273.15)
C   10 CONTINUE

```

```

1000 READ(U10,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      J=LENSTR(WORD)
      IF (J.LE.0) J=1
      IF (WORD(1:J).NE.'Flow:') GOTO 1000
1010 CALL GETWRD(STRING,K,WORD)
      I = INTCON(WORD,FLAG)
      J = AFENDX(AFEPT(1))
      ITYPE = AFEPT(J)
      CALL GETWRD(STRING,K,WORD)
      N = INTCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      M = INTCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      DP(I) = RELCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      AFLOW(1,I) = RELCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      AFLOW(2,I) = RELCON(WORD,FLAG)

      IF (LIST.GE.2) WRITE(U9,910) I,DP(I),AFLOW(1,I),AFLOW(2,I)

      FM = 1.0
      IF (ETYPE(I).EQ.4) FM = AZM(I)
      FLNTM(1)=AFLOW(1,I)*FM*1000/STDRBO
      FLNTM(2)=AFLOW(2,I)*FM*1000/STDRBO

      IF ((N.GE.NSOUT).AND.(M.LT.NSBSMT)) THEN
        FRNOD=N-NSBSMT+1
        IF (M.EQ.723.OR.M.EQ.727.OR.M.EQ.731.OR.M.EQ.735.OR.
          + M.EQ.739.OR.(M.GE.743.AND.M.LE.748)) THEN
          TONOD=SEPNOD
        ELSE
          TONOD=LASTND
        END IF
      ELSE IF ((M.GE.NSOUT).AND.(N.LT.NSBSMT)) THEN
        IF (N.EQ.723.OR.N.EQ.727.OR.N.EQ.731.OR.N.EQ.735.OR.
          + N.EQ.739.OR.(N.GE.743.AND.N.LE.748)) THEN
          FRNOD=SEPNOD
        ELSE
          FRNOD=LASTND
        END IF
      ELSE IF ((N.EQ.NSBSMT).AND.(M.LT.NSBSMT)) THEN
        FRNOD=N-NSBSMT+1
        TONOD=LASTND
      ELSE IF ((M.EQ.NSBSMT).AND.(N.LT.NSBSMT)) THEN
        FRNOD=LASTND
        TONOD=M-NSBSMT+1
      ELSE IF ((N.GE.NSBSMT).AND.(M.GE.NSBSMT)) THEN
        FRNOD=N-NSBSMT+1
        TONOD=M-NSBSMT+1
      ELSE IF ((N.LT.NSBSMT).AND.(M.LT.NSBSMT)) THEN
        GOTO 1050
      END IF

C INFILTRATION
  IF ((N.EQ.NSOUT).AND.(FLNTM(1).GT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(FRNOD,TONOD,1)=NODFLO(FRNOD,TONOD,1)+FLNTM(1)
  ELSE IF ((M.EQ.NSOUT).AND.(FLNTM(1).LT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(TONOD,FRNOD,1)=NODFLO(TONOD,FRNOD,1)-FLNTM(1)

C EXFILTRATION
  ELSE IF ((N.EQ.NSOUT).AND.(FLNTM(1).LT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(TONOD,FRNOD,2)=NODFLO(TONOD,FRNOD,2)-FLNTM(1)
  ELSE IF ((M.EQ.NSOUT).AND.(FLNTM(1).GT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(FRNOD,TONOD,2)=NODFLO(FRNOD,TONOD,2)+FLNTM(1)

C SUPPLY
  ELSE IF ((N.EQ.NSOUT).OR.(N.EQ.LASTND)).AND.
    (FLNTM(1).GT.0.0).AND.(ITYPE.EQ.4)) THEN
    NODFLO(FRNOD,TONOD,3)=NODFLO(FRNOD,TONOD,3)+FLNTM(1)
  ELSE IF ((M.EQ.NSOUT).OR.(M.EQ.LASTND)).AND.
    (FLNTM(1).LT.0.0).AND.(ITYPE.EQ.4)) THEN
    NODFLO(TONOD,FRNOD,3)=NODFLO(TONOD,FRNOD,3)-FLNTM(1)

C EXHAUST
  ELSE IF ((N.EQ.NSOUT).OR.(N.EQ.LASTND)).AND.
    (FLNTM(1).LT.0.0).AND.(ITYPE.EQ.4)) THEN
    NODFLO(TONOD,FRNOD,4)=NODFLO(TONOD,FRNOD,4)-FLNTM(1)
  ELSE IF ((M.EQ.NSOUT).OR.(M.EQ.LASTND)).AND.
    (FLNTM(1).GT.0.0).AND.(ITYPE.EQ.4)) THEN
    NODFLO(FRNOD,TONOD,4)=NODFLO(FRNOD,TONOD,4)+FLNTM(1)

C INTERZONE
  ELSE
    IF (FLNTM(1).GT.0.0) THEN
      NODFLO(FRNOD,TONOD,5)=NODFLO(FRNOD,TONOD,5)+FLNTM(1)
    ELSE IF (FLNTM(1).LT.0.0) THEN
      NODFLO(TONOD,FRNOD,5)=NODFLO(TONOD,FRNOD,5)-FLNTM(1)
    END IF
  END IF

C INFILTRATION
  IF ((N.EQ.NSOUT).AND.(FLNTM(2).GT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(FRNOD,TONOD,1)=NODFLO(FRNOD,TONOD,1)+FLNTM(2)
  ELSE IF ((M.EQ.NSOUT).AND.(FLNTM(2).LT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(TONOD,FRNOD,1)=NODFLO(TONOD,FRNOD,1)-FLNTM(2)

C EXFILTRATION
  ELSE IF ((N.EQ.NSOUT).AND.(FLNTM(2).LT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(TONOD,FRNOD,2)=NODFLO(TONOD,FRNOD,2)-FLNTM(2)
  ELSE IF ((M.EQ.NSOUT).AND.(FLNTM(2).GT.0.0).AND.
    + (ITYPE.NE.4)) THEN
    NODFLO(FRNOD,TONOD,2)=NODFLO(FRNOD,TONOD,2)+FLNTM(2)
  
```

```

      + (ITYPE.NE.4) THEN
      NODFLO(FRNOD,TONOD,2)=NODFLO(FRNOD,TONOD,2)+FLNTM(2)
C  SUPPLY
      ELSE IF ((N.EQ.NSOUT).OR.(N.EQ.LASTND)).AND.
      + (FLNTM(2).GT.0.0).AND.(ITYPE.EQ.4) THEN
      NODFLO(FRNOD,TONOD,3)=NODFLO(FRNOD,TONOD,3)+FLNTM(2)
      ELSE IF ((M.EQ.NSOUT).OR.(M.EQ.LASTND)).AND.
      + (FLNTM(2).LT.0.0).AND.(ITYPE.EQ.4) THEN
      NODFLO(TONOD,FRNOD,3)=NODFLO(TONOD,FRNOD,3)-FLNTM(2)
C  EXHAUST
      ELSE IF ((N.EQ.NSOUT).OR.(N.EQ.LASTND)).AND.
      + (FLNTM(2).LT.0.0).AND.(ITYPE.EQ.4) THEN
      NODFLO(TONOD,FRNOD,4)=NODFLO(TONOD,FRNOD,4)-FLNTM(2)
      ELSE IF ((M.EQ.NSOUT).OR.(M.EQ.LASTND)).AND.
      + (FLNTM(2).GT.0.0).AND.(ITYPE.EQ.4) THEN
      NODFLO(FRNOD,TONOD,4)=NODFLO(FRNOD,TONOD,4)+FLNTM(2)
C  INTERZONE
      ELSE
      IF (FLNTM(2).GT.0.0) THEN
      NODFLO(FRNOD,TONOD,5)=NODFLO(FRNOD,TONOD,5)+FLNTM(2)
      ELSE IF (FLNTM(2).LT.0.0) THEN
      NODFLO(TONOD,FRNOD,5)=NODFLO(TONOD,FRNOD,5)-FLNTM(2)
      END IF
      END IF
1050 READ(U10,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      J=LENSTR(WORD)
      IF (J.LE.0) J=1
      IF (WORD(1:J).EQ.'Flow:') GOTO 1010
      CALL OPENFL(11,FILENM,'SEQUENTIAL',IOS,'FORMATTED','NEW',
      - 'Enter FLOW SUMMARY OUTPUT file name (*A.SUM):',
      - NUE)
      write(11,901) FILNIN
      write(11,902) FILENM
      CALL OUTDAT(11)
      write(11,903)
      write(11,904)
      DO 60 J=1,5
      DO 61 N=1, LASTND
      DO 62 M=1, LASTND
62      IF (NODFLO(N,M,J).NE.0.0)
      + WRITE(11,960) ZONAME(N),ZONAME(M),NODFLO(N,M,J),FLOTYP(J)
61      CONTINUE
60      CONTINUE
      write(11,904)
      CLOSE(11)
1055 WRITE(*,*)
      CALL OPENFL(12,FILENM,'SEQUENTIAL',IOS,'FORMATTED','NEW',
      - 'Enter DISTURBANCE PRESSURE OUTPUT file name (*A.PRS):',
      - NUE)
      write(12,901) FILNIN
      FLNOUT=FILENM
      write(12,902) FLNOUT
      CALL OUTDAT(12)
      IF (WORD(1:J).EQ.'Room:') GOTO 1070
1060 READ(U10,900) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      J=LENSTR(WORD)
      IF (J.LE.0) J=1
      IF (WORD(1:J).NE.'Room:') GOTO 1060
1070 CALL GETWRD(STRING,K,WORD)
      N = INTCON(WORD,FLAG)
      CALL GETWRD(STRING,K,WORD)
      PZ(N) = RELCON(WORD,FLAG)
      DIMPRS=PZ(N)+RHCZ(N)*9.8*HZ(N)
      write(12,950) N,DIMPRS
1080 READ(U10,900,END=1100) STRING
      K = 0
      CALL GETWRD(STRING,K,WORD)
      J=LENSTR(WORD)
      IF (J.LE.0) J=1
      IF (WORD(1:J).EQ.'Room:') GOTO 1070
1100 CLOSE(12)
900 FORMAT(A)
901 FORMAT(' INPUT DATA FILE : ',A20,/)
902 FORMAT(' OUTPUT DATA FILE: ',A20)
903 FORMAT(2X,'FROM ZONE',7X,'TO ZONE',
      + 13X,'FLOW [L/s]',2X,'FLOW TYPE')
904 FORMAT(2X,'-----')
910 FORMAT(1X,I5,3E14.6)
950 FORMAT(14,2X,2E14.6)
960 FORMAT(2(2X,A14),2X,E14.6,2X,A14)

      RETURN
      END

```

```

C----- DUMPVD
C  SUBROUTINE DUMPVD(S,V,N,UOUT)
C  DESCRIPTION *****
C  Print the contents of the double precision "V" vector.
C  DECLARATIONS *****
C  INTEGER UOUT
C  INTEGER N, I

```

```

      REAL*8      V(*)
      CHARACTER*{*} S
C
C      CODE *****
C
      WRITE(UOUT,901) S
      WRITE(UOUT,902) (V(I),I=1,N)
901  FORMAT(/,1X,A)
902  FORMAT(1X,1P,5E15.7)
C
      RETURN
      END

C----- DUMPVI
      SUBROUTINE DUMPVI(S,V,N,UOUT)
C
C      DESCRIPTION *****
C
C      PRINT THE CONTENTS OF THE INTEGER*4 "V" VECTOR.
C
C      DECLARATIONS *****
C
C      INTEGER UOUT
C      INTEGER N, I, V(*)
C      CHARACTER*{*} S
C
C      CODE *****
C
      WRITE(UOUT,901) S
      WRITE(UOUT,902) (V(I),I=1,N)
901  FORMAT(/,1X,A)
902  FORMAT(1X,10I6)
C
      RETURN
      END

C----- DUMPVR
      SUBROUTINE DUMPVR(S,V,N,UOUT)
C
C      DESCRIPTION *****
C
C      Print the contents of the real "V" vector.
C
C      DECLARATIONS *****
C
C      INTEGER UOUT
C      INTEGER N, I
C      REAL V(*)
C      CHARACTER*{*} S
C
C      CODE *****
C
      WRITE(UOUT,901) S
      WRITE(UOUT,902) (V(I),I=1,N)
901  FORMAT(/,1X,A)
902  FORMAT(1X,1P,5E15.7)
C
      RETURN
      END

C$INCLUDE UTIL.FOR
C$INCLUDE OUTDAT.FOR

```

FILE: VPIC1.FOR

```

SUBROUTINE VPIC1
  REAL C(9,9,10), D, GRDT, PB, STDRHO, PCILCV, ND568, CRKAV
  INTEGER X, Y, Z, ZP, N, FLAG
  LOGICAL WDEND1, WDEND2
  CHARACTER*80 STRING
  CHARACTER*40 WORD
  CHARACTER*14 FILENM, FLNMIN, COMMENT(9)
  DATA COMMENT/'BASEMENT', 'OUTDOORS', 'LIVING ROOM', 'HALLWAY',
+ 'BEDROOM 1', 'BATHROOM', 'BATHROOM', 'MASTER BEDROOM',
+ 'BEDROOM 2', /
  WDEND1=.FALSE.
  WDEND2=.FALSE.

  NUE = 1
  CALL OPENFL(8, FILENM, 'SEQUENTIAL', IOS, 'FORMATTED', 'OLD',
- 'Enter STEADY-STATE CONCENTRATION file name (*C.STD): ',
- NUE)
  FLNMIN = FILENM
  WRITE(*,*)
  CALL OPENFL(9, FILENM, 'SEQUENTIAL', IOS, 'FORMATTED', 'NEW',
- 'Enter CONCENTRATION PICTURE file name (*C.VPC): ',
- NUE)
  write(9,900) FLNMIN
  write(9,901) FILENM
  CALL OUTDAT(9)
900 FORMAT('INPUT DATA FILE : ',A20,/)
901 FORMAT('OUTPUT DATA FILE: ',A20,/)

  OPEN(10, FILE='SOIL.XYZ', STATUS='OLD')
  REWIND(10)

  DO 10 Z=1, 10
    DO 20 Y=1, 9
      DO 30 X=1, 9
        C(X,Y,Z)=-99999999
30      CONTINUE
20    CONTINUE
10  CONTINUE

  PB=101325
  STDRHO=3.4838E-3*PB/(273.15+20)
  PCILCV=2.098E-6*STDRHO/.037

  WRITE(9,810)

  I=0
40  IF (WDEND2) GOTO 41
    CALL INRD2(10,X,Y,Z,WDEND2)
41  IF (WDEND1) GOTO 45
    CALL INRD1(8,STRING,WDEND1)
    K = 0
    CALL GETWRD(STRING,K,WORD)
    CALL GETWRD(STRING,K,WORD)
    N = INTCON(WORD,FLAG)
    CALL GETWRD(STRING,K,WORD)
    CALL GETWRD(STRING,K,WORD)
    D = RELCON(WORD,FLAG)
    D=D*PCILCV
    IF (WDEND2.AND.(.NOT.WDEND1)) THEN
      I=I+1
      IF (I.NE.6) WRITE(9,800) COMMENT(I),D
      GOTO 41
    ELSE
      IF (WDEND2.AND.WDEND1) GOTO 45
      C(X,Y,Z)=D
      GOTO 40
    END IF

45  ND568=C(1,1,8)
    CRKAV=0.0
    DO 46 I=1,4
46    CRKAV=CRKAV+C(I,4,9)
    DO 47 J=1,3
47    CRKAV=CRKAV+C(4,J,9)
    CRKAV=CRKAV/7

    WRITE(9,811)
    WRITE(9,990)

    WRITE(9,991) ND568
    WRITE(9,992) CRKAV

    DO 50 Y=1,9
      WRITE(9,1000) 'VERTICAL SLICE Y=',Y
      WRITE(9,1100)
      DO 60 Z=10,1,-1
        ZP=11-Z
        IF((Z.EQ.8).AND.(Y.LE.6)) WRITE(9,1150)
        IF((Z.EQ.8).AND.(Y.EQ.7)) WRITE(9,1160)
        IF((Z.EQ.2).AND.(Y.LE.7)) WRITE(9,1160)
        IF (Z.LE.8) THEN
          IF((Y.LE.7).AND.(Z.GT.2)) THEN
            WRITE(9,1200) ZP,(C(X,Y,Z),X=1,9)
          ELSE IF((Y.LE.7).AND.(Z.LE.2)) THEN
            WRITE(9,1210) ZP,(C(X,Y,Z),X=1,9)
          ELSE IF (Y.GT.7) THEN
            WRITE(9,1210) ZP,(C(X,Y,Z),X=1,9)
          END IF
        ELSE IF (Z.EQ.9) THEN
          IF (Y.LT.4) THEN
            WRITE(9,1300) ZP,C(4,Y,Z),(C(X,Y,Z),X=6,9)
          ELSE IF (Y.EQ.4) THEN

```

```

        WRITE(9,1400) ZP,(C(X,Y,Z),X=1,4),(C(X,Y,Z),X=6,9)
      ELSE IF (Y.EQ.5) THEN
        WRITE(9,1500) ZP,(C(X,Y,Z),X=6,9)
      ELSE IF (Y.EQ.6) THEN
        WRITE(9,1600) ZP,(C(X,Y,Z),X=1,9)
      ELSE IF (Y.EQ.7) THEN
        WRITE(9,1610) ZP,(C(X,Y,Z),X=1,9)
      ELSE IF (Y.GT.6) THEN
        WRITE(9,1620) ZP,(C(X,Y,Z),X=1,9)
      END IF
    ELSE IF (Z.EQ.10) THEN
      IF (Y.LT.4) THEN
        WRITE(9,1700) ZP,(C(X,Y,Z),X=6,9)
      ELSE IF (Y.EQ.4) THEN
        WRITE(9,1750) ZP,(C(X,Y,Z),X=6,9)
      ELSE IF (Y.EQ.5) THEN
        WRITE(9,1500) ZP,(C(X,Y,Z),X=6,9)
      ELSE IF (Y.EQ.6) THEN
        WRITE(9,1800) ZP,(C(X,Y,Z),X=1,9)
      ELSE IF (Y.EQ.7) THEN
        WRITE(9,1810) ZP,(C(X,Y,Z),X=1,9)
      ELSE IF (Y.GT.6) THEN
        WRITE(9,1820) ZP,(C(X,Y,Z),X=1,9)
      END IF
    END IF
  END IF
60  CONTINUE
  IF (Y.NE.9) WRITE(9,2000)
50 CONTINUE

  CLOSE(8)
  CLOSE(9)
  CLOSE(10)

800 FORMAT(A14,6X,F7.1)
810 FORMAT('RADON CONCENTRATIONS IN HOUSE [pCi/L]',/,/,
+        'ROOM' 'CONCENTRATION',/,/,
+        '-----')
811 FORMAT('//,RADON CONCENTRATIONS IN SOIL [pCi/L]',/,/,
990 FORMAT('CONCENTRATION AT SUBSLAB VENT LOCATION: ',F7.1)
992 FORMAT('AVERAGE CONCENTRATION AT BOTTOM OF CRACK: ',F7.1,/)
1000 FORMAT(5X,A18,I2)
1100 FORMAT(1X, 'Z= X=1      2      3      4      5      6',
+        '      7      8      9')
1150 FORMAT(5X, '-----')
1160 FORMAT(5X, '-----')
1200 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1210 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1300 FORMAT(1X,I4, '*****',F7.1, ' ',F7.1, ' ',
+        F7.1, ' ',2F7.1)
1400 FORMAT(1X,I4,4F7.1, ' ',*****',F7.1, ' ',F7.1, ' ',
+        F7.1, ' ',2F7.1)
1500 FORMAT(1X,I4, '*****',F7.1, ' ',F7.1, ' ',
+        F7.1, ' ',2F7.1)
1600 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1610 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1620 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1700 FORMAT(1X,I4, '*****',F7.1, ' ',F7.1, ' ',
+        F7.1, ' ',2F7.1)
1750 FORMAT(1X,I4, '*****',F7.1, ' ',F7.1, ' ',
+        F7.1, ' ',2F7.1)
1800 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1810 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
1820 FORMAT(1X,I4,5F7.1, ' ',F7.1, ' ',F7.1, ' ',2F7.1)
2000 FORMAT(1X)

  RETURN
  END

C----- INRD1
SUBROUTINE INRD1(LUN,STRING,WDEND)
C--SUB: INRD1 - Reads data from the source file defined
C----- in MAIN program.

