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Harmonic Gust Aerodynamic Influence Coefficients from Incompressible Strip Theory: Analytical Development and Computational Procedure

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Prepared for COMMANDER SPACE SYSTEMS DIVISION
UNITED STATES AIR FORCE
Inglewood, California

LABORATORIES DIVISION • AEROSPACE CORPORATION

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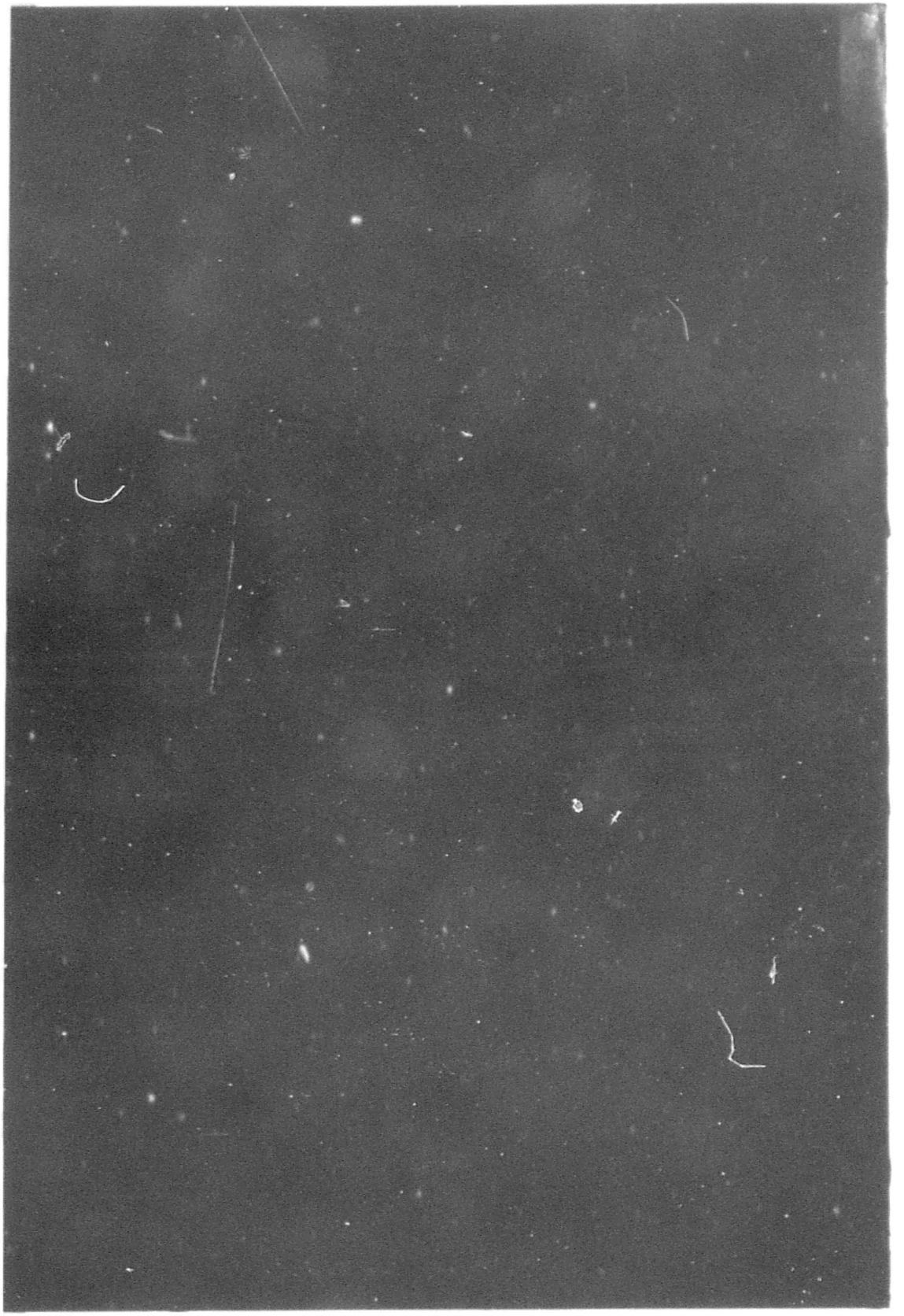

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HARMONIC GUST AERODYNAMIC INFLUENCE COEFFICIENTS FROM INCOMPRESSIBLE STRIP THEORY: ANALYTICAL DEVELOPMENT AND COMPUTATIONAL PROCEDURE

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ABSTRACT

A method is presented for computing the aerodynamic influence coefficients (AICs) for a surface traveling at subsonic speed through an oscillatory gust field. The method is based on one of the fundamental solutions of unsteady flow theory--that of Sears for a two-dimensional airfoil traveling through a harmonic gust field in an incompressible fluid.

