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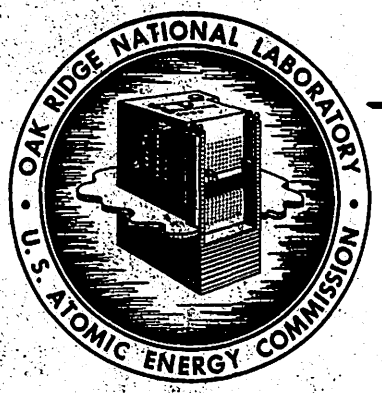
A CRYSTALLOGRAPHIC LEAST SQUARES REFINEMENT PROGRAM FOR THE IBM 704



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A CRYSTALLOGRAPHIC LEAST SQUARES REFINEMENT PROGRAM FOR THE IBM 704

By

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IDENTIFICATION

Symbolic decks OR XLS, OR XLS 1, 2, 3, 4, 5, 6.

Binary decks OR XLS A, B, C, D, E, F, G, H, J, K, L, M, N.

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GENERAL DESCRIPTION

OR XLS1-5 is a program for structure factor calculation and for the least squares refinement of crystal structures using X-ray or neutron diffraction data. The code is divided into five segments and the purpose of each will be described briefly:

OR XLS1 is the preliminary data processing segment. Its input data include the reciprocal cell parameters, the form factor tables (unless problem is a neutron one), and the data for each observation. The latter consist of the indices, the observed structure factor or its square, the estimated standard error of the observation, and an indication of which of several scale factors is to be applied. The output of this segment consists of a binary tape with the input data together with $(\sin \theta/\lambda)^2$ and the interpolated form factors for each reflection. The same information may also be put out in BCD form for off-line printing.

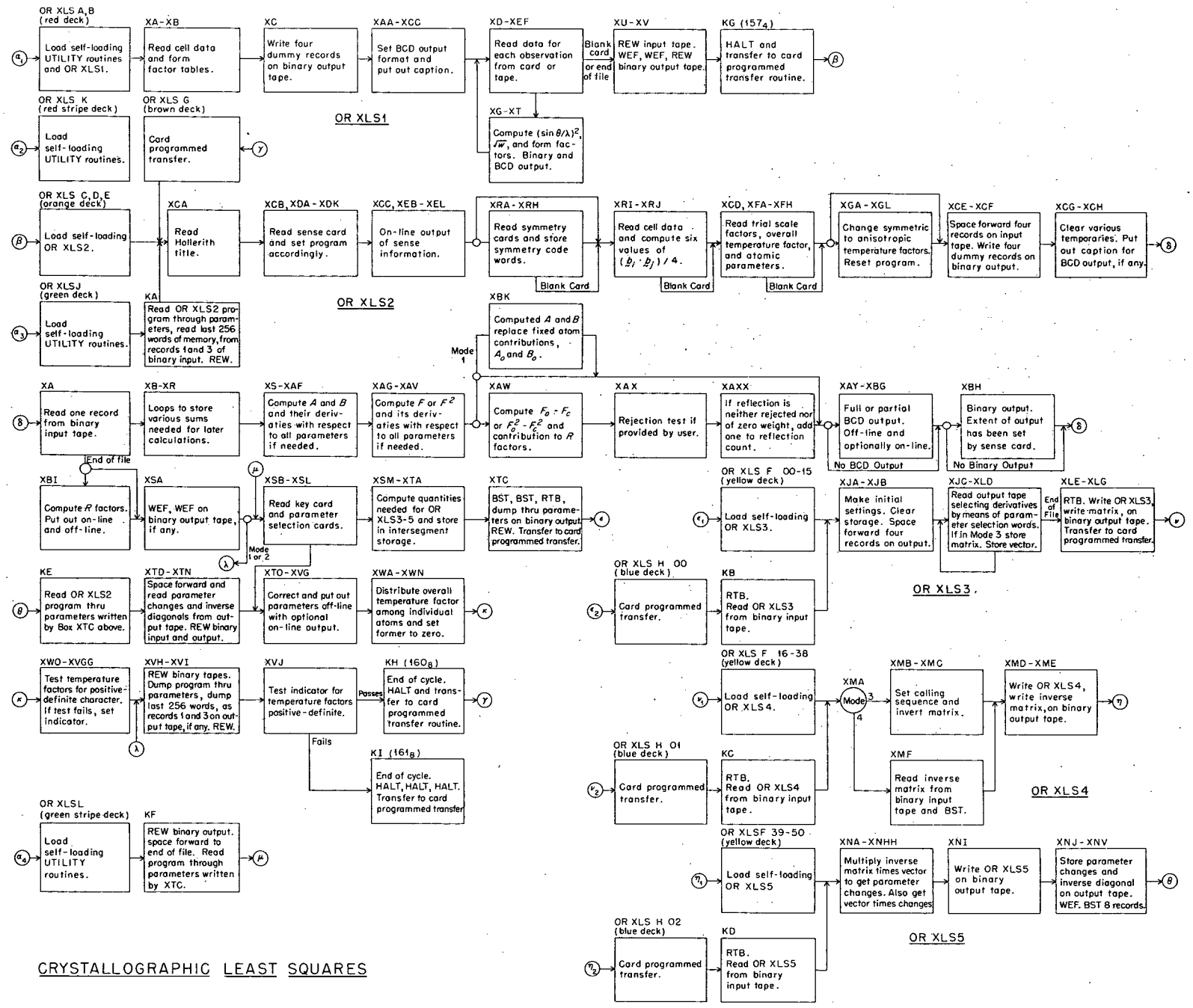
OR XLS2 is the main segment for least squares and structure factor calculations. Its input data consist of a sense card which specifies several options available to the user, symmetry information, reciprocal cell data, and trial parameters including an arbitrary number of scale factors, overall temperature factor coefficient, and, for each atom, the position parameters and one or six temperature factor coefficients. Also used as input is the binary tape from OR XLS1. The primary output of this segment when it is used for least squares is a binary tape on which are stored the derivatives of F_c or F_c^2 with respect to the parameters for each observation. The calculated structure factors may also be put out during this part of the calculation.

For a structure factor calculation this completes the problem. For least squares OR XLS2 calls for the input of parameter selection cards which specify the parameters to be adjusted. OR XLS3 then uses the derivatives from the binary output tape to set up the matrix and vector of the normal equations. OR XLS4 inverts this matrix, and OR XLS5 multiplies the resulting inverse by the vector to obtain the parameter changes.

Control is then returned to OR XLS2 which adjusts the parameters and puts them out off-line and optionally on-line.

During each cycle the input data for each reflection is copied onto the binary output tape as are the programs and input data for OR XLS2-5 so that this tape may serve as the main input for the next cycle.

An optional output of the matrix of the normal equations or its inverse is provided.



CRYSTALLOGRAPHIC LEAST SQUARES

MACHINE REQUIREMENTS

Minimum 704 with

1. 8192 word core storage or more
2. 3 on-line tape units
3. CAD instruction
4. Off-line tape printer.

CAPACITY

Core storage	Maximum number of parameters varied simultaneously
8,192	120
16,384	175
32,768	251

MATHEMATICAL METHOD

In this section the details of the computation will be briefly outlined.

OR XLS1

For each reflection this segment computes

$$\rho = (\sin\theta/\lambda)^2 = (.25)(h^2a^{*2} + k^2b^{*2} + \ell^2c^{*2} + 2hka^*b^*\cos\gamma^* + 2h\ell a^*c^*\cos\beta^* + 2k\ell b^*c^*\cos\alpha^*)$$

where a^*, b^*, c^*, $\cos\alpha^*$, $\cos\beta^*$, and $\cos\gamma^*$ are the reciprocal cell constants and h, k, and ℓ are the indices of the reflection.

Also computed for each reflection is $\sqrt{w} = 1/\sigma$ where σ is the standard error of the observed $|F|$ or F^2, whichever is being refined, and w is the least squares weight of the observation. (If $\sigma = 0$ the program sets $\sqrt{w} = 0.$)

For X-ray problems the atomic form factors for each observation are obtained by linear interpolation in the form factor tables which are stored at intervals of 0.05 in $\sin\theta/\lambda$.

The fixed atom contributions, A_o and B_o, (see below) are set at zero.

OR XLS2

Included in the data for this segment are the r scale factors s_q, overall temperature factor coefficient T_o, and the individual atom parameters. The latter are f_i, x_i, y_i, z_i, and T_i if symmetric temperature factors are to be used or f_i, x_i, y_i, z_i, β_{11i}, β_{22i}, β_{33i}, β_{12i}, β_{13i}, and β_{23i} for anisotropic temperature factors. For X-ray work f_i is an integer which indicates which form factor is to be used, while for neutron work it is the scattering factor itself.

If the sense card indicates that symmetric temperature factors are to be converted to anisotropic form the routine computes for each atom

$$\beta_{11i} = T_{ia}{}^{*2}/4$$
$$\beta_{12i} = T_{ia}{}^{*}b^{*}\cos\gamma^{*}/4$$
etc.,

relocates the parameters in anisotropic form, and resets the program on this basis.

The expressions for the scaled structure factor or its square and the derivatives of these with respect to the parameters are summarized in the following table:

	Centrosymmetric with origin at symmetry center	Acentric
(s_qF)	$2s_q \exp(-T_o\rho)A$	$s_q \exp(-T_o\rho)(A^2 + B^2)^{1/2}$
$\partial(s_qF)/\partial s_q$	$(s_qF)/s_q$	$(s_qF)/s_q$
$\partial(s_qF)/\partial T_o$	$-\rho(s_qF)$	$-\rho(s_qF)$
$\partial(s_qF)/\partial p$	$2s_q \exp(-T_o\rho)(\partial A/\partial p)$	$s_q \exp(-T_o\rho)(A^2 + B^2)^{-1/2}\left[A(\partial A/\partial p) + B(\partial B/\partial p)\right]$
$(s_qF)^2$	$4s_q{}^2 \exp(-2T_o\rho)A^2$	$s_q{}^2 \exp(-2T_o\rho)(A^2 + B^2)$
$\partial(s_qF)^2/\partial s_q$	$2(s_qF)^2/s_q$	$2(s_qF)^2/s_q$
$\partial(s_qF)^2/\partial T_o$	$-2\rho(s_qF)^2$	$-2\rho(s_qF)^2$
$\partial(s_qF)^2/\partial p$	$8s_q{}^2 \exp(-2T_o\rho)A(\partial A/\partial p)$	$2s_q{}^2 \exp(-2T_o\rho)\left[A(\partial A/\partial p) + B(\partial B/\partial p)\right]$

Here F is the structure factor, s_q is the scale factor, T_o is the overall temperature factor coefficient, ρ is $\sin^2\theta/\lambda^2$, A and B are the real and imaginary components of the structure factor, and p is any individual atom parameter.

The expressions for A and B and their derivatives are summarized as follows:

	Symmetric temperature factor	Anisotropic temperature factor
A	$A_o + \sum_i f_i \exp(-T_i\rho) \sum_j \cos_{ij}$	$A_o + \sum_i f_i \sum_j \exp_{ij}\cos_{ij}$
B	$B_o + \sum_i f_i \exp(-T_i\rho) \sum_j \sin_{ij}$	$B_o + \sum_i f_i \sum_j \exp_{ij}\sin_{ij}$
$\partial A/\partial f_i$	$\exp(-T_i\rho) \sum_j \cos_{ij}$	$\sum_j \exp_{ij}\cos_{ij}$
$\partial B/\partial f_i$	$\exp(-T_i\rho) \sum_j \sin_{ij}$	$\sum_j \exp_{ij}\sin_{ij}$

	Symmetric temperature factor	Anisotropic temperature factor
$\partial A/\partial T_i$	$-\rho f_i \exp(-T_i\rho) \sum_j \cos_{ij}$	-----
$\partial B/\partial T_i$	$-\rho f_i \exp(-T_i\rho) \sum_j \sin_{ij}$	-----
$\partial A/\partial x_i$	$-2\pi f_i \exp(-T_i\rho) \sum_j h'_j \sin_{ij}$	$-2\pi f_i \sum_j h'_j \exp_{ij} \sin_{ij}$
$\partial B/\partial x_i$	$2\pi f_i \exp(-T_i\rho) \sum_j h'_j \cos_{ij}$	$2\pi f_i \sum_j h'_j \exp_{ij} \cos_{ij}$
$\partial A/\partial \beta_{12i}$	-----	$-f_i \sum_j (2hk)'_j \exp_{ij} \cos_{ij}$
$\partial B/\partial \beta_{12i}$	-----	$-f_i \sum_j (2hk)'_j \exp_{ij} \sin_{ij}$

Here the subscripts i and j refer to the various atoms in the asymmetric unit and to the different equivalent positions, respectively. The terms $\cos_{ij}$, $\sin_{ij}$, and $\exp_{ij}$ are the trigonometric contributions and the anisotropic temperature factor of atom i in equivalent position j. The expressions h'_j and $(2hk)'_j$ are representative of the transformed indices and index products. All of these terms are discussed in detail in the section on Symmetry Considerations.

T_i and f_i are the symmetric temperature factor coefficient and scattering factor, respectively, of atom i. A_o and B_o are the contributions to A and B of fixed atoms, i.e., atoms not represented in the parameter table, and which are therefore not to be adjusted by the least squares procedure. For each reflection these terms are taken from the binary input tape, and they will be zero unless they have been computed using mode 1. Mode 1 is in every way similar to a structure factor calculation except that initially A_o and B_o are set to zero and finally they are set to equal to computed A and B. These computed values are then copied from tape to tape during the various least squares or structure factor computations until they are replaced by a new mode 1 calculation.

The program does the computation for each reflection in three steps. First the sums over j are accumulated. These are then converted to the derivatives of A and B with respect to the atomic parameters, and A and B are obtained. Finally the scaled structure factor or its square and the derivatives of this quantity

are computed. In determining which expressions to evaluate the program considers whether derivatives are needed or not, whether centrosymmetric or acentric computation is specified on the sense card, and whether the temperature factors are symmetric or anisotropic. Note that, except for the above restrictions, the program evaluates and stores on the binary output tape derivatives with respect to all the parameters regardless of which ones are to be varied.

A mode of operation (mode 4) is available in which the derivatives are not computed but rather are copied from the input tape where they were stored on a previous cycle. It is possible that this mode of operation will permit the running of several cycles in a minimum amount of time.

The following table gives the expressions for Δ, the difference between the observed and calculated structure factors or their squares, and for the various discrepancy factors which are computed while the structure factors and derivatives are being obtained.

	Refining of F	Refining on F^2
Δ	$\left[(\text{sign of } s_qF)\lvert F_o\rvert\right] - s_qF$	$F_o^2 - (s_qF)^2$
R	$\sum \lvert\Delta\rvert \,/\, \sum \lvert F_o\rvert$	$\sum \lvert\Delta\rvert \,/\, \sum \lvert F_o^2\rvert$
Weighted R	$\sqrt{\sum (\sqrt{w}\,\Delta)^2} \,/\, \sqrt{\sum (\sqrt{w}\,F_o)^2}$	$\sqrt{\sum (\sqrt{w}\,\Delta)^2} \,/\, \sqrt{\sum (\sqrt{w}\,F_o^2)^2}$
Error of fit	$\sqrt{\sum (\sqrt{w}\,\Delta)^2} \,/\, \sqrt{(m-n)}$	$\sqrt{\sum (\sqrt{w}\,\Delta)^2} \,/\, \sqrt{(m-n)}$

For the two R factors the summations are made both over all observations and over all non-zero observations. For the error of fit the summation is made over all reflections used in the least squares refinement, i.e., those with non-zero weight which pass the rejection test (if such a test is supplied by the user). The number of such observations is m and the number of parameters adjusted is n. (Before any refinement has been performed the program considers that n = 0.) These discrepancy factors refer, of course, to the input parameters.

Δ and $\sqrt{w}\,\Delta$ are put out with the structure factors under the headings OBS-CALC and (OBS-CALC)/SIGMA, respectively. Reflections for which the latter is greater than 2 (the constant stored at C7) are marked with a double asterisk (**).

OR XLS3

The function of this segment is to store the matrix $\underset{\sim}{a}$ and the vector $\underset{\sim}{v}$ of the normal equations. The elements of these are

$$a_{ij} = \sum(\sqrt{w}\, D_i)(\sqrt{w}\, D_j)$$

$$v_i = \sum(\sqrt{w}\, D_i)(\sqrt{w}\, \Delta)$$

where the summations are over the un-rejected observations of non-zero weight. For each reflection the n derivatives, D_i, are selected from the binary output tape and correspond to those parameters which are to be adjusted.

When operating in mode 4 only the vector $\underset{\sim}{v}$ is computed.

OR XLS4

This segment produces the inverse matrix $\underset{\sim}{b} = \underset{\sim}{a}^{-1}$ by a method to be described elsewhere (SHARE ROUTINE OR-SMI).

When mode 4 is specified the program copies the inverse matrix of the previous cycle from the binary input tape instead of inverting the matrix. In either case the resulting inverse is copied onto the binary output tape for use in the next cycle if needed.

OR XLS5

In this segment the parameter changes $\Delta p_i = \sum_j b_{ij} v_j$ are computed and stored on the binary output tape along with the diagonal elements b_{ii} of the inverse matrix. Also computed is $\sum_i \Delta p_i v_i$, the estimated decrease of $\sum(\sqrt{w}\, \Delta)^2$ produced by these parameter changes.

OR XLS2

Control is then returned to this segment and an estimated new value of the standard error of fit,

$$\sqrt{\left[\sum(\sqrt{w}\, \Delta)^2 - \sum_i \Delta p_i v_i\right]} \Big/ \sqrt{(m-n)},$$

is computed. The parameters p_i are corrected by Δp_i and their standard errors computed as

$$\sigma(p_i) = \sqrt{b_{ii}}\ \sqrt{\left[\sum(\sqrt{w}\, \Delta)^2 - \sum_i \Delta p_i v_i\right]}.$$

At this point the program puts out the old and new parameters with the parameter changes and standard errors for those which have been adjusted.

If the overall temperature factor T_o is not zero the program now adds it to the individual atom temperature factors so that $T_i' = T_i + T_o$ for symmetric temperature factors or

$$\beta_{11}' = \beta_{11} + T_o\, a^{*2}/4$$
$$\beta_{12}' = \beta_{12} + T_o\, a^*b^*\cos\gamma^*/4$$
etc.

for anisotropic temperature factors. T_o is then set to zero. These operations are performed so that the temperature factor coefficients may be tested for positive definite character as described below. Note that the result is not strictly correct if fixed atom contributions are used so that it is probably desirable to hold T_o at zero in this case.

The temperature factor coefficients are then tested to insure that the following conditions hold. For symmetric temperature factors:

$$T_i \geq +0.$$

For anisotropic temperature factors:

$$\beta_{11} \geq +0,\ \beta_{22} \geq +0,\ \beta_{33} \geq +0,$$
$$\begin{vmatrix} \beta_{22} & \beta_{23} \\ \beta_{23} & \beta_{33} \end{vmatrix} \geq +0,\quad \begin{vmatrix} \beta_{11} & \beta_{13} \\ \beta_{13} & \beta_{33} \end{vmatrix} \geq +0,\quad \begin{vmatrix} \beta_{11} & \beta_{12} \\ \beta_{12} & \beta_{22} \end{vmatrix} \geq +0,$$
$$\begin{vmatrix} \beta_{11} & \beta_{12} & \beta_{13} \\ \beta_{12} & \beta_{22} & \beta_{23} \\ \beta_{13} & \beta_{23} & \beta_{33} \end{vmatrix} \geq +0.$$

Failure of one of these tests means that the coefficients do not represent physical reality. The use of these parameters in subsequent calculations may cause a programmed stop indicating a negative argument for the temperature factor. When a test fails the program prints out an indication of this failure, and at the end of the calculation the programmed stop is at KI rather than at KH.

SYMMETRY CONSIDERATIONS

General positions

OR XLS2 computes structure factors or their squares in one of the following ways:

$$\left.\begin{aligned} s_qF &= 2s_q\exp(-T_o\rho)\,A \\ (s_qF)^2 &= 4s_q^2\exp(-2T_o\rho)\,A^2 \end{aligned}\right\}\ \text{Centrosymmetric, origin at center}$$

$$\left.\begin{aligned} s_qF &= s_q\exp(-T_o\rho)\,(A^2 + B^2)^{1/2} \\ (s_qF)^2 &= s_q^2\exp(2T_o\rho)\,(A^2 + B^2) \end{aligned}\right\}\ \text{Acentric}$$

Here s_q is the scale factor, T_o is the overall temperature factor coefficient, and ρ is $(\sin\theta/\lambda)^2$.

A and B are computed in space groups P1 or $P\bar{1}$ as follows:

$$A = A_o + \sum_i f_i \exp(-T_i\rho) \sum_j \exp_{ij}\cos_{ij}$$

$$B = B_o + \sum_i fi \exp(-T_i\rho) \sum_j \exp_{ij}\sin_{ij}$$

Here A_o and B_o are fixed atom contributions which may have been computed previously or which may be zero. The subscript i refers to the different atoms in the asymmetric unit while the subscript j refers to the symmetrically equivalent positions to which each ith atom may be transformed. (In the centrosymmetric case j numbers only half the equivalent positions). T_i and f_i are the symmetric temperature factor coefficient and the form factor for each atom. The terms $\cos_{ij}$ and $\sin_{ij}$ are the trigonometric contributions of the ith atom transformed to the jth equivalent position, and $\exp_{ij}$ is the anisotropic temperature factor for this atom. OR XLS2 sets either $\exp(-T_i\rho)$ or $\exp_{ij}$ at unity depending on which kind of temperature factor is to be used.

The trigonometric contribution $\cos_{ij}$ could be computed as

$\cos_{ij} = \cos 2\pi(hx'_{ij} + ky'_{ij} + \ell z'_{ij})$ with a similar expression for $\sin_{ij}$. Here h, k, and ℓ are the indices and x'_{ij}, y'_{ij}, and z'_{ij} are the coordinates of the ith atom in the asymmetric unit transformed (as indicated by the primes) to the jth equivalent position. OR XLS2 does not do this, however. Instead of transforming the coordinates, the indices h, k, and ℓ are transformed in a way which makes the result identical with the above:

$\cos_{ij} = \cos 2\pi(h'_j x_i + k'_j y_i + \ell'_j z_i + t_j)$ with a similar expression for $\sin_{ij}$. Here x_i, y_i, and z_i are the (untransformed) coordinates for the ith atom in the asymmetric unit, h'_j, k'_j, and ℓ'_j are the transformed indices, and t_j is a translational term. As an example we will illustrate the transformations used for the general positions of space group $C3_22$.

j	x'_j	y'_j	z'_j	h'_j	k'_j	ℓ'_j	t_j
1	x	y	z	h	k	ℓ	0
2	x-y	-y	-z	h	-h-k	$-\ell$	0
3	y-x	-x	1/3 + z	-h-k	h	ℓ	$\ell/3$
4	-x	y-x	1/3 - z	-h-k	k	$-\ell$	$\ell/3$
5	-y	x-y	2/3 + z	k	-h-k	ℓ	$2\ell/3$
6	y	x	2/3 -z	k	h	$-\ell$	$2\ell/3$

Substitution of these quantities in the two expressions for $\cos_{ij}$ will give identical results.

OR XLS2 permits this symmetry to be introduced in one of two ways: (1) A generalized symmetry routine is used which takes its instructions from symmetry cards which are supplied as data. There is one such card for each j value, and it consists of a statement of the coordinate transformations (as in the left half of the above table). The program then automatically performs the transformations on the indices which are equivalent to the coordinate transformations specified. (2) The user may elect to write his own symmetry routines to transform the indices. Specifications for such routines will be given below. It may be expected that some speed will be gained in this way.

The anisotropic temperature factor, exp_{ij}, is handled similarly. The fundamental expression is

$$exp_{ij} = exp\left\{-\left[h^2\beta'_{11_{ij}} + k^2\beta'_{22_{ij}} + \ell^2\beta'_{33_{ij}} + 2hk\beta'_{12_{ij}} + 2h\ell\beta'_{13_{ij}} + 2k\ell\beta'_{23_{ij}}\right]\right\}$$

where $\beta'_{11_{ij}}$, etc. are the six temperature factor coefficients for the ith atom of the asymmetric unit transformed to the jth equivalent position. Again the program makes the computation by transforming the index products rather than the coefficients themselves so that

$$exp_{ij} = exp\left\{-\left[(h^2)'_j\beta_{11_i} + (k^2)'_j\beta_{22_i} + (\ell^2)'_j\beta_{33_i} + (2hk)'_j\beta_{12_i} + (2h\ell)'_j\beta_{13_i} + (2k\ell)'_j\beta_{23_i}\right]\right\}.$$

Here $(h^2)'_j$, etc. are the transformed index products which make the two expressions identical.

Rules for obtaining the transformed coefficients $\beta'_{11_{ij}}$, etc. for any space group have been given by H. A. Levy (Acta Cryst. (1956) 9, 679). From these rules it may be deduced that for atoms in general positions $(h^2)'_j = (h'_j)^2$, etc. so that the transformed index products are simply the products of the transformed indices. This is not necessarily true for atoms in special positions, however. The generalized symmetry routine of OR XLS2 computes the products of transformed indices and assumes that $(h^2)'_j = (h'_j)^2$, etc., and therefore the computed anisotropic temperature factor may not be valid for atoms in special positions.

Cells with translational symmetry (centering)

The specification of symmetry in the case of face, end, or body centered cells can be simplified (and the computing time reduced) provided that the reflections which are extinguished by centering are not computed. Similar considerations apply to a rhombohedral cell described by hexagonal coordinates.

In these cases, symmetry cards or routines need be supplied only for positions not related by translation. The scattering factors should then be multiplied by the appropriate integer in the way described below (page 14).

Special positions

We must now consider the ways of handling the computation when atoms are in special positions. The important effects of an atom being in special positions are (a) that the number of these atoms is smaller than if they were in general positions, (b) that there are certain restrictions on the position parameters, and (c) that there may be some restrictions on the anisotropic temperature factor coefficients. No restrictions on symmetric temperature factors are introduced, however.

The ways of handling special positions with OR XLS2 depend on several factors: (1) whether all the atoms are in the same kind of special position, (2) whether the position parameters have a fixed value or whether there is a relationship between two or more coordinates, (3) whether anisotropic temperature factors are used or not, and (4) if used, whether there are (a) no restrictions on the coefficients, (b) certain coefficients fixed at zero, or (c) a relationship between two or more coefficients. H. A. Levy (loc. cit.) has given a rule for determining the restrictions on the anisotropic temperature factor coefficients of atoms in special positions.

Fixed parameters. When coordinates or temperature factor coefficients have fixed values then these values may be put into the list of trial parameters. The parameter selection words are then written so that these parameters are not varied. The symmetry cards are written for the general positions so that anisotropic temperature factors are correctly computed.

Symmetry cards for special positions. If all atoms are in the same kind of special position, and if anisotropic temperature factors are not used, then the correct result will be obtained by using symmetry cards for the special positions. For example, the space group $C3_22$ mentioned above has special positions for y = x, z = 1/3 with the transformations:

j	x'_j	y'_j	z'_j
1	x	x	1/3
2	0	-x	2/3
3	-x	0	0

This information can be punched on three symmetry cards instead of using the six general positions as data. All coordinates y and z in the parameter input are then irrelevant, and no attempt must be made to vary them.

Writing special patches. It is possible to handle any symmetry situation which can arise by using symmetry cards for the general positions, allowing the generalized symmetry routine to compute the transformed indices and the index products which would be valid for these general positions, and then transferring to a specially written section of code which modifies these transformed indices appropriately. Consider, for example, the special positions mentioned above. The generalized symmetry routine alone would produce the trigonometric argument

$$h'_j x_i + k'_j y_i + \ell'_j z_i + t_j .$$

Now let us make x_i the independent variable and require that $y_i = x_i$, $z_i = 1/3$. Substituting in the argument we have

$$h'_j x_i + k'_j x_i + \ell'_j/3 + t_j .$$

Now the program will produce this result if we replace h'_j by $h''_j = h'_j + k'_j$, k'_j by $k''_j = 0$, ℓ'_j by $\ell''_j = 0$, and t_j by $t'_j = t_j + \ell'_j/3$. Instructions for programming such a patch will be given below. The parameters y and z will again be irrelevant and must not be varied.

The restrictions on the anisotropic temperature factor coefficients may be handled in a similar way. For the atoms in the above example, Levy's rule shows that $\beta_{22} = \beta_{11}$, $\beta_{23} = -\beta_{13}$. Taking β_{11} and β_{13} as independent the required transformations are:

$$(h^2)''_j = (h^2_j)' + (k^2_j)'$$

$$(k^2)''_j = 0$$

$$(\ell^2)''_j = (\ell^2)'_j$$

$$(2hk)''_j = (2hk)'_j$$

$$(2h\ell)''_j = (2h\ell)'_j - (2k\ell)'_j$$

$$(2k\ell)_j = 0$$

Again β_{22} and β_{23} are irrelevant and must not be varied. It is desirable, however, after the parameters have been adjusted to reset $\beta_{22} = \beta_{11}$ and $\beta_{23} = -\beta_{13}$. This is necessary if the test for positive definite temperature factor coefficients is to be valid. Specifications for the code patch to do this resetting are given below.

Note that there is no reason why a combination of the fixed parameter and special patch methods may not be used. In the above example the z parameters could be fixed at 1/3 while the patch handles the y = x restriction. Note also that it may be possible to choose a coordinate system which simplifies the restrictions on the parameters.

Correcting the number of atoms. The program as written always sums over all the equivalent positions as specified by the symmetry cards. Thus the effective number of times an atom is included is equal to the number of symmetry cards (or the number of user's symmetry routines) for acentric structures and twice that number for centrosymmetric structures. If the symmetry cards (or routines) describe the general positions then atoms in special positions may be put in correctly by scaling their scattering factors by the appropriate integer. In the X-ray case this may be done when the form factor tables are prepared, and in the neutron case the scattering factor in the parameter table is adjusted. When the symmetry cards are written for the special positions directly then no modification of the scattering factor is necessary.

Specifications for user's symmetry routines

1. Entry at XD1. OR XLS2 automatically transfers to XD1 if sense card specifies "symmetry routine supplied by user".
2. Write μ routines where μ is the number of equivalent positions for acentric computation or one half this number for centrosymmetric computation.
3. The program transfers to XD1 μ times for each reflection and the user must arrange to enter each of his routines once per reflection. For this purpose Index 4 contains μ, μ-1, μ-2 ..... 1 on the first and subsequent entries.
4. The indices (floating point) of the reflection are found at M1, M2, and M3 (see program listing for addresses).
5. The jth routine must store t_j, h'_j, k'_j, and ℓ'_j (floating point) at T12-T15.
6. If anisotropic temperature factors are to be used the routine must also store $(h^2)'_j$, $(k^2)'_j$ .... $(2k\ell)'_j$ (floating point) at T16-T21.
7. OR XLS2 does not destroy the transformed indices so that subsequent entries may make use of the values previously obtained.
8. Index 2 is available. If indices 1 or 4 are used they must be saved and restored.
9. Return to XE.
10. Set the address in T5 to that of the last location used by the symmetry routines or other additions to the code.
11. Assemble routines and insert in the binary deck between OR XLSD and OR XLSE.
12. On the Sense Card specify that user's symmetry routines are to be used.

The following example illustrates the symmetry routines for space group $C3_22$ using symmetric temperature factors. The required transformations have been tabulated above.

```
          REM       EXAMPLE ØF USERS SYMMETRY ROUTINES
          ØRG       (Fill in address)
T5        PZE       THIRD                          LAST ADDRESS USED
XD1       TRA       A, 4                           ENTRY
          TRA       A
          TRA       B
          TRA       C
          TRA       D
          TRA       E
          TRA       F
A         STZ       TJ
          LXA       I3, 2
A1        CLA       H + 3, 2
          STØ       HJ + 3, 2
          TIX       A1, 2, 1
          TRA       XE
B         CLS       H
          FSB       K
          STØ       KJ
          CLS       L
          STØ       LJ
          TRA       XE
C         CLA       KJ
          STØ       HJ
          CLA       H
          STØ       KJ
          LDQ       L
          STQ       LJ
          FMP       THIRD
          STØ       TJ
          TRA       XE
D         CLA       K
          STØ       KJ
          CLS       L
          STØ       LJ
          TRA       XE
E         CLA       HJ
          STØ       KJ
          CLA       K
          STØ       HJ
          CLA       L
          STØ       LJ
          CLA       TJ
          FAD       TJ
          STØ       TJ
          TRA       XE
F         CLA       K
          STØ       HJ
          CLA       H
          STØ       KJ
          CLS       L
          STØ       LJ
          TRA       XE
```

```
THIRD    DEC     0.333333
H        EQU                    M1
K        EQU                    M2
L        EQU                    M3
TJ       EQU                    T12
HJ       EQU     (Fill in       T13
KJ       EQU      addresses)    T14
LJ       EQU                    T15
I3       EQU
XE       EQU
         END     0
```

Specifications for patch to handle special positions.

1. Insert a transfer at XI.
2. Patch is probably located somewhere after T5 at end of program. XD1 has no significance if general symmetry routine is used.
3. The program reaches XI ν times for each of the μ values of j. Here ν is the number of atoms in the asymmetric unit and μ is the number of symmetry cards. At each of the ν entries for a given j index 4 contains i = ν, ν - 1, ν - 2, ...2,1.
4. Before reaching XI with a new j value the transformed indices t_j, h'_j, k'_j, and ℓ'_j have been stored in locations T12-T15 by the generalized symmetry routine in accordance with the symmetry cards. If anisotropic temperature factors are specified then the products of these transformed indices, $(h'_j)^2$, $(k'_j)^2$, ... $2(h'_j)(\ell'_j)$, and $2(k'_j)(\ell'_j)$, have been stored in locations T16-T21.
5. The patch must modify these transformed indices according to the restrictions placed on the parameters by having atoms in special positions. Note that on subsequent entries for a given j value the transformed indices have not been changed but are as they were at the previous exit from the patch. Only when the value of j changes is the generalized symmetry routine re-entered. At this time the transformed indices and products are reset according to the next symmetry card.
6. If any index registers are used they must be saved and restored.
7. Return to XI + 1.
8. Set the address in T5 to that of the last location used by the patch or any other additions.
9. Assemble the patch and insert in the binary deck between OR XLSD and OR XLSE.
10. On the sense card specify that the generalized symmetry routine is to be used (unless user's routines have also been written).

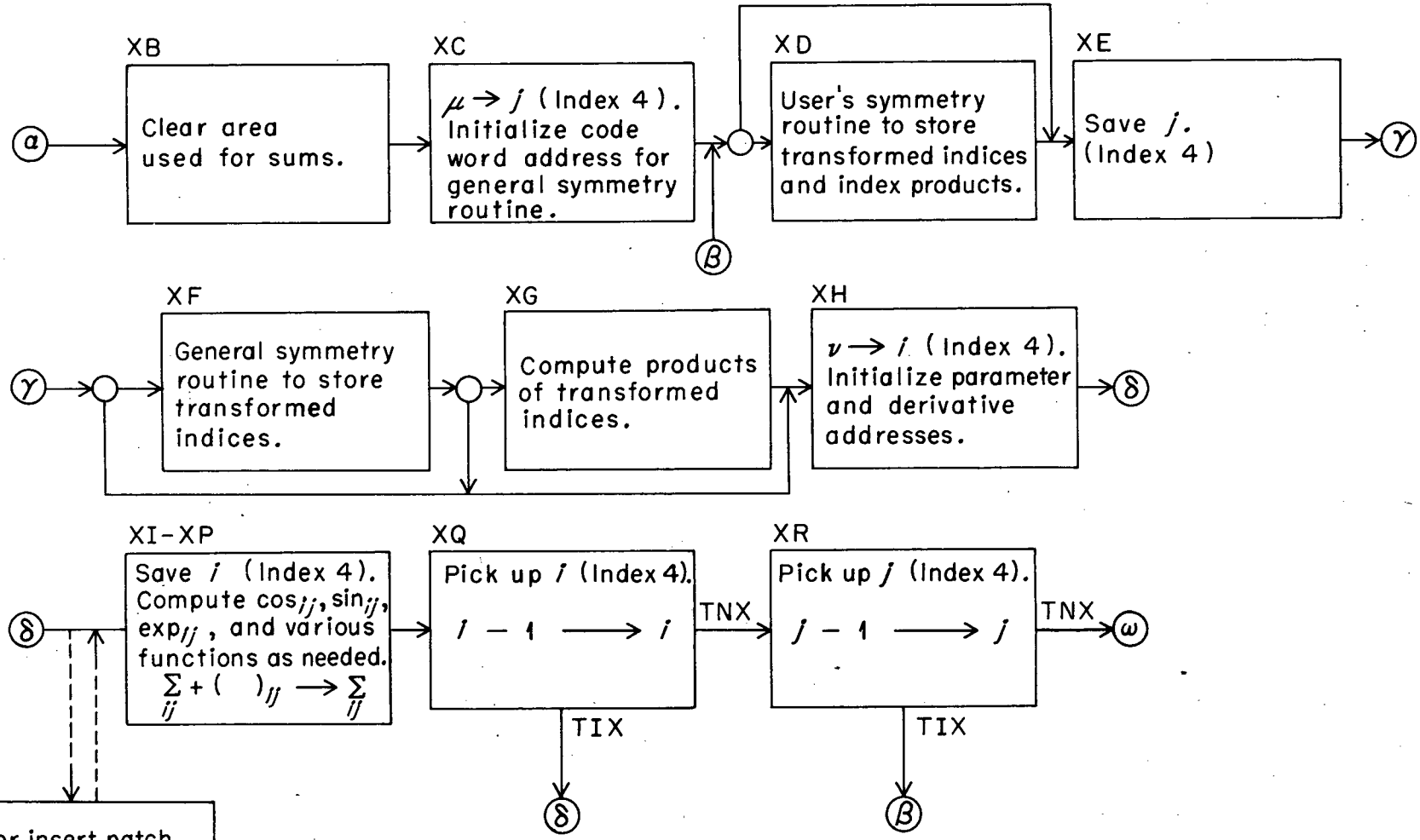
The following example illustrates the use of the patch for a hypothetical structure with one kind of atom in the general positions of $C3_22$ and two more kinds of atoms in the special positions with y = x and z = 1/3 mentioned above. The atoms in general positions will be listed first in the parameter table with the other two following. We select x as the independent variable for the atoms in special positions and fix their z parameters at 1/3. For these atoms the effect on the transformed indices has been discussed above.

```
        REM     SYMMETRY PATCH FØR SPECIAL PØSITIØNS
        ØRG     (Fill in address)
XI      TXL     A, 4, 2                 DØ NØT TRANSFER ØN FIRST ATØM
        ØRG     (Fill in address)
T5      PZE     B                       LAST ADDRESS USED
A       TXL     XI + 1, 4, 1            RETURN FØR THIRD ATØM
        CLA     HJ
        FAD     KJ
        STØ     HJ
        STZ     KJ
        CLA     HHJ
        FAD     KKJ
        STØ     HHJ
        STZ     KKJ
        CLA     2HLJ
        FSB     2KLJ
        STØ     2HLJ
        STZ     2KLJ
B       TRA     XI + 1
HJ      EQU                             T13
KJ      EQU                             T14
HHJ     EQU     (Fill in                T16
KKJ     EQU      addresses)             T17
2HLJ    EQU                             T20
2KLJ    EQU                             T21
        END     0
```

Specifications for patch to reset relationships between parameters.