  REAL D
  INTEGER LUN
  CHARACTER*80 STRING
  LOGICAL WDEND

  READ(LUN,900,ERR=5,END=10) STRING
  Read(UNIT=LUN,FMT=*,ERR=5,END=10) N,D
  Return

  5  Continue
  10 WDEND = .TRUE.
  900 FORMAT(A)
  RETURN
  END

C----- INRD2
SUBROUTINE INRD2(LUN,X,Y,Z,WDEND)
C--SUB: INRD2 - Reads data from the source file defined
C----- in MAIN program.

  INTEGER X,Y,Z,LUN
  LOGICAL WDEND

  Read(UNIT=LUN,FMT=*,ERR=5,END=10) X,Y,Z
  Return

  5  Continue
  10 WDEND = .TRUE.
  RETURN
  END

```


FILE: VPIC2.FOR

```

SUBROUTINE VPIC2(FLNMIN)
  REAL P(9,9,10),D
  INTEGER X,Y,Z,ZP,N,FLAG
  LOGICAL WDEND1,WDEND2
  CHARACTER*80 STRING
  CHARACTER*40 WORD
  CHARACTER*14 FILENM, FLNMIN, COMMENT(9)
  DATA COMMENT/'BASEMENT','OUTDOORS','LIVING ROOM','HALLWAY',
+ 'BEDROOM 3','BATHROOM','BATHROOM','MASTER BEDROOM',
+ 'BEDROOM 2'/

  WDEND1=.FALSE.
  WDEND2=.FALSE.

  NUC = 1
  WRITE(*,*)
  OPEN(8,FILE=FLNMIN,FORM='FORMATTED',STATUS='OLD')
  REWIND(8)
  CALL INRD1(8,STRING,WDEND1)
  CALL INRD1(8,STRING,WDEND1)
  CALL INRD1(8,STRING,WDEND1)
  CALL INRD1(8,STRING,WDEND1)
  CALL INRD1(8,STRING,WDEND1)
  CALL INRD1(8,STRING,WDEND1)

  CALL OPENFL(9,FILENM,'SEQUENTIAL',IOS,'FORMATTED','NEW',
- 'Enter DISTURBANCE PRESSURE PICTURE file name (*A.VPC): ',
- NUC)
  write(9,900) FLNMIN
  write(9,901) FILENM
  CALL OUTDAT(9)
900 FORMAT('INPUT DATA FILE: ',A20,/)
901 FORMAT('OUTPUT DATA FILE: ',A20)

  OPEN(10,FILE='SOIL.XYZ',STATUS='OLD')
  REWIND(10)

  DO 10 Z=1,10
    DO 20 Y=1,9
      DO 30 X=1,9
        P(X,Y,Z)=-99999999
      30 CONTINUE
    20 CONTINUE
  10 CONTINUE

  GRDT=7
  PB=101325
  RHO=3.4838E-3*PB/(273.15+GRDT)

  WRITE(9,810)

  I=0
40 IF (WDEND2) GOTO 41
  CALL INRD2(10,X,Y,Z,WDEND2)
41 IF (WDEND1) GOTO 45
  CALL INRD1(8,STRING,WDEND1)
  K = 0
  CALL GETWRD(STRING,K,WORD)
  N = INTCON(WORD,FLAG)
  CALL GETWRD(STRING,K,WORD)
  D = RELCON(WORD,FLAG)
  IF (WDEND2.AND.(.NOT.WDEND1)) THEN
    I=I+1
    IF (I.NE.6) WRITE(9,800) COMMENT(I),D
    GOTO 41
  ELSE
    IF (WDEND2.AND.WDEND1) GOTO 45
    P(X,Y,Z)=D
    GOTO 40
  END IF

45 CONTINUE

  WRITE(9,811)
  WRITE(9,990)

  DO 50 Y=1,9
    WRITE(9,1000) 'VERTICAL SLICE Y=',Y
    WRITE(9,1100)
    DO 60 Z=10,1,-1
      ZP=11-Z
      IF ((Z.EQ.8).AND.(Y.LE.6)) WRITE(9,1150)
      IF ((Z.EQ.8).AND.(Y.EQ.7)) WRITE(9,1160)
      IF ((Z.EQ.2).AND.(Y.LE.7)) WRITE(9,1160)
      IF (Z.LE.8) THEN
        IF ((Y.LE.7).AND.(Z.GT.2)) THEN
          WRITE(9,1200) ZP,(P(X,Y,Z),X=1,9)
        ELSE IF ((Y.LE.7).AND.(Z.LE.2)) THEN
          WRITE(9,1210) ZP,(P(X,Y,Z),X=1,9)
        ELSE IF (Y.GT.7) THEN
          WRITE(9,1210) ZP,(P(X,Y,Z),X=1,9)
        END IF
      ELSE IF (Z.EQ.9) THEN
        IF (Y.LT.4) THEN
          WRITE(9,1300) ZP,P(4,Y,Z),(P(X,Y,Z),X=6,9)
        ELSE IF (Y.EQ.4) THEN
          WRITE(9,1400) ZP,(P(X,Y,Z),X=1,4),(P(X,Y,Z),X=6,9)
        ELSE IF (Y.EQ.5) THEN
          WRITE(9,1500) ZP,(P(X,Y,Z),X=6,9)
        ELSE IF (Y.EQ.6) THEN
          WRITE(9,1600) ZP,(P(X,Y,Z),X=1,9)
        ELSE IF (Y.EQ.7) THEN
          WRITE(9,1610) ZP,(P(X,Y,Z),X=1,9)
        ELSE IF (Y.GT.6) THEN

```

```

      WRITE(9,1620) ZP,(P(X,Y,Z),X=1,9)
    END IF
  ELSE IF (Z.EQ.10) THEN
    IF (Y.LT.8) THEN
      WRITE(9,1700) ZP,(P(X,Y,Z),X=6,9)
    ELSE IF (Y.EQ.4) THEN
      WRITE(9,1750) ZP,(P(X,Y,Z),X=6,9)
    ELSE IF (Y.EQ.5) THEN
      WRITE(9,1500) ZP,(P(X,Y,Z),X=6,9)
    ELSE IF (Y.EQ.6) THEN
      WRITE(9,1800) ZP,(P(X,Y,Z),X=1,9)
    ELSE IF (Y.EQ.7) THEN
      WRITE(9,1810) ZP,(P(X,Y,Z),X=1,9)
    ELSE IF (Y.GT.6) THEN
      WRITE(9,1820) ZP,(P(X,Y,Z),X=1,9)
    END IF
  END IF
60  CONTINUE
    IF (Y.NE.9) WRITE(9,2000)
50  CONTINUE

  CLOSE(8)
  CLOSE(9)
  CLOSE(10)

800  FORMAT(A14,6X,F7.1)
810  FORMAT('PRESSURES IN HOUSE [Pa]',/,/,
+         'ROOM', 'PRESSURE',/,/,
+         '-----')
811  FORMAT('DISTURBANCE PRESSURES IN SOIL [Pa]',/,/)
990  FORMAT(5X,A18,12)
1000 FORMAT(5X,A18,12)
1100 FORMAT(1X,'Z= X=1      2      3      4      5      6',
+         '      7      8      9')
1150 FORMAT(5X,'-----')
1160 FORMAT(5X,'-----')
1200 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1210 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1300 FORMAT(1X,I4,' *****',F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',
+         F7.1,' ',2F7.1)
1400 FORMAT(1X,I4,4F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1500 FORMAT(1X,I4,' *****',F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',
+         F7.1,' ',2F7.1)
1600 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1610 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1620 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1700 FORMAT(1X,I4,' *****',F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',
+         F7.1,' ',2F7.1)
1750 FORMAT(1X,I4,' *****',F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',
+         F7.1,' ',2F7.1)
1800 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1810 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
1820 FORMAT(1X,I4,5F7.1,' ',F7.1,' ',F7.1,' ',F7.1,' ',2F7.1)
2000 FORMAT(1X)

  RETURN
  END

```

FILE: UTIL.FOR

```

C      SUBROUTINE ERROR(MSG,SEVR)
C      DESCRIPTION *****
C      Simple error message writer with fatal error termination.
C      DECLARATIONS *****
C      Input:
C      MSG      - message to be printed.
C      SEVR     - error severity code.
C      COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
C      INTEGER  U8,U9,U10,NSBSMT,NSOUT
C      INTEGER  SEVR
C      INTEGER  I
C      CHARACTER*(*) MSG
C      CHARACTER*16 SEVER(0:3)
C      CODE *****
C      DATA SEVER / ' *** NOTE *** ', ' *** WARNING *** ',
C      - ' *** SEVERE *** ', ' *** FATAL *** ' /
C      I = MAX(SEVR,0)
C      I = MIN(I,3)
C      WRITE(6,*) SEVER(I)
C      WRITE(U9,*) SEVER(I)
C      WRITE(6,*) MSG
C      WRITE(U9,*) MSG
C      IF(SEVR.GE.3) STOP
C      RETURN
C      END
C
C      SUBROUTINE ERROR2(MSG1,MSG2,SEVR)
C      DESCRIPTION *****
C      Simple error message writer (2 messages) with fatal termination.
C      DECLARATIONS *****
C      Input:
C      MSG1     - first message to be printed.
C      MSG2     - second message to be printed.
C      SEVR     - error severity code.
C      COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
C      INTEGER  U8,U9,U10,NSBSMT,NSOUT
C      INTEGER  SEVR
C      INTEGER  I
C      CHARACTER*(*) MSG1, MSG2
C      CHARACTER*16 SEVER(0:3)
C      CODE *****
C      DATA SEVER / ' *** NOTE *** ', ' *** WARNING *** ',
C      - ' *** SEVERE *** ', ' *** FATAL *** ' /
C      I = MAX(SEVR,0)
C      I = MIN(I,3)
C      WRITE(6,*) SEVER(I)
C      WRITE(U9,*) SEVER(I)
C      WRITE(6,*) MSG1,MSG2
C      WRITE(U9,*) MSG1,MSG2
C      IF(SEVR.GE.3) STOP
C      RETURN
C      END
C
C      SUBROUTINE GETSTR(UIN,A,NUE)
C      DESCRIPTION *****
C      Get character data from batch input file. On CDC computers,
C      an empty record is considered an end-of-file.
C      DECLARATIONS *****
C      Input:
C      UIN      - unit number of input file.
C      Output:
C      A        - user input (character string).
C      NUE      - (0 = no input).
C      INTEGER  UIN
C      INTEGER  NUE, I, L
C      CHARACTER A*(*)
C      CHARACTER*4 UNITNR
C      CODE *****
C      NUE = 1
C      READ(UNIT=UIN,FMT=901,END=10) A
C      GO TO 999
C      End-of-file.
C      10 NUE = 0
C      I = UIN
C      CALL INTDIS(I,UNITNR,L)
C      CALL ERROR2(' End-of-file on UNIT ',UNITNR(1:L),2)
C      901 FORMAT(A)
C      999 RETURN

```

```

END

SUBROUTINE GETWRD(String,K,WORD)
DESCRIPTION *****
Get next "WORD" from the "STRING" of characters.
Words are separated by blanks or commas: WORD,WORD,WORD or
WORD WORD WORD or WORD, WORD, WORD are all valid.
DECLARATIONS *****
Input/Output:
K - current position in "STRING".
Local:
LS - maximum length of "STRING".
L - current position in "WORD".
LW - maximum length of "WORD".
COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
INTEGER U8,U9,U10,NSBSMT,NSOUT
INTEGER K, LS, L, LW
CHARACTER*(*) WORD, STRING
CHARACTER*1 A
CODE *****
WORD = ' '
LS = LEN(String)
LW = LEN(WORD)
L = 0
10 CONTINUE
K = K+1
IF(K.GT.LS) GO TO 30
A = String(K:K)
IF(A.EQ.' ') GO TO 10
IF(A.EQ.',') GO TO 999
20 CONTINUE
L = L+1
IF(L.GT.LW) GO TO 40
WORD(L:L) = A
30 CONTINUE
Copy "WORD" from "STRING".
Copy character from "STRING" to "WORD".
Find separator in "STRING".
K = K+1
IF(K.GT.LS) GO TO 50
A = String(K:K)
IF(A.EQ.' ') GO TO 10
IF(A.EQ.',') GO TO 999
GO TO 20
40 CALL ERROR(' Did not find expected value',2)
50 CONTINUE
GO TO 60
60 CALL ERROR(' Word too long (parameter WRDLEN too short)',2)
70 CONTINUE
GO TO 60
80 CALL ERROR(' Did not find end of word (blank or comma)',2)
90 CONTINUE
WRITE(6,*) '****',String,'****'
WRITE(U9,1) '****',String,'****'
CALL ERROR(' Could not process the input line listed above',2)
999 CONTINUE
RETURN
END

INTEGER FUNCTION INTCON(ANUM,EFLAG)
DESCRIPTION *****
Convert character string "ANUM" to an integer.
The limiting values for short integers are +/- 32759;
for long integers +/- 2147483649.
DECLARATIONS *****
INTEGER EFLAG, I, J, MINUS
CHARACTER ANUM*(*), TEST*13
COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
INTEGER U8,U9,U10,NSBSMT,NSOUT
CODE *****
DATA TEST / ' +-0123456789' /
INTCON = 0
MINUS = 1
DO 40 J=1,LEN(ANUM)
I = INDEX(TEST,ANUM(J:J))
IF(I.GT.3) GO TO 10
GO TO(50,30,20), I
GO TO 60
10 IF(INTCON.GE.3276) GO TO 70
INTCON = INTCON*10+(I-4)
GO TO 40
20 MINUS = -1
30 IF(J.NE.1) GO TO 60
40 CONTINUE
50 CONTINUE
INTCON = MINUS*INTCON
EFLAG = 0

```

```

C      GO TO 999
C      Error messages.
60 CALL ERROR2(' Invalid integer (INTCON): ',ANUM,2)
GO TO 80
70 CALL ERROR2(' Too many digits (INTCON): ',ANUM,2)
80 EFLAG = 1
999 RETURN
END

SUBROUTINE INTDIS(I,ANUM,L)
C      DESCRIPTION *****
C      Convert integer I to character string ANUM(1:L) for display.
C      DECLARATIONS *****
      INTEGER K, L, M, N, NN
      INTEGER I
      CHARACTER*(*) ANUM
      CHARACTER*10 DISP
C      CODE *****
      DATA DISP / '0123456789' /
      IF(I.GE.0) THEN
        L = 0
      ELSE
        L = 1
      END IF
      N = ABS(I)
      K = LEN(ANUM)
10  CONTINUE
      IF(N.LT.10) THEN
        M = N
        N = 0
      ELSE
        NN = N/10
        M = N-10*NN
        N = NN
      END IF
      IF(K.LE.L) CALL ERROR(' String variable too short (INTDIS)',3)
      ANUM(K:K) = DISP(M+1:M+1)
      K = K-1
      IF(N.GT.0) GO TO 10
      N = LEN(ANUM)
20  IF(L.EQ.1) ANUM(L:L) = '-'
      CONTINUE
      L = L+1
      K = K+1
      ANUM(L:L) = ANUM(K:K)
      IF(K.LT.N) GO TO 20
C      RETURN
      END

SUBROUTINE INTGET(MSG,IDEF,IMIN,IMAX,IUNK,I)
C      DESCRIPTION *****
C      Interactive input processor for a short integer value.
C      Print message plus minimum, maximum, and default values.
C      Read user input; treat carriage return as default value.
C      DECLARATIONS *****
      Input:
      MSG - message to be printed.
      IDEF - default value.
      IMIN - minimum value.
      IMAX - maximum value.
      IUNK - undefined value.
      Output:
      I - INTEGER VALUE (INTEGER*4).
      Local:
      NUE - (0 = no user input).
      EFLAG - 1 indicates improper integer.
      ANUM - user input character string.
      INTEGER I, IDEF, IMIN, IMAX, IUNK
      INTEGER LD, LN, LX, J, EFLAG, NUE
      CHARACTER*(*) MSG
      CHARACTER*20 ANUM, CD, CN, CX
C      CODE *****
      J = 0
      IF(IMIN.EQ.IUNK) J = J+1
      IF(IMAX.EQ.IUNK) J = J+2
      IF(IDEF.EQ.IUNK) J = J+4
      CALL INTDIS(IDEF,CD,LD)
      CALL INTDIS(IMIN,CN,LN)
      CALL INTDIS(IMAX,CX,LX)
C      Print message and read user entry.
10  CONTINUE
      IF(MSG.NE.' ') WRITE(6,*) MSG
      GO TO (11,12,13,14,15,16,17), J
      WRITE(6,901) ' [min = ',CN(1:LN),', max = ',CX(1:LX),
      - default = ',CD(1:LD),'] '
      GO TO 17
11  WRITE(6,901) ' [max = ',CX(1:LX),', default = ',CD(1:LD),'] '
      GO TO 17
12  WRITE(6,901) ' [min = ',CN(1:LN),', default = ',CD(1:LD),'] '
      GO TO 17
13  WRITE(6,901) ' [default = ',CD(1:LD),'] '
      GO TO 17

```