The harmonic gust AICs relate the aerodynamic control point forces to the spanwise variation of the gust amplitude through the following definition

$$\left\{F_g\right\} \quad \rho V W_g \, b_r s \, \left[C_g\right] \left\{w_g / W_g\right\}$$

The Aerospace IBM 7090 Computer Program No. HM02 provides the gust AICs in printed and optional punched-card output formats. The program capacity is 100 surface strips and 100 values of reduced velocity.

CONTENTS

SYMBOLS

b	Local semichord
b_r	Reference semichord
$C(k)$	Theodorsen function
C_g	Element of gust AIC matrix
d	Distance between forward and aft control points
F_g	Control point force
J_0, J_1	Bessel functions of first kind of order zero and one, respectively
k	Local reduced frequency
k_r	Reference reduced frequency
L_g	Lift
M_g	Moment
s	Surface span
V	Velocity
W_g	Reference gust amplitude
w_g	Local gust amplitude
x	Leading edge coordinate
Λ	Sweep angle of surface quarter-chord line
λ	Gust wave length
ρ	Atmospheric density
$\phi(k)$	Sears function

SECTION I

FORMULATION OF PROBLEM

A. Introduction

The random response of a vehicle to atmospheric turbulence can be analyzed if the frequency response to a harmonic gust is known. The harmonic gust forces acting on a high aspect ratio surface at subsonic speeds can be found from the incompressible two-dimensional theory of Sears[1] from which the gust aerodynamic influence coefficients (AICs) may be derived. The present study is an extension of the computational aspects of the method previously reported.[2]

B. Sign Convention

A consistent sign convention is chosen between the force and gust directions. If the gust is specified as an upwash, a positive force acts upward; if the gust is specified as a downwash, a positive force acts downward. The leading edge coordinate x is chosen as positive aft.

C. Derivation of Equations

We define a set of AICs for a harmonic gust that relate the complex amplitudes of the control point forces to the spanwise variation of the gust velocity:

$$\left\{F_g\right\} = \rho V W_g b_r s \left[C_g\right] \left\{w_g / W_g\right\} \qquad (1)$$

This definition is completely general, being equally as applicable to a lifting surface theory as to a strip theory. However, in the case

of a strip theory, the AICs take on a simplified partitioned form that appears as follows:

$$[C_g] = \begin{bmatrix} 0 & 0 & 0 & \cdots & 0 \\ 0 & C_{g_1} & 0 & \cdots & 0 \\ 0 & 0 & C_{g_2} & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & C_{g_n} \end{bmatrix} \tag{2}$$

The first null partition is reserved for control points whose aerodynamic forces can be neglected (e.g., external stores) or can be found from some other theory (e.g., slender body theory). The remaining partitions are of size 2 x 1 since two control points are necessary on each strip if it has two flexible degrees of freedom (assuming a rigid chord).

To derive the strip AICs, we assume that the gust lift and moment about the airfoil quarter-chord are known. The equivalence between the given loads and the control point forces is shown in Fig. 1. From Fig. 1 we note the equivalence

$$F_{1_g} + F_{2_g} = L_g \tag{3}$$

$$dF_{2_g} = -M_g \quad ; \tag{4}$$

and in matrix form, the forces appear as

$$\begin{Bmatrix} F_{1_g} \\ F_{2_g} \end{Bmatrix} = \begin{Bmatrix} L_g + M_g/d \\ -M_g/d \end{Bmatrix} \tag{5}$$