1. At XWP insert transfer to reset position coordinates. Such resetting serves no essential purpose in the program as now written.
2. At XWQ insert transfer to reset anisotropic temperature factor coefficients. If symmetric temperature factors are used this transfer will automatically be bypassed.
3. Start these patches at end of program after T5 in locations which do not interfere with other patches.
4. On first entry to either patch index 1 contains ν, the number of atoms in the asymmetric unit. On subsequent entries it contains $\nu - 1$, $\nu - 2$, ... 2,1. Index 2 contains the complemented address of the form factor or form factor indicator for each atom so that the parameters of the atom under consideration are found as follows:

Parameter	Address and tag
x_i	1,2
y_i	2,2
z_i	3,2
β_{11i}	4,2
⋮	⋮
β_{13i}	8,2
β_{23i}	9,2



SECTION OF OR XLS2 RELEVANT TO SYMMETRY CONSIDERATIONS

5. Write the patch to reset the relationships between the parameters of atoms in special positions. Parameters are in floating point. Index 4 is free.
6. Return to XWP + 1 and XWQ + 1 after each patch.
7. Set the address in T5 to that of last location used by any patch or symmetry routine.
8. Assemble patches and insert in the binary deck between OR XLSD and OR XLSE.

The following is an example of the patches which would be used with the structure of the previous example. Note that this resetting is done after the parameters are printed but before the test for positive definite temperature factors is made.

```
        REM     PATCH TØ RESET PARAMETERS
        ØRG     (Fill in address)
XWP     TXL     C, 1, 2
        ØRG     (Fill in address)
XWQ     TXL     D, 1, 2
        ØRG     (Fill in address)
T5      PZE     E
        ØRG     (Fill in address)
C       CLA     1, 2
        STØ     2, 2
        TRA     XWP + 1
D       CLA     4, 2
        STØ     5, 2
        CLS     8, 2
        STØ     9, 2
E       TRA     XWQ + 1
        END     0
```

PROCEDURE WHEN SINGULAR MATRIX IS FOUND

The programmed stop in XMC of OR XLS4 indicates that the matrix of the normal equations is singular. This means that the program is attempting to adjust more parameters than are uniquely determined by the observations. Some of the ways in which this can occur will be listed:

1. Error in preparing parameter selection cards.
2. Attempting to vary more parameters than there are observations. An error in the weighting scheme or rejection test could cause this difficulty.
3. Attempting to vary some undetermined parameter (e.g., a z coordinate when hk0 data alone is used).
4. Attempting to vary a parameter which should be fixed because an atom is in a special position.
5. Attempting to vary redundant parameters (e.g., varying the overall temperature factor when all individual atom temperature factors are also varied, or varying the coordinates of all atoms when the origin is not fixed by the symmetry).

6. Attempting to vary parameters which are redundant because of overlapping atoms when data is for a projection. (Unless the overlap is exact this would be expected to produce very large parameter changes rather than a singularity stop.)

Operating procedure when matrix is singular.

1. Take octal dump of last 300 words of core storage.
2. Get off machine.
3. Hold tapes 4 and 5.
4. List tape 3.
5. After locating trouble get back on the machine using operating procedures B, C, D, or E.

Locating the trouble

The matrix as taken from a core dump at this point has been partially inverted. The original matrix may be taken from tape 5 if desired by means of OR XLSN (see page 38). However the vector of the normal equations is available in the dump at the location specified in K12. A zero element in this vector very probably means that the corresponding derivative was zero for all the observations. This could occur for reasons 1, 3, or 4 listed above. If all elements are zero this could mean an error in the weighting scheme or rejection test.

The parameter selection words can also be found in the dump at a location specified in K15. There are two parameter selection words for each parameter selection card, and each binary digit of the former corresponds to one card column.

DATA PROCESSING AND WEIGHT CALCULATION WITH OR XLS1

If the user wishes to compute estimated standard errors according to some formula or to perform on each reflection other preliminary data reduction operations such as scaling, taking a square root, etc., he may do so by writing a section of code according to the following specifications. Note that some of the symbols used in XLS1 are reused with different meansing in XLS2. The programmer should be careful to refer to addresses obtained from the listing of XLS1.

1. Start code at XH.
2. Available space includes 64 locations at XI with additional space at the end of the memory if required.
3. The following data is available in binary floating point:
   a. Cell data at D2-D7.

b. Data from observation card at M1-M5 (unchanged).

c. $(\sin \theta/\lambda)^2$ at M7.

d. Any desired floating point data typed in columns 55-63 and 64-71 of each observation card are found at T13 and T14, respectively.

4. To function as a weight calculator the code must store the standard error (not the weight) of F or F^2 at M5. The program later computes $\sqrt{w} = 1/\sigma$ for $\sigma \neq 0$ ($w = 0$ if $\sigma = 0$).

5. Exit to XJ.

6. Code should be assembled on absolute binary cards and inserted between OR XLSA and OR XLSB.

REJECTING OBSERVATIONS BY MEANS OF A REJECTION TEST

If it is desired to omit from the least squares treatment observations which fail to satisfy some criterion (e.g., reflections with F(calc) much smaller than F(obs)) the user may write a rejection test according to the specifications given below. Reflections rejected by this test will be marked with a single asterisk (*) in the structure factor output. The only effect of this test is to cause the reflection to be ignored when the normal equations are set up. If the reflection passes the test in subsequent cycles it will be reincluded.

Specifications for rejection test

1. Start rejection test at XAX. There are 66 locations available. If more space is needed use the area following T5 and change the address in T5 accordingly.

2. Data available for each observation includes the information in locations M1-M13, part of which is the input data and part of which has just been computed. In the listing of these locations "OBS" and "CALC" refer to F(obs) and sF(calc) or F^2(obs) and s^2F^2(calc), whichever is being used. M14 contains the rejection indicator from the previous cycle, if any.

3. All index registers are available to the programmer.

4. If the reflection is to be accepted (i.e., included in setting up the normal equations) store a zero at M14. If the reflection is to be rejected store something other than zero at M14.

5. Return to XAXX.

6. The test should be assembled on absolute binary cards and inserted between OR XLSD and OR XLSE.

UTILITY ROUTINES

OR XLS1-5 includes several routines which may be of interest to the user. A few of them will be described here.

RCD. Card programmer transfer. This routine reads the 9L word from a card and transfers to that word. This 9L word may be a transfer order, and such transfer cards are used to direct the course of the program. The location to which 9L is copied is RCD-1 so that a sequence of non-transfer instructions may be performed from a sequence of cards. Most of the programmed stops in OR XLS1-5 are coded to HTR RCD.

LDCD. Load self-loading cards. This routine clears the index registers and simulates the function of the load card button on the console.

DUMP is an octal and floating decimal off-line dump of the temporaries of OR XLS1-2. It is not available for use with OR XLS3-5. Transfer cards labeled OR XLSM are available, and these may be inserted in the deck at points where they will be read by the RCD routine, i.e,, immediately preceeding another such transfer card. After the dump is completed control is returned to the RCD routine, and the next transfer card is read so that the program proceeds without stops. Some of the positions where OR XLSM may be inserted in the card decks are given in the section on operating procedure (pages 33-38). Attempting to dump when OR XLS3-5 are in the memory cause the program to return to RCD and read the next card without dumping.

The initial and final addresses to be dumped are fixed by the program, but they can be changed by means of binary correction cards.

DATA DECKS

Data deck 1. Input for the preliminary processing segment, OR XLS1.

1. Title
2. Reciprocal cell data.
3. Form factor tables unless problem is a neutron diffraction one.
4. Reflection data unless this is on BCD tape. In either case this data is terminated either by a blank field (but with "R" in column 72) or an end of file (i.e., an empty hopper in card reader).

Data deck 2. Input for OR XLS2 when data is not in memory.

1. Title
2. Sense card
3. Symmetry cards if general symmetry routine is used
4. Reciprocal cell data
5. Trial parameters
6. Key card and parameter selection cards if least squares refinement is being made.

Data deck 3. Input for OR XLS2 when some of the data is already in the memory from previous cycles.

1. Title
2. Sense card. Any individual sense card field which is left blank will cause that sense indicator to keep its value from the previous cycle.

*3. Symmetry cards if general symmetry routine is used

*4. Reciprocal cell data

*5. Trial parameters

*6. Key card and parameter selection cards if least squares refinement is being made.

*Note: If the data from the previous cycle is to remain unchanged each of these groups of data cards may be replaced by one card which is blank except for the correct identification in column 72. CAUTION: Changing the number of scale factors changes the memory location of the parameters and of the symmetry data so that these cards must be supplied in this case.

DETAILS OF DATA INPUT

All input data except the parameter selection cards are converted by means of GL FILE to fixed point integers or floating point numbers with the form of conversion defined by the program. The field in which each entry is to be punched is specified below. The format in which a number should be punched is indicated by the following paragraphs from the GL FILE write-up:

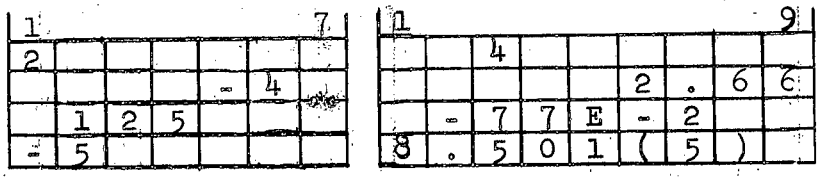
Fixed point integers

The routine examines the characters in the field, working from left to right, and discards all characters until a digit or a minus sign is encountered. This defines the beginning of the number and the next non-digit character (or the end of the field) defines the end of the number. Thus minus signs should immediately precede the number; plus signs may be omitted.

Floating point numbers

Working from left to right the first minus sign, decimal point, or digit encountered defines the beginning of the mantissa; the next non-digit (other than a point) defines the end of the mantissa. The routines then proceed to examine the rest of the field for an exponent in the manner described under the integer operation. If no exponent appears in the field, the routine assumes an exponent of zero. Thus minus signs should immediately precede both mantissa and exponent; plus signs may be omitted.

Examples



Fixed Point Integers Floating Point Numbers

Card identification

Each data card except for the parameter selection cards has an identifying letter punched in column 72. As each data card is read this letter is checked before any of the data is converted. An incorrect letter causes a stop which is monitored on the printer. If the error is located it is only necessary to put the deck back in the reader starting with the corrected data card. Pushing START causes the program to transfer back to the read order on which it stopped.

If it is the identification letter and not the card which is in error the test can be bypassed by turning on sense switch 6. It will then be necessary to put back in the reader the card on which the stop occurred and to START. Subsequent tests will be bypassed as long as sense switch 6 is left on.

Title card

The first card in each data deck.

Columns

1-71 The Hollerith information from these 71 columns is used unchanged as a heading for the output.

72 The identifying letter T.

Example:

1	71	72
2/20/59 HYDROGEN PEROXIDE, CYCLE 1		T

Reciprocal cell data card

One card included in each of data decks 1 and 2.

Columns

1-9	Integer n_f, the number of different X-ray form factor tables to be used. For neutron diffraction make $n_f = 0$. This field is relevant only in data deck 1. It must be the same as columns 19-21 of the sense card (see below).
10-18	Floating point a^*, the reciprocal lattice constant defined so that $\underset{\sim}{a} \cdot \underset{\sim}{a}^* = 1$ (not $\underset{\sim}{a} \cdot \underset{\sim}{a}^* = \lambda$).
19-27	Floating point b^*.
28-36	Floating point c^*.
37-45	Floating point cos α^*.
46-54	Floating point cos β^*.
55-63	Floating point cos γ^*.
72	The identifying letter C.

Example:

1	9 10	18 19	27 28	36 37	45 46	54 55	63	72
3	.2451	.5103	.4422	0	.1751	0		C

Form factor tables for X-ray problems

Each table consists of four cards and the program reads n_f such tables where n_f is given in columns 1-9 of the reciprocal cell data card. No form factor tables are used for neutron problems. The 32 form factors for sin θ/λ from 0.00 to 1.55 in intervals of 0.05 are listed in reverse order. Values of the form factor for sin θ/λ out of range of the problem may be inserted as zeros.

Card	Columns	
1	1-9	Floating point form factor for sin θ/λ = 1.55
	10-18	Floating point form factor for sin θ/λ = 1.50
	19-27	Floating point form factor for sin θ/λ = 1.45
	28-36	Floating point form factor for sin θ/λ = 1.40
	37-45	Floating point form factor for sin θ/λ = 1.35
	46-54	Floating point form factor for sin θ/λ = 1.30
	55-63	Floating point form factor for sin θ/λ = 1.25
	64-71	Floating point form factor for sin θ/λ = 1.20. (Note that this field is one column narrower than the others.)

Card	Columns	
.	72	The identifying letter F.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
4	55-63	Floating point form factor for sin θ/λ = 0.05
	64-71	Floating point form factor for sin θ/λ = 0.00
	72	The identifying letter F.

Example:

1 9	10 18	19 27	28 36	37 45	46 54	55 63	64 71	72
0	0	0	0	0	1.144	1.182	1.220	F
1.258	1.296	1.335	1.374	1.418	1.462	1.514	1.566	F
1.634	1.714	1.813	1.944	2.112	2.338	2.631	3.010	F
3.492	4.094	4.814	5.634	6.482	7.250	7.796	8.000	F

Reflection data cards

One card for each reflection observed or for each structure factor to be computed. These reflections may be put in in any desired sequence. The cards may be included in data deck 1, or they may be copied onto BCD tape before loading. In either case this set of data is terminated either by a card blank except for an R in column 72 or by an end of file (i.e., an empty hopper in the card reader).

Columns

1-9 Floating point index h.

10-18 Floating point index k.

19-27 Floating point index ℓ.

28-36 Floating point observed values of $|F|$ or F^2, whichever is being refined. For structure factor calculations this field need not be punched. If it is omitted then a 2 should be punched on the sense card (see below) in columns 16-18 to indicate that this field is to be ignored.

37-45 Floating point σ, the standard error of $|F|$ or F^2, whichever is being refined. The least squares weight of a reflection will be $w = 1/\sigma^2$ for $\sigma \neq 0$ (or $w = 0$ for $\sigma = 0$). If an error computing program has been added by the user then an error need not be punched. Nor need an error be punched for structure factor calculations.

Column

46-54 Integer q where q = 1, 2, 3 ....r and s_q is the scale factor to be used in computing this reflection. If this field is left blank the program will make q the same as for the previous reflection. This field must not be blank on the first reflection card read.

55-63 Floating point extra input 1. Any data punched in this field will be stored at T13 for use by an error calculating or data processing routine written by the user.

64-71 Floating point extra input 2. Any data punched in this field will be stored at T14 for the purpose described above.

72 The identifying letter R.

Example:

1	9 10	18 19	27 28	36 37	45 46	54 55	63 64	71 72
2	3	-5	17.2	2.5	2			R
10	0	0	4.5	1.0				R
5	4	1	3.1	1.0				R
-3	1	1	0	1.0	1			R
2	5	0	7.2	1.5				R
								R

Sense card

One such control card is read at the beginning of each cycle of least squares. Directly after reading this card the program prints on-line a summary of the control instructions which serves as an immediate check and which may be saved for reference.

Columns

1-3 Integer 1, 2, 3, or 4, the mode number:
(1) Compute fixed atom contributions.
(2) Compute structure factors s_qF or $(s_qF)^2$.
(3) Conventional least squares.
(4) Least squares cycle using derivatives and inverse matrix from previous mode 3 cycle. When this mode is used the kind of temperature factor and the parameter selection cards must be the same as those of the previous mode 3 cycle. Any number of mode 4 cycles may follow one mode 3 cycle.

4-6 Integer 1 or 2:
(1) Compute and base refinement on s_qF.
(2) Compute and base refinement on $(s_qF)^2$.

7-9 Integer 1, 2, or 3, the type of individual atom temperature factor.
(1) Isotropic or symmetric.
(2) Anisotropic.

Columns

(3) Start with symmetric temperature factors and convert to anisotropic form before refining. The symmetric coefficients may be left from the previous cycle or they may be read from the parameter cards. The parameter selection cards should be made up on the basis of six anisotropic coefficients per atom.

10-12 Integer 1, 2, or 3, the extent of BCD structure factor output desired:
(1) List results for all reflections.
(2) List results only for reflections which fail rejection test (supplied by user) or for which (obs-calc)/(error) > 2.
(3) No structure factor output.

13-15 Integer 1 or 2, but this field is irrelevant except in mode 2:
(1) Binary output tape is to be written.
(2) No binary output tape to be written.

16-18 Integer 1 or 2, but this field is irrelevant except in mode 2:
(1) F(obs) or F^2(obs) has been punched on reflection cards and is to be put out with the computed structure factors and used to compute the R factors.
(2) F(obs) or F^2(obs) is to be ignored if punched and no R factors are to be computed.

19-21 Integer n_f, the number of kinds of X-ray form factors. This must be zero for neutron diffraction, and n_f must be the same as that punched in columns 1-9 of the reciprocal cell data card, data deck 1.

22-24 Integer ν, the number of atoms in the asymmetric unit.

25-27 Integer 1 or 2, the kind of symmetry:
(1) Centrosymmetric with origin at symmetry center.
(2) Acentric.

28-30 Integer μ, the number of symmetrically equivalent positions for acentric computations or half that number for centrosymmetric computations. This is the number of symmetry cards or user's symmetry routines.

31-33 Integer 1 or 2, choice of symmetry routines:
(1) Use the general symmetry routine which is built into program and define symmetry with μ symmetry cards. Integer 1 should be specified even if code patches are written to handle special positions.
(2) Only the μ symmetry routines supplied by the user are to be applied. No symmetry cards are to be read.

34-36 Integer r, the number of scale factors. This must be at least one. There is no harm in including more scale factors than are actually used provided that no attempt is made to adjust the irrelevant ones.

72 The identifying letter S.

Example:

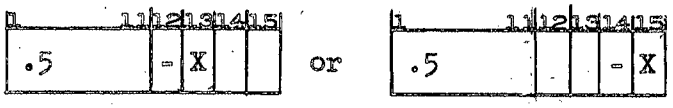
1 3	4 6	7 9	10 12	13 15	16 18	19 21	22 24	25 27	28 30	31 33	34 36	72
3	1	2	1			0	5	1	2	1	3	S

Symmetry cards

When the general symmetry routine is to be used μ symmetry cards are included in data deck 2. Each card describes one transformation of the atomic coordinates. For acentric structures μ is the number of equivalent positions. For centrosymmetric structures μ is half this number with pairs of positions related by a center being included only once.

CAUTION: The general symmetry routine can be assumed to give correct results (a) if all atoms are in general positions, or (b) if all atoms are in the same kind of special positions and only symmetric temperature factors are used. In all other cases consult the section on Symmetry Considerations for the correct procedure.

Column	
1-15	The expression for the transformed coordinate x' as follows:
1-11	Floating point translational part of x' or blank.
12	Hollerith -, +, or blank. The sign associated with the symbol in column 13. Blank and + are equivalent.
13	Hollerith X, Y, Z, or blank.
14	Hollerith -, +, or blank. The sign associated with the symbol in column 15. Blank and + are equivalent.
15	Hollerith X, Y, Z, or blank. Note that columns 12 and 13 are exactly equivalent to 14 and 15. Thus the transformation x' = 1/2 - x may be punched



Note that the expression x' = 2x must be treated as x' = x + x.

16-30	The expression for the transformed coordinate y' as follows:
16-26	Floating point translational part of y' or blank.
27-30	Hollerith sign, symbol, sign, symbol as described above.
31-45	The expression for the transformed coordinate z' as follows:
31-41	Floating point translational part of z' or blank.
42-45	Hollerith sign, symbol, sign, symbol as described above.
72	The identifying letter M.

Example: The six symmetry cards for space group $C3_22$ (see page 10) may be punched as follows:

1	11	12	13	14	15	16	26	27	28	29	30	31	41	42	43	44	45	72
		X						Y						Z				M
		X	-	Y			-	Y					-	Z				M
		Y	-	X			-	X			.333333		+	Z				M
	-	X						Y	-	X	.333333		-	Z				M
	-	Y						X	-	Y	.666667		+	Z				M
		Y						X			.666667		-	Z				M

Trial parameter cards

These include r scale factor cards, one overall temperature factor card, and ν atom parameter cards where ν and r are punched on the sense card (see above). These cards will be described separately.

Scale factor cards

Cards are read in the order s_1, s_2, ...s_q ....s_r where q is the scale factor identification punched in columns 46-54 of the reflection data cards. Note that s_q multiplies the calculated F, not the observed F.

Column

1-9 Floating point scale factor, s_q.

72 The identifying letter P.

Overall temperature factor card

Column

1-9 Floating point T_o, the coefficient for the overall temperature factor $\exp(-T_o \sin^2\theta/\lambda^2)$. T_o may be zero or any positive number. Do not leave blank.

72 The identifying letter P.

Atom parameter cards

One card for each atom in the asymmetric unit.

Column

1-7 For X-ray problems ($n_f \neq 0$) this is an integer from one to n_f which identifies the form factor to be used. The form factors are numbered in the order in which the form factor tables were read from data deck 1.

For neutron problems ($n_f = 0$) this is the floating point neutron scattering factor itself.

8-14 Floating point coordinate x_i.

15-21 Floating point coordinate y_i.

22-28 Floating point coordinate z_i.

For symmetric temperature factors (or for symmetric converted to anisotropic before refining):

Columns

29-35 Floating point T_i, the coefficient for the individual atoms isotropic temperature factor $\exp(-T_i \sin^2\theta/\lambda^2)$. T_i may be zero or any positive number.

36-70 Irrelevant.

72 The identifying letter P.

For anisotropic temperature factors:

Columns

29-35 Floating point β_{11i}, a coefficient in the expression for the anisotropic temperature factor

$$\exp\left[-(\beta_{11}h^2 + \beta_{22}k^2 + \beta_{33}\ell^2 + 2\beta_{12}hk + 2\beta_{13}h\ell + 2\beta_{23}k\ell)\right].$$

36-42 Floating point β_{22}.

43-49 Floating point β_{33}.

50-56 Floating point β_{12}.

57-63 Floating point β_{13}.

64-70 Floating point β_{23}.

72 The identifying letter P.

Example: The parameter cards for an X-ray problem with two scale factors, three atoms in the asymmetric unit, and symmetric temperature factors might be as follows:

1 9		72
.954		P
1.015		P
0		P

1 7	8 14	15 21	22 28	29 35		72
2	.4713	-.2521	.9412	1.75		P
2	.5433	.1112	-.1043	1.25		P
1	.2710	.4544	.3315	.70		P

Key card

One card included in data deck 2 for least squares (modes 3 or 4). This card is not used in the calculation of fixed atom contributions or structure factors (modes 1 or 2).

Columns

1-6 Integer n, the number of parameters to be adjusted. This is equal to the number of ones punched on the parameter selection cards. This number must be greater than zero and must not exceed the limit set by the memory capacity (see page 4).

7-12 Integer, the number of parameter selection cards which follow.

72 The identifying letter K.

Example:

1	6 7	12	72
57	2		K

Parameter selection cards

These cards follow the key card (see above) and the number of parameter selection cards must be the integer punched in columns 7-12 of that card. Their purpose is to specify the parameters which are to be adjusted by least squares.

Consider the entire list of parameters including the r scale factors, the overall temperature factor coefficient, and the individual atom parameters to be arranged in that order. There are either five or ten atom parameters per atom including the form factor, the three coordinates, and the one or six temperature factor coefficients (depending on whether symmetric or anisotropic temperature factors are being used). Each column of a parameter selection card corresponds to one parameter, the first scale factor to column one, the next to column two, etc., for the first 72 parameters. If there are more than 72 parameters the association is continued on the next card, parameter 73 corresponding to column one, etc.

If a parameter is to be varied a one is punched in the corresponding column, otherwise a zero or blank is punched. (Actually, all rows but the 1 row are ignored by the program.)

There is no identifying letter to be punched in column 72.

Note that in both the X-ray and neutron case the scattering factor is considered to be a parameter. The neutron scattering factor may be adjusted by least squares, but varying an X-ray scattering factor must not be attempted.

Examples: Consider an X-ray problem with three scale factors, two atoms in the asymmetric unit, and symmetric temperature factors. Only hk0 zone data are to be used and only the first scale factor will be adjusted. The parameter list and corresponding parameter selection card is:

s_1	s_2	s_3	T_o	f_1	x_1	y_1	z_1	B_1	f_2	x_2	y_2	z_2	B_2
1					6	7					12	13	
1	0	0	0	0	1	1	0	1	0	1	1	0	1

If the same problem were set up for anisotropic temperature factors the parameter list and the corresponding parameter selection card might be:

								β_{ij1}										β_{ij2}					
s_1	s_2	s_3	T_o	f_1	x_1	y_1	z_1	11	22	33	12	13	23	f_2	x_2	y_2	z_2	11	22	33	12	13	23
1					6	7							12	13				18	19				24
1	0	0	0	0	1	1	0	1	1	0	1			0	0	0	1	1	0	1	1	0	0

OPERATING PROCEDURE

*Inserting OR XLSM immediately preceding a deck marked with an asterisk will cause the program to put out via tape unit 3 an octal and floating decimal dump of the temporaries from the preceeding calculation. This does not interfere with the computation in any way.

A. Data processing following by least squares or by structure factor calculation.

Card deck

1. OR XLSA, B (red)
2. Data deck 1
*3. OR XLSC, D, E (orange)
4. Data deck 2

   For calculating only structure factors (mode 2) the cards after this point are not needed.

*5. OR XLSF (yellow)

   If only one cycle is to be run the cards after this point are not needed.

6. OR XLSG (brown)
7. Data deck 3
*8. OR XLSH (blue)
9. For each additional cycle repeat decks 6, 7, and 8.

Operating Instructions for Case A

1. If tape input of reflection data is to be used mount it on unit 4.
2. Blank tapes on units 3 and 5.
3. Sense switch 1: Off for tape input,
   On for card input.
4. Sense switch 2: Off if BCD output from XLS1 is desired,
   On to suppress this output.

5. Sense switch 3: Off for on-line output of F or F^2,
   On to suppress this on-line output.
   (Off-line output is unaffected by this setting.)

6. Sense switch 4: Off for on-line output of parameters,
   On to suppress this on-line output.
   (Off-line output is unaffected by this setting.)

7. Sense switch 6: Off normally,
   On to bypass data identification check.

8. Ready printer with SHARE II board.

9. Clear and load cards. Programmed stop at 157_8. This completes OR XLS1. Observations are now on logical tape 5.

10. Switch the tape unit that was 5 to 4. Put a blank tape on unit 5. Start.

11. Programmed stop at 160_8. This is the end of the cycle. Observations, derivatives, and programs are now on logical tape 5 and this may be used as the sole tape input for further cycles. Information on logical tape 4 is unchanged.

12. To start a new cycle switch tape unit that was 5 to 4. Put a blank tape on unit 5. Start. Stops as in step 11 above.

13. Repeat step 12 for as many cycles as desired.

14. List logical tape 3. Program control. Automatic overflow.

15. Hold logical tape 5 to use as the input for further cycles. If for some reason the problem was stopped in mid-cycle it is desirable to hold also logical tape 4. If structure factors were calculated with no binary output then logical tape 4 should be held if further calculations are to be made.

B. Least squares or structure factor calculation when output of OR XLS1 is used as input.

Card deck

1. OR XLSK (red stripe)

2. OR XLSC, D, E (orange)

3. Data deck 2

   For calculating only structure factors (mode 2) the cards after this point are not needed.

*4. OR XLSF (yellow)

   If only one cycle is to be run the cards after this point are not needed.

5. OR XLSG (brown)

6. Data deck 3

*7. OR XLSH (blue)

8. For each additional cycle repeat decks 5, 6, and 7.

C. Least squares or structure factor calculation when the output of a previous least squares cycle is used as the input.

Card deck

1. OR XLSJ (green)
2. Data deck 3

   For calculating only structure factors (mode 2) the cards after this point are not needed.

*3. OR XLSH (blue)
4. OR XLSG (brown)
5. Data deck 3
*6. OR XLSH (blue)
7. For each additional cycle repeat decks 4, 5, and 6.

D. Least squares or structure factor calculation when the output of a previous structure factor or fixed atom contribution calculation is used as the input.

Card deck

1. OR XLSJ (green)
2. Data deck 3 (except that new parameters will be needed if input is from fixed atom contribution calculation)

   For calculating only structure factors (mode 2) the cards after this point are not needed.

*3. OR XLSF (yellow)

   If only one cycle is to be run the cards after this point are not needed.

4. OR XLSG (brown)
5. Data deck 3
*6. OR XLSH (blue)
7. For each additional cycle repeat decks 4, 5, and 6.

Operating Instructions for Cases B, C, or D.

1. Mount binary input tape on unit 4.
2. Blank tapes on units 3 and 5.
3. Sense switch 3: Off for on-line output of F or F^2,
   On to suppress this on-line output.
   (Off-line output is unaffected by this setting.)
4. Sense switch 4: Off for on-line output of parameters,
   On to suppress this on-line output.
   (Off-line output is unaffected by this setting.)
5. Sense switch 6: Off normally,
   On to bypass data identification check.
6. Ready printer with SHARE II board.

7. Clear and load cards.

8. Programmed stop at 160_8. This is the end of the cycle. Observations, derivatives, and programs are now on logical tape 5 and this may be used as the sole tape input for further cycles. Information on logical tape 4 is unchanged.

9. To start a new cycle switch tape unit that was 5 to 4. Put a blank tape on unit 5. Start. Stops as in step 8 above.

10. Repeat step 9 for as many cycles as desired.

11. List logical tape 3. Program control. Automatic overflow.

12. Hold logical tape 5 to use as the input for further cycles. If for some reason the problem was stopped in mid-cycle it is desirable to hold also logical tape 4. If structure factors were calculated with no binary output then logical tape 4 should be held if further calculations are to be made.

E. To get back onto the machine when least squares has given wrong results because wrong parameters were varied.

Card deck

1. OR XLSL (green stripe)

2. Key card and parameter selection cards

*3. OR XLSF (yellow)

If only one cycle is to be run the cards after this point are not needed.

4. OR XLSG (brown)

5. Data deck 3

*6. OR XLSH (blue)

7. For each additional cycle repeat decks 4, 5, and 6.

Operating Instructions for Case E.

1. Mount output from faulty cycle on tape unit 5.

2. Blanks on units 3 and 4. Tape 4 is not written on, but it will receive a rewind order.

3. Follow steps 3 to 12 of the Instructions for Cases B, C, and D.

F. Data processing followed by calculation of fixed atom contribution and then by least squares.

Card deck

1. OR XLSA, B (red)

2. Data deck 1 including form factor tables for fixed and non-fixed atoms.

*3. OR XLSC, D, E (orange)

4. Data deck 2 with parameters of only the fixed atoms and with no key card or parameter selection card.

*5. OR XLSG (brown)

6. Data deck 2 with parameters of only the non-fixed atoms.

*7. OR XLSF (yellow)

If only one cycle is to be run the cards after this point are not needed.

8. OR XLSG (brown)

9. Data deck 3

*10. OR XLSH (blue)

11. For each additional cycle repeat decks 8, 9, and 10.

Operating Instructions for Case F.

1. If tape input of reflection data is to be used mount it on unit 4.

2. Blank tapes on units 3 and 5.

3. Sense switch 1: Off for tape input,
On for card input.

4. Sense switch 2: Off if BCD output from XLS1 is desired,
On to suppress this output.

5. Sense switch 3: Off for on-line output of F or F^2,
On to suppress this on-line output.
(Off-line output is unaffected by this setting.)

6. Sense switch 4: Off for on-line output of parameters,
On to suppress this on-line output.
(Off-line output is unaffected by this setting.)

7. Sense switch 6: Off normally,
On to bypass data identification check.

8. Ready printer with SHARE II board.

9. Clear and load cards. Programmed stop at 157_8. This completes OR XLS1. Observations are now on logical tape 5.

10. Switch the tape unit that was 5 to 4. Put a blank tape on unit 5. Start.

11. Programmed stop at 160_8. Observations and fixed atom contributions are now on logical tape 5. Information on logical tape 4 is unchanged.

12. Switch the tape that was 5 to 4. Put a blank tape on unit 5. Start.

13. Programmed stop at 160_8. This is the end of the cycle. Observations, fixed atom contributions, derivatives, and programs are now on logical tape 5 and this may be used as the sole tape input for further cycles. Information on logical tape 4 is unchanged.

14. To start a new cycle switch tape unit that was 5 to 4. Put a blank tape on unit 5. Start. Stops as in step 13 above.

15. Repeat step 14 for as many cycles as desired.

16. List logical tape 3. Program control. Automatic overflow.

17. Hold logical tape 5 to use as the input for further cycles. If for some reason the problem was stopped in mid-cycle it is desirable to hold also logical tape 4. If structure factors were calculated with no binary output then logical tape 4 should be held if further calculations are to be made.

G. Output of matrix of normal equations or its inverse.

Card deck

1. OR XLSN (orange stripe). (If tape 5 is the output of an incomplete cycle, e.g., after a singular matrix is found, it will be necessary to insert a single absolute binary card immediately preceding the transfer card of OR XLSN. This card should load N, the order of the matrix, in binary into the address part of location 1314_8.

Operating Instructions for Case G.

1. Mount on unit 5 the binary output tape from a least squares cycle, mode 3. (If the tape is from a mode 4 cycle only the inverse matrix can be put out.)
2. Blank tape on unit 3 or this may be the same output tape used for the least squares cycle. It is not rewound before using.
3. Sense switch 5: Off for direct matrix of normal equations,
   On for inverse matrix.
4. Clear and load cards. Stops at 3142_8.
5. If more than one matrix is to be put out repeat steps 1 to 4. The program does not reset itself.
6. List tape 3. Program control. Automatic overflow. Hold tape 5 if desired. It has not been written on.

PRELIMINARY TIME ESTIMATES

OR XLS1 with card input of data.

Time = (No. of observations + 50) (7.2×10^{-3} minutes).

OR XLS2 derivative calculation with off-line BCD output.

Time = (No. of observations)(No. of atoms in asymmetric unit)
x (No. of symmetry cards)(1 for centrosymmetric, 2 for acentric)
x (1 for symmetric temp. fact., 2 for anisotropic)(2.9×10^{-4} minutes).

OR XLS3 setting up matrix.

Time = (No. of observations)(No. of parameters varied)^2(4.3×10^{-6} minutes).

OR XLS4 inverting matrix.

Time = (No. of parameters varied)^3(3.6×10^{-6} minutes).

INSTRUCTIONS FOR ASSEMBLING

Binary decks ready for use are available so that it should not often be necessary to assemble the program from the symbolic cards. If such an assembly is made, however, it will be necessary to add to the resulting binary cards certain loaders, relocatable subroutines, tables, and transfer cards which can be obtained from the available binary decks. Reference should be made to the table of binary card decks supplied (pages 39 to 41).

Assembly of OR XLS using SAP3-7 produces only the Utility programs.

Assembly of OR XLS1 produces the program and origin cards for the relocatable subroutines DBD1, FILE, SQRT3, and OUT3 in that order.

Assembly of OR XLS2 produces the program, origin cards for DBD1, FILE, SQRT3, OUT3, and SINEXP, and the loader MU SBL2 with the correct shifting increment.

Assembly of OR XLS3 produces only the program.

Assembly of OR XLS4 produces the program and an origin card for the relocatable subroutine OR SMI.

Assembly of OR XLS5 produces only the program.

Assembly of OR XLS6 produces the program, an origin card for OUT3, and a transfer card.

The various transfer cards will need to be changed only if the memory locations of the first few words in each segment are changed.

BINARY CARD DECKS SUPPLIED

OR XLSA, B (red*)	Type of card	Identification
1. NY RBL1	Self-loading	OR XLSA 00-04
2. UTILITY	Absolute	OR XLSA 05-11
3. OR XLS1	Absolute	OR XLSA 12-36
4. Changes for OR XLS1 (if any)	Absolute	
5. Origin and NY DBD1	Relocatable	OR XLSB 00-08
6. Origin and GL FILE	Relocatable	OR XLSB 09-19
7. Origin and CL SQRT3	Relocatable	OR XLSB 20-22
8. Origin and NY OUT3	Relocatable	OR XLSB 23-41
9. HTR RCD	Transfer	OR XLSB 42
10. TXI START	Transfer	OR XLSB 43

*It is suggested that the user reproduce the cards in the indicated colors.

