REFERENCE 11

B. G. CARLSON, C. LEE, AND W. WORLTON, "THE DSN AND TDC NEUTRON TRANSPORT CODES," LOS ALAMOS SCIENTIFIC LABORATORY REPORTS LAMS-2346 AND LAMS-2346, APPENDIX 1 (OCTOBER 1959).

LAMS-2346

LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA o LOS ALAMOS NEW MEXICO

THE DSN AND TDC NEUTRON TRANSPORT CODES

Printed in USA. Price $1.25. Available from the

Office of Technical Services
U. S. Department of Commerce
Washington 25, D. C.

LAMS-2346
PHYSICS AND MATHEMATICS
TID-4500, 15th Ed.

LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS -NEW MEXICO

REPORT WRITTEN: October 16, 1959

REPORT DISTRIBUTED: February 12, 1960

THE DSN AND TDC NEUTRON TRANSPORT CODES

by

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Contract W-7405-ENG. 36 with the U. S. Atomic Energy Commission

ABSTRACT

This report describes two reactor codes, one for the one-dimensional geometries (DSN) and the other for the finite cylindrical case (TDC), based on the transport difference equations and calculation methods developed in Numerical Solution of Transient and Steady State Neutron Transport Problems (LA-2260).

Appendices I and II, which contain the actual machine codes, have been separated from the descriptive part of the report to make it easier for the user to study the material and apply it to problems.

CONTENTS

I. INTRODUCTION

By means of the reactor codes presented here, the DSN and TDC codes, a variety of neutron transport problems may be solved. These codes are written in the language of Floco II[1] for use on the IBM Type 704 calculator, and are based on a modified S_n-approach to the numerical solution of the transport equation.[2] The DSN code applies to systems described by one space variable, i.e., to systems with infinite plane (slab), infinite cylindrical (rod), or spherical symmetry. In essence it replaces the SNG code,[3] but also expands upon that code, since a number of new features have been added in DSN.

The S_n method was reexamined about six months ago, and it was then found that the method could be simplified and generalized, to make it practical to consider multi-dimensional transport calculations. The TDC code represents the first code, based on the new approach, capable of handling more than one variable. It pertains to a two-dimensional

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1. The Floco II Manual, LAMS-2339
2. Numerical Solution of Transient and Steady-State Neutron Transport Problems, LA-2260
3. The S_n Method and the SNG Code, LAMS-2201 (T-1-159).

system, the finite cylinder. To date, TDC calculations have shown every sign of being stable, accurate, and reasonably rapid, competing well in speed - in contrast to SNG and DSN - with the corresponding diffusion calculations. With success in the case of the finite cylinder, it should be a routine matter to write other multi-dimensional transport codes.

With the new S_n difference equations one obtains physically reasonable results even with relatively few intervals, for no restrictions are placed on interval sizes. One can, in fact, use the DSN code to solve infinite medium problems, by using just one very large interval. Normally, we feel, it should be sufficient to use half as many intervals in each variable as one is accustomed to use in diffusion calculations, and fewer than this - for example in parameter studies - if the geometry of the reactor permits it. High-precision calculations will however, as always, require high order S_n calculations with a large number of space intervals. To save time, such calculations should of course be started from results obtained by cruder intervals and a lower n.

The Floco II system is a considerably improved symbolic "load-and-go" coding system, particularly with regard to symbolism, input-output features, and programming control. The DSN and TDC codes handle very extensive problem complexes. It would be impractical to code such problems in either FORTRAN or SAP-type coding systems, unless, of course, one is satisfied with dividing the complexes in many separate codes with fixed limits on the number of materials, space points,

velocity groups, etc.

Since the Floco II language is simple, brief, and precise, it is not necessary to describe every detail of a code verbally. With respect to DSN and TDC, the user should first familiarize himself with the reports LA-2260 and LAMS-2339 and, second, with the actual codes, Appendix I (of this report) for DSN and Appendix II for TDC, and then examine these codes for details when questions arise. Brief definitive descriptions of the two codes will be given below. In general, a particular problem is defined by a set of input parameters plus a set of functions, some of which require input, and the solution results from executing a collection of coded formulae under control of a master code (the Flow Code, here formula #803).

The DSN code contains about 1800 instructions, the TDC about 2000, and Floco II itself occupies about 2500 memory locations. The codes can therefore be used on 704's with memory capacities of 8192 or more words. Although both codes are by now fairly well checked out, other difficulties may arise in some applications. A few of the numerical methods involved are new and not yet fully understood; in some instances they could possibly fail. The code admits physically questionable input data, e.g., negative scattering cross sections; in such cases no guarantees can be made. For some problems single precision 704 arithmetic is not adequate for the accuracy required, etc. To date, however, we have not encountered, in our own applications, any impossible situations.

II. THE DSN PARAMETERS

To prepare a DSN calculation, 28 parameters must be specified as follows (for example, see Appendix I):

A01 The regular (A01 = 0) or adjoint (A01 = 1) solution of the transport equation may be specified.

A02 The problem type may be either inhomogeneous (A02 = 0), or homogeneous (A02 $\neq$ 0) with an "eigenvalue" to be determined. If A02 $\neq$ 0 the reactor must contain fissionable material. A02 = 1 implies a reactivity (k) calculation, i.e., DSN is to vary k (which divides the fission density F0) until criticality is achieved. A02 = 2 specifies a type of time-dependent (α) calculation. The neutron flux is assumed separable with respect to the time t and the time variation given by a factor exp (αt). The quantity α enters into the collision term only, σ is replaced by $\sigma + \alpha/v$, where v is the neutron velocity. A02 = 3 implies that the concentration (c) of specified isotopes is to be varied. The vector P0 is furnished with basic concentrations, P4 with modifiers, and DSN computes the effective concentrations from P0 + c•P4 (see further p.10). A02 = 4 specifies that the thicknesses of certain material zones are to be varied (δ-calculations). The interval lengths (D6) given implicity by the input radial points, and the δ-modifiers (D4) listed by zones (numbered 1,2,3,..., and given by interval # in R7), are used to calculate

the effective intervals (D1): D1 = D6 (1 + δ D4). If A02 = 5, the whole reactor is to be uniformly expanded or contracted (a-calculations) until criticality is achieved.

A03 The geometry may be either slab (A03 = 0), rod (A03 = 1), or sphere (A03 = 2).

A04 The central (r = 0) boundary condition is specified by A04. For rods and spheres it is assumed always perfectly reflective (A04 = 1). For slabs there are two other options, A04 = 0 signals a free boundary (vacuum to the left) and is used when the slab system is not symmetric about a central plane. A04 = 2, which implies A05 = 2, specifies a periodic condition, i.e., the flow at the center (for each angular direction into the reactor) equals the flow at the outer boundary (for the corresponding outward directions).

A05 The outer (r = a) boundary condition is specified by A05. It may call for zero inward flow (A05 = 0), perfect reflection (A05 = 1), or slab periodicity as defined under A04 (A05 = A04 = 2), now involving those S_n angular rays directed to the left.

A06 The outer (power) iteration count is produced in A06. Initially A06 is set to 0, 1, or 2, to start the count and at the same time specify the input neutron flux. If A06 = 0 or 1, the coder provides a flux as a function of r for N4. If A06 = 0, DSN places N4 in

block N0 - where the flux as a function of r (radius) and g (velocity group) is to be located - for g = the base group (G02) with zeroes in all other N0 locations. If A06 = 1, then K7 • N4 is placed in N0, where K7 is the relative fission spectrum as a function of g. Exceptions: if A01 = 1 or A02 = 0, then A06 = 1 is assumed equivalent to A06 = 0. If A06 = 2, then a dump (result from a previous calculation) or other complete input for N0 is provided by the coder. This input must have I04 (no. of intervals) and G01 (no. of velocity groups) as required by the problem being prepared. If A06 = -2, then the complete input for N0 has I04 = 1/2 of the I04 for the problem.

A07 The order of the desired S_n approximation (2,4,6,...) is given in A07. The coder supplies a set of S_n constants (Appendix I) for input into blocks M5, M6, M7. One set is used if A03 = 0 or 2, another if A03 = 1, and the latter is expanded (with input for M4 also) for the TDC code.

I01 I01 is the problem identification number, a fixed or floating point number.

I02 I02 gives the number of material zones in the reactor, a zone being a more or less arbitrary grouping of contiguous intervals. One usually takes a zone to mean a reactor region with uniform material composition, involving a fixed density and isotope

combination.

I03 Multi-group transport theory with either isotropic (I03 = 0) or a form of linear anisotropic (I03 = 1) scattering may be specified. TDC handles the first of these cases only.

I04 The total number of space (r) intervals in the system, i = 1,2,..., I04.

I05 I05 gives the first guess for the eigenvalue (k, α, c, δ, or a). Enter zero here and in I06 if A02 = 0. If I05 specifies a, this quantity need not equal the last radial point given; the code adjusts the radii (R1) by the appropriate factor.

I06 The second eigenvalue guess is given here.

I07 This parameter specifies $\epsilon(\lambda)$, the precision wanted of the calculation. The precise meaning of ϵ can only be ascertained from experience with many calculations. Here λ is the total neutron population decay factor. If $\lambda < 1$ the system is super-critical, if $\lambda > 1$ the system is sub-critical. A λ is computed for each power iteration (during which the fission density is held fixed) and four successive λ's are saved. Convergence for a particular eigenvalue (p) is defined by $| \lambda_k - \lambda_{k-1} | < \epsilon(\lambda)$ for all three values of $\lambda_k - \lambda_{k-1}$. Final convergence is defined by $| 1 - \lambda_k | < 2\epsilon(\lambda)$ for the four values of $1 - \lambda_k$ available. After

DSN has determined $\lambda(105)$ and $\lambda(106)$, it proceeds to use an interpolated value (corresponding to $\lambda \approx 1$) saving the quantity $dp/d\lambda$ for the further modification of p which may be required before the final convergence criterion is satisfied.

G01 The number of neutron groups is given by G01, g = 1,2,..., G01, where g = 1 represents the neutrons of highest energy (lowest lethargy), and g = G01 the lowest energy group. If A01 = 1 the cross section matrices in block C0 are internally rearranged so that the a regular solution procedure is imitated. In the process the ordering of the groups is reversed by the code.

G02 The base group G02 is normally taken to be the group of highest energy with non-zero neutron flux (initially and throughout the calculation), thus if A01 = 0, G02 = 1, and if A01 = 1, G02 = G01. Other choices may be made if these particular groups are vacuous or contain but few neutrons. The point of the base group is that the code computes a "distance" (ϵ_k) between successive fluxes (NO^k, NO^{k-1}) for that group, whereupon calculations (one or more "inner" iterations) are performed on the succeeding groups until the equivalent accuracy, at least, has been achieved for these. The base group should therefore be one with a comparatively long neutron mean free path (on the average over the reactor).

G03, G04, G05 specify the form of the cross section matrices, which

contain one column for each group. Position G03 in a column contains σ^t, the total transport cross section, with position G03 - 1 occupied by $\nu\sigma^f$, ν times the fission cross section. If G03 > 2, the positions above G03 - 1 may be filled by other cross sections of the coder's choice. These are not used by the DSN code except in the preparation of "activities," i.e., cross sections times the final neutron fluxes. The position G04 contains σ^s_{gg} (self-scattering). The positions G03 + 1 to G04 - 1, if any, are filled with speed-up cross sections, position G04 - 1 with scattering cross sections from the group below (in energy), position G04 - 2 with similar data for moving neutrons up two steps in energy, etc. G05 specifies the last position in the column. Positions G04 + 1 to G05 are filled with slowing-down cross sections, position G04 + 1 with data for slowing down by one step, etc. Positions in the matrix with no physical meaning are filled with zeroes. Note also that DSN assumes that if position g', g' > G04, contains a zero, all succeeding entries are zero. Three additional vectors are regarded as part of the cross section input, the relative fission spectrum (K7), the velocities (V1), and ν as a function of g (N7).

G06, G07 are used by DSN, but are not input parameters; enter zeroes.

M01 The total number of isotopes for which input cross sections (for C0) are provided is specified in M01. The isotopes are numbered (1,2,...,M01) in the order loaded. If a material is described as anisotropic in scattering, two matrices are provided, and the subsidiary one is loaded just after the principal one, and numbered accordingly. The subsidiary table contains only speed-up and slowing-down cross sections. In entering M01 one must then count anisotropic materials twice.

M02 The total number of isotopes and isotope combinations are specified in M02. The latter are numbered M01 + 1, M01 + 2,..., M02, with two successive numbers assigned to anisotropic combinations. The composition of mixtures are specified in I0 and P0 if M02 > M01. Thus, if three materials (1,2,3) are involved (M01 = 3) and two mixtures (4,5) are to be formed, #4 from 1 and 3 with densities ρ_1, ρ_2, and #5 from 1, 2, and 3 with ρ_3, ρ_4, ρ_5 (M02 = 5); enter 1, 3, -4, 1, 2, 3, -5 in I0 and ρ_1, ρ_2, 0, ρ_3, ρ_4, ρ_5, 0 in P0 (M03 = 7). The minus sign on material numbers signals mixtures to be formed. If material #2 in this example is anisotropic the basic materials would be 1, 2, 3, 4 (M01 = 4) the mixtures 5 and 6 (M02 = 7), and the I0 entries 1, 4, -5, 1, 2, 4, -6. In the latter case one must also fill I4, of length M02, to mark with 1's the anisotropic materials; in this example the I4 entries are 0, 1, 0, 0, 0, 1, 0.

M03 M03 specifies the number of entries required in I0 (or P0) to define the desired isotope combinations. If M01 = M02, then M03 = 0.

M04 The order of "smear" is specified in M04. By smear we mean mixtures of isotopes and isotope combinations, by order of smear, the maximum (over all space intervals) of entries required to specify the material composition in any interval. If no smear is required, i.e., if all intervals can be specified in terms of the materials 1,2,..., M02, then M04 = 1. Smears may be used in a variety of situations, e.g., when there is differential loading or burn-out within a zone, or variable interpolation between two cross section sets, due for instance to temperature variation in the reactor, etc.

M05 M05 gives the number of entries required in M3 (material #'s) and R3 (densities) to specify the material composition (smear) in every interval. If M04 = 1 and the material composition is uniform by zone, then M05 = I02. The vector R3 contains, of course, sets of specifications. The last entry in a set is signaled by giving it a minus sign. So that DSN can find the material definition for a particular interval, the coder provides in S7, by interval #, the position of the first entry of the set in R3 which applies.

M06, M07 are used by DSN, but are not input parameters; enter zeroes.

S01 The absence (S01 = 0) or presence (S01 = 1) of a distributed source Q0 is specified here.

S02, S03 are not used by DSN; enter zeroes.

S04 The absence (S04 = 0) or presence (S04 $\neq$ 0) of a surface source Q4 at the outer boundary is specified here. If S04 $\neq$ 0, which implies A05 = 0, then Q4 contains either one vector q_g (S04 = 1) or two successive vectors q_g, q'_g (S04 = 2). In the first case an isotropic source is assumed with q_g as input for each negative S_n direction (μ), in the second case (linear source), DSN computes $q_g + |\mu| q'_g$ as the boundary input.

S05, S06 If S05 = 0, no effect, if S05 = 1, the calculation assumes a fixed k given in S06 and A02 may have any value except 1. If S05 = 2, the calculation assumes a fixed α given in S06 with any A02 $\neq$ 2.

S07 S07 is used by DSN, but is not an input parameter; enter zero.

III. THE TDC PARAMETERS

The parameter specifications in TDC, 30 in number, are quite similar to those in DSN.

A01 See DSN.

A02 See DSN if A02 = 0 and for k, α and c calculations. A02 = 5 is omitted in TDC; it is a special case of A02 = 4. If A02 = 4, then the thicknesses of zones (either cylindrical shells, slices or both) may be varied until criticality is achieved. The effective r-intervals (D1) are given as in DSN by $D1 = D6(1 + \delta D4)$. Similarly, for intervals in the axial variable z (Z1): $D2 = D7\ (1 + \delta D5)$, where D5 are modifiers by axial zone #'s (Z7). If no input is provided for R7 and Z7, and if D4 and D5 are constant (one entry for each), then R7 and Z7 are set to all 1's by the code, and we have effectively an a-calculation. Special cases here are $D4 \neq 0$, $D5 = 0$, or vice versa.

