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SOC CODE: LAGRANGIAN, FINITE-DIFFERENCE CALCULATIONAL
TECHNIQUE IN ONE-DIMENSIONAL SYMMETRY

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* These listings appear on microfiche attached to the inside back cover.

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SOC CODE: LAGRANGIAN, FINITE-DIFFERENCE CALCULATIONAL
TECHNIQUE IN ONE-DIMENSIONAL SYMMETRY *

ABSTRACT

We offer a brief description and complete listings of the SOC finite-difference computer code and its related family of codes.

1. INTRODUCTION

The SOC code is used to perform either dynamic or quasistatic stress calculations for a Lagrangian grid of zones. Calculations are possible in one-dimensional symmetry for planar geometry, cylindrically divergent geometry, or spherically divergent geometry. The physics routines in the code emphasize constitutive behavior for solid and vaporized geologic media.

The SOC system consists of three separate computer programs:

- A generator code, which reads input data and sets up the problem.
- The main code, which performs physics calculations.
- A post-processor or time plot code, which reads output from the main code and produces time-history plots of the results. All three of these codes are included in the subsequent listings.

The SOC codes are written in modified Fortran IV for Lawrence Livermore Laboratory's CDC 7600 computers. Changes are required to run these codes on any other computer system. In particular, extensive modifications would be necessary in the plot routines, input-output routines, and in certain nonstandard language features.

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In the main sections of this report, we discuss the major routines and common blocks of the SOC codes. The major routines section lists principal subroutines and summarizes their functions. For the major common blocks, we list the principal cliches that specify most of the common storage used in the SOC codes. We have included microfiche that contain the SOC codes listings and focal listings. The latter summarize the structure and variable assignments of each code.

2. MAJOR ROUTINES OF SOC CODES

GENERATOR SUBROUTINES

Main Code SG Main routine controls flow of code, calls input routines, initializes certain parameters, checks portions of input, sets up certain input tables and arrays, prints and plots generator output.

INI:T Initializes overburden and physics quantities. Writes initial restart dump for SOC main code.

MATRD Checks constitutive and viscosity input for solid materials. Sets up certain tables and arrays for material input.

GASRD Reads fixed-format or "long" gas tables. Checks gas table input. Sets up parts of the gas tables. Performs related calculations.

BUBGAS Calculates liquefaction energy and vaporization energy, radius, and time for a "bubbled" material. Calculates pressure-specific volume (P-V) gas adiabat from bubble gas tables. Corrects zoning to correspond with bubble radius. Prints and plots bubble routine output.

H2O Uses release curves for pure water vapor and solid material P-V curve to generate an altered (weighted) set of mixed-phase water release tables for a solid material that contains water. Prints and plots altered release tables. H2O routine is executed only if a water content is specified for a material.

ZONE Sets up and checks zoning for problem grid.

SOCINK Reads new input data for the physics quantities, and overwrites each zone of grid with new values. Used to link results from another code into a SOC problem.

DIMWIT Format-free input routine. Decodes and processes mnemonic input. Checks and sets up certain parts of input.

SUMS Prints current SOC version name and date in generator output. Should be modified whenever a major change is made in the codes.

MAIN CODE SUBROUTINES

MAIN Initializes main code run and sets up some starting parameters. Controls flow of code. Calls physics routine every cycle. Performs automatic dezoning operations. Checks for dumps, edits, and termination time. Writes edit output for main code.

CYCLE Physics calculation loop. Contains equation of motion and constitutive routines. Calculates artificial viscosities and time-step stability criterion, etc.

TAPER Writes restart dumps for main code and time plot dumps to be processed later by time plot code.

PLOTS Produces "snapshot" or radius plots during main code run. These plots show any physics variable vs radius at a given time.

PUTPET Special constitutive routine for porous compaction plasticity model. Called from CYCLE routine.

MPLOT Produces either black and white or color (multiframe) movie plot sequences of physics variables during main code run.