OR XLSC, D, E (orange)	Type of card	Identification
1. TXI LDCD	Transfer	OR XLSC 00
2. NY RBL1	Self-loading	OR XLSC 01-05
3. OR XLS2	Absolute	OR XLSC 06-99
4. Changes for OR XLS2 (if any)	Absolute	OR XLSD 00-27
5. User's symmetry routines (if any)	Absolute	
6. Origin and NY DBD1	Relocatable	OR XLSE 00-08
7. Origin and GL FILE	Relocatable	OR XLSE 09-19
8. Origin and CL SQRT3	Relocatable	OR XLSE 20-22
9. Origin and NY OUT3	Relocatable	OR XLSE 23-41
10. Origin and SINEXP subroutines	Relocatable	OR XLSE 42-45
11. HTR RCD	Transfer	OR XLSE 46
12. TXI LDCD	Transfer	OR XLSE 47
13. MU SBL2 for TABLES	Self-loading	OR XLSE 48
14. TABLES used by SINEXP	Absolute with nominal origin zero	OR XLSE 49-78
15. TXI START	Transfer	OR XLSE 79

OR XLSF (yellow)		
1. TXI LDCD	Transfer	OR XLSF 00
2. NY RBL1	Self-loading	OR XLSF 01-05
3. OR XLS3	Absolute	OR XLSF 06-13
4. Changes for OR XLS3 (if any)	Absolute	
5. HTR RCD	Transfer	OR XLSF 14
6. TXI START	Transfer	OR XLSF 15
7. TXI LDCD	Transfer	OR XLSF 16
8. NY RBL1	Self-loading	OR XLSF 17-21
9. OR XLS4	Absolute	OR XLSF 22-23
10. Changes for OR XLS4 (if any)	Absolute	
11. Origin and OR SMI	Relocatable	OR XLSF 24-36
12. HTR RCD	Transfer	OR XLSF 37
13. TXI START	Transfer	OR XLSF 38
14. TXI LDCD	Transfer	OR XLSF 39
15. NY RBL1	Self-loading	OR XLSF 40-44
16. OR XLS5	Absolute	OR XLSF 45-48
17. Changes for OR XLS5 (if any)	Absolute	
18. HTR RCD	Transfer	OR XLSF 49
19. TXI START	Transfer	OR XLSF 50

OR XLSG (brown)		
1. TXI START	Transfer	OR XLSG 00

OR XLSH (blue)		
1. TXI KB	Transfer	OR XLSH 00
2. TXI KC	Transfer	OR XLSH 01
3. TXI KD	Transfer	OR XLSH 02

OR XLSJ (green)	Type of card	Identification
1. NY RBL1	Self-loading	OR XLSJ 00-04
2. UTILITY	Absolute	OR XLSJ 05-11
3. HTR RCD	Transfer	OR XLSJ 12
4. TXI KA	Transfer	OR XLSJ 13
OR XLSK (red stripe)		
1. NY RBL1	Self-loading	OR XLSK 00-04
2. UTILITY	Absolute	OR XLSK 05-11
3. HTR RCD	Transfer	OR XLSK 12
OR XLSL (green stripe)		
1. NY RBL1	Self-loading	OR XLSL 00-04
2. UTILITY	Absolute	OR XLSL 05-11
3. HTR RCD	Transfer	OR XLSL 12
4. TXI KF	Transfer	OR XLSL 13
OR XLSM (Manila)		
1. TXI DUMP	Transfer	OR XLSM 00
OR XLSN (orange stripe)		
1. NY RBL1	Self-loading	OR XLSN 00-04
2. OR XLS6	Absolute	OR XLSN 05-15
3. Origin and NY OUT3	Relocatable	OR XLSN 16-34
4. HTR MA	Transfer	OR XLSN 35

ARRANGEMENT OF RECORDS ON BINARY OUTPUT TAPE

From OR XLS1	End of Mode 1 or 2 (if used)	Before loading OR XLS3	Before loading OR XLS4	Before loading OR XLS5	Before correcting parameters	End of cycle
Dummy record	Dump of OR XLS2 program through parameters	Dummy record	→	→	→	Dump of OR XLS2 through corrected parameters
Dummy record	→	→	→	→	→	→
Dummy record	Dump of last 256 words in memory	Dummy record	→	→	→	Dump of last 256 words in memory
Dummy record	→	→	→	→	→	→
Binary data, one record per observation. See next page	→	→	→	→	→	→
End of file	→	→	→	→	→	→
End of file	→	OR XLS2 thru input parameters	→	→	→	→
			OR XLS3 program	→	→	→
			Matrix	→	→	→
				OR XLS4 program	→	→
				Inverse matrix	→	→
					OR XLS5 program	→
					Parameter changes + diagonal elements of inverse	→
					End of file	→

ARRANGEMENT ON TAPE OF BINARY DATA FOR EACH OBSERVATION

	Output of OR XLS1	Output of OR XLS2 Mode 1	Output of OR XLS2 Mode 2	Output of OR XLS2 Mode 3	Output of ORXLS2 Mode 4
M1 h M2 k M3 ℓ M4 Observed F or F^2	Copied	Copied	Copied	Copied	Copied
M5 $1/\sigma = \sqrt{w}$	Computed				
M6 Scale factor identification, q	Copied				
M7 $(\sin\theta/\lambda)^2$ Form factors unless problem is a neutron one	Computed				
M8 Fixed atom A_o M9 Fixed atom B_o	Zero Zero	Computed			
M10 A M11 B M12 Calculated s_qF or $(s_qF)^2$			Computed		Computed
M13 Observed - calculated M14 Rejection indicator				Computed	
M15 $\partial/\partial s$ M16 $\partial/\partial T_o$ Derivatives with respect to atomic parameters (5 or 10 per atom).					Copied

```
                                        OR-XLS1-5   CRYSTALLOGRAPHIC LEAST SQUARES REFINEMENT
                                        OR-XLS      UTILITY ROUTINES AND INTERSEGMENT PROGRAM
                        00004   U1      EQU 4                NUMBER OF BINARY INPUT TAPE
                        00005   U3      EQU 5                NUMBER OF BINARY OUTPUT TAPE
                        00144           ORG 100
00144   0 02000 0 00165                 TRA RCD
00145   0 02000 0 00171                 TRA LDCD
00146   0 02000 0 00201                 TRA WTB
00147   0 02000 0 00241                 TRA RTB
00150   0 00000 0 00000                 PZE
00151   0 02000 0 00355                 TRA KA
00152   0 02000 0 00304                 TRA KB
00153   0 02000 0 00316                 TRA KC
00154   0 02000 0 00324                 TRA KD
00155   0 02000 0 00332                 TRA KE
00156   0 02000 0 00355                 TRA KF
00157   0 00000 0 00165         KG      HTR RCD              END OF OR XLS1
00160   0 00000 0 00165         KH      HTR RCD              END OF CYCLE. TEMP FACTORS OK.
00161   0 00000 0 00162         KI      HTR KI1              END OF CYCLE. TEMP FACTORS NO GOOD.
00162   0 00000 0 00163         KI1     HTR KI2                 DITTO
00163   0 00000 0 00165         KI2     HTR RCD                 DITTO
                                        CARD PROGRAMMED TRANSFER
00164   0 00000 0 00000                 PZE
00165   0 76200 0 00321         RCD     RCD
00166   0 70000 0 00164                 CPY RCD-1
00167   0 02000 0 00164                 TRA RCD-1
00170   0 00000 0 00165                 HTR RCD
                                        LOAD SELF-LOADING CARDS
00171   0 76200 0 00321         LDCD    RCD
T 00172 -0 73400 0 00000                PDX
00173   -0 75400 7 00000                PXD 0,7
00174   0 70000 0 00000                 CPY 0
TD 00175  1 00000 0 00177               TXI LDCD+6
00176   0 00000 0 00171                 HTR LDCD             END OF FILE
00177   0 70000 0 00001                 CPY 1
TD 00200  1 00000 0 00000               TXI 0
                                        SUBROUTINE TO STORE BLOCK ON TAPE
00201   0 50000 4 00001         WTB     CLA 1,4
00202   0 40000 0 00237                 ADD WTB12
00203   0 62100 0 00215                 STA WTB3
00204   0 62100 0 00222                 STA WTB7
00205   0 50000 4 00001                 CLA 1,4
00206   0 40000 0 00240                 ADD WTB13
```

```
00207   0 62100 0 00221          STA WTB6
00210   0 62100 0 00234          STA WTB11
00211  -0 53400 1 00226  WTB1    LXD WTB9,1
00212   0 50000 4 00002  WTB2    CLA 2,4
00213   0 73400 2 00000          PAX 0,2
00214   0 62200 0 00220          STD WTB5
00215   0 76600 0 00220  WTB3    WTB 0                    ADDRESS TO BESET
00216   0 70000 2 00000  WTB4    CPY 0,2
00217   1 77777 2 00220          TXI WTB5,2,-1
00220   3 00000 2 00216  WTB5    TXH WTB4,2,0             DECREMENT TO BE SET
00221   0 76400 0 00200  WTB6    BST 0                    ADDRESS TO BE SET
00222   0 76200 0 00220  WTB7    RTB 0                    ADDRESS TO BE SET
00223  -0 76000 0 00012          RTT
00224   0 76100 0 00000          NOP
00225   0 70000 0 00227  WTB8    CPY WTB10
00226   1 00003 0 00225  WTB9    TXI WTB8,0,3
00227   0 00000 0 00000  WTB10   PZE                      READ-BACK COPIED HERE
00230   0 76600 0 00333          IOD
00231  -0 76000 0 00012          RTT
00232   0 02000 0 00234          TRA WTB11
00233   0 02000 4 00003          TRA 3,4
00234   0 76400 0 00200  WTB11   BST 0                    ADDRESS TO BE SET
00235   2 00001 1 00212          TIX WTB2,1,1
00236   0 00000 0 00211          HTR WTB1                 RTT FAILS 3 TIMES. START TO TRY AGAIN
00237   0 76600 0 00220  WTB12   WTB 0                    CONSTANT
00240   0 76400 0 00200  WTB13   BST 0                    CONSTANT
                                 SUBROUTINE TO READ RECORD FROM TAPE
00241   0 50000 4 00001  RTB     CLA 1,4
00242   0 40000 0 00267          ADD RTB7
00243   0 60100 0 00252          STO RTB3
00244   0 50000 4 00001          CLA 1,4
00245   0 40000 0 00270          ADD RTB8
00246   0 60100 0 00264          STO RTB6
00247  -0 53400 1 00262  RTB1    LXD RTB5,1
00250   0 50000 4 00002  RTB2    CLA 2,4
00251   0 73400 2 00000          PAX 0,2
00252   0 76200 0 00220  RTB3    RTB 0                    TO BE SET
00253  -0 76000 0 00012          RTT
00254   0 76100 0 00000          NOP
00255   0 70000 2 00000  RTB4    CPY 0,2
00256   1 77777 2 00255          TXI RTB4,2,-1
00257   0 02000 4 00003          TRA 3,4
00260   0 76600 0 00333          IOD
```

```
00261 -0 76000 0 00012          RTT
00262  1 00003 0 00264  RTB5     TXI RTB6,0,3
00263  0 02000 4 00004          TRA 4,4
00264  0 76400 0 00200  RTB6     BST 0                    TO BE SET
00265  2 00001 1 00250          TIX RTB2,1,1
00266  0 00000 0 00247          HTR RTB1                 RTT FAILS 3 TIMES. START TO TRY AGAIN.
00267  0 76200 0 00220  RTB7     RTB 0                    CONSTANT
00270  0 76400 0 00200  RTB8     BST 0                    CONSTANT
                                    TAKE DUMP FROM TAPE AND START CYCLE
00271  0 07400 4 00241  KA1      TSX RTB,4
00272  0 00000 0 00004          PZE U1
00273  0 00000 0 77323          PZE -START
00274  0 00000 0 00165          HTR RCD                  END OF FILE
00275  0 76200 0 00224          RTB U1
00276  0 07400 4 00241          TSX RTB,4
00277  0 00000 0 00004          PZE U1
00300  0 00000 0 00400          PZE -32512
00301  0 00000 0 00165          HTR RCD
00302  0 77200 0 00204          REW U1
00303  0 02000 0 00455          TRA START
                                    TAKE OR XLS3 FROM TAPE AND ENTER
00304  0 76200 0 00224  KB       RTB U1
00305  0 70000 0 00315          CPY KB2
00306  0 02000 0 00310          TRA KB1
00307  0 00000 0 00165          HTR RCD                  OR XLS3 NOT ON TAPE. USE CARDS.
00310  0 07400 4 00241  KB1      TSX RTB,4
00311  0 00000 0 00004          PZE U1
00312  0 00000 0 77323          PZE -START
00313  0 00000 0 00165          HTR RCD                  END OF FILE
00314  0 02000 0 00455          TRA START
00315  0 00000 0 00000  KB2      PZE                      DISCARD COPIED HERE
                                    TAKE OR XLS4 FROM TAPE AND ENTER
00316  0 76200 0 00224  KC       RTB U1
00317  0 07400 4 00241          TSX RTB,4
00320  0 00000 0 00004          PZE U1
00321  0 00000 0 77323          PZE -START
00322  0 00000 0 00165          HTR RCD                  END OF FILE
00323  0 02000 0 00455          TRA START
                                    TAKE OR XLS5 FROM TAPE AND ENTER
00324  0 76200 0 00224  KD       RTB U1
00325  0 07400 4 00241          TSX RTB,4
00326  0 00000 0 00004          PZE U1
00327  0 00000 0 77323          PZE -START
```

```
00330  0 00000 0 00165          HTR RCD                 END OF FILE
00331  0 02000 0 00455          TRA START
                                TAKE OR XLS2 FROM TAPE AND ENTER SECOND TIME
00332  0 07400 4 00241  KE      TSX RTB,4
00333  0 00000 0 00005          PZE U3
00334  0 00000 0 77323          PZE -START
00335  0 00000 0 00165          HTR RCD                 END OF FILE
00336  0 02000 0 00456          TRA START+1
                                GET BACK ON WITH NEW PARAMETER SELECTION CARDS
00337  0 76200 0 00225  KF4     RTB U3
00340  0 76200 0 00225  KF1     RTB U3
00341  0 70000 0 00352          GPY KF3
00342  0 02000 0 00340          TRA KF1
00343  0 02000 0 00345          TRA KF2
00344  0 02000 0 00340          TRA KF1
00345  0 07400 4 00241  KF2     TSX RTB,4
00346  0 00000 0 00005          PZE U3
00347  0 00000 0 77323          PZE -START
00350  0 00000 0 00165          HTR RCD                 OR-XLS2 IS NOT ON TAPE
00351  0 02000 0 00460          TRA START+3
00352  0 00000 0 00000  KF3     PZE                     DISCARDS COPIED HERE
                        00455    START EQU 301
                        00000          END 0

00353  0 77200 0 00204  KA      REW U1
00354  0 02000 0 00271          TRA KA1
00355  0 77200 0 00205  KF      REW U3
00356  0 76200 0 00225          RTB U3
00357  0 76200 0 00225          RTB U3
00360  0 76200 0 00225          RTB U3
00361  0 02000 0 00337          TRA KF4
```

```
                                        OR-XLS1   SEGMENT FOR PRELIMINARY DATA PROCESSING
                    00004   U1      EQU 4                   INPUT TAPE NUMBER
                    00040   U2      EQU 32                  NO OF ENTRIES IN EACH TABLE
                    00005   U3      EQU 5                   BINARY OUTPUT TAPE
                    00003   U4      EQU 3                   BCD OUTPUT TAPE NUMBER
                    00144   RCD     EQU 100
                    00157   KG      EQU 111
                    00455           ORG 301
00455   0 02000 0 00461   START   TRA XA
00456   0 00000 0 00144           HTR RCD                 NO ENTRY HERE
00457   0 02000 0 01404           TRA DUMP
00460   0 00000 0 00144           HTR RCD                 NO ENTRY HERE
00461   0 76200 0 00321   XA      RCD
00462   0 07400 4 01542           TSX DBD1,4
00463   0 00000 0 03200           PZE T12
00464   0 00000 0 00461           HTR XA                  END OF FILE
00465   0 07400 4 01261           TSX IFF,4
00466   0 01217 0 03213           PZE T12+11,0,IT
00467   0 02000 0 00461           TRA XA
00470   0 76200 0 00321   XA1     RCD
00471   0 07400 4 01542           TSX DBD1,4
00472   0 00000 0 02257           PZE BUFFER
00473   0 00000 0 00144           HTR RCD                 END OF FILE
00474   0 07400 4 01261           TSX IFF,4
00475   0 01214 0 02272           PZE BUFFER+11,0,IC
00476   0 02000 0 00470           TRA XA1
00477   0 07400 4 01752           TSX FILE,4
00500  -1 00155 0 03156           MON D1,0,109
00501  -2 01772 0 03157           MTW D2,0,1018
00502  -2 03607 0 03160           MTW D3,0,1927
00503  -2 05424 0 03161           MTW D4,0,2836
00504  -2 07241 0 03162           MTW D5,0,3745
00505  -2 11056 0 03163           MTW D6,0,4654
00506  -2 12673 0 03164           MTW D7,0,5563
00507   0 00000 0 00144           HTR RCD                 ERROR RETURN FROM FILE
00510   0 50000 0 03156   XB      CLA D1
00511   0 10000 0 00554           TZE XG
00512   0 56000 0 03156           LDQ D1
00513   0 20000 0 01221           MPY C2
00514  -0 60000 0 03165           STQ T1
00515   0 50000 0 01222           CLA C3
00516   0 40000 0 03165           ADD T1
00517   0 62100 0 01121           STA XQ2
```

```
00520   0 62100 0 01124          STA XQ3
00521   0 40200 0 01203          SUB I1
00522   0 62100 0 01120          STA XQ1
00523   0 50000 0 03165          CLA T1
00524   0 40200 0 01221          SUB C2
00525   0 40000 0 01203          ADD I1
00526   0 60100 0 03176          STO T10
00527   0 53400 1 01202          LXA I0,1
00530   0 53400 2 03165          LXA T1,2
00531   0 76200 0 00321  XB1     RCD
00532   0 07400 4 01542          TSX DBD1,4
00533   0 00000 0 02257          PZE BUFFER
00534   0 00000 0 00144          HTR RCD                 END OF FILE
00535   0 07400 4 01261          TSX IFF,4
00536   0 01215 0 02272          PZE BUFFER+11,0,IF
00537   0 02000 0 00531          TRA XB1
00540   0 07400 4 01752          TSX FILE,4
00541  -2 00155 1 03371          MTW M8+100,1,109
00542  -2 01772 1 03372          MTW M8+101,1,1018
00543  -2 03607 1 03373          MTW M8+102,1,1927
00544  -2 05424 1 03374          MTW M8+103,1,2836
00545  -2 07241 1 03375          MTW M8+104,1,3745
00546  -2 11056 1 03376          MTW M8+105,1,4654
00547  -2 12673 1 03377          MTW M8+106,1,5563
00550  -2 14507 1 03400          MTW M8+107,1,6471
00551   0 00000 0 00144          HTR RCD                 ERROR RETURN FROM FILE
00552  -2 00010 2 00554          TNX XC,2,8
00553   1 77770 1 00531          TXI XB1,1,-8
00554   0 77200 0 00205  XC      REW U3
00555   0 53400 4 01205          LXA I4,4
00556   0 76600 0 00225  XC1     WTB U3
00557   0 70000 0 01202          CPY I0
00560   2 00001 4 00556          TIX XC1,4,1
00561   0 76600 0 00333          IOD
00562   0 76000 0 00162  XAA     SWT 2
TD 00563   1 00000 0 00565          TXI XBB
TD 00564   1 00000 0 00635          TXI XD
00565   0 53400 1 01202  XBB     LXA I0,1
00566   0 53400 2 03156          LXA D1,2
00567  -3 00000 2 00577          TXL XBB4,2,0
00570  -3 00013 2 00572          TXL XBB1,2,11
00571   0 53400 2 01212          LXA I11,2
00572   0 50000 0 01230  XBB1    CLA C14
```

```
00573   0 60100 1 01160  XBB2   STO XT1,1
00574   0 40200 0 01231         SUB G15
00575   1 77777 1 00576         TXI XBB3,1,-1
00576   2 00001 2 00573  XBB3   TIX XBB2,2,1
00577   0 50000 0 01232  XBB4   CLA G16
00600   0 60100 1 01160         STO XT1,1
00601   0 50000 0 01233         CLA G17
00602   0 60100 1 01161         STO XT1+1,1
00603   0 07400 4 02326  XCC    TSX OUT,4
00604   0 07400 4 01505         TSX ECHO,4
00605   3 27451 0 03200         PTH T12,0,12073
00606   3 02066 0 01220         PTH G1,0,1078
00607   1 00001 0 00003         PON U4,0,1
00610   0 07400 4 02326         TSX OUT,4
00611   0 07400 4 01505         TSX ECHO,4
00612   3 13625 0 01234         PTH G18,0,6037
00613   1 00000 0 00003         PON U4,0,0
00614   0 07400 4 02326         TSX OUT,4
00615   0 07400 4 01505         TSX ECHO,4
00616   3 05713 0 01242         PTH G19,0,3019
00617  -3 15564 0 03157         SVN D2,0,7028
00620  -3 15576 0 03160         SVN D3,0,7038
00621  -3 15610 0 03161         SVN D4,0,7048
00622  -3 15622 0 03162         SVN D5,0,7058
00623  -3 15634 0 03163         SVN D6,0,7068
00624  -3 15646 0 03164         SVN D7,0,7078
00625   1 00000 0 00003         PON U4,0,0
00626   0 07400 4 02326         TSX OUT,4
00627   0 07400 4 01505         TSX ECHO,4
00630   3 23516 0 01245         PTH G21,0,10062
00631   1 00000 0 00003         PON U4,0,0
00632   0 07400 4 02326         TSX OUT,4
00633   0 07400 4 01505         TSX ECHO,4
00634   1 00060 0 00003         PON U4,0,48
00635   0 76000 0 00161  XD     SWT 1
TD 00636   1 00000 0 00652         TXI XF
00637   0 76200 0 00321  XE     RCD
00640   0 07400 4 01542         TSX DBD1,4
00641   0 00000 0 02257         PZE BUFFER
00642   0 02000 0 01176         TRA XV
00643   0 07400 4 01261         TSX IFF,4
00644   0 01216 0 02272         PZE BUFFER+11,0,IR
00645   0 02000 0 00637         TRA XE
```

```
      00646   0 07400 4 01366          TSX BLNK,4
      00647   0 00011 0 02270          PZE BUFFER+9,0,9
      00650   0 02000 0 01176          TRA XV
      00651   0 02000 0 00677          TRA XEF
      00652   0 53400 1 01204  XF      LXA I3,1
      00653   0 76200 0 00204  XF1     RTD U1
      00654   0 53400 2 01213          LXA I14,2
      00655   0 70000 2 02275  XF2     CPY BUFFER+14,2
TD    00656   1 00000 0 00660          TXI XF3
TD    00657   1 00000 0 01175          TXI XU
      00660   2 00001 2 00655  XF3     TIX XF2,2,1
      00661   0 76600 0 00333          IOD
      00662  -0 76000 0 00012          RTT
TD    00663   1 00000 0 00665          TXI XF4
      00664   0 02000 0 00671          TRA XF5
      00665   0 76400 0 00204  XF4     BST U1
      00666   2 00001 1 00653          TIX XF1,1,1
      00667   0 76200 0 00204          RTD U1
      00670   0 00000 0 00652          HTR XF          RTT FAILS 3 TIMES. START TO SKIP RECORD
      00671   0 07400 4 01261  XF5     TSX IFF,4
      00672   0 01216 0 02272          PZE BUFFER+11,0,IR
      00673   0 00000 0 00144          HTR RCD         INCORRECT SYMBOL WAS ON TAPE
      00674   0 07400 4 01366          TSX BLNK,4
      00675   0 00013 0 02272          PZE BUFFER+11,0,11
      00676   0 02000 0 01175          TRA XU
      00677   0 07400 4 01752  XEF     TSX FILE,4
      00700  -2 00155 0 03216          MTW M1,0,109
      00701  -2 01772 0 03217          MTW M2,0,1018
      00702  -2 03607 0 03220          MTW M3,0,1927
      00703  -2 05424 0 03221          MTW M4,0,2836
      00704  -2 07241 0 03222          MTW M5,0,3745
      00705  -1 11056 0 03223          MON M6,0,4654
      00706  -2 12673 0 03214          MTW T13,0,5563
      00707  -2 14507 0 03215          MTW T14,0,6471
      00710   0 00000 0 00144          HTR RCD         ERROR RETURN FROM FILE
      00711   0 14000 0 00712  XG      TQV XG1
      00712   0 16100 0 00713  XG1     TQO XG2
      00713   0 53400 1 01204  XG2     LXA I3,1
      00714   0 56000 1 03162  XG3     LDQ D5,1
      00715   0 26000 1 03221          FMP M4,1
      00716   0 60100 1 03171          STO T5,1
      00717   2 00001 1 00714          TIX XG3,1,1
      00720   0 56000 0 03162          LDQ D5
```

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00721   0 26000 0 03167          FMP  T3
00722   0 76500 0 00043          LRS  35
00723   0 26000 0 03170          FMP  T4
00724   0 60100 0 03171          STO  T5
00725   0 56000 0 03163          LDQ  D6
00726   0 26000 0 03166          FMP  T2
00727   0 76500 0 00043          LRS  35
00730   0 26000 0 03170          FMP  T4
00731   0 30000 0 03171          FAD  T5
00732   0 60100 0 03171          STO  T5
00733   0 56000 0 03164          LDQ  D7
00734   0 26000 0 03166          FMP  T2
00735   0 76500 0 00043          LRS  35
00736   0 26000 0 03167          FMP  T3
00737   0 30000 0 03171          FAD  T5
00740   0 60100 0 03171          STO  T5
00741   0 30000 0 03171          FAD  T5
00742   0 60100 0 03171          STO  T5
00743   0 53400 1 01204          LXA  I3,1
00744   0 56000 1 03171  XG4     LDQ  T5,1
00745   0 26000 1 03171          FMP  T5,1
00746   0 30000 0 03171          FAD  T5
00747   0 60100 0 03171          STO  T5
00750   2 00001 1 00744          TIX  XG4,1,1
00751   0 56000 0 03171          LDQ  T5
00752   0 26000 0 01223          FMP  C9
00753   0 60100 0 03224          STO  M7
00754   0 16100 0 00756          TQO  XG5
00755  -0 14000 0 00757          TNO  XH
00756   0 00000 0 00144  XG5     HTR  RCD        SIN THETA/LAMBDA SQUARED OVERFLOWS
00757   0 02000 0 01060  XH      TRA  XJ
                         00760  XI      BSS  64
01060   0 50000 0 03222  XJ      CLA  M5
01061   0 60100 0 03172          STO  T6
01062   0 10000 0 01066          TZE  XK
01063   0 50000 0 01224          CLA  C10
01064   0 24000 0 03222          FDH  M5
01065  -0 60000 0 03222          STQ  M5
01066   0 50000 0 03223  XK      CLA  M6
01067  -0 10000 0 01073          TNZ  XM
01070   0 50000 0 03173  XL      CLA  T7
01071   0 60100 0 03223          STO  M6
01072   1 00000 0 01074          TXI  XN
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TD

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01073   0 60100 0 03173  XM     STO T7
01074   0 50000 0 03156  XN     CLA D1
01075   0 10000 0 01130         TZE XR
01076   0 50000 0 03224  XO     CLA M7
01077   0 07400 4 02275         TSX SQRT,4
01100   0 00000 0 00144         HTR RCD                 NEGATIVE RADICAND
01101   0 60100 0 03174         STO T8
01102   0 56000 0 03174  XP     LDQ T8
01103   0 26000 0 01227         FMP C13
01104   0 60100 0 03175         STO T9
01105  -0 30000 0 01225         UFA C11
01106   0 73400 1 00000         PAX 0,1
01107  -3 00037 1 01111         TXL XP1,1,U2-1
01110   0 00000 0 00144         HTR RCD                 OUT OF RANGE OF F TABLE
01111   0 40000 0 03176  XP1    ADD T10
01112   0 73400 1 00000         PAX 0,1
01113  -0 60000 0 03177         STQ T11
01114   0 50000 0 03177         CLA T11
01115   0 30000 0 01226         FAD C12
01116   0 60100 0 03177         STO T11
01117   0 53400 2 01202  XQ     LXA I0,2
01120   0 50000 1 00000  XQ1    CLA 0,1
01121   0 30200 1 00000  XQ2    FSB 0,1
01122   0 76500 0 00043         LRS 35
01123   0 26000 0 03177         FMP T11
01124   0 30000 1 00000  XQ3    FAD 0,1
01125   0 60100 2 03225         STO M8,2
01126   1 77777 2 01127         TXI XQ4,2,-1
01127   2 00040 1 01120  XQ4    TIX XQ1,1,U2
01130   0 76600 0 00225  XR     WTB U3
01131   0 50000 0 03156         CLA D1
01132   0 40000 0 01210         ADD I7
01133   0 73400 1 00000         PAX 0,1
01134   0 53400 2 01202         LXA I0,2
01135   0 70000 2 03216  XR1    CPY M1,2
01136   1 77777 2 01137         TXI XR2,2,-1
01137   2 00001 1 01135  XR2    TIX XR1,1,1
01140   0 70000 0 01202         CPY I0
01141   0 70000 0 01202         CPY I0
01142   0 76600 0 00333         IOD
01143   0 76000 0 00162  XS     SWT 2
TD      1 00000 0 01146         TXI XT
TD      1 00000 0 00635         TXI XD
```

```
01146   0 07400 4 02326   XT     TSX OUT,4
01147   0 07400 4 01505          TSX EGH0,4
01150   3 03734 0 01257          PTH C22,0,2012
01151  -3 00004 0 03216          SVN M1,0,4
01152  -3 00010 0 03217          SVN M2,0,8
01153  -3 00014 0 03220          SVN M3,0,12
01154  -3 05716 0 03221          SVN M4,0,3022
01155  -3 05730 0 03172          SVN T6,0,3032
01156  -0 00043 0 03223          FOR M6,0,35
01157  -3 11663 0 03224          SVN M7,0,5043
                    01160  XT1    BSS 13
01175   0 77200 0 00204   XU     REW U1
01176   0 77000 0 00205   XV     WEF U3
01177   0 77000 0 00205          WEF U3
01200   0 77200 0 00205          REW U3
01201   0 02000 0 00157          TRA KG
                                  CONSTANTS
01202   0 00000 0 00000   I0     PZE 0
01203   0 00000 0 00001   I1     PZE 1
01204   0 00000 0 00003   I3     PZE 3
01205   0 00000 0 00004   I4     PZE 4
01206   0 00000 0 00005   I5     PZE 5
01207   0 00000 0 00006   I6     PZE 6
01210   0 00000 0 00007   I7     PZE 7
01211   0 00000 0 00010   I8     PZE 8
01212   0 00000 0 00013   I11    PZE 11
01213   0 00000 0 00016   I14    PZE 14
01214   000000000023      IC     BCD 100000C
01215   000000000026      IF     BCD 100000F
01216   000000000051      IR     BCD 100000R
01217   000000000063      IT     BCD 100000T
01220   606060606060      C1     BCD 1
01221   0 00000 0 00040   C2     PZE U2                NUMBER OF ENTRIES IN EACH F TABLE
01222   0 00000 0 03371   C3     PZE M8+100            ADDRESS OF FIRST F TABLE
01223  +177400000000      C9     DEC .25               FLOATING ONE QUARTER
01224  +201400000000      C10    DEC 1.                FLOATING CONSTANT ONE
01225  +233000000000      C11    OCT 233000000000      FIXER TO GET INTEGER
01226  +200000000000      C12    OCT 200000000000      FIXER TO NORMALIZE FRACTION
01227  +205500000000      C13    DEC 20.               1/DELTA
01230  -3 05752 0 03225   C14    SVN M8,0,3050         INITIAL LINK WORDS FOR OUTPUT
01231   0 00007 0 00001   C15    PZE 1,0,7             CONSTANT TO ADVANCE LINK WORD
01232   1 00060 0 00003   C16    PON U4,0,48           TAPE WRITE ORDER
TD      1 00000 0 00635   C17    TXI XD                TRANSFER AFTER OUTPUT
```

```
01234  314547646360      C18   BCD 6INPUT DATA AS PROCESSED BY OR-XLS1
01235  242163216021
01236  626047514623
01237  256262252460
01240  227060465140
01241  674362016060
01242  232543436023      C19   BCD 3CELL CONSTANTS
01243  464562632145
01244  636260606060
01245  603060606042      C21   BCD   H   K   L  OBSERVED    SIGMA    Q    RHO       FORM FACTORS
01246  606060436060
01247  462262255165
01250  252460606060
01251  623127442160
01252  606050606060
01253  513046606060
01254  606060264651
01255  446026212363
01256  465162606060
01257  606060006060      C22   BCD 2   0   0   0
01260  600060606000

                                 SUBROUTINE TO CHECK IDENTIFICATION LETTER
01261   0 76000 0 00166  IFF    SWT 6
01262   0 02000 0 01264         TRA IFF1
01263   0 02000 4 00003         TRA 3,4
01264   0 50000 4 00001  IFF1   CLA 1,4
01265   0 62100 0 01271         STA IFF2
01266   0 77100 0 00022         ARS 18
01267   0 62100 0 01274         STA IFF3
01270   0 62100 0 01307         STA IFF6
01271   0 50000 0 00000  IFF2   CLA 0                  ADDRESS TO BE SET
01272  -0 32000 0 01364         ANA IFF11
01273   0 60100 0 01365         STO IFF12
01274   0 34000 0 00000  IFF3   GAS 0                  ADDRESS TO BE SET
01275   1 00000 0 01277  IFF4   TXI IFF5,0,0
01276   0 02000 4 00003         TRA 3,4
01277  -0 63400 4 01275  IFF5   SXD IFF4,4
01300   0 07400 4 02326         TSX OUT,4
01301   0 07400 4 01505         TSX ECHO,4
01302   3 02015 0 01365         PTH IFF12,0,1037
01303   3 13624 0 01327         PTH IFF7,0,6036
01304  -1 00000 0 00364         FVE 244
01305   0 07400 4 02326         TSX OUT,4
```