A03 In TDC A03 specifies the boundary condition at the bottom of the cylinder. If the cylinder is symmetric about a central plane perpendicular to the axis, that plane is at the bottom. At the boundary we may then call for zero input (A03 = 0) or perfect reflection (A03 = 1).

A04 The top boundary condition is specified here. It may call for zero flow in (A04 = 1) or for reflection (A04 = 1, S03 = 1), not perfect reflection here, but one correct as far as the current is concerned. In the future, we may substitute a more proper procedure here.

A05 Same as A04 but referring to the free (curved) surface of the cylinder. If A05 = 1, S04 = 1 also.

A06, A07 as for DSN, except that, if A06 = -2, then the complete input for N0 has I03 and I04 = 1/2 of the I03 and I04 for the problem. Note also that TDC performs an S_2 calculation (the S_2 constants are always loaded into E4, E5, E6, and E7) during the "discrete" part of the iteration scheme, i.e., up to the point where $dp/d\lambda$ is first calculated, whereupon a switch is made to the precision specified in A07. The object of this procedure is, of course, the saving of computing time.

I01, I02 as for DSN, with the comment that the zone #'s (listed by interval #) are stored in F0, in the last few bits of the words, and are here not to be confused with the r and z zoning (R7, Z7) defined for δ-calculations. To save space in TDC, two blocks besides F0 are double-valued. The quantities labeled S7 in DSN are placed in the lower bits of the words in W0, and the material #'s labeled M3 in DSN are similarly placed in N0 -

initially - then merged with R3 by TDC before NO is loaded with the initial flux.

I03 The total number of intervals in the axial direction, j = 1,2,..., I03, starting at the bottom of the cylinder.

I04-I07, G01-G07, and M01-M07 as in DSN.

S01 and S02 specify the distributed source; if none, enter zeroes. S01 gives the number of the first group with non-zero input for Q0, and S02 gives the total number of consecutive groups with source input. If some groups within this range have no source, enter the appropriate number of zeroes as part of Q0.

S03 The presence of an isotropic boundary source at the top of the cylinder is specified by S03 = 1 (if none, set S03 = 0). If S03 = 1, then A04 = 0.

S04 Same as S03 for the free boundary. If S04 = 1, then A05 = 0.

S05-S07 as for DSN.

IV. THE FORMULA CODES IN DSN

The DSN code contains 36 formulae numbered from 800 to 847, where 800, the Initial Code, and 801, the Assign Code, are executed as soon as loaded, and 802 is the collective label for the remaining, with the Flow Code (#803), connecting the formulae in 802, loaded last. The notation follows the Floco II conventions.

800 Initial Code (IC). In this formula a few parameters are computed: M06, M07, T01, and S07 (see Appendix I). M07 is the total number of S_n discrete angular directions, M07 = A07 + 1 for slabs and spheres, and $(\frac{1}{2}M07 + 1)^2 - 1$ for cylinders. Some of these directions (one for slabs and spheres, $\frac{1}{2}$M07 for cylinders) do not count as far as the average neutron flux is concerned. The fluxes along these directions are to be regarded as initial values for the integrations in the angular variables. These are then only of consequence in curved geometries. Formula 800 also sets ϵ(A06) stored in P04 to unity, the largest distance possible (see p. 8), and computes a number stored as T04, which is used to produce restart dumps periodically.

801 Assign Code (AC). This code assigns memory space to all functions involved in DSN calculations.

805 Initial Neutron Flux (NF) sets up a starting flux in N0, as specified on p. 5 under A06.

806 Adjoint Cross Sections (AX). The formula is executed only if A01 = 1 and A06 ≦ 2, and rearranges the cross sections as discussed on p. 8 under G01, also reversing the order of the elements in K7 (χ_g), N7 (ν_g), and V1 (v_g).

810 Mix Cross Sections (MX). Here the cross sections for materials M02 + 1, M02 + 2, etc. are generated, using the input cross sections loaded into C0, the quantities I0 and P0 which define the mixing, also P4 if a c-calculation is called for, and I4 if anisotropic materials are present.

811 Input Print (IP). The quantities listed are printed off-line if A06 ≦ 2.

812 Modify Geometry (MG). This formula modifies the radial points (r_i) in δ and a calculations. It also computes D1 = $\Delta_i = r_i - r_{i-1}$ and the midpoint r_i's, R2 = $\bar{r}_i = \frac{1}{2}(r_i + r_{i-1})$, except for spheres (see 813) where V4/R2 replaces $\bar{r}_i$.

813 Geometric Functions (GF). The volume elements V0 and V4 = V0/D1 are computed, V0 = D1 (slabs), D1 • R2 (rods), and V0 = = D1 • $(r_i^2 + r_i r_{i-1} + r_{i-1}^2)/3$ (spheres), thus omitting a factor 2π for rods and 4π for spheres. In addition, two quantities

$G1_{im}$ and $G3_{im}$, terms entering the S_n difference equations, are precomputed here:

Slabs:	$G1 = 0$	$G3 = \mid \mu_m \mid /\Delta_i$
Rods:	$G1 = \gamma_m/R2_i$	$G3 = \mid \mu_m \mid /\Delta_i$
Spheres:	$G1 = \gamma_m/R2_i$	$G3 = \mid \mu_m \mid /\Delta_i'$

where μ_m is in M7, γ_m in M6, and (for spheres) $\Delta_i' = \Delta_i$ for $m = 1$, otherwise $\Delta_i' = 2\Delta_i \; V4_i/(r_i^2 + r_{i-1}^2)$. For further details regarding the S_n difference equations, see LA-2260.

814 Form Weights (WS). In this formula the weight function $w_i = |\Sigma_g NO_{ig}| \cdot V4_i$ is computed and stored in WO. These weights are partially established on experience, having been found to aid in the estimation of the eigenvalue λ. In TO2 is stored $\Sigma_i \; w_i \, |\Sigma_g \; NO_{ig}|$. At the end of a power iteration the same quantity (TO3) is computed using the then revised NO values. The ratio TO2/TO3 defines λ.

815 Fissions Adjoint (FA). Here, if AO1 = 1, the adjoint fission density, given by:

$$FO_i = \Sigma_g \chi_g \; NO_{ig},$$

is calculated. Division by k (I05) or k_0 (S06) is performed if specified (A02 or S05 = 1).

816 Fissions Regular (FR). Here, if A01 = 0, the fission density:

$$FO_i = \Sigma_g \sigma_g^f NO_{ig},$$

is computed and division by k or k_0 performed if indicated. σ_g^f is first obtained as a function of radius, taking the material specifications by i (including smearing) into account.

817 Monitor Print (MP). Monitor output is obtained at this point, the printed monitor line giving P01 = A06, P02 = the count of all inner iterations, P03 (a spare, in the code = 0), P04 = = ϵ(A06), P05 = I05, P06 = dp/dλ, P07 = the neutron balance indicator (P07 should ideally equal G01, the number of groups), and finally P10 = λ. For further details see Appendix I. Switches 1, 2, and 3 come into play in this formula, #3 selects the card reader, if the operator wishes to change some of the input data and then proceed.

821 Effective Cross Sections (EX). An array of cross section columns (for a particular g) is formed here, one column for each i, and stored in H2. The material specifications are fully taken into account.

820 Anisotropic Cross Sections (EZ). This formula is executed if I03 = 1 and a table of σ's, as in 821, is formed in A2 for the anisotropic components.

822 Path Lengths (PL). Three positions of block H2, those containing σ^t, $\nu\sigma^f$ and σ^s_{gg} are selected, and the data transferred to H1, H4, and H5, respectively. Actually $\frac{1}{2}\sigma^t$ is placed in H1 and modified, if A02 or S05 = 2, by $\alpha/2v$. A special procedure is used if $\sigma + \alpha/v$ becomes negative (see code).

823 Source Term (ST). The source term of the transport equation is calculated for a particular g:

$$SO_i = \chi_g \, FO_i + \Sigma_{gi} \, \sigma_{g'g} \, NO_{ig'} + QO_{ig} \qquad \text{(regular)}$$

$$SO_i = \nu\sigma^f_g \, FO_i + \Sigma_{g'} \, \sigma_{g'g} \, NO_{ig'} \qquad \text{(adjoint)}$$

with summation (for each i) over the scattering cross sections $\sigma_{g'g}$ in the H2 columns (see 821).

824 Source, Anisotropic Part (SZ). The source is in the anisotropic case given by $SO_i + \mu_m \, S4_i$, with

$$S4_i = 3\Sigma_{g'} \, \sigma_{g'g} \, JO_{ig'}$$

where $\sigma_{g'g}$ here are the anisotropic components of scattering stored in A2 (see 820).

825 Boundary Conditions (BC). This formula executes the specification in A04, A05, and S04, for each μ_m and each group. Since, in reflective or periodic situations, NO at $\mu = 0$ and the outer boundary is given theoretically by SO/2H1, the input flux is given, for arbitrary μ_m, in terms of $(SO/2H1)(1 + B1_{mg})$, where

Bl_{mg} is reestimated at the end of each iteration on a particular group. Bl_{mg} is, in other words, obtained by an iteration concurrent with the regular one. We do not know as yet whether this procedure always gives proper convergence or not.

826 Perpendicular Flux (PF). This formula computes for fixed g the angular flux along the initializing μ-directions, of significance in the curved geometries.

827 Angular Flux (AF). This formula calculates the angular flux for fixed g along the basic S_n directions μ_m defined in LA-2260. These fluxes are averaged over m (but not in 827) to obtain the total flux NO, and with weights μ_m to obtain the net current JO. If any integration step here or in 826 yields a negative flux, the calculation is repeated using the alternate difference equations as discussed in LA-2260. The integration steps are performed from the outside of the reactor inward, if μ_m is negative, otherwise in the direction of increasing r.

831 Current (JC). The current JO is computed in this formula for a particular g.

830 Boundary Values (BV). The quantities Bl_{mg}, if required by the conditions specified, are revised here (initially $Bl_{mg} \equiv 0$):

$$Bl_{mg}\ (rev.) = (O_m - I_m)/3(O_m + I_m) + Bl_{mg}$$

where O_m and I_m are the appropriate outward and inward angular fluxes along the directions μ_m and $-\mu_m$, respectively. The above formula is essentially an empirical one, which so far has proved satisfactory.

833 Boundary Flow (BF). Here the currents, inward and outward separately, are computed at both r = 0 and r = a.

834 Neutron Balance (NB). In 834 a summary is performed yielding the NB factor J03: J03 = (leakage + collisions)/sources. This factor should ideally be unity in a precise calculation. Care is taken at both r = 0 and a to count negative leakage as source so that the scaling process in 835 will work.

835 Scaling (SC). The scaling process defined in LA-2260 is performed here, the final result being a scaled average flux N0 for a particular g, which is temporarily stored in N4.

836 Inner Iterations (II). In 836 N4 is first transferred to its proper place in N0 and the data displaced there moved to N4. The distance ϵ is then computed:

$$\epsilon = (\Sigma_i \mid N4_i - N0_i \mid w_i)/T02$$

except for the first inner iteration, in which case N0 is

multiplied by λ. If g = G02, the base group, ϵ is normally sent to P04, otherwise ϵ is compared with P04 and if $\epsilon >$ P04 another iteration on the same group is performed, first modifying S0:

$$S0_i \text{ (rev.)} = S0_i + \sigma_{gg}(N0_{ig} - N4_i)$$

For various controls on the inner iteration procedure, see code.

837 Group Print (GP). This is a monitor on the results after the completion of a particular group iteration. A line is printed off-line if an error indicator has been set, or on-line if Switch # 1 is down regardless of indicators. The line contains J01 = group #, J02 = scale factor, J03 = NB factor, J04 = leakage, J05 = collisions, J06 = source, J07 = error indicators (1st set), and J10 = error indicators (2nd set). Both J07 and J10 may be logical sums of indicator settings. Indicator J07 is built up by 1 if the inner iteration count is large (set in 836), by 2 if F0 is negative, etc. (Appendix, p. 3).

840 Interpolate (IN). In this formula new parameters (eigenvalues) are obtained by interpolation, which, of course, may amount to extrapolation in some cases. Care is taken to prevent unreasonable values, which may come about due, for instance, to poor initial guesses. If the "interpolated" parameter lies outside one of two limits computed using the initial guesses I05 and I06, one of these limits becomes the new I05, and I06 is taken to be either the previous I05 or I06, depending on which one is closest

to the new I05, and the iterative procedure is continued. Once the interpolate value is "in range," $dp/d\lambda$ is computed, and from then on I05 is calculated (in 847) from I05 (new) = $(1-\lambda)dp/d\lambda$ + I05.

841 Weights and Test (WT). This formula performs calculations as in 814 (WS). In addition, it includes the shift of the λ-set, the computation of the new λ, the convergence test for the current eigenvalue, and, if A02 $\neq$ 0, a scaling of N0 to make total fissions sum up to unity.

846 Final Print (FP). At the end of the calculation the quantities listed in 834 are printed. There is also in DSN a "forced convergence" technique, for the purpose of terminating a calculation, for whatever reason, which is brought into play by depressing Switch #4.

847 New Parameters (NP). This formula is activated if the convergence test in 841 is satisfied, it controls the various procedures for calculating new parameters, and includes the final convergence test.

803 Flow Code (FC). The Flow Code controls the whole DSN calculation, the first action it takes is to print the storage map, using the Floco II subroutine #976.

845, 842, 843, 844 (SM, SS, SK, SL). Summary Formulae. See Section VI.

V. THE FORMULA CODES IN TDC

The TDC code contains 39 formulae numbered from 800 to 847, where 800, the Initial Code, and 801, the Assign Code, are executed as loaded, and where 802 is the collective label for the remaining, with the Flow Code (#803), loaded last, connecting the other formulae in 802. The whole TDC code is organized in a manner quite similar to DSN. The integrations are performed starting with the top slice of the cylinder and each slice is treated as in the DSN cylindrical case, except that there is, of course, neutron flow in at the top surface, and flow out at the bottom (of each slice). When the bottom slice has been reached and the integrations performed here, the bottom boundary conditions are applied, and the process just described is repeated, now going from the bottom of the cylinder to the top, with neutron flow in at the bottom of each slice and flow out at the top. Thus, in total there are twice as many integration directions in TDC as in the DSN cylindrical case, and the TDC time of calculation is then approximately equal to 2J (2I03) multiplied by the time for a DSN rod calculation with the same number of r-intervals. For more details regarding the formulae listed below see either Appendix II or Section IV.

800 Initial Code (IC). Similar to 800 in DSN; the masks needed for the double storage in F0, W0, and R3 are computed here.

801 Assign Code (AC).

804 Merging (RN). The material #'s loaded into N0 are placed in R3 merged with the R3 input.

805 Initial Neutron Flux (NF).

806 Adjoint Cross Sections (AX).

810 Mix Cross Sections (MX).

807 Exchange S_n Constants (EN). The S_n constants are exchanged twice during a calculation: at the beginning of the calculation to place the S_2 constants in M4, M5, M6, and M7, and after $dp/d\lambda$ has been formed to place the S_n constants, n = A07, in those blocks.

811 Input Print (IP). The quantities listed are printed if A06 $\leqq$ 2.

812 Modify Geometry (MG). This formula handles the modification of r_i and z_j as needed in δ-calculations, computes Δ_i (D1), Δ_j (D2), and V_i (V0), $V_i = \frac{1}{2}\Delta_i(r_i + r_{i-1})$.

813 Geometric Function (GF). Here the quantities G1, G3, and G5, terms entering the S_n difference equations are precomputed:

$$G1 = \gamma_m/R2_i,\quad G3 = |\ \mu_m\ |/\Delta_i,\quad G5 = \bar{\mu}_m/\Delta_j,$$

where μ_m (M7), γ_m (M6), and $\bar{\mu}_m$ (M4) are S_n constants.

814 Form Weights (WS).

820 Vertical Current (VC). This formula is used when the next current is required at either the top or bottom of the cylinder. The current as a function of r is placed in J4 and the integrated current in F04.

816 Fissions Regular (FR).

815 Fissions Adjoint (FA).

817 Monitor Print (MP).

821 Effective Cross Sections (EX). Here as in DSN the table H2 of cross sections is formed for a fixed g; but for a particular j only.

822 Path Lengths (PL).

825 Boundary Condition (BC). This formula handles the conditions at the curved boundary.

823 Source Term (ST).

824 Top Boundary (TB). This formula handles the conditions at the top boundary of the cylinder. Also, a number of blocks are cleared: N4 in which the new neutron flux is to be accumulated, J5 and J6 where the horizontal inward and outward net currents (functions of j) are to be accumulated, and L0, L1, L2, and L3 where certain sums are formed for the neutron balance and scaling calculations.

