GOLDER ASSOCIATES

Numerical Modeling Capabilities
to Predict Repository Performance

PO # 8770703

MASTER

NUMERICAL MODELING CAPABILITIES TO PREDICT
REPOSITORY PERFORMANCE

951 6562
✓ Golder Associates, Inc.
1658 Cole Boulevard
Golden, Colorado 80401

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NUMERICAL MODELING CAPABILITIES TO PREDICT
REPOSITORY PERFORMANCE

This report presents a summary of current numerical modeling capabilities that are applicable to the design and performance evaluation of underground repositories for the storage of nuclear waste. The report includes codes that are available in-house, within Golder Associates and Lawrence Livermore Laboratories, as well as those that are generally available within the industry and universities.

The first listing of programs are in-house codes in the subject areas of hydrology, solute transport, thermal and mechanical stress analysis, and structural geology.

The second listing of programs are divided by subject into the following categories:

- Site Selection
- Structural Geology
- Mine Structural Design
- Mine Ventilation
- Hydrology
- Mine Design/Construction/Operation

These programs are not specifically designed for use in the design and evaluation of an underground repository for nuclear waste; we expect that several or most of them may be so used.

LIST OF ACRONYMS USED
FOR INDEXING COMPUTER CODES
(continued)

ACRONYM	CATEGORY	DESCRIPTION
General Problem Codes (primary acronym)		
STATAN	Statistical Analysis	Standard statistical calculations, regression, and curve fitting.
VENT	Ventilation	Flow resistance and pressure loss analysis, ventilation networks, and gas emission and dilution.
Specific Problem Areas (secondary acronym)		
ANAL	Analysis	Analysis of data, information or systems.
COSTA	Cost Analysis	Cost estimation of unit operations.
EQUIP	Equipment	Simulation or analysis of equipment functions.
GENENG	General Engineering	General Engineering Problems Analysis
GENMIN	General Mining	Traditional mining of any mineral.
GENUG	General Underground	Underground mining.
GEOLOG	Geological	Geological or rock analysis.
GEOSTA	Geostatistics	Geostatistical analysis of mineral deposits.
GEOUTL	Geo-Utility	Analysis of natural phenomenon.
GRAFIC	Graphics	Cartographic analysis and plotting.
GROUND	Ground Control	Ground reinforcement, and support design.
MINDEP	Mineral Deposits	Specific or regional mineral deposits.
SPECAL	Specialized Systems	Mining related or specialized analysis.
STATAN	Statistical Analysis	Standard statistical analysis.
COALU	Coal Underground	Underground coal mining operations.

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-Mine Ventilation	
-Hydrology	
-Mine Design/Construction/Operation	

CODES AT GOLDER ASSOCIATES

SOURCE OF INFORMATION GOLDER

APPLICATION CODE ROC SOL ANAL

APPLICATION STRESS ANALYSIS

DOCUMENTATION TITLE/AUTHOR

Two-Dimensional Non-linear Finite Element Method/Golder Associates

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Golder in-house, Golder Associates, Inc., 1658 Cole Boulevard,
Golden, Colorado 80401

PROGRAM CAPABILITIES AND METHODOLOGY

A finite element plane stress or plane strain program capable of performing 2 dimensional non-linear stress and displacement analysis. Non-linear soil and rock material behaviour are simulated using the initial stress method. An out-of-core solution routine combined with a stiffness matrix bandwidth reduction procedure remove size and complexity limits for most geotechnical problems. The types of finite elements available are:

1. Continuum elements (triangles or quadrilaterals) with linear-elastic orthotropic constant stress elements having a Mohr-Coulomb failure criterion with a tension cut-off.
2. Discontinuum elements that are similar to continuum elements but with one or two ubiquitous joint set directions defined with a limiting friction angle and no tension resistance. After failure continuum elements are treated as discontinuum elements.

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INITIAL OPERATIONAL DATE 1973

PROG ID FES-20

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE Seldom

COMPUTER
UNIVAC 1100 Series
Computers with EXEC - 8
operating system.

3. Joint elements which are line-elements of zero nominal thickness, do not resist tension, have a limiting friction angle, and can be dilatant.
4. Bar and cable elements which are line elements with defined cross sectioned properties to simulate rock bolts or cable anchors.

Construction and excavation sequences and changes in material properties can be simulated. Stress and displacement boundary conditions can be set and later modified, non-linear analysis iterations can be reduced through use of Aitken acceleration procedures. Results can be contoured and plotted by the STRCON program. A possible use of this program is to model openings in bedded salt including clay or shale bands.

SOURCE OF INFORMATION GOLDER

APPLICATION CODE ROC SOL
GRAFIC

APPLICATION Contour and vector plots of FES2D

DOCUMENTATION TITLE/AUTHOR

Contour and plot Results of FES2D/Golder Associates

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Golder in-house

PROGRAM CAPABILITIES AND METHODOLOGY

Used with FES 2D to plot function contours, nodal displacements, and stress vectors. All contours of functions are generated by following the variations of the functions through the finite element, thus accurately taking into account the effect of problem boundaries, boundary conditions and changes in material properties. General functions which may be contoured include normal and shear stresses on the x & y planes, maximum and minimum principal stresses, maximum shear stress, first, second and third invariant of stress tensors. The friction angle required to maintain action of finite elements and the average normal stress. Vector functions which may be plotted are element principal stress magnitudes and directions, element maximum shear stress magnitudes and direction, nodal displacement magnitudes and direction. Displaced finite elements mesh plots may also be generated (for machine plots only).

INITIAL OPERATIONAL DATE 1973

PROG ID STRCON

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE Seldom

COMPUTER UNIVAC
1100 Series

SOURCE OF INFORMATION

APPLICATION CODE ROC SOL ANAL

APPLICATION Stress and Deformation Analysis

DOCUMENTATION TITLE/AUTHOR

Information Base For Waste Repository Design Volume 4 - TASC

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Golder Associates, Inc., 1658 Cole Boulevard, Golden, Colorado 80401

PROGRAM CAPABILITIES AND METHODOLOGY

CRPSL(CRPLIB) is a two-dimensional, small displacement plain strain finite element package incorporating thermal and creep effects using the initial strain method. Thermal coefficient and creep laws are hardwired into the program, but these can easily be incorporated as part of the data to provide additional flexibility.

A general path dependent creep law is used. It is based on the pillar model tests of Project Salt Vault and extended to general 3D stress field using deviator stresses and stress and creep strain invariants in the theoretical formulation. A general structural analysis can be performed to include roof and floor structural response, near-canister behaviour, and pillar response when associated with shale partings.

A maximum of five different material types may be employed. Materials may be isotropic or transversely isotropic. The time dependent temperature field must be predetermined.

Continued on next page

INITIAL OPERATIONAL DATE '77

PROG ID CRPSL (CRPLIB)

PROGRAM SIZE LARGE

LANGUAGE CDC FORTRAN 4

FREQUENCY OF USE Infrequent

COMPUTER CDC CYBER with
NOS operating system

The code has been used to analyze hypothetical ventilated repository room in homogeneous salt and in salt with low strength shale beds. For the bedded shale a six noded line element (joint) was employed.

SOURCE OF INFORMATION GOLDER

APPLICATION CODE ROCSOL ANAL

APPLICATION STRESS ANALYSIS

DOCUMENTATION TITLE/AUTHOR

Two-Dimensional Integral Equation Method for Elastic Stress Analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Blvd., Golden (Denver) CO 80401

AVAILABILITY COMMENTS

Golder in-house

PROGRAM CAPABILITIES AND METHODOLOGY

BEM2D is a program for determining plane stress or plane strain distributions around holes in an infinite elastic plane. It utilizes the boundary integral equation method to solve linearly elastic continuum stress and strain problems. The material property must therefore be homogeneous, isotropic and linearly elastic as well as infinite or closed by a finite external boundary of arbitrary shape. The medium may contain a number of openings of arbitrary shape.

Boundary elements, which are used to discretize openings, may be optionally assigned applied loads. Output consists of an echo of the data input, stresses, and optionally displacements at the centre of each boundary element; stresses, and displacements at grid points generated automatically by the program, and stresses and displacements at additional points specified in the input state.

The efficiency of Boundary Integral Equation Methods may make this method attractive for estimating at the initial stress state around openings.

INITIAL OPERATIONAL DATE N/A

PROG ID BEM2D

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE Frequent

COMPUTER CDC CYBER w/NOS
operating system.

SOURCE OF INFORMATION Golder Associates APPLICATION CODE ROCSOL ANAL

APPLICATION Stresses and displacement due to excavation of tabular seam

DOCUMENTATION TITLE/AUTHOR

Three - Dimensional Planar Seam Analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Blvd., Golden (Denver) Colorado 80401

AVAILABILITY COMMENTS

PROGRAM CAPABILITIES AND METHODOLOGY

The MSIM3D program is limited to analyzing the effect of mining excavation in a single tabular region that is planar, remote from the ground surface, and has roof and floor materials with identical elastic properties. The problem is modeled as a three dimensional linear elastic rock mass into which discontinuities have been introduced. Solutions incorporate the displacement discontinuity method of numerical stress analysis. The tabular excavation may be inclined at any dip. Any in-situ (primitive) stress field is specified which varies with depth and need not have its principal directions perpendicular to the plane of the tabular orebody; up to 5000 rectangular dislocation pattern elements in a rectangular grid are available to idealize the mining region which can be irregular in the plan view.

The tabular mining region can be assumed to be rigid elastic, elasto-plastic or brittle. Strength/deformation behaviour can be input as a function of proximity to mined areas. Mined areas may be back-filled with compressible material. Areas of interest may be isolated and sealed to provide more detail of stress and displacement distributions.

INITIAL OPERATIONAL DATE

PROG ID MSIM3D

PROGRAM SIZE

LANGUAGE UNIVAC FORTRAN 4

FREQUENCY OF USE Moderate

COMPUTER

CDC CYBER series computer
with NOS operating system

SOURCE OF INFORMATION Golder

APPLICATION CODE ROCSAL
ANAL

APPLICATION Stress and displacements due to tabular openings

DOCUMENTATION TITLE/AUTHOR
Three-Dimensional Seam Scaling/Golder Associates

SURVEY PARTICIPANT/ADDRESS
Golder Associates, Inc. 1658 Cole Boulevard, Golden (Denver) CO 80401

AVAILABILITY COMMENTS
Golder in-house code

PROGRAM CAPABILITIES AND METHODOLOGY

SCAL3D will modify mine model information files produced by the MSIM 3D program to account for changed material properties and modifications to the mine layout, (sequential room excavations). The code can also be used to refine the displacement discontinuity pattern used in the mine model for more detail of stress variations in a particular area.

INITIAL OPERATIONAL DATE 1974

PROG ID SCAL3D

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE Moderate

COMPUTER

SOURCE OF INFORMATION
Golder Associates

APPLICATION CODE ROC SOL ANAL

APPLICATION Stress and Displacements due to multiple tabular or folded openings.

DOCUMENTATION TITLE/AUTHOR
Multiple and Folded Seam Analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS
Golder Associates, Inc., 1658 Cole Boulevard, Golden, Colorado 80401

PROGRAM CAPABILITIES AND METHODOLOGY

NFOLD is a three-dimensional displacement discontinuity code in which the rock mass is considered as an elastic body. It is similar to the MSIM 3D Code in methodology but is set up to analyze the stresses and displacement in multiple tabular (or folded) excavations in which the pillars and backfilled portions of the excavations may be assigned nonlinear behaviour. The prime restriction is that tabular seams must strike parallel to each other. An in-situ stress field can be specified which is general in orientation and can vary with depth and plan location. Upto 2500 to 3000 rectangular dislocation pattern elements could be economically used to idealize the mining region. The tabular regions can be assumed to be rigid, compressible or brittle. In addition slip or separation on a seam fault plane can be calculated and accumulated from one mining phase to the next.

Output consists of tabular reports of orebody stress and displacement distribution and a simple summary pictorial report of stresses and displacements on the orebody. This code may have use in modeling excavation of multilevel repository in three dimensions.

INITIAL OPERATIONAL DATE '78

PROG ID NFOLD

PROGRAM SIZE 30,000

LANGUAGE

FREQUENCY OF USE MODERATE

COMPUTER

CDC CYBER (IN AUSTRALIA)
with NOS operating system

SOURCE OF INFORMATION

Golder Associates

APPLICATION CODE ROC SOL**APPLICATION** Transient Heat Flow**DOCUMENTATION TITLE/AUTHOR**

One-Dimensional transient heat flow analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS**AVAILABILITY COMMENTS**

Golder in-house program. Golder Associates, Inc.

PROGRAM CAPABILITIES AND METHODOLOGY

The analysis of one-dimensional non-linear transient heat flow problems using the finite element method. Phase change of materials can be directly modelled. The thermal regime may be nonhomogeneous with different materials present. The following significant material properties must apply: conductivity constant or piece-wise linear with temperature; capacity (=density x specific heat) is constant or piece-wise linear with temperature, and the latent heat is constant.

Boundary conditions of specified heat flow or specified temperature variations with time can be applied. Unconditionally stable solution algorithm is used which does not require iteration.

INITIAL OPERATIONAL DATE N/A**PROG ID** THERM 1**PROGRAM SIZE** N/A**LANGUAGE** CDC FORTRAN 4**FREQUENCY OF USE** N/A**COMPUTER** CDC CYBER series
with NOS operating
system.

SOURCE OF INFORMATION GOLDER

APPLICATION CODE GEOLOG ANAL

APPLICATION Computer Analysis of Fracture Attitude Data

DOCUMENTATION TITLE/AUTHOR HISTGM - Dip and Dip-direction

Histogram Construction from Structural Geology Data/Golder Associates

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Golder Associates, Inc., 1658 Cole Boulevard, Golden, Colorado 80401

PROGRAM CAPABILITIES AND METHODOLOGY

The HISTGM program will handle structural geology data obtained from: a) area mapping; b) line surveys; c) drill hole core logging. Apparent core angles obtained from drill hole core logging will be converted to true dip and dip-direction angles. Data obtained from line surveys and core logging may be corrected using the Terzaghi multipliers to account for measurement bias. For all histograms a range of dip and dip-direction angles may be chosen. For spacing histograms up to ten rock types may be selected.

INITIAL OPERATIONAL DATE N/A

PROG ID HISTGM

PROGRAM SIZE N/A

LANGUAGE FORTRAN

FREQUENCY OF USE N/A

COMPUTER CDC CYBER 170 with
NOS operating system

SOURCE OF INFORMATION GOLDER

APPLICATION CODE GEOLOG GRAPHIC

APPLICATION Computer Printer Graphics of Structural Geology Data

DOCUMENTATION TITLE/AUTHOR STEREO

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS Golder Associates, Inc., 1638 Cole Boulevard,
Golden, Colorado

PROGRAM CAPABILITIES AND METHODOLOGY

The STEREO program will handle structural data obtained from area mapping, line surveys, and drill hole core logging. Apparent core angles obtained from drill hole core logging will be converted to true dip and dip-direction angles. Data obtained from line surveys and core logging may be corrected using the Terzaghi multipliers to account for measurements bias. Scatter and contoured equal area (lower hemisphere) projections are printed as 20 cm. diameter plots so that a standard 20 cm equal area net may be used to facilitate interpretations and additional manual constructions.