```
01306  0 07400 4 01505         TSX ECHO,4
01307  3 02015 0 00000   IFF6  PTH 0,0,1037         ADDRESS TO BE SET
01310  3 13624 0 01335         PTH IFF8,0,6036
01311 -1 00000 0 00364         FVE 244
01312  0 07400 4 02326         TSX OUT,4
01313  0 07400 4 01505         TSX ECHO,4
01314  3 15602 0 01343         PTH IFF9,0,7042
01315 -1 00000 0 00364         FVE 244
01316  0 07400 4 02326         TSX OUT,4
01317  0 07400 4 01505         TSX ECHO,4
01320  3 23514 0 01352         PTH IFF10,0,10060
01321 -1 00000 0 00364         FVE 244
01322  0 07400 4 02326         TSX OUT,4
01323  0 07400 4 01505         TSX ECHO,4
01324 -1 00000 0 00361         FVE 241
01325 -0 53400 4 01275         LXD IFF4,4
01326  0 00000 4 00002         HTR 2,4
01327  602421632160    IFF7  BCD 6 DATA CARD IDENTIFICATION LETTER IS
01330  232151246031
01331  242545633126
01332  312321633146
01333  456043256363
01334  255160316260
01335  604751462751    IFF8  BCD 6 PROGRAM CALLS FOR CARD WITH LETTER
01336  214460232143
01337  436260264651
01340  602321512460
01341  663163306043
01342  256363255160
01343  604764636023    IFF9  BCD 7 PUT CORRECT CARD IN READER AND PROCEED.
01344  465151252363
01345  602321512460
01346  314560512521
01347  242551602145
01350  246047514623
01351  252524336060
01352  606346602270    IFF10 BCD   TO BYPASS ALL IDENTIFICATION TESTS TURN ON SENSE SWITCH 6.
01353  472162626021
01354  434360312425
01355  456331263123
01356  216331464560
01357  632562636260
01360  636451456046
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01361   456062254562
01362   256062663163
01363   233060063360
01364   0 00000 0 00077   IFF11 PZE 63                    MASK
01365   0 00000 0 00000   IFF12                          LETTER FROM CARD
                                SUBROUTINE TO TEST FOR BLANK FIELD
01366  -0 63400 1 01374   BLNK  SXD BLNK2,1
01367   0 50000 4 00001         CLA 1,4
01370   0 62100 0 01372         STA BLNK1
01371  -0 73400 1 00000         PDX 0,1
01372   0 50000 1 00000   BLNK1 CLA 0,1                  ADDRESS TO BE SET
01373   0 34000 0 01403         CAS BLNK5
01374   1 00000 0 01376   BLNK2 TXI BLNK3,0,0
01375   0 02000 0 01400         TRA BLNK4
01376  -0 53400 1 01374   BLNK3 LXD BLNK2,1
01377   0 02000 4 00003         TRA 3,4
01400   2 00001 1 01372   BLNK4 TIX BLNK1,1,1
01401  -0 53400 1 01374         LXD BLNK2,1
01402   0 02000 4 00002         TRA 2,4
01403   606060606060      BLNK5 BCD 1
                                OCTAL AND FLOATING DECIMAL DUMP FOR TEST PURPOSES
01404   0 07400 4 02326   DUMP  TSX OUT,4
01405   0 07400 4 01505         TSX ECHO,4
01406   3 27451 0 03200         PTH T12,0,12073
01407   3 02066 0 01220         PTH G1,0,1078
01410   1 00001 0 00003         PON U4,0,1
01411   0 53400 1 01503         LXA DUMP7,1
01412   0 07400 4 02326   DUMP1 TSX OUT,4
01413   0 07400 4 01505         TSX ECHO,4
01414  -2 17531 1 00000         SIX 0,1,8025
01415  -2 17562 1 00001         SIX 1,1,8050
01416  -2 17613 1 00002         SIX 2,1,8075
01417  -2 17644 1 00003         SIX 3,1,8100
01420   1 00000 0 00003         PON U4,0,0
01421  -0 75400 1 00000         PXD 0,1
01422   0 77100 0 00022         ARS 18
01423   0 76000 0 00006         COM
01424   0 40000 0 01203         ADD I1
01425   0 73400 2 00000         PAX 0,2
01426  -0 75400 2 00000         PXD 0,2
01427   0 76500 0 00043         LRS 35
01430   0 53400 4 01207         LXA I6,4
01431   0 76700 0 00003   DUMP8 ALS 3
```

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01432 -0 76300 0 00003          LGL 3
01433  2 00001 4 01431          TIX DUMP8,4,1
01434 -0 50100 0 01504          ORA DUMP9
01435  0 60200 0 01502          SLW DUMP6+8
01436  0 53400 2 01211          LXA I8,2
01437  0 56000 1 00000  DUMP2   LDQ 0,1
01440  0 53400 4 01207          LXA I6,4
01441  0 76700 0 00003  DUMP3   ALS 3
01442 -0 76300 0 00003          LGL 3
01443  2 00001 4 01441          TIX DUMP3,4,1
01444  0 60200 2 01502          SLW DUMP6+8,2
01445  0 53400 4 01207          LXA I6,4
01446  0 76700 0 00003  DUMP4   ALS 3
01447 -0 76300 0 00003          LGL 3
01450  2 00001 4 01446          TIX DUMP4,4,1
01451  0 60200 2 01503          SLW DUMP6+9,2
01452  1 77777 1 01453          TXI DUMP5,1,-1
01453  2 00002 2 01437  DUMP5   TIX DUMP2,2,2
01454  0 07400 4 02326          TSX OUT,4
01455  0 07400 4 01505          TSX ECHO,4
01456  3 01756 0 01502          PTH DUMP6+8,0,1006
01457  3 01772 0 01472          PTH DUMP6,0,1018
01460  3 02001 0 01473          PTH DUMP6+1,0,1025
01461  3 02023 0 01474          PTH DUMP6+2,0,1043
01462  3 02032 0 01475          PTH DUMP6+3,0,1050
01463  3 02054 0 01476          PTH DUMP6+4,0,1068
01464  3 02063 0 01477          PTH DUMP6+5,0,1075
01465  3 02105 0 01500          PTH DUMP6+6,0,1093
01466  3 02114 0 01501          PTH DUMP6+7,0,1100
01467  1 00060 0 00003          PON U4,0,48
01470  3 74541 1 01412          TXH DUMP1,1,-M8-10     DECREMENT IS -(FINAL ADDRESS+1)
01471  0 02000 0 00144          TRA RCD
                   01472  DUMP6 BSS 9
01503  0 00000 0 74622  DUMP7   PZE -D1                -(INITIAL ADDRESS)
01504  600000000000     DUMP9   BCD 1 00000
                                SUBROUTINE TO TEST NATURE OF ERROR RETURN FROM NY OUT3
01505  0 12000 0 01523  ECHO    TPL ECHO4
01506 -0 10000 0 01523          TNZ ECHO4
01507 -0 63400 4 01541          SXD ECHO7,4
01510  0 07400 4 02326          TSX OUT,4
01511  0 02000 0 01514          TRA ECHO2
01512  3 15602 0 01532          PTH ECHO6,0,7042
01513 -1 00000 0 00000  ECHO1   FVE
```

```
01514  -0 53400 4 01541   ECHO2  LXD  ECHO7,4
01515  -0 50000 4 00001   ECHO3  CAL  1,4
01516  -0 77100 0 00041          ARS  33
01517    0 34000 0 01531          CAS  ECHO5
01520    1 77777 4 01515          TXI  ECHO3,4,-1
01521    0 02000 4 00002          TRA  2,4                    TO NORMAL RETURN OF NY OUT3
01522    1 77777 4 01515          TXI  ECHO3,4,-1
01523  -0 75400 4 00000   ECHO4  PXD  0,4
01524    0 76000 0 00006          COM
01525  -0 73400 4 00000          PDX  0,4
01526  -0 75400 4 00000          PXD  0,4
01527    0 77100 0 00022          ARS  18
01530    0 00000 0 00144          HTR  RCD                    CALLING SEQUENCE ERROR. ADDRESS IN ACC.
01531  -0 00000 0 00005   ECHO5  PSE  5
01532   605454546047      ECHO6  BCD  7 *** PRINTER ERROR IN PREVIOUS LINE ***
01533   513145632551
01534   602551514651
01535   603145604751
01536   256531466462
01537   604331452560
01540   545454606060
01541    0 00000 0 00000   ECHOT  PZE                        INDEX SAVED IN DECREMENT
                                  THE FOLLOWING SUBROUTINES ARE ON RELOCATABLE CARDS
                  01542    DBD1   BSS  136
                  01752    FILE   BSS  197
                  02257  BUFFER   BSS  14
                  02275    SQRT   BSS  25
                  02326    OUT    BSS  408
                                  DATA STORAGE
03156    0 00000 0 00000   D1                             NUMBER OF FORM FACTOR TABLES
03157    0 00000 0 00000   D2                             A*
03160    0 00000 0 00000   D3                             B*
03161    0 00000 0 00000   D4                             C*
03162    0 00000 0 00000   D5                             COS ALPHA*
03163    0 00000 0 00000   D6                             COS BETA*
03164    0 00000 0 00000   D7                             COS GAMMA*
                                  TEMPORARY STORAGE
03165    0 00000 0 00000   T1                             TOTAL NO OF ENTRIES IN TABLES
03166    0 00000 0 00000   T2                             HA*
03167    0 00000 0 00000   T3                             KB*
03170    0 00000 0 00000   T4                             LC*
03171    0 00000 0 00000   T5                             4(SIN THETA/LAMBDA)**2=Q
03172    0 00000 0 00000   T6                             SIGMA FOR BCD OUTPUT
```

```
03173  0 00000 0 00000  T7                        CURRENT VALUE OF S. SEE M6
03174  0 00000 0 00000  T8                        SIN THETA/LAMBDA
03175  0 00000 0 00000  T9                        (SIN THETA/LAMBDA)(1/DELTA)
03176  0 00000 0 00000  T10                       (U2)(D1-1)+1
03177  0 00000 0 00000  T11                       FRACTIONAL PART OF T9
                 03200  T12     BSS 12            OUTPUT HEADING
03214  0 00000 0 00000  T13                       EXTRA INPUT 1
03215  0 00000 0 00000  T14                       EXTRA INPUT 2
                         STORAGE FOR BINARY OUTPUT
03216  0 00000 0 00000  M1                        H
03217  0 00000 0 00000  M2                        K
03220  0 00000 0 00000  M3                        L
03221  0 00000 0 00000  M4                        OBSERVED F OR F SQUARED
03222  0 00000 0 00000  M5                        1/SIGMA=SQRT OF WEIGHT
03223  0 00000 0 00000  M6                        S, SCALE FACTOR DESIGNATION
03224  0 00000 0 00000  M7                        (SIN THETA/LAMBDA)**2=Q/4
03225  0 00000 0 00000  M8                        COMPUTED FORM FACTORS
                         THIS SECTION SUPPLIES ORIGIN CARDS FOR THE SUBROUTINES
                 00000           ORG 0
00000  0 00000 0 00000           PZE
00001  0 00000 0 01542           PZE DBD1
                 00000           ORG 0
00000  0 00000 0 00000           PZE
00001  0 00000 0 01752           PZE FILE
                 00000           ORG 0
00000  0 00000 0 00000           PZE
00001  0 00000 0 02275           PZE SQRT
                 00000           ORG 0
00000  0 00000 0 00000           PZE
00001  0 00000 0 02326           PZE OUT
                 00000           END 0
```

```
                                00144  RCD    EQU 100
                                00145  LDCD   EQU 101
                                00146  WTB    EQU 102
                                00160  KH     EQU 112
                                00161  KI     EQU 113
                                00004  U1     EQU 4                  NUMBER OF BINARY INPUT TAPE
                                00003  U2     EQU 3                  NUMBER OF BCD OUTPUT TAPE
                                00005  U3     EQU 5                  NUMBER OF BINARY OUTPUT TAPE
                                00455         ORG 301
00455   0 02000 0 00461  START  TRA XCA
00456   0 02000 0 03334         TRA XTD
00457   0 02000 0 05153         TRA DUMP
00460   0 02000 0 03164         TRA XSB
00461   0 76200 0 00321  XCA    RCD
00462   0 07400 4 05363         TSX DBD1,4
00463   0 00000 0 10406         PZE T55
00464   0 00000 0 00144         HTR RCD                            END OF FILE
00465   0 07400 4 05030         TSX IFF,4
00466   0 04357 0 10421         PZE T55+11,0,IT
00467   0 02000 0 00461         TRA XCA
00470   0 02000 0 02250  XCB    TRA XDA
00471   0 02000 0 02712  XCC    TRA XEB
00472   0 53400 1 10324  XRA    LXA T61,1                          OR TXI XCD
00473   0 53400 2 10316         LXA S10,2
00474   0 76200 0 00321  XRB    RCD
00475   0 07400 4 05363         TSX DBD1,4
00476   0 00000 0 06100         PZE BUFFER
00477   0 00000 0 00144         HTR RCD                            END OF FILE
00500   0 07400 4 05030         TSX IFF,4
00501   0 04354 0 06113         PZE BUFFER+11,0,IM
00502   0 02000 0 00474         TRA XRB
00503   0 07400 4 05135         TSX BLNK,4
00504   0 00010 0 06110         PZE BUFFER+8,0,8
00505   0 02000 0 00550         TRA XRI
00506   0 07400 4 05573  XRC    TSX FILE,4
00507  -2 00157 1 00000         MTW 0,1,111
00510  -2 03132 1 00002         MTW 2,1,1626
00511  -2 06105 1 00004         MTW 4,1,3141
00512  -0 01455 0 10435         MZE T63,0,813
00513  -0 04430 0 10436         MZE T63+1,0,2328
00514  -0 07403 0 10437         MZE T63+2,0,3843
00515  -0 01767 0 10440         MZE T63+3,0,1015
```

```
00516 -0 04742 0 10441          MZE T63+4,0,2530
00517 -0 07715 0 10442          MZE T63+5,0,4045
00520  0 00000 0 00144          HTR RCD                    ERROR RETURN FROM FILE
00521  0 53400 4 04340  XRD     LXA I3,4
00522  0 50000 0 04634  XRE     CLA C60
00523 -0 32000 4 10440          ANA T63+3,4
00524  0 10000 0 00532          TZE XRE1
00525  0 40200 0 04340          SUB I3
00526  0 56000 4 10440          LDQ T63+3,4
00527 -0 77300 0 00031          RQL 25
00530  0 16200 0 00532          TQP XRE1
00531  0 40200 0 04340          SUB I3
00532  0 76700 0 00022  XRE1    ALS 18
00533  0 60100 1 00001          STO 1,1
00534  0 50000 0 04634          CLA C60
00535 -0 32000 4 10443          ANA T63+6,4
00536  0 10000 0 00544          TZE XRE2
00537  0 40200 0 04340          SUB I3
00540  0 56000 4 10443          LDQ T63+6,4
00541 -0 77300 0 00031          RQL 25
00542  0 16200 0 00544          TQP XRE2
00543  0 40200 0 04340          SUB I3
00544 -0 60200 1 00001  XRE2    ORS 1,1
00545  1 77776 1 00546  XRF     TXI XRG,1,-2
00546  2 00001 4 00522  XRG     TIX XRE,4,1
00547  2 00001 2 00474  XRH     TIX XRB,2,1
00550  0 76200 0 00321  XRI     RCD
00551  0 07400 4 05363          TSX DBD1,4
00552  0 00000 0 06100          PZE BUFFER
00553  0 00000 0 00144          HTR RCD                    END OF FILE
00554  0 07400 4 05030          TSX IFF,4
00555  0 04352 0 06113          PZE BUFFER+11,0,IC
00556  0 02000 0 00550          TRA XRI
00557  0 07400 4 05135          TSX BLNK,4
00560  0 00013 0 06113          PZE BUFFER+11,0,11
00561  0 02000 0 00620          TRA XCD
00562  0 07400 4 05573          TSX FILE,4
00563 -2 01772 0 10462          MTW T78,0,1018
00564 -2 03607 0 10463          MTW T79,0,1927
00565 -2 05424 0 10464          MTW T80,0,2836
00566 -2 07241 0 10467          MTW T83,0,3745
00567 -2 11056 0 10466          MTW T82,0,4654
00570 -2 12673 0 10465          MTW T81,0,5563
```

```
00571  0 00000 0 00144          HTR RCD              ERROR RETURN FROM FILE
00572  0 56000 0 10462  XRJ     LDQ T78
00573  0 26000 0 10463          FMP T79
00574  0 60100 0 10473          STO T87
00575  0 56000 0 10462          LDQ T78
00576  0 26000 0 10464          FMP T80
00577  0 60100 0 10474          STO T88
00600  0 56000 0 10463          LDQ T79
00601  0 26000 0 10464          FMP T80
00602  0 60100 0 10475          STO T89
00603  0 53400 1 04340          LXA I3,1
00604  0 56000 1 10465  XRJ1    LDQ T78+3,1
00605  0 26000 1 10465          FMP T78+3,1
00606  0 60100 1 10473          STO T84+3,1
00607  0 56000 1 10476          LDQ T87+3,1
00610  0 26000 1 10470          FMP T81+3,1
00611  0 60100 1 10476          STO T87+3,1
00612  2 00001 1 00604          TIX XRJ1,1,1
00613  0 53400 1 04343          LXA I6,1
00614  0 56000 0 04752  XRJ2    LDQ C80
00615  0 26000 1 10476          FMP T84+6,1
00616  0 60100 1 10476          STO T84+6,1
00617  2 00001 1 00614          TIX XRJ2,1,1
00620  0 02000 0 03034  XCD     TRA XFB
00621  0 77200 0 00204  XCE     REW U1
00622  0 53400 4 04341          LXA I4,4
00623  0 76200 0 00224  XCE1    RTB U1
00624  0 76100 0 00000          NOP  CPY T69
00625  0 76100 0 00000          NOP  TRA XCE2
00626  0 76100 0 00000          NOP  HTR RCD         END OF FILE
00627  2 00001 4 00623  XCE2    TIX XCE1,4,1
00630  0 50000 0 05025  XCF     CLA C90              OR TRA XCG
00631  0 40200 0 10330          SUB T11
00632  0 77100 0 00001          ARS 1
00633  0 60100 0 10504          STO T96
00634  0 77100 0 00001          ARS 1
00635  0 40000 0 10504          ADD T96
00636  0 73400 1 00000          PAX 0,1
00637  0 77200 0 00205          REW U3
00640  0 76600 0 00225          WTB U3
00641  0 70000 0 04335  XCF1    CPY I0
00642  2 00001 1 00641          TIX XCF1,1,1
00643  0 53400 1 10504          LXA T96,1
```

```
00644   0 76600 0 00225          WTB U3
00645   0 70000 0 04335  XCF2    CPY I0
00646   2 00001 1 00645          TIX XCF2,1,1
00647   0 53400 1 05026          LXA C91,1
00650   0 76600 0 00225          WTB U3
00651   0 70000 0 04335  XCF3    CPY I0
00652   2 00001 1 00651          TIX XCF3,1,1
00653   0 53400 1 05027          LXA C92,1
00654   0 76600 0 00225          WTB U3
00655   0 70000 0 04335  XCF4    CPY I0
00656   2 00001 1 00655          TIX XCF4,1,1
00657   0 76600 0 00333          IOD
00660   0 53400 1 04343  XCG     LXA I6,1
00661   0 60000 1 10377  XCG1    STZ T42+6,1
00662   2 00001 1 00661          TIX XCG1,1,1
00663   0 60000 0 10444          STZ T65
00664   0 60000 0 10445          STZ T66
00665   0 60000 0 10500          STZ T92
00666   0 60000 0 05362  XCH     STZ SWTF8              OR TRA XA
00667   0 76000 0 00163          SWT 3
00670   0 02000 0 00672          TRA XCH1
00671   0 02000 0 00700          TRA XCH2
00672   0 07400 4 06147  XCH1    TSX OUT,4
00673   0 07400 4 05254          TSX ECHO,4
00674   3 23514 0 05005          PTH C86,0,10060
00675   3 06002 0 05021          PTH C88,0,3074
00676  -0 00027 0 04340          FOR I3,0,23
00677  -1 00000 0 00364          FVE 244
00700   0 07400 4 05336  XCH2    TSX SWTF,4
00701   0 00000 0 00707          PZE XCH3
00702   0 07400 4 06147          TSX OUT,4
00703   0 07400 4 05254          TSX ECHO,4
00704   3 27451 0 10406          PTH T55,0,12073
00705   3 02066 0 04362          PTH C3,0,1078
00706   1 00001 0 00003          PON U2,0,1
00707  -1 00000 0 00364  XCH3    FVE 244
00710   0 07400 4 05336  XCH4    TSX SWTF,4
00711   0 00000 0 00716          PZE XCH6
00712   0 07400 4 06147          TSX OUT,4
00713   0 07400 4 05254          TSX ECHO,4
00714   0 00000 0 00000  XCH5    PZE                    TO BE SET
00715   1 00000 0 00003          PON U2,0,0
00716  -1 00000 0 00364  XCH6    FVE 244
```

```
      00717   0 07400 4 05336  XCH7   TSX SWTF,4
      00720   0 00000 0 00724         PZE XCH8
      00721   0 07400 4 06147         TSX OUT,4
      00722   0 07400 4 05254         TSX ECH0,4
      00723   1 00060 0 00003         PON U2,0,48
      00724  -1 00000 0 00000  XCH8   FVE
      00725   0 53400 4 04340  XA     LXA I3,4
      00726   0 76200 0 00224  XA1    RTB U1
      00727  -0 76000 0 00012         RTT
      00730   0 76100 0 00000         NOP
      00731   0 53400 1 04344         LXA I7,1
      00732   0 70000 1 10514  XA2    CPY M1+7,1
TD    00733   1 00000 0 00736         TXI XA3
TD    00734   1 00000 0 02065         TXI XBI
      00735   0 00000 0 00144         HTR RCD          RECORD TOO SHORT
      00736   2 00001 1 00732  XA3    TIX XA2,1,1
      00737   0 53400 1 10313         LXA T4,1
      00740  -3 00000 1 00746         TXL XA5,1,0
      00741   0 53400 2 10330         LXA T11,2
      00742   0 70000 2 00000  XA4    CPY 0,2
      00743  -2 00001 1 00746         TNX XA5,1,1
      00744   1 77777 2 00742         TXI XA4,2,-1
      00745   0 00000 0 00144         HTR RCD          RECORD TOO SHORT
      00746   0 53400 1 04346  XA5    LXA I9,1
      00747   0 70000 1 10525  XA6    CPY M8+9,1
      00750   2 00001 1 00747         TIX XA6,1,1
TD    00751   1 00000 0 00753         TXI XA7
TD    00752   1 00000 0 00757         TXI XA9
      00753   0 53400 1 10327  XA7    LXA T8,1
      00754   0 70000 1 00000  XA8    CPY 0,1
      00755   1 77777 1 00754         TXI XA8,1,-1
      00756   0 00000 0 00000         PZE
      00757   0 76600 0 00333  XA9    IOD
      00760  -0 76000 0 00012         RTT
TD    00761   1 00000 0 00763         TXI XA10
TD    00762   1 00000 0 00767         TXI XB
      00763   0 76400 0 00204  XA10   BST U1
      00764   2 00001 4 00726         TIX XA1,4,1
      00765   0 76200 0 00224         RTB U1
      00766   0 00000 0 00725         HTR XA           RTT FAILS 3 TIMES. START TO SKIP RECORD
      00767   0 53400 1 10332  XB     LXA T10,1
      00770   0 53400 2 10326         LXA T7,2
      00771   0 60000 2 00000  XB1    STZ 0,2
```

```
00772 -2 00001 1 00774        TNX XC,1,1
00773  1 77777 2 00771        TXI XB1,2,-1
00774  0 53400 4 10316  XC     LXA T1,4
00775  0 53400 1 10324        LXA T61,1
00776 -0 63400 1 10434        SXD T62,1
00777  0 76100 0 00000  XD     NOP                    OR TRA XD1
01000 -0 63400 4 10353  XE     SXD T28,4
01001  0 60000 0 10333  XF     STZ T12                OR TRA XH
01002  0 53400 4 04343        LXA I6,4
01003  0 60000 4 10434  XF1    STZ T60+6,4
01004  2 00001 4 01003        TIX XF1,4,1
01005  0 53400 1 04340        LXA I3,1
01006 -0 53400 2 10434        LXD T62,2
01007  0 56000 1 10510  XF2    LDQ M1+3,1
01010  0 26000 2 00000        FMP 0,2
01011  0 30000 0 10333        FAD T12
01012  0 60100 0 10333        STO T12
01013  0 50000 2 00001        CLA 1,2
01014 -0 73400 4 00000        PDX 0,4
01015 -3 00000 4 01021        TXL XF3,4,0
01016  0 50000 1 10510        CLA M1+3,1
01017  0 30000 4 10434        FAD T60+6,4
01020  0 60100 4 10434        STO T60+6,4
01021  0 50000 2 00001  XF3    CLA 1,2
01022  0 73400 4 00000        PAX 0,4
01023 -3 00000 4 01027        TXL XF4,4,0
01024  0 50000 1 10510        CLA M1+3,1
01025  0 30000 4 10434        FAD T60+6,4
01026  0 60100 4 10434        STO T60+6,4
01027  1 77776 2 01030  XF4    TXI XF5,2,-2
01030  2 00001 1 01007  XF5    TIX XF2,1,1
01031 -0 63400 2 10434        SXD T62,2
01032  0 53400 1 04340        LXA I3,1
01033  0 53400 2 04335        LXA I0,2
01034  0 50200 1 10431  XF6    CLS T60+3,1
01035  0 30000 1 10434        FAD T60+6,1
01036  0 60100 2 10336        STO T15,2
01037  1 00001 2 01040        TXI XF7,2,1
01040  2 00001 1 01034  XF7    TIX XF6,1,1
TD 01041  1 00000 0 01070  XG     TXI XH                 OR LXA I3,1
01042  0 56000 1 10337  XG1    LDQ T13+3,1
01043  0 26000 1 10337        FMP T13+3,1
01044  0 60100 1 10342        STO T16+3,1
```

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01045   2 00001 1 01042          TIX XG1,1,1
01046   0 56000 0 10334          LDQ T13
01047   0 26000 0 10335          FMP T14
01050   0 60100 0 10342          STO T19
01051   0 56000 0 10342          LDQ T19
01052   0 26000 0 04366          FMP C7
01053   0 60100 0 10342          STO T19
01054   0 56000 0 10334          LDQ T13
01055   0 26000 0 10336          FMP T15
01056   0 60100 0 10343          STO T20
01057   0 56000 0 10343          LDQ T20
01060   0 26000 0 04366          FMP C7
01061   0 60100 0 10343          STO T20
01062   0 56000 0 10335          LDQ T14
01063   0 26000 0 10336          FMP T15
01064   0 60100 0 10344          STO T21
01065   0 56000 0 10344          LDQ T21
01066   0 26000 0 04366          FMP C7
01067   0 60100 0 10344          STO T21
01070   0 53400 4 10314  XH      LXA T2,4
01071   0 53400 2 10325          LXA T6,2
01072   0 53400 1 10326          LXA T7,1
01073   0 76100 0 00000  XI      NOP                    INSERT TRANSFER TO HANDLE SPECIAL POSITIONS
01074  -0 63400 4 10346          SXD T23,4
01075   0 50000 0 10333          CLA T12
01076   0 60100 0 10345          STO T22
01077   0 53400 4 04340          LXA I3,4
01100   1 77777 2 01101          TXI XI1,2,-1
01101   0 56000 2 00000  XI1     LDQ 0,2
01102   0 26000 4 10337          FMP T13+3,4
01103   0 30000 0 10345          FAD T22
01104   0 60100 0 10345          STO T22
01105   1 77777 2 01106          TXI XI2,2,-1
01106   2 00001 4 01101  XI2     TIX XI1,4,1
01107   0 07400 4 06777          TSX SIN,4
01110   0 60100 0 10347          STO T24
01111   0 50000 0 10345          CLA T22
01112   0 07400 4 07000          TSX SIN+1,4
01113   0 60100 0 10350          STO T25
01114   1 77777 2 01135  XJ      TXI XK,2,-1            OR LXA I6,4
01115   0 60000 0 10351          STZ T26
01116   0 56000 2 00000  XJ1     LDQ 0,2
01117   0 26000 4 10345          FMP T16+6,4
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01120  0 30000 0 10351        FAD T26
01121  0 60100 0 10351        STO T26
01122  1 77777 2 01123        TXI XJ2,2,-1
01123  2 00001 4 01116  XJ2   TIX XJ1,4,1
01124  0 07400 4 07027        TSX EXP,4
01125  0 00000 0 00144        HTR RCD          NEGATIVE ANIS TEMP FACTOR
01126  0 60100 0 10352        STQ T27
01127  0 56000 0 10352        LDQ T27
01130  0 26000 0 10347        FMP T24
01131  0 60100 0 10347        STQ T24
01132  0 56000 0 10352        LDQ T27
01133  0 26000 0 10350        FMP T25
01134  0 60100 0 10350        STQ T25
01135  0 50000 0 10350  XK    CLA T25
01136  0 30000 1 00000        FAD 0,1
01137  0 60100 1 00000        STQ 0,1
01140  1 77777 1 01141        TXI XL,1,-1
01141  0 53400 4 04340  XL    LXA I3,4         OR TXI XN
01142  0 56000 0 10347  XL1   LDQ T24
01143  0 26000 4 10337        FMP T13+3,4
01144  0 30000 1 00000        FAD 0,1
01145  0 60100 1 00000        STQ 0,1
01146  1 77777 1 01147        TXI XL2,1,-1
01147  2 00001 4 01142  XL2   TIX XL1,4,1
01150  1 77777 1 01157  XM    TXI XN,1,-1      OR LXA I6,4
01151  0 56000 0 10350  XM1   LDQ T25
01152  0 26000 4 10345        FMP T16+6,4
01153  0 30000 1 00000        FAD 0,1
01154  0 60100 1 00000        STQ 0,1
01155  1 77777 1 01156        TXI XM2,1,-1
01156  2 00001 4 01151  XM2   TIX XM1,4,1
TD 01157  1 00000 0 01201  XN    TXI XQ           OR CLA T24
01160  0 30000 1 00000        FAD 0,1
01161  0 60100 1 00000        STQ 0,1
01162  1 77777 1 01163        TXI XO,1,-1
01163  0 53400 4 04340  XO    LXA I3,4         OR TXI XQ
01164  0 56000 0 10350  XO1   LDQ T25
01165  0 26000 4 10337        FMP T13+3,4
01166  0 30000 1 00000        FAD 0,1
01167  0 60100 1 00000        STO 0,1
01170  1 77777 1 01171        TXI XO2,1,-1
01171  2 00001 4 01164  XO2   TIX XO1,4,1
01172  1 77777 1 01201  XP    TXI XQ,1,-1      OR LXA I6,4
```

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01173   0 56000 0 10347  XP1    LDQ T24
01174   0 26000 4 10345         FMP T16+6,4
01175   0 30000 1 00000         FAD 0,1
01176   0 60100 1 00000         STO 0,1
01177   1 77777 1 01200         TXI XP2,1,-1
01200   2 00001 4 01173  XP2    TIX XP1,4,1
01201  -0 53400 4 10346  XQ     LXD T23,4
01202   2 00001 4 01073         TIX XI,4,1
01203  -0 53400 4 10353  XR     LXD T28,4
01204   2 00001 4 00777         TIX XD,4,1
01205   0 53400 4 10314  XS     LXA T2,4
01206   0 53400 2 10325         LXA T6,2
01207   0 53400 1 10326         LXA T7,1
01210   0 50000 0 04335  XS1    CLA I0          OR TRA XS2
01211   0 56000 0 04335         LDQ I0
01212   0 02000 0 01215         TRA XS3
01213   0 50000 0 10514  XS2    CLA M8
01214   0 56000 0 10515         LDQ M9
01215   0 60100 0 10516  XS3    STO M10
01216  -0 60000 0 10517         STQ M11
01217  -0 63400 4 10346  XT     SXD T23,4
01220   0 50000 2 00000  XU     CLA 0,2
01221  -0 76000 0 00003  XU1    SSM             OR TXI XU2
01222   0 40000 0 10330         ADD T11
01223   0 40000 0 04336         ADD I1
01224   0 73400 4 00000         PAX 0,4
01225   0 50000 4 00000         CLA 0,4
01226   0 60100 0 10354  XU2    STO T29
01227   0 56000 0 10513  XV     LDQ M7          OR TXI XW,2,-10
01230   0 26000 2 00004         FMP 4,2
01231   0 07400 4 07027         TSX EXP,4
01232   0 00000 0 00144         HTR RCD         NEGATIVE SYMM TEMP FACTOR
01233   0 60100 0 10355         STO T30
01234   0 56000 0 10355         LDQ T30
01235   0 26000 0 10354         FMP T29
01236   0 60100 0 10354         STO T29
01237   1 77773 2 01242         TXI XX,2,-5
01240   0 50000 0 04360  XW     CLA C1
01241   0 60100 0 10355         STO T30
01242   0 56000 0 10354  XX     LDQ T29
01243   0 26000 1 00000         FMP 0,1
01244   0 60100 0 10356         STO T31
01245   0 30000 0 10516         FAD M10
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01246  0 60100 0 10516        STO M10
01247  0 56000 0 10355  XY    LDQ T30              OR TXI XAB,1,-1
01250  0 26000 1 00000        FMP 0,1
01251  0 60100 1 00000        STO 0,1
01252  1 77777 1 01253        TXI XY1,1,-1
01253  0 56000 0 10354  XY1   LDQ T29
01254  0 26000 0 04361        FMP C2
01255  0 60100 0 10360        STO T33
01256  0 76000 0 00002        GHS
01257  0 60100 0 10361        STO T34
01260  0 53400 4 04340        LXA I3,4
01261  0 56000 0 10361  XY2   LDQ T34
01262  0 26000 1 00000        FMP 0,1
01263  0 60100 1 00000        STO 0,1
01264  1 77777 1 01265        TXI XY3,1,-1
01265  2 00001 4 01261  XY3   TIX XY2,4,1
01266  0 56000 0 10356  XZ    LDQ T31              OR TXI XAA
01267  0 26000 0 10513        FMP M7
01270  0 76000 0 00002        GHS
01271  0 60100 1 00000        STO 0,1
01272  1 77777 1 01303        TXI XAB,1,-1
01273  0 50200 0 10354  XAA   GLS T29
01274  0 60100 0 10362        STO T35
01275  0 53400 4 04343        LXA I6,4
01276  0 56000 0 10362  XAA1  LDQ T35
01277  0 26000 1 00000        FMP 0,1
01300  0 60100 1 00000        STO 0,1
01301  1 77777 1 01302        TXI XAA2,1,-1
01302  2 00001 4 01276  XAA2  TIX XAA1,4,1
TD 01303  1 00000 0 01335  XAB   TXI XAF              OR LDQ T29
01304  0 26000 1 00000        FMP 0,1
01305  0 60100 0 10357        STO T32
01306  0 30000 0 10517        FAD M11
01307  0 60100 0 10517        STO M11
01310  0 56000 0 10355  XAC   LDQ T30              OR TXI XAF,1,-1
01311  0 26000 1 00000        FMP 0,1
01312  0 60100 1 00000        STO 0,1
01313  1 77777 1 01314        TXI XAC1,1,-1
01314  0 53400 4 04340  XAC1  LXA I3,4
01315  0 56000 0 10360  XAC2  LDQ T33
01316  0 26000 1 00000        FMP 0,1
01317  0 60100 1 00000        STO 0,1
01320  1 77777 1 01321        TXI XAC3,1,-1
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01321   2 00001 4 01315  XAC3   TIX XAG2,4,1
01322   0 56000 0 10357  XAD    LDQ T32                 OR TXI XAE
01323   0 26000 0 10513         FMP M7
01324   0 76000 0 00002         CHS
01325   0 60100 1 00000         STO 0,1
01326   1 77777 1 01335         TXI XAF,1,-1
01327   0 53400 4 04343  XAE    LXA I6,4
01330   0 56000 0 10362  XAE1   LDQ T35
01331   0 26000 1 00000         FMP 0,1
01332   0 60100 1 00000         STO 0,1
01333   1 77777 1 01334         TXI XAE2,1,-1
01334   2 00001 4 01330  XAE2   TIX XAE1,4,1
01335  -0 53400 4 10346  XAF    LXD T23,4
01336   2 00001 4 01217         TIX XT,4,1
01337   0 56000 0 10513  XAG    LDQ M7
01340   0 26000 0 00000  XAG1   FMP 0                   ADDRESS TO BE SET
01341   0 07400 4 07027         TSX EXP,4
01342   0 00000 0 00144         HTR RCD                 NEGATIVE OVERALL TEMP FACTOR
01343   0 60100 0 10363         STQ T36
01344   0 50000 0 10525         CLA T5
01345   0 40000 0 10512         ADD M6
01346   0 62100 0 01347         STA XAG2
01347   0 56000 0 00000  XAG2   LDQ 0                   ADDRESS TO BE SET
01350  -0 60000 0 10364         STQ T37
01351   0 26000 0 10363         FMP T36
01352   0 60100 0 10363         STO T36
TD 01353   1 00000 0 01354  XAH    TXI XAI                 OR TXI XAK
01354   0 50000 0 10363  XAI    CLA T36                 OR TXI XAJ
01355   0 30000 0 10363         FAD T36
01356   0 60100 0 10365         STO T38
01357   0 56000 0 10365         LDQ T38
01360   0 26000 0 10516         FMP M10
01361   0 60100 0 10520         STO M12
TD 01362   1 00000 0 01463         TXI XAM
01363   0 56000 0 10516  XAJ    LDQ M10
01364   0 26000 0 10516         FMP M10
01365   0 60100 0 10367         STO T40
01366   0 56000 0 10517         LDQ M11
01367   0 26000 0 10517         FMP M11
01370   0 30000 0 10367         FAD T40
01371  -0 10000 0 01376         TNZ XAJ1
01372   0 60000 0 10520         STZ M12
01373   0 60000 0 10365         STZ T38
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        01374   0 60000 0 10366          STZ T39
TD      01375   1 00000 0 01463          TXI XAM
        01376   0 07400 4 06116  XAJ1    TSX SQRT.4
        01377   0 00000 0 00144          HTR RCD          NEGATIVE RADICAND
        01400   0 60100 0 10367          STO T40
        01401   0 56000 0 10367          LDQ T40
        01402   0 26000 0 10363          FMP T36
        01403   0 60100 0 10520          STO M12
        01404   0 50000 0 10363          CLA T36
        01405   0 24000 0 10367          FDH T40
        01406  -0 60000 0 10366          STQ T39
        01407   0 26000 0 10516          FMP M10
        01410   0 60100 0 10365          STO T38
        01411   0 56000 0 10366          LDQ T39
        01412   0 26000 0 10517          FMP M11
        01413   0 60100 0 10366          STQ T39
TD      01414   1 00000 0 01463          TXI XAM
        01415   0 50000 0 10363  XAK     CLA T36          OR TXI XAL
        01416   0 30000 0 10363          FAD T36
        01417   0 60100 0 10365          STQ T38
        01420   0 56000 0 10365          LDQ T38
        01421   0 26000 0 10365          FMP T38
        01422   0 60100 0 10365          STO T38
        01423   0 56000 0 10365          LDQ T38
        01424   0 26000 0 10516          FMP M10
        01425   0 60100 0 10365          STO T38
        01426   0 56000 0 10365          LDQ T38
        01427   0 26000 0 10516          FMP M10
        01430   0 60100 0 10520          STO M12
        01431   0 50000 0 10365          CLA T38
        01432   0 30000 0 10365          FAD T38
        01433   0 60100 0 10365          STO T38
TD      01434   1 00000 0 01473          TXI XAN
        01435   0 56000 0 10363  XAL     LDQ T36
        01436   0 26000 0 10363          FMP T36
        01437   0 60100 0 10365          STO T38
        01440   0 30000 0 10365          FAD T38
        01441   0 60100 0 10366          STO T39
        01442   0 56000 0 10516          LDQ M10
        01443   0 26000 0 10516          FMP M10
        01444   0 60100 0 10367          STO T40
        01445   0 56000 0 10517          LDQ M11
        01446   0 26000 0 10517          FMP M11
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      01447   0 30000 0 10367         FAD  T40
      01450   0 60100 0 10367         STO  T40
      01451   0 56000 0 10367         LDQ  T40
      01452   0 26000 0 10365         FMP  T38
      01453   0 60100 0 10520         STO  M12
      01454   0 56000 0 10516         LDQ  M10
      01455   0 26000 0 10366         FMP  T39
      01456   0 60100 0 10365         STO  T38
      01457   0 56000 0 10517         LDQ  M11
      01460   0 26000 0 10366         FMP  T39
      01461   0 60100 0 10366         STO  T39
TD    01462   1 00000 0 01473         TXI  XAN
      01463   0 50000 0 10520  XAM    CLA  M12          OR TXI XAW
      01464   0 24000 0 10364         FDH  T37
      01465  -0 60000 0 10523         STQ  M15
      01466   0 56000 0 10513         LDQ  M7
      01467   0 26000 0 10520         FMP  M12
      01470   0 76000 0 00002         GHS
      01471   0 60100 0 10524         STO  M16
TD    01472   1 00000 0 01507         TXI  XAO
      01473   0 50000 0 10520  XAN    CLA  M12          OR TXI XAW
      01474   0 24000 0 10364         FDH  T37
      01475  -0 60000 0 10523         STQ  M15
      01476   0 50000 0 10523         CLA  M15
      01477   0 30000 0 10523         FAD  M15
      01500   0 60100 0 10523         STO  M15
      01501   0 56000 0 10513         LDQ  M7
      01502   0 26000 0 10520         FMP  M12
      01503   0 76000 0 00002         GHS
      01504   0 60100 0 10524         STO  M16
      01505   0 30000 0 10524         FAD  M16
      01506   0 60100 0 10524         STO  M16
      01507   0 53400 4 10314  XAO    LXA  T2,4
      01510   0 53400 2 10326         LXA  T7,2
      01511   0 53400 1 10327         LXA  T8,1
      01512  -0 63400 4 10346  XAP    SXD  T23,4
      01513   0 53400 4 10370         LXA  T41,4
      01514   0 56000 0 10365  XAQ    LDQ  T38
      01515   0 26000 2 00000         FMP  0,2
      01516   0 60100 1 00000         STO  0,1
TD    01517   1 00000 0 01523  XAR    TXI  XAS          OR LDQ T39
      01520   0 26000 2 00000  XAR1   FMP  0,2          ADDRESS TO BE SET
      01521   0 30000 1 00000         FAD  0,1
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   01522  0 60100 1 00000         STO 0,1
   01523  1 77777 2 01524  XAS    TXI XAS1,2,-1
   01524  1 77777 1 01525  XAS1   TXI XAT,1,-1
   01525  2 00001 4 01514  XAT    TIX XAQ,4,1
   01526 -0 53400 4 10346  XAU    LXD T23,4
   01527 -2 00001 4 01533         TNX XAW,4,1
TD 01530  1 00000 0 01512  XAV    TXI XAP                 OR NOP
   01531  2 00000 2 01512  XAV1   TIX XAP,2,0             DECREMENT TO BE SET
   01532  0 00000 0 00144         HTR RCD                 LOOKING FOR STORAGE THRU ZERO
   01533  0 50000 0 10510  XAW    CLA M4                  OR TXI XBK
   01534  0 56000 0 10520  XAW1   LDQ M12                 OR TXI XAW3
   01535  0 16200 0 01540         TQP XAW2
   01536 -0 76000 0 00003         SSM
TD 01537  1 00000 0 01541         TXI XAW3
   01540  0 76000 0 00003  XAW2   SSP
   01541  0 30200 0 10520  XAW3   FSB M12
   01542  0 60100 0 10521         STO M13
   01543  0 76000 0 00003         SSP
   01544  0 30000 0 10371         FAD T42
   01545  0 60100 0 10371         STO T42
   01546  0 56000 0 10511         LDQ M5
   01547  0 26000 0 10521         FMP M13
   01550  0 60100 0 10377         STO T48
   01551  0 56000 0 10377         LDQ T48
   01552  0 26000 0 10377         FMP T48
   01553  0 60100 0 10423         STO T57
   01554  0 30000 0 10373         FAD T44
   01555  0 60100 0 10373         STO T44
   01556  0 50000 0 10510         CLA M4
   01557  0 10000 0 01567         TZE XAW4
   01560  0 50000 0 10521         CLA M13
   01561  0 76000 0 00003         SSP
   01562  0 30000 0 10372         FAD T43
   01563  0 60100 0 10372         STO T43
   01564  0 50000 0 10423         CLA T57
   01565  0 30000 0 10374         FAD T45
   01566  0 60100 0 10374         STO T45
   01567  0 50000 0 10510  XAW4   CLA M4
   01570  0 76000 0 00003         SSP
   01571  0 30000 0 10375         FAD T46
   01572  0 60100 0 10375         STO T46
   01573  0 56000 0 10510         LDQ M4
   01574  0 26000 0 10511         FMP M5
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01575   0 60100 0 10400          STO T49
01576   0 56000 0 10400          LDQ T49
01577   0 26000 0 10400          FMP T49
01600   0 60100 0 10400          STO T49
01601   0 30000 0 10376          FAD T47
01602   0 60100 0 10376          STO T47
01603   0 60000 0 10522  XAX     STZ M14          OR REJECTION TEST
01604   0 02000 0 01705          TRA XAXX
                  01605          BSS 64
01705   0 50000 0 10522  XAXX    CLA M14
01706  -0 10000 0 01717          TNZ XAY
01707   0 50000 0 10511          CLA M5
01710   0 10000 0 01717          TZE XAY
01711   0 50000 0 10444          CLA T65
01712   0 30000 0 04360          FAD C1
01713   0 60100 0 10444          STO T65
01714   0 50000 0 10445          CLA T66
01715   0 30000 0 10423          FAD T57
01716   0 60100 0 10445          STO T66
01717   0 50000 0 10377  XAY     CLA T48          OR TXI XBH
01720   0 76000 0 00003          SSP
01721   0 30200 0 04366          FSB C7
01722   0 12000 0 01732          TPL XBC
01723   0 50000 0 10522  XAZ     CLA M14
01724   0 10000 0 01727          TZE XBB
01725   0 50000 0 04363  XBA     CLA C4
TD 01726   1 00000 0 01737          TXI XBF
01727   0 50000 0 04362  XBB     CLA C3
01730   0 60100 0 10401          STO T50
TD 01731   1 00000 0 01740  XBB1    TXI XBG          OR TXI XBH
01732   0 50000 0 10522  XBC     CLA M14
01733   0 10000 0 01736          TZE XBE
01734   0 50000 0 04365  XBD     CLA C6
TD 01735   1 00000 0 01737          TXI XBF
01736   0 50000 0 04364  XBE     CLA C5
01737   0 60100 0 10401  XBF     STO T50
01740   0 07400 4 05336  XBG     TSX SWTF,4       OR TRA XBG2,4, OR 6
01741   0 00000 0 01753          PZE XBG1
01742   0 07400 4 06147          TSX OUT,4
01743   0 07400 4 05254          TSX ECHO,4
01744   3 03734 0 04367          PTH C9,0,2012
01745  -3 00004 0 10505          SVN M1,0,4
01746  -3 00010 0 10506          SVN M2,0,8
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01747 -3 00014 0 10507          SVN M3,0,12
01750 -3 05721 0 10520          SVN M12,0,3025
01751 -3 05736 0 10516          SVN M10,0,3038
01752  1 00060 0 00003          PON U2,0,48
01753 -1 00000 0 00000  XBG1    FVE
01754  0 02000 0 02035          TRA XBH
01755  0 07400 4 05336  XBG2    TSX SWTF,4
01756  0 00000 0 01771          PZE XBG3
01757  0 07400 4 06147          TSX OUT,4
01760  0 07400 4 05254          TSX ECHO,4
01761  3 03734 0 04367          PTH C9,0,2012
01762 -3 00004 0 10505          SVN M1,0,4
01763 -3 00010 0 10506          SVN M2,0,8
01764 -3 00014 0 10507          SVN M3,0,12
01765 -3 05721 0 10520          SVN M12,0,3025
01766 -3 05736 0 10516          SVN M10,0,3038
01767 -3 05753 0 10517          SVN M11,0,3051
01770  1 00060 0 00003          PON U2,0,48
01771 -1 00000 0 00000  XBG3    FVE
01772  0 02000 0 02035          TRA XBH
01773  0 07400 4 05336  XBG4    TSX SWTF,4
01774  0 00000 0 02012          PZE XBG5
01775  0 07400 4 06147          TSX OUT,4
01776  0 07400 4 05254          TSX ECHO,4
01777  3 03734 0 04367          PTH C9,0,2012
02000 -3 00004 0 10505          SVN M1,0,4
02001 -3 00010 0 10506          SVN M2,0,8
02002 -3 00014 0 10507          SVN M3,0,12
02003 -3 05721 0 10510          SVN M4,0,3025
02004 -3 05736 0 10520          SVN M12,0,3038
02005 -3 05753 0 10516          SVN M10,0,3051
02006 -3 05770 0 10521          SVN M13,0,3064
02007 -3 04033 0 10377          SVN T48,0,2075
02010  3 02072 0 10401          PTH T50,0,1082
02011  1 00060 0 00003          PON U2,0,48
02012 -1 00000 0 00000  XBG5    FVE
02013  0 02000 0 02035          TRA XBH
02014  0 07400 4 05336  XBG6    TSX SWTF,4
02015  0 00000 0 02034          PZE XBG7
02016  0 07400 4 06147          TSX OUT,4
02017  0 07400 4 05254          TSX ECHO,4
02020  3 03734 0 04367          PTH C9,0,2012
02021 -3 00004 0 10505          SVN M1,0,4
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02022 -3 00010 0 10506          SVN M2,0,8
02023 -3 00014 0 10507          SVN M3,0,12
02024 -3 05721 0 10510          SVN M4,0,3025
02025 -3 05736 0 10520          SVN M12,0,3038
02026 -3 05753 0 10516          SVN M10,0,3051
02027 -3 05770 0 10517          SVN M11,0,3064
02030 -3 06005 0 10521          SVN M13,0,3077
02031 -3 04050 0 10377          SVN T48,0,2088
02032  3 02107 0 10401          PTH T50,0,1095
02033  1 00060 0 00003          PON U2,0,48
02034 -1 00000 0 00000  XBG7    FVE
02035  0 76600 0 00225  XBH     WTB U3                  OR TXI XA
02036  0 53400 1 04344          LXA I7,1
02037  0 70000 1 10514  XBH1    CPY M1+7,1
02040  2 00001 1 02037          TIX XBH1,1,1
02041  0 53400 1 10313          LXA T4,1
02042 -3 00000 1 02047          TXL XBH3,1,0
02043  0 53400 2 10330          LXA T11,2
02044  0 70000 2 00000  XBH2    CPY 0,2
02045 -2 00001 1 02047          TNX XBH3,1,1
02046  1 77777 2 02044          TXI XBH2,2,-1
02047  0 70000 0 10514  XBH3    CPY M8
02050  0 70000 0 10515          CPY M9
02051  0 70000 0 10516  XBH4    CPY M10                 OR TXI XA
02052  0 70000 0 10517          CPY M11
02053  0 70000 0 10520          CPY M12
02054  0 70000 0 10521  XBH5    CPY M13                 OR TXI XA
02055  0 70000 0 10522          CPY M14
02056  0 70000 0 10523          CPY M15
02057  0 70000 0 10524          CPY M16
02060  0 53400 1 10331          LXA T9,1
02061  0 53400 2 10327          LXA T8,2
02062  0 70000 2 00000  XBH6    CPY 0,2
02063 -2 00001 1 00725          TNX XA,1,1
02064  1 77777 2 02062          TXI XBH6,2,-1
02065  0 50000 0 10375  XBI     CLA T46                 OR TRA XSA
02066 -0 10000 0 02072          TNZ XBI1
02067  0 60000 0 10402          STZ T51
02070  0 60000 0 10403          STZ T52
TD  02071  1 00000 0 02100      TXI XBI2
02072  0 50000 0 10371  XBI1    CLA T42
02073  0 24000 0 10375          FDH T46
02074 -0 60000 0 10402          STQ T51
```