826 Perpendicular Flux (PF).

827 Angular Flux (AF).

830 Horizontal Current (HC). Here the currents at the free boundary are calculated (for fixed j), separately for inward and outward directions.

831 Bottom Boundary (BB). The formula handles the conditions at the bottom boundary of the cylinder.

833 Top Boundary Flow (TF). The boundary values $T5_{im}$ are computed in 823, to be used in setting a reflective condition, at the top, for each i, if $A0^4 = 1$.

832 Free Boundary Flow (FF). The boundary values $F5_{jm}$ are computed here, to be used as in 833, but for the free boundary. Also, the quantities needed for the scaling and the final neutron balance, for the current value of g, are computed here and cumulated.

834 Neutron Balance (NB).

835 Scaling (SC).

836 Inner Iterations (II).

837 Group Print (GP).

845, 842, 843, 844 (SM, SS, SK, SL). Summary formulae. See Section VI.

840, 841, 846, 847, 803, (IN, WT, FP, NP, FC). See DSN.

VI. ARRANGEMENT OF THE DSN AND TDC DECKS

The DSN and TDC decks are arranged in the same manner. The cards are loaded in the order in which they are described.

1. Floco-2 deck. This deck is completely self-contained: it is self-loading and contains its own transition card.

2. Parameter header. This card initializes loading and storage assignment addresses.

3. Parameter cards. A00 is normally loaded first. If a punch dump is to be loaded, the first four cards following the punch ID are loaded after the initial parameters; these four cards must be preceded by a 9* A00 card.

4. IC header. This card reserves storage for formula sets 800, 801, and 802; it also sets NLA to the proper value to load formula 800.

5. Formula 800.

6. Transition card for formula 800. Formula 800 is executed.

7. AC header. This card sets NLA to load formula 801.

8. Formula 801.

9. Transition card for formula 801. Formula 801 is executed.

10. Remark cards. Formulas 850 to 863 are loaded here. Formula 850 may be changed from problem to problem to provide an identification on the listing.

11. General code header. This card sets NLA to load the 802 formula set.

12. Formulas 804 to 847.

13. Formula 803. This is the Flow Code.

14. Data. If a punch dump is being loaded, the NO cards must be preceded by a 9* NO card. If B1 cards are dumped, these must be identified (by comparing the loading address with the storage map) and preceded by a 9* B1 card. In TDC, the cards for R3 and NO must be followed by an I* 4804 card.

15. Transition card for 803. This card starts the problem running.

Use of Switches. Switch #1 is placed in the down position if additional monitor printing is desired, e.g., the group monitor (see 817 and 837). If Switch #2 is depressed a restart card dump is obtained (see 817); on pressing "Start," the calculation is resumed. Switch #4 is used to force convergence, i.e., to terminate the problem arbitrarily with a final print and a restart dump (see 837 and 846).

Summary. At the end of a calculation a summary of "activities," average cross sections times neutron fluxes, is generated by zone, where data for zone #0 (the whole reactor) are first given. Two tables, A and B, are printed for each zone:

Table A contains columns corresponding to the entries in the cross section tables, up to and including entry #G03, followed by two columns, one for entry #G04 (self-scattering) and the other for the total scattering cross section, and then by two final columns, one for the

neutron flux and the other for the source QO, if any. The entries in a particular column give the activity by velocity group, the last entry being the total for all groups.

Table B is arranged as Table A, except that the last two columns are omitted, and the activity is given by material number rather than by velocity group.

LAMS-2346, Appendix I
PHYSICS AND MATHEMATICS
TID-4500, 15th Ed.

LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

REPORT WRITTEN: October 16, 1959

REPORT DISTRIBUTED: February 12, 1960

THE DSN CODE

by

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Contract W-7405-ENG. 36 with the U. S. Atomic Energy Commission

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
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IN REPLY
REFER TO:

July 6, 1960

To: Copyholders of LAMS-2346, Appendix I

From: Report Library

Please staple the attached revision pages to the inside front cover of LAMS-2346, Appendix I.

Changes in the DSN Code, I
LAMS-2346, Appendix I

1) The "ϵ-system" in the DSN code has in some instances failed to bring about convergence to a principal eigenvalue. The code changes given under Revision I (attached) defines a different and more satisfactory procedure. The ϵ given in I07 assumes now a different meaning; it specifies the accuracy wanted in the solution of the difference equations for each neutron group, holding the eigenvalue (I05) fixed. The variable ϵ (P04) is set to 10^2I07 whenever iterative calculations begin on a new fixed I05 and P04 is then allowed to decrease as the calculation progresses until P04 < I07, and the λ (P10) last found is taken as the λ corresponding to I05.

Note: Until experience in choosing ϵ is available take $\epsilon=10^{-4}$/no. of groups.

2) The empirical procedure for imposing a reflective (or periodic) condition at the outer boundary has proved to be unsatisfactory as was expected. A proper procedure has now been established. It involves keeping the reflected neutrons fixed (except for a scale factor) during a given outer iteration. The code changes are given under Revision II (attached).

Note: The corresponding corrections should be made in TDC if difficulities in these areas are encountered.

FLOCO 704

77 78 79 80 PROBLEM			
PROGRAMMER		DATE	PAGE
DSN Revision I			191

	C	OPERATION P R S	ADDRESS X R S	REMARKS		C	OPERATION P R S	ADDRESS X R S	REMARKS
0	I	8	2 X31	Changes in IC	I		CLA	T06	Changes in NP
1	10	CLA	P04	Patch 6IC.	1	10	TNZ	X24	(3 cards)
2	19	TNZ	X32	and a NOP	2	19	CLA	401	
3	28	LDQ	I07	in X33, and		28	STØ	T06	
4	37	FMP	432	a new HIC	4	37	CLA	A06	
5	46	STØ	P04	card.	5	46	SUB	T13	
6	55	TRA	X32		6	55	SUB	403	
7	64			6IC	7	64	TPL	X36	2NP no comm
0	I	*	800	Changes in IF	I		STZ	T13	
1	10	*	70	Insert	1	10	NØP		
2	19	*	801	NOP's	2	19	NØP		
3	28	*	130	in X43,	3	28	NØP		
4	37	*	802	X44, X54	4	37	CLA	401	
5	46	*	3600		5	46	STØ	T07	
6	55	*	800		6	55	7000	2 X52	
7	64			HIC	7	64	CLA	421	3NP
0	I	CLA	E01	Changes in WT	0	I	FSB	P10	
1	10	FDH	T03	(2 cards)	1	10	LRS	43	
2	19	STQ	P10		2	19	FMP	P06	
3	28	CLA	P04		3	28	FAD	T05	
4	37	FSB	I07		4	37	STØ	T05	
5	46	TPL 4	1	no comm.	5	46	CLA	A06	
6	55	LDQ	I07		6	55	STØ	T13	
7	64	FMP	432	4WT	7	64	LXD 4	E01	4NP
0	I	STØ	P04		0				
1	10	NØP			1	10			
2	19	NØP			2	19			
3	28	NØP			3	28			
4	37	NØP			4	37			
5	46	CLA	A02		5	46			
6	55	TNZ	X61		6	55			
7	64	CLA	401	5WT	7	64			

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77 78 79 80	PROBLEM		
	PROGRAMMER: DSN Revision II	DATE	PAGE: 1 of 2

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	2 X00	Changes in AC
1	10	TSX	4971	Space for B7
2	19	YMOT	1 B7	
3	28	TRA	X01	
4	37			
5	46			
6	55			
7	64			10 AC
0	I	FAD	2 B0	
1	10	STØ	2 B7	
2	19	TRA	X41	
3	28	NØP		
4	37	NØP		
5	46	NØP		
6	55	NØP		
7	64	NØP		3 B 4
0				Changes in SC
1	10			Insert NOP's
2	19			in X05, X06
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	2 X55	Changes in I
1	10	LXA	2 A05	FBC (4 words)
2	19	7000	2 X56	
3	28	LXD	2 B07	
4	37	CLA	NOR	
5	46	SUB	2 N1	
6	55	STA	Y07	
7	64	CLA	B1*	7 II
0	I	SUB	2 B2	
1	10	STA	Y23	
2	19	LXA	2 M07	
3	28	CLA	2 M7	↖
4	37	LXA	1 Y01	
5	46	TPL	Y07	
6	55	LXA	1 I04	
7	64	CLA	1	8 II
0	I	FSB	1 N4	
1	10	LRS	43	
2	19	FMP	1 H5	
3	28	FAD	1 S0	
4	37	TZE	Y24	
5	46	FDH	1 H1	
6	55	STQ	E01	
7	64	CLA	2 B7	9 II
0	I	FDH	E01	
1	10	FMP	Y21	
2	19	FSB	Y21	
3	28	STØ	2	
4	37	2001	2 Y03	↗
5	46	TRA	4 2	
6	55			
7	64			10 II

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77	78	79	80	PROBLEM		
				PROGRAMMER	DATE	PAGE
				DSN Revision II		272

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I		FAD				JO6			Changes in NB
1	10		STØ				JO6			2NB etc.
2	19		2001			1	XO7			↗
3	28		LDQ				JO5			
4	37		FMP				JO1			
5	46		STØ				JO5			
6	55		LXA			1	AOY			CBC
7	64		CLA				JO6			2NB
0	I		FSB				FO5			
1	10		3001			1	X33			
2	19		3000			1	X34			
3	28		FAD				FO3			CFin
4	37		STØ				JO6			Source
5	46		CLA				FO6			FFout
6	55		3001			1	XYO			
7	64		3000			1	X41			3NB
0	I		FSB				FOY			
1	10		STØ				JOY			Leakage
2	19		FAD				JO5			Coll
3	28		TNZ				XY6			
4	37		LDQ				Y21			
5	46		TRA				XY7			
6	55		FDH				JO6			
7	64		STQ				JO3			YNB NB/acc
0	I		STZ				FO1			
1	10		STZ				FO2			
2	19		LXA			2	AO5			
3	28		7000			2	YO2			
4	37		LXD			1	607			
5	46		CLA				NOX			
6	55		SUB			1	N1			
7	64		STA				X71			5NB

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I		LXA			1	IOY			FB 1022
1	10		CLS				FO5			
2	19		STØ				FO3			↖
3	28		CLA			1	SO			
4	37		TZE				Y00			
5	46		LDQ			1	H5			
6	55		FMP				FO3			
7	64		FDH			1	SO			6NB
0	I		STQ				FOY			
1	10		FMP	1						
2	19		FAD				FO1			
3	28		STØ				FO1			
4	37		LDQ				FOY			
5	46		FMP			1	NY			
6	55		FAD				FO2			
7	64		STØ				FO2			7NB
0	I	7001				2	YO2			end (right)
1	10	2001				2	YO3			(per.)
2	19		TRA	4			1			
3	28		LXA			1	YO1			CB conv
4	37		CLA				FO3			
5	46		TRA				X62			↗
6	55									
7	64									8NB
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

FLOCO 704

77 78 79 80	PROBLEM		
DSW	PROGRAMMER Parameters	DATE	PAGE 5

	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	9	*	A00	Gen specs
1	10		0	Rg/adj
2	19		5	Q/lk/d/c/b/a
3	28		2	Pl/Lyl/Spk
4	37		1	CBC 0/left/prev
5	46		0	FBC 0/left/prev
6	55		1	Ieh, NF 0/1/2
7	64		4	A m
0	9	*	I00	Def. specs
1	10		2	Idno
2	19		2	K (zones)
3	28		0	Source: no/anvil
4	37		20	I (n-int)
5	46	28.		Eign (1st)
6	55	30.		(2nd)
7	64	.002		I E(1)
0	9	*	G00	Cross sections
1	10		3	G (groups)
2	19		1	bare gr.
3	28		2	pos g
4	37		3	pos gg
5	46		8	σ: table length
6	55		0	space
7	64		0	G g (temp)
0	9	*	M00	Materials
1	10		2	No of bare mats
2	19		4	total mats
3	28		6	mix specs
4	37		1	order of smear
5	46		2	smear specs
6	55		0	(SS)
7	64		0	M m' (chis)

	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	9	*	S00	Sources
1	10		0	DS: no/yes
2	19		0	spare
3	28		0	spare
4	37		0	FBS: no/fiss/Bin.
5	46		0	0/ko/do
6	55		0	ko or do
7	64		0	S BC end
0	9	*	P00	Monitor
1	10		12Z	
2	19	*	T00	Temp sto
3	28		12Z	
4	37	*	F00	Currents
5	46		8Z	
6	55	*	J00	Balance
7	64		8Z	P
0	9	*	E00	Execute
1	10		7Z	
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			E
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

FLOCO 704

77	78	79	80	PROBLEM		
	DSN			PROGRAMMER Control cards	DATE	PAGE C

	C	OPERATION P R S				ADDRESS X R S				REMARKS
	1	2	3	4	5	6	7	8	9	
0	I	*								PM header
1	10	*					1	3	0	
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									HPM
0	I	*					8	0	0	IC hdr
1	10	*						6	0	
2	19	*					8	0	1	AC
3	28	*					1	3	0	
4	37	*					8	0	2	FS
5	46	*				3	8	0	0	
6	55	*					8	0	0	
7	64									HIC
0	I	*				4	8	0	0	To to IC
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									TIC
0	I	*					8	0	1	AC hdr
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									HAC

	C	OPERATION P R S				ADDRESS X R S				REMARKS
	1	2	3	4	5	6	7	8	9	
0	I	*				4	8	0	1	To to AC
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									TAC
0	I	*					8	0	2	Code hdr
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									HFS
0	I	*				4	8	0	3	To to code
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									TFC
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

FLOCO 704

77	78	79	80	PROBLEM		
		DSW		PROGRAMMER Param. storage	DATE	PAGE P00

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0			P01	Ict
1	10		2	Left
2	19		3	spare
3	28		4	ε (sites)
4	37		5	Figr
5	46		6	sinl. factor
6	55		7	monte. bal.
7	64		10	1
0			11	λ_1
1	10		12	λ_2
2	19		13	λ_3
3	28		14	spare
4	37			
5	46		F01	spare
6	55		2	spare
7	64		3	ε FF in
0			4	out
1	10		5	FF in
2	19		6	out
3	28		7	spare
4	37		10	FBS
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

	C	OPERATION P R S	ADDRESS X R S	REMARKS T00 F00 J00 err. ind.
	1	2 3 4 5	6 7 8 9	
0			T01	I/Dins
1	10		2	ΣWN'
2	19		3	ΣWN
3	28		4	2^{13} IB
4	37		5	Ido
5	46		6	cond. ind
6	55		7	conv. ind
7	64		10	λ_0
0			11	I/O Dins
1	10		12	ISct
2	19		13	NP ind.
3	28		14	S.f. x F01
4	37			
5	46		J01	9
6	55		2	S.f.
7	64		3	Bal.
0			4	Bakage
1	10		5	roll.
2	19		6	source
3	28		7	err ind #1
4	37		10	#2
5	46			
6	55	ISct large	1	err ind (J07)
7	64	neg F0	2	
0		neg S0	4	
1	10	neg NF	8	
2	19			
3	28	shaky scal.	1	err ind (J10)
4	37	sprk neg	2	
5	46	ε off neg	4	
6	55	Δ ≠ 0	8	
7	64			

FLOCO 704

77	78	79	80	PROBLEM		
		DSN		test problem	DATE	PAGE TP

	C	OPERATION P	R	S	ADDRESS X	R	S	REMARKS
	1	2	3	4 5	6	7	8 9	
0	9	*				R	1	n,'
1	10	0						
2	19						4I	
3	28	5.						
4	37						3I	
5	46	7.						
6	55	8.						
7	64						9I	0R1
0	9	28.						
1	10	*				R	7	zone #'s (n,')
2	19						1	
3	28						6R	
4	37						2	
5	46					12	R	
6	55							
7	64							1R1
0								
1	10							
2	19							
3	28							
4	37							
5	46							
6	55							
7	64							
0								
1	10							
2	19							
3	28							
4	37							
5	46							
6	55							
7	64							