```

14 WRITE(6,901) ' [min = ',CN(1:LN),', max = ',CX(1:LX),'] '
GO TO 17
15 WRITE(6,901) ' [max = ',CX(1:LX),'] '
GO TO 17
16 WRITE(6,901) ' [min = ',CN(1:LN),'] '
17 CONTINUE
CALL STRGET(ANUM,NUE)
IF(NUE.EQ.0) GO TO 30
C      Decode and test user entry.
      I = INTCON(ANUM,EFLAG)
      IF(EFLAG.EQ.1) GO TO 10
      IF(IMIN.EQ.IUNK) GO TO 20
      IF(I.GE.IMIN) GO TO 20
      WRITE(6,*) ' Number too small'
      GO TO 10
20 CONTINUE
      IF(IMAX.EQ.IUNK) GO TO 999
      IF(I.LE.IMAX) GO TO 999
      WRITE(6,*) ' Number too large'
      GO TO 10
30 CONTINUE
      IF(IDEF.EQ.IUNK) GO TO 10
      I = IDEF
901 FORMAT(A,$)
C      901 FORMAT(A)
999 RETURN
END

C      INTEGER FUNCTION LENSTR(A)
C      DESCRIPTION *****
C      Determine the location of the last non-blank character in "A".
C      DECLARATIONS *****
C      CHARACTER*(*) A
C      INTEGER I
C      CODE *****
DO 10 I=LEN(A),1,-1
  IF(A(I:I).NE.' ') GO TO 20
10 CONTINUE
I = 0
20 LENSTR = I
RETURN
END

C      INTEGER FUNCTION NOYES(MSG)
C      DESCRIPTION *****
C      Obtain a YES or NO response from the user; 0 = no, 1 = yes.
C      To be called from an interactive program with the
C      unit numbers for the interaction input and output files.
C      Be careful with the length of the integer variables.
C      DECLARATIONS *****
Input:
MSG      - Message to user.
Local:
NUE      - (0 = no user entry).
C      CHARACTER*(*) MSG
C      CHARACTER*1 A
C      INTEGER NUE
C      CODE *****
10 WRITE(6,901) ' ',MSG,' (Y/N)? '
CALL STRGET(A,NUE)
IF(A.EQ.'Y' .OR. A.EQ.'y') GO TO 20
IF(A.EQ.'N' .OR. A.EQ.'n') GO TO 30
WRITE(6,*) ' Valid responses are: Y or y for YES, N or n for NO.'
GO TO 10
20 NOYES = 1
GO TO 999
30 NOYES = 0
901 FORMAT(A,$)
C      901 FORMAT(A)
999 RETURN
END

C      SUBROUTINE OPENFL(U,FNM,ACC,RL,FOR,STA,MSG,NUE)
C      DESCRIPTION *****
C      Open a file; to be called from an interactive program with the
C      unit numbers for the interaction input and output files.
C      For use with named files (status cannot = SCRATCH).
C      Be careful with the length of the integer variables.
C      DECLARATIONS *****
Input:
U      - unit number of file to be opened.
FNM    - name of file (supplied by user).
ACC    - access ('SEQUENTIAL' or 'DIRECT').
RL     - record length (for direct access files only).
FOR    - format ('FORMATTED' or 'UNFORMATTED').
STA    - status ('NEW' or 'OLD' or 'UNKNOWN').
MSG    - message to user.

```

```

C   Local:
C   NUE      - (0 = no user entry).
C
C       INTEGER U, RL, IOS
C       INTEGER NUE
C       CHARACTER*(*) FNM, ACC, FOR, STA, MSG
C       CHARACTER*80 FNM0
C
C   CODE *****
C
10  CONTINUE
   WRITE(6,901) MSG
   CALL STRGET(FNM,NUE)
   IF(NUE.EQ.0) GO TO 100
   FNM0=FNM
   FNM=FNM0
   IF(ACC.EQ.'SEQUENTIAL') THEN
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,FORM=FOR,STATUS=STA,
-       IOSTAT=IOS,ERR=20)
   ELSE
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,RECL=RL,FORM=FOR,STATUS=STA,
-       IOSTAT=IOS,ERR=20)
   ENDIF
   GO TO 999
C
C       Failed to open file.
20  CONTINUE
   WRITE(6,*) ' Could not open file named: ' FNM
   WRITE(6,*) ' FORTRAN I/O status: ',IOS,' (See FORTRAN manual)'
   IF(STA.EQ.'NEW') THEN
     WRITE(6,*) ' Expected the name of a new file.'
   ELSE IF(STA.EQ.'OLD') THEN
     WRITE(6,*) ' Expected the name of an existing file.'
   ENDIF
   WRITE(6,*) ' Try again. Enter revised file name.'
   WRITE(6,*) ' (To stop program execution, press only ENTER)'
   WRITE(6,*)
   GO TO 10
C
C       User termination.
100 STOP 'User Termination'
C
901 FORMAT(A,$)
C 901 FORMAT(A)
999 RETURN
END

SUBROUTINE OPNCTL(U,FNM,ACC,RL,FOR,STA,MSG)
C
C   DESCRIPTION *****
C
C   Open a data file containing airflow element control values.
C   For use with named files (status cannot = SCRATCH).
C   Be careful with the length of the integer variables.
C
C   DECLARATIONS *****
C
C   Input:
C   U      - unit number of file to be opened.
C   FNM    - name of file (supplied by user).
C   ACC    - access ('SEQUENTIAL' or 'DIRECT').
C   RL     - record length (for direct access files only).
C   FOR    - format ('FORMATTED' or 'UNFORMATTED').
C   STA    - status ('NEW' or 'OLD' or 'UNKNOWN').
C   MSG    - message to user.
C   Local:
C   NUE    - (0 = no user entry).
C
C       INTECER U, RL, IOS
C       INTEGER NUE
C       CHARACTER*(*) FNM, ACC, FOR, STA, MSG
C
C   CODE *****
C
C   FNM='AFE CTL'
10  CONTINUE
   IF(ACC.EQ.'SEQUENTIAL') THEN
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,FORM=FOR,STATUS=STA,
-       IOSTAT=IOS,ERR=20)
   ELSE
     OPEN(UNIT=U,FILE=FNM,ACCESS=ACC,RECL=RL,FORM=FOR,STATUS=STA,
-       IOSTAT=IOS,ERR=20)
   ENDIF
   GO TO 999
C
C       Failed to open file.
20  CONTINUE
   WRITE(6,*) ' Could not open file named: ' FNM
   WRITE(6,*) ' FORTRAN I/O status: ',IOS,' (See FORTRAN manual)'
   IF(STA.EQ.'NEW') THEN
     WRITE(6,*) ' Expected the name of a new file.'
   ELSE IF(STA.EQ.'OLD') THEN
     WRITE(6,*) ' Expected the name of an existing file.'
   ENDIF
   WRITE(6,*) ' Try again. Enter revised file name.'
   WRITE(6,*) ' (To stop program execution, press only ENTER)'
   WRITE(6,*)
   WRITE(6,901) MSG
   CALL STRGET(FNM,NUE)
   IF(NUE.EQ.0) GO TO 100
   GO TO 10
C
C       User termination.
100 STOP 'User Termination'
C
901 FORMAT(A,$)
C 901 FORMAT(A)
999 RETURN
END

```



```

CALL INTDIS(I,ANUM,L)
FORM = '(1PE30. '//ANUM(1:L)//)'
WRITE(ANUM,FMT=FORM) R
I = 0
10 I = I+1
   IF(ANUM(I:I).EQ.' ') GO TO 10
12 LFC = I
   I = I+1
   IF(ANUM(I:I).NE.' ') GO TO 12
14 LDEC = I
   I = I+1
   IF(ANUM(I:I).NE.'E') GO TO 14
16 LEXP = I
   I = I-1
   IF(ANUM(I:I).EQ.'0') GO TO 16
   LSIG = I
   EXPT = INTCON(ANUM(LEXP+1:30),EFLAG)
   IF(EXPT.LT.-4) GO TO 30
   IF(EXPT.GE.M+3) GO TO 30
C   Display number in normal format.
   DECML = .FALSE.
   L = 0
   IF(ANUM(LFC:LFC).EQ.'-') THEN
     L = L+1
     ANUM(L:L) = '-'
   END IF
   IF(EXPT.LT.0) THEN
     L = L+1
     ANUM(L:L) = '0'
     L = L+1
     ANUM(L:L) = '.'
     DECML = .TRUE.
   END IF
20 CONTINUE
   EXPT = EXPT+1
   IF(EXPT.GE.0) GO TO 22
   L = L+1
   ANUM(L:L) = '0'
   GO TO 20
22 CONTINUE
   L = L+1
   ANUM(L:L) = ANUM(LDEC-1:LDEC-1)
   I = LDEC+1
24 CONTINUE
   EXPT = EXPT-1
   IF(EXPT.EQ.0) THEN
     L = L+1
     ANUM(L:L) = '.'
     DECML = .TRUE.
   END IF
   IF(I.GT.LSIG) THEN
     IF(DECML) GO TO 999
     L = L+1
     ANUM(L:L) = '0'
   ELSE
     L = L+1
     ANUM(L:L) = ANUM(I:I)
     I = I+1
   END IF
   GO TO 24
C   Display number in exponential format.
30 CONTINUE
   L = 0
   DO 32 I=LFC,LSIG
     L = L+1
     ANUM(L:L) = ANUM(I:I)
32 CONTINUE
   DO 34 I=LEXP,30
     L = L+1
     ANUM(L:L) = ANUM(I:I)
34 CONTINUE
C
999 RETURN
END

SUBROUTINE RELGET(MSG,RDEF,RMIN,RMAX,RUNK,R)
DESCRIPTION *****
Interactive input processor for a real value.
Print message plus minimum, maximum, and default values.
Read user input; treat carriage return as default value.
DECLARATIONS *****
Input:
MSG      - message to be printed.
RDEF     - default value.
RMIN     - minimum value.
RMAX     - maximum value.
RUNK     - undefined value.
Output:
R        - real value.
Local:
NUE      - (0 = no user input).
EFLAG    - 1 indicates improper real.
ANUM     - user input character string.
C
C   INTEGER I, LD, LN, LX, EFLAG, NUE
C   REAL R, RDEF, RMIN, RMAX, RUNK
C   CHARACTER(*) MSG
C   CHARACTER*20 ANUM
C   CHARACTER*30 CD, CN, CX
C
CODE *****
I = 0

```

```

IF (RMIN.EQ.RUNK) I = 1+1
IF (RMAX.EQ.RUNK) I = 1+2
IF (RDEF.EQ.RUNK) I = 1+4
CALL RELDIS (RDEF,6,CD,LD)
CALL RELDIS (RMIN,6,CN,LN)
CALL RELDIS (RMAX,6,CX,LX)
C      Print message and read user entry.
10 CONTINUE
IF (MSG.NE.' ') WRITE(6,*) MSG
GO TO (11,12,13,14,15,16,17), I
WRITE(6,901) ' {min = ',CN(1:LN),', max = ',CX(1:LX),
- ' default = ',CD(1:LD),'} '
GO TO 17
11 WRITE(6,901) ' {max = ',CX(1:LX),', default = ',CD(1:LD),'} '
GO TO 17
12 WRITE(6,901) ' {min = ',CN(1:LN),', default = ',CD(1:LD),'} '
GO TO 17
13 WRITE(6,901) ' {default = ',CD(1:LD),'} '
GO TO 17
14 WRITE(6,901) ' {min = ',CN(1:LN),', max = ',CX(1:LX),'} '
GO TO 17
15 WRITE(6,901) ' {max = ',CX(1:LX),'} '
GO TO 17
16 WRITE(6,901) ' {min = ',CN(1:LN),'} '
17 CONTINUE
CALL STRGET (ANUM,NUE)
IF (NUE.EQ.0) GO TO 30
C      Decode and test user entry.
R = RELCON (ANUM,EFLAG)
IF (EFLAG.EQ.1) GO TO 10
IF (RMIN.EQ.RUNK) GO TO 20
IF (R.GE.RMIN) GO TO 20
WRITE(6,*) ' Number too small'
GO TO 10
20 CONTINUE
IF (RMAX.EQ.RUNK) GO TO 999
IF (R.LE.RMAX) GO TO 999
WRITE(6,*) ' Number too large'
GO TO 10
30 CONTINUE
IF (RDEF.EQ.RUNK) GO TO 10
R = RDEF
C
901 FORMAT(A,$)
C 901 FORMAT(A)
999 RETURN
END

SUBROUTINE STRGET(A,NUE)
DESCRIPTION *****
Get character data from interactive input file. This is a likely
place for machine dependencies: On CDC computers, an empty record
is considered an end-of-file.
DECLARATIONS *****
Output:
A      - user input (character string).
NUE    - (0 = no user input).
COMMON /UNITS/ U8,U9,U10,NSBSMT,NSOUT
INTEGER U8,U9,U10,NSBSMT,NSOUT
INTEGER NUE
CHARACTER A*(*)
CODE *****
NUE = 1
READ(18,FMT=901) A
C      Test for no user input.
WRITE(6,*) A
IF (A.EQ.' ') NUE = 0
901 FORMAT(A)
999 RETURN
END

```

FILE: OUTDAT.FOR

SUBROUTINE OUTDAT(LUN)

C Normally prints Day of Week, plus Year-Month-Day and
C Hour:Minute:Seconds to screen.

```

C
      INTEGER*2 IYR,IMON,IDY,IHR,IMIN,ISEC,IBSEC,IWEEK
      INTEGER LUN
      LOGICAL FOUND
      CHARACTER*3 WKDY(7)*3,WKSTR*21
      EQUIVALENCE (WKSTR,WKDY(1))
      DATA WKSTR/'SunMonTueWedThuFriSat'/

      CALL GETDAT(IYR,IMON,IDY,IWEEK)
      CALL GETTIM(IHR,IMIN,ISEC,IBSEC)

      IWEEK=IWEEK+1
      WRITE(LUN,100) WKDY(IWEEK),IYR,IMON,IDY,IHR,IMIN,ISEC,IBSEC
100  FORMAT(/,A3,I5,'-',I2.2,'-',I2.2,2X,
+        I2,':',I2.2,':',I2.2,':',I2.2,/,)

      RETURN
      END
C$INCLUDE GETDAT.INC
C$INCLUDE GETTIM.INC

```

FILE: GETDAT.INC

```

SUBROUTINE GETDAT( IYEAR, IMONTH, IDAY ,IWEEK)
*$noextensions
  integer*2 iyear,imonth,iday,iweek
* Define registers: These correspond to the element of an
* array which is to contain the values of the registers.
  integer*2 AX,BX,CX,DX,BP,DI,SI,ES,DS,FLAGS
  parameter (AX=1,BX=2,CX=3,DX=4,BP=5,DI=6,SI=7)
  parameter (ES=8,DS=9,FLAGS=10)
  integer NUM$REGS
  parameter (NUM$REGS=10)
* Define DOS functions.
  integer*2 GETDATE,DOSCALL
  parameter (DOSCALL=33,GETDATE=42)
* Define array to contain registers.
  integer*2 regs(NUM$REGS)
  integer*1 mon$day(2),week$(2)
  integer*2 year
  integer*1 month,day,week
  equivalence (regs(AX),week$)
  equivalence (regs(CX),year)
  equivalence (regs(DX),mon$day)
  equivalence (month, mon$day(2))
  equivalence (day , mon$day(1))
  equivalence (week , week$(1))
* Set AH to be DOS 'get date' function.
  regs(AX) = GETDATE*256
* Return the date.
  call intr( DOSCALL, regs )
  iyear = year
  imonth = month
  iday = day
  iweek = week
end

```

FILE: GETTIM.INC