PLOT CODE SUBROUTINES

MAIN	Controls flow of plot code. Reads and unpacks dump files produced by main code. Calls input routines. Produces plots and edits as requested. Calls subsidiary plotting routines. Handles disposition of output.
TICON	Format-free input routine. Decodes and processes either mnemonic or numeric input. Checks parts of input.
PLOT3D	Set of routines for preparing isocontour "3D" plots of a variable vs range and time.
KONTURS	Set of routines for preparing "2D" contour line plots of a variable vs range and time. Also contains color plot coding.
NICE	Nice number routine used to generate suitable scale increments for plots.
SAPX	Mapping routines used to draw grids and scales for various types of plots.

PROBLEMS

Sample problem input for generator and plot codes. Used to test codes and check modifications.

3. BIBLIOGRAPHY FOR SOC CODES

Burton, D. E., and J. F. Schatz, Rock Modeling in TENSOR74, a Two-Dimensional Lagrangian Shock Propagation Code, Lawrence Livermore Laboratory, Livermore, Calif., UCID-16719 (1975).

Butkovich, T. R., The Gas Equation of State for Natural Materials, Lawrence Livermore Laboratory, Livermore, Calif., UCRL-14729 (1967).

Butkovich, T. R., A Technique for Generating Pressure-Volume Relationships and Failure Envelopes for Rocks, Lawrence Livermore Laboratory, Livermore, Calif., UCRL-51441 (1973).

Cherry, J. T., and F. L. Peterson, Numerical Simulation of Stress Wave Propagation from Underground Nuclear Explosions, in Proc. Am. Nucl. Soc. Symp. Eng. with Nucl. Explosions, Las Vegas, Nev., January, 1970 (American Nuclear Society, Hinsdale, Ill., 1970), CONF-700101.

Lee, E. L., H. C. Hornig, and J. W. Kury, Adiabatic Expansion of High Explosive Detonation Products, Lawrence Livermore Laboratory, Livermore, Calif., UCRL-50422 (1968).

Lee, E. L., M. Finger, and W. Collins, JWL Equation of State Coefficients for High Explosives, Lawrence Livermore Laboratory, Livermore, Calif., UCID-16189 (1973).

Schatz, J. F., The Physics of SOC and TENSOR, Lawrence Livermore Laboratory, Livermore, Calif., UCRL-51352 (1973).

Schatz, J. F., SOC73, A One-Dimensional Wave Propagation Code for Rock Media, Lawrence Livermore Laboratory, Livermore, Calif., UCRL-51689 (1974).

- Seidl, F. C. P., SOC, A Numerical Model for the Behavior of Materials Exposed to Intense Impulsive Stresses, Lawrence Livermore Laboratory, Livermore, Calif., UCID-5033 (1965).
- Snell, C. M., and D. E. Burton, SCON, New K-Division Production System for SOC74 Codes, Lawrence Livermore Laboratory, Livermore, Calif., RKCD 75-14 (1975).
- Snell, C. M., and D. E. Burton, Use of B-Division ELFIT System to Place K-Division Production Files in Photostore, Lawrence Livermore Laboratory, Livermore, Calif., RKCD 75-20 (1975).
- Snell, C. M., and G. D. Mendez, BCONSOC, A Special-Purpose Teletype Controller Package for the SOC74 Codes, Lawrence Livermore Laboratory, Livermore, Calif., RKCD 75-10 (1975).
- Snell, C. M., and G. D. Mendez, User Information for Revised SOC74 Codes, Lawrence Livermore Laboratory, Livermore, Calif., UCID-16811 (1975).
- Snell, C. M., and G. D. Mendez, Revised SOC74 Codes Available, Lawrence Livermore Laboratory, Livermore, Calif., RKCD 76-3 (1976).
- Snell, C. M., and G. D. Mendez, Revised SOC Codes; New Super-Plot Code SPLT74P, Lawrence Livermore Laboratory, Livermore, Calif., RKCD 76-11 (1976).
- Terhune, R. W., D. R. Stephens, and F. L. Peterson, Pressure-Volume Release Path Model for SOC and TENSOR, Lawrence Livermore Laboratory, Livermore, Calif., Memo UOPKL 72-46 (1972).