	C	OPERATION P	R	S	ADDRESS X	R	S	REMARKS
	1	2	3	4 5	6	7	8 9	
0	9	*				S	7	spec #'s
1	10						1	
2	19					6	R	
3	28						2	
4	37					12	R	
5	46	*				R	3	p's
6	55	-	1.					
7	64	-	1.					0S3
0	9	*				M	3	mat #'s
1	10						3	
2	19						4	
3	28							
4	37							
5	46							
6	55							
7	64							1S3
0	9	*				N	4	Initial mem. block
1	10	1.						
2	19	.9	8					
3	28						4I	
4	37	.6	5					
5	46						3I	
6	55	.2	5					
7	64						4I	0N4
0	9	.0	3					
1	10						3I	
2	19	.0	1					
3	28							
4	37							
5	46							
6	55							
7	64							1N4

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	PROGRAMMER: DSW TP cont	DATE	PAGE: TP

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9	*	TO	signed.
1	10		1	
2	19		2	
3	28		-3	
4	37		1	
5	46		2	
6	55		-4	
7	64			TO
0	9	*	N7	xy
1	10	2.5-		
2	19	2.5-		
3	28	2.5-		
4	37	*	CO	
5	46			
6	55			
7	64			N7
0	9	.1561		
1	10	.2179		
2	19	.0853		
3	28		5Z	
4	37	.1476		
5	46	.2487		
6	55	.1595-		
7	64	.0506		OAY
0	9		4Z	
1	10	.2033		
2	19	.4535-		
3	28	.3586		
4	37	.0217		
5	46	.0159		
6	55		3Z	
7	64			1AY

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9	*	PO	mpy.
1	10	.94		
2	19	.06		
3	28	0		
4	37	.007		
5	46	.993		
6	55	0		
7	64			PO
0	9	*	K7	xy
1	10	.56		
2	19	.341		
3	28	.099		
4	37	*	V1	y
5	46	22.2		
6	55	12.5-		
7	64	5.6		K7
0	9	.064		
1	10	.2131		
2	19	.0928		
3	28		5Z	
4	37	.0024		
5	46	.2391		
6	55	.2039		
7	64	.0707		OTU
0	9		5Z	
1	10	.4536		
2	19	.4416		
3	28	.0284		
4	37	.0221		
5	46		3Z	
6	55			
7	64			1TU

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77	78	79	80	PROBLEM		
	DSN			PROGRAMMER Initial code	DATE	PAGE IC

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	18	800	
1	10	CLA	I04	I
2	19	ADD	401	
3	28	STQ	M06	I+1 v
4	37	CLA	A07	m
5	46	LXA	1 A03	gen.
6	55	3001	1 X17	
7	64	7000	1 X17	0 IC
0	I	ARS	1	
1	10	ADD	401	
2	19	STQ	E01	
3	28	LDQ	E01	
4	37	MPY	E01	
5	46	LLS	43	
6	55	SUB	402	
7	64	ADD	401	1 IC
0	I	STQ	M07	dim (m') v
1	10	CLA	A07	m
2	19	3001	1 X27	
3	28	7000	1 X27	
4	37	CLS	A07	
5	46	ARS	1	
6	55	ADD	M07	
7	64	ADD	420	2 IC
0	I	FAD	400	
1	10	STQ	E01	
2	19	CLA	421	
3	28	STQ	P04	s (sites) v
4	37	FDH	E01	
5	46	STQ	T01	1/dim v
6	55	LDQ	I04	I
7	64	MPY	M07	3 IC m'

	C	OPERATION P R S	ADDRESS X R S	REMARKS (800)
	1	2 3 4 5	6 7 8 9	
0	I	STQ	E01	
1	10	CLA	401	
2	19	LRS	20	
3	28	DVH	E01	
4	37	STQ	T04	2^19/dim'
5	46	NOP	T05	Lido
6	55	CLA	A05	
7	64	TZE	X51	4 IC
0	I	CLA	401	
1	10	STQ	S07	BC ind.
2	19	TSX	4 970	
3	28			
4	37			
5	46			
6	55			
7	64			5 IC
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN			PROGRAMMER: Assign code	DATE	PAGE: AC

	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	I	8	60/	
1	10	TSX	4 97/	
2	19	OMO6	1 R/	n_i · ✓
3	28	OIO4	1 R2	$\overline{n_i}$ ·
4	37	OMO5	1 R3	ρ_s (amaar) ✓
5	46	OMO5	1 M3	mat #'s ✓
6	55	OMO4	1 R4	Λ (temp)
7	64	OMO4	1 R5	DAC #'s (temp)
0	I	OIO4	1 R7	zones (n_i ·) ✓
1	10	OIO4	1 S7	mat spaces ✓
2	19	OIO4	1 D/	Δ_i ·
3	28	OIO4	1 D6	Δ_i · (limits)
4	37	OIO2	1 D4	Δ_i · (mod) (✓)
5	46	OIO4	1 V0	V_i ·
6	55	OIO4	1 V4	V_i ·
7	64	OMO3	1 I0	DAC I_s (mix) ✓
0	I	OMO3	1 P0	P_s (prop's) ✓
1	10	OMO2	1 I4	I_s' (amiss sou.) (✓)
2	19	OMO3	1 P4	P_s' (B_s mod) (✓)
3	28	O605	1 C0	σ_{ij} m ✓
4	37	O601	2 C/	
5	46	OMO2	3 C2	
6	55	O601	1 F7	(temp)
7	64	O601	1 K7	3AC x_s ✓
0	I	O601	1 N7	x_s ✓
1	10	O601	1 V1	v_s ✓
2	19	OMO7	1 M5	m' (mates) ✓
3	28	OMO7	1 M6	f_m ✓
4	37	OMO7	1 M7	M_m ✓
5	46	OIO4	1 61	f_{im}
6	55	OMO7	2 62	
7	64	OIO4	1 63	4AC

	C	OPERATION P R S	ADDRESS X R S	REMARKS (801)
0	I	OMO7	2 64	M_{im}
1	10	OIO4	1 H/	h_i ·
2	19	O605	1 H2	σ_{ij} ·
3	28	OIO4	2 H3	
4	37	OIO4	1 H4	h_i^2
5	46	OIO4	1 H5	$h_i^{1/2}$
6	55	OIO3	1 A2	σ_{ij} (amiss)
7	64	O605	1 A2	4AC
0	I	OIO4	2 A3	
1	10	OIO4	1 S0	S_i ·
2	19	OIO3	1 S4	S_i · (amiss)
3	28	OIO4	1 S4	
4	37	OIO4	1 F0	F_i · (fissions)
5	46	OIO4	1 W0	W_i · (weights)
6	55	OIO4	1 N0	N_{ig}
7	64	O601	2 N1	5AC
0	I	OIO3	1 J0	J_{ig}
1	10	OIO4	1 J0	
2	19	O601	2 J1	
3	28	OIO4	1 N3	N_{im} (aug. ext.)
4	37	OIO4	1 N4	N_{ig} (temp) ✓
5	46	OIO4	1 N5	N_{im}
6	55	OMO7	2 N6	
7	64	OMO7	1 B0	6AC
0	I	OMO7	1 B4	
1	10	OSO4	1 Q4	FBS β_g (✓)
2	19	O601	1 Q4	
3	28	OSO1	1 Q0	Q_{ij} · (✓)
4	37	OIO4	1 R0	
5	46	O601	2 R1	
6	55	OSO7	1 B1	6.m. (mfg)
7	64	OMO7	1 B1	7AC

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	0 6 0 1	2 B 2	
1	10	0 6 0 1	1 T 0	
2	19	0 M 0 2	2 T 1	
3	28	0 6 0 1	1 T 2	
4	37	0 6 0 3	2 T 3	
5	46	0 M 0 2	1 S 2	
6	55	4 6 0 3	2 S 3	
7	64	T S X	4 9 7 0	S A C
0	I	9	1 4 Y 0 3	
1	10	9	4 4 Y 0 4	
2	19	9	2 4 Y 0 6	
3	28			
4	37			
5	46			
6	55			
7	64			9 A C
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

	C	OPERATION P R S	ADDRESS X R S	REMARKS Ent. ind. patches
	1	2 3 4 5	6 7 8 9	
0	I	8	2 X 1 J	(optional)
1	10	T P L	X 2 0	
2	19	T Z E	X 2 0	
3	28	C L A	4 0 2	Neg F0
4	37	∅ R S	T 0 7	
5	46	T R A	X 2 0	
6	55			
7	64			6 S T
0	I	8	2 X 5 3	
1	10	T P L	X 5 4	
2	19	T Z E	X 5 4	
3	28	C L A	4 0 4	Neg S0
4	37	∅ R S	T 0 7	
5	46	T R A	X 5 4	
6	55			
7	64			7 S T
0	I	8	2 X 5 2	
1	10	T P L	X 5 3	
2	19	T Z E	X 5 3	
3	28	C L A	4 1 0	Neg N0
4	37	∅ R S	T 0 7	
5	46	T R A	X 5 9	
6	55			
7	64			6 S C
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	D	S	W	PROGRAMMER Initial needs check	DATE	PAGE NF

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	805	
1	10	LXA	1 A06	Ict
2	19	3000	1 X17	
3	28	LXD	1 N1*	Clear NO
4	37	STZ	1 NO	
5	46	2001	1 X04	
6	55	LXA	1 I04	
7	64	LXA	2 602	OMF Change
0	I	CLA	NO*	
1	10	SUB	2 N1	
2	19	STA	X14	
3	28	CLA	1 N4	↖
4	37	STØ	1	NO
5	46	2001	1 X13	↗
6	55	TRA	X36	
7	64	3001	1 X36	1MF
0	I	LXA	1 A01	
1	10	3000	1 X03	Tally
2	19	LXA	1 A02	
3	28	7000	1 X03	↗Q
4	37	LXA	2 601	2
5	46	CLA	NO*	↖
6	55	SUB	2 N1	
7	64	STA	X33	2MF
0	I	LXA	1 I04	
1	10	LDQ	2 K7	X2↖
2	19	FMP	1 N4	
3	28	STØ	1	
4	37	2001	1 X31	↗
5	46	2001	2 X25	↗
6	55	CLA	A06	Ict
7	64	TPL	X53	3MF

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	SLW	A06	Expand NO
1	10	LXD	1 N1*	IG
2	19	PXD	1	
3	28	ARS	1	
4	37	PDX	2	½ IG
5	46	CLA	2 NO	↖
6	55	STØ	1 NO	
7	64	2001	1 X50	4MF
0	I	STØ	1 NO	
1	10	2001	1 X52	
2	19	2001	2 X45	↗
3	28	TRA	4 1	
4	37			
5	46			
6	55			
7	64			5MF
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN			PROGRAMMER Adj. cross sections	DATE	PAGE A-X

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	806	
1	10	LXA	1 A01	Reg/adj.
2	19	7000	1 X76	
3	28	LXA	1 A06	Test
4	37	3003	1 X76	
5	46	LXA	1 M01	5
6	55	CLA	C0*	
7	64	SUB	1 C2	0AX
0	I	STO	F01	Track
1	10	SXD	1 F02	same 5
2	19	LXA	1 G05	cell # (1)
3	28	LXA	2 401	9'
4	37	LXA	4 601	9''
5	46	7603	1 X30	→ (same (a)
6	55	PXD	1	
7	64	ARS	22	1AX
0	I	SUB	G04	Loc Tag (2)
1	10	3604	1 X26	→ (c)
2	19	ADD	G01	(b)
3	28	TMI	X50	X2 XY
4	37	PAX 4		9' 1 c
5	46	TRA	X30	5' 1 compl
6	55	ADD	401	c) Wrap c
7	64	PAX 2		2AX
0	I	SXD 2	X31	
1	10	7000	4 X50	
2	19	CLA	F01	Track
3	28	SUB 2	C1	
4	37	STA	X42	
5	46	STA	X45	
6	55	CLA	F01	
7	64	SUB 4	C1	3AX

	C	OPERATION P R S	ADDRESS X R S	REMARKS (806)
	1	2 3 4 5	6 7 8 9	
0	I	STA	X43	
1	10	STA	X44	
2	19	CLA	1	invert
3	28	LDQ	1	σ-terms
4	37	STQ	1	
5	46	STQ	1	
6	55	1001	2 X47	
7	64	2001	4 X30	4AX
0	I	2001	1 X13	
1	10	LXD	1 F02	5
2	19	2001	1 X06	
3	28	LXA	2 401	invert
4	37	LXA	4 601	$\sigma_a, \sigma_b, \sigma_f$
5	46	SXD	2 X56	
6	55	7000	4 X75	
7	64	LDQ	4 X7	5AX
0	I	CLA	2 X7	
1	10	STQ	2 X7	
2	19	STO	4 X7	
3	28	LDQ	4 N7	
4	37	CLA	2 N7	
5	46	STQ	2 N7	
6	55	STO	4 N7	
7	64	LDQ	4 V1	6AX
0	I	CLA	2 V1	
1	10	STQ	2 V1	
2	19	STO	4 V1	
3	28	1001	2 X74	
4	37	2001	4 X55	
5	46	LXD	4 457	
6	55	TRA	4 1	
7	64			7AX

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		DSW		PROGRAMMER: Mix cross assembly	DATE	PAGE: MX

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	S	810	
1	10	LXA	1 M03	mix specs
2	19	7000	1 X53	
3	28	CLA	A02	no
4	37	SUB	403	
5	46	TZE	X10	
6	55	CLA	1 P0	
7	64	TRA	X13	OMX
0	I	LDQ	1 PY	c-calc
1	10	FMP	F05	
2	19	FAD	1 P0	
3	28	STQ	F01	p
4	37	TPL	X20	
5	46	CLA	404	
6	55	ORS	J10	sind.
7	64	STZ	F01	1MX
0	I	CLA	1 J0	
1	10	TZE	X52	
2	19	PAX	2	mat #
3	28	CLA	C0X	
4	37	SUB	2 C2	
5	46	STA	X46	
6	55	LDQ	1 J0	
7	64	TQP	X32	2MX
0	I	STA	X47	
1	10	STA	X50	
2	19	CLA	J03	anso.?
3	28	TZE	X40	
4	37	CLA	2 J4	
5	46	TZE	X40	
6	55	LXD	2 C1X	
7	64	1C1	2 X41	3MX

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	LXD	2 C1X	
1	10	LDQ	F01	p
2	19	CLA	1 J0	
3	28	TPL	X46	
4	37	CLA	400	
5	46	TRA	X50	
6	55	FMP	2	
7	64	FAD	2	4MX
0	I	STQ	2	
1	10	2001	2 X41	
2	19	2001	1 X03	
3	28	TRA	4 1	
4	37			
5	46			
6	55			
7	64			5MX
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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		DSN		PROGRAMMER	Input print	DATE	PAGE 1P

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0		I	8					5	1	
1	10			L	X	A	1	A	06	Ict
2	19	3	0	0	2	1	X	5	3	
3	28			T	S	X	4	9	74	Print
4	37	0				1				
5	46	0					8	5	0	Iol ldg
6	55	0					5	5	3	Param ldg
7	64	0			1					0 1P
0		I	0			7	1	A	00	
1	10	0				7	1	I	00	
2	19	0				5	1	6	00	
3	28	0				5	1	M	00	
4	37	0				6	1	S	00	
5	46	0				2				
6	55	0					8	5	4	ldg
7	64	0					R	1		1 1P
0		I	0					R	7	
1	10	0						5	7	
2	19	0						D	4	
3	28	0						M	5	
4	37	0						M	6	
5	46	0						M	7	
6	55	0				1				
7	64	1	M	0	5	1	R	3		2 1P
0		I	1	M	0	5	1	M	3	
1	10	0			2					
2	19	0					8	5	5	ldg
3	28	0						I	0	
4	37	0						P	0	
5	46	0						I	4	
6	55	0						P	4	
7	64	0						Q	4	3 1P