```

SUBROUTINE GETTIM( IHRS, IMINS, ISECS, IHSECS )
  integer*2 ihrs, imins, isecs, ihsecs
*
* Define registers: These correspond to the element of an
* array which is to contain the values of the registers.
*
  integer*2 AX, BX, CX, DX, BP, DI, SI, ES, DS, FLAGS
  parameter (AX=1, BX=2, CX=3, DX=4, BP=5, DI=6, SI=7)
  parameter (ES=8, DS=9, FLAGS=10)
  integer NUM$REGS
  parameter (NUM$REGS=10)
*
* Define DOS functions.
*
  integer*2 GETTIME, DOSCALL
  parameter (DOSCALL=33, GETTIME=44)
*
* Define array to contain registers.
*
  integer*2 regs(NUM$REGS)
  integer*1 hrs$min(2), sec$tic(2)
  integer*1 hours, mins, secs, tics
  equivalence (regs(CX), hrs$min)
  equivalence (regs(DX), sec$tic)
  equivalence (hours, hrs$min(2))
  equivalence (mins, hrs$min(1))
  equivalence (secs, sec$tic(2))
  equivalence (tics, sec$tic(1))
*
* Set AH to be DOS 'get time' function.
*
  regs(AX) = GETTIME*256
*
* Return the time.
*
  call intr( DOSCALL, regs )
  ihrs = hours
  imins = mins
  isecs = secs
  ihsecs = tics
end

```

APPENDIX D - ZONAL AIRFLOW PREDICTIONS

Table D.1: Zonal airflow summary - Case 1.
Basement suction, 1 mm separation.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	8.6E+00	INFILTRATION
OUTDOORS	LIVING ROOM	3.1E+01	INFILTRATION
OUTDOORS	BEDROOM 3	5.2E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	9.6E+00	INFILTRATION
OUTDOORS	BEDROOM 2	5.3E+00	INFILTRATION
OUTDOORS	SEPARATION	2.0E+00	INFILTRATION
OUTDOORS	SOIL	3.8E-01	INFILTRATION
BASEMENT	OUTDOORS	2.7E+01	EXHAUST
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
BASEMENT	LIVING ROOM	2.7E+01	INTERZONE
LIVING ROOM	BASEMENT	4.3E+01	INTERZONE
HALLWAY	LIVING ROOM	2.6E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	5.2E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	9.6E+00	INTERZONE
BEDROOM 2	HALLWAY	5.3E+00	INTERZONE
SOIL	BASEMENT	2.3E+00	INTERZONE

Table D.2: Zonal airflow summary - Case 2.
Subslab depressurization, 1 mm separation, low flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	8.6E+00	INFILTRATION
OUTDOORS	LIVING ROOM	3.1E+01	INFILTRATION
OUTDOORS	BEDROOM 3	5.2E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	9.6E+00	INFILTRATION
OUTDOORS	BEDROOM 2	5.3E+00	INFILTRATION
OUTDOORS	SEPARATION	2.1E+00	INFILTRATION
OUTDOORS	SOIL	4.1E-01	INFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	2.7E+01	EXHAUST
BASEMENT	LIVING ROOM	2.7E+01	INTERZONE
BASEMENT	SOIL	2.4E+01	INTERZONE
LIVING ROOM	BASEMENT	4.3E+01	INTERZONE
HALLWAY	LIVING ROOM	2.6E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	5.2E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	9.6E+00	INTERZONE
BEDROOM 2	HALLWAY	5.3E+00	INTERZONE

Table D.3: Zonal airflow summary - Case 3.
Subslab pressurization, 1 mm separation, low flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	3.7E+00	INFILTRATION
OUTDOORS	LIVING ROOM	4.6E+00	INFILTRATION
OUTDOORS	BEDROOM 3	3.4E-01	INFILTRATION
OUTDOORS	SEPARATION	6.1E-01	INFILTRATION
OUTDOORS	SOIL	1.0E-01	INFILTRATION
LIVING ROOM	OUTDOORS	4.1E+00	EXFILTRATION
BEDROOM 3	OUTDOORS	1.3E-01	EXFILTRATION
MASTER BEDROOM	OUTDOORS	3.3E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	1.8E+00	EXFILTRATION
SOIL	OUTDOORS	4.7E-03	EXFILTRATION
BASEMENT	LIVING ROOM	7.3E+01	INTERZONE
LIVING ROOM	BASEMENT	6.9E+00	INTERZONE
LIVING ROOM	HALLWAY	2.2E+01	INTERZONE
LIVING ROOM	SOIL	4.4E+01	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	3.3E+00	INTERZONE
HALLWAY	BEDROOM 2	1.8E+00	INTERZONE
BEDROOM 3	HALLWAY	2.1E-01	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	6.2E+01	INTERZONE

Table D.4: Zonal airflow summary - Case 4.
Subslab depressurization, 1 mm separation, high flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	1.0E+01	INFILTRATION
OUTDOORS	LIVING ROOM	3.8E+01	INFILTRATION
OUTDOORS	BEDROOM 3	6.4E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	1.2E+01	INFILTRATION
OUTDOORS	BEDROOM 2	6.8E+00	INFILTRATION
OUTDOORS	SEPARATION	2.6E+00	INFILTRATION
OUTDOORS	SOIL	5.1E-01	INFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	4.2E+01	EXHAUST
BASEMENT	LIVING ROOM	2.1E+01	INTERZONE
BASEMENT	SOIL	3.9E+01	INTERZONE
LIVING ROOM	BASEMENT	5.0E+01	INTERZONE
HALLWAY	LIVING ROOM	8.1E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	6.4E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	1.2E+01	INTERZONE
BEDROOM 2	HALLWAY	6.8E+00	INTERZONE

Table D.5: Zonal airflow summary - Case 5.
Subslab pressurization, 1 mm separation, high flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	3.7E+00	INFILTRATION
OUTDOORS	LIVING ROOM	4.6E+00	INFILTRATION
OUTDOORS	BEDROOM 3	3.6E-01	INFILTRATION
OUTDOORS	SEPARATION	5.5E-01	INFILTRATION
OUTDOORS	SOIL	8.8E-02	INFILTRATION
LIVING ROOM	OUTDOORS	4.1E+00	EXFILTRATION
BEDROOM 3	OUTDOORS	1.3E-01	EXFILTRATION
MASTER BEDROOM	OUTDOORS	3.3E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	1.8E+00	EXFILTRATION
SOIL	OUTDOORS	1.0E-02	EXFILTRATION
BASEMENT	LIVING ROOM	8.4E+01	INTERZONE
LIVING ROOM	BASEMENT	2.6E+00	INTERZONE
LIVING ROOM	HALLWAY	2.2E+01	INTERZONE
LIVING ROOM	SOIL	6.0E+01	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	3.3E+00	INTERZONE
HALLWAY	BEDROOM 2	1.8E+00	INTERZONE
BEDROOM 3	HALLWAY	2.3E-01	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	7.8E+01	INTERZONE

Table D.6: Zonal airflow summary - Case 6.
Basement suction, 20 mm separation.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	2.3E+00	INFILTRATION
OUTDOORS	LIVING ROOM	2.5E+00	INFILTRATION
OUTDOORS	SEPARATION	7.7E+01	INFILTRATION
OUTDOORS	SOIL	1.3E-02	INFILTRATION
LIVING ROOM	OUTDOORS	9.5E+00	EXFILTRATION
BEDROOM 3	OUTDOORS	1.8E+00	EXFILTRATION
MASTER BEDROOM	OUTDOORS	5.5E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	3.0E+00	EXFILTRATION
BASEMENT	OUTDOORS	2.7E+01	EXHAUST
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
BASEMENT	LIVING ROOM	6.4E+01	INTERZONE
LIVING ROOM	BASEMENT	1.2E+01	INTERZONE
LIVING ROOM	HALLWAY	2.8E+01	INTERZONE
HALLWAY	BEDROOM 3	1.8E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	5.5E+00	INTERZONE
HALLWAY	BEDROOM 2	3.0E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
SOIL	BASEMENT	7.7E+01	INTERZONE

Table D.7: Zonal airflow summary - Case 7.
Subslab depressurization, 20 mm separation, low flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	1.6E+00	INFILTRATION
OUTDOORS	LIVING ROOM	2.1E+00	INFILTRATION
OUTDOORS	SEPARATION	8.1E+01	INFILTRATION
OUTDOORS	SOIL	2.3E-02	INFILTRATION
LIVING ROOM	OUTDOORS	1.1E+01	EXFILTRATION
BEDROOM 3	OUTDOORS	2.2E+00	EXFILTRATION
MASTER BEDROOM	OUTDOORS	6.1E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	3.4E+00	EXFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	2.7E+01	EXHAUST
BASEMENT	LIVING ROOM	6.6E+01	INTERZONE
LIVING ROOM	BASEMENT	1.0E+01	INTERZONE
LIVING ROOM	HALLWAY	2.9E+01	INTERZONE
HALLWAY	BEDROOM 3	2.2E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	6.1E+00	INTERZONE
HALLWAY	BEDROOM 2	3.4E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
SOIL	BASEMENT	5.4E+01	INTERZONE

Table D.8: Zonal airflow summary - Case 8.
Subslab pressurization, 20 mm separation, low flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	6.7E-01	INFILTRATION
OUTDOORS	LIVING ROOM	1.6E+00	INFILTRATION
OUTDOORS	SEPARATION	2.5E+01	INFILTRATION
OUTDOORS	SOIL	2.0E-03	INFILTRATION
BASEMENT	OUTDOORS	1.2E-01	EXFILTRATION
LIVING ROOM	OUTDOORS	1.3E+01	EXFILTRATION
BEDROOM 3	OUTDOORS	2.6E+00	EXFILTRATION
MASTER BEDROOM	OUTDOORS	6.8E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	3.8E+00	EXFILTRATION
SEPARATION	OUTDOORS	2.9E-01	EXFILTRATION
SOIL	OUTDOORS	2.1E-02	EXFILTRATION
BASEMENT	LIVING ROOM	8.8E+01	INTERZONE
LIVING ROOM	BASEMENT	1.5E+00	INTERZONE
LIVING ROOM	HALLWAY	3.1E+01	INTERZONE
LIVING ROOM	SOIL	4.4E+01	INTERZONE
HALLWAY	BEDROOM 3	2.6E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	6.8E+00	INTERZONE
HALLWAY	BEDROOM 2	3.8E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	8.6E+01	INTERZONE

Table D.9: Zonal airflow summary - Case 9.
Subslab depressurization, 20 mm separation, high flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	2.0E+00	INFILTRATION
OUTDOORS	LIVING ROOM	2.3E+00	INFILTRATION
OUTDOORS	SEPARATION	9.4E+01	INFILTRATION
OUTDOORS	SOIL	3.1E-02	INFILTRATION
LIVING ROOM	OUTDOORS	1.0E+01	EXFILTRATION
BEDROOM 3	OUTDOORS	2.0E+00	EXFILTRATION
MASTER BEDROOM	OUTDOORS	5.8E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	3.2E+00	EXFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	4.2E+01	EXHAUST
BASEMENT	LIVING ROOM	6.5E+01	INTERZONE
LIVING ROOM	BASEMENT	1.1E+01	INTERZONE
LIVING ROOM	HALLWAY	2.8E+01	INTERZONE
HALLWAY	BEDROOM 3	2.0E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	5.8E+00	INTERZONE
HALLWAY	BEDROOM 2	3.2E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
SOIL	BASEMENT	5.2E+01	INTERZONE

Table D.10: Zonal airflow summary - Case 10.
Subslab pressurization, 20 mm separation, high flow rate.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	1.0E+00	INFILTRATION
OUTDOORS	LIVING ROOM	1.9E+00	INFILTRATION
OUTDOORS	SEPARATION	2.5E+01	INFILTRATION
OUTDOORS	SOIL	2.0E-03	INFILTRATION
LIVING ROOM	OUTDOORS	1.2E+01	EXFILTRATION
BEDROOM 3	OUTDOORS	2.4E+00	EXFILTRATION
MASTER BEDROOM	OUTDOORS	6.5E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	3.6E+00	EXFILTRATION
SEPARATION	OUTDOORS	2.8E+00	EXFILTRATION
SOIL	OUTDOORS	2.7E-02	EXFILTRATION
BASEMENT	LIVING ROOM	1.0E+02	INTERZONE
LIVING ROOM	HALLWAY	3.0E+01	INTERZONE
LIVING ROOM	SOIL	6.0E+01	INTERZONE
HALLWAY	BEDROOM 3	2.4E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	6.5E+00	INTERZONE
HALLWAY	BEDROOM 2	3.6E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	9.9E+01	INTERZONE

Table D.11: Zonal airflow summary - Case 11.
Basement suction, 20 mm separation, soil air barrier.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	8.9E+00	INFILTRATION
OUTDOORS	LIVING ROOM	3.2E+01	INFILTRATION
OUTDOORS	BEDROOM 3	5.4E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	1.0E+01	INFILTRATION
OUTDOORS	BEDROOM 2	5.5E+00	INFILTRATION
OUTDOORS	SOIL	9.3E-02	INFILTRATION
BASEMENT	OUTDOORS	2.7E+01	EXHAUST
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
BASEMENT	LIVING ROOM	2.6E+01	INTERZONE
LIVING ROOM	BASEMENT	4.4E+01	INTERZONE
HALLWAY	LIVING ROOM	3.5E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	5.4E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	1.0E+01	INTERZONE
BEDROOM 2	HALLWAY	5.5E+00	INTERZONE
SOIL	BASEMENT	9.3E-02	INTERZONE

Table D.12: Zonal airflow summary - Case 12.
Subslab depressurization, 20 mm separation, low flow rate, soil air barrier.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	8.9E+00	INFILTRATION
OUTDOORS	LIVING ROOM	3.2E+01	INFILTRATION
OUTDOORS	BEDROOM 3	5.4E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	1.0E+01	INFILTRATION
OUTDOORS	BEDROOM 2	5.5E+00	INFILTRATION
OUTDOORS	SOIL	1.1E-01	INFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	2.7E+01	EXHAUST
BASEMENT	LIVING ROOM	2.6E+01	INTERZONE
BASEMENT	SOIL	2.7E+01	INTERZONE
LIVING ROOM	BASEMENT	4.4E+01	INTERZONE
HALLWAY	LIVING ROOM	3.4E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	5.4E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	1.0E+01	INTERZONE
BEDROOM 2	HALLWAY	5.5E+00	INTERZONE

Table D.13: Zonal airflow summary - Case 13.
Subslab pressurization, 20 mm separation, low flow rate, soil air barrier.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	3.8E+00	INFILTRATION
OUTDOORS	LIVING ROOM	4.7E+00	INFILTRATION
OUTDOORS	BEDROOM 3	4.8E-01	INFILTRATION
OUTDOORS	SOIL	8.9E-03	INFILTRATION
LIVING ROOM	OUTDOORS	3.9E+00	EXFILTRATION
BEDROOM 3	OUTDOORS	1.2E-01	EXFILTRATION
MASTER BEDROOM	OUTDOORS	3.2E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	1.7E+00	EXFILTRATION
SOIL	OUTDOORS	3.4E-03	EXFILTRATION
BASEMENT	LIVING ROOM	7.3E+01	INTERZONE
LIVING ROOM	BASEMENT	7.1E+00	INTERZONE
LIVING ROOM	HALLWAY	2.2E+01	INTERZONE
LIVING ROOM	SOIL	4.4E+01	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	3.2E+00	INTERZONE
HALLWAY	BEDROOM 2	1.7E+00	INTERZONE
BEDROOM 3	HALLWAY	3.6E-01	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	6.2E+01	INTERZONE

Table D.14: Zonal airflow summary - Case 14.
Subslab depressurization, 20 mm separation, high flow rate, soil air barrier.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	1.1E+01	INFILTRATION
OUTDOORS	LIVING ROOM	4.0E+01	INFILTRATION
OUTDOORS	BEDROOM 3	6.6E+00	INFILTRATION
OUTDOORS	MASTER BEDROOM	1.3E+01	INFILTRATION
OUTDOORS	BEDROOM 2	7.1E+00	INFILTRATION
OUTDOORS	SOIL	1.4E-01	INFILTRATION