4. COMMON VARIABLES USED IN SOC CODE ROUTINES

The SOC generator code uses two cliches that define common storage allocations. Cliche SOCOM contains final material properties data, compressibility and shear strength tables, gas tables, altered water-release tables, boundary profile data, and some other input and calculational parameters. Cliche GENCOM contains various input and calculational parameters, physics quantities storage for every zone in the grid, and temporary storage used to read and process generator input data.

The SOC main code shares part of the common storage that appears in the generator. Cliche SOCOM is used directly in the main code. The first part of GENCOM is duplicated in cliche MAINCM of the main code. The second part of GENCOM (temporary storage) is used only in the generator and does not appear in the main code. Cliche MAINCM also contains storage for the time plot dump information and some parameters used in preparing movie plots; these appear in the main code only. Finally, the main code has a cliche BOCOM, which specifies variables used locally in the constitutive routines and related physics calculations. These variables do not appear elsewhere.

The SOC time plot code shares cliche SOCOM with the generator and main codes. No other cliches are used.

This section lists and briefly defines the quantities appearing in GENCOM, MAINCM, and SOCOM.

Cliche GENCOM

These quantities are needed in both the generator and main code; they are thus duplicated in the main code cliche MAINCM. A double asterisk (**) before an entry indicates one of the basic physics parameter arrays or storage arrays for every zone in the grid. Currently, all grid arrays (**) are dimensioned for 1200 zones (maximum).

A2BON2	Second-order rate correction for transmitting outer boundary calculations. Not currently used.
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A2BOUN Dimensionless stress rate factor for transmitting outer boundary calculations.

AA Current radius of inner pressure profile. Saved for restarting problem. Also used as temporary variable in dezoning calculations, regional energy sums, and constitutive calculations.

AB $(0.5*DT(N+1/2))^{**2}$.

AC Current pressure of inner pressure profile. Saved for restarting problem.

AE $0.5*DT(N)$.

**AM Mass of zone.

ATBOUN Geometry-dependent attenuation factor at transmitting outer boundary.

BR Bank time left to run.

**C1 Liquefaction or water vaporization weighting factor for the zone. Gradually reduces shear strength and shear modulus of the zone toward zero as material approaches liquefaction energy or water vaporization point.

CRTI Crt(plot) i.d. indicator; set to zero when crtld is called.

**DR Displacement of zone; the change in radius relative to initial radius RN. Also called Delta-R.

****DRMX** Peak value storage for zone. Maximum displacement in left 30 bits; maximum velocity in right 30 bits. These are maximum values experienced throughout entire calculation.

DT Time step at cycle N, $\Delta T(\text{at } N)$.

DTBON Time step for transmitting boundary calculation. Not currently used.

DTH Time step at $N+1/2$, $\Delta T(N+1/2)$.

DTN $DT(N+1/2) - 0.5 \cdot DT(N)$.

DTPR Edit time interval (current interval between edit printouts).

****DV** Change in zone volume due to compression (delta-volume).

****DVO** Change in zone volume due to initial overburden. Carried separately from active compression DV.

****E** Internal energy of zone (per original unit volume).

****EO** Internal energy of zone on previous time step (saved value of E from previous cycle). Also used as temporary storage after physics calculations are complete.

****FF** State indicators for zone. Failure mode indicator in left 6 bits; nothing in next 10 bits; region index in next 4 bits; material state in next 3 bits; material number in next 7 bits; stored value of excess compression MU in right 30 bits.

HDTH $0.5 \cdot DT(N+1/2)$.

IDM Integer quantity. Not currently used.

IDMIX	Integer quantity. Not currently used.
IDSK	High-speed output file name for generator warning messages. Also used as index for time plot disk file names.
IHALF	Mask to zero out right half of a word (last 30 bits).
IL	Index for array of times "RPL" at which radius plots are to be made.
IPB	Counter for time plot disk files (identifies currently open file).
IPI	Index used in tabular profile boundary-condition calculations.
IPO	Outer boundary-condition indicator. Specifies presence and type of outer boundary condition.
IPORP	Saved initial value of outer boundary-condition indicator. Needed after boundary condition is turned off.
IPPO	Inner boundary-condition indicator. Specifies presence and type of inner boundary condition.
IPPORP	Saved initial value of inner boundary-condition indicator. Needed after boundary condition is turned off.
ITBH	Storage array; integer. Not currently used.
ITBI	Sentinel to read fixed-format link data after all other generator input is read (+1). Or, sentinel to stop problem after cavity interface velocity reverses direction (-1).