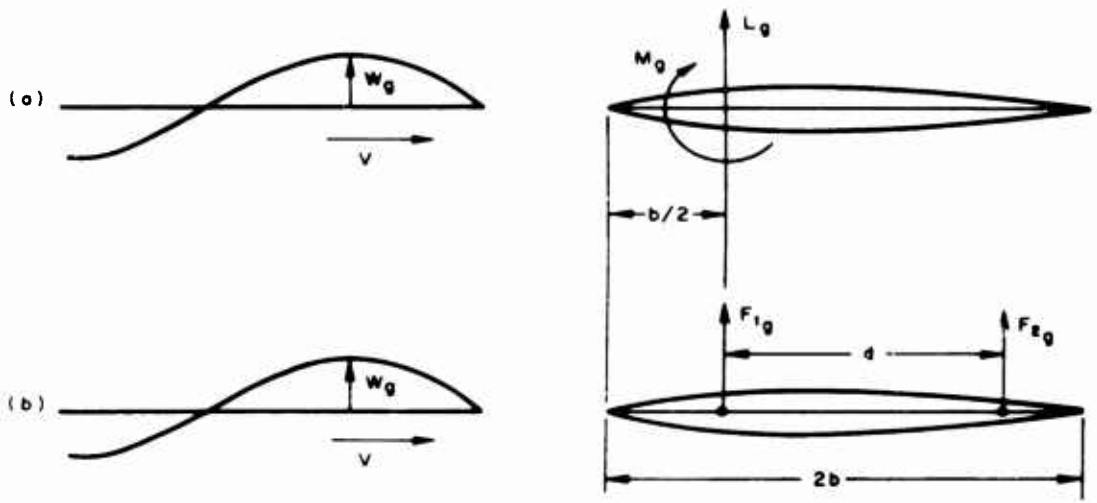


Fig. 1. Given (a) and Replacement (b) Force Systems and Geometry.

To continue the derivation, we must have the relationships between the lift and moment and the gust velocity. To this end we select the incompressible solution of Sears (cf., Ref. 1) who gives the lift and moment (when corrected for sweep) as

$$L_g = 2\pi \cos \Lambda \, \rho V \, w_g b \Delta y \, \phi(k) \exp(-ikx/b) \tag{6}$$

$$M_g = 0 \tag{7}$$

where the Sears function $\phi(k)$ is related to the Theodorsen function $C(k)$ as

$$\phi(k) = [J_0(k) - iJ_1(k)]\, C(k) + iJ_1(k) \tag{8}$$

The first sweep correction, the factor cos Λ, adjusts the two-dimensional lift curve slope; the second sweep correction, the factor exp(-ikx/b), accounts for the phase difference in the gust maximum amplitude reaching the leading edge of each surface strip. Substituting Eqs. (6) and (7) into Eq. (5) yields the force-gust velocity relationship

$$\begin{Bmatrix} F_{1_g} \\ F_{2_g} \end{Bmatrix} = 2\pi \cos \Lambda \, \rho V \, w_g \begin{Bmatrix} b\Delta y \; \phi(k) \exp(-ikx/b) \\ 0 \end{Bmatrix} \tag{9}$$

which, by comparison with Eq. (1), yields the harmonic gust AICs for the j'th strip.

$$\begin{Bmatrix} C_{g_j} \end{Bmatrix} = 2\pi \cos \Lambda \begin{Bmatrix} (b_j/b_r)(\Delta y_j/s) \; \phi(k_j) \exp(-ik_j x_j/b_j) \\ 0 \end{Bmatrix} \tag{10}$$

where the local reduced frequency k_j is based upon the local semichord length.

$$k_j = \omega b_j / V \tag{11a}$$

$$= (2\pi V/\lambda)(b_j/V) \tag{11b}$$

$$= 2\pi b_j/\lambda \tag{11c}$$

where λ is the gust wave length, and the reference reduced frequency is based upon the reference semichord

$$k_r = 2\pi b_r/\lambda \tag{12}$$

Once the partitions have been obtained for each strip, the total matrix is assembled as indicated in Eq. (2).

D. References

1. Y. C. Fung. An Introduction to the Theory of Aeroelasticity. New York: John Wiley and Sons, Inc., 1955, p. 409.

2. W. P. Rodden, E. F. Farkas, and F. C. Slack. "Harmonic Gust Aerodynamic Influence Coefficients by Incompressible Strip Theory: Analytical Development and Procedure for the IBM 7090 Computer." Norair Division, Northrop Corporation, Report NOR-61-59, 14 April 1961.