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02075   0 50000 0 10372          CLA T43
02076   0 24000 0 10375          FDH T46
02077  -0 60000 0 10403          STQ T52
02100   0 50000 0 10373  XBI2    CLA T44
02101   0 07400 4 06116          TSX SQRT,4
02102   0 00000 0 00144          HTR RCD                 NEGATIVE RADICAND
02103   0 60100 0 10373          STO T44
02104   0 50000 0 10374          CLA T45
02105   0 07400 4 06116          TSX SQRT,4
02106   0 00000 0 00144          HTR RCD                 NEGATIVE RADICAND
02107   0 60100 0 10374          STO T45
02110   0 50000 0 10376          CLA T47
02111   0 07400 4 06116          TSX SQRT,4
02112   0 00000 0 00144          HTR RCD                 NEGATIVE RADICAND
02113   0 60100 0 10376          STO T47
02114  -0 10000 0 02120          TNZ XBI3
02115   0 60000 0 10404          STZ T53
02116   0 60000 0 10405          STZ T54
TD  02117   1 00000 0 02126      TXI XBI4
02120   0 50000 0 10373  XBI3    CLA T44
02121   0 24000 0 10376          FDH T47
02122  -0 60000 0 10404          STQ T53
02123   0 50000 0 10374          CLA T45
02124   0 24000 0 10376          FDH T47
02125  -0 60000 0 10405          STQ T54
02126   0 07400 4 06147  XBI4    TSX OUT,4
02127   0 07400 4 05254          TSX ECHO,4
02130   3 27451 0 10406          PTH T55,0,12073
02131   3 02066 0 04362          PTH C3,0,1078
02132   1 00001 0 00003          PON U2,0,1
02133  -1 00000 0 00364          FVE 244
02134   0 07400 4 06147          TSX OUT,4
02135   0 07400 4 05254          TSX ECHO,4
02136   3 17560 0 04766          PTH C83,0,8048
02137   3 11727 0 04371          PTH C19,0,5079
02140   1 00000 0 00003          PON U2,0,0
02141  -1 00000 0 00364          FVE 244
02142   0 07400 4 06147          TSX OUT,4
02143   0 07400 4 05254          TSX ECHO,4
02144   3 03734 0 04376          PTH C20,0,2012
02145   3 05724 0 04403          PTH C22,0,3028
02146  -3 05762 0 10371          SVN T42,0,3058
02147  -3 05777 0 10375          SVN T46,0,3071
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02150 -3 06011 0 10402        SVN T51,0,3081
02151  1 00000 0 00003        PON U2,0,0
02152 -1 00000 0 00364        FVE 244
02153  0 07400 4 06147        TSX OUT,4
02154  0 07400 4 05254        TSX ECHO,4
02155  3 03734 0 04376        PTH C20,0,2012
02156  3 05724 0 04406        PTH C23,0,3028
02157 -3 05762 0 10372        SVN T43,0,3058
02160 -3 05777 0 10375        SVN T46,0,3071
02161 -3 06011 0 10403        SVN T52,0,3081
02162  1 00000 0 00003        PON U2,0,0
02163 -1 00000 0 00364        FVE 244
02164  0 07400 4 06147        TSX OUT,4
02165  0 07400 4 05254        TSX ECHO,4
02166  3 05712 0 04400        PTH C21,0,3018
02167  3 05735 0 04403        PTH C22,0,3037
02170 -3 05762 0 10373        SVN T44,0,3058
02171 -3 05777 0 10376        SVN T47,0,3071
02172 -3 06011 0 10404        SVN T53,0,3081
02173  1 00000 0 00003        PON U2,0,0
02174 -1 00000 0 00364        FVE 244
02175  0 07400 4 06147        TSX OUT,4
02176  0 07400 4 05254        TSX ECHO,4
02177  3 05712 0 04400        PTH C21,0,3018
02200  3 05735 0 04406        PTH C23,0,3037
02201 -3 05762 0 10374        SVN T45,0,3058
02202 -3 05777 0 10376        SVN T47,0,3071
02203 -3 06011 0 10405        SVN T54,0,3081
02204  1 00000 0 00003        PON U2,0,0
02205 -1 00000 0 00364        FVE 244
02206  0 50000 0 10444        CLA T65
02207  0 30200 0 10446        FSB T67
02210 -0 12000 0 02237        TMI XB111
02211  0 10000 0 02237        TZE XB111
02212  0 60100 0 10447        STO T68
02213  0 50000 0 10445        CLA T66
02214  0 24000 0 10447        FDH T68
02215 -0 60000 0 10447        STQ T68
02216  0 50000 0 10445        CLA T66
02217  0 07400 4 06116        TSX SQRT,4
02220  0 00000 0 00144        HTR RCD          NEGATIVE RADICAND
02221  0 60100 0 10503        STO T95
02222  0 50000 0 10447        CLA T68
```

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02223   0 07400 4 06116          TSX SQRT,4
02224   0 00000 0 00144          HTR RCD                 NEGATIVE RADICAND
02225   0 60100 0 10447          STO T68
02226   0 07400 4 06147          TSX OUT,4
02227   0 07400 4 05254          TSX ECHO,4
02230   3 31426 0 04650          PTH C63,0,13078
02231  -3 05762 0 10503          SVN T95,0,3058
02232  -3 00104 0 10444          SVN T65,0,68
02233  -3 00110 0 10446          SVN T67,0,72
02234  -3 06011 0 10447          SVN T68,0,3081
02235   1 00000 0 00003          PON U2,0,0
02236  -1 00000 0 00364          FVE 244
02237   0 07400 4 06147  XBI11   TSX OUT,4
02240   0 07400 4 05254          TSX ECHO,4
02241  -1 00000 0 00361          FVE 241
02242   0 02000 0 03162          TRA XSA
02243   0 50000 0 10516  XBK     CLA M10                 OR TXI XAY
02244   0 60100 0 10514          STO M8
02245   0 50000 0 10517          CLA M11
02246   0 60100 0 10515          STO M9
TD 02247   1 00000 0 01717       TXI XAY
02250   0 76200 0 00321  XDA     RCD
02251   0 07400 4 05363          TSX DBD1,4
02252   0 00000 0 06100          PZE BUFFER
02253   0 00000 0 00144          HTR RCD                 END OF FILE
02254   0 07400 4 05030          TSX IFF,4
02255   0 04356 0 06113          PZE BUFFER+11,0,IS
02256   0 02000 0 02250          TRA XDA
02257   0 53400 1 04350  XDB     LXA I12,1
02260   0 50000 0 04466          CLA C28
02261   0 60100 0 02265          STO XDC1
02262   0 50000 0 04467          CLA C29
02263   0 60100 0 02273          STO XDD1
02264   0 07400 4 05573  XDC     TSX FILE,4
02265   0 00000 0 00000  XDC1    PZE                     TO BE SET
02266   0 00000 0 00144          HTR RCD                 ERROR RETURN FROM FILE
02267   0 50000 0 10424          CLA T58
02270   0 40200 0 04362          SUB C3
02271   0 10000 0 02275          TZE XDE
02272   0 07400 4 05573  XDD     TSX FILE,4
02273   0 00000 0 00000  XDD1    PZE                     TO BE SET
02274   0 00000 0 00144          HTR RCD                 ERROR RETURN FROM FILE
02275  -2 00001 1 02303  XDE     TNX XDFF,1,1
```

```
      02276  0 50000 0 02265  XDF    CLA XDG1
      02277  0 40000 0 04470         ADD C30
      02300  0 62200 0 02265         STD XDC1
      02301  0 62200 0 02273         STD XDD1
TD    02302  1 00000 0 02264         TXI XDC
      02303  0 07400 4 02305  XDFF   TSX XDG,4
      02304  0 02000 0 00471         TRA XCC
      02305 -0 63400 4 10422  XDG    SXD T56,4
      02306  0 53400 4 10305         LXA S1,4
      02307  3 00004 4 02317         TXH XDG1,4,4
      02310  0 50000 4 04314         CLA 1XEC1+1,4
      02311  0 60100 0 02722         STO XEG1
      02312  0 02000 4 02317         TRA XDG1,4
TD    02313  1 00000 0 02350         TXI XDG5
TD    02314  1 00000 0 02336         TXI XDG4
TD    02315  1 00000 0 02331         TXI XDG3
TD    02316  1 00000 0 02320         TXI XDG2
      02317  0 00000 0 00144  XDG1   HTR RCD                 MODE NOT SPECIFIED
      02320  0 50000 0 04336  XDG2   CLA I1
      02321  0 60100 0 10311         STO S5
      02322  0 60100 0 10321         STO S12
      02323  0 60100 0 10323         STO S14
      02324  0 50000 0 04337         CLA I2
      02325  0 60100 0 10312         STO S6
      02326  0 60100 0 10322         STO S13
      02327  0 50000 0 04160         CLA 1XSB
      02330  0 02000 0 02361         TRA XDG6
      02331  0 50000 0 04337  XDG3   CLA I2
      02332  0 60100 0 10321         STO S12
      02333  0 60100 0 10322         STO S13
      02334  0 50000 0 04160         CLA 1XSB
      02335  0 02000 0 02361         TRA XDG6
      02336  0 50000 0 04336  XDG4   CLA I1
      02337  0 60100 0 10311         STO S5
      02340  0 60100 0 10312         STO S6
      02341  0 60100 0 10322         STO S13
      02342  0 50000 0 04337         CLA I2
      02343  0 60100 0 10321         STO S12
      02344  0 50000 0 04340         CLA I3
      02345  0 60100 0 10323         STO S14
      02346  0 50000 0 04157         CLA 2XSB
      02347  0 02000 0 02361         TRA XDG6
      02350  0 50000 0 04336  XDG5   CLA I1
```

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02351  0 60100 0 10311          STO S5
02352  0 60100 0 10312          STO S6
02353  0 50000 0 04337          CLA I2
02354  0 60100 0 10321          STO S12
02355  0 60100 0 10322          STO S13
02356  0 50000 0 04340          CLA I3
02357  0 60100 0 10323          STO S14
02360  0 50000 0 04157          CLA 2XSB
02361  0 60100 0 03164  XDG6    STO XSB
02362  0 53400 4 10306  XDH     LXA S2,4
02363  3 00002 4 02365          TXH XDH1,4,2
02364  3 00000 4 02366          TXH XDH2,4,0
02365  0 00000 0 00144  XDH1    HTR RCD                 S2 NOT SPECIFIED
02366  0 50000 4 04163  XDH2    CLA 1XAH+1,4
02367  0 60100 0 01353          STO XAH
02370  0 50000 4 04165          CLA 1XAW1+1,4
02371  0 60100 0 01534          STO XAW1
02372  0 50000 4 04316          CLA 1XEC2+1,4
02373  0 60100 0 02727          STO XEC2
02374  0 53400 4 10307          LXA S3,4
02375  3 00003 4 02377          TXH XDH3,4,3
02376  3 00000 4 02400          TXH XDH4,4,0
02377  0 00000 0 00144  XDH3    HTR RCD                 S3 NOT SPECIFIED
02400  0 50000 4 04153  XDH4    CLA 1XGA+1,4
02401  0 60100 0 03116          STO XGA
02402  0 50000 4 04144          CLA 1S3+1,4
02403  0 60100 0 10307          STO S3
02404  0 50000 4 04321          CLA 1XEC3+1,4
02405  0 60100 0 02734          STO XEC3
02406  0 53400 4 10307          LXA S3,4
02407  0 50000 4 04167          CLA 1XFF2+1,4
02410  0 60100 0 03104          STO XFF2
02411  0 50000 4 04171          CLA 1XG+1,4
02412  0 60100 0 01041          STO XG
02413  0 50000 4 04173          CLA 1XJ+1,4
02414  0 60100 0 01114          STO XJ
02415  0 50000 4 04175          CLA 1XM+1,4
02416  0 60100 0 01150          STO XM
02417  0 50000 4 04177          CLA 1XP+1,4
02420  0 60100 0 01172          STO XP
02421  0 50000 4 04201          CLA 1XV+1,4
02422  0 60100 0 01227          STO XV
02423  0 50000 4 04203          CLA 1XZ+1,4
```

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02424  0 60100 0 01266          STO XZ
02425  0 50000 4 04205          CLA 1XAD+1,4
02426  0 60100 0 01322          STO XAD
02427  0 50000 4 04207          CLA 1T41+1,4
02430  0 60100 0 10370          STO T41
02431  0 62100 0 01520          STA XAR1
02432  0 76700 0 00022          ALS 18
02433  0 62200 0 01531          STD XAV1
02434  0 62200 0 04102          STD XWU
02435  0 50000 4 04150          CLA 1XWD+1,4
02436  0 60100 0 03747          STO XWD
02437  0 50000 4 04146          CLA 1XWP1+1,4
02440  0 60100 0 03773          STO XWP1
02441  0 53400 4 10310          LXA S4,4
02442  3 00003 4 02444          TXH XDH5,4,3
02443  3 00000 4 02445          TXH XDH6,4,0
02444  0 00000 0 00144  XDH5    HTR RCD          S4 NOT SPECIFIED
02445  0 50000 4 04212  XDH6    CLA 1XCH+1,4
02446  0 60100 0 00666          STO XCH
02447  0 50000 4 04215          CLA 1XAY+1,4
02450  0 60100 0 01717          STO XAY
02451  0 50000 4 04220          CLA 1XBB1+1,4
02452  0 60100 0 01731          STO XBB1
02453  0 50000 4 04324          CLA 1XEC4+1,4
02454  0 60100 0 02741          STO XEC4
02455  0 53400 4 10311          LXA S5,4
02456  3 00002 4 02460          TXH XDH7,4,2
02457  3 00000 4 02461          TXH XDH8,4,0
02460  0 00000 0 00144  XDH7    HTR RCD          S5 NOT SPECIFIED
02461  0 50000 4 04222  XDH8    CLA 1XBH+1,4
02462  0 60100 0 02035          STO XBH
02463  0 50000 4 04155          CLA 1XCF+1,4
02464  0 60100 0 00630          STO XCF
02465  0 50000 4 04157          CLA 1XSA+1,4
02466  0 60100 0 03162          STO XSA
02467  0 50000 4 04224          CLA 1XVI+1,4
02470  0 60100 0 04121          STO XVI
02471  0 53400 4 10312          LXA S6,4
02472  3 00002 4 02474          TXH XDH9,4,2
02473  3 00000 4 02475          TXH XDH10,4,0
02474  0 00000 0 00144  XDH9    HTR RCD          S6 NOT SPECIFIED
02475  0 50000 4 04226  XDH10   CLA 1XAW+1,4
02476  0 60100 0 01533          STO XAW
```

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02477   0 50000 4 04230          CLA 1XBI+1,4
02500   0 60100 0 02065          STO XBI
02501   0 50000 4 04331          CLA 1XEG1+1,4
02502   0 60100 0 02763          STO XEG1
02503   0 50000 0 10313          CLA S7
02504   0 10000 0 02512          TZE XDH11
02505   0 50000 0 04235          CLA 1XUO
02506   0 60100 0 03631          STO XUO
02507   0 50000 0 04231          CLA 1XFF1
02510   0 56000 0 04233          LDQ 1XU1
TD      02511   1 00000 0 02516          TXI XDH12
02512   0 50000 0 04234  XDH11   CLA 2XUO
02513   0 60100 0 03631          STO XUO
02514   0 50000 0 04230          CLA 2XFF1
02515   0 56000 0 04232          LDQ 2XU1
02516   0 60100 0 03076  XDH12   STO XFF1
02517  -0 60000 0 01221          STQ XU1
02520   0 53400 4 10315          LXA S9,4
02521   3 00002 4 02523          TXH XDH13,4,2
02522   3 00000 4 02524          TXH XDH14,4,0
02523   0 00000 0 00144  XDH13   HTR RCD                 S9 NOT SPECIFIED
02524   0 50000 4 04240  XDH14   CLA 1XN+1,4
02525   0 60100 0 01157          STO XN
02526   0 50000 4 04242          CLA 1XAB+1,4
02527   0 60100 0 01303          STO XAB
02530   0 50000 4 04244          CLA 1XAI+1,4
02531   0 60100 0 01354          STO XAI
02532   0 50000 4 04246          CLA 1XAK+1,4
02533   0 60100 0 01415          STO XAK
02534   0 50000 4 04250          CLA 1XAR+1,4
02535   0 60100 0 01517          STO XAR
02536   0 50000 4 04252          CLA 1XAV+1,4
02537   0 60100 0 01530          STO XAV
02540   0 50000 4 04333          CLA 1XEK1+1,4
02541   0 60100 0 03010          STO XEK1
02542   0 53400 4 10317          LXA S15,4
02543   3 00002 4 02545          TXH XDH15,4,2
02544   3 00000 4 02546          TXH XDH16,4,0
02545   0 00000 0 00144  XDH15   HTR RCD                 S15 NOT SPECIFIED
02546   0 50000 4 04137  XDH16   CLA 1XD+1,4
02547   0 60100 0 00777          STO XD
02550   0 50000 4 04141          CLA 1XF+1,4
02551   0 60100 0 01001          STO XF
```

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02552   0 50000 4 04335          CLA 1XEK2+1,4
02553   0 60100 0 03021          STO XEK2
02554   0 53400 4 10321          LXA S12,4
02555   0 50000 4 04254          CLA 1XS1+1,4
02556   0 60100 0 01210          STO XS1
02557   0 50000 4 04256          CLA 1XBK+1,4
02560   0 60100 0 02243          STO XBK
02561   0 53400 4 10322          LXA S13,4
02562   0 50000 4 04260          CLA 1XL+1,4
02563   0 60100 0 01141          STO XL
02564   0 50000 4 04262          CLA 1XO+1,4
02565   0 60100 0 01163          STO XO
02566   0 50000 4 04264          CLA 1XY+1,4
02567   0 60100 0 01247          STO XY
02570   0 50000 4 04266          CLA 1XAC+1,4
02571   0 60100 0 01310          STO XAC
02572   0 50000 4 04270          CLA 1XAM+1,4
02573   0 60100 0 01463          STO XAM
02574   0 50000 4 04272          CLA 1XAN+1,4
02575   0 60100 0 01473          STO XAN
02576   0 53400 4 10323          LXA S14,4
02577   0 50000 4 04275          CLA 1XBH4+1,4
02600   0 60100 0 02051          STO XBH4
02601   0 50000 4 04300          CLA 1XBH5+1,4
02602   0 60100 0 02054          STO XBH5
02603   0 50000 4 04327          CLA 1XEE1+1,4
02604   0 60100 0 02750          STO XEE1
02605   0 50000 0 04337  XDI     CLA I2
02606   0 40200 0 10312          SUB S6
02607   0 76700 0 00001          ALS 1
02610   0 40000 0 10315          ADD S9
02611   0 73400 4 00000          PAX 0,4
02612   0 50000 4 04304          CLA 1XCH5+1,4
02613   0 60100 0 00714          STO XCH5
02614   0 50000 4 04310          CLA 1XBG+1,4
02615   0 60100 0 01740          STO XBG
02616   0 56000 0 10314  XDJ     LDQ S8
02617   0 20000 0 04342          MPY I5
02620   0 20000 0 10307          MPY S3
02621  -0 60000 0 10331          STQ T9
02622   0 53400 4 10322          LXA S13,4
02623  -3 00001 4 02625          TXL XDJ1,4,1
02624   0 56000 0 10314          LDQ S8
```

```
02625   0 20000 0 10315  XDJ1   MPY  S9
02626  -0 60000 0 10332         STQ  T10
02627   0 50000 0 04337         CLA  I2
02630   0 40200 0 10317         SUB  S15
02631   0 60100 0 10443         STO  T64
02632   0 56000 0 10443         LDQ  T64
02633   0 20000 0 04343         MPY  I6
02634   0 20000 0 10316         MPY  S10
02635  -0 60000 0 10443         STQ  T64
T 02636  -0 75400 0 00000         PXD
02637   0 76000 0 00006         COM
02640  -0 73400 1 00000         PDX  0,1
02641  -0 75400 1 00000         PXD  0,1
02642   0 77100 0 00022         ARS  18
02643   0 60100 0 10425         STO  T59
02644   0 50000 0 10525         CLA  T5
02645   0 40000 0 04336         ADD  I1
02646   0 40000 0 10320         ADD  S11
02647   0 62100 0 01340         STA  XAG1
02650   0 62100 0 03505         STA  XTW
02651   0 62100 0 03535         STA  XTY1
02652   0 62100 0 03547         STA  XUB1
02653   0 62100 0 03550         STA  XUB2
02654   0 62100 0 03742         STA  XWA
02655   0 62100 0 03765         STA  XWN
02656   0 60100 0 10324         STO  T61
02657   0 40000 0 10443         ADD  T64
02660   0 60100 0 10325         STO  T6
02661   0 40000 0 10331         ADD  T9
02662   0 60100 0 10330         STO  T11
02663   0 40000 0 10313         ADD  S7
02664   0 60100 0 10326         STO  T7
02665   0 40000 0 10332         ADD  T10
02666   0 60100 0 10327         STO  T8
02667   0 53400 4 10305         LXA  S1,4
02670  -3 00002 4 02674         TXL  XDJ2,4,2
02671   0 40000 0 05024         ADD  G89
02672   0 40000 0 77760         ADD  K1
02673   0 40000 0 10331         ADD  T9
02674   0 34000 0 10425  XDJ2   CAS  T59
02675   0 00000 0 00144         HTR  RCD
02676   0 76100 0 00000         NOP
02677   0 53400 4 04342         LXA  I5,4
```

PROBLEM EXCEEDS MEMORY CAPACITY

```
02700  0 50000 4 10331  XDJ3   CLA T61+5,4
02701  0 76000 0 00006         COM
02702  0 60100 4 10331         STO T61+5,4
02703  2 00001 4 02700         TIX XDJ3,4,1
02704  0 50000 0 10330         CLA T11
02705  0 76700 0 00022         ALS 18
02706  0 62200 0 03331         STD XTC1
02707  0 62200 0 04124         STD XVI1
02710 -0 53400 4 10422  XDK    LXD T56,4
02711  0 02000 4 00001         TRA 1,4
02712  0 07400 4 06147  XEB    TSX OUT,4
02713  0 07400 4 05254         TSX ECHO,4
02714  3 27451 0 10406         PTH T55,0,12073
02715  3 02066 0 04362         PTH C3,0,1078
02716 -1 00000 0 00364         FVE 244
02717  0 07400 4 06147  XEC    TSX OUT,4
02720  0 07400 4 05254         TSX ECHO,4
02721  3 01756 0 04471         PTH C31,0,1006
02722  0 00000 0 00000  XEC1   PZE                    TO BE SET
02723 -1 00000 0 00364         FVE 244
02724  0 07400 4 06147         TSX OUT,4
02725  0 07400 4 05254         TSX ECHO,4
02726  3 03734 0 04521         PTH C36,0,2012
02727  0 00000 0 00000  XEC2   PZE                    TO BE SET
02730 -1 00000 0 00000         FVE
02731  0 07400 4 06147         TSX OUT,4
02732  0 07400 4 05254         TSX ECHO,4
02733  3 07670 0 04526         PTH C39,0,4024
02734  0 00000 0 00000  XEC3   PZE                    TO BE SET
02735 -1 00000 0 00000         FVE
02736  0 07400 4 06147         TSX OUT,4
02737  0 07400 4 05254         TSX ECHO,4
02740  3 03734 0 04536         PTH C42,0,2012
02741  0 00000 0 00000  XEC4   PZE                    TO BE SET
02742 -1 00000 0 00000         FVE
02743  0 53400 4 10311         LXA S5,4
02744  3 00001 4 02753         TXH XEF,4,1
02745  0 07400 4 06147  XEE    TSX OUT,4
02746  0 07400 4 05254         TSX ECHO,4
02747  3 05712 0 04544         PTH C46,0,3018
02750  0 00000 0 00000  XEE1   PZE                    TO BE SET
02751 -1 00000 0 00000         FVE
TD 02752  1 00000 0 02760         TXI XEG
```