ITBJ Sentinel to construct special gas table with interpolation from solid Hugoniot to gas equation of state for any solid material that has a gas table.

ITBK Reserved input storage; integer. Not currently used.

ITBL Sentinel to turn off linear "q" viscosity for expanding zones.

ITBM Movie plot sentinel (equal to MSENT).

ITBN Reserved input storage
through words; integer. Not
ITBO currently used.

ITB01 Reserved input storage
through words; integer. Not
ITB05 currently used.

ITBP Reserved input storage
through words; integer. Not
ITBV currently used.

ITBW,ITBX Indices for large common block buffers.

ITBY,ITBZ Integer storage. Not currently used.

ITCX Index for array of times to change edit interval.

JN Index of outermost active zone.

LHALF Mask to zero out left half of word (first 30 bits).

LN Index of last zone (innermost zone) in problem. Zone indices increase in inward direction for SOC.

LX Index of last zone plus one(LN+1).

MCNT Counter to keep track of number of time plot dumps since last set of movie plots was made.

MSENT Movie sentinel. Index to prepare movie plots once every "MSENT" time plot dumps.

MSENT2 Sentinel to prepare 16mm black and white movies rather than 35mm color movie stock. This sentinel is set if the input value of the movie sentinel is given as a negative (-) number.

MSENT3 Number of title frames preceding movie sequences. May be an input value or default.

MSENT4 Movie plotting index. Not currently used.

MSENT5 Array of indices for movie plots. Not currently used.

MZERO Movie plotting index. Not currently used.

NC Cycle number.

NCT Plot counter used in making movie peak plots.

NCT1 Movie plotting index. Not currently used.

**p Zone pressure.

PBON2 Second-order pressure term at transmitting outer boundary. Not currently used.

PBOUN Previous cycle pressure at transmitting outer boundary.

PDT Plot interval. Time interval between successive time plot dumps.

**PTF Relaxed tensile pressure. Stress increase corresponding to volume expansion created by tensile failure.

PTS Time at which next time plot dump is to be made.

**PX Peak value storage for zone. Maximum value of pressure in left 30 bits; maximum value of radial stress σ_r in right 30 bits.

**Q Artificial viscosity "q" value for zone.

**QJS1 Radial tensile void strain for zone.

**QJS2 Tangential tensile void strain for zone.

**QK Deviatoric artificial viscosity "qk" for zone.

**QKS1 Maximum previously attained shear modulus for zone. Used in maximum shear modulus calculations.

**QKS2 Physics storage quantity. Not currently used.

**QKS3 Shear strain for zone.

**QKS4 Accumulated plastic shear strain for zone stored in left half; hydrostatic tensile void strain stored in right half.

**QKS5 Physics storage for
through zone. Not
**QKS8 currently used.

****RN** Initial radius for zone.

****S1** Radial principal stress deviator for zone.

S1BON2 Second-order radial stress deviator at transmitting outer boundary. Not currently used.

S1BOUN Previous cycle radial stress deviator at transmitting outer boundary.

****SBF** Accumulated failure shear strain (plastic strain) for zone.

SDSPBN Previous cycle compressive soundspeed at transmitting outer boundary. Calculated from true moduli.

SHRBN Previous cycle shear velocity at transmitting outer boundary. Calculated from true moduli.

SHRBN2 Second-order shear term at transmitting outer boundary. Not currently used.

****SIGT** Peak value storage for zone. Maximum value of tangential stress σ_t in the left 30 bits; current value of slope or bulk modulus in right 30 bits.

SLUR Stored quantity used in velocity cutoff calculation.