SECTION II

GENERAL DESCRIPTION OF INPUT

A. Units

Since all input is geometrical and the gust matrix is dimensionless, the units of length are only required to be consistent--feet or inches (or centimeters).

B. Classes of Numerical Data and Limitations

1. Example Problem

As an example we consider a two-strip wing with the following geometrical properties:

$$\cos \Lambda = 0.7500$$

$$b_r = 2.00 \text{ ft}$$

$$s = 5.00 \text{ ft}$$

Strip No.	Δy(ft)	b(ft)	x(ft)
1	3.00	3.00	0.20
2	2.00	1.60	0.30

We seek the gust AICs for the two reduced velocities $1/k_r = 1.00$ and 5.00, and for the steady case (input as $1/k_r = 0$).

2. Program Restrictions and Options

a. The maximum number of wing strips per data deck is 100.

b. The maximum number of reduced velocities per data deck is 100.

c. Any practical number of input data decks may be stacked successively and run during one machine pass.

SECTION III

DATA DECK SETUP

A. Loading Order

Input decks punched from keypunch forms are loaded behind column binary deck HM02. The data for each input deck must be in the following order:

(1) Heading card

(2) NSTRIP, NFREQ, NPUNCH

(3) cos Λ, b_r, s

(4) Δy_i series

(5) b_i series

(6) x_i series

(7) $(1/k_r)_j$ series

B. Input Data Description

(1) The heading card is for data identification; any characters desired may be used in Columns 2 through 72. Column 1 should be blank.

(2) Control card (FORMAT 18I4)

(a) NSTRIP = number of strips; $\leq$ 100

(b) NFREQ = number of reduced velocities; $\leq$ 100

(c) NPUNCH = 0 or blank if aerodynamic matrices are to be punched in cards.

NPUNCH $\neq$ 0 if no punched output is desired.

(3) Constant parameters (FORMAT 6E12.8)

(a) $\cos \Lambda$ = cosine of sweep angle of quarter-chord

(b) b_r = reference semichord

(c) s = surface span

(4) Δy_i series (FORMAT 6E12.8)

$\Delta y_1, \Delta y_2, \cdots, \Delta y_{(NSTRIP)}$ = strip widths

(5) b_i series (FORMAT 6E12.8)

$b_1, b_2, \cdots, b_{(NSTRIP)}$ = local semichords

(6) x_i series (FORMAT 6E12.8)

$x_1, x_2, \cdots, x_{(NSTRIP)}$ = leading edge coordinates

(7) $(1/k_r)_j$ series (FORMAT 6E12.8)

$(1/k_r)_1, (1/k_r)_2, \cdots, (1/k_r)_{NFREQ}$ = reduced velocities

NOTE: Each new series starts on a new line (card).

C. Example Keypunch Forms

Keypunch forms for the example problem are shown on the following page. Columns 73 through 80 are for data deck sequencing and may be any choice of letters and numbers.

HARMONIC GUST AICS - CHECK CASE HMO20000

Heading card

2 3 0 HMO20001

NSTRIP

NFREQ

NPUNCH

cos Λ		b_r		s			
75	+00	2	+01	5	+01		HMO20002
Δy_1		Δy_2		Δy_3	Δy_4	Δy_5	Δy_6
3	+01	2	+01				HMO20003
b_1		b_2		b_3	b_4	b_5	b_6
3	+01	16	+01				HMO20004
x_1		x_2		x_3	x_4	x_5	x_6
2	+00	3	+00				HMO20005
$(1/k_r)_1$		$(1/k_r)_2$		$(1/k_r)_3$	$(1/k_r)_4$	$(1/k_r)_5$	$(1/k_r)_6$
1	+01	5	+01	0	+00		HMO20006

NOTE: The sequenced cards make up the data deck.

SECTION IV

PROGRAM OUTPUT

A. Printed Output

1. All input data.

2. For each reduced velocity:

   a. Reduced velocity value

   b. Elements of AIC matrix partition representing each strip.

   c. Punched card identification and sequencing.