INITIAL OPERATIONAL DATE '72

PROG ID STEREO

PROGRAM SIZE N/A

LANGUAGE FORTRAN

FREQUENCY OF USE N/A

COMPUTER CDC CYBER 170 with
NOS operating system

SOURCE OF INFORMATION GOLDER

APPLICATION CODE ROC SOL/ANAL

APPLICATION Computer Analysis of Underground Excavation Stability

DOCUMENTATION TITLE/AUTHOR UGWEDG

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS Golder Associates, Inc., 1658 Cole Boulevard,
Golden, Colorado 80401

PROGRAM CAPABILITIES AND METHODOLOGY

UGWEDG is designed to analyze wedges formed on the roof and walls of underground openings of rectangular cross-section in a rock mass. Wedges are formed by three planes of weakness and one planar free-face. When using the limiting equilibrium methods of analysis, only translational movement modes are considered; no attempt is made to consider the rotational effects.

INITIAL OPERATIONAL DATE 1976

PROG ID UGWEDG

PROGRAM SIZE N/A

LANGUAGE FORTRAN

FREQUENCY OF USE MODERATE

COMPUTER UNIVAC 1100 with
EXEC-8 operating
system

SOURCE OF INFORMATION Golder

APPLICATION CODE DRAIN
SEDUTL

APPLICATION Fluid Flow and Mass Transport

DOCUMENTATION TITLE/AUTHOR

REPFL - GOLDER

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

at L.L.L. & Golder Associates, Inc.

PROGRAM CAPABILITIES AND METHODOLOGY

A pipe model in which a network of one dimensional path segments is made to simulate steady state flow and transient nuclide transport in 2 or 3 dimensions. The background heads and gradients in aquifers (before repository excavations) must be known and are assumed to be unaffected by the repository. The model is composed of: node points defining junctions of flow paths, connections between nodes characterized by their effective area, hydraulic conductivity porosity, dispersion factors and dispersivities; overlying or underlying aquifers, receiving units which can be associated with some nodes and represent many waste-disposal rooms, each containing an initial inventory of waste; and waste-pockets which are released once the hydraulic flow system is established. The transport of three different groups of radionuclides may be considered by defining separate retardation factors and dispersivities for each group in a connection. The output listing of radionuclides is computed for the aquifers and for all nodal sinks.

The model does not have any means of dealing with reactive chemistry.

INITIAL OPERATIONAL DATE

PROG ID REPFL0

PROGRAM SIZE

LANGUAGE CDC FORTRAN

FREQUENCY OF USE MODERATE

COMPUTER CDC CYBER 170

SOURCE OF INFORMATION GOLDER

APPLICATION CODE DRAIN GELOG

APPLICATION GROUND WATER FLOW

DOCUMENTATION TITLE/AUTHOR

Static and Transient groundwater flow, 2-dimensional planar or axisymmetric/Golder Associates.

SURVEY PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Boulevard, Golden (Denver) Colorado 80401

AVAILABILITY COMMENTS

Golder in-house code.

PROGRAM CAPABILITIES AND METHODOLOGY

Two dimensional transient and steady state planar or axisymmetric groundwater flow conditions using the finite element method. Elements of the flow regime may differ in material properties. The permeability may be linear isotropic or linear anisotropic, the stiffness must be constant, the specific yield must be constant, and the evapotranspiration must be linear with depth (within limits). Boundary conditions of either known flow rates or fluid pressure may be applied. The program can compute the fluid potentials and pressures at nodes throughout the flow regime, element flow rates and directions, and the net inflow/outflow for transient problems.

The code is setup to minimize user involvement in data setup and run control and to minimize computer time required to perform analyses.

INITIAL OPERATIONAL DATE '70

PROG ID FPM

PROGRAM SIZE 30,000 decimal words
of core

LANGUAGE Fortran

FREQUENCY OF USE

COMPUTER CDC

- CDC Cyber Series with
NUS Operating System.

SOURCE OF INFORMATION GOLDER

APPLICATION CODE DRAIN GEOLOG

APPLICATION GROUND WATER FLOW

DOCUMENTATION TITLE/AUTHOR

Quasi Three-dimesnional aquifer flow analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Boulevard, Golden (Denver) Colorado 80401

AVAILABILITY COMMENTS

Golder in-house code.

PROGRAM CAPABILITIES AND METHODOLOGY

Three - dimensional steady state and transient ground water flow conditions using the finite element method. The flow regime must be approximately geometrically represented as a layered system of confined, unconfined (containing phreatic surface) and leaky aquifers (to simulate rock matrix with joint flow). Each aquifer layer is sub-divided into triangular and rectangular elements which have appropriate material properties assigned. Elements of an aquifer may differ in material properties. The permeability may be linear isotropic or linear anisotropic, the specific storage must be incompressible or constant, the specific yield must be constant and the evapotranspiration must be zero or linear with depth (within limits).

The elements of a layer may vary in thickness and dip to conform to the variable thicknesses and slopes of an aquifer. Boundary conditions of either known flow rates or known head may be applied (and altered at any time for transient problems).

The program can compute the location of the phreatic surface in the top aquifer (unconfined flow), fluid potentials and pressures at nodes throughout the flow regime element flow rates and directions, connected surface stream
(Continued on Next Page)

INITIAL OPERATIONAL DATE '75

PROG IDAFPM

PROGRAM SIZE 30,000 Decimal Words
of Core on CDC

LANGUAGE FORTRAN 4

FREQUENCY OF USE: Frequent

COMPUTER CDC CYBER SERIES
W/NOS operating system

flows and leakage rates between aquifer elements.

This program would be useful in determining the flow net in the repository basin .

SOURCE OF INFORMATION GOLDER

APPLICATION CODE DRAIN GEOLOG

APPLICATION Plotting of ground water seepage and solute transport

DOCUMENTATION TITLE/AUTHOR

Contouring and plotting of FPM and AFPM results/Golder Associates

SUBJECT PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Boulevard, Golden (Denver) Colorado 80401

AVAILABILITY COMMENTS

Golder in-house code.

PROGRAM CAPABILITIES AND METHODOLOGY

The FLOCON Code prepares contour plots displaying results of ground water seepage analysis performed by AFPM or FPM; and solute transport performed by SOLTR. It can plot head and fluid pressure as well as flownet for FPM only. With SOLTR, the plots can be made of solute concentration levels, vector velocities of solute transport, and solute mass flux vectors. FLOCON uses the standard FPM/AFPM/SOLTR Program output information file.

INITIAL OPERATIONAL DATE '74

PROG ID FLOCON

PROGRAM SIZE

LANGUAGE CDC FORTRAN

FREQUENCY OF USE - Frequent

COMPUTER CDC CYBER Series with
NOS Operating System.

PERIPHERALS REQUIRED Plotter

SOURCE OF INFORMATION GOLDER

APPLICATION CODE DRAIN GEOLOG

APPLICATION SOLUTE TRANSPORT

DOCUMENTATION TITLE/AUTHOR

Solute Transport Analysis/Golder Associates

SURVEY PARTICIPANT/ADDRESS

Golder Associates, Inc., 1658 Cole Boulevard, Golden (Denver) Colorado 80401

AVAILABILITY COMMENTS

Golder in-house

PROGRAM CAPABILITIES AND METHODOLOGY

SOLTR is a code for the analysis of solute transport in a planar or axisymmetric finite element mesh or through layers of a multi aquifer finite element mesh corresponding to the flow regimes modeled in the AFPM or FPM programs. The processes of convection, dispersion, diffusion, dilution, sorption and radioactive decay are simulated. Solute concentrations are presumed to be small so that the fluid density is unaffected by concentration.

Significant element (limit of 30) material transport property relationships are constant dispersion coefficient in the average direction of flow and perpendicular to the average direction of flow, a constant solute retardation factor and constant material porosity.

Initial and boundary conditions are defined by using an initial solute concentration distribution and prescribed concentrations for all recharging flows. Boundary conditions and material properties may be altered at any stage in the analysis to reflect changing conditions of the flow regime.

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INITIAL OPERATIONAL DATE '77

PROG ID SOLTR

PROGRAM SIZE

LANGUAGE FORTRAN CDC

FREQUENCY OF USE - Frequent

COMPUTER CDC CYBER with NOS
operating system

The transport model for multi-layer aquifer (AFPM) is limited by the fact that inner layer leakage is assumed to have no time lag.

Program output includes nodal concentrations, element fluxes and nodal solute discharge rates.

This program may be applicable to radionuclides transport modeling in the resaturated regime of the repository and flow regime of the repository basin.

CODES AT LAWRENCE LIVERMORE LABORATORY

SOURCE OF INFORMATION MIT
Report 82448-1

APPLICATION CODE ROC SOL
ANAL

APPLICATION

DOCUMENTATION TITLE/AUTHOR

A Finite Element Program for Automatic Dynamic Increment Non-Linear
Analysis/Klaus- Jurgen Bathe

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

\$10K one-time fee

PROGRAM CAPABILITIES AND METHODOLOGY

A finite element code for linear and non-linear, static and dynamic analysis in two-dimensional plane stress or plane strain or in three dimensions. Five types of elements are available as follows: Stress elements, plane stress and plane strain elements, axisymmetric shell or solid elements, three-dimensional solid or thick shell element or three-dimensional beam elements. The following 2-D and 3-D material models are available: isotropic linear elastic, orthotropic linear elastic, isotropic thermo-elastic, curve description, concrete, Drucker-Prager (not in 3-D), isothermal elastic-plastic (isotropic hardening), isothermal elastic plastic (kinematic hardening), thermo-elastic plastic and creep (isotropic hardening), thermo-elastic plastic and creep (kinematic hardening), Mooney-Rivlin (not 3-D), or user supplied. The curve description model is based on volumetric strain and is suitable for many geologic materials. It can also be used to simulate either tension cut-off yielding or tensile failure (cracking). Besides material nonlinearities, nonlinearities may be due to large displacements and large strains.

Continued on next page

INITIAL OPERATIONAL DATE

PROG ID ADINA

PROGRAM SIZE 24,000

LANGUAGE

FREQUENCY OF USE Large General Use

COMPUTER

PERIPHERALS REQUIRED
Fortran Simulated Deck
L.L.L. Sandia, USBR

IBM, CDC or UNIVAC

ADINA uses an out-of-core solution of equilibrium equations to obtain maximum program capacity, finite elements are processed on blocks according to their type and whether they are linear or non-linear elements. The finite element system response is calculated using an incremented solution of the equations of equilibrium.

SOURCE OF INFORMATION M.I.T. REPORT
824481

APPLICATION CODE ROC SOL
ANAL

APPLICATION

DOCUMENTATION TITLE/AUTHOR A Finite Element Program for Automatic
Dynamic Incremental Nonlinear Analysis of Temperature (ADINAT)/
Klaus-Jurgen Bathe

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

PROGRAM CAPABILITIES AND METHODOLOGY ADINAT is a compatible
heat transfer analysis program to the stress analysis program
ADINA. It can be used for general linear and nonlinear steady-state
and transient transfer analysis. It employs the finite element
method and incremental heat flow equations. For transient analysis
a numerical time integration scheme is employed. Material models
available are isotropic constant conductivity, orthotropic constant
conductivity. Boundary conditions of surface (of element) convection,
radiation or heat flow input may be specified.

ADINAT is an out-of-core solver and allocates storage dynamically
during the different phases of solution.

INITIAL OPERATIONAL DATE

PROC ID ADINANT

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE

COMPUTER IBM, CDC, or
UNIVAC Versions

SOURCE OF INFORMATION

APPLICATION CODE ROC SOL
ANAL

APPLICATION Nonlinear, transient fluid flow

DOCUMENTATION TITLE/AUTHOR

Federal Information Processing Software Summary/J. Parliagrigo

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

At L.L.L.
L.L.L. PUB. UCRL -14754

PROGRAM CAPABILITIES AND METHODOLOGY

Heat transfer or fluid flow capabilities. Finite difference code. Incompatible with finite element. Arbitrary geometries, 2D, 3D. Anisotropic, Non-linear.

TRUMP has been used to solve for the 3-D unsteady state temperature profiles within a unit cell of a deep geological waste repository.

Problem parameters may vary. Spatial position and sources and/or boundary conditions may vary with time.

INITIAL OPERATIONAL DATE

PROG ID TRUMP

PROGRAM SIZE Large

LANGUAGE FORTRAN

FREQUENCY OF USE Large general use.

COMPUTER CDC 7600
cyber systems

OTHER USERS DOE and NRC waste management

SOURCE OF INFORMATION N/A

APPLICATION CODE DRAIN GENENG

APPLICATION Fluid flow through porous media and mass transport

DOCUMENTATION TITLE/AUTHOR N/A

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

At L.L.L. available to public

PROGRAM CAPABILITIES AND METHODOLOGY

OGRE can be used for time simulation of fluid flow and mass transport through porous media in one or two dimensions. Using an implicit (Backward Euler) finite difference scheme specifically, OGRE can and has been used to simulate the time dependant flow of ground water into or out of underground openings and the mass transport of radionuclides under the influence of pressure gradient.

Parameters may be either time and space dependent or fixed in either time or space. Initial and boundary conditions may also vary with time and space. Zoning of the grid must be constant in both directions, but zoning is dynamic and set at execution time.

Output includes a time dependent pressure and velocity graphics file.

INITIAL OPERATIONAL DATE N/A

PROG ID OGRE

PROGRAM SIZE N/A

LANGUAGE L.L.L. FORTRAN

FREQUENCY OF USE

COMPUTER CDC 7600

SOURCE OF INFORMATION N/A

APPLICATION CODE DRAIN GENENG

APPLICATION HYDROLOGY

DOCUMENTATION TITLE/AUTHOR

Arbitrary Plane and Axisymmetric flow in Porous Media/R.L.Taylor

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

AT L.L.L.

PROGRAM CAPABILITIES AND METHODOLOGY

A finite element, two-dimensional, seepage code where flow is governed by Darcy's Equation. Pressures, equipotentials and flow velocities are determined for both plane and axisymmetric problems under the conditions of saturated, steady state flow. Different material properties may be assigned to zones of the flow regime. Free surface (unconfined flow) problems are solvable by the program which systematically varies the free surface until free surface boundary conditions are met (flow = 0, pressure = 0). User must specify the initial mesh including the free surface boundary if there is one. The program will regenerate the mesh for free surface problems, and generally requires 5 - 20 iterations to solve the problem. Known flow rates and pressures may be used as boundary conditions.

Output information includes nodal point pressures and equipotential values, element flow rates at the center of each element and printout of each mesh correction for free surface problems.