SSPBN2 Retarded soundspeed at transmitting outer boundary. Not currently used.

TBON2 Second-order shear stress at transmitting outer boundary. Not currently used.

TBOUN Previous cycle shear stress at transmitting outer boundary.

****TK** Shear stress "Y" or "K" for zone.

TPR Time for next edit.

TT Total time (current time in problem calculation).

TTS Stop time (problem termination time).

TTSTOP Last word in physics variable section of common block GENCOM.
 Used only as a last word marker when reading in or buffering
 out the physics variables.

****V** Zone velocity.

****VN** Initial zone volume, not including overburden compression.

****VO** Zone velocity on previous time step (saved value of V from
 previous cycle). Also used as temporary storage after physics
 calculations are complete.

WKS Total energy in problem.

WONL Energy added during problem run.

WONU Initial (input) problem energy.

XINCR Factor by which permissible dezzone displacement ratio
 decreases each time a dezzone occurs.

XITBH Storage array. Not currently used.

XITBI Special stability factor, normally 0.; if nonzero, special
 stability tests are performed and time step is reduced by up
 to a factor of XITBI if instabilities are detected.

XITBJ Sentinel for transmitting outer boundary; also serves to store the attenuation coefficient employed at transmitting boundary (chosen appropriately for problem geometry).

XITBK Static problem sentinel and relaxation time constant (positive number) or acceleration factor (negative number).

XITBL Start time of problem. Normally 0.

XITBM Reserved input storage words. Not
through
XITBZ currently used.

XMOVRL Starting range scale for movie radius plots.

XMOVRL2 Increment by which movie range scale is to be increased.

**XMU Maximum excess compression experienced by zone, μ -max.

XN Stability factor of dt^2 or "delta-t squared" for the zone that limits calculational time step.

ZINCR Minimum displacement ratio $(RN+DR)/RN$ at which dezoning is permitted.

ZONMX Maximum zone size at outer boundary of problem. Activates automatic zoner option (number of zones in geometrically zoned problem regions is not specified; zoner automatically calculates correct number of zones).

ZYINCR Minimum ratio of successive zone radii for which dezoning is allowed. Determines maximum zoning gradient near inner boundary of grid.

GENCOM

These quantities are used only in the generator; they are not duplicated in the main code and do not appear in main code cliches.

A	Temporary storage used in generator.
AAA	Temporary storage used in generator.
ANG	Angle of problem (zero degrees vertical; 90 degrees horizontal).
DNC	"Do not continue" or error indicator. Causes generator to terminate with error message if serious input error is detected. No dump file is written for main code run.
DX	Maximum allowed time step. Generator input value.
DTED	Radius plot indicator. Also serves to store plot time interval (positive number); or causes plots to be made every 1/25th of the stop time (negative number).
EN	Internal energy of a region.
ENC	Energy density of a region.
F	Temporary storage used in generator.
FGC	Warning indicator. Prints warning message when certain types of input are encountered during generation.
G	Temporary storage used in generator.

GEOM	Geometry constants used during problem generation (planar = 1.0, cylindrical = π , spherical = $4/3 \pi$).
GI	Zoning buffer. Used for mean zone size or last zone size in each region.
GL	Zoning ratio. Ratio of successive zone sizes in each region.
H	Temporary array for material input constants.
HC	Temporary pressure array for fully compacted P-Mu table.
HCD	Temporary array of slopes for fully compacted P-Mu table.
HCM	Temporary Mu array for fully compacted P-Mu table.
HD	Temporary array of slopes for virgin P-Mu table.
HDD	Temporary array of slopes for virgin strength table.
HDP	Temporary array of slopes for fully failed strength table.
HDIL	Temporary array of pressures for dilatancy table.
HCDIL	Temporary array of volumes for dilatancy table.
HDDIL	Temporary array of slopes for dilatancy table.
HE	Temporary array of shear strengths for virgin strength table.
HG	Temporary array of densities for gas table.
HGAM	Temporary array of shear strengths for fully failed strength table.