LIVING ROOM	OUTDOORS	1.7E+01	EXHAUST
BATH (TUB)	OUTDOORS	1.7E+01	EXHAUST
SOIL	OUTDOORS	4.2E-01	EXHAUST
BASEMENT	LIVING ROOM	2.0E+01	INTERZONE
BASEMENT	SOIL	4.2E+01	INTERZONE
LIVING ROOM	BASEMENT	5.1E+01	INTERZONE
HALLWAY	LIVING ROOM	9.1E+00	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
BEDROOM 3	HALLWAY	6.6E+00	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
MASTER BEDROOM	HALLWAY	1.3E+01	INTERZONE
BEDROOM 2	HALLWAY	7.1E+00	INTERZONE

Table D.15: Zonal airflow summary - Case 15.
Subslab pressurization, 20 mm separation, high flow rate, soil air barrier.

FROM ZONE	TO ZONE	FLOW [L/s]	FLOW TYPE
OUTDOORS	BASEMENT	3.8E+00	INFILTRATION
OUTDOORS	LIVING ROOM	4.7E+00	INFILTRATION
OUTDOORS	BEDROOM 3	4.8E-01	INFILTRATION
OUTDOORS	SOIL	4.5E-03	INFILTRATION
LIVING ROOM	OUTDOORS	3.9E+00	EXFILTRATION
BEDROOM 3	OUTDOORS	1.2E-01	EXFILTRATION
MASTER BEDROOM	OUTDOORS	3.2E+00	EXFILTRATION
BEDROOM 2	OUTDOORS	1.7E+00	EXFILTRATION
SOIL	OUTDOORS	7.7E-03	EXFILTRATION
BASEMENT	LIVING ROOM	8.4E+01	INTERZONE
LIVING ROOM	BASEMENT	2.8E+00	INTERZONE
LIVING ROOM	HALLWAY	2.2E+01	INTERZONE
LIVING ROOM	SOIL	6.0E+01	INTERZONE
HALLWAY	BATH (SINK)	1.7E+01	INTERZONE
HALLWAY	MASTER BEDROOM	3.2E+00	INTERZONE
HALLWAY	BEDROOM 2	1.7E+00	INTERZONE
BEDROOM 3	HALLWAY	3.6E-01	INTERZONE
BATH (SINK)	BATH (TUB)	1.7E+01	INTERZONE
BATH (TUB)	SOIL	1.7E+01	INTERZONE
SOIL	BASEMENT	7.7E+01	INTERZONE



APPENDIX E - HOUSE AND SOIL DISTURBANCE PRESSURE PROFILES

Figure E.1. Predicted disturbance pressures - Case 1.
Basement suction, 1 mm separation.

ZONE	PRESSURE [Pa]
BASEMENT	-12.5
OUTDOORS	0.0
LIVING ROOM	-12.5
HALLWAY	-12.5
BEDROOM 3	-12.5
BATHROOM	-12.5
MASTER BEDROOM	-12.5
BEDROOM 2	-12.5

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.2	0.1
2	*****	*****	*****	-12.9	*****	-9.4	-9.4	-0.9	-0.1
3	-12.8	-12.8	-12.8	-12.9	-12.8	-12.7	-12.8	-1.2	-0.3
4	-12.8	-12.8	-12.8	-12.9	-12.8	-12.8	-12.8	-1.2	-0.3
5	-12.8	-12.8	-12.8	-12.9	-12.8	-12.8	-12.8	-1.2	-0.3
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.2	-0.3
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.2	-0.3
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.2	-0.3
9	-7.7	-7.1	-6.4	-6.3	-6.2	-6.1	-5.9	-2.8	-1.2
10	-4.3	-4.1	-3.8	-3.8	-3.7	-3.7	-3.6	-2.7	-1.8
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.4	-9.4	-0.8	-0.1
3	-12.8	-12.8	-12.8	-12.9	-12.8	-12.7	-12.8	-1.1	-0.2
4	-12.8	-12.8	-12.8	-12.9	-12.8	-12.8	-12.8	-1.1	-0.2
5	-12.8	-12.8	-12.8	-12.9	-12.8	-12.8	-12.8	-1.1	-0.2
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.1	-0.2
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.1	-0.2
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.1	-0.2
9	-7.0	-6.5	-5.8	-5.7	-5.6	-5.5	-5.3	-2.5	-1.1
10	-3.9	-3.7	-3.4	-3.4	-3.4	-3.3	-3.3	-2.5	-1.7
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.4	-9.3	-0.7	-0.1
3	-12.8	-12.8	-12.8	-12.9	-12.8	-12.7	-12.8	-0.9	-0.2
4	-12.8	-12.8	-12.8	-12.9	-12.8	-12.7	-12.8	-0.9	-0.2
5	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.0	-0.2
9	-5.9	-5.4	-4.9	-4.8	-4.7	-4.7	-4.5	-2.1	-1.0
10	-3.4	-3.2	-3.0	-3.0	-3.0	-3.0	-2.9	-2.3	-1.5
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.4	-9.3	-0.7	-0.1
3	-12.9	-12.9	-12.9	-12.9	-12.8	-12.7	-12.8	-0.9	-0.2
4	-12.9	-12.9	-12.9	-12.9	-12.8	-12.7	-12.8	-0.9	-0.2
5	-12.9	-12.9	-12.9	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-1.0	-0.2
9	-5.8	-5.4	-4.8	-4.7	-4.7	-4.6	-4.4	-2.1	-1.0
10	-3.4	-3.2	-3.0	-3.0	-3.0	-2.9	-2.9	-2.2	-1.5
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.1	0.1
2	*****	*****	*****	*****	*****	-9.4	-9.3	-0.7	-0.1
3	-12.8	-12.8	-12.8	-12.8	-12.8	-12.7	-12.8	-0.9	-0.2
4	-12.8	-12.8	-12.8	-12.8	-12.8	-12.7	-12.8	-0.9	-0.2
5	-12.8	-12.8	-12.8	-12.8	-12.8	-12.7	-12.8	-0.9	-0.2
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
9	-5.7	-5.3	-4.7	-4.7	-4.6	-4.5	-4.4	-2.1	-1.0
10	-3.4	-3.2	-3.0	-3.0	-2.9	-2.9	-2.9	-2.2	-1.5
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.8	-2.8	-0.1	0.1
2	*****	*****	*****	-9.4	-9.4	-9.4	-9.3	-0.7	-0.1
3	-12.7	-12.7	-12.7	-12.7	-12.7	-12.6	-12.8	-0.9	-0.2
4	-12.8	-12.8	-12.7	-12.7	-12.7	-12.7	-12.8	-0.9	-0.2
5	-12.8	-12.8	-12.8	-12.8	-12.8	-12.7	-12.8	-0.9	-0.2
6	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-0.9	-0.2
9	-5.6	-5.2	-4.7	-4.6	-4.5	-4.5	-4.3	-2.1	-1.0
10	-3.3	-3.2	-3.0	-2.9	-2.9	-2.9	-2.8	-2.2	-1.5

Figure E.2. Predicted disturbance pressures - Case 2.
Subslab depressurization, 1 mm separation, low flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-12.5
OUTDOORS	0.0
LIVING ROOM	-12.5
HALLWAY	-12.5
BEDROOM 3	-12.5
BATHROOM	-12.5
MASTER BEDROOM	-12.5
BEDROOM 2	-12.5

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.2	-3.1	-0.2	0.1
2	*****	*****	*****	-13.0	*****	-10.4	-10.4	-1.2	-0.2
3	-25.7	-18.1	-14.6	-13.2	-14.2	-14.1	-14.2	-1.5	-0.4
4	-25.7	-18.1	-14.6	-13.5	-14.2	-14.1	-14.2	-1.5	-0.4
5	-25.6	-18.1	-14.6	-13.9	-14.2	-14.2	-14.2	-1.5	-0.4
6	-25.6	-18.1	-14.6	-14.2	-14.2	-14.2	-14.2	-1.5	-0.4
7	-25.6	-18.1	-14.6	-14.4	-14.2	-14.2	-14.2	-1.5	-0.4
8	-25.6	-18.1	-14.6	-14.4	-14.2	-14.2	-14.2	-1.6	-0.4
9	-11.8	-10.1	-8.8	-8.6	-8.5	-8.3	-8.0	-3.7	-1.6
10	-6.0	-5.6	-5.2	-5.1	-5.1	-5.0	-4.9	-3.7	-2.4
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.0	-2.9	-0.2	0.1
2	*****	*****	*****	-12.9	*****	-9.8	-9.8	-1.0	-0.2
3	-16.3	-14.6	-13.4	-13.0	-13.3	-13.2	-13.3	-1.3	-0.3
4	-16.3	-14.6	-13.4	-13.1	-13.3	-13.2	-13.3	-1.3	-0.3
5	-16.3	-14.6	-13.4	-13.2	-13.3	-13.3	-13.3	-1.3	-0.3
6	-16.3	-14.6	-13.4	-13.3	-13.3	-13.3	-13.3	-1.3	-0.4
7	-16.3	-14.6	-13.5	-13.4	-13.3	-13.3	-13.3	-1.4	-0.4
8	-16.3	-14.6	-13.5	-13.4	-13.3	-13.3	-13.3	-1.4	-0.4
9	-9.3	-8.3	-7.3	-7.2	-7.1	-7.0	-6.7	-3.2	-1.5
10	-5.2	-4.9	-4.6	-4.5	-4.5	-4.5	-4.4	-3.3	-2.2
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.9	-2.9	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.6	-9.6	-0.9	-0.2
3	-13.7	-13.3	-13.1	-12.9	-13.0	-13.0	-13.1	-1.1	-0.3
4	-13.7	-13.3	-13.1	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
5	-13.7	-13.3	-13.1	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
6	-13.7	-13.3	-13.1	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
7	-13.7	-13.3	-13.1	-13.1	-13.1	-13.1	-13.1	-1.2	-0.3
8	-13.7	-13.3	-13.1	-13.1	-13.1	-13.1	-13.1	-1.2	-0.3
9	-7.5	-6.8	-6.0	-5.9	-5.9	-5.8	-5.6	-2.7	-1.3
10	-4.6	-4.3	-4.0	-4.0	-4.0	-3.9	-3.9	-3.0	-2.1
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.9	-2.9	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.6	-9.6	-0.9	-0.2
3	-13.0	-13.0	-12.9	-12.9	-13.0	-12.9	-13.1	-1.1	-0.3
4	-13.2	-13.0	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
5	-13.5	-13.3	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
6	-13.5	-13.3	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
7	-13.6	-13.3	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
8	-13.6	-13.3	-13.1	-13.1	-13.0	-13.1	-13.1	-1.2	-0.3
9	-7.3	-6.7	-5.9	-5.9	-5.8	-5.7	-5.5	-2.7	-1.3
10	-4.5	-4.3	-4.0	-4.0	-3.9	-3.9	-3.8	-3.0	-2.1
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.9	-2.9	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.6	-9.6	-0.9	-0.2
3	-13.5	-13.2	-13.0	-13.0	-13.0	-12.9	-13.1	-1.1	-0.3
4	-13.5	-13.2	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
5	-13.5	-13.2	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
6	-13.5	-13.2	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
7	-13.5	-13.2	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
8	-13.5	-13.2	-13.0	-13.0	-13.0	-13.1	-13.1	-1.2	-0.3
9	-7.2	-6.6	-5.8	-5.8	-5.7	-5.6	-5.4	-2.7	-1.3
10	-4.5	-4.2	-4.0	-3.9	-3.9	-3.9	-3.8	-3.0	-2.0
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-2.9	-2.9	-0.1	0.1
2	*****	*****	*****	-12.9	*****	-9.6	-9.6	-0.9	-0.2
3	-13.3	-13.1	-12.9	-12.9	-13.0	-12.9	-13.1	-1.1	-0.3
4	-13.4	-13.1	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
5	-13.4	-13.1	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
6	-13.5	-13.2	-13.0	-13.0	-13.0	-13.0	-13.1	-1.1	-0.3
7	-13.5	-13.2	-13.1	-13.1	-13.0	-13.1	-13.1	-1.1	-0.3
8	-13.5	-13.2	-13.1	-13.1	-13.0	-13.1	-13.1	-1.1	-0.3
9	-7.1	-6.5	-5.8	-5.7	-5.6	-5.5	-5.3	-2.6	-1.3
10	-4.4	-4.2	-3.9	-3.9	-3.9	-3.8	-3.8	-2.9	-2.0

VERTICAL SLICE Y= 7									
Z=	X=1	2	3	4	5	6	7	8	9
1	-3.0	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-0.1	-0.1
2	-9.8	-9.7	-9.6	-9.6	-9.6	-9.6	-9.5	-0.8	-0.1
3	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.0	-0.3
4	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.0	-0.3
5	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.0	-0.3
6	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.1	-0.3
7	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.1	-0.3
8	-13.4	-13.2	-13.1	-13.1	-13.1	-13.1	-13.1	-1.1	-0.3
9	-6.8	-6.2	-5.5	-5.4	-5.4	-5.3	-5.1	-2.5	-1.3
10	-4.3	-4.1	-3.8	-3.8	-3.8	-3.8	-3.7	-2.9	-2.0
VERTICAL SLICE Y= 8									
Z=	X=1	2	3	4	5	6	7	8	9
1	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
2	-1.0	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8	-0.3	-0.1
3	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
4	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
5	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
6	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
7	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
8	-1.3	-1.2	-1.1	-1.1	-1.0	-1.0	-1.0	-0.4	-0.2
9	-3.0	-2.8	-2.6	-2.5	-2.5	-2.5	-2.4	-1.7	-1.0
10	-3.1	-3.0	-2.8	-2.8	-2.8	-2.8	-2.7	-2.3	-1.7
VERTICAL SLICE Y= 9									
Z=	X=1	2	3	4	5	6	7	8	9
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.0
3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
4	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
5	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
6	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
7	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
8	-0.3	-0.3	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.1
9	-1.3	-1.2	-1.2	-1.2	-1.2	-1.2	-1.1	-0.9	-0.7
10	-2.0	-1.9	-1.9	-1.9	-1.8	-1.8	-1.8	-1.6	-1.4

Figure E.3. Predicted disturbance pressures - Case 3.
Subslab pressurization, 1 mm separation, low flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-5.2
OUTDOORS	0.0
LIVING ROOM	-5.2
HALLWAY	-5.2
BEDROOM 3	-5.2
BATHROOM	-5.2
MASTER BEDROOM	-5.2
BEDROOM 2	-5.2

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.2	*****	-0.4	-0.4	0.3	0.3
3	23.9	6.5	-1.6	-4.7	-2.4	-2.4	-2.4	0.4	0.4
4	23.9	6.5	-1.5	-4.0	-2.4	-2.4	-2.4	0.4	0.4
5	23.9	6.5	-1.5	-3.2	-2.4	-2.4	-2.4	0.4	0.4
6	23.9	6.5	-1.5	-2.4	-2.4	-2.4	-2.4	0.4	0.4
7	23.9	6.5	-1.5	-2.0	-2.3	-2.3	-2.4	0.4	0.4
8	23.9	6.5	-1.4	-1.9	-2.3	-2.3	-2.4	0.4	0.4
9	6.2	3.8	2.8	2.7	2.6	2.6	2.4	1.0	0.6
10	2.1	1.9	1.7	1.7	1.6	1.6	1.6	1.1	0.8
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.4	*****	-0.8	-0.8	0.2	0.3
3	2.5	-1.4	-4.1	-5.3	-4.4	-4.3	-4.3	0.2	0.3
4	2.5	-1.4	-4.1	-5.0	-4.4	-4.3	-4.3	0.2	0.3
5	2.5	-1.4	-4.1	-4.7	-4.4	-4.3	-4.3	0.2	0.3
6	2.5	-1.4	-4.1	-4.4	-4.4	-4.4	-4.3	0.2	0.3
7	2.5	-1.4	-4.1	-4.3	-4.4	-4.3	-4.3	0.3	0.3
8	2.5	-1.4	-4.1	-4.2	-4.3	-4.3	-4.3	0.3	0.3
9	2.2	1.4	1.1	1.0	1.0	1.0	0.9	0.7	0.5
10	1.5	1.4	1.3	1.3	1.2	1.2	1.2	0.9	0.7
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.5	*****	-0.9	-0.9	0.2	0.3
3	-3.6	-4.5	-4.9	-5.4	-4.9	-4.8	-4.7	0.2	0.3
4	-3.6	-4.5	-4.9	-5.3	-4.9	-4.8	-4.7	0.2	0.3
5	-3.6	-4.5	-4.9	-5.1	-4.9	-4.8	-4.7	0.2	0.3
6	-3.6	-4.5	-4.9	-5.0	-4.9	-4.8	-4.7	0.2	0.3
7	-3.6	-4.5	-4.9	-4.9	-4.9	-4.8	-4.7	0.2	0.3
8	-3.6	-4.5	-4.9	-4.9	-4.9	-4.8	-4.7	0.2	0.3
9	1.3	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.5
10	1.3	1.2	1.1	1.1	1.1	1.1	1.0	0.8	0.7
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.4	*****	-0.9	-0.9	0.2	0.3
3	-5.2	-5.3	-5.4	-5.4	-4.9	-4.8	-4.7	0.2	0.3
4	-4.8	-5.1	-5.3	-5.3	-4.9	-4.8	-4.7	0.2	0.3
5	-4.4	-4.9	-5.2	-5.1	-4.9	-4.8	-4.7	0.2	0.3
6	-4.0	-4.7	-5.0	-5.0	-4.9	-4.8	-4.7	0.2	0.3
7	-3.8	-4.6	-4.9	-4.9	-4.9	-4.8	-4.7	0.2	0.3
8	-3.8	-4.6	-4.9	-4.9	-4.9	-4.8	-4.7	0.2	0.3
9	1.2	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.5
10	1.2	1.1	1.1	1.1	1.1	1.1	1.0	0.8	0.7
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	-0.9	-0.9	0.2	0.3
3	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
4	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
5	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
6	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
7	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
8	-4.0	-4.7	-4.9	-4.9	-4.8	-4.8	-4.8	0.2	0.3
9	1.1	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.5
10	1.2	1.1	1.1	1.1	1.0	1.0	1.0	0.8	0.7