INITIAL OPERATIONAL DATE

PROG ID TAYLOR

PROGRAM SIZE

LANGUAGE ASA FORTRAN

FREQUENCY OF USE

COMPUTER GE. 400 Series

SOURCE OF INFORMATION
U.S. DEPARTMENT OF COMMERCE
ORNL-4927
APPLICATION HYDROLOGY

APPLICATION CODE DRAIN
GEOLOG

DOCUMENTATION TITLE/AUTHOR

Water Movement through saturated - unsaturated porous media:
A finite-element Galerkin Model/MReeves et al.

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

PROGRAM CAPABILITIES AND METHODOLOGY

Two-dimensional transient flow code for saturated-unsaturated porous media. Numerical implementation is by a finite-element grid. Galerkin spatial discretization and Gaussian elimination. The flow regime may be non-homogeneous with anisotropic permeability. In saturated regions conductivity and medium compressibility are needed for each formation. In the unsaturated regions curves of conductivity vs. pressure, and of water content vs. pressure, for each soil type are required. The code is set up to include constant rainfall seepage. Output includes flow information, pressure heads, total heads, water contents, and Darcy velocity distributions.

Plotting of data requires an auxiliary program.

INITIAL OPERATIONAL DATE

PROG ID OAKFLOW

PROGRAM SIZE LARGE

LANGUAGE FORTRAN IV

FREQUENCY OF USE

COMPUTER

SOURCE OF INFORMATION U.S. Department
of Commerce ORNL-4928

APPLICATION CODE

DRAIN
GEOUTL

APPLICATION Solute Transport

DOCUMENTATION TITLE/AUTHOR Material Transport Through Porous
Media: A Finite Element Galerkin Model/J.O. Doguid, et al.

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS At L.L.L.

PROGRAM CAPABILITIES AND METHODOLOGY A two-dimensional transient model for flow of a dissolved constituent through porous media has been developed. Mechanisms for advective transport, hydrodynamic dispersion, chemical absorption, and radioactive decay are included in the mathematical formulation. Implementations of quadrilateral finite elements, bilinear spatial interpolation and Gaussian elimination are used in the numerical formulation. The program is completely compatible with the OAKFLOW/saturated-unsaturated flow through porous media code. Material properties to be input to the code include the longitudinal and transverse dispersivity, bulk density of the solid material within an element, element porosity, modified coefficient of compressibility, and the radioactive decay constant.

Output information includes concentrations and fluxes.

INITIAL OPERATIONAL DATE

PROG ID MATTRAN

PROGRAM SIZE

LANGUAGE Fortran IV

FREQUENCY OF USE

COMPUTER

SOURCE OF INFORMATION N/A

APPLICATION CODE

APPLICATION Transient heat flow or groundwater flow

DOCUMENTATION TITLE/AUTHOR N/A

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Developed at Princeton by G. Pinder and Others

PROGRAM CAPABILITIES AND METHODOLOGY

The code solves a very general pair of coupled time-dependent non-linear, partial differential equations. The code can solve any subset of the coupled equations such as the 3-D transient heat equation or the 3D groundwater flow equation and the solute transport equations simultaneously. The basic method of solution is the Galerkin finite element method for spatial discretization and any combination of explicit euler, implicit euler or trapezoid rule for time integration.

Output consists of nodal histories. Program is not as yet optimized for CDC computers;

A program of this type may be needed for coupling field phenomena i.e temperature field flow and radionuclides transport.

INITIAL OPERATIONAL DATE

PROG ID PINDER OR BIFERS

PROGRAM SIZE

LANGUAGE

FREQUENCY OF USE

COMPUTER
Originally IBM CODE
Has run on CDC at L.L.L.
but with no optimization

OUTSIDE CODES

SITE SELECTION

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE DATMAN
MINDEP

APPLICATION Mineral Resources Information Processing

DOCUMENTATION TITLE/AUTHOR "CRIB - The Mineral Resources Data
Bank of the U. S. Geological Survey"/James A. Calkins, Olaf Kays,
Eleanor K. Keefeer, United States Geological Survey

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from Geological Survey Circulars,
under the above title, Accession Number CIRC. 681.

PROGRAM CAPABILITIES AND METHODOLOGY "CRIB consists of a set of
variable-length records containing the basic information needed
to characterize one or more mineral commodities, a mineral
deposit, or several related deposits. The information consists
of text, numeric data, and codes. Some topics covered are: name,
location, commodity information, geology, production, reserves,
potential resources, and references. The data are processed
by the GIPSY program, which performs all the processing tasks
needed to build, operate, and maintain the CRIB file. The
sophisticated retrieval program allows the user to make highly
selective searches of the file for words, parts of words,
phrases, numeric data, word ranges, numeric ranges, and others,
and to interrelate variables by logic statements to any degree
of refinement desired. Three print options are available,
or the retrieved data can be passed to another program for
further processing."

INITIAL OPERATIONAL DATE NA

PROG ID CRIB

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE DATMAN
GENENG

APPLICATION Information Retrieval

DOCUMENTATION TITLE/AUTHOR "U.S. Geological Survey Data Bases
and Retrieval Systems"/United States Geological Survey

SURVEY PARTICIPANT/ADDRESS Lamont O. Wilch/United States
Geological Survey, Denver Federal Center, Building 25, M/S
912, Denver, Colorado 80225

AVAILABILITY COMMENTS

Contact Lamont O. Wilch at above address.

PROGRAM CAPABILITIES AND METHODOLOGY The above document abstracts
a number of programs that USGS has operational. Some of these
we judged to have application in mining practice. The following
are some of the programs that deal with data bases and
retrieval systems:

1. RASS - geochem analyses, sample location, minerals, organics,
rock type, geologic formation.
2. CRIB - commodities information, reserves, mineral resources
data, geology, occurrences, deposits, mines, references.
3. NCDS - geochemical analyses, coal resources, locations
with geologic descriptions.
4. MINREF - bibliographic information, location, geologic forma-
tion, rock type, various analyses, crystallographic data,
X-ray data.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE Varies

FREQUENCY OF USE NA

COMPUTER Varies

OTHER USERS NA

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE ROC SOL
ANAL

APPLICATION Rock Analysis Storage

DOCUMENTATION TITLE/AUTHOR Rock Analysis Storage System (RASS-II)
United States Geological Survey

SURVEY PARTICIPANT/ADDRESS United States Geological Survey/Geological
Division, United States Geological Survey, Denver, CO

AVAILABILITY COMMENTS Contact George Van Tramp, telephone number
(303) 234-2758 or Raoul Mendes, telephone number (303) 234-2438

PROGRAM CAPABILITIES AND METHODOLOGY "The Rock Analysis Storage
System (RASS) is designed for the storage and retrieval of
analytical data and sample identification and location. RASS
is designed to accept data not only from rocks but also unconsoli-
dated sediments, minerals, soils, water, plants, organic fuels,
and miscellaneous substances. RASS is for data storage and
retrieval only; STATPAC (Statistical Package) is a series of
computer programs for the manipulation of data."

INITIAL OPERATIONAL DATE NA

PROG ID RASS-II

PROGRAM SIZE NA

LANGUAGE Fortran

FREQUENCY OF USE NA

COMPUTER Dec 10

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
ANAL

APPLICATION Rock Analysis

DOCUMENTATION TITLE/AUTHOR "Graphic Normative Analysis Program"/
Roger W. Bowen, United States Geological Survey, Computer Contri-
bution, USGS-CCD-71-004.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-206-736.

PROGRAM CAPABILITIES AND METHODOLOGY A user oriented command language
is developed to provide direct control over the computation and
output of the standard CIPW Norm computation. Once the oxide
values have been read by the computer, these values may be
manipulated by the user and the "norm" recalculated on the basis
of the manipulated or "adjusted" values. Up to 99 rock analysis
cards may be processed on a group, which consists of weight per
cents of oxides. The program has twelve subroutines. The output
provides tabular listings, X-Y plots and ternary diagrams.

INITIAL OPERATIONAL DATE NA

PROG ID GNAP

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 360/65

OTHER USERS NA

SOURCE OF INFORMATION PAPER

APPLICATION CODE EXPRES
ANAL

APPLICATION Drill Core Data Storage

DOCUMENTATION TITLE/AUTHOR "Computerized Data as an Aid to Kaolin Exploration"/Harland E. Cofer, Jr., Chairman, Division of Science and Mathematics, Georgia Southwestern College, Americus, Georgia, Office of Mineral Resources, United States Geological Survey, Grant Number 14-08-1110-G-173

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Society of Mining Engineers of AIME, 540 Arapleen Drive, Salt Lake City, Utah 84108, under the above title, preprint number 77-H-20. This paper was presented at the 1977 AIME Annual Meeting-Atlanta, Georgia - March 6-10, 1977.

PROGRAM CAPABILITIES AND METHODOLOGY

The GRASP file was created by Nancy A. Wright of the U. S. Geological Survey, Reston, Virginia, and was used for storage and retrieval of drill core data. "(GRASP is an acronym for the Geological Retrieval and Synopsis Program of the U. S. Geological Survey. A portable data-retrieval system requiring minimal user training)"

INITIAL OPERATIONAL DATE NA

PROG ID GRASP

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE EXPRES
GEOLOG

APPLICATION Drill Hole Data Analysis

DOCUMENTATION TITLE/AUTHOR "COREMAP-A Data System for Drill Cores
and Bore Holes"/Tom K. Ekstrom, Ake Wirstam, Lars-Elve Larsson.

SURVEY PARTICIPANT/ADDRESS. None

AVAILABILITY COMMENTS Reference to program published in Economic
Geology, March-April, 1975 issue, Volume 70, number 2, pp. 359-368.

PROGRAM CAPABILITIES AND METHODOLOGY "COREMAP produces de-coded
lists, lists of any specified parameter or parameters, and
simplified description of the core on a line-printer. COREMAP
plots the deviation of boreholes, data locations on chosen levels,
and vertical sections parallel to the x-or y-axes. Furthermore,
COREMAP plots the length of each analyzed interval together with
one optional chemical element. All boreholes running through
a defined slice of rock are projected on a given plane. The
scale of the plot is determined by the user, and it is also
possible to correct the error of strike and dip during the
projection."

INITIAL OPERATIONAL DATE NA

PROG ID COREMAP

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 370/155

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE EXPRES
GEOLOG

APPLICATION Drill Hole Data Analysis

DOCUMENTATION TITLE/AUTHOR "Geolog System" for Computer and Manual
Analysis of Geologic Data from Porphyry and Other Deposits/
P. E. Blanchet, C. I. Godwin.

SURVEY PARTICIPANT/ADDRESS--None

AVAILABILITY COMMENTS Reference to program published in Economic
Geology, September-October, 1972 issue, volume 67, number 6,
pp. 796-813.

PROGRAM CAPABILITIES AND METHODOLOGY "In this program the assay
or geological values are plotted in three dimensions as averages
weighted with respect to the distance from plotting point to
data points in drill holes. The symbols printed on the plan
effectively contour the data. Data summaries for these plans
list tons of each category within each bench and the reliability
of that estimate. Analysis of these data might, for example,
be a guide to zoning classification or an important consideration
in mining or pit design."

INITIAL OPERATIONAL DATE NA

PROG ID CUBE

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE EXPRES
GEOSTA

APPLICATION Geostatistics

DOCUMENTATION TITLE/AUTHOR "Computerized Determination of Mine Planning Data from Boreholes"/Christopher Haycocks, Assistant Professor of Mining Engineering, J. Richard Lucas, Head, Division of Minerals Engineering Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in Mining Engineering, April, 1973 issue, volume 25, number 4, pp. 52-56.

PROGRAM CAPABILITIES AND METHODOLOGY The basic purpose of this program is to provide accurate estimates of mineable tonnage based on the geological structure. The program also calculates ore body dimensions, pillar dimensions, heading widths, roof-bolt spacing and length, subsidence data, and plot subsidence and strain curves as well as a "traverse plot or contoured coal thickness."

INITIAL OPERATIONAL DATE NA

PROG ID RAMPLAN

PROGRAM SIZE 156K

LANGUAGE Fortran IV
Level G

FREQUENCY OF USE NA

COMPUTER IBM 370/155 ASP

OTHER USERS NA

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE EXPRES
SPECIAL

APPLICATION Predict Mineral Occurrences

DOCUMENTATION TITLE/AUTHOR "First Interim Report on Digital Geographic Data Handling Activities in the USGS"/Ray Batson,
Western, Flagstaff Field Center

SURVEY PARTICIPANT/ADDRESS... Lamont O. Wilch/United States, Geological Survey, Denver Federal Center, Building 25, M/S 912, Denver, Colorado 80225.

AVAILABILITY COMMENTS Report is internal

PROGRAM CAPABILITIES AND METHODOLOGY LANDSAT "can significantly help detect and predict mineral resource occurrences and provide information relevant to mineral exploration that may not be acquired by other methods. Enhancement techniques are employed."

INITIAL OPERATIONAL DATE NA

PROG ID LANDSAT

PROGRAM SIZE 28K words each

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER PDP/11 (11/45 & 11/20
central processor)

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE GEOLOG
GRAPHIC

APPLICATION Computer-Drawn Maps of Geological Data

DOCUMENTATION TITLE/AUTHOR USEM RI 8151 "Applying Computer-Drawn
Maps of Geologic Data to Analysis of Mining Problems"/Charles
M. McCulloch, Pittsburgh Mining and Safety Research Center, United
States Bureau of Mines, Pittsburgh, Pennsylvania, 1976

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical
Information Service (NTIS), under the above title, Accession
Number PB-255-497.

PROGRAM CAPABILITIES AND METHODOLOGY The computer is used to
draw the following kinds of geologic maps for mining areas:

(1)structure contour maps (2)coal isopach maps (3)overburden
isopach maps (4) maps showing ratio of sandstone types (5) percent
sandstone or shale maps (6) environmental ratio maps (7) lithologic
frequency maps (8) and various other contour maps. Any type of
geologic map can be drawn as long as some unit can be contoured.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER IBM 370/115

OTHER USERS NA

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE GRAFIC
GEOUTL

APPLICATION Mylar Map Overlay Production

DOCUMENTATION TITLE/AUTHOR Internal

SURVEY PARTICIPANT/ADDRESS Don Donaven/Division of Automatic
Data Processing, USBM, P. O. Box 25407, Denver Federal Center,
Denver, Colorado 80225

AVAILABILITY COMMENTS

Contact Don Donaven at above address.

PROGRAM CAPABILITIES AND METHODOLOGY The Division of ADP has implemented three map projection programs used principally to provide Mylar map overlays demonstrating aspects of the minerals industry. The projections available are Mercator, Lambert, Conformal Conic, and Albers. Each is stand-alone program, accepting as input a tape file or disk file of selected data, usually in the Minerals Industry Location System format, and a few necessary parameters such as map scale, map delimiters, title, and "cluster radius".

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE On demand

COMPUTER NA

OTHER USERS Extensive within the Bureau of Mines

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE GRAFIC
GEOUTL

APPLICATION Mapping and Plotting

DOCUMENTATION TITLE/AUTHOR "Software"/United States Geological
Survey, Reston, Virginia 22092

SURVEY PARTICIPANT/ADDRESS Nancy Sage/Technical Information Section,
Branch of Computer Information, Computer Center Division, USGS
National Center, Stop 804, Reston, Virginia 22092

AVAILABILITY COMMENTS

Contact Nancy Sage at above address.