HGD	Temporary array of slopes for gas table.
HGDE	Temporary array of delta-energies for gas table.
HGE	Temporary array of energies for gas table.
HGG	Temporary array of (Gamma-1) values for gas table.
HGL	Temporary array of log densities for gas table.
HK	Temporary array of pressures for virgin strength table.
HM	Temporary Mu array for virgin P-Mu table.
HP	Temporary pressure array for virgin P-Mu table.
HPRE	Temporary array of pressures for fully failed strength table.
Il6	Five-character base name for problem dump files (or tape).
IC	Temporary storage used in generator for eight-word material title.
ICLK	Clock time when generator run starts.
IDV	Disk or tape indicator (problem runs using either disk or tape for dump file storage).
IES	Temporary array for material number and state of each region.
ILT	Temporary array for last index of each strength table.
IM	Temporary quantity for reading and storing material number.
IM2	Temporary array for second material input number. Specifies type of constitutive relation.

IM3 Temporary array for third material input number. Not currently used.

IMATMX Parameter used in generator. Length of storage block reserved for all equation-of-state input quantities and tables for each material.

IMTMP Temporary storage for second "MAT" input number IM2.

IMTMP2 Temporary storage for third "MAT" input number IM3. Not currently used.

INN Index used in generator.

IPL Temporary array for last index of each P-Mu table.

IPNH Punch indicator to produce punched card output of bubble table.

IR Number of regions in problem.

IRZ Dezone sentinel. Indicates that dezone factor is set.

ITTY Sentinel to send messages to teletype or to high-speed output file while generator is running.

I2 Array for number of zones in each region.

J Index used in generator.

K Index used in generator.

KNT Counter for number of material data sets read in.

LVELED Sentinel to input an initial velocity (rather than an initial compression Mu) for a region.

M Index used to temporarily store number of materials in problem. Also serves as bubble gas indicator (if number of materials is input as a negative number, the bubble routine will be called for the first material).

MACH Machine used for generator run.

N Index used in generator.

NOW Number of edit change times minus 1.

PWW Temporary storage for water-release pressure and volume tables.

QC Input array of initial compressions (or initial velocities if LVELRD was set) for each region.

TD Word printed to specify dump file assignment medium ("disk" or "tape").

ZZ1 Temporary storage used to specify plot mapping scales.

ZZ2 Temporary storage used to specify plot mapping scales.

GENCOM

These dimensioned arrays are used only in the generator; they are not duplicated in the main code and do not appear in main code cliches.

BST Temporary storage for bubble calculations.

HH Bubble storage buffer.

HGS Temporary storage for gas.

IAMM	Material usage table in generator. This array contains the region number for materials already stored (used) for a given region.
IBST	Bubble temporary storage.
IDR	Temporary storage buffer used for material data.
IF	Temporary storage. Equivalenced to FF.
IH	Bubble storage buffer.
IKT	Material title storage array.
ITL	Pick-up indices for material title.
ITL1	Pick-up indices for virgin strength tables.
ITL2	Pick-up indices for fully failed strength tables.
ITTL	Pick-up indices for gas tables.
ZM	Volumes used for fully compacted P-Mu table printout.
ZP	Volumes used for virgin P-Mu table printout.

MAINCM

These quantities are used only in the main code; they are not duplicated in the generator and do not appear in generator cliches. (See GENCOM above for quantities shared by GENCOM and MAINCM.)

ABF	Array used to buffer out time plot dump quantities.
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CAVR	Cavity radius.
DTMPBB	Reserved variable for special stability check. Not currently used.
DTMPK	Change of stress between adjacent zones. Used in special stability check.
DTMPP	Change of pressure between adjacent zones. Used in special stability check.
DTRAD	Radius of zone that currently limits time step.
IBX	Index counter for time plot dump array.
IDNUG	Base name used to construct names of plot output files.
IDTMPM	Material number plus state. Used in special stability check.
IDUM	Names used for movie plot files.
ISMART	Array used in movie plot routine.
ITTS	Message line counter.
ITY	Message device number.
K	Integer index. Used in various do loops.
LENDL	Track lengths for movie plot files.
LEVTRACK	Current track level (file family) to be used for movie plots.
LP	Cavity radius index.