	C	OPERATION				ADDRESS				REMARKS (1811)
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0		I	0					V	1	
1	10	0						N	7	
2	19	0						K	7	
3	28	0			2					
4	37	0					8	5	6	ldg
5	46	0						C	0	
6	55	0			2					
7	64	0					8	5	7	4 1P ldg
0		I	0					N	8	
1	10	4						R	0	
2	19		L	X	D	4	4	5	7	
3	28		T	R	A	4			1	
4	37									
5	46									
6	55									
7	64									5 1P
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	8/2	
1	10	LXA	1 A06	Ict
2	19	3002	1 X10	
3	28	LXA	1 I04	
4	37	CLA	1 R1+	↖
5	46	FSB	1 R1	
6	55	STØ	1 D6	↗
7	64	2001	1 X04	DMG
0	I	LXA	1 A02	
1	10	7003	1 X40	
2	19	7004	1 X24	
3	28	LXA	1 M06	a-calc
4	37	CLA	I05	a
5	48	FDH	1 R1	
6	55	STQ	E01	
7	64	LDQ	E01	IMG
0	I	FMP	1 R1	↖
1	10	STØ	1 R1	
2	19	2001	1 X17	↗
3	28	TRA	X40	
4	37	LXA	1 401	δ-calc
5	46	CLA	1 R7	Zone #
6	55	PAX	2	↖
7	64	LDQ	2 D4	2MG δ mod.
0	I	FMP	I05	δ
1	10	FAD	421	
2	19	LRS	43	
3	28	FMP	1 D6	
4	37	FAD	1 R1	
5	46	STØ	1 R1+	
6	55	1001	1 X37	↗
7	64	7104	1 X25	3MG

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	LXA	1 I04	
1	10	LXA	2 A03	geo
2	19	CLA	1 R1+	↖
3	28	FSB	1 R1	
4	37	TZE	X46	
5	46	TPL	X51	
6	55	CLA	410	acc. ind.
7	64	ØRS	J10	4MG
0	I	CLA	440	10^4
1	10	STØ	1 D1	A_i
2	19	STØ	1 H1	(temp)
3	28	CLA	1 R1+	
4	37	FAD	1 R1	
5	46	SUB	411	
6	55	STØ	1 R2	$\bar{x}_i$
7	64	3000	2 X61	5MG
0	I	CLA	421	
1	10	STØ	1 V4	V_i
2	19	2001	1 X42	g
3	28	TRA	4	1
4	37			
5	46			
6	55			
7	64			6MG
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN	PROGRAMMER	Geometric functions	DATE	PAGE	GF

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	813	
1	10	LXA	1 I04	
2	19	LXA	2 A03	go
3	28	7001	2 X31	↖
4	37	LDQ	1 R1+	sphere fcns
5	46	FMP	1 R1+	
6	55	STØ	E01	
7	64	LDQ	1 R1+	0GF
0	I	FMP	1 R1	
1	10	STØ	E02	
2	19	LDQ	1 R1	
3	28	FMP	1 R1	
4	37	FAD	E01	
5	46	STØ	E01	
6	55	FAD	E02	
7	64	FDH	423	1GF
0	I	STQ	1 V4	V_i'
1	10	CLA	1 V4	
2	19	FDH	1 R2	
3	28	STQ	1 R2	$\bar{n}_i$
4	37	CLA	1 D1	
5	46	ADD	411	
6	55	FDH	E01	
7	64	FMP	1 V4	2GF
0	I	STØ	1 H1	A_i' (temp)
1	10	LDQ	1 V4	V_i'
2	19	FMP	1 D1	A_i'
3	28	STØ	1 V0	V_i'
4	37	2001	1 X03	
5	46	LXA	2 M07	m' (chins)
6	55	CLA	G3*	↖
7	64	SUB	2 G4	3GF

	C	OPERATION P R S	ADDRESS X R S	REMARKS (813)
	1	2 3 4 5	6 7 8 9	
0	I	STA	X50	
1	10	CLA	G1*	
2	19	SUB	2 G2	
3	28	STA	X55	
4	37	LXA	1 I04	
5	46	CLA	2 M7	μ_m ↖
6	55	SSP		
7	64	FDH	1 H1	4GF A_i'
0	I	STQ	1	63
1	10	CLA	403	go
2	19	TZE	X54	
3	28	CLA	2 M6	μ_m
4	37	FDH	1 R2	
5	46	STQ	1	61 ↗
6	55	2001	1 X45	↗
7	64	2001	2 X36	5GF
0	I	TRA	4 1	
1	10	8	2 X46	Patch
2	19	3001	2 X47	
3	28	FDH	1 D1	A_i'
4	37	TRA	X50	
5	46			
6	55			
7	64			6GF
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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		DSW		PROGRAMMER: Form weights; Simmons (lady)	DATE	PAGE: WS (814) FA (815)	

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	814	
1	10	STZ	T02	
2	19	LXA	3 401	i
3	28	LXA	4 601	
4	37	CLA	400	
5	46	FAD	1 N0	
6	55	1 IOY	1 X07	
7	64	2 001	4 X05	0WS
0	I	SLW	E01	
1	10	LDQ	E01	
2	19	FMP	2 V4	N_4
3	28	STØ	2 W0	N_1
4	37	LDQ	E01	
5	46	FMP	2 W0	
6	55	FAD	T02	
7	64	STØ	T02	1WS
0	I	1 001	2 X21	
1	10	PXD	2	
2	19	PDX	1	
3	28	7 IOY	2 X03	
4	37	LXD	4 457	
5	46	TRA	4 1	
6	55			
7	64			2WS
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	815	
1	10	CLA	A01	Reg lady
2	19	TZE	4 1	
3	28	LXA	1 401	i
4	37	SXD	1 E01	save i
5	46	LXA	2 401	
6	55	STZ	E02	Σ
7	64	CLA	2 K7	0FA
0	I	TZE	X15	
1	10	LDQ	2 K7	x_2
2	19	FMP	1 N0	N_2
3	28	FAD	E02	
4	37	STØ	E02	
5	46	1 IOY	1 X16	
6	55	1 001	2 X17	
7	64	7 601	2 X07	1FA
0	I	LXD	1 E01	i
1	10	CLA	E02	Σ_1
2	19	LXA	2 A02	no
3	28	7000	2 X34	
4	37	3001	2 X27	
5	46	FDH	T05	A
6	55	TRA	X33	
7	64	LXA	2 S05	2FA
0	I	7000	2 X34	
1	10	3001	2 X34	
2	19	FDH	S06	A_0
3	28	FMP	Y21	
4	37	STØ	1 F0	F_1
5	46	1001	1 X36	
6	55	7 IOY	1 X04	
7	64	TRA	4 2	3FA

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		DSW		PROGRAMMER Simons (reg.)	DATE	PAGE FR	

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	816	
1	10	STZ	E01	
2	19	LXA	1 401	i
3	28	SXD	1 E02	save i
4	37	CLA	1 S7	sm. specs
5	46	PAX 2		
6	55	PXD 2		
7	64	SUB	E01	DFR
0	I	SXD 2	E01	
1	10	TZE	X47	repeat
2	19	LXA	1 401	s
3	28	CLA	2 R3	
4	37	SLW	1 R4	
5	46	CLA	2 M3	mat #
6	55	PAX	4	
7	64	CLA	CO*	1FR
0	I	SUB	4 C2	
1	10	STA	1 R5	add
2	19	CLA	2 R3	
3	28	TMI	X26	
4	37	1001	1 X25	
5	46	1001	2 X13	
6	55	SXD	1 E03	save s
7	64	LXA	4 G03	2FR
0	I	2001	4 X31	no of
1	10	LXA	2 G01	
2	19	STZ	E04	
3	28	LXD	1 E03	s
4	37	CLA	1 R5	
5	46	SUB	2 C1	
6	55	STA	X37	
7	64	LDQ	4	3FR yes

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	FMP	1 R4	
1	10	FAD	E04	
2	19	STO	E04	
3	28	2001	1 X34	
4	37	STO	2 F7	eff. yes
5	46	2001	2 X32	
6	55	LXD	1 E02	i
7	64	LXA	2 401	4FR 9
0	I	STZ	E03	Σ
1	10	LDQ	2 F7	
2	19	FMP	1 N0	
3	28	FAD	E03	
4	37	STO	E03	
5	46	1 504	1 X56	
6	55	1001	2 X57	
7	64	7601	2 X51	5FR Eff. in Acc
0	I	LXD	1 E02	i
1	10	LXA	2 A02	no
2	19	7000	2 X73	
3	28	3001	2 X66	
4	37	FDH	505	4
5	46	TRA	X72	
6	55	LXA	2 505	
7	64	7000	2 X73	6FR
0	I	3001	2 X73	
1	10	FDH	506	40
2	19	FMP	421	
3	28	STO	1 F0	
4	37	1001	1 X75	
5	46	7504	1 X03	
6	55	LXD	4 457	
7	64	TRA	4 1	7FR

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	DSN	PROGRAMMER	Monitor print	DATE		PAGE	MP

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	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I	8					8	1	7	
1	10		LXA			1	A	0	6	Ict
2	19	3	0	0	2	1	X	1	1	
3	28		TSX			4	9	7	5	
4	37	0					8	5	0	Id hdg
5	46	0					8	5	1	Mon hdg
6	55	4					8	5	2	Gr hdg
7	64		TSX			4	9	7	4	DMP
0	I	4					8	5	1	
1	10		TSX			4	9	7	4	Mon. Print
2	19	4		1	0	1	P	0	0	
3	28		PSE				1	6	1	#1
4	37		TRA				X	1	7	
5	46		TSX			4	9	7	5	
6	55	4		1	0	1	P	0	0	
7	64		CLA				T	0	5	1MP Lch
0	I		ADD				T	0	4	
1	10		SUB				P	0	2	
2	19		TPL				X	2	6	
3	28		ADD				P	0	2	
4	37		STØ				T	0	5	
5	46		TRA				X	3	0	
6	55		PSE				1	6	2	#2
7	64		TRA				X	4	1	2MP
0	I		CLA				4	0	2	Dump
1	10		STØ				A	0	6	
2	19		TSX			4	9	7	3	
3	28	0	1	3	0	1	A	0	0	
4	37	0					N	0		
5	46	4					B	1		
6	55		HPR				1	1	7	
7	64		CLA				P	0	1	3MP

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I		STØ				A	0	6	
1	10		CLA				A	0	6	Mon Ict
2	19		ADD				4	0	1	
3	28		STØ				A	0	6	
4	37		STØ				P	0	1	
5	46		CLA				1	0	5	
6	55		STØ				P	0	5	
7	64		LXD			4	4	5	7	4MP
0	I		PSE				1	6	3	#3
1	10		TRA			4			1	
2	19		HPR				2	1	7	
3	28		TSX			4	9	7	0	
4	37									
5	46									
6	55									
7	64									5MP
0	I	8				2	X	3	1	
1	10		NRS				3	4	1	Dump Id
2	19		CPY				T	0	1	card
3	28		CPY				P	0	2	
4	37		TRA				X	3	2	
5	46									
6	55									
7	64									6MP
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

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	PROGRAMMER: DSN Eff. cross sections	DATE	PAGE: EX

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	I	8	821	
1	10	LXD	2 G07	2
2	19	CLA	C0*	
3	28	SUB	2 C1	
4	37	STØ	E01	c0 adr
5	46	STZ	E02	
6	55	LXA	1 401	i'
7	64	CLA	H2*	0EX
0	I	SUB	1 H3	
1	10	STA	X25	
2	19	STA	X60	(H2,·)
3	28	ADD	G05	
4	37	STA	X24	(H2,-1)
5	46	CLA	1 S7	sm. specs
6	55	PAX	2	
7	64	PXD	2	1EX
0	I	SUB	E02	
1	10	SXD	2 E02	
2	19	TNZ	X30	
3	28	LXA	2 G05	
4	37	CLA	2	H2,-1
5	46	STØ	2	H2,·
6	55	2001	2 X24	
7	64	TRA	X66	2EX
0	I	SXD	1 E03	save i'
1	10	LXA	1 401	s
2	19	CLA	2 R3	ρ
3	28	SLW	1 R4	
4	37	CLA	2 M3	mat #
5	46	PAX	4	
6	55	CLA	E01	
7	64	SUB	4 C2	3EX

	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	I	STA	1 R5	σ adr
1	10	CLA	2 R3	
2	19	TMI	X45	
3	28	1001	1 X44	
4	37	1001	2 X32	
5	46	SXD	1 E04	save s
6	55	LXA	2 401	g'
7	64	STZ	E05	4EX 2
0	I	LXD	1 E04	s
1	10	CLA	1 R5	
2	19	STA	X53	
3	28	LDQ	2	σ
4	37	FMP	1 R4	ρ
5	46	FAD	E05	
6	55	STØ	E05	
7	64	2001	1 X51	5EX
0	I	STØ	2	H2,·
1	10	7604	2 X63	
2	19	TZE	X65	
3	28	1001	2 X64	
4	37	7605	2 X47	
5	46	LXD	1 E03	i'
6	55	1001	1 X67	
7	64	7704	1 X07	6EX
0	I	LXD	4 457	
1	10	TRA	4	1
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			7EX

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	820	
1	10	CLA	103	Each ?
2	19	TZE	4 1	→ yes
3	28	LXD	2 607	2
4	37	CLA	C0*	
5	46	SUB	2 C1	
6	55	STO	E01	C0 code
7	64	STZ	E02	0EZ
0	I	LXA	1 401	2'
1	10	CLA	A2*	
2	19	SUB	1 A3	
3	28	STA	X27	
4	37	STA	X66	(A2,1)
5	46	ADD	605	
6	55	STA	X26	(A2,1-1)
7	64	CLA	1 57	1EZ
0	I	PAX	2	
1	10	PXD	2	
2	19	SUB	E02	
3	28	SXD	2 E02	
4	37	TNZ	Y00	patch (see 822)
5	46	LXA	2 605	
6	55	CLA	2	A2,1-1
7	64	STO	2	2EZ A2,1
0	I	2001	2 X26	
1	10	TRA	X74	
2	19	LXA	1 401	5
3	28	CLA	2 R3	P
4	37	SLW	1 R4	
5	46	CLA	2 M3	mask
6	55	PAX	4	
7	64	CLA	4 74	3EZ 01

	C	OPERATION P R S	ADDRESS X R S	REMARKS (820)
	1	2 3 4 5	6 7 8 9	
0	I	TZE	XY4	
1	10	1001	4 XY2	
2	19	CLA	E01	
3	28	SUB	4 C2	
4	37	STA	1 R5	code
5	46	CLA	2 R3	
6	55	TMI	X51	
7	64	1001	1 X50	4EZ
0	I	1001	2 X33	
1	10	SXD	1 E04	
2	19	LXA	2 603	2'
3	28	STZ	E05	2
4	37	LXD	1 E04	5
5	46	CLA	1 R5	
6	55	TZE	X64	
7	64	STA	X60	5EZ
0	I	LDQ	2	0
1	10	FMP	1 R4	
2	19	FAD	E05	
3	28	STO	E05	
4	37	2001	1 X55	
5	46	CLA	E05	
6	55	STO	2	A2,1
7	64	7604	2 X71	6EZ
0	I	TZE	X73	
1	10	1001	2 X72	
2	19	7605	2 X53	
3	28	LXD	1 E03	1'
4	37	1001	1 X75	
5	46	7104	1 X11	
6	55	LXD	4 457	
7	64	TRA	4 1	7EZ

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DSN	PROGRAMMER Path lengths	DATE	PAGE PL

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	822	
1	10	STZ	E01	
2	19	LXA	1 A02	no
3	28	3002	1 X07	
4	37	7001	1 X07	
5	46	CLA	T05	c
6	55	TRA	X12	
7	64	LXA	1 505	OPL
0	I	7001	1 X15	
1	10	CLA	506	c
2	19	LXD	2 607	
3	28	FDH	2 V1	
4	37	STQ	E01	c/v
5	46	LXA	1 401	c'
6	55	LXA	2 603	
7	64	LXA	4 604	1PL
0	I	CLA	2 H2	
1	10	FAD	E01	
2	19	TZE	X34	
3	28	TPL	X33	
4	37	STZ	1 H1	
5	46	CHS		
6	55	FAD	4 H2	
7	64	STO	4 H2	2PL
0	I	CLA	402	
1	10	ORS	J10	ent. ind
2	19	TRA	X35	
3	28	SUB	411	
4	37	STO	1 H1	
5	46	CLA	4 H2	
6	55	STO	1 H5	sgn
7	64	CLA	2 H2	3PL