PROGRAM CAPABILITIES AND METHODOLOGY The above document abstracts
a large number of programs that USGS has operational. Some of
these we judged to have application in mining practice, especially
the ones dealing with mapping and plotting. The following are
some of the programs that deal with mapping, data reduction, and
plotting:

1. Calcomp Basic - set of subroutines that provide all
functions for controlling and driving Calcomp Plotting
Systems.
2. Calcomp DRAFTING - five subroutines that performs general
graphical details.
3. Calcomp GENERAL - plots various functions.
4. Calcomp Plotting Software (Benson-Lehner) - produces plots by
incorporating a conversion deck with the applications program.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE Varies

LANGUAGE Varies

FREQUENCY OF USE NA

COMPUTER Varies

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE OPERAN
COALU

APPLICATION Underground Mining Systems

DOCUMENTATION TITLE/AUTHOR "Computer Applications in Underground
Mining Systems - Volume 1"/E. P. Bucklen, L. J. Prelaz,
S. C. Suboleski, J. Richard Lucas

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-237-053

PROGRAM CAPABILITIES AND METHODOLOGY The volume includes three
of seven sections: Section 1 - Summary Report, Section 2 - COST-
SCHED Program, Section 3 - RAILSIN Program. "Computerized simula-
tion, coal mining, mine haulage, mine ventilation, coal handling,
power supply circuits. Two computer programs developed for use
in the operation and design in underground mining systems supporting
primary face operations are discussed. Each program is described
in detail for analysis of problems, data procurement, and im-
plementation."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE OPERAN
COSTAN

APPLICATION Cost and Scheduling Analysis of Mine Development

DOCUMENTATION TITLE/AUTHOR Computer Applications in Underground Mining Systems, Seven Volumes/Division of Minerals Engineering Virginia Polytechnic Institute and State University, Blacksburg, Virginia, R & D Report No. 37, Interim Report, OCR, Department of the Interior, Washington, D. C.

SURVEY PARTICIPANT/ADDRESS Department of Mining and Minerals Engineering Virginia Polytechnic Institute & State University, Blacksburg, Virginia 24061

AVAILABILITY COMMENTS

National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151

PROGRAM CAPABILITIES AND METHODOLOGY "COST-SCHED" economically schedules mine development and projects the cost of mining. The scheduling can be done separately or in conjunction with cost projections for up to 24 time periods, usually months. Such costs as labor, supply, general inside and outside, plant, supervision and overhead cost are accumulated as mining advance. Also supplies may be designated recoverable or non-recoverable for later reuse as a section retreats. Monthly costs are outputted for such items as labor, supplies, and other costs. Final output summarizes days worked, tons mined, and various cost categories.

INITIAL OPERATIONAL DATE Sept. 1968

PROG ID COST-SCHED

PROGRAM SIZE 200K

LANGUAGE Fortran IV

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS Both foreign and U.S.A. mining companies, various universities and research groups.

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE   OPERAN
                              GENCNG

APPLICATION Mine Operation Analysis

DOCUMENTATION TITLE/AUTHOR Program List/International Business
Machines Corporation (IBM)

SURVEY PARTICIPANT/ADDRESS Ann Loidl/Marketing Representative
Data Processing Division, Branch Office 131, 777 Grant Street,
Denver, Colorado 80203 Telephone: (303) 831-5000

AVAILABILITY COMMENTS
Contact Ann Loidl at the above address.

PROGRAM CAPABILITIES AND METHODOLOGY The following is a list
of programs that IBM has operational. The list consists of the
program name, followed by the program number if given:

1. Surface Techniques, Annotation and Mapping Programs for
Exploration Development and Engineering (STAMPEDE) -
360D-17.4.001.
2. Calgary Seismic Package
3. Scientific Subroutin Package (OS/PLI) - 360A-CM-07X.
4. Cooley-Tukey Fast Fourier Transform on Direct Access Stored
Data - 360D-13.4.006.
5. Remote Access Statistical System S/360/DOS - 360-13.0.003.
6. Graphic Analysis of Three-Dimensional Data - 5734-XXZ.

(CONTINUED ON FOLLOWING PAGE)

INITIAL OPERATIONAL DATE   NA

PROG ID   NA

PROGRAM SIZE   NA

LANGUAGE Varies

FREQUENCY OF USE   NA

COMPUTER Varies

OTHER USERS   NA

PROGRAM CAPABILITIES AND METHODOLOGY - continued

7. Subroutine Library - MATH (SL-MATH) - 5736-XM7.
8. Procedure Library - MATH (PL-MATH) - 5734-XM3.
9. Array Processor Subroutine Package (APSP) - 5734-P72.
10. 1130 Economic Analysis of Petroleum Project Programs - 1130-MP-01X.
11. 1130 Casing Design Program - 1130-MP-02X.
12. 1130 Decline Curve Analysis Program 1130-MP-03X.
13. 1130 Turner Material Balance Program 1130-MP-04X.
14. 1130 Schilthuis Material Balance Program 1130-MP-05X.
15. 1130 Two-Dimensional Water Flooding Program - 1130-MP-06X.
16. 1130 Gas Deliverability Program - 1130-MP-07X.
17. 1130 Velocity Functions from Time Depth Data Program - 1130-MP-09X.
18. 1130 Wave-Front Ray-Path Determination Program - 1130-MP-10X.
19. 1130 Synthetic Seismogram Program - 1130-MP-11X.
20. 1130 Gravity and Magnetics Continuous Derivatives and Residuals - 1130-MP-12X.
21. 1130 Theoretical Gravity of a 3-D Mass Program - 1130-MP-13X.
22. 1130 Quantitative Log Analysis Program - 1130-MP-14X.
23. 1130 Dipmeter Program - 1130-MP-15X.
24. 1130 Statistical System - 1130-MP-16X.
25. 1130 Numerical Surface Techniques and Contour Map Plotting - 1130-CX-11-.38X.
26. 1130 Scientific Subroutine Package - 1130-CM-02X.
27. Least Squares Curve Fit for a Time-Depth Chart - 1620-MP-03X.
28. Wave-Front Ray-Path Chart for Geophysical Seismic Interpretations - 1620-MP-04X.
29. Integration Template Plotting - 1620-MP-05X.
30. Normal Move-Out Chart 1620-MP-06X.
31. Synthetic Seismogram - 1620-MP-07X.
32. Grid Value Determination - 1620-MP-08X.
33. Analysis of Magnetic or Gravity Anomalies - 1620-MP-10X.
34. Data Point Plotting Program - 1620-MP-11X.
35. Calculation of Intercepts and Velocities From Observed Seismic First Arrivals - 1620-MP-12X.
36. Refraction Interpretation and Velocity Determination - 1620-MP-13X.
37. Contouring by Triangulation - 1620-MP-21X.
38. Velocity Determination by Delta-T Analysis (Card) - 1620-MP-24X.
39. Gas Deliverability (Card) - 1620-MP-25X.
40. Turner Material Balance (Card) - 1620-MP-27X.
41. Prediction of Water Cut vs. Recovery (Card) - 1620-MP-28X.
42. Sand Volume Determination (Card) - 1620-MP-30X.
43. Filter Analysis Routine (Card) - 1620-MP-31X.
44. CVL or Sonic Log Adjustment to Check-Shot Data (Card) - 1620-MP-32X.
45. Two Dimensional Waterflooding (Card) - 1620-MP-33X.
46. Calculation of Mineral Unit Cell Contents - 1620-MH.3.004
47. A Program to Index Crystals - 1620-MH.3.005.

STRUCTURAL GEOLOGY

1. The first part of the book is devoted to the study of the structure of the Earth's crust.

SOURCE OF INFORMATION JOUR

APPLICATION CODE ROC SOL
GEOLOG

APPLICATION Seismic Refraction Modeling

DOCUMENTATION TITLE/AUTHOR "Seismic Refraction Modeling by
Computer"/James H. Scott, United States Bureau of Mines,
Denver, Colorado 80225

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in
Geophysics, April, 1973 issue, Volume 38, number 2, pp. 271-289

PROGRAM CAPABILITIES AND METHODOLOGY "A computer program has been developed by the U. S. Bureau of Mines for designing a two-dimensional, layered earth model as an aid in interpreting seismic refraction field measurements. The program requires input data consisting of shotpoint and geophone locations, refraction traveltimes, and identification of the refraction layer associated with each traveltime. In the program, a first approximation model is generated by a computer adaptation of the delaytime method, followed by a series of improved approximations that are made by use of a ray-tracing procedure. The final result of the program is a model designed to minimize the discrepancy between field-measured traveltimes and computed traveltimes of rays traced through the model.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE ROC SOL
GEOLOG

APPLICATION Seismic Data Analysis

DOCUMENTATION TITLE/AUTHOR "Borehole Seismics Multiply Drill
Data"/B.B. Brenden, V.I. Neeley, G. F. Garlick, Acoustical
Minerals Exploration, Inc.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in Engineer-
ing and Mining Journal, February, 1970 issue, volume 171,
number 2, pp. 93-96.

PROGRAM CAPABILITIES AND METHODOLOGY By analysis of seismic data
the "program provides the structure angle and cross-section-
al thickness of the fault plane or mineralized zone. This
analysis also provides information necessary to calculate
strike and dip of the detected anomalies. In effect, the
computer analysis of the collected data reconstructs a three-
dimensional representation of the structures which had to
have existed to produce the particular pattern of data collected."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE Fortran

FREQUENCY OF USE NA

COMPUTER Univac 1108

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
GEOU TL

APPLICATION Stress Wave Analysis

DOCUMENTATION TITLE/AUTHOR USBM IC 8563 "WAVE-A Computer Program for One-Dimensional Stress Wave Analysis in a Time-Dependent Inelastic Rock using a Generalized Voigt Model"/Stephen Sawyer, Pittsburgh Technical Support Center, United States Bureau of Mines, 1972

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-214-236

PROGRAM CAPABILITIES AND METHODOLOGY The program provides a one-dimensional stress wave analysis in a generalized, linear viscoelastic rock. Numerical results calculated by this technique are free of spurious oscillations that occur in certain other methods of numerical calculations. WAVE generates results that are most accurate near the wave front. WAVE is a powerful tool for analyzing the propagation of stress waves in not only time-dependent inelastic rocks but also in any viscoelastic material whose properties are defined by a Prony series fitted to its compliance curve.

INITIAL OPERATIONAL DATE NA

PROG ID WAVE

PROGRAM SIZE 20K core storage

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6500

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
GRAFIC

APPLICATION Seismis Refraction interpreter-interactive

DOCUMENTATION TITLE/AUTHOR SIPT - A seismic refraction inverse
modeling program for timeshare terminal computer systems/
James H. Scott (USGS Open File Report 77-365)

SURVEY PARTICIPANT/ADDRESS J. H. Scott/U.S. Geological Survey
Box 25046 Denver Federal Center MS 964, Denver, Colorado 80225

AVAILABILITY COMMENTS Documents available at USGS libraries at
Denver, Colorado, Menlo Park, California, and Reston, Virginia-
Program available from J. H. Scott by request.

PROGRAM CAPABILITIES AND METHODOLOGY Creates layered earth model
consistent with input locations of shotpoints and geophones
and refraction arrival times for up to 5 in-line spreads
with up to 7 shotpoints and 48 geophones each, and up to
5 velocity layers. Input is by terminal (disc file) - Output
is to terminal and/or line printer.

INITIAL OPERATIONAL DATE July 1977

PROG ID SIPT

PROGRAM SIZE 30K words

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER DEC-10, Honeywell
Multics, Burroughs,
IBM, CDC Univac

OTHER USERS Utah International, USBM,
Newmont Exploration, Ltd., Geo-Recon
Div. Shannon & Wilson, etc.

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
GRAFIC

APPLICATION Seismic refraction interp.-batch

DOCUMENTATION TITLE/AUTHOR SIPB - A seismic refraction inverse
modeling program for batch computer systems/James H. Scott
(USGS Open File Report 77-366)

SURVEY PARTICIPANT/ADDRESS J. H. Scott/U.S. Geological Survey,
Box 25046 Denver Federal Center MS 964, Denver, Colorado 80225

AVAILABILITY COMMENTS Documentation available at USGS libraries
in Denver, Colorado, Menlo Park, California, and Reston, VA
program available from J. H. Scott on request

PROGRAM CAPABILITIES AND METHODOLOGY Creates layered earth model
consistent with inputted locations of shotpoints and geophones
and refraction arrival times for up to 5 in-line spreads with
up to 7 shotpoints and 48 geophones each, and up to 5 velocity
layers. Input is by cards, output on line printer.

INITIAL OPERATIONAL DATE July 1977

PROG ID SIPB

PROGRAM SIZE 25K words

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER Dec-10, Honeywell
Multics, Burroughs, IBM, CDC,
Univac

OTHER USERS USBM, USBR, Fugro, Inc.,
Newmont Exploration Ltd., UCLA, etc.

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE STATAN
GEOUTL

APPLICATION Analysis of Point Clusters

DOCUMENTATION TITLE/AUTHOR USBM IC 8671 "FRACTAN: A Computer
Code for Analysis of Clusters Defined on the Unit Hemisphere"/
R.J. Shanley and M.A. Mahtab, Denver Mining Research Center,
United States Bureau of Mines, Denver, Colorado 1975

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-240-685

PROGRAM CAPABILITIES AND METHODOLOGY "The report presents a
computer code that has been developed for isolating naturally
occurring clusters of data plotted on the unit hemisphere
and testing these clusters against a probability distribution
which admits elliptical symmetry about its mean. A listing
of the computer code is provided along with an example
output illustrating the delineation and analysis of clusters
in fracture orientations measured in a porphyry copper deposit."

INITIAL OPERATIONAL DATE NA

PROG ID FRACTAN

PROGRAM SIZE 1,818

LANGUAGE Computer Code

FREQUENCY OF USE NA

COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE STATAN
GEOUTL

APPLICATION Clustering Data Points on the Sphere

DOCUMENTATION TITLE/AUTHOR USBM IC 8624 "A Computer Program
for Clustering Data Points on the Sphere"/Robert J. Shanley and
M. Ashraf Mahtab, Denver Mining Research Center, United States
Bureau of Mines, Denver, Colorado 1974

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-231-285

PROGRAM CAPABILITIES AND METHODOLOGY "The computer program, HYBMODE,
has been developed to meet the need for a fast and economical
method for clustering data points on the sphere. The algorithm
used in this development is an extension of D. Wishart's one-
level mode analysis. The program can be used to cluster either
vectorial or axial data; it is currently being used by
the Bureau of Mines to cluster fracture orientations."

INITIAL OPERATIONAL DATE NA

PROG ID HYBMODE

PROGRAM SIZE 75,600 words max.