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```
02753   0 07400 4 06147  XEF    TSX OUT,4
02754   0 07400 4 05254         TSX ECHO,4
02755   3 05712 0 04544         PTH C46,0,3018
02756   3 01775 0 04543         PTH C45,0,1021
02757  -1 00000 0 00000         FVE
02760   0 07400 4 06147  XEG    TSX OUT,4
02761   0 07400 4 05254         TSX ECHO,4
02762   3 11646 0 04563         PTH C50,0,5030
02763   0 00000 0 00000  XEG1   PZE                    TO BE SET
02764  -1 00000 0 00000         FVE
02765   0 50000 0 10313  XEH    CLA S7
02766  -0 10000 0 02774         TNZ XEJ
02767   0 07400 4 06147  XEI    TSX OUT,4
02770   0 07400 4 05254         TSX ECHO,4
02771   3 03734 0 04574         PTH C53,0,2012
02772  -1 00000 0 00000         FVE
TD 02773   1 00000 0 03001         TXI XEK
02774   0 07400 4 06147  XEJ    TSX OUT,4
02775   0 07400 4 05254         TSX ECHO,4
02776   3 13624 0 04576         PTH C54,0,6036
02777  -0 00016 0 10313         FOR S7,0,14
03000  -1 00000 0 00000         FVE
03001   0 07400 4 06147  XEK    TSX OUT,4
03002   0 07400 4 05254         TSX ECHO,4
03003   3 13624 0 04604         PTH C55,0,6036
03004  -0 00047 0 10314         FOR S8,0,39
03005  -1 00000 0 00000         FVE
03006   0 07400 4 06147         TSX OUT,4
03007   0 07400 4 05254         TSX ECHO,4
03010   0 00000 0 00000  XEK1   PZE                    TO BE SET
03011  -1 00000 0 00000         FVE
03012   0 07400 4 06147         TSX OUT,4
03013   0 07400 4 05254         TSX ECHO,4
03014   3 17560 0 04617         PTH C58,0,8048
03015  -0 00062 0 10316         FOR S10,0,50
03016  -1 00000 0 00000         FVE
03017   0 07400 4 06147         TSX OUT,4
03020   0 07400 4 05254         TSX ECHO,4
03021   0 00000 0 00000  XEK2   PZE                    TO BE SET
03022  -1 00000 0 00000         FVE
03023   0 07400 4 06147         TSX OUT,4
03024   0 07400 4 05254         TSX ECHO,4
03025   3 11646 0 04627         PTH C59,0,5030
```

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03026 -0 00034 0 10320            FOR S11,0,28
03027 -1 00000 0 00000            FVE
03030  0 07400 4 06147            TSX OUT,4
03031  0 07400 4 05254            TSX ECHO,4
03032 -1 00000 0 00361            FVE 241
03033  0 02000 0 00472      XEL   TRA XRA
03034  0 50000 0 10320      XFB   CLA T3
03035  0 40000 0 04336            ADD I1
03036  0 73400 1 00000            PAX 0,1
03037  0 50000 0 10525            CLA T5
03040  0 76000 0 00006            COM
03041  0 73400 2 00000            PAX 0,2
03042  0 76200 0 00321      XFC   RCD
03043  0 07400 4 05363            TSX DBD1,4
03044  0 00000 0 06100            PZE BUFFER
03045  0 00000 0 00144            HTR RCD                    END OF FILE
03046  0 07400 4 05030            TSX IFF,4
03047  0 04355 0 06113            PZE BUFFER+11,0,IP
03050  0 02000 0 03042            TRA XFC
03051  0 07400 4 05135            TSX BLNK,4
03052  0 00002 0 06102            PZE BUFFER+2,0,2
03053  0 02000 0 03116            TRA XGA
03054  0 07400 4 05573            TSX FILE,4
03055 -2 00155 2 00000            MTW 0,2,109
03056  0 00000 0 00144            HTR RCD                    ERROR RETURN FROM FILE
03057  1 77777 2 03060            TXI XFD,2,-1
03060  2 00001 1 03042      XFD   TIX XFC,1,1
03061  0 53400 1 10314      XFE   LXA T2,1
03062  0 53400 2 10325            LXA T6,2
03063  0 76200 0 00321      XFF   RCD
03064  0 07400 4 05363            TSX DBD1,4
03065  0 00000 0 06100            PZE BUFFER
03066  0 00000 0 00144            HTR RCD                    END OF FILE
03067  0 07400 4 05030            TSX IFF,4
03070  0 04355 0 06113            PZE BUFFER+11,0,IP
03071  0 02000 0 03063            TRA XFF
03072  0 07400 4 05135            TSX BLNK,4
03073  0 00013 0 06113            PZE BUFFER+11,0,11
03074  0 02000 0 03116            TRA XGA
03075  0 07400 4 05573            TSX FILE,4
03076 -1 00153 2 00000      XFF1  MON 0,2,107                OR MTW 0,2,107
03077 -2 01456 2 00001            MTW 1,2,814
03100 -2 02761 2 00002            MTW 2,2,1521
```

```
03101 -2 04264 2 00003        MTW 3,2,2228
03102 -2 05567 2 00004        MTW 4,2,2935
03103  0 00000 0 00144        HTR RCD              ERROR RETURN FROM FILE
03104  1 77773 2 03115 XFF2   TXI XFG,2,-5         OR TXI XFF3,2,-5
03105  0 07400 4 05573 XFF3   TSX FILE,4
03106 -2 07072 2 00000        MTW 0,2,3642
03107 -2 10375 2 00001        MTW 1,2,4349
03110 -2 11700 2 00002        MTW 2,2,5056
03111 -2 13203 2 00003        MTW 3,2,5763
03112 -2 14506 2 00004        MTW 4,2,6470
03113  0 00000 0 00144        HTR RCD              ERROR RETURN FROM FILE
03114  1 77773 2 03115        TXI XFG,2,-5
03115  2 00001 1 03063 XFG    TIX XFF,1,1
03116  0 02000 0 00621 XGA    TRA XCE              OR CLA I2
03117  0 60100 0 10307        STQ S3
03120  0 07400 4 02305 XGB    TSX XDG,4
03121  0 56000 0 04342 XGC    LDQ I5
03122  0 20000 0 10314        MPY S8
03123 -0 60000 0 10476        STQ T90
03124  0 50000 0 10325        CLA T6
03125  0 40200 0 10476        SUB T90
03126  0 40000 0 04336        ADD I1
03127  0 73400 1 00000        PAX 0,1
03130  0 40200 0 10476        SUB T90
03131  0 40000 0 04342        ADD I5
03132  0 73400 2 00000        PAX 0,2
03133  0 53400 4 10314 XGD    LXA S8,4
03134  0 50000 1 00000 XGE    CLA 0,1
03135  0 60100 0 10477        STO T91
03136 -0 63400 1 10346        SXD T23,1
03137  0 53400 1 04343 XGF    LXA I6,1
03140  0 56000 0 10477 XGG    LDQ T91
03141  0 26000 1 10476        FMP T84+6,1
03142  0 60100 2 00000        STQ 0,2
03143 -2 00001 1 03145 XGH    TNX XGJ,1,1
03144  1 77777 2 03140 XGI    TXI XGG,2,-1
03145 -2 00001 4 00621 XGJ    TNX XCE,4,1
03146  1 00017 2 03147 XGK    TXI XGL,2,15
03147 -0 53400 1 10346 XGL    LXD T23,1
03150  1 00005 1 03151        TXI XGM,1,5
03151  0 50000 1 00001 XGM    CLA 1,1
03152  0 60100 2 00006        STO 6,2
03153  0 50000 1 00002        CLA 2,1
```

```
03154   0 60100 2 00007          STO 7,2
03155   0 50000 1 00003          CLA 3,1
03156   0 60100 2 00010          STO 8,2
03157   0 50000 1 00004          CLA 4,1
03160   0 60100 2 00011          STO 9,2
03161   0 02000 0 03134          TRA XGE
03162   0 77000 0 00205  XSA     WEF U3                  OR TRA XSB
03163   0 77000 0 00205          WEF U3
03164   0 76200 0 00321  XSB     RCD                     OR TRA XVH
03165   0 07400 4 05363          TSX DBD1,4
03166   0 00000 0 06100          PZE BUFFER
03167   0 00000 0 03164          HTR XSB                 END OF FILE
03170   0 07400 4 05030  XSC     TSX IFF,4
03171   0 04353 0 06113          PZE BUFFER+11,0,IK
03172   0 02000 0 03164          TRA XSB
03173   0 07400 4 05135  XSD     TSX BLNK,4
03174   0 00002 0 06102          PZE BUFFER+2,0,2
03175   0 02000 0 03217          TRA XSK
03176   0 07400 4 05573  XSE     TSX FILE,4
03177  -1 00152 0 77761          MON K2,0,106
03200  -1 01310 0 77760          MON K1,0,712
03201  -2 00152 0 10446          MTW T67,0,106
03202   0 00000 0 00144          HTR RCD                 ERROR RETURN FROM FILE
03203   0 50000 0 77760          CLA K1
03204   0 76700 0 00001          ALS 1
03205   0 60100 0 77760          STO K1
03206   0 53400 1 77760  XSF     LXA K1,1
03207   0 76200 0 00321  XSG     RCD
03210   0 53400 2 04346          LXA I9,2
03211   0 70000 1 77760  XSH     CPY K1,1
03212   0 02000 0 03214          TRA XSH1
03213   0 00000 0 03207          HTR XSG                 END OF FILE
03214   0 70000 1 77761  XSH1    CPY K1+1,1
03215   2 00001 2 03211  XSI     TIX XSH,2,1
03216   2 00002 1 03207  XSJ     TIX XSG,1,2
03217   0 53400 1 77761  XSK     LXA K2,1
03220   3 00000 1 03223          TXH XSM,1,0
03221   0 60000 0 77760  XSL     STZ K1
03222   0 02000 0 03361          TRA XTO
03223   0 50000 0 10313  XSM     CLA S7
03224   0 60100 0 77763          STO K4
03225   0 50000 0 10305          CLA S1
03226   0 60100 0 77774          STO K13
```

```
03227   0 50000 0 77761  XSN    CLA K2
03230   0 40000 0 04336          ADD I1
03231   0 76500 0 00043          LRS 35
03232   0 20000 0 77761          MPY K2
03233   0 76500 0 00001          LRS 1
03234  -0 60000 0 77775          STQ K14
03235   0 50000 0 04665          CLA C64
03236   0 40200 0 77760          SUB K1
03237   0 60100 0 77776          STO K15
03240   0 40200 0 77761          SUB K2
03241   0 60100 0 77773          STO K12
03242   0 40200 0 77775          SUB K14
03243   0 60100 0 77775          STO K14
03244   0 40200 0 77761          SUB K2
03245   0 40200 0 04336          SUB I1
03246   0 76000 0 00006          COM
03247   0 60100 0 77771          STO K10
03250   0 50000 0 77775          CLA K14
03251   0 40200 0 04336          SUB I1
03252   0 76000 0 00006          COM
03253   0 62100 0 77777          STA K16
03254   0 50000 0 77773          CLA K12
03255   0 40200 0 04336          SUB I1
03256   0 76000 0 00006          COM
03257   0 76700 0 00022          ALS 18
03260   0 62200 0 77777          STD K16
03261   0 50000 0 77775          CLA K14
03262   0 40000 0 77761          ADD K2
03263   0 60100 0 77772          STO K11
03264   0 53400 4 77771  XSO    LXA K10,4
03265   0 60000 0 77762          STZ K3
03266   0 53400 2 10320  XSP    LXA S11,2
03267   0 53400 1 77760  XSQ    LXA K1,1
03270  -0 50000 1 77760  XSR    CAL K1,1
03271  -0 63400 1 77766          SXD K7,1
03272   0 53400 1 04351          LXA I36,1
03273  -0 76000 0 00001  XSS    PBT
03274   0 02000 0 03303          TRA XSU
03275   0 60200 0 77767  XST    SLW K8
03276   0 50000 0 77762          CLA K3
03277   0 40000 0 04336          ADD I1
03300   0 60100 0 77762          STO K3
03301  -0 50000 0 77767          CAL K8
```

```
03302  1 77777 4 03303          TXI XSU,4,-1
03303  0 76700 0 00001   XSU    ALS 1
03304 -2 00001 1 03307   XSV    TNX XSX,1,1
03305  2 00001 2 03273   XSW    TIX XSS,2,1
03306  0 02000 0 03315          TRA XTA
03307 -0 53400 1 77766   XSX    LXD K7,1
03310 -2 00001 1 03322          TNX XTB,1,1
03311  2 00001 2 03270   XSY    TIX XSR,2,1
03312 -0 50000 1 77760   XSZ    CAL K1,1
03313 -0 63400 1 77766          SXD K7,1
03314  0 53400 1 04351          LXA I36,1
03315  0 60200 0 77767   XTA    SLW K8
03316 -0 63400 1 77765          SXD K6,1
03317 -0 63400 4 77764          SXD K5,4
03320  0 50000 0 04336          CLA I1
03321  0 02000 0 03323          TRA XTB1
03322  0 50000 0 04337   XTB    CLA I2
03323  0 60100 0 77770   XTB1   STO K9
03324  0 76400 0 00205   XTC    BST U3
03325  0 76400 0 00205          BST U3
03326  0 76200 0 00225          RTB U3
03327  0 07400 4 00146          TSX WTB,4
03330  0 00000 0 00005          PZE U3
03331  0 00000 0 77323   XTC1   PZE -START,0,0          DECREMENT TO BE SET
03332  0 77200 0 00205          REW U3
03333  0 02000 0 00144          TRA RCD                 ENTER OR-XLS3
03334  0 53400 1 04342   XTD    LXA I5,1                RETURN FROM OR XLS5
03335  0 76200 0 00225   XTD1   RTB U3
03336  2 00001 1 03335          TIX XTD1,1,1
03337  0 53400 4 04340   XTE    LXA I3,4
03340  0 76200 0 00225   XTF    RTB U3
03341 -0 76000 0 00012          RTT
03342  0 76100 0 00000          NOP
03343  0 53400 1 10326   XTG    LXA T7,1
03344  0 70000 0 10502          CPY T94
03345  0 70000 1 00000   XTH    CPY 0,1
03346  1 77777 1 03345   XTI    TXI XTH,1,-1
03347  0 00000 0 00144          HTR RCD                 END OF FILE
03350  0 76600 0 00333   XTJ    IOD
03351 -0 76000 0 00012          RTT
03352  0 02000 0 03356          TRA XTL
03353  0 77200 0 00205   XTK    REW U3
03354  0 77200 0 00204          REW U1
```

```
03355   0 02000 0 03361          TRA XTO
03356   0 76400 0 00205  XTL     BST U3
03357   2 00001 4 03340  XTM     TIX XTF,4,1
03360   0 00000 0 03337  XTN     HTR XTE
03361   0 07400 4 06147  XTO     TSX OUT,4
03362   0 07400 4 05254          TSX ECHO,4
03363   3 27451 0 10406          PTH T55,0,12073
03364   3 02066 0 04362          PTH C3,0,1078
03365   1 00001 0 00003          PON U2,0,1
03366  -1 00000 0 00364          FVE 244
03367   0 50000 0 10445  XTOO    CLA T66
03370   0 30200 0 10502          FSB T94
03371   0 60100 0 10445          STO T66
03372   0 50000 0 10444          CLA T65
03373   0 30200 0 10446          FSB T67
03374   0 60100 0 10447          STO T68
03375   0 10000 0 03401          TZE XTOO1
03376   0 50000 0 10445          CLA T66
03377   0 24000 0 10447          FDH T68
03400  -0 60000 0 10447          STQ T68
03401   0 50000 0 10445  XTOO1   CLA T66
03402   0 07400 4 06116          TSX SQRT,4
03403  -0 76000 0 00003          SSM
03404   0 60100 0 10503          STO T95
03405   0 50000 0 10447          CLA T68
03406   0 07400 4 06116          TSX SQRT,4
03407  -0 76000 0 00003          SSM
03410   0 60100 0 10447          STO T68
03411   0 07400 4 06147  XTOO2   TSX OUT,4
03412   0 07400 4 05254          TSX ECHO,4
03413   3 03734 0 04776          PTH C84,0,2012
03414   3 11727 0 04371          PTH C19,0,5079
03415   1 00000 0 00003          PON U2,0,0
03416  -1 00000 0 00364          FVE 244
03417   0 07400 4 06147  XTOO3   TSX OUT,4
03420   0 07400 4 05254          TSX ECHO,4
03421   3 31426 0 04650          PTH C63,0,13078
03422  -3 05762 0 10503          SVN T95,0,3058
03423  -3 00104 0 10444          SVN T65,0,68
03424  -3 00110 0 10446          SVN T67,0,72
03425  -3 06011 0 10447          SVN T68,0,3081
03426   1 00000 0 00003          PON U2,0,0
03427  -1 00000 0 00364          FVE 244
```

RTT FAILS 3 TIMES. START TO TRY AGAIN

```
03430   0 07400 4 06147  XT004  TSX  OUT,4
03431   0 07400 4 05254         TSX  ECHO,4
03432   3 11646 0 05000         PTH  C85,0,5030
03433   1 00000 0 00003         PON  U2,0,0
03434  -1 00000 0 00364         FVE  244
03435   0 50000 0 05334  XTPP   CLA  SWTP7
03436   0 60100 0 05335         STO  SWTP8
03437   0 76000 0 00164  XTPP1  SWT  4
03440   0 02000 0 03442         TRA  XTPP2
03441   0 02000 0 03450         TRA  XTPP3
03442   0 07400 4 06147  XTPP2  TSX  OUT,4
03443   0 07400 4 05254         TSX  ECHO,4
03444   3 23514 0 05005         PTH  C86,0,10060
03445   3 04024 0 05017         PTH  C87,0,2068
03446  -0 00027 0 04341         FOR  I4,0,23
03447  -1 00000 0 00364         FVE  244
03450   0 07400 4 05311  XTPP3  TSX  SWTP,4
03451   0 00000 0 03456         PZE  XTPP4
03452   0 07400 4 06147         TSX  OUT,4
03453   0 07400 4 05254         TSX  ECHO,4
03454   3 23514 0 04666         PTH  C65,0,10060
03455   1 00000 0 00003         PON  U2,0,0
03456  -1 00000 0 00364  XTPP4  FVE  244
03457   0 50000 0 04700  XTP    CLA  C66
03460   0 60100 0 10451         STO  T70
03461   0 50000 0 04701         CLA  C66+1
03462   0 60100 0 10452         STO  T70+1
03463   0 50000 0 04336         CLA  I1
03464   0 60100 0 10453         STO  T71
03465   0 53400 2 10326  XTQ    LXA  T7,2
03466   0 53400 1 10320         LXA  S11,1
03467   0 53400 4 77760         LXA  K1,4
03470   3 00000 4 03473         TXH  XTS,4,0
03471   0 60000 0 77767  XTR    STZ  K8
03472   0 02000 0 03475         TRA  XTT
03473  -0 50000 4 77760  XTS    CAL  K1,4
03474   0 60200 0 77767         SLW  K8
03475  -0 63400 4 77766  XTT    SXD  K7,4
03476   0 53400 4 04351         LXA  I36,4
03477  -0 63400 4 77765  XTU    SXD  K6,4
03500  -0 50000 0 77767         CAL  K8
03501  -0 76000 0 00001         PBT
03502   0 02000 0 03537         TRA  XUA
```

```
03503   0 76700 0 00001  XTV    ALS 1
03504   0 60200 0 77767         SLW K8
03505   0 50000 1 00000  XTW    CLA 0,1              ADDRESS TO BE SET
03506   0 60100 0 10454         STO T72
03507   0 30000 2 00000         FAD 0,2
03510   0 60100 0 10455         STO T73
03511   0 50000 2 00001         CLA 1,2
03512   0 07400 4 06116         TSX SQRT,4
03513   0 00000 0 00144         HTR RCD              INVERSE DIAGONAL IS NEGATIVE
03514   0 60100 0 10456         STO T74
03515   0 56000 0 10456         LDQ T74
03516   0 26000 0 10447         FMP T68
03517   0 60100 0 10456         STO T74
03520   0 07400 4 05311  XTX    TSX SWTP,4
03521   0 00000 0 03533         PZE XTX1
03522   0 07400 4 06147         TSX OUT,4
03523   0 07400 4 05254         TSX ECHO,4
03524   3 03735 0 10451         PTH T70,0,2013
03525  -0 00020 0 10453         FOR T71,0,16
03526  -3 07671 0 10454         SVN T72,0,4025
03527  -3 07704 2 00000         SVN 0,2,4036
03530  -3 07717 0 10455         SVN T73,0,4047
03531  -3 07732 0 10456         SVN T74,0,4058
03532   1 00000 0 00003         PON U2,0,0
03533  -1 00000 0 00364  XTX1   FVE 244
03534   0 50000 0 10455  XTY    CLA T73
03535   0 60100 1 00000  XTY1   STO 0,1              ADDRESS TO BE SET
03536   1 77776 2 03553  XTZ    TXI XUC,2,-2
03537   0 76700 0 00001  XUA    ALS 1
03540   0 60200 0 77767         SLW K8
03541   0 07400 4 05311  XUB    TSX SWTP,4
03542   0 00000 0 03552         PZE XUB3
03543   0 07400 4 06147         TSX OUT,4
03544   0 07400 4 05254         TSX ECHO,4
03545   3 03735 0 10451         PTH T70,0,2013
03546  -0 00020 0 10453         FOR T71,0,16
03547  -3 07671 1 00000  XUB1   SVN 0,1,4025         ADDRESS TO BE SET
03550  -3 07717 1 00000  XUB2   SVN 0,1,4047         ADDRESS TO BE SET
03551   1 00000 0 00003         PON U2,0,0
03552  -1 00000 0 00364  XUB3   FVE 244
03553  -2 00001 1 03564  XUC    TNX XUH,1,1
03554   0 50000 0 10453  XUD    CLA T71
03555   0 40000 0 04336         ADD I1
```

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03556   0 60100 0 10453          STO T71
03557  -0 53400 4 77765  XUE     LXD K6,4
03560   2 00001 4 03477          TIX XTU,4,1
03561  -0 53400 4 77766  XUF     LXD K7,4
03562   2 00001 4 03473          TIX XTS,4,1
03563   0 02000 0 03471          TRA XTR
03564  -3 00000 1 03574  XUH     TXL XUJ,1,0
03565   0 53400 1 04335  XUI     LXA I0,1
03566   0 60000 0 10453          STZ T71
03567   0 50000 0 04702          CLA C67
03570   0 60100 0 10451          STO T70
03571   0 50000 0 04703          CLA C67+1
03572   0 60100 0 10452          STO T70+1
03573   0 02000 0 03557          TRA XUE
03574   0 53400 4 10314  XUJ     LXA S8,4
03575   0 50000 0 04336  XUK     CLA I1
03576   0 60100 0 10453          STO T71
03577   0 53400 1 10325  XUL     LXA T6,1
03600  -0 63400 1 10457          SXD T75,1
03601  -0 63400 4 10460  XUM     SXD T76,4
03602   0 07400 4 05311  XUM1    TSX SWTP,4
03603   0 00000 0 03611          PZE XUM2
03604   0 07400 4 06147          TSX OUT,4
03605   0 07400 4 05254          TSX ECH0,4
03606   3 01756 0 04704          PTH C68,0,1006
03607  -0 00010 0 10453          FOR T71,0,8
03610   1 00000 0 00003          PON U2,0,0
03611  -1 00000 0 00364  XUM2    FVE 244
03612   0 50000 0 10370  XUN     CLA T41
03613   0 76700 0 00001          ALS 1
03614   0 73400 1 00000          PAX 0,1
03615   0 40000 0 04740          ADD C78
03616   0 62100 0 03652          STA XUV1
03617   0 40000 0 04336          ADD I1
03620   0 62100 0 03654          STA XUV2
03621  -3 00012 1 03625          TXL XUN1,1,10
03622   0 50000 0 04733          CLA C72
03623   0 56000 0 04734          LDQ C72+1
03624   0 02000 0 03627          TRA XUN2
03625   0 50000 0 04731  XUN1    CLA C71
03626   0 56000 0 04732          LDQ C71+1
03627   0 60100 0 04715  XUN2    STO C70
03630  -0 60000 0 04716          STQ C70+1
```

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03631 -0 50000 0 04735  XUO   CAL C75              OR TRA XUP
03632  0 02000 0 03634         TRA XUP1
03633 -0 50000 0 04736  XUP   CAL C76
03634  0 60200 0 03724  XUP1  SLW XVD1
03635  0 40000 0 04737         ADD C77
03636  0 60200 0 03725         SLW XVD2
03637 -0 53400 4 77765  XUQ   LXD K6,4
03640  2 00001 4 03651         TIX XUV,4,1
03641 -0 53400 4 77766  XUR   LXD K7,4
03642  2 00001 4 03645         TIX XUT,4,1
03643  0 60000 0 77767  XUS   STZ K8
03644  0 02000 0 03647         TRA XUU
03645 -0 50000 4 77760  XUT   CAL K1,4
03646  0 60200 0 77767         SLW K8
03647 -0 63400 4 77766  XUU   SXD K7,4
03650  0 53400 4 04351         LXA I36,4
03651 -0 63400 4 77765  XUV   SXD K6,4
03652  0 50000 1 00000  XUV1  CLA 0,1              ADDRESS TO BE SET
03653  0 60100 0 10451         STO T70
03654  0 50000 1 00000  XUV2  CLA 0,1              ADDRESS TO BE SET
03655  0 60100 0 10452         STO T70+1
03656 -0 63400 1 10461         SXD T77,1
03657 -0 53400 1 10457         LXD T75,1
03660 -0 50000 0 77767  XUW   CAL K8
03661 -0 76000 0 00001         PBT
03662  0 02000 0 03715         TRA XVG
03663  0 76700 0 00001  XUX   ALS 1
03664  0 60200 0 77767         SLW K8
03665  0 50000 1 00000  XUY   CLA 0,1
03666  0 30000 2 00000         FAD 0,2
03667  0 60100 0 10455         STO T73
03670  0 50000 2 00001         CLA 1,2
03671  0 07400 4 06116         TSX SQRT,4
03672  0 00000 0 00144         HTR RCD              INVERSE DIAGONAL IS NEGATIVE
03673  0 60100 0 10456         STO T74
03674  0 56000 0 10456         LDQ T74
03675  0 26000 0 10447         FMP T68
03676  0 60100 0 10456         STO T74
03677  0 07400 4 05311  XUZ   TSX SWTP,4
03700  0 00000 0 03711         PZE XUZ1
03701  0 07400 4 06147         TSX OUT,4
03702  0 07400 4 05254         TSX ECHO,4
03703  3 03734 0 10451         PTH T70,0,2012
```