	C	OPERATION P R S	ADDRESS X R S	REMARKS (822)
	1	2 3 4 5	6 7 8 9	
0	I	STO	1 H4	sgn
1	10	1605	4 X42	
2	19	1605	2 X43	
3	28	1001	1 X44	
4	37	7104	1 X20	
5	46	LXD	4 457	
6	55	TRA	4 1	
7	64			4PL
0	I	SXD	1 E03	Patch 820
1	10	TRA	X32	
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			8EZ
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	823	
1	10	LXD	2 607	2
2	19	CLA	60*	
3	28	SUB	2 61	
4	37	STA	X16	
5	46	LXA	4 501	Q rind.
6	55	LXA	1 F04	i'
7	64	LDQ	1 F0	0ST
0	I	CLA	A01	Rg/adj.
1	10	TZE	X14	
2	19	FMP	1 H4	XFP
3	28	TRA	X17	
4	37	FMP	2 K7	Xg
5	46	7000	4 X17	
6	55	FAD	1	Q0
7	64	STO	1 50	1ST
0	I	2001	1 X07	
1	10	LXA	1 F04	calc SO
2	19	CLA	H2*	
3	28	SUB	1 H3	
4	37	STA	X34	
5	46	STA	X43	
6	55	STZ	F01	Σ
7	64	LXA	4 603	2ST
0	I	1001	4 X31	g'(σ)
1	10	1604	2 X32	
2	19	2603	2 X33	
3	28	2001	2 X34	g'(NO)
4	37	CLA	4	σ
5	46	TNZ	X40	
6	55	3604	4 X51	
7	64	TRA	X47	3ST

	C	OPERATION P R S	ADDRESS X R S	REMARKS (623)
	1	2 3 4 5	6 7 8 9	
0	I	CLA	NO*	
1	10	SUB	2 N1	
2	19	STA	X44	
3	28	LDQ	4	σ
4	37	FMP	1	NO
5	46	FAD	F01	
6	55	STO	F01	
7	64	1001	4 X50	4ST
0	I	7605	4 X33	
1	10	CLA	F01	
2	19	FAD	1 50	
3	28	STO	1 50	Si.
4	37	LXD	2 607	
5	46	2001	1 X22	
6	55	LXD	4 457	
7	64	TRA	4 1	5ST
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN			PROGRAMMER: Source (anisotr. part)	DATE	PAGE 5Z

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	C	OPERATION P	OPERATION R S	ADDRESS X	ADDRESS R S	REMARKS
0	I	8			824	
1	10		CLA		I03	Isot?
2	19		TZE	4	1	→mo
3	28		LXA	1	I04	
4	37		CLA		A2*	↖
5	46		SUB	1	A3	
6	55		STA		X16	
7	64		STA		X25	0SZ
0	I		STZ		E01	I
1	10		LXA	4	G03	
2	19	1	001	4	X13	g'(σ)
3	28	1	G04	2	X14	
4	37	2	G03	2	X15	
5	46	2	001	2	X16	g'(J0) ↖
6	55		CLA	4		σ
7	64		TNZ		X22	1SZ
0	I	3	G04	4	X33	
1	10		TRA		X31	
2	19		CLA		J0*	
3	28		SUB	2	J1	
4	37		STA		X26	
5	46		LDQ	4		σ
6	55		FMP	1		J0
7	64		FAD		E01	2SZ
0	I		STO		E01	
1	10	1	001	4	X32	↗
2	19	7	G05	4	X15	
3	28		LDQ		E01	
4	37		FMP		423	
5	46		STO	1	S4	
6	55		LXD	2	G07	↗
7	64	2	001	1	X04	3SZ

	C	OPERATION P	OPERATION R S	ADDRESS X	ADDRESS R S	REMARKS
0	I		LXD	4	457	
1	10		TRA	4	1	
2	19					
3	28					
4	37					
5	46					
6	55					
7	64					4SZ
0						
1	10					
2	19					
3	28					
4	37					
5	46					
6	55					
7	64					
0						
1	10					
2	19					
3	28					
4	37					
5	46					
6	55					
7	64					
0						
1	10					
2	19					
3	28					
4	37					
5	46					
6	55					
7	64					

FLOCO 704

77 78 79 80	PROBLEM		
DSN	PROGRAMMER Bdry conditions	DATE	PAGE BC

(825)

	C	OPERATION (P R S)	ADDRESS X	ADDRESS (R S)	REMARKS
0	I	8		825	
1	(10)	LXD	4	G07	g
2	(19)	CLA		B1*	
3	(28)	SUB	4	B2	
4	(37)	STA		X34	
5	(46)	CLS	2	M7	-μm
6	(55)	LRS		43	
7	(64)	TMI		X24	0BC
0	I	LXA	1	S04	FBC
1	(10)	7000	1	X20	→ no BS
2	(19)	CLA	4	Q4	
3	(28)	7001	1	X20	→ BS iso.
4	(37)	STØ		E01	
5	(46)	1G01	4	X16	
6	(55)	FMP	4	Q4	
7	(64)	FAD		E01	1BC
0	I	LXA	1	A05	
1	(10)	7000	1	X41	zero or BS →
2	(19)	LXA	1	S04	
3	(28)	TRA		X33	refl or per. →
4	(37)	LXA	1	A04	CBC
5	(46)	7000	1	X41	zero →
6	(55)	2001	1	X33	per →
7	(64)	CLA	2	M5	2BC
0	I	PAX	1		
1	(10)	CLA	1	B4	
2	(19)	TRA		X41	refl →
3	(28)	CLA		421	
4	(37)	FAD	2		Blmg
5	(46)	LRS		43	
6	(55)	FMP	1	S0	S_i
7	(64)	FDH	1	H1	3BC h_i

	C	OPERATION (P R S)	ADDRESS X	ADDRESS (R S)	REMARKS
0	I	FMP		426	
1	(10)	STØ	2	B0	
2	(19)	STØ	2	B4	
3	(28)	LXD	4	457	
4	(37)	TRA	4	1	
5	(46)				
6	(55)				
7	(64)				4BC

FLOCO 704

77	78	79	80	PROBLEM		
	D	S	N	PROGRAMMER Phys. flux	DATE	PAGE PF

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	826	
1	10	CLA	2 M5	m'(m=mates)
2	19	TNZ	4 1	→ AF
3	28	LXA	4 I03	
4	37	CLA	N5*	
5	46	SUB	2 N6	
6	55	STA	X55	
7	64	CLA	63*	OPF
0	I	SUB	2 G4	
1	10	STA	X15	
2	19	STA	X17	
3	28	LXA	1 I04	
4	37	CLA	1 H1	↖
5	46	FAD	1	63
6	55	STØ	E01	
7	64	CLA	1	1PF G3
0	I	FSB	1 H1	
1	10	LRS	43	
2	19	FMP	2 B4	
3	28	FAD	1 S0	
4	37	STØ	E02	
5	46	7000	4 X32	
6	55	LDQ	2 M7	
7	64	FMP	1 S4	2PF
0	I	FAD	E02	
1	10	STØ	E02	Num.
2	19	FDH	E01	
3	28	CLA	2 B4	
4	37	STØ	E03	
5	46	TQP	X50	
6	55	CLA	E01	Neg. flux
7	64	FAD	1 H1	3PF

	C	OPERATION P R S	ADDRESS X R S	REMARKS (826)
	1	2 3 4 5	6 7 8 9	
0	I	STØ	E01	
1	10	LDQ	1 H1	
2	19	FMP	E03	
3	28	FAD	E02	
4	37	FDH	E01	
5	46	STQ	2 B4	
6	55	CLA	2 B4	
7	64	TRA	X54	4PF
0	I	STQ	2 B4	Pos. flux
1	10	FAD	2 B4	
2	19	TMI	X36	
3	28	SUB	4 I1	
4	37	STØ	1 N3	
5	46	STØ	1	↗
6	55	2001	1 X14	
7	64	LXD	4 457	5PF
0	I	TRA	4 2	
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			6PF
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

FLOCO 704

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	PROGRAMMER	DATE	PAGE
DSN	Angular flux		AF

(827)

	C	OPERATION	ADDRESS	REMARKS
		P R S	X R S	
	1	2 3 4 5	6 7 8 9	
0	I	8	827	
1	10	LXA	4 I03	
2	19	CLA	N5*	
3	28	SUB	2 N6	
4	37	STA	Y00	
5	46	CLA	63*	
6	55	SUB	2 64	
7	64	STA	X24	0AF
0	I	STA	X26	
1	10	CLA	61*	
2	19	SUB	2 62	
3	28	STA	X22	
4	37	STA	X33	
5	46	LXA	1 401	i (outer.)
6	55	CLA	2 N7	
7	64	TPL	X21	1AF
0	I	LXA	1 I04	i (inner.)
1	10	CLA	1 H1	
2	19	FAD	1	61
3	28	STO	E03	
4	37	FAD	1	63
5	46	STO	E01	Den.
6	55	CLA	1	63
7	64	FSB	E03	2AF
0	I	LRS	43	
1	10	FMP	2 B4	
2	19	STO	E02	
3	28	LDQ	1	61
4	37	FMP	1 N3	
5	46	STO	E04	
6	55	ACL	411	
7	64	FAD	E02	3AF

	C	OPERATION	ADDRESS	REMARKS
		P R S	X R S	
	1	2 3 4 5	6 7 8 9	
0	I	FAD	1 50	
1	10	STO	E02	Num.
2	19	TOOO	4 X47	
3	28	LDQ	2 N7	
4	37	FMP	1 54	
5	46	FAD	E02	
6	55	STO	E02	
7	64	FDH	E01	4AF
0	I	CLA	2 B4	
1	10	STO	E05	
2	19	TQP	X67	
3	28	CLA	E01	Neg. flux
4	37	FAD	1 H1	
5	46	STO	E01	Den.
6	55	LDQ	E03	
7	64	FMP	E05	5AF
0	I	FSB	E04	
1	10	FAD	E02	
2	19	FDH	E01	
3	28	STQ	2 B4	
4	37	STQ	1 N3	
5	46	CLA	2 B4	
6	55	TRA	Y00	
7	64	STQ	2 B4	6AF
0	I	FAD	2 B4	Pos. flux
1	10	TMI	X53	
2	19	STO	E06	
3	28	FSB	1 N3	
4	37	TMI	X53	
5	46	STO	1 N3	
6	55	CLA	E06	
7	64	SUB	411	7AF

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77 78 79 80	PROBLEM		
DSN	PROGRAMMER AF cont	DATE	PAGE AF(827) JC(831)

Current

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	STØ	1	Nim
1	10	7002	2 Y03	
2	19	FAD	1 N4	
3	28	STØ	1 N4	
4	37	CLA	2 N7	
5	46	TPL	Y10	
6	55	2001	1 X21	
7	64	TRA	Y12	8AF
0	I	1001	1 Y11	
1	10	7304	1 X21	
2	19	LXD	4 457	
3	28	TRA	4 1	
4	37			
5	46			
6	55			
7	64			9AF
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	831	
1	10	CLA	I03	
2	19	TZE	4 1	
3	28	LXD	2 G07	6
4	37	CLA	JO*	
5	46	SUB	2 J1	
6	55	STA	X31	
7	64	LXA	2 402	0JC
0	I	CLA	2 N5	
1	10	TZE	X24	
2	19	CLA	N5*	
3	28	SUB	2 N6	
4	37	STA	X17	
5	46	LXA	1 I04	i
6	55	LDQ	2 N7	
7	64	FMP	1	1JC Nim
0	I	7002	2 X22	
1	10	FAD	1 N4	
2	19	STØ	1 N4	acc JO
3	28	2001	1 X16	
4	37	1001	2 X25	
5	46	7M07	2 X10	
6	55	LXA	1 I04	
7	64	LDQ	1 N4	2JC
0	I	FMP	J14	
1	10	STØ	1	JO
2	19	2001	1 X27	
3	28	TRA	4 1	
4	37			
5	46			
6	55			
7	64			3JC

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77	78	79	80	PROBLEM			
		DSW		PROGRAMMER Baby values		DATE	PAGE BV

	C	OPERATION P R S	ADDRESS X R S	REMARKS
0	I	8	830	
1	10	SXD	2 F01	save m
2	19	LXD	4 607	2
3	28	CLA	81*	
4	37	SUB	4 82	
5	46	STA	X40	
6	55	STA	X37	
7	64	LXA	4 400	OBV ind.
0	I	CLA	2 M7	m
1	10	TPL	X17	
2	19	LXA	1 A04	CBC
3	28	7001	1 X53	
4	37	CLA	2 B4	CBC per
5	46	STO	F02	
6	55	1001	4 X30	
7	64	LXA	1 A05	1BV
0	I	7000	1 X53	
1	10	3001	1 X14	FBC per*
2	19	PXD	2	FBC right
3	28	PDX	1	
4	37	CLA	1 M5	m'
5	46	PAX	2	
6	55	CLA	1 B4	
7	64	STO	F02	2BV
0	I	FAD	2 B0	
1	10	TZE	X52	
2	19	STO	F03	
3	28	CLA	F02	
4	37	FSB	2 B0	
5	46	FDH	F03	
6	55	FMP	427	
7	64	FAD	2	3BV

	C	OPERATION P R S	ADDRESS X R S	REMARKS (830)
0	I	STO	2	BV
1	10	3000	4 X52	→ per
2	19	1001	1 X43	
3	28	3M07	1 X46	
4	37	CLA	1 M5	
5	46	TNZ	X52	
6	55	2001	2 X47	
7	64	LXA	1 I04	4BV
0	I	CLA	1 M3	PF right
1	10	1001	4 X27	
2	19	LXD	2 F01	
3	28	LXD	4 457	
4	37	TRA	4	1
5	46			
6	55			
7	64			5BV
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN			PROGRAMMER Bobby Flow	DATE	PAGE BF

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	833	
1	10	STZ	F01	CFim (mag BO)
2	19	LXA 1	M07	
3	28	LDQ 1	M7	↖
4	37	TQP	X06	
5	46	TRA	X11	
6	55	FMP 1	BO	
7	64	FAD	F01	0BF
0	I	STØ	F01	
1	10	2001 1	X03	↗
2	19	TSX 4	X54	
3	28	STØ	F03	
4	37	LDQ 1	M7	CFout (mag BY)
5	46	TQP	X23	↖
6	55	CLA 1	M5	
7	64	TZE	X23	1BF
0	I	FMP 1	BY	
1	10	FAD	F01	
2	19	STØ	F01	
3	28	2001 1	X14	↗
4	37	TSX 4	X54	
5	46	STØ	F04	
6	55	LDQ 1	M7	FFim (mag BO)
7	64	TQP	X35	2BF ↖
0	I	CLA 1	M5	
1	10	TZE	X35	
2	19	FMP 1	BO	
3	28	FAD	F01	
4	37	STØ	F01	
5	46	2001 1	X26	↗
6	55	TSX 4	X53	
7	64	STØ	F05	3BF

	C	OPERATION P R S	ADDRESS X R S	REMARKS (833)
	1	2 3 4 5	6 7 8 9	
0	I	LDQ 1	M7	FFout (mag BY)
1	10	TQP	X43	↖
2	19	TRA	X46	
3	28	FMP 1	BY	
4	37	FAD	F01	
5	46	STØ	F01	
6	55	2001 1	X40	↗
7	64	TSX 4	X53	4BF
0	I	STØ	F06	
1	10	LXD 4	457	
2	19	TRA 4	1	
3	28	1FO4 1	X54	Subroutine
4	37	LXA 2	A03	geo
5	46	CLA	F01	
6	55	7000 2	X64	
7	64	LDQ	F01	5BF
0	I	FMP 1	R1	R1
1	10	7001 2	X64	
2	19	LRS	43	
3	28	FMP 1	R1	
4	37	LRS	43	
5	46	FMP	T01	1/Dens
6	55	STZ	F01	
7	64	LXA 1	M07	6BF
0	I	TRA 4	1	
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			7BF

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	DSN	PROGRAMMER	Neutron balance	DATE		PAGE	NB

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	834	
1	10	CLA	P02	Add Let
2	19	ADD	Y01	
3	28	STØ	P02	
4	37	STZ	J05	Σcell
5	46	STZ	J06	Σsum
6	55	LXA /	J04	i
7	64	LDQ /	H1	ONB Eq.
0	I	FMP /	V0	V_i ↖
1	10	ADD	Y11	
2	19	LRS	43	
3	28	FMP /	NY	
4	37	FAD	J05	
5	46	STØ	J05	Cell
6	55	LDQ /	V0	
7	64	FMP /	S0	1NB
0	I	FAD	J06	
1	10	STØ	J06	Sum
2	19	2001 /	X07	
3	28	LDQ	J05	
4	37	FMP	J01	
5	46	STØ	J05	
6	55	LXA /	A04	CBC
7	64	7000 /	X34	2NB
0	I	CLA	F03	CFin
1	10	FAD	F04	
2	19	TPL	X36	
3	28	STØ	F04	
4	37	STZ	F07	
5	46	TRA	X42	
6	55	STØ	F07	
7	64	FAD	J06	3NB