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
ANAL

APPLICATION Fracture Orientation Analysis

DOCUMENTATION TITLE/AUTHOR USBM RI 7669 "Analysis of Fracture Orientation for Input to Structural Models of Discontinuous Rock"/M.A. Mahtab, D.D. Bolstad, J.R. Alldredge and R. J. Shanley, Denver Mining Research Center, United States Bureau of Mines, 1972

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-212-696

PROGRAM CAPABILITIES AND METHODOLOGY This computer program analyzes the orientations of fractures in rock, identifies clusters or groupings among fracture orientations, calculates the mean orientation of the fractures within each cluster, and calculates the dispersion among these fracture orientations. The program also initiates a polar plot of point concentrations for a cluster mean to be situated at the pole.

INITIAL OPERATIONAL DATE NA

PROG ID PATCH

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
ANAL

APPLICATION Simulation of Spacing Between Planar Discontinuities

DOCUMENTATION TITLE/AUTHOR M. Monicov

SURVEY PARTICIPANT/ADDRESS Professor H.H. Einstein/Department of
Civil Engineering, Room 1-330, MIT Cambridge, Massachusetts
02139

AVAILABILITY COMMENTS Listing available from Professor Einstein
at above address. User manual not available.

PROGRAM CAPABILITIES AND METHODOLOGY Input includes orientation and
the coordinates of a point on the discontinuity, as well as the
orientation and end points of the reference line along which
the spacings are desired. The program will then compute the
distance separating adjacent discontinuities and the results
can be compared to a user supplied probability distribution.

INITIAL OPERATIONAL DATE 4/77

PROG ID NA

PROGRAM SIZE 450K bytes

LANGUAGE Fortran IV

FREQUENCY OF USE Occasional

COMPUTER IBM 370/168

OTHER USERS NA

NINE STRUCTURAL DESIGN

SOURCE OF INFORMATION Golder Associates APPLICATION CODE RCESOL

APPLICATION General structural analysis

DOCUMENTATION TITLE/AUTHOR "General Purpose Finite Element Analysis Program"/Control Data Corporation

SURVEY PARTICIPANT/ADDRESS Golder Associates

AVAILABILITY COMMENTS Available at Control Data Corporation s CYBERNET Centers.

PROGRAM CAPABILITIES AND METHODOLOGY A 3D or 2D finite element structural analysis program with broad capabilities obtained by allowing the user to select from three comprehensive libraries for elements, materials and structural procedures. The three libraries contain over 50 element geometrics, 35 material models and 15 structural procedures that steer the program through its various modules in order to simulate a particular physical phenomenon such as temperature cycling, viscoplasticity, etc. Elastic-plastic and large displacement analysis is effected in a series of piece-wise linear increments. Creep and thermal effects which cause initial strains are analyzed as a series of steps in which an increment of initial strain occurs at the start of each step. This initial strain can be a function of nuclear irradiation as well as of temperature. An automatic load control for creep selects the time step for each increment so that the resulting stress and strain changes remain within a specified limit. A higher order step by step integration in time, known as the residual load correction, may be specified for creep and other non-linear problems. Additional program features include a three-dimensional search generator with an integrated plotting feature which eliminates hidden lines.

INITIAL OPERATIONAL DATE

NA

PROGRAM SIZE Variable

FREQUENCY OF USE On demand

OTHER USERS NA

PROG ID

MARC-CDC

LANGUAGE

Fortran IV

COMPUTER

CDC CYBER Series

SOURCE OF INFORMATION: SUBMIT

APPLICATION CODE ROCSOL
ANAL

APPLICATION Structural Analysis and Design

DOCUMENTATION TITLE/AUTHOR "GTICES STRUDL, GTICES STRUDL-II
User's Manual Update"/Emkin, Leroy Z., et.al.

SURVEY PARTICIPANT/ADDRESS Dr. Leroy Z. Emkin/GTICES Project,
School of Civil Engineering, Georgia Institute of Technology,
Atlanta, Georgia 30332

AVAILABILITY COMMENTS Available for a lease and maintenance fee.
Write Dr. Emkin or call (404) 894-2204. Note, source not available.

PROGRAM CAPABILITIES AND METHODOLOGY GTICES STRUDL-II operates
as a subsystem of the GTICES system on CDC computers. Both are
proprietary to the Georgia Tech Research Institute of Technology,
Atlanta, Georgia.

GTICES STRUDL-II provides the engineer with the ability to specify
characteristics of structural problems, perform analyses, reduce
and combine results, perform design, and output any part, or all
of the information stored in the structural problem data base
on a selective basis.

Analytic procedures apply to any combination of framed structures
and continuum mechanics problems of arbitrary configuration and
composition. Framed structures consist of an assemblage of one-
dimensional member elements, which can be represented by properties
along a centroidal axis.

INITIAL OPERATIONAL DATE 10/77

PROG ID GTSTRUDL

PROGRAM SIZE 200,000 source state-
ments

LANGUAGE Ices Icetran & CDL

FREQUENCY OF USE On demand

COMPUTER CDC and IBM

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
ANAL

APPLICATION Analysis of structures in Jointed Rock

DOCUMENTATION TITLE/AUTHOR JRKSTF User's Manual/F.E. Heuze, May, 1977

SURVEY PARTICIPANT/ADDRESS Dr. F.E. Heuze/2448 Brainwood Drive,
Boulder, Colorado 80303

AVAILABILITY COMMENTS Program for CDC 6400 and 6600 available
with a surcharge in object form. Contact Dr. Heuze at (303)
499-7841.

PROGRAM CAPABILITIES AND METHODOLOGY Finite element program with
joint elements. Two-dimensional (plane strain, plane stress).
Can model strain-softening both in the joint/faults and in
the solids. Can model sequential construction or excavation -
has a restart option. Has plotting facilities. Well suited
to the analysis of rock structures with or without reinforcement.

INITIAL OPERATIONAL DATE 1975

PROG ID JRKSTF

PROGRAM SIZE 120,000

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER CDC 6400 or 6600

OTHER USERS Engineering Consultant.

SOURCE OF INFORMATION JOUR

APPLICATION CODE OPERAN
GENUG

APPLICATION Mine Pillar Systems Analysis

DOCUMENTATION TITLE/AUTHOR "How High-Speed Computers Advance Design of Practical Mine Pillar Systems"/A.M. Starfield, Assistant Professor, C. Fairhurst, Professor and Associate Head, School of Mineral and Metallurgical Engineering, University of Minnesota, Minneapolis.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in Engineering and Mining Journal, May, 1968 issue, volume 169, number 5, pp. 78-87

PROGRAM CAPABILITIES AND METHODOLOGY "This paper presented an approach to the calculation of pillar loads and convergences in flat-lying tabular deposits. These calculations can be made with the aid of either a resistance analog or digital computer. The digital computer method is of a general nature and can, in principle, be applied to any pattern or system of mining. Problems that have not been discussed in the paper but which have been solved by an extension of the digital computer method include:

- 1) the calculation of loads and displacements resulting from extraction of two or more levels.
- 2) the calculation of loads and shear stresses in a dipping ore body.
- 3) the calculation of time-dependent deformations in a non-elastic ore body."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE ROC SOL
COALU

APPLICATION Roof Support (Coal)

DOCUMENTATION TITLE/AUTHOR Final Report "A Master Environmental Control and Mine System Design Simulator for Underground Coal Mining Volume IV - Roof Support"/C.B. Manula, B. Mozumdar, D.K. Jeng, The Pennsylvania State University, University Park, PA 16802, USBM, Grant Number G0111808

SURVEY PARTICIPANT/ADDRESS Department of Mineral Engineering/
The College of Earth and Mineral Sciences, The Pennsylvania State University, University Park, PA 16802

AVAILABILITY COMMENTS

Available from NTIS, under the above title, Accession Number PB-255-424.

PROGRAM CAPABILITIES AND METHODOLOGY "This volume of the final report describes the roof support subsystem of the Master Design Simulator. This model is based on popular roof support practices for different geological environments with related restrictions imposed by the Coal Mine Health and Safety Act of 1969. From geological sections, the model determines the anchor horizon for roof bolts and the density of roof support necessary. The roof support subsystem is tied to both the geology and reserves subsystem and the production subsystem of the Master Design Simulator, but can also operate as a free standing model. Several case studies are presented showing the application of the model. A detailed user's manual, including a program listing is presented in the appendices."

INITIAL OPERATIONAL DATE NA

PROG IDNA

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 370/168

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROCSOL
GEOLOG

APPLICATION Physical Property Testing of Rocks

DOCUMENTATION TITLE/AUTHOR Two Dimensional Finite Element Simulation
of Brazilian Test/J. Basas, R.W. Heins

SURVEY PARTICIPANT/ADDRESS R.W. Heins/U. of Wisconsin, Dept.
of Met. & Min. Engineering, 1509 University Ave., Madison,
WI 53706
AVAILABILITY COMMENTS NA

PROGRAM CAPABILITIES AND METHODOLOGY Program is based upon
isoparametric finite elements which may be either isotropic
or non-homogeneous and a failure criterion in which a fixed
percentage of the stiffness of the failed elements is sub-
traced from the total stiffness during each loading cycle.

INITIAL OPERATIONAL DATE Sept. 1972 PROG ID NA

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER Univac 1108

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE ROC SOL
COALU

APPLICATION Coal Mine Roof Monitoring

DOCUMENTATION TITLE/AUTHOR "How Computerized Instrumentation
Monitors Coal Mine Roofs"/James R. McVey, Maynard O. Serbousek,
USBM Spokane Research Center, East 318 Montgomery Ave., Spokane,
WA 99207

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in Mining
Engineering, September, 1976 issue, volume 28, number 9, pp. 40-43

PROGRAM CAPABILITIES AND METHODOLOGY "The Spokane Mining Research
Center of the U.S. Bureau of Mines has developed a computerized
instrumentation system that can examine the structural behavior
of roof supports in a coal mine. It can instantaneously
compute and plot the load, load rates, deformation, stresses,
opening, closures, etc., in an actual production operation
carried out by such conventional mining techniques as room-
and-pillar.

INITIAL OPERATIONAL DATA NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE ROC SOL
GEN MIN

APPLICATION Mine Structure Design

DOCUMENTATION TITLE/AUTHOR "Theory and Practice Gap Closes in
Rock Mechanics"/R.K. Agarwal, assistant professor, Stefan Boshkov,
professor, Henry Krumb School of Mines, Columbia University,
New York, NY 10027

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to programs published in Mining
Engineering, February, 1970 issue, volume 22, number 2, pp. 74-76.

PROGRAM CAPABILITIES AND METHODOLOGY The numerical technique
of finite element analysis has enabled the development of models
devised for open-pit, room-and-pillar, and longwall mining.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE ROCSOL
GENMIN

APPLICATION Rock Mechanics

DOCUMENTATION TITLE/AUTHOR "Two-Dimensional Analysis of Near-Surface
Single-Seam Extraction"/S.L. Crouch, University of Minnesota,
Minneapolis, MN

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in International
Journal of Rock Mechanics and Mining Sciences, March, 1973 issue,
volume 10, number 2, pp. 85-96.

PROGRAM CAPABILITIES AND METHODOLOGY "This paper describes a
digital computer method for calculating the stresses and dis-
placements induced by underground excavations in a single flat-
lying seam that is arbitrarily near to the surface of the earth.
The method is developed by superposition from solutions previously
given for a displacement discontinuity, or dislocation, in an
otherwise continuous, linearly elastic, infinite rock mass. The
new solution can be applied to complicated extraction patterns
in the plane of a seam in a semi-infinite mass, the surface of
which can be subjected to arbitrary prescribed tractions. The
method can be used to study a wider class of problems than
has previously been possible, and is not limited to mining
applications.

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROCSOL
GENUG

APPLICATION Design of Underground Excavation

DOCUMENTATION TITLE/AUTHOR S.L. Crouch

SURVEY PARTICIPANT/ADDRESS S.L. Crouch/Department of Civil and
Mineral Engineering, University of Minnesota, Minneapolis, MN 55455

AVAILABILITY COMMENTS Presented in "Analysis of Stresses and Dis-
placement Around Underground Excavations: An Application of the
Displacement Discontinuity Method," University of Minnesota,
Geomechanics Report, November, 1976.

PROGRAM CAPABILITIES AND METHODOLOGY

The program is intended for the calculation of stresses and
displacements around an underground excavation (cavity) or a seam
type mining pattern. The program is based on the Displacement
Discontinuity Method. It is two-dimensional (plane strain)
and includes treatment of faults and seam materials displaying
nonlinear behavior.

INITIAL OPERATIONAL DATE 1976

PROG ID MINAP

PROGRAM SIZE 130,000 octal

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER CDC 6400/6600

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROCSOL
GENUG

APPLICATION Mine Design

DOCUMENTATION TITLE/AUTHOR A Computer Controlled Electrical
Resistance Network Analog for Rational Mine Design/S.L. Crouch,
M.P. Hardy, K.P. Sinha, C. Fairhurst, University of Minnesota,
Minneapolis, MN 55455, USBM, Grant Number G0122107

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number
PB-243-468. Also from United States Bureau of Mines, Open
File Report (OPF) Number 57-75

PROGRAM CAPABILITIES AND METHODOLOGY

"This report describes a combined analog-digital computer system for solving problems that are impractical when either device is used separately. This method applied to the important class of mining problems involving excavations to tubular seam or vein-type deposits. The Hybrid computer has many implications for rational planning of underground excavations, since it allows practically any type of inelastic seam behavior or artificial support characteristics to be simulated. The Hybrid computer shows considerable potential as a design tool for coal mine layout. It is ideally suited to investigations of effects of design changes due to the speed with which parameter changes can be implemented."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROCSOL
GEOLOG

APPLICATION Geomechanical Problems in Mining

DOCUMENTATION TITLE/AUTHOR Vol. 1, AD 761 648; Vol. 2, AD 761 649;
Vol. 3, AD 761 650 Available from NTIS. New User's and Other
Documents Available 9/77.

SURVEY PARTICIPANT/ADDRESS Spokane Mining Research Center/
E. 315 Montgomery, Spokane, Washington 99207

AVAILABILITY COMMENTS Latest Version of Code Available from
Agbabian Associates, 250 North Nash Street, El Segundo,
California 90245

PROGRAM CAPABILITIES AND METHODOLOGY Capability: Static,
linear and nonlinear material properties, two-and three-
dimensional representations, applied external forces and
pressures, displacements, gravity loading; sequence of
construction (i.e., addition or removal of elements).
Modeling of slip surfaces (faults). Both structural
and continuum elements available. Sophisticated mesh
generation capability for ease of mesh description. Quite
efficient. Restartable from tape. User oriented.

Method: Finite-element method.

Input: Basic structural configurations, loads, material definitions
sequence of element removal and insertion.

Output: Displacement, stresses, strains. Mesh plots.