3. The example problem printed output is shown on the following pages.

HARMONIC GUST AICS, CHECK CASE. HM020967

HARMONIC GUST AICS

2 STRIPS, 3 REDUCED FREQUENCIES

COSINE LAMBDA = 0.75000000E 00, BR = 0.20000000E 01, S = 0.49999999E 01

I	DELY(I)	B(I)	X(I)
1	0.30000000E 01	0.30000000E 01	0.20000000E-00
2	0.20000000E 01	0.16000000E 01	0.30000000E-00

1/K(R) = 0.09999999E 01 0.49999999E 01 0.

HARMONIC GUST AICS, 1/K(R) = 0.09999999E 01, NUMBER OF STRIPS = 2

ALL STRIP PARTITIONS 2 ROWS BY 1 COLUMN, COMPLEX ELEMENTS

STRIP	ROW 1 REAL	ROW 1 IMAG	ROW 2 REAL	ROW 2 IMAG
1	0.10493396E 01	0.87333830E 00	0.	0.
2	0.65001410E 00	0.21947099E-02	0.	0.

PUNCHED CARDS NOS. HM02 0 THRU HM02 3

HARMONIC GUST AICS, 1/K(R) = 0.49999999E 01, NUMBER OF STRIPS = 2

ALL STRIP PARTITIONS 2 ROWS BY 1 COLUMN, COMPLEX ELEMENTS

STRIP	ROW 1 REAL	ROW 1 IMAG	ROW 2 REAL	ROW 2 IMAG
1	0.26331602E 01	-0.58553309E 00	0.	0.
2	0.11122498E 01	-0.28599958E-00	0.	0.

PUNCHED CARDS NOS. HM02 4 THRU HM02 7

HARMONIC GUST AICS, 1/K(R) = 0. , NUMBER OF STRIPS = 2

ALL STRIP PARTITIONS 2 ROWS BY 1 COLUMN, COMPLEX ELEMENTS

STRIP	ROW 1 REAL	ROW 1 IMAG	ROW 2 REAL	ROW 2 IMAG
1	0.42411499E 01	0.	0.	0.
2	0.15079644E 01	0.	0.	0.

PUNCHED CARDS NOS. HM02 8 THRU HM02 11

B. Punched Output

1. A deck of punched cards (output) from this program is suitable as an input deck to other programs requiring the use of AICs.

2. All punched output is sequenced in order on Columns 73 through 80 starting with HM02000. The data appear in the following order:

a. Card 1 contains $(1/k_r)_1$ (FORMAT 6E12.8).

b. Card 2 contains m, the size (number of control points) of the AIC matrix, and n, the number of strips (partitions) (FORMAT 18I4).

c. The AIC matrix punched in column binary form and its TRA card make up the remainder of the punched output for $(1/k_r)_1$.

3. The order of Statement 2 is repeated for all reduced velocities per input deck.

4. Each matrix is punched in compact form by columns. Column 1 begins in Origin 1 and Column 2 in Location (1 + matrix size).

5. The matrix is punched in the order: Column 1 (real), Column 1 (imaginary); Column 2 (real), Column 2 (imaginary); · ; Column m (real), Column m (imaginary).

SECTION V

PROCESSING INFORMATION

A. Operation

STANDARD FORTRAN MONITOR system

B Estimated Machine Time

T	time in minutes
NSTRIP	number of strips
FREQ	number of reduced velocities
n	number of sets (decks) of input data

$$T = 0.2 + 0.01 \sum_{j=1}^{n} (NSTRIP)_j \times (FREQ)_j$$

C Machine Components Used

About 2000 core storages

Standard FORTRAN input tape (NT1)

Standard FORTRAN output print tape (NT2)

Standard FORTRAN output punch tape (NT3)