MAXCHNL Parameter that specifies total number of file families used for all main code radius plots and movie plots.

MSKM Mask for unpacking storage word FF.

MSKR Mask for unpacking storage word FF.

MSKS Mask for unpacking storage word FF.

N Integer index. Used in various do loops.

NAMED Name of current track (file family) for movie plots.

OFF Termination indicator.

PCT Volume-weighted cavity pressure.

PLMU Temporary Mu storage array. Used in polynomial calculations for special Abey equation of state.

PLP Temporary pressure storage array. Used in polynomial calculations for special Abey equation of state.

QZ Plot mapping constant. Sets plot grid size.

Cliche SOCOM

These quantities are used in the generator, main, and plot codes. This cliche appears in all three codes.

A1 A-one constant in crush-up relation for interpolation between virgin and fully compacted P-Mu tables.

A2 A-two constant in crush-up relation.

A3 A-three constant in crush-up relation.

AK Initial bulk modulus for solid materials.

ALF Floating-point geometry constant (equal to IALF).

AM1 Mu-one. Compression at which hysteretic crush-up begins for tabular P-Mu relations.

AM2 Mu-two. Merge point of virgin and fully compacted P-Mu curves for tabular P-Mu relations.

BDP Brittle-ductile transition pressure. Merge point of virgin and fully failed Y-P curves. Also the pressure above which low-pressure-regime Maxwell relaxation of shear stresses terminates.

BDP2 "High-pressure" brittle-ductile transition. Pressure above which high-pressure-regime Maxwell relaxation of shear stresses terminates.

BDP4 Porous compaction plasticity model. Slope of strength curve (dY/dP) in linear region.

BDP5 Porous compaction plasticity model. Ultimate strength limit (maximum Y) at very high pressures.

BDP6 Porous compaction plasticity model. $\hat{P}$, or transition pressure from linear to exponential strength behavior.

BDP7 Porous compaction plasticity model. Cohesion of material (strength at $P = 0$).

BDP8, BDP9	Porous compaction plasticity model. Exponential strength parameters: $Y = BCP8 * E^{**} (BDP9 * (P - BDP10))$.
BDP10	Porous compaction plasticity model. Intercept pressure (pressure at which strength curve intersects P axis).
BDP11	Porous compaction plasticity model. Rate-dependent pore-collapse time constant.
BDP12	Linear viscosity enhancement factor for highly porous materials in crush-up region.
BDP13	Material input parameters.
through	Not
BDP26	currently used.
BDP27, BDP28	Material property parameters. Not currently used.
CLX	High-explosive (HE) burn parameter. Also, formerly used as Voigt relaxation time for solid material viscosity calculation. In the current version of SOC, shock width "tau" is used to calculate solid material viscosities (a constant Voigt relaxation time is not assumed).
C3X	HE burn constant.
C4X	HE burn constant.
C5X	HE burn slope.
CBF	Plastic shear strain or plastic damage for complete failure of a solid material. Strength is reduced to fully failed curve when this amount of damage accumulates.

CCN Geometry factor (planar = 1.0, cylindrical = π ,
spherical = $4/3 \pi$).

CDIL Dilatancy tables. Volume term array.

CDKP Slope array for fully failed strength tables.

CF 0.25*CCN.

CGE 4.0*IAM.

CK Shear strength "Y" or "K" array for fully failed strength
tables.

CMU MU (excess strain) array for virgin P-Mu tables.

CP Pressure array for virgin P-Mu tables.

CRMU Mu array for fully compacted P-Mu tables.

CRP Pressure array for fully compacted P-Mu tables.

DDIL Dilatancy tables. Slope array.

DPM Slope array (DP/DMU) for virgin P-Mu tables.

DPMC Slope array for fully compacted P-Mu tables.

DPT Time interval at which time plot dumps are to be taken.

DSKWD Array of disk file names.

DTSL Maximum time step Δt for HE burn calculations.