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03704 -3 15561 1 00000         SVN 0,1,7025
03705 -3 15574 2 00000         SVN 0,2,7036
03706 -3 15607 0 10455         SVN T73,0,7047
03707 -3 15622 0 10456         SVN T74,0,7058
03710  1 00000 0 00003         PON U2,0,0
03711 -1 00000 0 00364  XUZ1   FVE 244
03712  0 50000 0 10455  XVA    CLA T73
03713  0 60100 1 00000         STO 0,1
03714  1 77776 2 03730  XVB    TXI XVE,2,-2
03715  0 76700 0 00001  XVC    ALS 1
03716  0 60200 0 77767         SLW K8
03717  0 07400 4 05311  XVD    TSX SWTP,4
03720  0 00000 0 03727         PZE XVD3
03721  0 07400 4 06147         TSX OUT,4
03722  0 07400 4 05254         TSX ECHO,4
03723  3 03734 0 10451         PTH T70,0,2012
03724 -3 15561 1 00000  XVD1   SVN 0,1,7025        OR FOR 0,1,21
03725 -3 15607 1 00000  XVD2   SVN 0,1,7047        OR FOR 0,1,43
03726  1 00000 0 00003         PON U2,0,0
03727 -1 00000 0 00364  XVD3   FVE 244
03730  1 77777 1 03731  XVE    TXI XVE1,1,-1
03731 -0 63400 1 10457  XVE1   SXD T75,1
03732 -0 53400 1 10461         LXD T77,1
03733  2 00002 1 03633         TIX XUP,1,2
03734 -0 53400 4 10460  XVF    LXD T76,4
03735 -2 00001 4 03742         TNX XWA,4,1
03736  0 50000 0 10453  XVG    CLA T71
03737  0 40000 0 04336         ADD I1
03740  0 60100 0 10453         STO T71
03741  0 02000 0 03601         TRA XUM
03742  0 50000 0 00000  XWA    CLA 0                ADDRESS TO BE SET
03743  0 10000 0 03766         TZE XWQ
03744  0 60100 0 10477  XWB    STO T91
03745  0 53400 1 10314  XWC    LXA S8,1
03746  0 53400 2 10325         LXA T6,2
03747  0 50000 0 10477  XWD    CLA T91              OR TRA XWH
03750  0 30000 2 00004         FAD 4,2
03751  0 60100 2 00004         STO 4,2
03752 -2 00001 1 03765  XWE    TNX XWN,1,1
03753  1 77773 2 03747  XWF    TXI XWD,2,-5
03754  1 77774 2 03755  XWH    TXI XWI,2,-4
03755  0 53400 4 04343  XWI    LXA I6,4
03756  0 56000 0 10477  XWJ    LDQ T91
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03757   0 26000 4 10476          FMP  T84+6,4
03760   0 30000 2 00000          FAD  0,2
03761   0 60100 2 00000          STO  0,2
03762   1 77777 2 03763  XWK     TXI  XWL,2,-1
03763   2 00001 4 03756  XWL     TIX  XWJ,4,1
03764   2 00001 1 03754  XWM     TIX  XWH,1,1
03765   0 60000 0 00000  XWN     STZ  0                    ADDRESS TO BE SET
03766   0 53400 1 10314  XWO     LXA  S8,1
03767   0 53400 2 10325          LXA  T6,2
03770   0 50000 0 04336          CLA  I1
03771   0 60100 0 10453          STO  T71
03772   0 76100 0 00000  XWP     NOP                       TRANSFER TO RESET RELATIONS BETWEEN X,Y,Z
03773   0 50000 2 00004  XWP1    CLA  4,2                  OR TRA XWQ
03774  -0 12000 0 04071          TMI  XWS
03775   0 02000 0 04101          TRA  XWT
03776   0 76100 0 00000  XWQ     NOP                       TRANSFER TO RESET RELATIONS BETWEEN BETAS
03777   0 50000 2 00004  XWR     CLA  4,2
04000  -0 12000 0 04071          TMI  XWS
04001   0 50000 2 00005          CLA  5,2
04002  -0 12000 0 04071          TMI  XWS
04003   0 50000 2 00006          CLA  6,2
04004  -0 12000 0 04071          TMI  XWS
04005   0 56000 2 00011          LDQ  9,2
04006   0 26000 2 00011          FMP  9,2
04007   0 60100 0 10501          STO  T93
04010   0 56000 2 00005          LDQ  5,2
04011   0 26000 2 00006          FMP  6,2
04012   0 30200 0 10501          FSB  T93
04013  -0 12000 0 04071          TMI  XWS
04014   0 56000 2 00010          LDQ  8,2
04015   0 26000 2 00010          FMP  8,2
04016   0 60100 0 10501          STO  T93
04017   0 56000 2 00004          LDQ  4,2
04020   0 26000 2 00006          FMP  6,2
04021   0 30200 0 10501          FSB  T93
04022  -0 12000 0 04071          TMI  XWS
04023   0 56000 2 00007          LDQ  7,2
04024   0 26000 2 00007          FMP  7,2
04025   0 60100 0 10501          STO  T93
04026   0 56000 2 00004          LDQ  4,2
04027   0 26000 2 00005          FMP  5,2
04030   0 30200 0 10501          FSB  T93
04031  -0 12000 0 04071          TMI  XWS
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04032   0 56000 2 00004          LDQ 4,2
04033   0 26000 2 00011          FMP 9,2
04034   0 76500 0 00043          LRS 35
04035   0 26000 2 00011          FMP 9,2
04036   0 60100 0 10501          STO T93
04037   0 56000 2 00007          LDQ 7,2
04040   0 26000 2 00007          FMP 7,2
04041   0 76500 0 00043          LRS 35
04042   0 26000 2 00006          FMP 6,2
04043   0 30000 0 10501          FAD T93
04044   0 60100 0 10501          STO T93
04045   0 56000 2 00010          LDQ 8,2
04046   0 26000 2 00010          FMP 8,2
04047   0 76500 0 00043          LRS 35
04050   0 26000 2 00005          FMP 5,2
04051   0 30000 0 10501          FAD T93
04052   0 60100 0 10501          STO T93
04053   0 56000 2 00004          LDQ 4,2
04054   0 26000 2 00005          FMP 5,2
04055   0 76500 0 00043          LRS 35
04056   0 26000 2 00006          FMP 6,2
04057   0 30200 0 10501          FSB T93
04060   0 60100 0 10501          STO T93
04061   0 56000 2 00007          LDQ 7,2
04062   0 26000 2 00010          FMP 8,2
04063   0 76500 0 00043          LRS 35
04064   0 26000 2 00011          FMP 9,2
04065   0 76500 0 00043          LRS 35
04066   0 26000 0 04753          FMP G81
04067   0 30000 0 10501          FAD T93
04070   0 12000 0 04101          TPL XWT
04071   0 07400 4 06147   XWS    TSX OUT,4
04072   0 07400 4 05254          TSX ECHO,4
04073   3 23514 0 04754          PTH G82,0,10060
04074  -0 00036 0 10453          FOR T71,0,30
04075   1 00000 0 00003          PON U2,0,0
04076  -1 00000 0 00364          FVE 244
04077   0 50000 0 04336          CLA I1
04100   0 60100 0 10500          STO T92
04101  -2 00001 1 04110   XWT    TNX XVGG,1,1
04102   2 00000 2 04104   XWU    TIX XWV,2,0          DECREMENT TO BE SET
04103   0 00000 0 00144          HTR RCD
04104   0 50000 0 10453   XWV    CLA T71
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04105   0 40000 0 04336          ADD I1
04106   0 60100 0 10453          STQ T71
04107   0 02000 0 03772          TRA XWP
04110   0 50000 0 10500  XVGG    CLA T92
04111  -0 10000 0 04115          TNZ XVGG1
04112   0 76000 0 00164          SWT 4
04113   0 02000 0 04115          TRA XVGG1
04114   0 02000 0 04120          TRA XVH
04115   0 07400 4 06147  XVGG1   TSX OUT,4
04116   0 07400 4 05254          TSX ECHO,4
04117  -1 00000 0 00361          FVE 241
04120   0 77200 0 00204  XVH     REW U1
04121   0 77200 0 00205  XVI     REW U3                  OR TRA XVJ
04122   0 07400 4 00146          TSX WTB,4
04123   0 00000 0 00005          PZE U3
04124   0 00000 0 77323  XVI1    PZE -START,0,0          DECREMENT TO BE SET
04125   0 76200 0 00225          RTB U3
04126   0 07400 4 00146          TSX WTB,4
04127   0 00000 0 00005          PZE U3
04130   0 00000 0 00400          PZE -32512,0,0
04131   0 77200 0 00205          REW U3
04132   0 50000 0 10500  XVJ     CLA T92
04133   0 10000 0 00160          TZE KH
04134   0 02000 0 00161          TRA KI
                                 SENSE-SETTING WORDS
04135   0 02000 0 10526          TRA XD1
04136   0 76100 0 00000  1XD     NOP
04137   0 02000 0 01070          TRA XH
04140   0 60000 0 10333  1XF     STZ T12
04141   0 00000 0 00001          PZE 1
04142   0 00000 0 00002          PZE 2
04143   0 00000 0 00001  1S3     PZE 1
04144   0 02000 0 03776          TRA XWQ
04145   0 50000 2 00004  1XWP1   CLA 4,2
04146   0 02000 0 03754          TRA XWH
04147   0 50000 0 10477  1XWD    CLA T91
04150   0 50000 0 04337          CLA I2
04151   0 02000 0 00621          TRA XCE
04152   0 02000 0 00621  1XGA    TRA XCE
04153   0 02000 0 00660          TRA XCG
04154   0 50000 0 05025  1XCF    CLA C90
04155   0 02000 0 03164          TRA XSB
04156   0 77000 0 00205  1XSA    WEF U3
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        04157   0 76200 0 00321  2XSB   RCD
        04160   0 02000 0 04120  1XSB   TRA XVH
TD      04161   1 00000 0 01415         TXI XAK
TD      04162   1 00000 0 01354  1XAH   TXI XAI
TD      04163   1 00000 0 01541         TXI XAW3
        04164   0 56000 0 10520  1XAW1  LDQ M12
        04165   1 77773 2 03105         TXI XFF3,2,-5
        04166   1 77773 2 03115  1XFF2  TXI XFG,2,-5
        04167   0 53400 1 04340         LXA I3,1
TD      04170   1 00000 0 01070  1XG    TXI XH
        04171   0 53400 4 04343         LXA I6,4
        04172   1 77777 2 01135  1XJ    TXI XK,2,-1
        04173   0 53400 4 04343         LXA I6,4
        04174   1 77777 1 01157  1XM    TXI XN,1,-1
        04175   0 53400 4 04343         LXA I6,4
        04176   1 77777 1 01201  1XP    TXI XQ,1,-1
        04177   1 77766 2 01240         TXI XW,2,-10
        04200   0 56000 0 10513  1XV    LDQ M7
TD      04201   1 00000 0 01273         TXI XAA
        04202   0 56000 0 10356  1XZ    LDQ T31
TD      04203   1 00000 0 01327         TXI XAE
        04204   0 56000 0 10357  1XAD   LDQ T32
        04205   0 00000 0 00012         PZE 10
        04206   0 00000 0 00005  1T41   PZE 5
        04207   0 02000 0 00725         TRA XA
        04210   0 60000 0 05362         STZ SWTF8
        04211   0 60000 0 05362  1XCH   STZ SWTF8
TD      04212   1 00000 0 02035         TXI XBH
        04213   0 50000 0 10377         CLA T48
        04214   0 50000 0 10377  1XAY   CLA T48
TD      04215   1 00000 0 02035         TXI XBH
TD      04216   1 00000 0 02035         TXI XBH
TD      04217   1 00000 0 01740  1XBB1  TXI XBG
TD      04220   1 00000 0 00725         TXI XA
        04221   0 76600 0 00225  1XBH   WTB U3
        04222   0 02000 0 04132         TRA XVJ
        04223   0 77200 0 00205  1XVI   REW U3
TD      04224   1 00000 0 02243         TXI XBK
        04225   0 50000 0 10510  1XAW   CLA M4
        04226   0 02000 0 03162         TRA XSA
        04227   0 50000 0 10375  1XBI   CLA T46
        04230  -2 00153 2 00000  2XFF1  MTW 0,2,107
        04231  -1 00153 2 00000  1XFF1  MON 0,2,107
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TD      04232   1 00000 0 01226   2XU1   TXI XU2
        04233  -0 76000 0 00003   1XU1   SSM
        04234   0 02000 0 03633   2XUO   TRA XUP
        04235  -0 50000 0 04735   1XUO   CAL C75
        04236   0 50000 0 10347          CLA T24
TD      04237   1 00000 0 01201   1XN    TXI XQ
        04240   0 56000 0 10354          LDQ T29
TD      04241   1 00000 0 01335   1XAB   TXI XAF
TD      04242   1 00000 0 01363          TXI XAJ
        04243   0 50000 0 10363   1XAI   CLA T36
TD      04244   1 00000 0 01435          TXI XAL
        04245   0 50000 0 10363   1XAK   CLA T36
        04246   0 56000 0 10366          LDQ T39
TD      04247   1 00000 0 01523   1XAR   TXI XAS
        04250   0 76100 0 00000          NOP
TD      04251   1 00000 0 01512   1XAV   TXI XAP
        04252   0 02000 0 01213          TRA XS2
        04253   0 50000 0 04335   1XS1   CLA I0
TD      04254   1 00000 0 01717          TXI XAY
        04255   0 50000 0 10516   1XBK   CLA M10
TD      04256   1 00000 0 01157          TXI XN
        04257   0 53400 4 04340   1XL    LXA I3,4
TD      04260   1 00000 0 01201          TXI XQ
        04261   0 53400 4 04340   1XO    LXA I3,4
        04262   1 77777 1 01303          TXI XAB,1,-1
        04263   0 56000 0 10355   1XY    LDQ T30
        04264   1 77777 1 01335          TXI XAF,1,-1
        04265   0 56000 0 10355   1XAC   LDQ T30
TD      04266   1 00000 0 01533          TXI XAW
        04267   0 50000 0 10520   1XAM   CLA M12
TD      04270   1 00000 0 01533          TXI XAW
        04271   0 50000 0 10520   1XAN   CLA M12
        04272   0 70000 0 10516          CPY M10
        04273   0 70000 0 10516          CPY M10
TD      04274   1 00000 0 00725   1XBH4  TXI XA
        04275   0 70000 0 10521          CPY M13
TD      04276   1 00000 0 00725          TXI XA
TD      04277   1 00000 0 00725   1XBH5  TXI XA
        04300   3 37340 0 04446          PTH C27,0,16096
        04301   3 33404 0 04430          PTH C26,0,14084
        04302   3 21536 0 04417          PTH C25,0,9054
        04303   3 13624 0 04411   1XCH5  PTH C24,0,6036
        04304   0 02000 0 02014          TRA XBG6
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04305   0 02000 0 01773          TRA XBG4
04306   0 02000 0 01755          TRA XBG2
04307   0 07400 4 05336  1XBG    TSX SWTF,4
04310   3 13632 0 04513          PTH C35,0,6042
04311   3 15610 0 04504          PTH C34,0,7048
04312   3 07676 0 04500          PTH C33,0,4030
04313   3 13632 0 04472  1XEC1   PTH C32,0,6042
04314   3 03745 0 04524          PTH C38,0,2021
04315   3 01767 0 04523  1XEC2   PTH C37,0,1015
04316   3 21563 0 04741          PTH C79,0,9075
04317   3 03761 0 04534          PTH C41,0,2033
04320   3 03761 0 04532  1XEC3   PTH C40,0,2033
04321   3 01772 0 04543          PTH C45,0,1018
04322   3 03750 0 04541          PTH C44,0,2024
04323   3 01772 0 04540  1XEC4   PTH C43,0,1018
04324   3 05731 0 04560          PTH C49,0,3033
04325   3 07707 0 04554          PTH C48,0,4039
04326   3 11665 0 04547  1XEE1   PTH C47,0,5045
04327   3 03772 0 04572          PTH C52,0,2042
04330   3 03772 0 04570  1XEG1   PTH C51,0,2042
04331   3 03734 0 04615          PTH C57,0,2012
04332   3 05712 0 04612  1XEK1   PTH C56,0,3018
04333   3 13624 0 04642          PTH C62,0,6036
04334   3 11646 0 04635  1XEK2   PTH C61,0,5030
                                 INTEGERS
04335   0 00000 0 00000  I0      PZE 0
04336   0 00000 0 00001  I1      PZE 1
04337   0 00000 0 00002  I2      PZE 2
04340   0 00000 0 00003  I3      PZE 3
04341   0 00000 0 00004  I4      PZE 4
04342   0 00000 0 00005  I5      PZE 5
04343   0 00000 0 00006  I6      PZE 6
04344   0 00000 0 00007  I7      PZE 7
04345   0 00000 0 00010  I8      PZE 8
04346   0 00000 0 00011  I9      PZE 9
04347   0 00000 0 00013  I11     PZE 11
04350   0 00000 0 00014  I12     PZE 12
04351   0 00000 0 00044  I36     PZE 36
04352   000000000023     IC      BCD 100000C
04353   000000000042     IK      BCD 100000K
04354   000000000044     IM      BCD 100000M
04355   000000000047     IP      BCD 100000P
04356   000000000062     IS      BCD 100000S
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04357   000000000063     IT     BCD 100000T
                                    CONSTANTS
04360  +201400000000     C1     OCT 201400000000        FLOATING ONE
04361  +203622077324     C2     DEC 6.2831853           2PI
04362   606060606060     C3     BCD 1                   INDICATORS FOR OUTPUT
04363   546060606060     C4     BCD 1*                  X
04364   545460606060     C5     BCD 1**                 X
04365   547354546060     C6     BCD 1*,**               X
04366  +202400000000     C7     DEC 2.                  LIMIT ON DELTA/SIGMA
04367   606060006060     C9     BCD 2    0    0    0
04370   600060606000
04371   456444255121     C19    BCD 5NUMERATOR    DENOMINATOR       R
04372   634651606060
04373   242545464431
04374   452163465160
04375   606060606051
04376   605160262123     C20    BCD 2 R FACTOR
04377   634651606060
04400   606625312730     C21    BCD 3 WEIGHTED R FACTOR
04401   632524605160
04402   262123634651
04403   314523436424     C22    BCD 3INCLUDING ZEROS
04404   314527607125
04405   514662606060
04406   464431636331     C23    BCD 3OMITTING ZEROS
04407   452760712551
04410   466260606060
04411   606060306060     C24    BCD 6    H    K    L    CALCULATED          A
04412   604260606043
04413   606060232143
04414   236443216325
04415   246060606060
04416   606060602160
04417   606060306060     C25    BCD 9    H    K    L    CALCULATED          A              B
04420   604260606043
04421   606060232143
04422   236443216325
04423   246060606060
04424   606060602160
04425   606060606060
04426   606060606022
04427   606060606060
04430   606060306060     C26    BCD      H    K    L     OBSERVED   CALCULATED         A              OBS
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04431  604260606043
04432  606060606046
04433  226225516525
04434  246060602321
04435  432364432163
04436  252460606060
04437  606060606021
04440  606060606060
04441  606060462262
04442  402321436060          BCD 4-CAL  (OBS-CAL)/SIGMA
04443  744622624023
04444  214334616231
04445  274421606060
04446  606060306060    C27   BCD     H   K   L     OBSERVED   CALCULATED         A
04447  604260606043
04450  606060606046
04451  226225516525
04452  246060602321
04453  432364432163
04454  252460606060
04455  606060606021
04456  606060606060
04457  606060606060
04460  226060606060          BCD 6B          OBS-CAL   (OBS-CAL)/SIGMA
04461  606060604622
04462  624023214360
04463  607446226240
04464  232143346162
04465  312744216060
04466 -0 00147 0 10424  C28   MZE T58,0,103
04467 -1 00147 1 10321  C29   MON S1+12,1,103
04470 -0 00457 0 00000  C30   MZE 0,0,303
04471  604446242540     C31   BCD 1 MODE-
04472  602346444764     C32   BCD 6 COMPUTE FIXED ATOM CONTRIBUTIONS
04473  632560263167
04474  252460216346
04475  446023464563
04476  513122646331
04477  464562606060
04500  602346444764     C33   BCD 4 COMPUTE F OR F SQUARED
04501  632560266046
04502  516026606250
04503  642151252460
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04504   602346444764      C34    BCD 7 COMPUTE DERIVATIVES FOR LEAST SQUARES
04505   632560242551
04506   316521633165
04507   256260264651
04510   604325216263
04511   606250642151
04512   256260606060
04513   604325216263      C35    BCD 6 LEAST SQUARES USING OLD DERIVATIVES
04514   606250642151
04515   256260646231
04516   452760464324
04517   602425513165
04520   216331652562
04521   602221622524      C36    BCD 2 BASED ON
04522   604645606060
04523   602660606060      C37    BCD 1 F
04524   602660625064      C38    BCD 2 F SQUARED
04525   215125246060
04526   606325444725      C39    BCD 4 TEMPERATURE FACTORS-
04527   512163645125
04530   602621236346
04531   516240606060
04532   606270444425      C40    BCD 2 SYMMETRIC
04533   635131236060
04534   602145316246      C41    BCD 2 ANISOTROPIC
04535   635146473123
04536   602223246046      C42    BCD 2 BCD OUTPUT-
04537   646347646340
04540   602664434360      C43    BCD 1 FULL
04541   604721516331      C44    BCD 2 PARTIAL
04542   214360606060
04543   604546452560      C45    BCD 1 NONE
04544   602231452151      C46    BCD 3 BINARY OUTPUT-
04545   706046646347
04546   646340606060
04547   606330516460      C47    BCD 5 THRU FIXED ATOM CONTRIBUTIONS
04550   263167252460
04551   216346446023
04552   464563513122
04553   646331464562
04554   606330516460      C48    BCD 4 THRU F OR F SQUARED
04555   266046516026
04556   606250642151
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04557  252460606060
04560  606330516460      C49   BCD 3 THRU DERIVATIVES
04561  242551316521
04562  633165256260
04563  604622622551      C50   BCD 5 OBSERVED F OR F SQUARED TO BE
04564  652524602660
04565  465160266062
04566  506421512524
04567  606346602225
04570  602346456231      C51   BCD 2 CONSIDERED
04571  242551252460
04572  603127454651      C52   BCD 2 IGNORED
04573  252460606060
04574  604525646351      C53   BCD 2 NEUTRON
04575  464560606060
04576  606740512170      C54   BCD 6 X-RAY WITH    KINDS OF FORM FACTORS
04577  606631633060
04600  606060423145
04601  246260462660
04602  264651446026
04603  212363465162
04604  604564442225      C55   BCD 6 NUMBER OF ATOMS IN ASYMMETRIC UNIT-
04605  516046266021
04606  634644626031
04607  456021627044
04610  442563513123
04611  606445316340
04612  602325456351      C56   BCD 3 CENTROSYMMETRIC
04613  466270444425
04614  635131236060
04615  602123254563      C57   BCD 2 ACENTRIC
04616  513123606060
04617  604564442225      C58   BCD 8 NUMBER OF SYMMETRY CARDS OR SYMMETRY ROUTINES-
04620  516046266062
04621  704444256351
04622  706023215124
04623  626046516062
04624  704444256351
04625  706051466463
04626  314525624060
04627  604564442225      C59   BCD 5 NUMBER OF SCALE FACTORS-
04630  516046266062
04631  232143256026
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04632  212363465162
04633  406060606060
04634  0 00000 0 00017  C60   PZE 15                    MASK USED TO DECODE SYMMETRY CARDS
04635  606462256027     C61   BCD 5 USE GENERAL SYMMETRY ROUTINE
04636  254525512143
04637  606270444425
04640  635170605146
04641  646331452560
04642  606270444425     C62   BCD 6 SYMMETRY ROUTINES SUPPLIED BY USER
04643  635170605146
04644  646331452562
04645  606264474743
04646  312524602270
04647  606462255160
04650  606250642151     C63   BCD   SQUARE ROOT (SUM W(OBS-CALC)**2/(M-N))                    S
04651  256051464663
04652  607462644460
04653  667446226240
04654  232143233454
04655  540261744440
04656  453434606060
04657  606060606060
04660  606060606060
04661  606060606062
04662  505163746060           BCD 3QRT(   0-  0)
04663  600040606000
04664  346060606060
04665  0 00000 0 77760  C64   PZE K1                  ADDRESS OF FIRST INTERSEGMENT TEMPORARY
04666  604721512144     C65   BCD   PARAMETER          OLD      CHANGE       NEW       ERROR
04667  256325516060
04670  606060606060
04671  606046432460
04672  606060606023
04673  302145272560
04674  606060606060
04675  452566606060
04676  606060602551
04677  514651606060
04700  622321432560     C66   BCD 2SCALE FACTOR
04701  262123634651
04702  466525512143     C67   BCD 20VERALL B
04703  436022606060
04704  602163464460     C68   BCD 1 ATOM
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04705   602646514460      C69    BCD 2 FORM FACTOR
04706   262123634651
04707   606760606060             BCD 2 X
04710   606060606060
04711   607060606060             BCD 2 Y
04712   606060606060
04713   607160606060             BCD 2 Z
04714   606060606060
                    04715  C70   BSS 2                    TO BE SET
04717   602225632174             BCD 2 BETA(2,2)
04720   027302346060
04721   602225632174             BCD 2 BETA(3,3)
04722   037303346060
04723   602225632174             BCD 2 BETA(1,2)
04724   017302346060
04725   602225632174             BCD 2 BETA(1,3)
04726   017303346060
04727   602225632174             BCD 2 BETA(2,3)
04730   027303346060
04731   602163464431      C71    BCD 2 ATOMIC B
04732   236022606060
04733   602225632174      C72    BCD 2 BETA(1,1)
04734   017301346060
04735  -0 00025 1 00000   C75    FOR 0,1,21              X-RAY FORM FACTOR OUTPUT
04736  -3 15561 1 00000   C76    SVN 0,1,7025            NEUTRON FORM FACTOR OUTPUT
04737   0 00026 0 00000   C77    PZE 0,0,22
04740   0 00000 0 04705   C78    PZE C69                 ADDRESS OF FIRST TITLE
04741   606270444425      C79    BCD 9 SYMMETRIC CONVERTED TO ANISOTROPIC BEFORE REFINING
04742   635131236023
04743   464565255163
04744   252460634660
04745   214531624663
04746   514647312360
04747   222526465125
04750   605125263145
04751   314527606060
04752  +177400000000      C80    DEC .25
04753  +202400000000      C81    DEC 2.
04754   606325444725      C82    BCD   TEMPERATURE FACTOR OF ATOM    IS NOT POSITIVE-DEFINITE.
04755   512163645125
04756   602621236346
04757   516046266021
04760   634644606060
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04761  603162604546
04762  636047466231
04763  633165254024
04764  252631453163
04765  253360606060
04766  602431622351      C83   BCD 8 DISCREPANCY FACTORS BASED ON INPUT PARAMETERS.
04767  254721452370
04770  602621236346
04771  516260222162
04772  252460464560
04773  314547646360
04774  472151214425
04775  632551623360
04776  602562633144      C84   BCD 2 ESTIMATE OF
04777  216325604626
05000  602221622524      C85   BCD 5 BASED ON OUTPUT PARAMETERS.
05001  604645604664
05002  634764636047
05003  215121442563
05004  255162336060
05005  606364514560      C86   BCD   TURN ON SENSE SWITCH   TO SUPPRESS ON-LINE PRINTING OF
05006  464560622545
05007  622560626631
05010  632330606060
05011  634660626447
05012  475125626260
05013  464540433145
05014  256047513145
05015  633145276046
05016  266060606060
05017  472151214425      C87   BCD 2PARAMETERS.
05020  632551623360
05021  266046516026      C88   BCD 3F OR F SQUARED.
05022  606250642151
05023  252433606060
05024  0 00000 0 00020   C89   PZE 16                NO. OF INTERSEGMENT STORAGE LOCATIONS
05025  3 77777 7 77323   C90   PTH -START,7,32767    USED TO COMPUTE LENGTH OF DUMMY RECORD
05026  0 00000 0 00300   C91   PZE 192               LENGTH OF DUMMY RECORD 3
05027  0 00000 0 00200   C92   PZE 128               LENGTH OF DUMMY RECORD 4
                               SUBROUTINE TO CHECK IDENTIFICATION LETTER
05030  0 76000 0 00166   IFF   SWT 6
05031  0 02000 0 05033         TRA IFF1
05032  0 02000 4 00003         TRA 3,4
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05033   0 50000 4 00001   IFF1   CLA 1,4
05034   0 62100 0 05040          STA IFF2
05035   0 77100 0 00022          ARS 18
05036   0 62100 0 05043          STA IFF3
05037   0 62100 0 05056          STA IFF6
05040   0 50000 0 00000   IFF2   CLA 0                    ADDRESS TO BE SET
05041  -0 32000 0 05133          ANA IFF11
05042   0 60100 0 05134          STO IFF12
05043   0 34000 0 00000   IFF3   CAS 0                    ADDRESS TO BE SET
05044  -1 00000 0 05046   IFF4   TXI IFF5,0,0
05045   0 02000 4 00003          TRA 3,4
05046  -0 63400 4 05044   IFF5   SXD IFF4,4
05047   0 07400 4 06147          TSX OUT,4
05050   0 07400 4 05254          TSX ECHO,4
05051   3 02015 0 05134          PTH IFF12,0,1037
05052   3 13624 0 05076          PTH IFF7,0,6036
05053  -1 00000 0 00364          FVE 244
05054   0 07400 4 06147          TSX OUT,4
05055   0 07400 4 05254          TSX ECHO,4
05056   3 02015 0 00000   IFF6   PTH 0,0,1037           ADDRESS TO BE SET
05057   3 13624 0 05104          PTH IFF8,0,6036
05060  -1 00000 0 00364          FVE 244
05061   0 07400 4 06147          TSX OUT,4
05062   0 07400 4 05254          TSX ECHO,4
05063   3 15602 0 05112          PTH IFF9,0,7042
05064  -1 00000 0 00364          FVE 244
05065   0 07400 4 06147          TSX OUT,4
05066   0 07400 4 05254          TSX ECHO,4
05067   3 23514 0 05121          PTH IFF10,0,10060
05070  -1 00000 0 00364          FVE 244
05071   0 07400 4 06147          TSX OUT,4
05072   0 07400 4 05254          TSX ECHO,4
05073  -1 00000 0 00361          FVE 241
05074  -0 53400 4 05044          LXD IFF4,4
05075   0 00000 4 00002          HTR 2,4
05076   602421632160      IFF7   BCD 6 DATA CARD IDENTIFICATION LETTER IS
05077   232151246031
05100   242545633126
05101   312321633146
05102   456043256363
05103   255160316260
05104   604751462751      IFF8   BCD 6 PROGRAM CALLS FOR CARD WITH LETTER
05105   214460232143
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05106   436260264651
05107   602321512460
05110   663163306043
05111   256363255160
05112   604764636023        IFF9  BCD 7 PUT CORRECT CARD IN READER AND PROCEED.
05113   465151252363
05114   602321512460
05115   314560512521
05116   242551602145
05117   246047514623
05120   252524336060
05121   606346602270        IFF10 BCD   TO BYPASS ALL IDENTIFICATION TESTS TURN ON SENSE SWITCH 6.
05122   472162626021
05123   434360312425
05124   456331263123
05125   216331464560
05126   632562636260
05127   636451456046
05130   456062254562
05131   256062663163
05132   233060063360
05133   0 00000 0 00077     IFF11 PZE 63                    MASK
05134   0 00000 0 00000     IFF12                           LETTER FROM CARD
                                    SUBROUTINE TO TEST FOR BLANK FIELD
05135  -0 63400 1 05143     BLNK  SXD BLNK2,1
05136   0 50000 4 00001           CLA 1,4
05137   0 62100 0 05141           STA BLNK1
05140  -0 73400 1 00000           PDX 0,1
05141   0 50000 1 00000     BLNK1 CLA 0,1                   ADDRESS TO BE SET
05142   0 34000 0 05152           GAS BLNK5
05143   1 00000 0 05145     BLNK2 TXI BLNK3,0,0
05144   0 02000 0 05147           TRA BLNK4
05145  -0 53400 1 05143     BLNK3 LXD BLNK2,1
05146   0 02000 4 00003           TRA 3,4
05147   2 00001 1 05141     BLNK4 TIX BLNK1,1,1
05150  -0 53400 1 05143           LXD BLNK2,1
05151   0 02000 4 00002           TRA 2,4
05152   606060606060        BLNK5 BCD 1
                                    OCTAL AND FLOATING DECIMAL DUMP FOR TEST PURPOSES
05153   0 07400 4 06147     DUMP  TSX OUT,4
05154   0 07400 4 05254           TSX ECHO,4
05155   3 27451 0 10406           PTH T55,0,12073
05156   3 02066 0 04362           PTH C3,0,1078
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05157   1 00001 0 00003          PON  U2,0,1
05160   0 53400 1 05252          LXA  DUMP7,1
05161   0 07400 4 06147  DUMP1   TSX  OUT,4
05162   0 07400 4 05254          TSX  ECHO,4
05163  -2 17531 1 00000          SIX  0,1,8025
05164  -2 17562 1 00001          SIX  1,1,8050
05165  -2 17613 1 00002          SIX  2,1,8075
05166  -2 17644 1 00003          SIX  3,1,8100
05167   1 00000 0 00003          PON  U2,0,0
05170  -0 75400 1 00000          PXD  0,1
05171   0 77100 0 00022          ARS  18
05172   0 76000 0 00006          COM
05173   0 40000 0 04336          ADD  I1
05174   0 73400 2 00000          PAX  0,2
05175  -0 75400 2 00000          PXD  0,2
05176   0 76500 0 00043          LRS  35
05177   0 53400 4 04343          LXA  I6,4
05200   0 76700 0 00003  DUMP8   ALS  3
05201  -0 76300 0 00003          LGL  3
05202   2 00001 4 05200          TIX  DUMP8,4,1
05203  -0 50100 0 05253          ORA  DUMP9
05204   0 60200 0 05251          SLW  DUMP6+8
05205   0 53400 2 04345          LXA  I8,2
05206   0 56000 1 00000  DUMP2   LDQ  0,1
05207   0 53400 4 04343          LXA  I6,4
05210   0 76700 0 00003  DUMP3   ALS  3
05211  -0 76300 0 00003          LGL  3
05212   2 00001 4 05210          TIX  DUMP3,4,1
05213   0 60200 2 05251          SLW  DUMP6+8,2
05214   0 53400 4 04343          LXA  I6,4
05215   0 76700 0 00003  DUMP4   ALS  3
05216  -0 76300 0 00003          LGL  3
05217   2 00001 4 05215          TIX  DUMP4,4,1
05220   0 60200 2 05252          SLW  DUMP6+9,2
05221   1 77777 1 05222          TXI  DUMP5,1,-1
05222   2 00002 2 05206  DUMP5   TIX  DUMP2,2,2
05223   0 07400 4 06147          TSX  OUT,4
05224   0 07400 4 05254          TSX  ECHO,4
05225   3 01756 0 05251          PTH  DUMP6+8,0,1006
05226   3 01772 0 05241          PTH  DUMP6,0,1018
05227   3 02001 0 05242          PTH  DUMP6+1,0,1025
05230   3 02023 0 05243          PTH  DUMP6+2,0,1043
05231   3 02032 0 05244          PTH  DUMP6+3,0,1050
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05232   3 02054 0 05245          PTH DUMP6+4,0,1068
05233   3 02063 0 05246          PTH DUMP6+5,0,1075
05234   3 02105 0 05247          PTH DUMP6+6,0,1093
05235   3 02114 0 05250          PTH DUMP6+7,0,1100
05236   1 00060 0 00003          PON U2,0,48
05237   3 66653 1 05161          TXH DUMP1,1,-T5-256    DECREMENT IS -(FINAL ADDRESS+1)
05240   0 02000 0 00144          TRA RCD
                  05241  DUMP6  BSS 9
05252   0 00000 0 67473  DUMP7  PZE -S1                 -(INITIAL ADDRESS)
05253   600000000000     DUMP9  BCD 1 00000
                                SUBROUTINE TO TEST NATURE OF ERROR RETURN FROM NY OUT3
05254   0 12000 0 05272  ECHO   TPL ECHO4
05255  -0 10000 0 05272          TNZ ECHO4
05256  -0 63400 4 05310          SXD ECHO7,4
05257   0 07400 4 06147          TSX OUT,4
05260   0 02000 0 05263          TRA ECHO2
05261   3 15602 0 05301          PTH ECHO6,0,7042
05262  -1 00000 0 00000  ECHO1  FVE
05263  -0 53400 4 05310  ECHO2  LXD ECHO7,4
05264  -0 50000 4 00001  ECHO3  CAL 1,4
05265  -0 77100 0 00041          ARS 33
05266   0 34000 0 05300          CAS ECHO5
05267   1 77777 4 05264          TXI ECHO3,4,-1
05270   0 02000 4 00002          TRA 2,4                TO NORMAL RETURN OF NY OUT3
05271   1 77777 4 05264          TXI ECHO3,4,-1
05272  -0 75400 4 00000  ECHO4  PXD 0,4
05273   0 76000 0 00006          COM
05274  -0 73400 4 00000          PDX 0,4
05275  -0 75400 4 00000          PXD 0,4
05276   0 77100 0 00022          ARS 18
05277   0 00000 0 00144          HTR RCD                CALLING SEQUENCE ERROR. ADDRESS IN ACC.
05300  -0 00000 0 00005  ECHO5  PZE 5
05301   605454546047     ECHO6  BCD 7 *** PRINTER ERROR IN PREVIOUS LINE ***
05302   513145632551
05303   602551514651
05304   603145604751
05305   256531466462
05306   604331452560
05307   545454606060
05310   0 00000 0 00000  ECHO7  PZE                    INDEX SAVED IN DECREMENT
                                SUBROUTINE TO SUPPRESS ON-LINE PRINTING OF PARAMETERS
05311   0 50000 4 00001  SWTP   CLA 1,4
05312   0 62100 0 05331          STA SWTP5
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05313   0 76000 0 00164          SWT 4
05314   0 02000 0 05327          TRA SWTP4
05315   0 50000 0 05335          CLA SWTP8
05316   0 10000 0 05325          TZE SWTP2
05317   0 60000 0 05335          STZ SWTP8
05320  -0 63400 4 05326          SXD SWTP3,4
05321   0 07400 4 06147  SWTP1   TSX OUT,4
05322   0 07400 4 05254          TSX ECHO,4
05323  -1 00000 0 00361          FVE 241
05324  -0 53400 4 05326          LXD SWTP3,4
05325   0 56000 0 05333  SWTP2   LDQ SWTP6
05326   1 00000 0 05331  SWTP3   TXI SWTP5,0,0          INDEX SAVED IN DECREMENT
05327   0 56000 0 05334  SWTP4   LDQ SWTP7
05330  -0 60000 0 05335          STQ SWTP8
05331  -0 62000 0 00000  SWTP5   SLQ 0                  ADDRESS TO BE SET
05332   0 02000 4 00002          TRA 2,4
05333   0 76100 0 00000  SWTP6   NOP                    CONSTANT
05334  -1 00000 0 00000  SWTP7   FVE                    CONSTANT
05335   0 00000 0 00000  SWTP8   PZE                    INDICATOR
                                 SUBROUTINE TO SUPPRESS ON-LINE PRINTING OF F OR F**2
05336   0 50000 4 00001  SWTF    CLA 1,4
05337   0 62100 0 05356          STA SWTF5
05340   0 76000 0 00163          SWT 3
05341   0 02000 0 05354          TRA SWTF4
05342   0 50000 0 05362          CLA SWTF8
05343   0 10000 0 05352          TZE SWTF2
05344   0 60000 0 05362          STZ SWTF8
05345  -0 63400 4 05353          SXD SWTF3,4
05346   0 07400 4 06147  SWTF1   TSX OUT,4
05347   0 07400 4 05254          TSX ECHO,4
05350  -1 00000 0 00361          FVE 241
05351  -0 53400 4 05353          LXD SWTF3,4
05352   0 56000 0 05360  SWTF2   LDQ SWTF6
05353   1 00000 0 05356  SWTF3   TXI SWTF5,0,0          INDEX SAVED IN DECREMENT
05354   0 56000 0 05361  SWTF4   LDQ SWTF7
05355  -0 60000 0 05362          STQ SWTF8
05356  -0 62000 0 00000  SWTF5   SLQ 0                  ADDRESS TO BE SET
05357   0 02000 4 00002          TRA 2,4
05360   0 76100 0 00000  SWTF6   NOP                    CONSTANT
05361  -1 00000 0 00000  SWTF7   FVE                    CONSTANT
05362   0 00000 0 00000  SWTF8   PZE                    INDICATOR
                                 THE FOLLOWING SUBROUTINES ARE ON RELOCATABLE CARDS
                    05363 DBD1   BSS 136
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                    05573  FILE   BSS 197
                    06100 BUFFER  BSS 14
                    06116  SQRT   BSS 25
                    06147  OUT    BSS 408
                    06777  SIN    BSS 24
                    07027  EXP    BSS 35
                    07072 TABLES  BSS 651
                                  SENSE INDICATORS
10305   0 00000 0 00000   S1                    MODE INDICATOR
10306   0 00000 0 00001   S2      PZE 1         F OR F SQUARED INDICATOR
10307   0 00000 0 00001   S3      PZE 1         SYMM OR ANIS INDICATOR
10310   0 00000 0 00001   S4      PZE 1         BCD OUTPUT INDICATOR
10311   0 00000 0 00002   S5      PZE 2         BINARY OUTPUT YES OR NO
10312   0 00000 0 00001   S6      PZE 1         OBSERVED TO BE CONSIDERED
10313   0 00000 0 00000   S7                    NUMBER OF FORM FACTOR TABLES
10314   0 00000 0 00000   S8                    NUMBER OF ATOMS IN ASYMMETRIC UNIT
10315   0 00000 0 00000   S9                    CENTRO OR ACENTRIC
10316   0 00000 0 00000   S10                   NO. OF SYMM CARDS OR SYMM ROUTINES
10317   0 00000 0 00001   S15     PZE 1         GENERAL OR USERS SYMMETRY ROUTINE
10320   0 00000 0 00001   S11     PZE 1         NO. OF SCALE FACTORS
10321   0 00000 0 00000   S12                   FIXED ATOM CONTRIBUTION INDICATOR
10322   0 00000 0 00000   S13                   ARE DERIVATIVES COMPUTED
10323   0 00000 0 00000   S14                   EXTENT OF BINARY OUTPUT
                                  TEMPORARY STORAGE
                    10316  I1     SYN S10
                    10314  T2     SYN S8
                    10320  T3     SYN S11
                    10313  T4     SYN S7
10324   0 00000 0 00000   T61                   COMP LOC FIRST SYMMETRY CODE WORD
10325   0 00000 0 00000   T6                    COMP LOC FIRST ATOM PARAMETER
10326   0 00000 0 00000   T7                    COMP LOC SUMMATION STORAGE
10327   0 00000 0 00000   T8                    COMP LOC DERIVATIVE STORAGE
10330   0 00000 0 00000   T11                   COMP LOC FORM FACTOR STORAGE
10331   0 00000 0 00000   T9                    NO. OF ATOMIC PARAMETERS
10332   0 00000 0 00000   T10                   NO. OF INTERMEDIATE SUMS
10333   0 00000 0 00000   T12                   T(J)
10334   0 00000 0 00000   T13                   H(J)
10335   0 00000 0 00000   T14                   K(J)
10336   0 00000 0 00000   T15                   L(J)
10337   0 00000 0 00000   T16                   H**2(J)
10340   0 00000 0 00000   T17                   K**2(J)
10341   0 00000 0 00000   T18                   L**2(J)
10342   0 00000 0 00000   T19                   2HK(J)
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10343   0 00000 0 00000   T20                    2HL(J)
10344   0 00000 0 00000   T21                    2KL(J)
10345   0 00000 0 00000   I22                    TRIG ARGUMENT (I,J)
10346   0 00000 0 00000   I23                    INDEX I IN DECREMENT
10347   0 00000 0 00000   T24                    SIN(I,J), EXP(I,J)SIN(I,J)
10350   0 00000 0 00000   T25                    COS(I,J), EXP(I,J)COS(I,J)
10351   0 00000 0 00000   T26                    EXP ARGUMENT (I,J)
10352   0 00000 0 00000   T27                    EXP(I,J)
10353   0 00000 0 00000   T28                    INDEX J IN DECREMENT
10354   0 00000 0 00000   T29                    F(I), SYM T.F.(I)F(I)
10355   0 00000 0 00000   T30                    SYM T.F.(I)
10356   0 00000 0 00000   I31                    F(I)SYM T.F.(I)SUM(I)EXP(I,J)COS(I,J)
10357   0 00000 0 00000   T32                    F(I)SYM T.F.(I)SUM(I)EXP(I,J)SIN(I,J)
10360   0 00000 0 00000   T33                    2PI F(I)SYM T.F.(I)
10361   0 00000 0 00000   T34                    MINUS 2PI F(I)SYM T.F.(I)
10362   0 00000 0 00000   T35                    MINUS F(I)SYM T.F.(I)
10363   0 00000 0 00000   T36                    OVERALL T.F., SCALE*OV.T.F
10364   0 00000 0 00000   I37                    SCALE FACTOR
10365   0 00000 0 00000   I38                    COEFFICIENT OF D A/D PARAMETER
10366   0 00000 0 00000   I39                    COEFFICIENT OF D B/D PARAMETER
10367   0 00000 0 00000   I40                    A**2, (A**2+B**2)**(1/2),A**2+B**2
10370   0 00000 0 00000   T41                    5 FOR SYM OR 10 FOR ANIS T.F.
10371   0 00000 0 00000   I42                    R FACTOR NUMERATOR
10372   0 00000 0 00000   I43                    SAME OMITTING UNOBSERVEDS
10373   0 00000 0 00000   T44                    WEIGHTED R FACTOR NUMERATOR
10374   0 00000 0 00000   T45                    SAME OMITTING UNOBSERVEDS
10375   0 00000 0 00000   T46                    R FACTOR DENOMINATOR
10376   0 00000 0 00000   I47                    WEIGHTED R FACTOR DENOMINATOR
10377   0 00000 0 00000   T48.                   (OBS-CALC)/SIGMA
10400   0 00000 0 00000   T49                    W*OBS**2
10401   0 00000 0 00000   T50                    HOLLERITH DISAGREEMENT INDICATOR
10402   0 00000 0 00000   I51                    R FACTOR
10403   0 00000 0 00000   T52                    SAME OMITTING UNOBSERVEDS
10404   0 00000 0 00000   T53                    WEIGHTED R FACTOR
10405   0 00000 0 00000   T54                    SAME OMITTING UNOBSERVEDS
                          10406   T55   BSS 12   IDENTIFICATION OF PROBLEM
10422   0 00000 0 00000   T56                    INDEX 4 IN DECREMENT
10423   0 00000 0 00000   T57                    W(OBS-CALC)**2
10424   0 00000 0 00000   T58                    SENSE INPUT TO TEST FOR BLANK
10425   0 00000 0 00000   T59                    MACHINE CAPACITY LESS ONE
                          10426   T60   BSS 6    COMPONENTS OF TRANSFORMED INDICES
10434   0 00000 0 00000   T62                    COMP CURRENT LOC SYMM CODE WORD
                          10435   T63   BSS 6    HOLLERITH INPUT FROM SYMMETRY CARDS
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10443   0 00000 0 00000   T64                  NUMBER OF SYMMETRY CODE WORDS
10444   0 00000 0 00000   T65                  M, NUMBER OF REFLECTIONS USED
10445   0 00000 0 00000   T66                  SUM W(OBS-CALC)**2 FOR REFLECTIONS USED
10446   0 00000 0 00000   T67                  N, NUMBER OF PARAMETERS VARIED
10447   0 00000 0 00000   T68                  SQRT (SUM W(OBS-CALC)**2/(M-N))
10450   0 00000 0 00000   T69                  DISCARDS COPIED HERE
                  10451   T70   BSS 2          PARAMETER TITLE FOR OUTPUT
10453   0 00000 0 00000   T71                  SCALE FACTOR OR ATOM NUMBER
10454   0 00000 0 00000   T72                  OLD PARAMETER
10455   0 00000 0 00000   T73                  NEW PARAMETER
10456   0 00000 0 00000   T74                  STANDARD ERROR OF PARAMETER
10457   0 00000 0 00000   T75                  INDEX P IN DECREMENT
10460   0 00000 0 00000   T76                  INDEX I IN DECREMENT
10461   0 00000 0 00000   T77                  INDEX Q IN DEGREMENT
10462   0 00000 0 00000   T78                  A*
10463   0 00000 0 00000   T79                  B*
10464   0 00000 0 00000   T80                  C*
10465   0 00000 0 00000   T81                  COS GAMMA*
10466   0 00000 0 00000   T82                  COS BETA*
10467   0 00000 0 00000   T83                  COS ALPHA*
10470   0 00000 0 00000   T84                  (.25)(A*)(A*)
10471   0 00000 0 00000   T85                  (.25)(B*)(B*)
10472   0 00000 0 00000   T86                  (.25)(C*)(C*)
10473   0 00000 0 00000   T87                  (.25)(A*)(B*)(COS GAMMA*)
10474   0 00000 0 00000   T88                  (.25)(A*)(C*)(COS BETA*)
10475   0 00000 0 00000   T89                  (.25)(B*)(C*)(COS ALPHA*)
10476   0 00000 0 00000   T90                  5(NO. OF ATOMS)
10477   0 00000 0 00000   T91                  B(I), OVERALL B
10500   0 00000 0 00000   T92                  INDICATOR FOR POS-DEF TEMP. FACTOR
10501   0 00000 0 00000   T93                  USED FOR TESTS ON TEMP. FACTORS
10502   0 00000 0 00000   T94                  CORRECTION TO SUM W(OBS-CALC)**2
10503   0 00000 0 00000   T95                  SQRT (SUM W(OBS-CALC)**2)
10504   0 00000 0 00000   T96                  HALF LENGTH OF CODE DUMP