INITIAL OPERATIONAL DATE 1972

PROG ID BuMINES

PROGRAM SIZE Source Decic 12,000

LANGUAGE Fortran

FREQUENCY OF USE Daily/Qualified Users COMPUTER CDC 3200, 6600, 7600
may access Code on Univ. of CA. CDC IBM 360-65

OTHER USERS 7600 at Berkeley, CA

University of Illinois, ERDA at Sandia, Bureau of Reclamation at
Denver, C.S.I.R.O. at Victoria, Australia. Lawrence Berkely
Laboratory, Berkeley, California

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE ROCSOL
GEOLOG

APPLICATION Nonlinear Structural Response Analysis

DOCUMENTATION TITLE/AUTHOR "ANSR-1...General Purpose Program for
Analysis of Nonlinear Structural Response"/D.P. Mondkar and
G.H. Powell, Department of Civil Engineering, University of
California, Berkeley, California 94720

SURVEY PARTICIPANT/ADDRESS K.K. Wong/Associate Development Engineer,
Earthquake Engineering Research Center, Computer Applications,
Davis Hall, University of California, Berkeley, California 94720
AVAILABILITY COMMENTS

Write for catalog which contains program description, and program
documentation prices to: NISEE/Computer Applications, Davis Hall,
University of CA, Berkeley, CA 94720 (415) 642-5113.

PROGRAM CAPABILITIES AND METHODOLOGY

"ANSR is a general purpose computer program for static and
dynamic analysis of nonlinear structures. In it, a structure
is idealized as an assemblage of discrete finite elements.
Each node may possess up to six degrees of freedom. The structure
mass is assumed to be lumped at the nodes. Viscous damping effects
may be included, or damping proportional to mass, initial elastic
stiffness and/or tangent stiffness can be specified. Static loads
are applied in a series of load increments, each load increment
being specified as a linear combination of static force patterns.
This feature permits nonproportional loads to be applied.
Dynamic loading may consist of earthquake ground accelerations,
time-dependent nodal loads, or prescribed initial values of nodal
velocities and accelerations.

INITIAL OPERATIONAL DATE 12/75

PROG ID ANSR-1

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE ROC SOL
GEOLOG

APPLICATION Linear Structural Analysis

DOCUMENTATION TITLE/AUTHOR "SAP IV...A Structural Analysis Program for Static and Dynamic Response of Linear Systems"/ K.J. Bathe, E.L. Wilson, and F.E. Peterson, Department of Civil Engineering, University of California, Berkeley, CA 94720

SURVEY PARTICIPANT/ADDRESS Edward L. Wilson/Department of Civil Engineering, University of California, Berkeley, California 94720

AVAILABILITY COMMENTS

Write for catalog which contains program description, and program documentation prices to: NISEE/Computer Applications, Davis Hall, University of California, Berkeley, CA 94720 (415) 642-5113

PROGRAM CAPABILITIES AND METHODOLOGY

"SAP IV is finite element structural program for the static and dynamic response of linear three dimensional systems. The program is written to analyze structures which are idealized by combinations of structural element types. The capacity of the problem depends mainly on the number of finite element nodal points in the system. There is practically no restriction on the number of elements, the number of loadcases and the number or bandwidth of the equations to be solved." In a dynamic analysis the options are (1) frequency calculations only, (2) frequency calculations followed by response history analysis. (3) frequency calculations followed by response spectrum analysis, and (4) response history analysis using step-by-step direct integration. Despite large system capacity, no loss in efficiency is encountered in solving smaller problems.

INITIAL OPERATIONAL DATE 6/73 revised 4/74 PROG ID SAP IV

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6400
IBM 370/158

OTHER USERS NA

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE ROC SOL
GEOLOG

APPLICATION Nonlinear Structural Analysis

DOCUMENTATION TITLE/AUTHOR "NONSAP...A Structural Analysis Program for Static and Dynamic Response of Nonlinear Systems"/K.J. Bathe, E.L. Wilson, and R.H. Iding, Department of Civil Engineering, University of California, Berkeley, CA 94720

SURVEY PARTICIPANT/ADDRESS Edward L. Wilson/Department of Civil Engineering, University of California, Berkeley, California 94720

AVAILABILITY COMMENTS

Write for catalog which contains program description, and program documentation prices to: NI EE/Computer Applications, Davis Hall, University of California, Berkeley, CA (415) 642-5113

PROGRAM CAPABILITIES AND METHODOLOGY

"NONSAP is a finite element structural analysis program for the static and dynamic response of nonlinear systems. The program is an in-core solver. The capacity of the program is essentially determined by the total number of degrees of freedom in the system. However, all structures matrices are stored in compacted form, i.e. only nonzero elements are processed. The system response is calculated using an incremental solution of the equations of equilibrium with the Wilson θ or Newmark time integration scheme. Before the time integration is carried out, the constant structure matrices, namely the linear effective stiffness matrix, the linear stiffness, mass and damping matrices, whichever applicable and the load vectors are assembled and stored on low-speed storage. During the step-by-step solution the linear effective stiffness matrix is up-dated for the nonlinearities in the system. Therefore, only the nonlinearities are dealt with in the time integration."

INITIAL OPERATIONAL DATE 2/74

PROG ID NONSAP

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER CDC 6400
IBM 370/158

OTHER USERS NA

SOURCE OF INFORMATION SUBINFO

APPLICATION CODE ROC SOL
GEOLOG

APPLICATION Three Dimensional Static Analysis

DOCUMENTATION TITLE/AUTHOR "SOLID SAP...Static Analysis Program
for Three Dimensional Solid Structures"/E.L. Wilson, Department of
Civil Engineering, University of California, Berkeley, CA

SURVEY PARTICIPANT/ADDRESS Edward L. Wilson/Department of Civil
Engineering, University of California, Berkeley, California

AVAILABILITY COMMENTS Write for catalog which contains program
description, and program documentation prices to: NISEE/ Computer
Applications, Davis Hall, University of California, Berkeley, CA

PROGRAM CAPABILITIES AND METHODOLOGY

"SOLID SAP or SSAP is designed to perform static, linear, elastic analyses of three dimensional structural systems. The program had flexibility of application to structures which contain combinations of structural element types. The capacity of the program depends mainly on the number of joints in the system. There is practically no restriction on the number of elements, number of load cases, or the "bandwidth" of the equations to be solved. Despite large system capacity, no efficiency loss is encountered in solving smaller problems. The report contains a discussion of the use of incompatible displacement nodes with solid elements and the use of the static condensation algorithm. A brief discussion of each element type is also given. SSAP is machine independent and coded in FORTRAN IV."

INITIAL OPERATIONAL DATE 9/71 revised 12/72 PROG ID SSAP

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROCSOL
GROUND

APPLICATION Group Mining for Shaft Sinking

DOCUMENTATION TITLE/AUTHOR Larry S. Jaycox-Program Manager

SURVEY PARTICIPANT/ADDRESS Larry S. Jaycox, Mining Engineer/
S.A. Scott & Company, Inc., 12567 West Cedar Drive, Lakewood,
CO 80228

AVAILABILITY COMMENTS By special arrangement

PROGRAM CAPABILITIES AND METHODOLOGY This program calculates the amount of heat to be extracted for ground consolidation by means of forming an ice wall around shaft excavation. Input data includes physical, mechanical, and thermal properties for single and multiple rock formations.

INITIAL OPERATIONAL DATE 9/28/76

PROG ID FREEZE

PROGRAM SIZE 39791 bytes

LANGUAGE Fortran IV

FREQUENCY OF USE On Engineer Demand

COMPUTER IBM 360/40

OTHER USERS None

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROCSOL
GROUND

APPLICATION Design of Shaft Linings

DOCUMENTATION TITLE/AUTHOR Witold Ostrowski-Author

SURVEY PARTICIPANT/ADDRESS Larry S. Jaycox, Mining Engineer/
S.A. Scott & Company, Inc., 12567 West Cedar Drive, Lakewood,
CO 80228

AVAILABILITY COMMENTS By special arrangement.

PROGRAM CAPABILITIES AND METHODOLOGY This program calculates
stress around shaft openings for rock in the elasto-plastic
and elasto-elastic state of equilibrium.

INITIAL OPERATIONAL DATE 7/75

PROG ID ELASTO-PC

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE On Engineer Demand

COMPUTER IBM 360/40

OTHER USES None

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
GROUND

APPLICATION Calculation of Stresses on Concrete Shaft Linings

DOCUMENTATION TITLE/AUTHOR Larry S. Jaycox-Author

SURVEY PARTICIPANT/ADDRESS. Larry S. Jaycox, Mining Engineer/
S.A. Scott & Company, Inc., 12567 West Cedar Drive, Lakewood,
CO 80228

AVAILABILITY COMMENTS By special arrangement

PROGRAM CAPABILITIES AND METHODOLOGY This program calculates
stress on concrete shaft linings for uniform and combined
uniform and nonuniform loadings.

INITIAL OPERATIONAL DATE 12/4/75

PROG ID STRESCON

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE On Engineer Demand

COMPUTER IBM 360/40

OTHER USERS None

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
GROUND

APPLICATION Stabilizing Pressures

DOCUMENTATION TITLE/AUTHOR USBM RI 8128 "A Method for Computing Stabilization Pressures for Excavations in Incompetent Rock, with Computer User Information"/J.D. Dixon, M.A. Mahtab, Denver Mining Research Center, United States Bureau of Mines, Denver, CO

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-252-902

PROGRAM CAPABILITIES AND METHODOLOGY The purpose is to compute stabilization pressures for excavations in incompetent rock by means of a confining pressure analysis (CPA) and a failure evaluation analysis (FEA). The CPA evaluates concentrated nodal point forces to confine elements wherein shear stress along the critical failure plane exceeds Mohr-Coulomb strength criteria. The FEA evaluates the stress condition at the centroid of a finite element. When run in conjunction with the CPA, indication of its confining forces resulting in an overall stable element will be given. When FEA is run alone, overstressed shear and tensile zones will be given. The program code is a by-product of this research and its development has not been oriented for general use. The USBM assumes no responsibility for its operation. This program is experimental, it compiles for syntax but is not tested for accuracy.

INITIAL OPERATIONAL DATE NA

PROG ID STABIL

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER Cyber 74-28

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE SAFETY
COALU

APPLICATION Space-Frame Protective Canopies

DOCUMENTATION TITLE/AUTHOR USBM IC 8546 "CANOPY-A Computer Program
for the Structural Analysis of Space-Frame Protective Canopies"/
Stephen Sawyer, Pittsburgh Technical Support Center, United
States Bureau of Mines, Pittsburgh, PA, 1972

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-210-166

PROGRAM CAPABILITIES AND METHODOLOGY Computer program performs a
structural analysis of space-frame protective canopies used in
underground mines to protect equipment operators from falls
of roof, face and rib. Rapid calculation of the elastic strength
of a canopy for a variety of loading conditions is done.
Output also includes identification of all members that have
commenced yielding weight of the canopy, total loads on the
canopy and maximum loads the canopy can sustain elastically.

INITIAL OPERATIONAL DATE NA

PROG ID CANOPY

PROGRAM SIZE 40K core storage

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER CDC 6500

OTHER USERS NA

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE ROC SOL
COALU

APPLICATION Subsidence

DOCUMENTATION TITLE/AUTHOR Final Report "A Master Environmental Control and Mine System Design Simulator for Underground Coal Mining Volume V - Subsidence Susystem"/C.B. Manula, B. Mozumdar, D.K. Jeng, The Pennsylvania State University, University Park, PA 16802, USBM, Grant Number G0111808

SURVEY PARTICIPANT/ADDRESS Department of Mineral Engineering/
The College of Earth and Mineral Sciences, The Pennsylvania State University, University Park, PA 16802

AVAILABILITY COMMENTS

Available from National Technical Information Service (NTIS)
under the above title, Accession Number PB-255-425

PROGRAM CAPABILITIES AND METHODOLOGY "This volume of the final report describes the subsidence subsystem of the Master Design Simulator. This subsystem uses the finite element method to simulate ground movement caused by an advancing mining face in an underground coal mine. The model is structured around the concept that the ground mass is a layered media of different thicknesses and material properties. Gob areas are considered to be unfilled with broken rock at the beginning of mining. After mining starts, the gob areas are filled with broken materials which provides resistance to the lowering of the overlying strata. The model is tied to the geology and reserves subsystem, but it can also operate as a free standing routine. A case study is presented illustrating the application of the model. A detailed user's manual, including a program listing, is included in the appendices."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 370/168

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE STATAN
GSOUTL

APPLICATION Nonlinear Regression

DOCUMENTATION TITLE/AUTHOR USBM IC 8649 "Computer Program for Non-Linear Regression Using Least Squares"/Robert T. Langland and Norman N. Yabe, Denver Mining Research Center, United States Bureau of Mines, Denver, Colorado, 1974

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title Accession Number PB-237-036

PROGRAM CAPABILITIES AND METHODOLOGY "This program will solve nonlinear regression problems. The program is written in a general form so that, regardless of the functional relationship assumed, the unknown parameters may be evaluated by the Newton-Raphson method of iteration. Variances and co-variances of the parameters are derived, based on the propagation of errors. A creep function is established from shale test data as are examples of program utility. Program accuracy is compared to the accuracies of other programs in present day use."

INITIAL OPERATIONAL DATE NA PROG ID REGRESS

PROGRAM SIZE 16K core memory Mac 900 LANGUAGE Fortran IV
data points, 30 parameters

FREQUENCY OF USE NA COMPUTER CDC 6400

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ROC SOL
GENUG

APPLICATION Prediction of Surface Subsidence

DOCUMENTATION TITLE/AUTHOR Mining Subsidence/Naiem S. Tanious

SURVEY PARTICIPANT/ADDRESS U.S. Steel Research Center/B. Street,
Pittsburgh, PA 15235

AVAILABILITY COMMENTS Available from National Technical Information
Service (NTIS), under the above title, Accession Number PB-252-455.

PROGRAM CAPABILITIES AND METHODOLOGY The program predicts surface subsidence caused by multiple mining or flat seam type deposits. The numerical method in the program is based on a transversely inotropic, elastic solution given by means of a mathematical method in the Theory of Elasticity called the displacement discontinuity method. To describe the rock mass behavior, elastic constants are needed which can be obtained by a back calculation procedure. The program data input consists of specifying number of seams in the problem under consideration, elastic constants of the rock mass, depth and thickness of seams, mining pattern in the seams and whether it has been mined and caved.

INITIAL OPERATIONAL DATE 1/75

PROG ID MINSIM

PROGRAM SIZE CM 145,000

LANGUAGE Fortran

FREQUENCY OF USE Unlimited

COMPUTER CDC 660
Cyber 74

OTHER USERS Department of Civil and
Mineral Engineering, University of Minnesota,
Minneapolis, MN

MINE VENTILATION

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE VENT
COALU

APPLICATION Mine Ventilation Network Analysis

DOCUMENTATION TITLE/AUTHOR Mine Ventilation Simulator Users
Manual/A. Owili-Eger, R. V. Ramani, C. B. Manula (March 1973)

SURVEY PARTICIPANT/ADDRESS Peabody Coal Company/301 N. Memorial
Drive, St. Louis, Missouri 63102 ATTENTION: EDP Department

AVAILABILITY COMMENTS Contact U.S. Bureau of Mines, Ventilation
Group, Pittsburgh, PA or authors of documentation at Penn State
U., Department of Mineral Engineering.