DTSL1	Parameter used in HE time step calculations.
DXT	Current delta-t max squared.
EDKP	Slope array for virgin strength tables.
EF	Internal energy needed to liquefy solid material (melt energy).
EK	Shear strength "Y" or "K" array for virgin strength tables.
EP	Pressure array for virgin strength tables.
EV	Internal energy needed to vaporize a solid (vaporization energy).
F103	Constant 1/3.
F203	Constant 2/3.
F403	Constant 4/3.
GAS	Long gas table arrays. Up to two tables per problem.
GO	Input value of gravitational acceleration.
GR	Gravitational acceleration corrected for angle of problem.
H2O	Water fraction by weight for a solid material. If nonzero, water release tables are calculated and water vaporization is allowed.
HCCN	0.5*CCN.

IALF Geometry indicator (planar = 1, cylindrical = 2, spherical = 3).

IAM IALF-1.

IBDP Second material sentinel. Second input number entered after "MAT," indicates type of constitutive relation for the material.

IBDP2 Third material sentinel. Third input number entered after "MAT." Not currently used.

IDX Problem name. Eight-word array containing problem title.

IE Sentinel for special overburden option. If this sentinel is turned on, solid P-Mu curves will be translated by correct initial overburden pressure and compression in each zone.

IP Initial index for shear strength tables.

IRP Peak plot indicator. Sentinel to save, plot, and edit peak quantities for each zone.

IT Initial index for P-Mu tables.

ITT Initial index for gas table.

IW Heading for printed output (specifies whether problem is dezoned, horizontal or vertical, etc.).

MTB Table used in altering and packing integer information words.

PD Table of radii for which time plot data are to be saved.

PDIL Dilatancy tables. Pressure array.

PPR Boundary-condition input or profile array. Table of pressures or velocities, or other input for boundary conditions. First 61 words reserved for inner boundary, next 61 words for outer boundary.

PT Pressure array for virgin P-Mu tables.

PW Water release table pressures.

PWH Water release table pressures.

QKMUL Deviator-q multiplier factor (used only when the special deviatoric-q shear stress damping is activated).

QXT Shock front indicator.

RB Radii of region boundaries for every region in the problem.

REZF Dezone factor (positive number produces normal dezoneing; negative number gives severe dezoneing used only for certain HE problems).

RHO Zero-pressure density (solid materials), or initial-state density (gases).

RPL Times at which radius plots will occur during main code run.

SE Poisson's ratio (positive number) or shear modulus (negative number). Poisson's ratio internally changed to shear stress slope factor for convenience in calculations.

SHR Maxwell relaxation time for low-pressure-regime relaxation of failure shear stresses (below merge point of virgin and fully failed strength curves). If input as negative number, tensile failure will be skipped.

SHR2 Maxwell relaxation time for high-pressure-regime relaxation of failure shear stresses. If input as negative number, Maxwell relaxation time will be set to minimum of $3\Delta t$.

SHRMX Maximum permitted value of shear modulus. For solid materials with an input Poisson's ratio only. Limits maximum shear modulus to this input value.

SHRMX2 Material input parameter. Not currently used.

SI Gas mode indicator. Specifies type of gas table or HE equation of state used for a material.

SPD Initial soundspeed for solid materials.

TAU Shock width (positive number) or linear artificial viscosity (negative number) for solid materials.

TBFT Time burn is completed for HE slurry equation of state.

TC Array of times to change edit interval.

TIC Array of new edit intervals.

TP Boundary condition time array. Table of times to correspond with pressure or velocity profile boundary condition, or with other boundary condition input. First 61 words reserved for inner boundary, next 61 words for outer boundary.

VI Linear artificial viscosity for gas or vaporized materials
(positive number).

VW Water release Mu table.

VWH Water release Hugoniot specific volume.

VWHS Water release slopes.

VWS Water release slopes.

VXC Activity cutoff test parameter. Default value of 2.0 sets
cutoff velocity somewhat higher than the acceleration of
gravity times delta-t (the velocity that would be created by
an acceleration of 1 g acting over one time step). The
activity cutoff is deactivated for all quasistatic problems.

WMU Excess strain Mu required to vaporize water content in solid
material.