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-4.0	-4.6	-4.8	-4.8	-4.8	-4.8	-4.8	0.2	0.3
4	-4.0	-4.6	-4.8	-4.8	-4.8	-4.8	-4.8	0.2	0.3
5	-4.0	-4.7	-4.9	-4.8	-4.8	-4.8	-4.8	0.2	0.3
6	-4.0	-4.7	-4.9	-4.8	-4.8	-4.8	-4.8	0.2	0.3
7	-4.0	-4.7	-4.9	-4.8	-4.8	-4.8	-4.8	0.2	0.3
8	-4.0	-4.7	-4.9	-4.8	-4.8	-4.8	-4.8	0.2	0.3
9	1.1	0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.5
10	1.2	1.1	1.1	1.0	1.0	1.0	1.0	0.8	0.7

Figure E.4. Predicted disturbance pressures - Case 4.
Subslab depressurization, 1 mm separation, high flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-15.6
OUTDOORS	0.0
LIVING ROOM	-15.6
HALLWAY	-15.6
BEDROOM 3	-15.6
BATHROOM	-15.6
MASTER BEDROOM	-15.6
BEDROOM 2	-15.6

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-16.2	*****	-4.1	-13.2	-0.4	0.0
3	-36.1	-24.2	-18.7	-16.6	-18.1	-17.9	-18.1	-2.0	-0.6
4	-36.1	-24.2	-18.7	-17.0	-18.1	-18.0	-18.1	-2.0	-0.6
5	-36.1	-24.2	-18.7	-17.5	-18.1	-18.0	-18.1	-2.0	-0.6
6	-36.1	-24.2	-18.7	-18.1	-18.1	-18.1	-18.1	-2.0	-0.6
7	-36.1	-24.2	-18.7	-18.4	-18.1	-18.1	-18.1	-2.1	-0.6
8	-36.1	-24.2	-18.7	-18.4	-18.1	-18.1	-18.1	-2.1	-0.7
9	-16.1	-13.6	-11.7	-11.5	-11.3	-11.1	-10.6	-4.9	-2.2
10	-8.1	-7.5	-6.9	-6.9	-6.8	-6.8	-6.6	-4.9	-3.2
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-16.1	*****	-3.8	-12.3	-0.3	0.1
3	-21.4	-18.7	-16.9	-16.2	-16.7	-16.6	-16.7	-1.8	-0.5
4	-21.4	-18.7	-16.9	-16.3	-16.7	-16.6	-16.7	-1.8	-0.5
5	-21.4	-18.7	-16.9	-16.5	-16.7	-16.7	-16.7	-1.8	-0.5
6	-21.4	-18.7	-16.9	-16.7	-16.7	-16.7	-16.7	-1.8	-0.5
7	-21.4	-18.7	-16.9	-16.8	-16.7	-16.7	-16.7	-1.8	-0.6
8	-21.4	-18.7	-16.9	-16.8	-16.7	-16.7	-16.7	-1.9	-0.6
9	-12.3	-10.9	-9.6	-9.5	-9.3	-9.2	-8.8	-4.3	-2.0
10	-7.0	-6.5	-6.1	-6.0	-6.0	-6.0	-5.8	-4.4	-3.0
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-16.0	*****	-3.7	-12.0	-0.2	0.1
3	-17.2	-16.6	-16.3	-16.1	-16.3	-16.2	-16.4	-1.5	-0.5
4	-17.2	-16.6	-16.3	-16.1	-16.3	-16.2	-16.4	-1.5	-0.5
5	-17.2	-16.6	-16.3	-16.2	-16.3	-16.3	-16.4	-1.5	-0.5
6	-17.2	-16.6	-16.3	-16.3	-16.3	-16.3	-16.4	-1.5	-0.5
7	-17.2	-16.6	-16.3	-16.3	-16.3	-16.3	-16.4	-1.5	-0.5
8	-17.2	-16.6	-16.3	-16.3	-16.3	-16.3	-16.4	-1.6	-0.5
9	-9.8	-8.9	-7.9	-7.8	-7.7	-7.6	-7.3	-3.7	-1.8
10	-6.1	-5.7	-5.4	-5.3	-5.3	-5.3	-5.2	-4.0	-2.8
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-16.1	*****	-3.7	-12.0	-0.2	0.1
3	-16.3	-16.1	-16.1	-16.1	-16.3	-16.2	-16.3	-1.5	-0.5
4	-16.3	-16.2	-16.1	-16.1	-16.3	-16.2	-16.3	-1.5	-0.5
5	-16.7	-16.4	-16.2	-16.2	-16.3	-16.3	-16.3	-1.5	-0.5
6	-17.0	-16.5	-16.2	-16.2	-16.3	-16.3	-16.3	-1.5	-0.5
7	-17.1	-16.6	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
8	-17.1	-16.6	-16.3	-16.3	-16.3	-16.3	-16.3	-1.6	-0.5
9	-9.7	-8.7	-7.8	-7.7	-7.6	-7.5	-7.2	-3.6	-1.8
10	-6.0	-5.7	-5.3	-5.3	-5.3	-5.2	-5.1	-4.0	-2.8
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	-3.7	-12.0	-0.2	0.1
3	-16.9	-16.5	-16.3	-16.3	-16.3	-16.2	-16.3	-1.5	-0.4
4	-16.9	-16.5	-16.3	-16.3	-16.3	-16.2	-16.3	-1.5	-0.5
5	-16.9	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
6	-16.9	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
7	-17.0	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
8	-17.0	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.6	-0.5
9	-9.5	-8.6	-7.7	-7.6	-7.5	-7.4	-7.1	-3.6	-1.8
10	-6.0	-5.6	-5.3	-5.3	-5.2	-5.2	-5.1	-4.0	-2.8
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-12.4	-12.1	-12.0	-12.0	-1.1	0.1
3	-16.8	-16.3	-16.2	-16.2	-16.2	-16.1	-16.3	-1.5	-0.4
4	-16.8	-16.4	-16.2	-16.2	-16.2	-16.2	-16.3	-1.5	-0.4
5	-16.9	-16.4	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
6	-16.9	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
7	-16.9	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
8	-17.0	-16.5	-16.3	-16.3	-16.3	-16.3	-16.3	-1.5	-0.5
9	-9.3	-8.5	-7.5	-7.4	-7.3	-7.2	-7.0	-3.5	-1.8
10	-5.9	-5.6	-5.2	-5.2	-5.2	-5.1	-5.0	-3.9	-2.8

Figure E.5. Predicted disturbance pressures - Case 5.
Subslab pressurization, 1 mm separation, high flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-5.2
OUTDOORS	0.0
LIVING ROOM	-5.2
HALLWAY	-5.2
BEDROOM 3	-5.2
BATHROOM	-5.2
MASTER BEDROOM	-5.2
BEDROOM 2	-5.2

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	0.3	0.3
2	*****	*****	*****	-5.1	*****	-1.1	-1.1	0.5	0.4
3	31.3	9.5	-0.6	-4.5	-1.6	-1.6	-1.6	0.6	0.4
4	31.3	9.5	-0.6	-3.6	-1.6	-1.6	-1.6	0.6	0.4
5	31.3	9.5	-0.5	-2.7	-1.6	-1.6	-1.6	0.6	0.4
6	31.3	9.5	-0.5	-1.7	-1.6	-1.6	-1.6	0.6	0.4
7	31.2	9.5	-0.5	-1.1	-1.5	-1.5	-1.6	0.6	0.5
8	31.2	9.5	-0.4	-1.0	-1.5	-1.5	-1.6	0.6	0.5
9	8.6	5.6	4.2	4.1	3.9	3.8	3.6	1.5	0.8
10	3.1	2.7	2.5	2.5	2.4	2.4	2.3	1.6	1.1
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	0.3	0.3
2	*****	*****	*****	-5.4	*****	-0.8	-0.7	0.3	0.4
3	4.5	-0.4	-3.8	-5.2	-4.1	-4.0	-4.0	0.4	0.4
4	4.5	-0.4	-3.8	-4.9	-4.1	-4.1	-4.0	0.4	0.4
5	4.5	-0.4	-3.8	-4.5	-4.1	-4.1	-4.0	0.4	0.4
6	4.5	-0.4	-3.8	-4.1	-4.1	-4.1	-4.0	0.4	0.4
7	4.5	-0.4	-3.7	-3.9	-4.1	-4.1	-4.0	0.4	0.4
8	4.5	-0.4	-3.7	-3.9	-4.1	-4.0	-4.0	0.4	0.4
9	3.5	2.4	1.9	1.9	1.8	1.8	1.7	1.1	0.7
10	2.3	2.1	1.9	1.9	1.9	1.9	1.8	1.4	1.0
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	0.2	0.3
2	*****	*****	*****	-5.5	*****	-0.9	-3.2	0.3	0.4
3	-3.1	-4.2	-4.8	-5.4	-4.7	-4.6	-4.5	0.3	0.4
4	-3.1	-4.2	-4.8	-5.2	-4.7	-4.7	-4.5	0.3	0.4
5	-3.1	-4.2	-4.8	-5.1	-4.7	-4.7	-4.5	0.3	0.4
6	-3.1	-4.2	-4.8	-4.9	-4.7	-4.7	-4.5	0.3	0.4
7	-3.1	-4.2	-4.8	-4.8	-4.7	-4.7	-4.5	0.4	0.4
8	-3.1	-4.2	-4.8	-4.7	-4.7	-4.7	-4.5	0.4	0.4
9	2.2	1.6	1.3	1.3	1.3	1.2	1.2	1.0	0.7
10	1.9	1.8	1.7	1.6	1.6	1.6	1.6	1.3	1.0
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	0.2	0.3
2	*****	*****	*****	-5.5	*****	-0.9	-3.2	0.3	0.4
3	-5.1	-5.3	-5.4	-5.4	-4.7	-4.6	-4.6	0.3	0.4
4	-4.6	-5.0	-5.2	-5.2	-4.7	-4.6	-4.6	0.3	0.4
5	-4.2	-4.6	-5.1	-5.0	-4.7	-4.7	-4.6	0.3	0.4
6	-3.7	-4.5	-4.9	-4.8	-4.7	-4.7	-4.6	0.3	0.4
7	-3.4	-4.4	-4.8	-4.7	-4.7	-4.7	-4.6	0.4	0.4
8	-3.3	-4.3	-4.7	-4.7	-4.7	-4.7	-4.6	0.4	0.4
9	2.1	1.5	1.3	1.3	1.2	1.2	1.2	0.9	0.7
10	1.9	1.8	1.6	1.6	1.6	1.6	1.6	1.3	1.0
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	0.2	0.3
2	*****	*****	*****	*****	*****	-0.9	-3.3	0.3	0.4
3	-3.7	-4.5	-4.8	-4.7	-4.7	-4.6	-4.6	0.3	0.4
4	-3.7	-4.5	-4.8	-4.7	-4.7	-4.6	-4.6	0.3	0.4
5	-3.6	-4.5	-4.8	-4.7	-4.7	-4.6	-4.6	0.3	0.4
6	-3.6	-4.5	-4.7	-4.7	-4.7	-4.6	-4.6	0.3	0.4
7	-3.6	-4.5	-4.7	-4.7	-4.7	-4.6	-4.6	0.3	0.4
8	-3.6	-4.4	-4.7	-4.7	-4.7	-4.6	-4.6	0.4	0.4
9	2.0	1.5	1.2	1.2	1.2	1.2	1.1	0.9	0.7
10	1.9	1.7	1.6	1.6	1.6	1.6	1.6	1.3	1.0
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	-0.7	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	0.2	0.3
2	-2.7	-3.2	-3.3	-3.3	-3.3	-3.3	-3.3	0.3	0.4
3	-3.6	-4.4	-4.7	-4.6	-4.6	-4.6	-4.6	0.3	0.4
4	-3.6	-4.4	-4.7	-4.7	-4.6	-4.6	-4.6	0.3	0.4
5	-3.6	-4.5	-4.7	-4.7	-4.6	-4.6	-4.6	0.3	0.4
6	-3.6	-4.5	-4.7	-4.7	-4.7	-4.6	-4.6	0.3	0.4
7	-3.6	-4.4	-4.7	-4.7	-4.7	-4.6	-4.6	0.3	0.4
8	-3.6	-4.4	-4.7	-4.7	-4.7	-4.6	-4.6	0.4	0.4
9	2.0	1.4	1.2	1.2	1.2	1.2	1.1	0.9	0.7
10	1.8	1.7	1.6	1.6	1.6	1.6	1.5	1.2	0.9

Figure E.7. Predicted disturbance pressures - Case 7.
Subslab depressurization, 20 mm separation, low flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-3.1
OUTDOORS	0.0
LIVING ROOM	0.0
HALLWAY	0.0
BEDROOM 3	0.0
BATHROOM	0.0
MASTER BEDROOM	0.0
BEDROOM 2	0.0

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
4	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
5	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
6	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
7	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
8	-13.9	-6.3	-2.7	-3.2	-1.7	-0.1	-1.0	-0.1	0.1
9	-4.6	-3.4	-2.7	-2.6	-2.5	-2.5	-2.3	-0.9	-0.3
10	-1.8	-1.7	-1.5	-1.5	-1.5	-1.4	-1.4	-0.9	-0.5
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
4	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
5	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
6	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
7	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
8	-4.7	-3.1	-2.0	-3.1	-1.3	0.1	-0.7	-0.1	0.1
9	-2.7	-2.2	-1.8	-1.8	-1.7	-1.7	-1.6	-0.7	-0.2
10	-1.5	-1.3	-1.2	-1.2	-1.2	-1.2	-1.1	-0.8	-0.5
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
4	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
5	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
6	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
7	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
8	-2.2	-1.9	-1.5	-3.0	-0.9	0.1	-0.4	0.0	0.1
9	-1.9	-1.6	-1.3	-1.3	-1.3	-1.2	-1.2	-0.5	-0.2
10	-1.2	-1.1	-1.0	-1.0	-1.0	-1.0	-1.0	-0.7	-0.4
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
4	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
5	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
6	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
7	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
8	-3.3	-3.3	-3.3	-3.3	*****	0.2	0.2	0.2	0.2
9	-1.9	-1.5	-1.3	-1.3	-1.2	-1.2	-1.2	-0.5	-0.2
10	-1.2	-1.1	-1.0	-1.0	-1.0	-1.0	-1.0	-0.7	-0.4
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	*****	*****	*****	*****
3	-1.4	-1.2	-0.9	-0.7	-0.4	0.2	-0.4	0.0	0.1
4	-1.4	-1.2	-0.9	-0.7	-0.4	0.1	-0.4	0.0	0.1
5	-1.4	-1.2	-0.9	-0.7	-0.4	0.1	-0.4	0.0	0.1
6	-1.4	-1.2	-0.9	-0.7	-0.4	0.1	-0.4	0.0	0.1
7	-1.4	-1.2	-0.9	-0.7	-0.4	0.1	-0.4	0.0	0.1
8	-1.4	-1.2	-0.9	-0.7	-0.4	0.1	-0.4	0.0	0.1
9	-1.8	-1.5	-1.3	-1.2	-1.2	-1.2	-1.1	-0.5	-0.2
10	-1.2	-1.1	-1.0	-1.0	-1.0	-1.0	-0.9	-0.7	-0.4
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
3	0.1	0.1	0.1	0.2	0.2	0.2	-0.4	0.0	0.1
4	-0.1	0.0	0.0	0.1	0.1	0.1	-0.4	0.0	0.1
5	-0.2	-0.2	-0.1	0.0	0.0	0.0	-0.4	0.0	0.1
6	-0.5	-0.5	-0.3	-0.2	-0.1	-0.1	-0.4	0.0	0.1
7	-0.9	-0.8	-0.5	-0.4	-0.3	-0.3	-0.4	0.0	0.1
8	-1.1	-0.9	-0.6	-0.5	-0.4	-0.3	-0.4	0.0	0.1
9	-1.8	-1.5	-1.2	-1.2	-1.2	-1.2	-1.1	-0.5	-0.2
10	-1.2	-1.1	-1.0	-1.0	-1.0	-1.0	-0.9	-0.7	-0.4

Figure E.8. Predicted disturbance pressures - Case 8.
Subslab pressurization, 20 mm separation, low flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-2.5
OUTDOORS	-0.005
LIVING ROOM	-0.000000000
HALLWAY	-0.000000000
BEDROOM 3	-0.000000000
BATHROOM	-0.000000000
MASTER BEDROOM	-0.000000000
BEDROOM 2	-2.5

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-2.5	0.3	0.3	0.3	0.4	0.3
3	27.0	9.4	1.2	-2.0	0.3	0.3	0.3	0.7	0.5
4	27.0	9.4	1.2	-1.3	0.3	0.3	0.3	0.7	0.5
5	27.0	9.4	1.2	-0.5	0.3	0.3	0.3	0.7	0.5
6	27.0	9.4	1.2	0.3	0.3	0.3	0.3	0.7	0.5
7	27.0	9.4	1.3	0.7	0.4	0.4	0.3	0.8	0.5
8	26.9	9.4	1.3	0.8	0.4	0.4	0.3	0.8	0.5
9	8.2	5.6	4.4	4.3	4.2	4.1	3.8	1.8	1.0
10	3.3	3.0	2.7	2.7	2.7	2.6	2.6	1.8	1.3
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-2.6	0.2	0.2	0.1	0.5	0.4
3	5.9	2.1	-0.5	-1.3	-0.5	0.2	-0.2	0.6	0.5
4	5.9	2.1	-0.5	-1.3	-0.5	0.2	-0.2	0.6	0.5
5	5.9	2.1	-0.5	-1.3	-0.5	0.2	-0.2	0.6	0.5
6	5.9	2.1	-0.5	-1.3	-0.5	0.2	-0.2	0.6	0.5
7	5.9	2.1	-0.5	-1.3	-0.5	0.2	-0.2	0.6	0.5
8	5.9	2.1	-0.4	-0.5	-0.5	0.3	-0.2	0.6	0.5
9	4.1	3.2	2.7	2.6	2.6	2.5	2.4	1.4	0.9
10	2.6	2.4	2.2	2.2	2.2	2.2	2.1	1.6	1.2
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-2.7	0.2	0.2	0.1	0.5	0.4
3	-0.1	-0.7	-1.0	-2.4	-0.6	0.2	-0.2	0.6	0.4
4	-0.1	-0.7	-1.0	-2.0	-0.6	0.1	-0.2	0.6	0.4
5	-0.1	-0.7	-1.0	-1.5	-0.6	0.0	-0.2	0.6	0.4
6	-0.1	-0.7	-1.0	-1.0	-0.5	-0.1	-0.2	0.6	0.4
7	-0.1	-0.7	-0.9	-0.6	-0.5	-0.2	-0.2	0.6	0.5
8	-0.1	-0.7	-0.9	-0.7	-0.5	-0.4	-0.2	0.6	0.5
9	2.9	2.4	2.1	2.0	2.0	2.0	1.9	1.2	0.8
10	2.2	2.1	1.9	1.9	1.9	1.9	1.9	1.5	1.1
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-2.6	0.2	0.2	0.1	0.5	0.4
3	-2.2	-2.3	-2.4	-2.3	-0.4	0.2	-0.2	0.6	0.4
4	-1.7	-1.9	-2.0	-1.9	-0.4	0.1	-0.2	0.6	0.4
5	-1.2	-1.4	-1.5	-1.4	-0.4	0.1	-0.2	0.6	0.4
6	-0.6	-1.0	-1.0	-0.9	-0.4	-0.1	-0.2	0.6	0.4
7	-0.2	-0.7	-0.8	-0.6	-0.4	-0.2	-0.2	0.6	0.5
8	-0.2	-0.6	-0.7	-0.6	-0.4	-0.3	-0.2	0.6	0.5
9	2.8	2.3	2.0	2.0	2.0	1.9	1.9	1.2	0.8
10	2.2	2.1	1.9	1.9	1.9	1.9	1.9	1.5	1.1
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	0.2	0.1	0.5	0.4
3	-0.3	-0.6	-0.6	-0.4	-0.2	0.2	-0.1	0.6	0.4
4	-0.3	-0.6	-0.6	-0.4	-0.2	0.2	-0.1	0.6	0.4
5	-0.3	-0.6	-0.6	-0.4	-0.2	0.1	-0.1	0.6	0.4
6	-0.3	-0.6	-0.6	-0.4	-0.2	0.0	-0.1	0.6	0.4
7	-0.3	-0.6	-0.5	-0.4	-0.2	-0.1	-0.1	0.6	0.5
8	-0.3	-0.6	-0.5	-0.4	-0.2	-0.2	-0.1	0.6	0.5
9	2.7	2.3	2.0	2.0	1.9	1.9	1.8	1.2	0.8
10	2.2	2.0	1.9	1.9	1.9	1.9	1.8	1.5	1.1
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.5	0.4
3	0.2	0.2	0.2	0.2	0.2	0.2	-0.1	0.6	0.4
4	0.1	0.1	0.1	0.1	0.1	0.2	-0.1	0.6	0.4
5	0.1	0.0	0.0	0.1	0.1	0.1	-0.1	0.6	0.4
6	0.0	-0.2	-0.1	-0.1	0.0	0.0	-0.1	0.6	0.4
7	-0.1	-0.3	-0.3	-0.2	-0.1	-0.1	-0.1	0.6	0.4
8	-0.2	-0.4	-0.4	-0.3	-0.2	-0.1	-0.1	0.6	0.5
9	2.7	2.2	1.9	1.9	1.9	1.9	1.8	1.2	0.8