PROGRAM CAPABILITIES AND METHODOLOGY Program input defines all
airways in ventilation network by specifying each branch in
terms of nodes, resistance or friction factor and airway dimensions
air quantity or NVP pressures, # of entries, fan number if one
exists, and type of airway (fixed, NVP, fan, leak or general).
Additional input defines fan curve characteristics (Q vs H, and
efficiency) for each fan. Constraints on iterative methods of
network computation are also variably input (maximum iterations,
allowable error). To compute Q (air quantity) and H (head loss)
in each airway, program utilized GeussSeidel form of iteration,
Hardy Cross Correction factor, Kirchhoff's law for networks
and Atkinson's law for pressure drop.

G

INITIAL OPERATIONAL DATE Nov. 1973

PROG. ID MVS (Mine Ventilation
Simulator)

PROGRAM SIZE 95,000 bytes

LANGUAGE Fortran

FREQUENCY OF USE On Demand, at
Division Engineers request

COMPUTER IBM 360

OTHER USERS None

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE VENT
COALU

APPLICATION Mine Ventilation Underground Coal

DOCUMENTATION TITLE/AUTHOR Final Report "A Master Environmental Control and Mine System Design Simulator for Underground Coal Mining Volume X - Ventilation Subsystem"/R.V. Ramani, A. Owili-Eger, C.B. Manula, The Pennsylvania State University, University Park, PA 16802, USBM, Grant Number G0111808

SURVEY PARTICIPANT/ADDRESS Department of Mineral Engineering/
The College of Earth and Mineral Sciences, The Pennsylvania State University, University Park, PA 16802

AVAILABILITY COMMENTS

Available from National Technical Information Service (NTIS) under the above title, Accession Number PB-255-430

PROGRAM CAPABILITIES AND METHODOLOGY

"This volume of the final report describes the ventilation subsystem of the Master Design Simulator. The ventilation subsystem has the capabilities to handle: (1) branches in parallel or series, (2) fans in parallel or series, (3) multiple fans, (4) methane, compressed air, or other injections into the system, (5) leakages and fixed quantities, and (6) calculations of absolute pressure at nodes. The program uses the Kirchhoff's Junction and mesh laws, and the Hardy-Cross iterative technique to converge to the desired accuracy in solving for the head quantity. A case study is included in the report illustrating the use of the model. The appendices of the report constitute a user's manual for the ventilation subsystem, and include program listing."

INITIAL OPERATIONAL DATE NA

PROG ID PSU/MVS

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 370/168

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE VENT
COALU

APPLICATION Ventilation Problems

DOCUMENTATION TITLE/AUTHOR USBM RI-7665, "Solving Ventilation Problems with Analog and Digital Computers"/Richard J. Kline, Stanley C. Suboleski, United States Bureau of Mines. Washington D.C.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-212 655.

PROGRAM CAPABILITIES AND METHODOLOGY "The underground mining industry is presently using the fluid network analyzer and digital computer to analyze ventilation systems. The availability of the digital computer and ventilation programs to mining companies has escalated its use permitting the design and modification of new or existing mine systems to be projected completely and thoroughly with consistent precision. Furthermore, the analog computer has been analyzing ventilation systems accurately for many years, and a comparison of the analog and digital methods was warranted. The report summarizes a detailed comparison for one mine and illustrates the paralleled analysis between the computers."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE VENT
GENUG

APPLICATION Ventilation Simulator

DOCUMENTATION TITLE/AUTHOR Computer Applications in Underground Mining Systems, Seven Volumes/Division of Minerals Engineering, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, R & D Report No. 37. Interim Report, OCR, Department of the Interior, Washington, D.C.

SURVEY PARTICIPANT/ADDRESS Department of Mining and Minerals Engineering/Virginia Polytechnic Institute & State University, Blacksburg, VA 24061

AVAILABILITY COMMENTS

National Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151.

PROGRAM CAPABILITIES AND METHODOLOGY "VENTSIM" utilizes one or a combination of three options: (1) measured pressure drops and volumes; (2) friction factor calculation; and (3) friction factor definition, to calculate the resistance of mine airways. From this and other input dealing with the flow network, fans, regulators, and airways, the program calculates volumes, pressure drops, flow rates, horsepower requirements and flow distributions. It can be used to model, predict, and solve a number of problems dealing with ventilation networks.

INITIAL OPERATIONAL DATE Sept. 1968

PROG ID VENTSIM

PROGRAM SIZE App. 150K

LANGUAGE Fortran IV

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS Both foreign and U.S.A. mining companies, various universities and research groups.

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE VENT
GENUC

APPLICATION Ventilation Planning

DOCUMENTATION TITLE/AUTHOR Interactive Ventilation Planning
System/R.A. Turpin

SURVEY PARTICIPANT/ADDRESS W.D. Bender/Bethlehem Steel Corporation,
Research Department, Bethlehem, PA 18016

AVAILABILITY COMMENTS Program or listing not available but
may negotiate.

PROGRAM CAPABILITIES AND METHODOLOGY The INVENT ventilation planning package contains interactive computer programs to perform the complex and lengthy calculations required in solving ventilation problems. These programs primarily compute: (1) airway resistances from air survey data. (2) air flow rates and pressures in a ventilation system, and (3) optimum fan blade settings and fan speed adjustments for single and multiple fan mines. The package also contains extensive user accommodations that simplify the work required to enter air-survey data into the computer, constructs ventilation system models, and selectively displays the results of a ventilation analysis.

INITIAL OPERATIONAL DATE 7/23/75

PROG ID INVENT

PROGRAM SIZE 3000 stmts

LANGUAGE Fortran IV

FREQUENCY OF USE On demand

COMPUTER IBM 370/168

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE VENT
GENUG

APPLICATION Ventilation

DOCUMENTATION TITLE/AUTHOR Computer Program for Mine Ventilation
Network Analysis/Y.J. Wang

SURVEY PARTICIPANT/ADDRESS Y.J. Wang/Sr. Mining Engineer Lykes
Resources, Inc., 420 South Washington Rd., McMurray, PA 15317

AVAILABILITY COMMENTS The original version of the program appeared
in Trans. SME/AIME, Vol. 247, Sept., 1970, pp. 241-245

PROGRAM CAPABILITIES AND METHODOLOGY Data input includes nodal
points of airways, airway resistance (or friction factor, height,
width and length of airway), fan characteristics, natural ven-
tilation pressures, and if desired, air quantities for regulated
airways. The solution to mine ventilation network is obtained
by applying Hardy Cross iteration technique. Program output
includes air quantity and pressure drop for each airway, cumulative
pressure drop for each mode, operating points of fans, and pressures
to be adjusted for regulated airways.

INITIAL OPERATIONAL DATE Oct. 1975

PROG ID Penn State Vent. Prog.

PROGRAM SIZE 120 K bytes

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS NA

HYDROLOGY & HYDROCHEMICAL

SOURCE OF INFORMATION See Below

APPLICATION CODE DRAIN
GEOUTL

APPLICATION Solute Waste Isolation Flow and Transport (SWIFT)

DOCUMENTATION TITLE/AUTHOR

Risk Methodology for Radioactive Waste Disposal in Geologic Media (Draft) Chapter C - Sandia Laboratories and the USGS

SURVEY PARTICIPANT/ADDRESS

AVAILABILITY COMMENTS

Contact Sandia Laboratories

PROGRAM CAPABILITIES AND METHODOLOGY

Three dimensional finite difference code that solves the combined effects of the differential equations of continuity combined with Darcy's Law (single phase flow), energy balance (heat transfer), solute concentration equation for material present in sufficient quantity to cause a density or viscosity effect, and a material transport equation for radionuclides which includes decay chains.

The code is comprehensive enough to include the effects of hydrodynamic dispersion in both the temperature and compositional mixing between resident and injected fluids. Convective flow modeling uses second-order correct space and time approximations minimizing the numerical dispersion problem.

Fluid and material properties to be input include radionuclide data, thermal properties of the fluid, thermal properties of porous media in each direction, rock density, reference temperatures and pressures, well properties, concentration viscosity tables, hydraulic conductivity, porosity, longitudinal and transverse

(Continued on Next Page)
INITIAL OPERATIONAL DATE PROG ID SWIFT

PROGRAM SIZE VERY LARGE

LANGUAGE

FREQUENCY OF USE

COMPUTER

OTHER USERS
USGS

dispersivity and molecular dispersivity.

To establish initial conditions the relevant state includes solute concentrations (salt in water etc.), initial velocities of resident fluid, and initial concentration of the radionuclides. Source value of radionuclides may be varied.

The code has been developed for the specific purpose of modeling radionuclide transport considering many physical phenomena and appears to be the most complete code for the task. The code has been verified hydrologically by comparison with an USGS geohydrology code and has also been used for a number of thermal calculations.

SOURCE OF INFORMATION SUBDOC

APPLICATION CODE DRAIN
COALU

APPLICATION Water Flow

DOCUMENTATION TITLE/AUTHOR Final Report "A Master Environmental Control and Mine System Design Simulator for Underground Coal Mining Volume IX - Water Generator"/C.B. Manula, A. Owili-Eger, The Pennsylvania State University, University Park, PA 16802
USBM, Grant Number G0111808

SURVEY PARTICIPANT/ADDRESS Department of Mineral Engineering/
The College of Earth and Mineral Sciences, The Pennsylvania State University, University Park, PA 16802

AVAILABILITY COMMENTS
Available from National Technical Information Service (NTIS)
under the above title, Accession Number PB-255-429

PROGRAM CAPABILITIES AND METHODOLOGY "The Water Generator (WATGEN) represents one part of the total system entitled "A Master Environmental Control and Mine Systems Design Simulator for Underground Coal Mining", and is applied to predict mine drainage quantity. The development of WATGEN as outlined in the report is based on a finite difference approximation coupled with a finite element analysis. The main differences between this model and its predecessors is the ability to consider such processes as precipitation, infiltration, runoff, evaporation, evapotranspiration and interflow. The second difference that characterizes the model is the consideration given to the unsaturated zone which allows application to a continuous water shed. Although WATGEN can be readily tied to the Geology and Reserves subsystem as a part of MDS, it is free standing and operates as an event-oriented routine."

INITIAL OPERATIONAL DATE NA

PROG ID WATGEN

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 370/168

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE DRAIN
COALU

APPLICATION Mine Drainage Estimation

DOCUMENTATION TITLE/AUTHOR Water Generator User's Manual/C.B. Manula,
A.S.C. Owili-Eger

SURVEY PARTICIPANT/ADDRESS Angelus S.C. Owili-Eger/CONOCO,
P. O. Box 1267, Ponca City, Oklahoma 74601

AVAILABILITY COMMENTS NA

PROGRAM CAPABILITIES AND METHODOLOGY Two-phase (water-air/gas)
flow model. Solution procedure combines finite difference
approximation with finite element method. Input data requirements
includes geologic, fluid properties, meteorologic and miscellaneous
(book-keeping) data. These data are input for each block or
element.

INITIAL OPERATIONAL DATE 1975

PROG ID WATGEN

PROGRAM SIZE 280K

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER IBM 370

OTHER USERS USBM, Underground coal mines

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE PHYCHM
GENNCL

APPLICATION In Situ Leaching Fluid Hydrology Analysis

DOCUMENTATION TITLE/AUTHOR U.S. Bureau of Mines Report of
Investigation by Donald I. Kurth and Robert D. Schmidt

SURVEY PARTICIPANT/ADDRESS Robert D. Schmidt/Twin Cities
Mining Research Center, Twin Cities, MN 55111

AVAILABILITY COMMENTS Program listing and documentation available
upon request.

PROGRAM CAPABILITIES AND METHODOLOGY Computer model simulates
aquifer hydrology associated with in situ leaching (of uranium).
The model simulates a 5-spot pattern on input and output wells.
Leaky and non-leaky aquifers are modeled using closed form
solutions of the partial differential equations describing the
change in fluid head as the leaching is carried out. User
input consists of aquifer, well and leachant flow characteristics.
Numeric and graphic output such as iso pressure, iso velocity
and iso time contours are available.

INITIAL OPERATIONAL DATE 2/77

PROG ID 5-SISL

PROGRAM SIZE 11,300 words

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER CDC 6600

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE PHYCHEM
SPECIAL

APPLICATION Chemical Reactions in Natural Waters

DOCUMENTATION TITLE/AUTHOR "MIX2: A Computer Program for Modeling Chemical Reactions in Natural Waters"/L. Niel Plummer, David L. Parkhurst, David R. Kosiur, Water Resources Division, Geological Survey, Reston, VA

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-251 668.

PROGRAM CAPABILITIES AND METHODOLOGY "MIX2 is a Fortran IV computer program that utilizes an aqueous model and the constraints of mass balance and electrical balance to compute the pH and equilibrium distribution of inorganic species as a result of net reaction progress in the closed system: $\text{CaO-MgO-Na}_2\text{O-K}_2\text{O-CO}_2\text{-H}_2\text{SO}_4$. The program considers three general classes of problems involving net reaction progress:

(1) mixing of two solutions in fixed volume, (2) titration of one solution into another (variable volume), and (3) the addition or subtraction of a net stoichiometric reaction to or from an aqueous solution. In addition MIX2 will follow one phase boundary through any of the above classes of problems. This report presents the theory and method of calculation used by MIX2, describes the input to the program, presents results of two test cases, and provides a program listing."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE PHYCHM
SPECIAL

APPLICATION Chemical Equilibria of Natural Waters

DOCUMENTATION TITLE/AUTHOR "WATEQ, A Computer Program for Calculating Chemical Equilibria of Natural Waters"/Alfred H. Truesdell, Blair F. Jones, USGS, Washington, DC.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service (NTIS), under the above title, Accession Number PB-220-464.

PROGRAM CAPABILITIES AND METHODOLOGY "The computer program, WATEQ, calculates the equilibrium distribution of inorganic aqueous species of major and important minor elements in natural waters using the chemical analysis and insitu measurements of temperature, pH and redox potential. From this model, the states of reaction of the water with solid and gaseous phases are calculated. Thermodynamic stabilities of aqueous species, minerals and gases have been selected from a careful consideration of all available experimental data."

INITIAL OPERATIONAL DATE NA

PROG ID WATEQ

PROGRAM SIZE NA

LANGUAGE PL-1

FREQUENCY OF USE NA

COMPUTER IBM 360

OTHER USERS NA

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE PHYCHM
SPECIAL

APPLICATION Inorganic Aqueous Equilibrium Distribution

DOCUMENTATION TITLE/AUTHOR "SOLMNEQ: Solution-Mineral Equilibrium Computations"/Yousif K. Kharaka, Ivan Barnes Department of Geology and Geophysics, California University, Berkeley, CA

SURVEY PARTICIPANT/ADDRESS. None

AVAILABILITY COMMENTS Available from National Technical Information Service, under the above title, Accession Number PB-215 899.