                                  DATA AND OUTPUT TEMPORARIES
10505   0 00000 0 00000   M1                   H
10506   0 00000 0 00000   M2                   K
10507   0 00000 0 00000   M3                   L
10510   0 00000 0 00000   M4                   OBS
10511   0 00000 0 00000   M5                   SQRT W=1/SIGMA
10512   0 00000 0 00000   M6                   SCALE FACTOR IDENTIFICATION
10513   0 00000 0 00000   M7                   (SIN THETA/LAMBDA)**2
10514   0 00000 0 00000   M8                   FIXED ATOM A
10515   0 00000 0 00000   M9                   FIXED ATOM B
```

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10516   0 00000 0 00000   M10                    A
10517   0 00000 0 00000   M11                    B
10520   0 00000 0 00000   M12                    CALC
10521   0 00000 0 00000   M13                    OBS-CALC
10522   0 00000 0 00000   M14                    REJECTION INDICATOR
10523   0 00000 0 00000   M15                    D CALC/D SCALE
10524   0 00000 0 00000   M16                    D CALC/D OVERALL T.F.
                                THE FOLLOWING MAY BE CHANGED BY THE USER
10525   0 00000 0 10526   T5    PZE XD1          ADDRESS OF LAST LOC USED
10526   0 00000 0 00000   XD1                    SYMMETRY ROUTINES IF WRITTEN BY USER
                                IMMEDIATELY FOLLOWING THE ADDRESS SPECIFIED IN T5 THE
                                PROGRAM ASSIGNS THE FOLLOWING STORAGE-
                                    SCALE FACTORS.
                                    OVERALL TEMPERATURE FACTOR.
                                    SIX SYMMETRY CODE WORDS FOR EACH SYMMETRY CARD.
                                    FIVE OR TEN PARAMETERS PER ATOM.
                                    FORM FACTORS UNLESS PROBLEM IS NEUTRON ONE.
                                    FIVE, TEN, OR TWENTY LOCATIONS PER ATOM USED
                                        FOR DERIVATIVES OF A AND B.
                                        THIS AREA LATER USED FOR PARAMETER CHANGES AND
                                        DIAGONAL ELEMENTS OF INVERSE MATRIX.
                                    FIVE OR TEN LOCATIONS PER ATOM USED FOR
                                        DERIVATIVES OF F OR F SQUARED.
                                THE PROGRAM ASSIGNS THE FOLLOWING STORAGE
                                IMMEDIATELY PRECEEDING INTERSEGMENT STORAGE-
                                    PARAMETER SELECTION WORDS.
                                INTERSEGMENT TEMPORARY STORAGE
                    77760       ORG 32752
77760   0 00000 0 00000   K1                     NUMBER OF PARAMETER SELECTION WORDS
77761   0 00000 0 00000   K2                     NUMBER OF PARAMETERS TO BE VARIED
77762   0 00000 0 00000   K3                     NUMBER OF SCALE FACTORS TO BE VARIED
77763   0 00000 0 00000   K4                     NUMBER OF KINDS OF FORM FACTORS
77764   0 00000 0 00000   K5                     COMP. DERIV. ADDRESS IN DECREMENT
77765   0 00000 0 00000   K6                     BIT COUNTER IN DECREMENT
77766   0 00000 0 00000   K7                     SELECTION WORD COUNTER IN DECREMENT
77767   0 00000 0 00000   K8                     PARTLY SHIFTED SELECTION WORD
77770   0 00000 0 00000   K9                     BY-PASS INDICATOR
77771   0 00000 0 00000   K10                    COMP. INITIAL DERIVATIVE ADDRESS
77772   0 00000 0 00000   K11                    INITIAL MATRIX ADDRESS +N
77773   0 00000 0 00000   K12                    INITIAL VECTOR ADDRESS
77774   0 00000 0 00000   K13                    MODE NUMBER
77775   0 00000 0 00000   K14                    INITIAL MATRIX ADDRESS
77776   0 00000 0 00000   K15                    INITIAL SELECTION WORD ADDRESS
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77777   0 00000 0 00000  K16                                  -MATRIX ADDRESS,0,-VECTOR ADDRESS
                                     THIS SECTION SUPPLIES ORIGIN CARDS FOR THE SUBROUTINES
                  00000          ORG 0
00000   0 00000 0 00000          PZE
00001   0 00000 0 05363          PZE DBD1
                  00000          ORG 0
00000   0 00000 0 00000          PZE
00001   0 00000 0 05573          PZE FILE
                  00000          ORG 0
00000   0 00000 0 00000          PZE
00001   0 00000 0 06116          PZE SQRT
                  00000          ORG 0
00000   0 00000 0 00000          PZE
00001   0 00000 0 06147          PZE OUT
                  00000          ORG 0
00000   0 00000 0 00000          PZE
00001   0 00000 0 06777          PZE SIN
                  00000          ORG 0
                                     MU SBL 2  0026 CARDS   SHIFTING BINARY LOADER-ONE CARD
00000   0 53400 4 00000  SBL2    LXA 0,4          CLEAR IR4
00001   0 70000 4 00002          CPY 2,4          COPYLOADER INTO 2,3, ETC.
00002   1 77777 4 00001          TXI 1,4,32767    REPEAT UNTIL LOADER IN
00003   0 00000 0 07072          HTR TABLES         SHIFTING INCREMENT
00004   0 76200 0 00321          RCD              SELECT CARD READER
00005   0 70000 0 00000          CPY 0            9L IN 0 AND MQ
00006   0 76300 0 00021          LLS 17           WORD COUNT (=WC) IN AC ADDRESS
00007  -0 32000 0 00027          ANA 23           EXTRACT WORD COUNT
00010   0 70000 0 00001          CPY 1            9R IN 1 (CHECK SUM)
00011   0 10000 0 00000          TZE 0            IF WC=0, HAVE TRANSFER CARD, GO TO IT
00012   0 73400 4 00000          PAX 0,4          SET IR4=WC
00013   0 40000 0 00000          ADD 0            (WC+LA) IN AC (LA=LOAD ADDRESS)
00014   0 40000 0 00003          ADD 3            (WC+LA+INC) IN AC
00015   0 62100 0 00020          STA 16           PLANT (WC+LA+INC) AS CPY ADDRESS
00016   0 62100 0 00021          STA 17           AND AS ACL ADDRESS
00017  -0 50000 0 00000          CAL 0            PREPARE FOR CARD SUM
00020   0 70000 4 00000          CPY 0,4          COPY WORD FROM BINARY CARD
00021   0 36100 4 00000          ACL 0,4          AND ADD IT TO CARD SUM
00022   2 00001 4 00020          TIX 16,4,1       REPEATING UNTIL DONE
00023   0 60200 0 00002          SLW 2            FORM (CARD SUM)-(CHECK SUM)
00024   0 50000 0 00002          CLA 2            X
00025   0 40200 0 00001          SUB 1            X
00026   0 10000 0 00004          TZE 4            IF 0, PROCEED TO NEXT CARD
00027   0 00000 0 00037          HTR 31           MASK FOR WORD COUNT (HALT FOR ERROR)
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00000          END 0
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                                   OR-XLS3   MATRIX STORING SEGMENT
                     00005   U3     EQU 5                 NUMBER OF BINARY OUTPUT TAPE
                     00144   RCD    EQU 100
                     00146   WTB    EQU 102
                     00455          ORG 301
00455   0 02000 0 00461   START  TRA XJA
00456   0 00000 0 00144          HTR RCD                  NO ENTRY HERE
00457   0 02000 0 00144          TRA RCD
00460   0 00000 0 00144          HTR RCD                  NO ENTRY HERE
00461   0 53400 4 77774   XJA    LXA K13,4
00462   3 00004 4 00464          TXH XJA1,4,4
00463   3 00002 4 00465          TXH XJA2,4,2
00464   0 00000 0 00144   XJA1   HTR RCD                  INCORRECT MODE SPECIFIED
00465   0 50000 4 00717   XJA2   CLA 3XKL+3,4
00466   0 60100 0 00645          STO XKL
00467   0 53400 4 77770          LXA K9,4
00470   0 50000 4 00717          CLA 1XJK+1,4
00471   0 60100 0 00546          STO XJK
00472   0 50000 0 77775          CLA K14
00473   0 62100 0 00642          STA XKK2
00474   0 62100 0 00643          STA XKK3
00475   0 62100 0 00653          STA XKO
00476   0 62100 0 00654          STA XKO1
00477   0 62100 0 00674          STA XKT1
00500   0 50000 0 77776          CLA K15
00501   0 62100 0 00675          STA XKT2
00502   0 62100 0 00676          STA XKT3
00503   0 62100 0 00515          STA XJA3
00504   0 50000 0 77777          CLA K16
00505   0 76700 0 00022          ALS 18
00506   0 62200 0 00561          STD XJN1
00507   0 50000 0 77761          CLA K2
00510   0 40000 0 00720          ADD I3
00511   0 76500 0 00043          LRS 35
00512   0 20000 0 77761          MPY K2
00513   0 76300 0 00042          LLS 34
00514   0 73400 1 00000          PAX 0,1
00515   0 60000 1 00000   XJA3   STZ 0,1                  ADDRESS TO BE SET
00516   2 00001 1 00515          TIX XJA3,1,1
00517   0 53400 4 00721   XJB    LXA I4,4
00520   0 76200 0 00225   XJB1   RTB U3
00521   2 00001 4 00520          TIX XJB1,4,1
00522   0 53400 4 00720   XJC    LXA I3,4
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00523 -0 63400 4 00724  XJD   SXD T301,4
00524  0 76200 0 00225        RTB U3
00525 -0 76000 0 00012        RTT
00526  0 76100 0 00000        NOP
00527  0 70000 0 00725  XJE   CPY T302
00530  0 02000 0 00533        TRA XJF
00531  0 02000 0 00701        TRA XLE
00532  0 00000 0 00144        HTR RCD          NO WORDS IN RECORD
00533  0 53400 4 00721  XJF   LXA I4,4
00534  0 70000 0 00725  XJF1  CPY T302
00535  2 00001 4 00534        TIX XJF1,4,1
00536  0 70000 0 00726  XJG   CPY T303
00537  0 50000 0 77763  XJH   CLA K4
00540  0 40000 0 00722        ADD I7
00541  0 73400 4 00000        PAX 0,4
00542  0 70000 0 00727  XJH1  CPY T304
00543  2 00001 4 00542        TIX XJH1,4,1
00544  0 70000 0 00730  XJI   CPY T305
00545  0 70000 0 00731  XJJ   CPY T306
00546 -0 53400 4 77764  XJK   LXD K5,4          OR TRA XJS
00547 -0 53400 1 77765        LXD K6,1
00550 -0 53400 2 77766        LXD K7,2
00551 -0 50000 0 77767        CAL K8
00552  0 70000 4 00000  XJL   CPY 0,4
00553  0 02000 0 00556        TRA XJM
00554  0 00000 0 00000        PZE
00555  0 02000 0 00573        TRA XJT
00556 -0 76000 0 00001  XJM   PBT
00557  0 02000 0 00562        TRA XJO
00560  1 77777 4 00561  XJN   TXI XJN1,4,-1
00561 -3 00000 4 00570  XJN1  TXL XJS,4,0       DECREMENT TO BE SET
00562  0 76700 0 00001  XJO   ALS 1
00563  2 00001 1 00552  XJP   TIX XJL,1,1
00564 -2 00001 2 00570  XJQ   TNX XJS,2,1
00565  0 53400 1 00723  XJR   LXA I36,1
00566 -0 50000 2 77760        CAL K1,2
00567  0 02000 0 00552        TRA XJL
00570  0 70000 0 00732  XJS   CPY T307
00571  0 02000 0 00570        TRA XJS
00572  0 00000 0 00000        PZE
00573  0 76600 0 00333  XJT   IOD
00574 -0 76000 0 00012        RTT
00575  0 02000 0 00577        TRA XJU
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```
00576   0 02000 0 00604         TRA XJX
00577  -0 53400 4 00724  XJU    LXD T301,4
00600  -2 00001 4 00603         TNX XJW,4,1
00601   0 76400 0 00205  XJV    BST U3
00602   0 02000 0 00523         TRA XJD
00603   0 00000 0 00522  XJW    HTR XJC          RTT FAILS 3 TIMES. START TO SKIP RECORD
00604   0 50000 0 00730  XJX    CLA T305
00605  -0 10000 0 00522         TNZ XJC
00606   0 50000 0 00725  XJY    CLA T302
00607   0 10000 0 00522         TZE XJC
00610   0 53400 1 77762  XJZ    LXA K3,1
00611  -3 00000 1 00640         TXL XKK,1,0
00612   0 53400 2 77771         LXA K10,2
00613   0 60000 2 00000  XJZ1   STZ 0,2
00614   1 77777 2 00615         TXI XJZ2,2,-1
00615   2 00001 1 00613  XJZ2   TIX XJZ1,1,1
00616   0 53400 2 77771  XKA    LXA K10,2
00617   0 53400 4 00726         LXA T303,4
00620   0 53400 1 77760         LXA K1,1
00621  -0 50000 1 77760  XKB    CAL K1,1
00622  -0 63400 1 00724         SXD T301,1
00623   0 53400 1 00723         LXA I36,1
00624  -0 76000 0 00001  XKC    PBT
00625   0 02000 0 00633         TRA XKG
00626   2 00001 4 00632  XKD    TIX XKF,4,1
00627   0 56000 0 00731  XKE    LDQ T306
00630  -0 60000 2 00000         STQ 0,2
00631   0 02000 0 00640         TRA XKK
00632   1 77777 2 00634  XKF    TXI XKH,2,-1
00633  -2 00001 4 00640  XKG    TNX XKK,4,1
00634   0 76700 0 00001  XKH    ALS 1
00635   2 00001 1 00624  XKI    TIX XKC,1,1
00636  -0 53400 1 00724  XKJ    LXD T301,1
00637   2 00001 1 00621         TIX XKB,1,1
00640   0 53400 1 77761  XKK    LXA K2,1
00641   0 56000 0 00725  XKK1   LDQ T302
00642   0 26000 1 00000  XKK2   FMP 0,1          ADDRESS TO BE SET
00643   0 60100 1 00000  XKK3   STO 0,1          ADDRESS TO BE SET
00644   2 00001 1 00641         TIX XKK1,1,1
00645   0 50000 0 77772  XKL    CLA K11          OR TRA XKS
00646   0 62100 0 00655         STA XKO2
00647   0 62100 0 00656         STA XKO3
00650   0 53400 1 77761  XKM    LXA K2,1
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00651 -0 75400 1 00000  XKN   PXD 0,1
00652 -0 73400 2 00000        PDX 0,2
00653  0 56000 1 00000  XKO   LDQ 0,1                ADDRESS TO BE SET
00654  0 26000 2 00000  XKO1  FMP 0,2                ADDRESS TO BE SET
00655  0 30000 2 00000  XKO2  FAD 0,2                ADDRESS TO BE SET
00656  0 60100 2 00000  XKO3  STO 0,2                ADDRESS TO BE SET
00657  2 00001 2 00653  XKP   TIX XKO,2,1
00660 -2 00001 1 00667  XKQ   TNX XKS,1,1
00661 -0 75400 1 00000  XKR   PXD 0,1
00662  0 77100 0 00022        ARS 18
00663  0 40000 0 00655        ADD XKO2
00664  0 62100 0 00655        STA XKO2
00665  0 62100 0 00656        STA XKO3
00666  0 02000 0 00651        TRA XKN
00667  0 53400 1 77761  XKS   LXA K2,1
00670  0 56000 0 00725        LDQ I302
00671  0 26000 0 00727        FMP I304
00672  0 60100 0 00727        STO T304
00673  0 56000 0 00727  XKT   LDQ T304
00674  0 26000 1 00000  XKT1  FMP 0,1                ADDRESS TO BE SET
00675  0 30000 1 00000  XKT2  FAD 0,1                ADDRESS TO BE SET
00676  0 60100 1 00000  XKT3  STO 0,1                ADDRESS TO BE SET
00677  2 00001 1 00673  XKU   TIX XKT,1,1
00700  0 02000 0 00522        TRA XJC
00701  0 76200 0 00225  XLE   RTB U3
00702  0 07400 4 00146  XLF   TSX WTB,4
00703  0 00000 0 00005        PZE U3
00704  0 77054 0 77323        PZE -START,0,-I36-1
00705  0 50000 0 77777  XLG   CLA K16
00706  0 60100 0 00711        STO XLG1
00707  0 07400 4 00146        TSX WTB,4
00710  0 00000 0 00005        PZE U3
00711  0 00000 0 00000  XLG1  PZE                    TO BE SET
00712  0 02000 0 00144        TRA RCD                ENTER OR-XLS4
                                 SENSE-SETTING WORDS
00713  0 02000 0 00667        TRA XKS
00714  0 50000 0 77772  3XKL  CLA K11
00715  0 02000 0 00570        TRA XJS
00716 -0 53400 4 77764  1XJK  LXD K5,4
00717  0 00000 0 00001  I1    PZE 1
00720  0 00000 0 00003  I3    PZE 3
00721  0 00000 0 00004  I4    PZE 4
00722  0 00000 0 00007  I7    PZE 7
```

```
00723  0 00000 0 00044  I36   PZE 36
00724  0 00000 0 00000  T301                    INDEX STORED IN DECREMENT
00725  0 00000 0 00000  T302                    SQRT W
00726  0 00000 0 00000  T303                    SCALE FACTOR IDENTIFICATION
00727  0 00000 0 00000  T304                    OBS-CALC
00730  0 00000 0 00000  T305                    REJECTION INDICATOR
00731  0 00000 0 00000  T306                    D CALC/D SCALE
00732  0 00000 0 00000  T307                    DISCARDS ARE COPIED HERE
                                    THE PROGRAM ASSIGNS THE FOLLOWING STORAGE
                                    IMMEDIATELY PRECEEDING INTERSEGMENT STORAGE-
                                        N LOCATIONS FOR THOSE DERIVATIVES USED.
                                        N(N+1)/2 LOCATIONS FOR THE MATRIX.
                                        N LOCATIONS FOR THE VECTOR.
                                        PARAMETER SELECTION WORDS.
                                    INTERSEGMENT TEMPORARY STORAGE
                77760  K1    EQU 32752           NUMBER OF PARAMETER SELECTION WORDS
                77761  K2    EQU K1+1            NUMBER OF PARAMETERS TO BE VARIED
                77762  K3    EQU K2+1            NUMBER OF SCALE FACTORS TO BE VARIED
                77763  K4    EQU K3+1            NUMBER OF KINDS OF FORM FACTORS
                77764  K5    EQU K4+1            COMP. DERIV. ADDRESS IN DECREMENT
                77765  K6    EQU K5+1            BIT COUNTER IN DECREMENT
                77766  K7    EQU K6+1            SELECTION WORD COUNTER IN DECREMENT
                77767  K8    EQU K7+1            PARTLY SHIFTED SELECTION WORD
                77770  K9    EQU K8+1            BY-PASS INDICATOR
                77771  K10   EQU K9+1            COMP. INITIAL DERIVATIVE ADDRESS
                77772  K11   EQU K10+1           INITIAL MATRIX ADDRESS +N
                77773  K12   EQU K11+1           INITIAL VECTOR ADDRESS
                77774  K13   EQU K12+1           MODE NUMBER
                77775  K14   EQU K13+1           INITIAL MATRIX ADDRESS
                77776  K15   EQU K14+1           INITIAL SELECTION WORD ADDRESS
                77777  K16   EQU K15+1           -MATRIX ADDRESS,0,-VECTOR ADDRESS
                00000         END 0
```

```
                                         OR-XLS4   MATRIX INVERSION SEGMENT
                         00004  U1    EQU 4                 NUMBER OF BINARY INPUT TAPE
                         00005  U3    EQU 5                 NUMBER OF BINARY OUTPUT TAPE
                         00144  RCD   EQU 100
                         00146  WTB   EQU 102
                         00147  RTB   EQU 103
                         00455        ORG 301
00455  0 02000 0 00461  START TRA XMA
00456  0 00000 0 00144        HTR RCD                       NO ENTRY HERE
00457  0 02000 0 00144        TRA RCD
00460  0 00000 0 00144        HTR RCD                       NO ENTRY HERE
00461  0 53400 4 77774  XMA   LXA K13,4
00462  3 00003 4 00504        TXH XMF,4,3
00463  0 50000 0 77761  XMB   CLA K2
00464  0 76700 0 00022        ALS 18
00465  0 62200 0 00471        STD XMC1
00466  0 50000 0 77777        CLA K16
00467  0 62100 0 00471        STA XMC1
00470  0 07400 4 00514  XMC   TSX SMI,4
00471  0 00000 0 00000  XMC1  PZE                           TO BE SET
00472  0 00000 0 00144        HTR RCD                       MATRIX IS SINGULAR
00473  0 07400 4 00146  XMD   TSX WTB,4
00474  0 00000 0 00005        PZE U3
00475  0 76720 0 77323        PZE -START,0,-SMI-228
00476  0 50000 0 77777  XME   CLA K16
00477  0 60100 0 00502        STO XME1
00500  0 07400 4 00146        TSX WTB,4
00501  0 00000 0 00005        PZE U3
00502  0 00000 0 00000  XME1  PZE                           TO BE SET
00503  0 02000 0 00144        TRA RCD                       ENTER OR-XLS5
00504  0 50000 0 77777  XMF   CLA K16
00505  0 62100 0 00510        STA XMF1
00506  0 07400 4 00147        TSX RTB,4
00507  0 00000 0 00004        PZE U1
00510  0 00000 0 00000  XMF1  PZE                           ADDRESS TO BE SET
00511  0 00000 0 00144        HTR RCD                       END OF FILE
00512  0 76400 0 00204        BST U1
00513  0 02000 0 00473        TRA XMD
                         00514  SMI   BSS 228
                                      THE PROGRAM ASSIGNS THE FOLLOWING STORAGE
                                      IMMEDIATELY PRECEEDING INTERSEGMENT STORAGE-
                                          N LOCATIONS USED BY OR SMI
                                          N(N+1)/2 LOCATIONS FOR THE MATRIX.
```

```
                                          N LOCATIONS FOR THE VECTOR.
                                          PARAMETER SELECTION WORDS.
                                      INTERSEGMENT TEMPORARY STORAGE
                      77760   K1     EQU 32752                NUMBER OF PARAMETER SELECTION WORDS
                      77761   K2     EQU K1+1                 NUMBER OF PARAMETERS TO BE VARIED
                      77762   K3     EQU K2+1                 NUMBER OF SCALE FACTORS TO BE VARIED
                      77763   K4     EQU K3+1                 NUMBER OF KINDS OF FORM FACTORS
                      77764   K5     EQU K4+1                 COMP. DERIV. ADDRESS IN DECREMENT
                      77765   K6     EQU K5+1                 BIT COUNTER IN DECREMENT
                      77766   K7     EQU K6+1                 SELECTION WORD COUNTER IN DECREMENT
                      77767   K8     EQU K7+1                 PARTLY SHIFTED SELECTION WORD
                      77770   K9     EQU K8+1                 BY-PASS INDICATOR
                      77771   K10    EQU K9+1                 COMP. INITIAL DERIVATIVE ADDRESS
                      77772   K11    EQU K10+1                INITIAL MATRIX ADDRESS +N
                      77773   K12    EQU K11+1                INITIAL VECTOR ADDRESS
                      77774   K13    EQU K12+1                MODE NUMBER
                      77775   K14    EQU K13+1                INITIAL MATRIX ADDRESS
                      77776   K15    EQU K14+1                INITIAL SELECTION WORD ADDRESS
                      77777   K16    EQU K15+1                -MATRIX ADDRESS,0,-VECTOR ADDRESS
                                         THIS SECTION PRODUCES AN ORIGIN CARD FOR THE SUBROUTINE
                      00000          ORG 0
00000  0 00000 0      00000          PZE
00001  0 00001 0      00514          PZE SMI
                      00000          END 0
```

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```
                                                OR-XLS5   MATRIX-VECTOR MULTIPLICATION SEGMENT
                        00005   U3      EQU 5                   NUMBER OF BINARY OUTPUT TAPE
                        00144   RCD     EQU 100
                        00146   WTB     EQU 102
                        00155   KE      EQU 109
                        00455           ORG 301
00455   0 02000 0 00461 START   TRA XNA
00456   0 00000 0 00144         HTR RCD                 NO ENTRY HERE
00457   0 02000 0 00144         TRA RCD
00460   0 00000 0 00144         HTR RCD                 NO ENTRY HERE
00461   0 50000 0 77776 XNA     CLA K15
00462   0 62100 0 00475         STA XND1
00463   0 62100 0 00517         STA XNHH2
00464   0 50000 0 77775         CLA K14
00465   0 62100 0 00507         STA XNG
00466   0 62100 0 00534         STA XNL
00467   0 53400 4 77777 XNB     LXA K16,4
00470   0 53400 1 77761         LXA K2,1
00471   0 60000 0 00566 XNC     STZ T501
00472  -0 63400 4 00571         SXD T504,4
00473   0 53400 2 77761         LXA K2,2
00474   0 56000 4 00000 XND     LDQ 0,4
00475   0 26000 2 00000 XND1    FMP 0,2                 ADDRESS TO BE SET
00476   0 30000 0 00566         FAD T501
00477   0 60100 0 00566         STO T501
00500  -2 00001 2 00507 XNE     TNX XNG,2,1
00501  -0 63400 2 00502 XNEE    SXD XNEE1,2
00502   3 00000 1 00506 XNEE1   TXH XNFF,1,0            DECREMENT TO BE SET
00503  -0 63400 2 00504 XNF     SXD XNF1,2
00504   2 00000 4 00474 XNF1    TIX XND,4,0             DECREMENT TO BE SET
00505   0 00000 0 00144         HTR RCD
00506   1 77777 4 00474 XNFF    TXI XND,4,-1
00507   0 60100 1 00000 XNG     STO 0,1                 ADDRESS TO BE SET
00510  -2 00001 1 00513 XNH     TNX XNHH,1,1
00511  -0 53400 4 00571 XNCC    LXD T504,4
00512   1 77777 4 00471         TXI XNC,4,-1
00513   0 60000 0 00570 XNHH    STZ T503
00514   0 53400 1 77771         LXA K10,1
00515   0 53400 2 77761         LXA K2,2
00516   0 56000 1 00000 XNHH1   LDQ 0,1
00517   0 26000 2 00000 XNHH2   FMP 0,2                 ADDRESS TO BE SET
00520   0 30000 0 00570         FAD T503
00521   0 60100 0 00570         STO T503
```

```
00522   1 77777 1 00523         TXI XNHH3,1,-1
00523   2 00001 2 00516  XNHH3  TIX XNHH1,2,1
00524   0 07400 4 00146  XNI    TSX WTB,4
00525   0 00000 0 00005         PZE U3
00526   0 77212 0 77323         PZE -START,0,-I8-1
00527   0 53400 4 00564  XNJ    LXA I3,4
00530   0 76600 0 00225  XNK    WTB U3
00531   0 53400 1 77761         LXA K2,1
00532   0 53400 2 77777         LXA K16,2
00533   0 70000 0 00570         CPY T503
00534   0 70000 1 00000  XNL    CPY 0,1                 ADDRESS TO BE SET
00535   0 70000 2 00000         CPY 0,2
00536  -0 63400 1 00537  XNM    SXD XNM1,1
00537   2 00000 2 00541  XNM1   TIX XNN,2,0             DECREMENT TO BE SET
00540   0 00000 0 00144         HTR RCD
00541   2 00001 1 00534  XNN    TIX XNL,1,1
00542   0 76400 0 00205  XNO    BST U3
00543   0 76200 0 00225         RTB U3
00544  -0 76000 0 00012         RTT
00545   0 76100 0 00000         NOP
00546   0 70000 0 00567  XNP    CPY T502
00547   0 02000 0 00546         TRA XNP
00550   0 00000 0 00000         PZE
00551   0 76600 0 00333  XNQ    IOD
00552  -0 76000 0 00012         RTT
00553   0 02000 0 00561         TRA XNT
00554   0 77000 0 00205  XNR    WEF U3
00555   0 53400 4 00565  XNS    LXA I8,4
00556   0 76400 0 00205  XNS1   BST U3
00557   2 00001 4 00556         TIX XNS1,4,1
00560   0 02000 0 00155         TRA KE
00561   0 76400 0 00205  XNT    BST U3
00562   2 00001 4 00530  XNU    TIX XNK,4,1
00563   0 00000 0 00527  XNV    HTR XNJ                 RTT FAILS 3 TIMES. START TO TRY AGAIN
00564   0 00000 0 00003  I3     PZE 3
00565   0 00000 0 00010  I8     PZE 8
00566   0 00000 0 00000  T501                          COMPUTED PARAMETER CHANGE, X(I)
00567   0 00000 0 00000  T502                          DISCARDS COPIED HERE
00570   0 00000 0 00000  T503                          CORRECTION TO SUM W(OBS-CALC)**2
00571   0 00000 0 00000  T504                          INITIAL ADDRESS SAVED HERE
                      THE PROGRAM ASSIGNS THE FOLLOWING STORAGE
                      IMMEDIATELY PRECEEDING INTERSEGMENT STORAGE-
                          N LOCATIONS FOR THE COMPUTED PARAMETER CHANGES
```

```
                                N(N+1)/2 LOCATIONS FOR THE MATRIX.
                                N LOCATIONS FOR THE VECTOR.
                                PARAMETER SELECTION WORDS.
                           INTERSEGMENT TEMPORARY STORAGE
77760   K1      EQU 32752           NUMBER OF PARAMETER SELECTION WORDS
77761   K2      EQU K1+1            NUMBER OF PARAMETERS TO BE VARIED
77762   K3      EQU K2+1            NUMBER OF SCALE FACTORS TO BE VARIED
77763   K4      EQU K3+1            NUMBER OF KINDS OF FORM FACTORS
77764   K5      EQU K4+1            COMP. DERIV. ADDRESS IN DECREMENT
77765   K6      EQU K5+1            BIT COUNTER IN DECREMENT
77766   K7      EQU K6+1            SELECTION WORD COUNTER IN DECREMENT
77767   K8      EQU K7+1            PARTLY SHIFTED SELECTION WORD
77770   K9      EQU K8+1            BY-PASS INDICATOR
77771   K10     EQU K9+1            COMP. INITIAL SOLUTION ADDRESS
77772   K11     EQU K10+1           INITIAL MATRIX ADDRESS +N
77773   K12     EQU K11+1           INITIAL VECTOR ADDRESS
77774   K13     EQU K12+1           MODE NUMBER
77775   K14     EQU K13+1           INITIAL MATRIX ADDRESS
77776   K15     EQU K14+1           INITIAL SELECTION WORD ADDRESS
77777   K16     EQU K15+1           -MATRIX ADDRESS,0,-VECTOR ADDRESS
00000           END 0
```

```
                                     OR XLS6   OUTPUT OF MATRIX OR INVERSE
                    00455   START EQU 301              REFERS TO OR XLS2
                    10406   T55   EQU 4358             REFERS TO OR XLS2
                    77761   K2    EQU 32753            REFERS TO OR XLS2
                    00125         ORG 85
00125   0 77200 0 00205   MA      REW 5
00126   0 76200 0 00225   MB      RTB 5
00127  -0 76200 0 00225           RTB 5
00130   0 50000 0 01314   MC      CLA N
00131  -0 10000 0 00142           TNZ ME
00132   0 07400 4 00343           TSX RTB,4
00133   0 00000 0 00005           PZE 5
00134   0 00000 0 76463           PZE -A
00135   0 00000 0 00000           HTR 0                END OF FILE
00136   0 50000 0 01676           CLA A-32512+K2
00137   0 60100 0 01314           STO N
00140  -0 10000 0 00142   MD      TNZ ME
00141   0 00000 0 00000           HTR 0                N IS ZERO
00142   0 76200 0 00225   ME      RTB 5
00143   0 76200 0 00225           RTB 5
00144   0 76200 0 00225   ME3     RTB 5
00145   0 70000 0 01315           CPY A
00146   0 02000 0 00144           TRA ME3
00147   0 07400 4 00343   ME1     TSX RTB,4
00150   0 00000 0 00005           PZE 5
00151   0 00000 0 76463           PZE -A
00152   0 00000 0 00000           HTR 0                END OF FILE. TAPE IS INCOMPLETE.
00153   0 53400 4 00426           LXA I12,4
00154   0 50000 4 11262   ME2     CLA A-START+T55+12,4
00155   0 60100 4 00445           STO TITLE+12,4
00156   2 00001 4 00154           TIX ME2,4,1
00157   0 76200 0 00225           RTB 5
00160   0 76000 0 00165   MF      SWT 5
00161   0 02000 0 00166           TRA MH
00162   0 76200 0 00225   MG      RTB 5
00163   0 76200 0 00225           RTB 5
00164   0 50000 0 00417           CLA C5
00165   0 60100 0 00245           STO MP2
00166   0 07400 4 00343   MH      TSX RTB,4
00167   0 00000 0 00005           PZE 5
```

```
                        00310          BSS 16
00330   0 50000 0 01314 MV     CLA N
00331   0 40200 0 01313        SUB I
00332   0 76700 0 00022        ALS 18
00333   0 62200 0 00334        STD MV1
00334   2 00000 2 00335 MV1    TIX MW,2,0          DECREMENT SET AT N-I
00335   1 00001 1 00336 MW     TXI MW1,1,1
00336  -3 00000 1 00271 MW1    TXL MR,1,0          DECREMENT SET AT J2
00337   0 53400 1 00445 MX     LXA J1,1
00340   1 00016 1 00341        TXI MX1,1,14
00341  -3 00000 1 00176 MX1    TXL MJ,1,0          DECREMENT SET AT N
00342   0 00000 0 00000        HTR 0               END OF PROGRAM
                               SUBROUTINE TO READ RECORD FROM TAPE
00343   0 50000 4 00001 RTB    CLA 1,4
00344   0 40000 0 00371        ADD RTB7
00345   0 60100 0 00354        STO RTB3
00346   0 50000 4 00001        CLA 1,4
00347   0 40000 0 00372        ADD RTB8
00350   0 60100 0 00366        STO RTB6
00351  -0 53400 1 00364 RTB1   LXD RTB5,1
00352   0 50000 4 00002 RTB2   CLA 2,4
00353   0 73400 2 00000        PAX 0,2
00354   0 76200 0 00220 RTB3   RTB 0               TO BE SET
00355  -0 76000 0 00012        RTT
00356   0 76100 0 00000        NOP
00357   0 70000 2 00000 RTB4   CPY 0,2
00360   1 77777 2 00357        TXI RTB4,2,-1
00361   0 02000 4 00003        TRA 3,4
00362   0 76600 0 00333        IOD
00363  -0 76000 0 00012        RTT
00364   1 00003 0 00366 RTB5   TXI RTB6,0,3
00365   0 02000 4 00004        TRA 4,4
00366   0 76400 0 00200 RTB6   BST 0               TO BE SET
00367   2 00001 1 00352        TIX RTB2,1,1
00370   0 00000 0 00351        HTR RTB1            RTT FAILS 3 TIMES. START TO TRY AGAIN.
00371   0 76200 0 00220 RTB7   RTB 0               CONSTANT
00372   0 76400 0 00200 RTB8   BST 0               CONSTANT
00373   0 02000 0 00330 C1     TRA MV
00374  -0 00006 0 01313 C2     FOR I,0,6
00375  -2 05710 2 01314        SIX A-1,2,3016
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```
00376  -2 05720 2 01315          SIX A,2,3024
00377  -2 05730 2 01316          SIX A+1,2,3032
00400  -2 05740 2 01317          SIX A+2,2,3040
00401  -2 05750 2 01320          SIX A+3,2,3048
00402  -2 05760 2 01321          SIX A+4,2,3056
00403  -2 05770 2 01322          SIX A+5,2,3064
00404  -2 06000 2 01323          SIX A+6,2,3072
00405  -2 06010 2 01324          SIX A+7,2,3080
00406  -2 06020 2 01325          SIX A+8,2,3088
00407  -2 06030 2 01326          SIX A+9,2,3096
00410  -2 06040 2 01327          SIX A+10,2,3104
00411  -2 06050 2 01330          SIX A+11,2,3112
00412  -2 06060 2 01331          SIX A+12,2,3120
00413   1 00060 0 00003          PON 3,0,48
00414   442163513167      C3     BCD 1MATRIX
00415   314565255162      C4     BCD 2INVERSE
00416   256060606060
00417   3 03735 0 00415   C5     PTH C4,0,2013
00420   606060606060      C6     BCD 1
00421   3 01757 0 00420   C7     PTH C6,0,1007
00422   0 00000 0 01313   C8     PZE I
00423   0 02000 0 00265   C9     TRA MP1
00424   2 00000 0 00000   C10    PTW                    LARGE POSITIVE INTEGER
00425   0 00000 0 00001   I1     PZE 1
00426   0 00000 0 00014   I12    PZE 12
00427   0 00000 0 00015   I13    PZE 13
00430   0 00000 0 00020   I16    PZE 16
                  00431   TITLE  BSS 12
                  00445   J1     BSS 13                 FIRST COLUMN IN SECTION
00462   0 00000 0 00000   J2                            LAST COLUMN IN SECTION
                  00463   OUT    BSS 408
01313   0 00000 0 00000   I                             CURRENT ROW NUMBER
01314   0 00000 0 00000   N                             ORDER OF MATRIX
01315   0 00000 0 00000   A                             START OF STORAGE AREA
                                ORIGIN CARD FOR OUT
                  00000         ORG 0
00000   0 00000 0 00000           PZE
00001   0 00000 0 00463           PZE OUT
                  00125         END MA
```

```
00170   0 00000 0 76463          PZE -A
00171   0 00000 0 00000          HTR 0
00172   0 77200 0 00205          REW 5
00173   0 53400 1 01314  MI      LXA N,1
00174  -0 63400 1 00341          SXD MX1,1
00175   0 53400 1 00425          LXA I1,1
00176  -0 63400 1 00274  MJ      SXD MS,1
00177  -0 75400 1 00000          PXD 0,1
00200   0 77100 0 00022          ARS 18
00201   0 60100 0 00445          STO J1
00202   0 50000 0 00424          CLA C10
00203   0 40200 0 00445          SUB J1
00204   0 73400 2 00000          PAX 0,2
00205   0 53400 4 00430  MK      LXA I16,4
00206   0 50000 4 00414  MK1     CLA C2+16,4
00207   0 60100 4 00330          STO MU+18,4
00210   2 00001 4 00206          TIX MK1,4,1
00211   0 53400 4 00427  ML      LXA I13,4
00212   0 50000 0 00445          CLA J1
00213   0 40000 0 00425  ML1     ADD I1
00214   0 60100 4 00463          STO J1+14,4
00215   2 00001 4 00213          TIX ML1,4,1
00216   0 50000 0 00462  MM      CLA J2
00217   0 40200 0 01314          SUB N
00220  -0 12000 0 00234          TMI MO
00221   0 10000 0 00234          TZE MO
00222   0 73400 4 00000  MN      PAX 0,4
00223   0 50000 0 00373          CLA C1
00224   0 60100 4 00330          STO MV,4
00225   0 50000 0 00423          CLA C9
00226   0 60100 4 00265          STO MP1,4
00227   0 50000 0 00413          CLA C2+15
00230   0 60100 4 00327          STO MV-1,4
00231   0 60100 4 00264          STO MP1-1,4
00232   0 53400 4 01314          LXA N,4
00233   0 02000 0 00235          TRA MO1
00234   0 53400 4 00462  MO      LXA J2,4
00235  -0 63400 4 00336  MO1     SXD MW1,4
00236   0 07400 4 00463  MO2     TSX OUT,4
00237   0 00000 0 00236          HTR MO2
```

END OF FILE

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```
00240   3 27451 0 00431          PTH TITLE,0,12073
00241   3 02066 0 00420          PTH C6,0,1078
00242   1 00001 0 00003          PON 3,0,1
00243   0 07400 4 00463  MP      TSX OUT,4
00244   0 00000 0 00243          HTR MP
00245   3 01757 0 00414  MP2     PTH C3,0,1007
00246  -0 00016 0 00445          FOR J1,0,14
00247  -0 00026 0 00446          FOR J1+1,0,22
00250  -0 00036 0 00447          FOR J1+2,0,30
00251  -0 00046 0 00450          FOR J1+3,0,38
00252  -0 00056 0 00451          FOR J1+4,0,46
00253  -0 00066 0 00452          FOR J1+5,0,54
00254  -0 00076 0 00453          FOR J1+6,0,62
00255  -0 00106 0 00454          FOR J1+7,0,70
00256  -0 00116 0 00455          FOR J1+8,0,78
00257  -0 00126 0 00456          FOR J1+9,0,86
00260  -0 00136 0 00457          FOR J1+10,0,94
00261  -0 00146 0 00460          FOR J1+11,0,102
00262  -0 00156 0 00461          FOR J1+12,0,110
00263  -0 00166 0 00462          FOR J1+13,0,118
00264   1 00060 0 00003          PON 3,0,48
00265   0 07400 4 00463  MP1     TSX OUT,4
00266   0 00000 0 00245          HTR MP2
00267   1 00060 0 00003          PON 3,0,48
00270   0 53400 1 00425  MQ      LXA I1,1
00271  -0 75400 1 00000  MR      PXD 0,1
00272   0 77100 0 00022          ARS 18
00273   0 60100 0 01313          STO I
00274  -3 00000 1 00306  MS      TXL MU,1,0              J1 SET IN DECREMENT
00275   0 50000 0 00462  MT      CLA J2
00276   0 40200 0 01313          SUB I
00277   0 73400 4 00000          PAX 0,4
00300   0 50000 4 00262          CLA MP+15,4
00301   0 60100 4 00325          STO MU+15,4
00302   0 50000 0 00422          CLA C8
00303   0 62100 4 00325          STA MU+15,4
00304   0 50000 0 00421          CLA C7
00305   0 60100 4 00324          STO MU+14,4
00306   0 07400 4 00463  MU      TSX OUT,4
00307   0 00000 0 00306          HTR MU
```

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