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	STØ	J06	
1	10	STZ	F04	
2	19	LXA /	A05	FBC
3	28	7000 /	X50	
4	37	CLS	F05	FFin
5	46	FSB	F06	
6	55	TPL	X52	
7	64	SLW	F06	4NB
0	I	STZ	F10	
1	10	TRA	X56	
2	19	STØ	F10	
3	28	FAD	J06	
4	37	STØ	J06	
5	46	STZ	F06	
6	55	LXA /	S04	
7	64	7000 /	X64	5NB
0	I	CLS	F05	FBS
1	10	STØ	F10	
2	19	FAD	J06	
3	28	STØ	J06	
4	37	CLS	F04	NBcalc
5	46	FAD	F06	
6	55	STØ	J04	Leakage
7	64	FAD	J05	6NB
0	I	TNZ	X73	
1	10	LDQ	42 /	
2	19	TRA	X74	
3	28	FDH	J06	
4	37	STQ	J03	NBfactor
5	46	TRA 4	/	
6	55			
7	64			7NB

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				PROGRAMMER	DATE	PAGE
				DSN Scaling		5C

(635)

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	835	
1	10	LXD	2 607	
2	19	CLA	NOX	
3	28	SUB	2 N1	
4	37	STA	X13	
5	46	STZ	E01	
6	55	STZ	E02	
7	64	LXA	1 704	OSC ;
0	I	LDQ	1 V0	↖
1	10	FMP	1 H5	Temp. Vi
2	19	STQ	E03	
3	28	LDQ	1	N'
4	37	FMP	E03	
5	46	FAD	E01	
6	55	STQ	E01	
7	64	LDQ	1 N4	1SC N
0	I	FMP	E03	
1	10	FAD	E02	
2	19	STQ	E02	
3	28	2001	1 X10	↗
4	37	LDQ	T01	1/2 ains
5	46	FMP	E02	
6	55	FSB	T06	source
7	64	STQ	E03	2SC
0	I	TZE	X37	
1	10	FDH	T06	
2	19	CLS	440	10^{-4}
3	28	ADD	414	
4	37	TLQ	X41	
5	46	CLA	401	"shaky SC"
6	55	ORS	T10	
7	64	LDQ	421	3SC

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	TRA	X44	
1	10	CLA	E01	N'
2	19	FSB	T06	source
3	28	FDH	E03	
4	37	STQ	T02	S.f.
5	46	FMP	T01	
6	55	STQ	T14	
7	64	LXA	1 T04	4SC
0	I	LDQ	T14	Scale N ↑
1	10	FMP	1 N4	
2	19	STQ	1 N4	
3	28	2001	1 X50	↗
4	37	TRA	4	1
5	46			
6	55			
7	64			5SC
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	DSN	PROGRAMMER Inner Iterations		DATE	PAGE II

(836)

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	836	
1	10	LXD	2 G07	2
2	19	CLA	NO*	
3	28	SUB	2 N1	
4	37	STA	X14	
5	46	STA	X16	
6	55	STA	X20	NO adr
7	64	STA	X60	OII
0	I	LXD	2 T12	
1	10	STZ	F01	
2	19	LXA	1 I04	i
3	28	CLA	1 NY	
4	37	LDQ	1	NO
5	46	STQ	1 NY	
6	55	STQ	1	
7	64	3000	2 X22	1II
0	I	LDQ	1	(comp. E(iter)
1	10	FMP	P10	
2	19	FSB	1 NY	
3	28	SLM	F02	
4	37	LDQ	F02	
5	46	FMP	1 W0	
6	55	FAD	F01	
7	64	STQ	F01	2II
0	I	2001	1 X13	
1	10	FDH	T02	8 in MQ
2	19	CLA	G07	
3	28	ARS	22	
4	37	SUB	G02	
5	46	PAX	1	6. gr. ind.
6	55	CLA	P04	
7	64	7000	1 X42	3II

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	TLQ	X55	
1	10	TRA	X45	
2	19	TLQ	X53	6. gr.
3	28	LXA	1 T13	
4	37	3000	1 X53	NP ind. on
5	46	1001	2 X46	
6	55	SXD	2 T12	II ct
7	64	7040	2 X57	4II
0	I	CLA	401	
1	10	ORS	T07	ass. ind.
2	19	3000	1 X55	
3	28	STQ	P04	
4	37	STZ	T13	
5	46	STZ	T12	
6	55	TRA	4 2	
7	64	LXA	1 I04	5II
0	I	CLA	1	Mod. 50
1	10	FSB	1 NY	
2	19	LRS	43	
3	28	FMP	1 H5	Typ P.
4	37	FAD	1 50	
5	46	STQ	1 50	
6	55	2001	1 X60	
7	64	TRA	4 1	6II
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

FLOCO 704

77	78	79	80	PROBLEM		
DSN				PROGRAMMER Group print	DATE	PAGE GP

(837)

	C	OPERATION P	OPERATION R S	ADDRESS X	ADDRESS R S	REMARKS
0	I	8			837	
1	10		CLA		607	
2	19		LXD	1	607	g
3	28		ARS		22	
4	37		STØ		J01	
5	46		CLA		J03	NB fact.
6	55	7	001	1	X10	
7	64		FAD		P07	0GP
0	I		STØ		P07	
1	10	3	001	1	X16	
2	19		PSE		164	#4
3	28		TRA		X16	
4	37		CLA		402	Forced conv.
5	46		STØ		T07	
6	55		CLA		T07	
7	64		TZE		X32	1GP
0	I		CLA		F07	
1	10		STØ		J07	
2	19		CLA		F10	
3	28		STØ		J10	
4	37	3	001	1	X27	
5	46		TSX	4	974	
6	55	4			852	Gr. hdg
7	64		TSX	4	974	2GP
0	I	4	10	1	J00	
1	10		TRA		X41	
2	19		CLA		J07	err. ind.
3	28		ADD		J10	
4	37		TNZ		X37	
5	46		PSE		161	#1
6	55		TRA		X43	
7	64		TSX	4	975	3GP

	C	OPERATION P	OPERATION R S	ADDRESS X	ADDRESS R S	REMARKS
0	I	4	10	1	J00	
1	10		STZ		J07	
2	19		STZ		J10	
3	28		LXD	4	457	
4	37		TRA	4	1	
5	46					
6	55					
7	64					4GP

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	PROGRAMMER	DATE	PAGE
DSN	Summary & Subroutine		S19 (845) S5 (842)

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	845	
1	10	SXD	4 F02	
2	19	CLA	400	
3	28	STØ	F06	Zone #
4	37	LXD	1 T1*	
5	46	STZ	1 T0	Clear
6	55	2001	1 X05	T0, T2, S2
7	64	LXD	1 T3*	OSM
0	I	STZ	1 T2	
1	10	2001	1 X10	
2	19	LXD	1 S3*	
3	28	STZ	1 S2	
4	37	2001	1 X13	
5	46	TSX	4 844	T0, T2 calc
6	55	LXA	2 G03	
7	64	1004	2 X20	1SM
0	I	CLA	T2*	
1	10	SUB	2 T3	
2	19	STA	X26	
3	28	STA	X31	
4	37	LXA	1 G01	
5	46	CLA	400	Sum T2
6	55	FAD	1	
7	64	2001	1 X26	2SM
0	I	1601	1 X31	
1	10	STØ	1	
2	19	2001	2 X20	
3	28	TSX	4 843	S2-calc
4	37	TSX	4 974	Print
5	46	0 2		
6	55	0	863	Adv
7	64	0 1	1 E05	3SM

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	0	T2	
1	10	4	S2	
2	19	CLA	E06	
3	28	ADD	401	
4	37	PAX	1	
5	46	7 T02	1 X03	
6	55	LXD	4 E02	
7	64	TRA	4 1	4SM
0	I	8	842	G5 subroutine
1	10	SXD	1 G07	
2	19	LXA	1 G01	
3	28	STZ	E07	Sum T4
4	37	PXD	1	↖
5	46	SUB	G07	
6	55	ARS	22	
7	64	ADD	G04	0SS
0	I	TMI	X24	
1	10	PAX	4	
2	19	3 G05	4 X23	
3	28	7 G03	4 X24	
4	37	CLA	C0*	
5	46	SUB	1 C1	
6	55	SUB	2 C2	
7	64	STA	X20	1SS
0	I	CLA	4	
1	10	FAD	E07	
2	19	STØ	E07	↗
3	28	2001	1 X04	
4	37	LXD	1 G07	
5	46	LXD	4 457	
6	55	LDQ	E07	G5 (cont'd)
7	64	TRA	4 1	2SS

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	843	Mod TO
1	10	SXD 4	E03	
2	19	LXA 4	M03	mic specs
3	28	CLA 4	T0	
4	37	TZE	X35	
5	46	LRS		
6	55	PAX 2		
7	64	CLA	T0*	OSK
0	I	SUB 2	T1	
1	10	TQP	X14	
2	19	STA	X30	
3	28	TRA	X35	
4	37	STA	X32	
5	46	STA	X33	
6	55	CLA	A02	mo
7	64	SUB	403	1SK
0	I	TZE	X23	
1	10	CLA 4	P0	
2	19	TRA	X26	
3	28	LDQ 4	P4	
4	37	FMP	T05	
5	46	FAD 4	P0	
6	55	STQ	E04	C
7	64	LXA 1	601	2SK
0	I	LDQ 1		
1	10	FMP	E04	
2	19	FAD 1		
3	28	STQ 1		TO
4	37	2001 1	X30	
5	46	2001 4	X03	
6	55	LXA 4	G03	Calc S2
7	64	1002 4	X40	3SK

	C	OPERATION P R S	ADDRESS X R S	REMARKS (843)
	1	2 3 4 5	6 7 8 9	
0	I	CLA	S2*	
1	10	SUB 4	S3	
2	19	STA	XT0	
3	28	STA	XT1	(S2)
4	37	SXD 4	E04	
5	46	LXA 2	M02	m
6	55	CLA	T0*	
7	64	SUB 2	T1	4SK
0	I	STA	X53	
1	10	STA	X67	
2	19	LXA 1	G01	2
3	28	CLA 1		N
4	37	TZE	XT3	
5	46	7G03 4	X62	
6	55	7G03 4	X61	
7	64	TSX 4	842	5SK
0	I	TRA	X67	
1	10	LXA 4	G04	
2	19	CLA	C0*	
3	28	SUB 1	C1	
4	37	SUB 2	C2	
5	46	STA	X66	
6	55	LDQ 4		C
7	64	FMP 1		6SK N
0	I	FAD 2		
1	10	STQ 2		S2
2	19	LXD 4	E04	
3	28	2001 1	X53	
4	37	2001 2	X46	
5	46	2001 4	X40	
6	55	LXD 4	E03	
7	64	TRA 4	1	7SK

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	844	calc TO
1	10	SXD	4 F03	
2	19	LXA	1 G03	
3	28	1003	1 X04	9'
4	37	CLA	T2*	
5	46	SUB	1 T3	
6	55	STA	X31	N
7	64	STA	X32	0SL
0	I	SUB	G01	
1	10	SUB	401	
2	19	STA	X42	
3	28	STA	X43	Q
4	37	LXA	1 F04	1'
5	46	CLA	1 R7	zone #
6	55	SUB	F06	current #
7	64	TZE	X22	1SL
0	I	CLA	F06	
1	10	TNZ	X70	
2	19	LXA	2 G01	2
3	28	CLA	N0*	
4	37	SUB	2 N1	
5	46	STA	X26	
6	55	LDQ	1	NO
7	64	FMP	1 V0	2SL
0	I	STO	2 F7	
1	10	FAD	2	
2	19	STO	2	T2
3	28	CLA	S01	
4	37	TZE	X44	no DS
5	46	CLA	Q0*	
6	55	SUB	2 Q1	
7	64	STA	X40	3SL

	C	OPERATION P R S	ADDRESS X R S	REMARKS (844)
	1	2 3 4 5	6 7 8 9	
0	I	LDQ	1	Q0
1	10	FMP	1 V0	
2	19	FAD	2	
3	28	STO	2	
4	37	2001	2 X23	A
5	46	CLA	1 S7	spec #
6	55	PAX	2	
7	64	CLA	2 M3	4SL
0	I	PAX	4	mat #
1	10	CLA	T0*	
2	19	SUB	4 T1	
3	28	STA	X62	
4	37	STA	X63	
5	46	CAL	2 R3	
6	55	STO	F04	P
7	64	LXA	4 G01	5SL
0	I	LDQ	F04	
1	10	FMP	4 F7	
2	19	FAD	4	
3	28	STO	4	
4	37	2001	4 X60	
5	46	CLA	2 R3	
6	55	TMI	X70	
7	64	1001	2 X47	6SL
0	I	2001	1 X15	
1	10	LXA	4 G03	calc T2
2	19	1002	4 X73	
3	28	CLA	T2*	
4	37	SUB	4 T3	
5	46	STA	Y23	
6	55	STA	Y24	
7	64	SXD	4 F04	7SL

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	C	OPERATION P R S (2 3 4 5)	ADDRESS X (6)	ADDRESS R S (7 8 9)	REMARKS
0	I	LXA	2	M02	m
1	10	CLA		T0*	↖
2	19	SUB	2	T1	
3	28	STA		Y06	
4	37	STA		Y22	
5	46	LXA	1	G01	g
6	55	CLA	1		Ngm ↖
7	64	TZE		Y26	8SL
0	I	7603	4	Y15	
1	10	7603	4	Y14	
2	19	TSX	4	842	
3	28	TRA		Y22	
4	37	LXA	4	G04	gg
5	46	CLA		C0*	
6	55	SUB	1	C1	
7	64	SUB	2	C2	9SL
0	I	STA		Y21	
1	10	LDQ	4		
2	19	FMP	1		Ngm
3	28	FAD	1		
4	37	STØ	1		
5	46	LXD	4	E04	
6	55	2001	1	Y06	↗
7	64	2001	2	Y01	10SL ↗
0	I	2001	4	X73	↗
1	10	LXD	4	E03	
2	19	TRA	4	1	
3	28	9 1	4	Y11	
4	37				
5	46				
6	55				
7	64				11SL

	C	OPERATION P R S (2 3 4 5)	ADDRESS X (6)	ADDRESS R S (7 8 9)	REMARKS
0	I	9 1	4	X56	843 cont.
1	10	8	2	X02	
2	19	7000	4	X36	
3	28	TRA		X03	
4	37				
5	46				
6	55				
7	64				8SK
0					
1	10				
2	19				
3	28				
4	37				
5	46				
6	55				
7	64				
0					
1	10				
2	19				
3	28				
4	37				
5	46				
6	55				
7	64				
0					
1	10				
2	19				
3	28				
4	37				
5	46				
6	55				
7	64				

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	840	
1	10	CLA	P10	1
2	19	FSB	T10	10
3	28	STQ	E02	
4	37	CLA	T05	
5	46	FSB	T06	
6	55	STQ	E03	p - p0
7	64	SLW	E04	0 IN
0	I	FDH	E02	
1	10	STQ	P06	dp/dt (int. fact.)
2	19	LDQ	T05	Interp.
3	28	FMP	T10	
4	37	STQ	E05	
5	46	LDQ	T06	
6	55	FMP	P10	
7	64	FSB	E05	1 IN
0	I	FAD	E03	
1	10	FDH	E02	
2	19	STQ	E02	new p
3	28	CLA	T05	
4	37	LDQ	T06	
5	46	TLQ	X31	
6	55	STQ	E06	Mx
7	64	STQ	E05	2 IN Mn
0	I	TRA	X33	
1	10	STQ	E05	
2	19	STQ	E06	
3	28	CLA	E06	Mx
4	37	FAD	E04	1/1
5	46	LDQ	E02	new p
6	55	TLQ	X42	
7	64	STQ	E02	3 IN p mod