10	2.1	2.0	1.9	1.9	1.9	1.9	1.8	1.5	1.1

Figure E.9. Predicted disturbance pressures - Case 9.
Subslab depressurization, 20 mm separation, high flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-3.4
OUTDOORS	0.0
LIVING ROOM	-3.4
HALLWAY	-3.4
BEDROOM 3	-3.4
BATHROOM	-3.4
MASTER BEDROOM	-3.4
BEDROOM 2	-3.4

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.1	0.2
2	*****	*****	*****	-3.7	*****	0.2	-0.2	-0.1	0.1
3	-21.1	-9.1	-3.5	-3.6	-2.1	0.0	-1.2	-0.3	0.0
4	-21.1	-9.1	-3.5	-3.4	-2.1	-0.2	-1.2	-0.3	0.0
5	-21.1	-9.1	-3.5	-3.1	-2.1	-0.5	-1.2	-0.3	0.0
6	-21.1	-9.1	-3.5	-2.9	-2.1	-0.9	-1.2	-0.3	0.0
7	-21.1	-9.1	-3.5	-2.8	-2.1	-1.4	-1.2	-0.3	0.0
8	-21.1	-9.1	-3.5	-2.8	-2.1	-1.7	-1.2	-0.3	0.0
9	-6.9	-5.0	-4.0	-3.9	-3.8	-3.6	-3.4	-1.4	-0.5
10	-2.8	-2.5	-2.2	-2.2	-2.2	-2.2	-2.1	-1.4	-0.6
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.1	0.2
2	*****	*****	*****	-3.6	*****	0.2	-0.1	-0.1	0.1
3	-6.7	-4.1	-2.3	-3.4	-1.5	0.1	-0.8	-0.2	0.0
4	-6.7	-4.1	-2.3	-3.0	-1.5	-0.1	-0.8	-0.2	0.0
5	-6.7	-4.1	-2.3	-2.6	-1.5	-0.3	-0.8	-0.2	0.0
6	-6.7	-4.1	-2.3	-2.2	-1.5	-0.6	-0.8	-0.2	0.0
7	-6.7	-4.1	-2.3	-1.9	-1.5	-1.0	-0.9	-0.2	0.0
8	-6.7	-4.1	-2.3	-1.9	-1.5	-1.2	-0.9	-0.2	0.0
9	-3.9	-3.1	-2.6	-2.6	-2.5	-2.4	-2.3	-1.1	-0.4
10	-2.2	-2.0	-1.8	-1.8	-1.8	-1.8	-1.7	-1.2	-0.6
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.2	0.2
2	*****	*****	*****	-3.6	*****	0.2	0.0	0.0	0.1
3	-2.6	-2.2	-1.7	-3.2	-1.0	0.1	-0.5	-0.1	0.0
4	-2.6	-2.2	-1.7	-2.7	-1.0	0.0	-0.5	-0.1	0.0
5	-2.6	-2.2	-1.7	-2.2	-1.0	-0.1	-0.5	-0.1	0.0
6	-2.6	-2.1	-1.7	-1.7	-1.0	-0.3	-0.5	-0.1	0.0
7	-2.6	-2.1	-1.6	-1.3	-1.0	-0.6	-0.5	-0.1	0.0
8	-2.5	-2.1	-1.6	-1.3	-1.0	-0.7	-0.5	-0.2	0.0
9	-2.8	-2.3	-1.9	-1.9	-1.9	-1.8	-1.7	-0.9	-0.4
10	-1.8	-1.7	-1.6	-1.5	-1.5	-1.5	-1.5	-1.1	-0.7
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.2	0.2
2	*****	*****	*****	-3.6	*****	0.2	0.0	0.0	0.1
3	-3.4	-3.3	-3.2	-3.1	-0.8	0.1	-0.5	-0.1	0.0
4	-3.1	-2.9	-2.7	-2.6	-0.8	0.1	-0.5	-0.1	0.0
5	-2.7	-2.5	-2.2	-2.0	-0.8	-0.1	-0.5	-0.1	0.0
6	-2.3	-2.1	-1.7	-1.4	-0.7	-0.3	-0.5	-0.1	0.0
7	-2.1	-1.8	-1.3	-1.1	-0.7	-0.5	-0.5	-0.1	0.0
8	-2.1	-1.8	-1.3	-1.0	-0.8	-0.6	-0.5	-0.1	0.0
9	-2.7	-2.2	-1.9	-1.9	-1.8	-1.8	-1.7	-0.8	-0.4
10	-1.8	-1.7	-1.5	-1.5	-1.5	-1.5	-1.5	-1.1	-0.7
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.2	0.2
2	*****	*****	*****	*****	*****	0.2	0.0	0.0	0.1
3	-1.6	-1.4	-1.0	-0.8	-0.5	0.2	-0.4	-0.1	0.0
4	-1.6	-1.4	-1.0	-0.8	-0.5	0.1	-0.4	-0.1	0.0
5	-1.6	-1.4	-1.0	-0.8	-0.5	0.0	-0.4	-0.1	0.0
6	-1.6	-1.4	-1.0	-0.8	-0.5	-0.2	-0.4	-0.1	0.0
7	-1.6	-1.4	-1.0	-0.8	-0.5	-0.4	-0.4	-0.1	0.0
8	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.1	0.0
9	-2.6	-2.2	-1.9	-1.8	-1.8	-1.8	-1.7	-0.8	-0.4
10	-1.8	-1.6	-1.5	-1.5	-1.5	-1.5	-1.4	-1.1	-0.7
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2	0.2	0.2	0.2	0.2	0.2	0.2	-0.1	0.0	0.1
3	0.1	0.1	0.1	0.1	0.2	0.2	-0.4	-0.1	0.0
4	-0.1	-0.1	-0.0	-0.1	0.1	0.1	-0.4	-0.1	0.0
5	-0.3	-0.3	-0.1	-0.1	0.0	0.0	-0.4	-0.1	0.0
6	-0.7	-0.6	-0.3	-0.3	-0.2	-0.1	-0.4	-0.1	0.0
7	-1.1	-0.9	-0.6	-0.5	-0.4	-0.3	-0.4	-0.1	0.0
8	-1.3	-1.1	-0.7	-0.6	-0.5	-0.4	-0.4	-0.1	0.0
9	-2.6	-2.1	-1.8	-1.8	-1.8	-1.7	-1.6	-0.8	-0.4
10	-1.8	-1.6	-1.5	-1.5	-1.5	-1.5	-1.4	-1.1	-0.7

VERTICAL SLICE Y= 7									
Z=	X=1	2	3	4	5	6	7	8	9
1	0.2	-0.2	0.2	0.2	0.2	-0.2	0.2	0.2	0.2
2	-0.1	-0.1	0.0	0.0	0.0	-0.1	-0.1	0.0	0.1
3	-0.9	-0.8	-0.5	-0.5	-0.4	-0.4	-0.4	-0.1	0.0
4	-0.9	-0.8	-0.5	-0.5	-0.4	-0.4	-0.4	-0.1	0.0
5	-0.9	-0.8	-0.5	-0.5	-0.4	-0.4	-0.4	-0.1	0.0
6	-0.9	-0.8	-0.5	-0.5	-0.4	-0.4	-0.4	-0.1	0.0
7	-0.9	-0.8	-0.5	-0.5	-0.5	-0.4	-0.4	-0.1	0.0
8	-0.9	-0.8	-0.5	-0.5	-0.5	-0.4	-0.4	-0.1	0.0
9	-2.4	-2.0	-1.7	-1.7	-1.7	-1.8	-1.5	-0.8	-0.3
10	-1.7	-1.6	-1.5	-1.4	-1.4	-1.4	-1.4	-1.0	-0.7

VERTICAL SLICE Y= 8									
Z=	X=1	2	3	4	5	6	7	8	9
0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
3	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
4	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
5	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
6	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
7	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
8	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
9	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1
10	-0.9	-0.8	-0.8	-0.7	-0.7	-0.7	-0.7	-0.5	-0.5
11	-1.1	-1.0	-1.0	-1.0	-1.0	-1.0	-0.9	-0.8	-0.5

[illegible]

Figure E.10. Predicted disturbance pressures - Case 10.
Subslab pressurization, 20 mm separation, high flow rate.

ZONE	PRESSURE [Pa]
BASEMENT	-2.8
OUTDOORS	0.0
LIVING ROOM	-2.8
HALLWAY	-2.8
BEDROOM 3	-2.8
BATHROOM	-2.8
MASTER BEDROOM	-2.8
BEDROOM 2	-2.8

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.3	0.3	0.4	0.3
2	*****	*****	*****	-2.8	0.3	0.3	0.3	0.7	0.5
3	33.9	12.0	1.7	-2.2	0.5	0.3	0.4	0.9	0.6
4	33.9	12.0	1.7	-1.3	0.5	0.3	0.4	0.9	0.6
5	33.9	12.0	1.7	-0.4	0.5	0.3	0.4	0.9	0.6
6	33.9	12.0	1.7	0.5	0.5	0.4	0.4	0.9	0.6
7	33.9	12.0	1.7	1.1	0.6	0.5	0.4	0.9	0.6
8	33.9	12.0	1.8	1.2	0.6	0.5	0.4	0.9	0.6
9	10.3	7.1	5.6	5.4	5.3	5.1	4.8	2.2	1.2
10	4.1	3.7	3.4	3.3	3.3	3.3	3.2	2.3	1.6
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.4	0.3
2	*****	*****	*****	-2.9	0.2	0.2	0.1	0.6	0.5
3	7.6	2.8	-0.5	-2.5	-0.5	0.2	-0.2	0.7	0.5
4	7.6	2.8	-0.5	-2.0	-0.5	0.1	-0.2	0.7	0.5
5	7.6	2.8	-0.5	-1.4	-0.5	0.0	-0.2	0.7	0.5
6	7.6	2.8	-0.4	-0.8	-0.5	-0.1	-0.2	0.7	0.5
7	7.6	2.8	-0.4	-0.5	-0.5	-0.3	-0.2	0.7	0.5
8	7.6	2.8	-0.4	-0.4	-0.5	-0.3	-0.2	0.8	0.5
9	5.2	4.0	3.4	3.3	3.2	3.2	3.0	1.7	1.0
10	3.2	3.0	2.8	2.7	2.7	2.7	2.6	2.0	1.5
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.3	0.3
2	*****	*****	*****	-2.9	0.2	0.2	0.1	0.5	0.4
3	0.0	-0.8	-1.1	-2.6	-0.6	0.2	-0.2	0.7	0.5
4	0.0	-0.8	-1.1	-2.2	-0.6	0.1	-0.2	0.7	0.5
5	0.0	-0.8	-1.1	-1.7	-0.6	0.0	-0.2	0.7	0.5
6	0.0	-0.7	-1.1	-1.2	-0.6	-0.1	-0.2	0.7	0.5
7	0.1	-0.7	-1.0	-0.9	-0.6	-0.3	-0.2	0.7	0.5
8	0.1	-0.7	-1.0	-0.8	-0.6	-0.4	-0.2	0.7	0.5
9	3.6	3.0	2.6	2.5	2.5	2.5	2.4	1.5	1.0
10	2.8	2.6	2.4	2.4	2.4	2.4	2.3	1.8	1.4
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.3	0.3
2	*****	*****	*****	-2.9	0.2	0.2	0.1	0.5	0.4
3	-2.5	-2.6	-2.6	-2.6	-0.5	0.2	-0.2	0.7	0.5
4	-1.9	-2.1	-2.2	-2.1	-0.5	0.1	-0.2	0.7	0.5
5	-1.2	-1.6	-1.7	-1.5	-0.4	0.0	-0.2	0.7	0.5
6	-0.5	-1.0	-1.2	-1.0	-0.4	-0.1	-0.2	0.7	0.5
7	-0.2	-0.7	-0.9	-0.7	-0.4	-0.2	-0.2	0.7	0.5
8	-0.1	-0.7	-0.8	-0.6	-0.4	-0.3	-0.2	0.7	0.5
9	3.5	2.9	2.5	2.5	2.5	2.4	2.3	1.5	1.0
10	2.7	2.6	2.4	2.4	2.4	2.3	2.3	1.8	1.4
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	0.2	0.2	0.3	0.3
2	*****	*****	*****	*****	*****	0.2	0.1	0.5	0.4
3	-0.3	-0.7	-0.6	-0.5	-0.3	0.2	-0.2	0.6	0.5
4	-0.3	-0.7	-0.6	-0.5	-0.3	0.1	-0.2	0.6	0.5
5	-0.3	-0.7	-0.6	-0.5	-0.3	0.1	-0.2	0.6	0.5
6	-0.3	-0.6	-0.6	-0.4	-0.3	0.0	-0.2	0.7	0.5
7	-0.3	-0.6	-0.6	-0.4	-0.3	-0.2	-0.2	0.7	0.5
8	-0.2	-0.6	-0.6	-0.4	-0.3	-0.2	-0.2	0.7	0.5
9	3.4	2.8	2.5	2.5	2.4	2.4	2.3	1.5	1.0
10	2.7	2.5	2.4	2.4	2.3	2.3	2.3	1.8	1.4
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.5	0.4
3	0.2	0.2	0.2	0.2	0.2	0.2	-0.2	0.6	0.5
4	0.2	0.1	0.1	0.1	0.1	0.2	-0.2	0.6	0.5
5	0.1	0.0	0.0	0.0	0.1	0.1	-0.2	0.6	0.5
6	0.0	-0.2	-0.2	-0.1	0.0	0.0	-0.2	0.6	0.5
7	-0.1	-0.4	-0.3	-0.2	-0.2	-0.1	-0.2	0.7	0.5
8	-0.2	-0.5	-0.4	-0.3	-0.2	-0.2	-0.2	0.7	0.5
9	3.4	2.8	2.4	2.4	2.4	2.3	2.3	1.5	1.0
10	2.7	2.5	2.4	2.3	2.3	2.3	2.3	1.8	1.4

Figure E.11. Predicted disturbance pressures - Case 11.
Basement suction, 20 mm separation, soil air barrier.

ZONE	PRESSURE [Pa]
BASEMENT	-13.0
OUTDOORS	0.0
LIVING ROOM	-13.0
HALLWAY	-13.0
BEDROOM 3	-13.0
BATHROOM	-13.0
MASTER BEDROOM	-13.0
BEDROOM 2	-13.0

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-13.4	-13.2	-0.4	0.1
2	*****	*****	*****	-13.4	*****	-13.4	-13.3	-1.2	-0.2
3	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
4	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
5	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
6	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
7	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
8	-13.3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.5	-0.3
9	-8.2	-7.5	-6.7	-6.6	-6.6	-6.5	-6.2	-3.0	-1.3
10	-4.6	-4.3	-4.0	-4.0	-4.0	-4.0	-3.9	-2.9	-1.9
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-13.4	-13.2	-0.3	0.1
2	*****	*****	*****	-13.4	*****	-13.4	-13.3	-1.2	-0.1
3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
5	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
6	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
7	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
8	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.4	-0.3
9	-7.4	-6.9	-6.1	-6.1	-6.0	-5.9	-5.7	-2.7	-1.2
10	-4.2	-3.9	-3.7	-3.6	-3.6	-3.6	-3.5	-2.7	-1.8
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-13.4	-13.2	-0.3	0.1
2	*****	*****	*****	-13.4	*****	-13.4	-13.2	-1.0	-0.1
3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
5	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
6	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
7	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
8	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
9	-6.2	-5.8	-5.2	-5.1	-5.1	-5.0	-4.8	-2.3	-1.1
10	-3.7	-3.5	-3.3	-3.3	-3.2	-3.2	-3.1	-2.5	-1.7
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-13.4	-13.1	-0.3	0.1
2	*****	*****	*****	-13.4	*****	-13.4	-13.2	-1.0	-0.1
3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
5	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
6	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
7	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
8	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
9	-6.1	-5.7	-5.1	-5.1	-5.0	-4.9	-4.7	-2.3	-1.1
10	-3.6	-3.5	-3.2	-3.2	-3.2	-3.2	-3.1	-2.4	-1.7
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-13.4	-13.1	-0.3	0.1
2	*****	*****	*****	*****	*****	-13.4	-13.2	-1.0	-0.1
3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
5	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
6	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
7	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
8	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
9	-6.0	-5.6	-5.1	-5.0	-4.9	-4.9	-4.7	-2.3	-1.1
10	-3.6	-3.4	-3.2	-3.2	-3.2	-3.2	-3.1	-2.4	-1.7
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.1	-0.3	0.1
2	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.2	-1.0	-0.1
3	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.1	-0.2
4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.1	-0.2
5	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.1	-0.2
6	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
7	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
8	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-13.4	-1.2	-0.2
9	-5.9	-5.5	-5.0	-4.9	-4.9	-4.8	-4.6	-2.3	-1.1
10	-3.6	-3.4	-3.2	-3.2	-3.1	-3.1	-3.1	-2.4	-1.7

Figure E.12. Predicted disturbance pressures - Case 12.
Subslab depressurization, 20 mm separation, low flow rate, soil air barrier.

ZONE	PRESSURE [Pa]
BASEMENT	-13.0
OUTDOORS	0.0
LIVING ROOM	-13.0
HALLWAY	-13.0
BEDROOM 3	-13.0
BATHROOM	-13.0
MASTER BEDROOM	-13.0
BEDROOM 2	-13.0

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-14.3	-14.2	-0.5	0.1
2	*****	*****	*****	-13.5	*****	-14.3	-14.2	-1.5	-0.3
3	-26.1	-18.5	-14.9	-13.7	-14.5	-14.3	-14.4	-1.8	-0.4
4	-26.1	-18.5	-14.9	-13.9	-14.5	-14.3	-14.4	-1.8	-0.4
5	-26.1	-18.5	-14.9	-14.2	-14.5	-14.3	-14.4	-1.8	-0.4
6	-26.1	-18.5	-14.9	-14.5	-14.5	-14.3	-14.4	-1.8	-0.4
7	-26.1	-18.5	-14.9	-14.7	-14.5	-14.4	-14.4	-1.9	-0.5
8	-26.1	-18.5	-14.9	-14.7	-14.5	-14.4	-14.4	-1.9	-0.5
9	-12.2	-10.5	-9.1	-8.9	-8.8	-8.6	-8.3	-3.9	-1.8
10	-6.3	-5.9	-5.4	-5.4	-5.4	-5.3	-5.2	-3.9	-2.5
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-14.2	-14.1	-0.4	0.1
2	*****	*****	*****	-13.4	*****	-14.2	-14.1	-1.4	-0.2
3	-16.8	-15.2	-14.1	-13.5	-14.1	-14.2	-14.1	-1.6	-0.4
4	-16.8	-15.2	-14.1	-13.7	-14.1	-14.2	-14.1	-1.6	-0.4
5	-16.8	-15.2	-14.1	-13.8	-14.1	-14.2	-14.1	-1.7	-0.4
6	-16.8	-15.2	-14.1	-14.0	-14.1	-14.2	-14.1	-1.7	-0.4
7	-16.8	-15.2	-14.1	-14.1	-14.1	-14.1	-14.1	-1.7	-0.4
8	-16.8	-15.2	-14.2	-14.1	-14.1	-14.1	-14.1	-1.7	-0.4
9	-9.6	-8.7	-7.7	-7.6	-7.5	-7.3	-7.0	-3.5	-1.6
10	-5.5	-5.2	-4.8	-4.8	-4.7	-4.7	-4.6	-3.5	-2.4
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-14.2	-14.0	-0.4	0.1
2	*****	*****	*****	-13.4	*****	-14.2	-14.0	-1.2	-0.2
3	-14.2	-13.9	-13.8	-13.5	-13.9	-14.2	-14.0	-1.4	-0.3
4	-14.2	-13.9	-13.8	-13.6	-13.9	-14.2	-14.0	-1.4	-0.3
5	-14.2	-13.9	-13.8	-13.7	-13.9	-14.2	-14.0	-1.4	-0.3
6	-14.2	-13.9	-13.8	-13.8	-13.9	-14.1	-14.0	-1.4	-0.3
7	-14.2	-13.9	-13.8	-13.9	-13.9	-14.0	-14.0	-1.5	-0.4