PROGRAM CAPABILITIES AND METHODOLOGY "SOLMNEQ computes the equilibrium distribution of 162 inorganic aqueous species generally present in natural waters over the temperature range of 0 to 350° from the reported chemical analyses, temperature, pH, and Eh (optional). Interpolated dissociation constants of the aqueous complexes and the computed activity coefficients are also used in these computations. States of reactions of the aqueous solutions with respect to 158 solid phases (minerals) are computed from the distribution of aqueous species and an internally consistent set of thermodynamic data. Ionic proportions and subsurface temperature estimates are computed."

INITIAL OPERATIONAL DATENA

PROG ID SOLMNEQ

PROGRAM SIZE NA

LANGUAGE PL/I

FREQUENCY OF USE NA

COMPUTER IBM 360

OTHER USERS NA

MINE DESIGN/CONSTRUCTION/OPERATION

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ECONAN
GENUG

APPLICATION Tunnel Cost Estimated Risk Analysis

DOCUMENTATION TITLE/AUTHOR "Tunnel Cost Model User's Manual/
Saturnino Suarez-Reynoso and David J. Gray

SURVEY PARTICIPANT/ADDRESS Michael J. Markow/Massachusetts
Institute of Technology, Room 1-170, Cambridge, Massachusetts
02139

AVAILABILITY COMMENTS
Contact Mr. Markow. Prior request of descriptive reports is
strongly advised before obtaining program.

PROGRAM CAPABILITIES AND METHODOLOGY The Tunnel Cost Model (TCM)
is a simulation model of tunnel construction. It includes
probabilistic descriptions of anticipated geology, construction
productivity and equipment reliability to enable users to gauge
risk in project cost and schedule estimates. The model provides
owners and engineers a rapid way of analyzing alternative tunnel
locations to seek the most favorable geologic environment. It
allows owners, engineers and contractors to test different con-
struction options to seek the most rapid and economical construc-
tion program. The TCM may also be used by owners and contractors
during construction to update and revise the construction plan.
The model operates at various levels of detail, and is therefore
suited to estimates ranging from preliminary to final.

INITIAL OPERATIONAL DATE 4/74

PROG ID Tunnel Cost Model (TCM)

PROGRAM SIZE 300-600K bytes

LANGUAGE PL/1

FREQUENCY OF USE On demand

COMPUTER IBM 370/168

OTHER USERS Program has been used in case studies in conjunction with
Perini Corporation, United Engineers and Construction, Inc., and
Morrison-Knudsen, Inc. Intended for owners, design engineers,
contractors, CM's, cost estimators involved in underground con-
struction.

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
COSTAN

APPLICATION Tunneling

DOCUMENTATION TITLE/AUTHOR Final Report "A Computer Program for Estimating Costs of Hard Rock Tunneling"/F.T. Wheby, E.M. Cikanek, Harza Engineering Company, 400 West Madison Street, Chicago, IL 60606
The Office of High Speed Ground Transportation and The Urban Mass Transportation Administration, Department of Transportation, Washington, D.C. Contract Number DOT-FR-9-00003.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service. Program Cards for a Computer Program for Estimating Costs of Hard Rock Tunneling (COHART), Accession Number PB-201-834. See also PB-193-272

PROGRAM CAPABILITIES AND METHODOLOGY

"A computer performs all logic and computations customarily done by hand in preparation of engineer's estimates or contractor's bids on tunnel-shaft systems. The program described is based on construction methods, work forces, and equipment selections corresponding to the current state of the art of tunneling. The program contains logic to permit the estimate of costs of complicated tunnel-shaft systems. In any estimate, the program will accommodate a large number of values or changes in the values of the factors that affect costs, such as tunnel shape and size, shaft depth, rock characteristics, and construction method. To provide great flexibility, the user of the program is provided with the option of selecting lining type and thickness, profit and overhead margins, and other input data. Suggestions for selecting an appropriate value for these inputs are contained in the report."

INITIAL OPERATIONAL DATE 5/70

PROG ID COHART

PROGRAM SIZE 265K

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER IBM 360 Mod 50

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE DRBLAS
COALS

APPLICATION Drilling and Blasting

DOCUMENTATION TITLE/AUTHOR Report FE-1520-116, User's Manual
for Drilling and Blasting

SURVEY PARTICIPANT/ADDRESS Bonner & Moore Associates, Inc./
500 Jefferson, Suite 1124, Houston, Texas 77002

AVAILABILITY COMMENTS User's Manuals available from National
Technical Information Services, Accession Number FE-1520-116,
U.S. Dept. of Commerce, Springfield, VA 22161. Also, available
on GE time sharing.

PROGRAM CAPABILITIES AND METHODOLOGY

The DAB (Drilling and Blasting) model was designed for evaluation
of rotary and auger drills (from the data files) for drilling
either coal or overburden. The model determines equipment
requirements and costs for blasting agents. It can determine
spacing and burden for specified drills and powder factors,
or evaluate drills for user-set burden and spacing.

INITIAL OPERATIONAL DATE March 1977

PROG ID DAB

PROGRAM SIZE 16K

LANGUAGE XDS Fortran IV

FREQUENCY OF USE NA

COMPUTER XDS Sigma 7

OTHER USERS NA

SOURCE OF INFORMATION

APPLICATION CODE ENGDES

APPLICATION Shaft Design

DOCUMENTATION TITLE/AUTHOR

SURVEY PARTICIPANT/ADDRESS Fritz Penning, Earth Mechanics Institute,
Colorado School of Mines, Golden, Colorado

AVAILABILITY COMMENTS E. H. Skinner, USBM, Spokane Mining Research
Center, Spokane, WA

PROGRAM CAPABILITIES AND METHODOLOGY

SKIP I determines the dynamic load interaction between shaft conveyances and guides. Input variables include conveyance mass, location of center of gravity with respect to geometric center, guide material, size and shape, bunton spacing, conveyance velocity, guide misalignment, and variations in spring constant of guide rollers. Output includes forces normal to the guides, guide displacement, conveyance displacement, lateral accelerations. Program may be used as a design tool for guide and cage/skip specifications or may be used to evaluate the structural stability of particular shaft designs subject to vibrational loads.

INITIAL OPERATIONAL DATE 1978

PROG ID SKIP I

PROGRAM SIZE NA

LANGUAGE Fortran IV

FREQUENCY OF USE NA

COMPUTER USBM CYBER
System

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ENGDES
EQUIP

APPLICATION Mine Hoist Sizing

DOCUMENTATION TITLE/AUTHOR H011, H013, H015, H016/NA

SURVEY PARTICIPANT/ADDRESS Rexnord, Inc./P. O. Box 383,
Milwaukee, Wisconsin 53201

AVAILABILITY COMMENTS Not available

PROGRAM CAPABILITIES AND METHODOLOGY Mine hoist sizing program prints out the rope speed, drum size, rope size, skip load, skip weight, rms h.p., peak h.p., tread pressure, T1/T2 ratio for various mine hoisting applications. Input data consists of capacity requirements (TPH) or (LOADS), rope safety factor required, type of rope to be used, type of drive system, duty cycle data, drum dia. to rope dia. ratio, skip weights or cage weights and number of ropes. Programs are available for double drum hoists, single drum hoists, friction hoists and vertical or inclined shafts.

INITIAL OPERATIONAL DATE 1967

PROG ID NA

PROGRAM SIZE NA

LANGUAGE Fortran

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS Mining companies, consulting firms, electrical drive suppliers.

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE ENGDES
GENUG

APPLICATION Mining Design and Evaluation

DOCUMENTATION TITLE/AUTHOR Computer Applications in Underground
Mining Systems, Five Selections/Division of Minerals Engineering
Blacksburg, VA - R & D Report No. 37, Final Report, GPO Catalog
No. 163.10:37.

SURVEY PARTICIPANT/ADDRESS Department of Mining and Minerals
Engineering/Virginia Polytechnic Institute & State University
Blacksburg, VA 24061

AVAILABILITY COMMENTS

National Technical Information Services, U.S. Department of Commerce,
5285 Port Royal Road, Springfield, VA 22151.

PROGRAM CAPABILITIES AND METHODOLOGY "RAMPLAN" provides a first
order estimate of tonnages based on an assessment of structural
evaluation problems. The program input gridded data from
VPI & SU's "CONTUR" and "RESERV-COAL" along with dimensional
data, subsidence data, and roof and floor data. From this it
obtains and outputs panel and barrier pillar dimensions, unsupported
roof spans, safety factors (both roof and floor), roof bolt
length and capacity, bolts set, set spacing, and vertical subsi-
dence dimensions. All calculations are done using design equations
currently in use by industry.

INITIAL OPERATIONAL DATE Dec. 1973

PROG ID RAMPLAN I

PROGRAM SIZE 152K

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS Foreign and U.S.A. mining companies, various universities,
and research groups.

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE DRIAN
GENUG

APPLICATION Pump Network Simulator

DOCUMENTATION TITLE/AUTHOR Computer Applications in Underground Mining Systems, Seven Volumes/Division of Minerals Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA R & D Report No. 37, Interim Report, OCR, Department of Interior, Washington, D.C.

SURVEY PARTICIPANT/ADDRESS Department of Mining and Minerals Engineering/Virginia Polytechnic Institute & State University, Blacksburg, VA 24061

AVAILABILITY COMMENTS
National Technical Information Services, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151

PROGRAM CAPABILITIES AND METHODOLOGY

"PUMPSIM" analyzes a network of up to 20 pumps, 50 regulators, and 200 total line segments. It is a steady-state network analysis and shows whether a system design is feasible and illustrates the under-designed portions of the system. Data can be obtained from handbooks, schematics, and manufacturer's data. Output includes information on pumps, regulators, lines, fittings, quantities delivered, operating pressures, and water horsepower. Other output includes volumes, pressure losses and frictional factors.

INITIAL OPERATIONAL DATE Sept. 1968

PROG ID PUMPSIM

PROGRAM SIZE App. 150K

LANGUAGE Fortran IV

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS Both foreign and U.S.A. mining companies, various universities and research groups.

CODES AT GOLDER ASSOCIATES

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE SAFETY
GENUG

APPLICATION Mine Evacuation Simulation

DOCUMENTATION TITLE/AUTHOR "Development of Emergency Escape
Systems Guidelines for Underground Metal and Non-Metal Mines"/
(PTO)

SURVEY PARTICIPANT/ADDRESS Ashok B. Boghani/Program Manager,
Foster-Miller Associates, Inc., 135 Second Avenue, Waltham,
Massachusetts 02154

AVAILABILITY COMMENTS

Card deck, listing, documentation available from USBM, Spokane.
Foster-Miller will negotiate application assistance.

PROGRAM CAPABILITIES AND METHODOLOGY

The simulation input variables include characteristics of the mine, expressed in form of a network of passages, properties of hoists, and hoisting strategies, initial miner positions, ventilation and compressed air velocities, stench warning system and self rescuer capabilities. The simulation can be carried out for cases in which there is no fire or for cases in which there is a fire at any arbitrary location. The simulation output includes the evacuation time for each miner, movement of the hoists, propagation of smoke through the mine passages and smoke exposure of the miners.

INITIAL OPERATIONAL DATE 5/75

PROG ID FIRE

PROGRAM SIZE 130,000 words

LANGUAGE Fortran

FREQUENCY OF USE On demand

COMPUTER CDC 6600

OTHER USERS NA

SOURCE OF INFORMATION JOUR

APPLICATION CODE SAFETY
GEOLOG

APPLICATION Geological Hazard Detection With Radar

DOCUMENTATION TITLE/AUTHOR "Computer-Aided Underground Radar
Penetrates Rock Formations"/ENSCO, Inc., Washington, D.C.

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Reference to program published in Coal
Age, March, 1976 issue, volume 81, number 3, p. 196.

PROGRAM CAPABILITIES AND METHODOLOGY "A subsurface-probing radar system has been used to successfully detect and map underground features. The computerized-radar technique could reveal the location of potentially hazardous geological features in hard rock. In the method, radar signals transmitted and received in hard rock are combined with advanced computer-based signal processing techniques. The equipment would operate from small bore-holes to provide accurate information on the size and location of weathered zones, faults, water pockets, cavities, and other potentially hazardous conditions."

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA

SOURCE OF INFORMATION SUBMIT

APPLICATION CODE POWER
GENUG

APPLICATION Power Simulator

DOCUMENTATION TITLE/AUTHOR Computer Applications in Underground Mining Systems, Seven Volumes/Division of Minerals Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA R & D Report No. 37, Interim Report, OCR, Department of the Interior, Washington, D.C.

SURVEY PARTICIPANT/ADDRESS Department of Mining and Minerals Engineering/Virginia Polytechnic Institute & State University, Blacksburg, VA 24061

AVAILABILITY COMMENTS

National Technical Information Services (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151

PROGRAM CAPABILITIES AND METHODOLOGY

"POWERSIM" determines the adequacy of a power system with either AC or DC power, and containing up to 10 voltage sources, 75 loads, 300 total segments, and up to 9 levels of voltage. Most of the input data may be determined from handbooks, manufacturers data and schematic diagrams. Output includes currents, voltages, percent of rated voltage, watts, var, volt-amperes available, and the power factors for the loads and sources. Similar output including voltage-drop and power-consumed are provided for the lines.

INITIAL OPERATIONAL DATE Sept. 1968

PROG ID POWERSIM

PROGRAM SIZE App. 150K

LANGUAGE Fortran IV

FREQUENCY OF USE On demand

COMPUTER IBM 370/158

OTHER USERS Both foreign and U.S.A. mining companies, various universities and research groups.

SOURCE OF INFORMATION PUBDOC

APPLICATION CODE ROC SOL
GENUG

APPLICATION Rock Block Model

DOCUMENTATION TITLE/AUTHOR Technical Report "Rational Design of Tunnel Supports: A Computer Model for Rock Mass Behavior Using Interactive Graphics for the Input and Output of Geometrical Data"/Peter Cundall, University of Minnesota, Minneapolis, MN 55455, Contract Number DACW 45-74-0066. MRD-TR-2-74

SURVEY PARTICIPANT/ADDRESS None

AVAILABILITY COMMENTS Available from National Technical Information Service under the above title, Accession Number AD-A-001-602.

PROGRAM CAPABILITIES AND METHODOLOGY "The report describes a computer program that can model the behavior of assemblages of rock blocks, and visually display this behavior on the screen of a Cathode Ray Tube (CRT). There is no restriction on block shapes and no limits to the magnitudes of displacements and rotations that are allowed. The rock geometry is specified by the user, who "draws" lines on the CRT screen, which is connected to a mini-computer. The program then interprets each closed area between lines as a discrete block, and allows the blocks to move relative to one another, under the action of gravity and forces specified by the user. Joint properties may be specified, and blocks may be "excavated", fixed and released or "reinforced".

INITIAL OPERATIONAL DATE NA

PROG ID NA

PROGRAM SIZE NA

LANGUAGE NA

FREQUENCY OF USE NA

COMPUTER NA

OTHER USERS NA