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	STZ	P06	
1	10	TRA	X51	
2	19	CLA	E05	Mn
3	28	FSB	E04	1/1
4	37	LRS	43	
5	46	CLA	E02	new p
6	55	TLQ	X51	
7	64	STQ	E02	4 IN p mod
0	I	STZ	P06	
1	10	CLA	T06	closest p0 ?
2	19	FSB	E02	
3	28	SLW	E03	
4	37	CLA	T05	
5	46	FSB	E02	
6	55	SSP		
7	64	LDQ	E03	5 IN
0	I	TLQ	X65	
1	10	CLA	T05	
2	19	STQ	T06	
3	28	CLA	P10	
4	37	STQ	T10	
5	46	CLA	E02	
6	55	STQ	T05	
7	64	TRA	4 1	6 IN
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I	8					84	1		
1	10		CL	A			T0	2		
2	19		ST	Ø			E0	1		
3	28		ST	Z			T0	2		
4	37		ST	Z			T0	3		
5	46		LX	A		3	40	1		i'
6	55		LX	A		4	60	1		g
7	64		CL	A			40	0		0WT
0	I		FA	D	1	N0				
1	10	1	T0	4	1	X1	2			
2	19	2	00	1	4	X1	0			
3	28		SL	N			E0	2		
4	37		LD	Q			E0	2		
5	46		FM	P	2	N0				
6	55		FA	D			T0	3		INN
7	64		ST	Ø			T0	3		1WT
0	I		LD	Q			E0	2		
1	10		FM	P	2	V4				
2	19		ST	Ø	2	N0				N:
3	28		LD	Q			E0	2		
4	37		FM	P	2	N0				
5	46		FA	D			T0	2		
6	55		ST	Ø			T0	2		INN'
7	64	1	00	1	2	X3	0			2WT
0	I		PX	D	2					
1	10		PD	X	1					
2	19	7	T0	4	2	X0	6			
3	28		LX	A	1	40	3			Move 1.
4	37		CL	A	1	P0	7			
5	46		ST	Ø	1	P1	0			
6	55	2	00	1	1	X3	4			
7	64		LX	D	4	45	7			3WT

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	I		CL	A			E0	1		
1	10		FD	H			T0	3		
2	19		ST	Q			P1	0		new 1
3	28		LX	A	1	40	3			
4	37		CL	A			T0	6		cont. and
5	46		TZ	E			X4	7		
6	55	2	00	2	1	X4	7			
7	64		CL	A	1	P1	0			4WT
0	I		FS	B	1	P0	7			
1	10		SS	P						
2	19		SU	B			T0	7		E(1)
3	28		TP	L	4			1		no comp.
4	37	2	00	1	1	X4	7			
5	46		CL	A			A0	2		no
6	55		TN	Z			X6	1		
7	64		CL	A			40	1		5WT
0	I		ST	Ø			P0	6		int. fac.
1	10		TR	A	4			2		→ FP, NP
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									6WT
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

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	C	OPERATION (P R S)		ADDRESS (X R S)	REMARKS
	1	2 3 4 5	6	7 8 9	
0	I	8	2	X04	(X62)
1	(10)	CLA		A02	
2	(19)	TZE		X05	
3	(28)	STZ		E02	
4	(37)	LXA	1	I04	
5	(46)	LDQ	1	V0	↑
6	(55)	FMP	1	F0	
7	(64)	FAD		E02	7WT
0	I	STQ		E02	↑
1	(10)	2001	1	X67	
2	(19)	LXD	1	N1X	
3	(28)	CLA	1	N0	↑
4	(37)	FDH		E02	
5	(46)	STQ	1	N0	↑
6	(55)	2001	1	X75	
7	(64)	CLA		E01	8WT
0	I	FDH		E02	
1	(10)	STQ		E01	
2	(19)	TRA		X05	
3	(28)	8	2	X42	
4	(37)	LXA	1	T07	
5	(46)	7000	1	X43	
6	(55)	TRA		X55	
7	(64)				9WT

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Row	C	P	R S	X	Address (R S)	Remarks
0	I	8			846	
1	(10)		SXD	4	E01	
2	(19)		LXA	1	T07	Conv. ind
3	(28)	7	000	1	X45	
4	(37)		TSX	4	974	Print
5	(46)	0	4			
6	(55)	0			860	hdg
7	(64)	0	1			0FP
0	I	0	10	1	P00	
1	(10)	0	2			
2	(19)	0			R7	
3	(28)	0			R1	
4	(37)	0			R2	
5	(46)	0			F0	
6	(55)	0			V0	
7	(64)	0			S7	1FP
0	I	0			R3	
1	(10)	0			M3	
2	(19)	0	2			
3	(28)	0			862	hdg
4	(37)	0	1			
5	(46)	4			N0	
6	(55)		TSX	4	845	SM
7	(64)		CLA		402	2FP
0	I		STØ		A06	
1	(10)		TSX	4	973	Punch
2	(19)	0	130	1	A00	
3	(28)	0			N0	
4	(37)	4			B1	
5	(46)		CLA		P01	
6	(55)		STØ		A06	
7	(64)		LXD	4	E01	3FP

Row	C	P	R S	X	Address (R S)	Remarks
0	I		LXA	1	T07	
1	(10)	7	001	1	X44	
2	(19)		STZ		T07	
3	(28)		HTR	4	1	
4	(37)		TRA	4	5	
5	(46)		TRA	4	1	
6	(55)					
7	(64)					4FP
0						
1	(10)					
2	(19)					
3	(28)					
4	(37)					
5	(46)					
6	(55)					
7	(64)					
0						
1	(10)					
2	(19)					
3	(28)					
4	(37)					
5	(46)					
6	(55)					
7	(64)					
0						
1	(10)					
2	(19)					
3	(28)					
4	(37)					
5	(46)					
6	(55)					
7	(64)					

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	847	
1	10	SXD	4 E01	
2	19	LXA	2 A02	no
3	28	CLA	P06	integr. fac.
4	37	TNZ	X20	
5	46	CLA	T10	1₀
6	55	TNZ	X16	
7	64	CLA	T05	ONP
0	I	LDQ	T06	Excl.
1	10	STQ	T05	
2	19	STØ	T06	
3	28	CLA	P10	
4	37	STØ	T10	1→1₀
5	46	TRA	X45	
6	55	TSX	4 840	Integr. Rtn
7	64	TRA	X45	1NP
0	I	CLA	T06	Cont. ind.
1	10	TNZ	X24	
2	19	CLA	401	
3	28	STØ	T06	
4	37	LXA	1 404	Final conv. test
5	46	CLA	1 P07	↖
6	55	FSB	421	
7	64	SSP		2NP
0	I	SUB	411	
1	10	SUB	T07	
2	19	TPL	X36	no ↗
3	28	2001	1 X25	
4	37	CLA	401	
5	46	STØ	T07	conv. ind
6	55	7000	2 X52	
7	64	CLA	421	3NP

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	FSB	P10	1 Extrap.
1	10	LRS	43	
2	19	FMP	P06	integr. fac.
3	28	FAD	T05	
4	37	STØ	T05	
5	46	CLA	401	
6	55	STØ	T13	NP ind.
7	64	LXD	4 E01	4NP
0	I	3003	2 X53	
1	10	3002	2 X54	
2	19	TRA	4 1	→FA
3	28	TRA	4 2	MG
4	37	TRA	4 3	MX
5	46			
6	55			
7	64			5NP
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	I	8	803	
1	10	TSX	4 976	STOMAP
2	19	TSX	4 805	NF
3	28	TSX	4 806	AX
4	37	TSX	4 810	MX
5	46	TSX	4 811	IP
6	55	TSX	4 812	MG
7	64	TSX	4 813	OFC GF
0	I	TSX	4 814	NS
1	10	TSX	4 815	FA ← Main loop
2	19	TSX	4 816	FR
3	28	TSX	4 817	MP
4	37	LXA	2 401	1→2
5	46	SXD	2 607	← C-loop
6	55	TSX	4 820	EZ
7	64	TSX	4 821	1FC EX
0	I	TSX	4 822	PL
1	10	TSX	4 823	ST
2	19	TSX	4 824	SZ
3	28	LXA	2 401	1→m
4	37	TSX	4 825	BC ← M-loop
5	46	TSX	4 826	PF
6	55	TSX	4 827	AF
7	64	TSX	4 830	2FC BV
0	I	100 1	2 X31	
1	10	TMI	2 X28	
2	19	TSX	4 833	BF
3	28	TSX	4 834	NB
4	37	TSX	4 835	SC
5	46	TSX	4 836	II
6	55	TRA	X23	
7	64	TSX	4 831	3FC JC

	C	OPERATION P R S	ADDRESS X R S	REMARKS (803)
	1	2 3 4 5	6 7 8 9	
0	I	TSX	4 837	GP
1	10	LXD	2 607	
2	19	100 1	2 X43	
3	28	760 1	2 X15	(SN: 840)
4	37	TSX	4 841	NT
5	46	TRA	X11	no comp.
6	55	TSX	4 846	FP (SN: 845)
7	64	TSX	4 847	4FC NP
0	I	TRA	X11	→FA
1	10	TRA	X06	MG
2	19	TRA	X04	MX
3	28	HPR	103	
4	37	TSX	4 970	
5	46			
6	55			
7	64			5FC
0				
1	10			
2	19			
3	28			
4	37			
5	46			
6	55			
7	64			

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	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	9	*					M	5		
1	10								0	
2	19								3	
3	28								2	
4	37	*					M	6		
5	46								0	
6	55	.	5	7	7	3	5	0	3	
7	64	.	5	7	7	3	5	0	3	0 5 2
0	9	*					M	7		
1	10	-	1	.						
2	19		5	7	7	3	5	0	3	
3	28	.	5	7	7	3	5	0	3	
4	37									
5	46									
6	55									
7	64									1 5 2
0	9	*					M	5		
1	10								0	
2	19								5	
3	28								4	
4	37								3	
5	46								2	
6	55	*					M	6		
7	64								0	0 5 4
0	9	.	7	7	4	5	9	6	7	
1	10	1	8	0	7	3	9	2	3	
2	19	1	8	0	7	3	9	2	3	
3	28	.	7	7	4	5	9	6	7	
4	37	*					M	7		
5	46	-	1	.						
6	55		7	7	4	5	9	6	7	
7	64		2	5	8	1	9	8	9	1 5 4

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0	9	.	2	5	8	1	9	8	9	
1	10	.	7	7	4	5	9	6	7	
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									2 5 4
0	9	*					M	5		
1	10								0	
2	19								9	
3	28								8	
4	37								7	
5	46								6	
6	55								5	
7	64								4	0 5 8
0	9								3	
1	10								2	
2	19	*					M	6		
3	28								0	
4	37	.	8	8	1	9	1	7	1	
5	46	2	3	9	3	7	7	5	0	
6	55	3	9	0	1	6	8	0	3	
7	64	3	9	0	5	6	3	3	0	1 5 8
0	9	3	9	0	5	6	3	3	0	
1	10	3	9	0	1	6	8	0	3	
2	19	2	3	9	3	7	7	5	0	
3	28	.	8	8	1	9	1	7	1	
4	37	*					M	7		
5	46	-	1	.						
6	55		8	8	1	9	1	7	1	
7	64		2	9	9	4	0	8	2	2 5 8

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	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9	377	9645	
1	10	125	9882	
2	19	.125	9882	
3	28	.377	9645	
4	37	.629	9408	
5	46	.881	9171	
6	55			
7	64			458
0	9	*	45	
1	10		0	
2	19		17	
3	28		16	
4	37		15	
5	46		14	
6	55		13	
7	64		12 05 16	
0	9		11	
1	10		10	
2	19		9	
3	28		8	
4	37		7	
5	46		6	
6	55		5	
7	64		4 15 16	
0	9		3	
1	10		2	
2	19	*	46	
3	28		0	
4	37	.939	3364	
5	46	-2692	7644	
6	55	4195	7027	
7	64	5448	1513	2516

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9	6450	1102	
1	10	7201	5793	
2	19	7202	5587	
3	28	7553	0484	
4	37	7553	0484	
5	46	7202	5587	
6	55	7201	5793	
7	64	6450	1023	3516
0	9	5448	1513	
1	10	4195	7027	
2	19	-2692	7644	
3	28	.939	3364	
4	37	*	47	
5	46	-1.		
6	55	939	3364	
7	64	814	0916	4516
0	9	688	8467	
1	10	563	6019	
2	19	438	3570	
3	28	313	1121	
4	37	187	8673	
5	46	062	6224	
6	55	.062	6224	
7	64	.187	8673	5516
0	9	.313	1121	
1	10	.438	3570	
2	19	.563	6019	
3	28	.688	8467	
4	37	.814	0916	
5	46	.939	3364	
6	55			
7	64			6516

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		DSN		PROGRAMMER Cylinder	DATE 52	PAGE 54

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9	*	M5	
1	10		0	
2	19		3	
3	28		2	
4	37	*	M6	
5	46		0	
6	55	. 2 8 8	6 7 5 2	
7	64	. 2 8 8	6 7 5 2	0 C 2
0	9	*	M7	
1	10	8	1 6 4 9 6 6	
2	19	5	7 7 3 5 0 3	
3	28	. 5	7 7 3 5 0 3	
4	37			
5	46			
6	55			
7	64			1 C 2
0	9	*	M4	
1	10	. 5	7 7 3 5 0 3	
2	19		2 R	
3	28			
4	37			
5	46			
6	55			
7	64			F C 2
0	9	*	M5	
1	10		0	
2	19		3	
3	28		2	
4	37		0	
5	46		8	
6	55		7	
7	64		6	0 C 4

	C	OPERATION P R S	ADDRESS X R S	REMARKS
	1	2 3 4 5	6 7 8 9	
0	9		5	
1	10	*	M6	
2	19		0	
3	28	. 1	7 4 0 7 7 6	
4	37	. 1	7 4 0 7 7 6	
5	46		0	
6	55	. 4	3 3 0 3 9 3	
7	64	1	8 4 5 4 4 9 4	1 C 4
0	9	1	8 4 5 4 4 9 4	
1	10	. 4	3 3 0 3 9 3	
2	19	*	M7	
3	28	4	9 2 3 6 5 9	
4	37	3	4 8 1 5 5 3	
5	46	. 3	4 8 1 5 5 3	
6	55	9	3 7 4 3 6 9	
7	64	8	6 6 0 7 8 7	2 C 4
0	9	3	5 8 7 4 1 5	
1	10	. 3	5 8 7 4 1 5	
2	19	. 8	6 6 0 7 8 7	
3	28			
4	37			
5	46			
6	55			
7	64			3 C 4
0	9	*	M4	
1	10	. 8	7 0 3 8 8 3	
2	19		2 R	
3	28	. 3	4 8 1 5 5 3	
4	37		4 R	
5	46			
6	55			
7	64			F C 4

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		DSN		PROGRAMMER Grimaldi		DATE	PAGE 56

	C	OPERATION P	R	S	ADDRESS X	R	S	REMARKS
	1	2	3	4 5	6	7	8 9	
0	9	*				145		
1	10						0	
2	19						3	
3	28						2	
4	37						0	
5	46						8	
6	55						7	
7	64						6	0C6
0	9						5	
1	10						0	
2	19						15	
3	28						14	
4	37						13	
5	46						12	
6	55						11	
7	64						10	1C6
0	9	*				146		
1	10						0	
2	19	.	124		0898			
3	28	.	124		0898			
4	37						0	
5	46	.	338		2686			
6	55	.	816		6526			
7	64	.	816		6526			2C6
0	9	.	338		2686			
1	10						0	
2	19	.	466		9486			
3	28	/	275		7273			
4	37	/	426		7600			
5	46	/	426		7600			
6	55	/	275		7273			
7	64	.	466		9486			3C6

	C	OPERATION P	R	S	ADDRESS X	R	S	REMARKS
	1	2	3	4 5	6	7	8 9	
0	9	*				147		
1	10			350		9820		
2	19			248		1796		
3	28	.	248		1796			
4	37			732		2786		
5	46			676		5372		
6	55			280		2309		
7	64	.	280		2309			4C6
0	9	.	676		5372			
1	10			966		8416		
2	19			933		8972		
3	28			683		6603		
4	37			350		2370		
5	46	.	350		2370			
6	55	.	683		6603			
7	64	.	933		8972			5C6
0	9	*				144		
1	10	.	936		3822			
2	19						2R	
3	28	.	681		0052			
4	37						4R	
5	46	.	255		3770			
6	55						6R	
7	64							FC6
0								
1	10							
2	19							
3	28							
4	37							
5	46							
6	55							
7	64							

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				PROGRAMMER	DATE	PAGE

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									

	C	OPERATION				ADDRESS				REMARKS
		P	R	S		X	R	S		
	1	2	3	4	5	6	7	8	9	
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
0										
1	10									
2	19									
3	28									
4	37									
5	46									
6	55									
7	64									
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1	10									
2	19									
3	28									
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7	64									
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4	37									
5	46									
6	55									
7	64									