8	-14.2	-13.9	-13.8	-13.9	-13.9	-14.0	-14.0	-1.5	-0.4
9	-7.8	-7.1	-6.4	-6.3	-6.2	-6.1	-5.9	-3.0	-1.4
10	-4.8	-4.6	-4.3	-4.2	-4.2	-4.2	-4.1	-3.2	-2.2
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-14.2	-13.9	-0.3	0.1
2	*****	*****	*****	-13.4	*****	-14.2	-14.0	-1.2	-0.2
3	-13.5	-13.5	-13.5	-13.5	-14.0	-14.2	-14.0	-1.4	-0.3
4	-13.7	-13.6	-13.6	-13.6	-14.0	-14.2	-14.0	-1.4	-0.3
5	-13.8	-13.7	-13.7	-13.7	-14.0	-14.2	-14.0	-1.4	-0.3
6	-14.0	-13.8	-13.8	-13.8	-14.0	-14.1	-14.0	-1.4	-0.3
7	-14.1	-13.9	-13.8	-13.9	-14.0	-14.0	-14.0	-1.4	-0.4
8	-14.1	-13.9	-13.9	-13.9	-14.0	-14.0	-14.0	-1.5	-0.4
9	-7.7	-7.0	-6.3	-6.2	-6.1	-6.0	-5.8	-2.9	-1.4
10	-4.8	-4.5	-4.2	-4.2	-4.2	-4.1	-4.1	-3.2	-2.2
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-14.2	-13.9	-0.3	0.1
2	*****	*****	*****	*****	*****	-14.2	-14.0	-1.2	-0.2
3	-14.0	-13.8	-13.9	-13.9	-14.0	-14.2	-14.0	-1.4	-0.3
4	-14.0	-13.8	-13.9	-13.9	-14.0	-14.2	-14.0	-1.4	-0.3
5	-14.0	-13.8	-13.9	-13.9	-14.0	-14.2	-14.0	-1.4	-0.3
6	-14.0	-13.8	-13.9	-13.9	-14.0	-14.1	-14.0	-1.4	-0.3
7	-14.0	-13.8	-13.9	-13.9	-14.0	-14.0	-14.0	-1.4	-0.4
8	-14.0	-13.8	-13.9	-13.9	-14.0	-14.0	-14.0	-1.4	-0.4
9	-7.6	-6.9	-6.2	-6.1	-6.0	-5.9	-5.7	-2.9	-1.4
10	-4.7	-4.5	-4.2	-4.2	-4.1	-4.1	-4.0	-3.2	-2.2
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.8	-0.3	0.1
2	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-1.1	-0.2
3	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-14.0	-1.4	-0.3
4	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-14.0	-1.4	-0.3
5	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-14.0	-1.4	-0.3
6	-13.9	-13.9	-13.9	-13.9	-13.9	-14.0	-14.0	-1.4	-0.3
7	-14.0	-13.9	-13.9	-13.9	-13.9	-14.0	-14.0	-1.4	-0.3
8	-14.0	-13.9	-13.9	-13.9	-14.0	-14.0	-14.0	-1.4	-0.4
9	-7.4	-6.8	-6.1	-6.0	-5.9	-5.8	-5.6	-2.9	-1.4
10	-4.7	-4.4	-4.2	-4.1	-4.1	-4.1	-4.0	-3.1	-2.2

Figure E.13. Predicted disturbance pressures - Case 13.
Subslab pressurization, 20 mm separation, low flow rate, soil air barrier.

ZONE	PRESSURE [Pa]
BASEMENT	-5.3
OUTDOORS	0.0
LIVING ROOM	-5.3
HALLWAY	-5.3
BEDROOM 3	-5.3
BATHROOM	-5.3
MASTER BEDROOM	-5.3
BEDROOM 2	-5.3

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.5	-3.5	0.2	0.3
2	*****	*****	*****	-5.3	*****	-3.5	-3.4	0.2	0.3
3	23.6	6.1	-2.1	-4.9	-3.1	-3.5	-3.2	0.3	0.3
4	23.6	6.1	-2.1	-4.3	-3.1	-3.4	-3.2	0.3	0.3
5	23.6	6.1	-2.1	-3.7	-3.1	-3.4	-3.2	0.3	0.3
6	23.6	6.1	-2.1	-3.0	-3.1	-3.3	-3.2	0.3	0.3
7	23.6	6.1	-2.0	-2.6	-3.0	-3.2	-3.2	0.3	0.3
8	23.6	6.1	-2.0	-2.5	-3.0	-3.1	-3.2	0.3	0.4
9	6.1	3.7	2.6	2.6	2.5	2.4	2.2	0.9	0.5
10	2.0	1.8	1.6	1.6	1.6	1.5	1.5	1.0	0.7
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.6	-3.6	0.2	0.3
2	*****	*****	*****	-5.5	*****	-3.6	-3.6	0.1	0.3
3	2.4	-1.3	-3.8	-5.2	-4.0	-3.6	-3.8	0.2	0.3
4	2.4	-1.3	-3.8	-4.9	-4.0	-3.7	-3.8	0.2	0.3
5	2.4	-1.3	-3.8	-4.5	-4.0	-3.7	-3.8	0.2	0.3
6	2.4	-1.3	-3.8	-4.1	-4.0	-3.8	-3.8	0.2	0.3
7	2.4	-1.3	-3.8	-3.9	-4.0	-3.8	-3.8	0.2	0.3
8	2.4	-1.3	-3.8	-3.9	-4.0	-3.8	-3.8	0.2	0.3
9	2.1	1.3	1.0	1.0	0.9	0.9	0.9	0.6	0.5
10	1.4	1.3	1.2	1.2	1.2	1.2	1.1	0.9	0.7
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.6	-3.7	0.2	0.3
2	*****	*****	*****	-5.5	*****	-3.6	-3.8	0.1	0.3
3	-3.8	-4.4	-4.6	-5.3	-4.3	-3.7	-4.0	0.2	0.3
4	-3.8	-4.4	-4.6	-5.1	-4.3	-3.7	-4.0	0.2	0.3
5	-3.8	-4.4	-4.6	-4.8	-4.3	-3.8	-4.0	0.2	0.3
6	-3.8	-4.4	-4.6	-4.6	-4.3	-3.9	-4.0	0.2	0.3
7	-3.8	-4.4	-4.6	-4.4	-4.3	-4.1	-4.0	0.2	0.3
8	-3.7	-4.4	-4.6	-4.4	-4.3	-4.1	-4.0	0.2	0.3
9	1.2	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.5
10	1.2	1.1	1.0	1.0	1.0	1.0	1.0	0.8	0.6
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.6	-3.7	0.2	0.3
2	-5.5	-5.5	-5.5	-5.5	*****	-3.6	-3.8	0.1	0.3
3	-5.3	-5.3	-5.4	-5.3	-4.3	-3.7	-4.1	0.2	0.3
4	-4.6	-4.6	-4.9	-4.8	-4.3	-3.7	-4.1	0.2	0.3
5	-4.6	-4.6	-4.9	-4.6	-4.3	-3.8	-4.1	0.2	0.3
6	-4.6	-4.6	-4.9	-4.5	-4.3	-3.9	-4.1	0.2	0.3
7	-4.6	-4.6	-4.9	-4.4	-4.3	-4.1	-4.1	0.2	0.3
8	-4.6	-4.6	-4.9	-4.4	-4.3	-4.1	-4.1	0.2	0.3
9	1.1	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.5
10	1.2	1.1	1.0	1.0	1.0	1.0	1.0	0.8	0.6
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-3.6	-3.8	0.2	0.3
2	*****	*****	*****	*****	*****	-3.6	-3.8	0.1	0.3
3	-4.2	-4.5	-4.5	-4.3	-4.3	-3.7	-4.1	0.2	0.3
4	-4.2	-4.5	-4.5	-4.3	-4.3	-3.7	-4.1	0.2	0.3
5	-4.2	-4.5	-4.5	-4.3	-4.3	-3.8	-4.1	0.2	0.3
6	-4.2	-4.5	-4.5	-4.3	-4.3	-3.9	-4.1	0.2	0.3
7	-4.2	-4.5	-4.5	-4.3	-4.3	-4.1	-4.1	0.2	0.3
8	-4.2	-4.5	-4.4	-4.3	-4.2	-4.1	-4.1	0.2	0.3
9	1.1	0.7	0.6	0.6	0.5	0.5	0.5	0.5	0.5
10	1.2	1.1	1.0	1.0	1.0	1.0	1.0	0.8	0.6
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-3.8	0.2	0.3
2	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-3.9	0.1	0.3
3	-4.3	-4.4	-4.4	-4.4	-4.3	-4.3	-4.1	0.2	0.3
4	-4.3	-4.4	-4.4	-4.4	-4.3	-4.3	-4.1	0.2	0.3
5	-4.3	-4.4	-4.4	-4.3	-4.3	-4.3	-4.1	0.2	0.3
6	-4.3	-4.4	-4.4	-4.3	-4.3	-4.3	-4.1	0.2	0.3
7	-4.3	-4.5	-4.4	-4.3	-4.3	-4.2	-4.1	0.2	0.3
8	-4.2	-4.5	-4.4	-4.3	-4.3	-4.2	-4.1	0.2	0.3
9	1.0	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
10	1.1	1.1	1.0	1.0	1.0	1.0	1.0	0.8	0.6

Figure E.14. Predicted disturbance pressures - Case 14.
Subslab depressurization, 20 mm separation, high flow rate, soil air barrier.

ZONE	PRESSURE [Pa]
BASEMENT	-16.3
OUTDOORS	0.0
LIVING ROOM	-16.3
HALLWAY	-16.3
BEDROOM 3	-16.3
BATHROOM	-16.3
MASTER BEDROOM	-16.3
BEDROOM 2	-16.3

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-18.1	-18.0	-0.7	0.0
2	*****	*****	*****	-16.9	*****	-18.1	-18.1	-2.0	-0.4
3	-36.7	-24.7	-19.1	-17.2	-18.4	-18.1	-18.3	-2.4	-0.7
4	-36.7	-24.7	-19.1	-17.6	-18.4	-18.2	-18.3	-2.4	-0.7
5	-36.7	-24.7	-19.1	-18.0	-18.4	-18.2	-18.3	-2.4	-0.7
6	-36.7	-24.7	-19.1	-18.5	-18.4	-18.3	-18.3	-2.5	-0.7
7	-36.7	-24.7	-19.1	-18.7	-18.4	-18.3	-18.3	-2.5	-0.7
8	-36.7	-24.7	-19.2	-18.8	-18.5	-18.4	-18.3	-2.5	-0.7
9	-16.6	-14.1	-12.1	-11.9	-11.7	-11.5	-11.0	-5.3	-2.4
10	-8.4	-7.9	-7.3	-7.2	-7.2	-7.1	-6.9	-5.2	-3.4
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-18.1	-17.9	-0.6	0.0
2	*****	*****	*****	-16.8	*****	-18.1	-17.9	-1.8	-0.4
3	-22.2	-19.6	-17.9	-17.0	-17.8	-18.0	-17.9	-2.2	-0.6
4	-22.2	-19.6	-17.9	-17.2	-17.8	-18.0	-17.9	-2.2	-0.6
5	-22.2	-19.6	-17.9	-17.4	-17.8	-18.0	-17.9	-2.2	-0.6
6	-22.2	-19.6	-17.9	-17.7	-17.8	-17.9	-17.9	-2.2	-0.6
7	-22.2	-19.6	-17.9	-17.8	-17.8	-17.9	-17.9	-2.3	-0.6
8	-22.2	-19.6	-17.9	-17.9	-17.8	-17.9	-17.9	-2.3	-0.6
9	-12.8	-11.4	-10.1	-10.0	-9.8	-9.7	-9.3	-4.6	-2.2
10	-7.3	-6.9	-6.4	-6.4	-6.3	-6.3	-6.2	-4.7	-3.2
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-18.1	-17.7	-0.5	0.1
2	*****	*****	*****	-16.8	*****	-18.1	-17.7	-1.6	-0.3
3	-17.9	-17.5	-17.4	-16.9	-17.6	-18.0	-17.8	-1.9	-0.5
4	-17.9	-17.5	-17.4	-17.0	-17.6	-18.0	-17.8	-1.9	-0.5
5	-17.9	-17.5	-17.4	-17.2	-17.6	-17.9	-17.8	-1.9	-0.5
6	-17.9	-17.5	-17.4	-17.4	-17.6	-17.8	-17.8	-1.9	-0.5
7	-18.0	-17.5	-17.4	-17.5	-17.6	-17.7	-17.8	-2.0	-0.5
8	-18.0	-17.5	-17.4	-17.5	-17.6	-17.7	-17.8	-2.0	-0.6
9	-10.3	-9.4	-8.4	-8.3	-8.2	-8.0	-7.7	-4.0	-2.0
10	-6.4	-6.1	-5.7	-5.7	-5.6	-5.6	-5.5	-4.3	-3.0
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-18.1	-17.6	-0.5	0.1
2	*****	*****	*****	-16.8	*****	-18.1	-17.7	-1.6	-0.3
3	-16.9	-16.9	-16.8	-16.9	-17.6	-18.0	-17.7	-1.9	-0.5
4	-17.2	-17.0	-17.0	-17.0	-17.6	-18.0	-17.7	-1.9	-0.5
5	-17.4	-17.2	-17.2	-17.2	-17.6	-17.9	-17.7	-1.9	-0.5
6	-17.6	-17.4	-17.3	-17.4	-17.6	-17.8	-17.7	-1.9	-0.5
7	-17.8	-17.5	-17.4	-17.5	-17.6	-17.7	-17.7	-1.9	-0.5
8	-17.8	-17.5	-17.5	-17.5	-17.6	-17.7	-17.7	-2.0	-0.6
9	-10.2	-9.2	-8.3	-8.2	-8.1	-7.9	-7.6	-3.9	-1.9
10	-6.4	-6.0	-5.7	-5.6	-5.6	-5.5	-5.4	-4.3	-3.0
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-18.1	-17.6	-0.5	0.1
2	*****	*****	*****	*****	*****	-18.0	-17.7	-1.6	-0.3
3	-17.6	-17.4	-17.5	-17.5	-17.6	-18.0	-17.7	-1.9	-0.5
4	-17.6	-17.4	-17.5	-17.5	-17.6	-18.0	-17.7	-1.9	-0.5
5	-17.6	-17.4	-17.5	-17.5	-17.6	-17.9	-17.7	-1.9	-0.5
6	-17.6	-17.4	-17.5	-17.6	-17.6	-17.8	-17.7	-1.9	-0.5
7	-17.6	-17.4	-17.5	-17.6	-17.6	-17.7	-17.7	-1.9	-0.5
8	-17.7	-17.4	-17.5	-17.6	-17.6	-17.7	-17.7	-1.9	-0.6
9	-10.0	-9.1	-8.1	-8.0	-7.9	-7.8	-7.5	-3.9	-1.9
10	-6.3	-6.0	-5.6	-5.6	-5.5	-5.5	-5.4	-4.2	-3.0
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	-17.5	-17.5	-0.5	0.1
2	*****	*****	*****	-17.5	*****	-17.5	-17.6	-1.5	-0.3
3	-17.5	-17.5	-17.5	-17.5	-17.5	-17.6	-17.7	-1.8	-0.5
4	-17.6	-17.5	-17.5	-17.5	-17.6	-17.6	-17.7	-1.8	-0.5
5	-17.6	-17.5	-17.5	-17.5	-17.6	-17.6	-17.7	-1.8	-0.5
6	-17.6	-17.5	-17.5	-17.6	-17.6	-17.6	-17.7	-1.9	-0.5
7	-17.6	-17.5	-17.5	-17.6	-17.6	-17.7	-17.7	-1.9	-0.5
8	-17.6	-17.5	-17.5	-17.6	-17.6	-17.7	-17.7	-1.9	-0.6
9	-9.8	-8.9	-8.0	-7.9	-7.8	-7.7	-7.4	-3.8	-1.9
10	-6.3	-5.9	-5.6	-5.5	-5.5	-5.4	-5.3	-4.2	-2.9

Figure E.15. Predicted disturbance pressures - Case 15.
Subslab pressurization, 20 mm separation, high flow rate, soil air barrier.

ZONE	PRESSURE [Pa]
BASEMENT	-5.3
OUTDOORS	0.0
LIVING ROOM	-5.3
HALLWAY	-5.3
BEDROOM 3	-5.3
BATHROOM	-5.3
MASTER BEDROOM	-5.3
BEDROOM 2	-5.3

DISTURBANCE PRESSURES IN SOIL [Pa]

VERTICAL SLICE Y= 1									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.3	*****	-3.0	-2.9	0.2	0.3
3	30.9	9.0	-1.2	-4.7	-2.5	-2.9	-2.6	0.5	0.4
4	30.9	9.0	-1.2	-4.0	-2.5	-2.9	-2.6	0.5	0.4
5	30.9	9.0	-1.2	-3.2	-2.5	-2.8	-2.6	0.5	0.4
6	30.9	9.0	-1.2	-2.3	-2.4	-2.7	-2.6	0.5	0.4
7	30.9	9.0	-1.1	-1.9	-2.4	-2.6	-2.6	0.5	0.4
8	30.9	9.0	-1.1	-1.7	-2.3	-2.5	-2.6	0.5	0.4
9	8.4	5.4	4.0	3.9	3.7	3.6	3.3	1.4	0.8
10	3.0	2.6	2.4	2.4	2.3	2.3	2.2	1.6	1.1
VERTICAL SLICE Y= 2									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.4	*****	-3.1	-3.1	0.2	0.3
3	4.4	-0.3	-3.4	-5.1	-3.6	-3.1	-3.4	0.3	0.4
4	4.4	-0.3	-3.4	-4.7	-3.6	-3.2	-3.4	0.3	0.4
5	4.4	-0.3	-3.4	-4.2	-3.6	-3.2	-3.4	0.3	0.4
6	4.4	-0.3	-3.4	-3.8	-3.5	-3.3	-3.4	0.3	0.4
7	4.4	-0.3	-3.4	-3.5	-3.5	-3.4	-3.4	0.4	0.4
8	4.4	-0.3	-3.3	-3.4	-3.5	-3.4	-3.4	0.4	0.4
9	3.4	2.4	1.9	1.8	1.8	1.8	1.7	1.1	0.7
10	2.2	2.0	1.9	1.8	1.8	1.8	1.6	1.3	1.0
VERTICAL SLICE Y= 3									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.5	*****	-3.1	-3.3	0.2	0.4
3	-3.3	-4.1	-4.3	-5.3	-3.9	-3.2	-3.6	0.3	0.4
4	-3.3	-4.1	-4.3	-5.0	-3.9	-3.2	-3.6	0.3	0.4
5	-3.3	-4.1	-4.3	-4.7	-3.9	-3.3	-3.6	0.3	0.4
6	-3.3	-4.1	-4.3	-4.3	-3.9	-3.5	-3.6	0.3	0.4
7	-3.3	-4.0	-4.3	-4.1	-3.9	-3.7	-3.6	0.3	0.4
8	-3.3	-4.0	-4.2	-4.1	-3.9	-3.8	-3.6	0.3	0.4
9	2.1	1.5	1.3	1.3	1.2	1.2	1.2	0.9	0.7
10	1.9	1.7	1.6	1.6	1.6	1.6	1.5	1.2	0.9
VERTICAL SLICE Y= 4									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	-5.5	*****	-3.1	-3.4	0.2	0.3
3	-5.2	-5.3	-5.3	-5.3	-3.9	-3.2	-3.7	0.3	0.4
4	-4.8	-5.0	-5.0	-4.9	-3.9	-3.2	-3.7	0.3	0.4
5	-4.3	-4.7	-4.7	-4.6	-3.9	-3.3	-3.7	0.3	0.4
6	-3.9	-4.3	-4.4	-4.3	-3.9	-3.5	-3.7	0.3	0.4
7	-3.6	-4.2	-4.2	-4.1	-3.9	-3.7	-3.7	0.3	0.4
8	-3.6	-4.1	-4.2	-4.1	-3.9	-3.8	-3.7	0.3	0.4
9	2.0	1.5	1.3	1.2	1.2	1.2	1.1	0.9	0.7
10	1.8	1.7	1.6	1.6	1.6	1.5	1.5	1.2	0.9
VERTICAL SLICE Y= 5									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	-3.1	-3.4	0.2	0.3
3	-3.9	-4.2	-4.2	-4.0	-3.9	-3.2	-3.7	0.3	0.4
4	-3.9	-4.2	-4.2	-4.0	-3.9	-3.2	-3.7	0.3	0.4
5	-3.9	-4.2	-4.2	-4.0	-3.9	-3.3	-3.7	0.3	0.4
6	-3.9	-4.2	-4.2	-4.0	-3.9	-3.5	-3.7	0.3	0.4
7	-3.9	-4.2	-4.2	-4.0	-3.9	-3.7	-3.7	0.3	0.4
8	-3.8	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	0.3	0.4
9	1.9	1.4	1.2	1.2	1.2	1.2	1.1	0.9	0.7
10	1.8	1.7	1.6	1.6	1.5	1.5	1.5	1.2	0.9
VERTICAL SLICE Y= 6									
Z=	X=1	2	3	4	5	6	7	8	9
1	*****	*****	*****	*****	*****	*****	*****	*****	*****
2	*****	*****	*****	*****	*****	-4.0	-3.5	0.2	0.3
3	-4.0	-4.1	-4.0	-4.0	-4.0	-4.0	-3.7	0.3	0.4
4	-4.0	-4.1	-4.1	-4.0	-4.0	-4.0	-3.7	0.3	0.4
5	-4.0	-4.1	-4.1	-4.0	-4.0	-3.9	-3.7	0.3	0.4
6	-4.0	-4.1	-4.1	-4.0	-4.0	-3.9	-3.7	0.3	0.4
7	-3.9	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	0.3	0.4
8	-3.9	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	0.3	0.4
9	1.9	1.4	1.2	1.2	1.2	1.1	1.1	0.9	0.7
10	1.8	1.6	1.5	1.5	1.5	1.5	1.5	1.2	0.9

APPENDIX F - HOUSE AND SOIL RADON CONCENTRATION PROFILES

[illegible]

VERTICAL SLICE Y= 8												
Z=	X=1	2	3	4	5	6	7	8	9	10	11	12
2	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
3	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
4	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
5	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
6	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
7	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
8	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
9	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7
10	2032.6	2048.5	2073.1	2079.7	2083.2	2087.6	2098.1	2238.7	2225.7	2275.7	2285.7	2295.7

[illegible]