SECTION VI

PROGRAM NOTES

A. Subroutines Used

RDLN: reads and prints title cards

AEROP5: punch AIC matrix

BESSEL function routine

BJYO: computes Bessel functions, order zero

BJY1: computes Bessel functions, order one

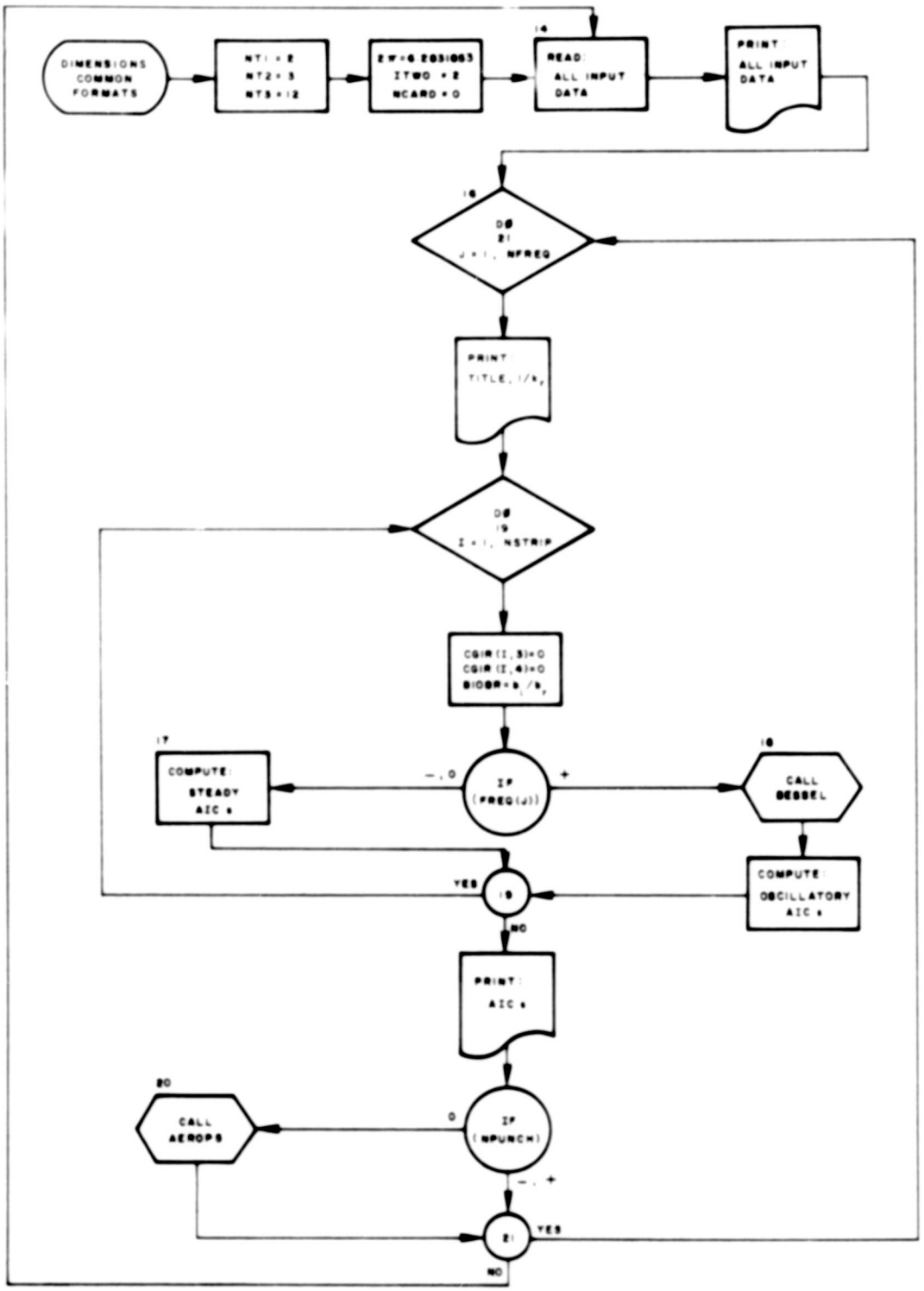
BINPU: binary punch routine

B. Generalized Tapes

Input, print, and punch tapes are defined as Units 2, 3, and 12, respectively; however, these may be altered by placing the desired units on symbolic cards HM020028, HM020029, and HM020030.

SECTION VII

FLOW DIAGRAM



SECTION VIII

SYMBOLIC LISTING

A partial list of the principal FORTRAN symbols used in the program may be related to the physical notation as follows:

FORTRAN Notation	Physical Notation
BR	b_r
B(I)	b_i
CGIR (I)	Real AICs for strip i
CGII (I)	Imaginary AICs for strip i
COSLAM	$\cos \Lambda$
DELY (I)	Δy_i
EJOX	Bessel functions of the first kind
EYOX	Bessel functions of the second kind
FREQ (J)	$1/k_r$, j'th value
NSTRIP	Number of strips
NFREQ	Number of reduced velocities
S	s

The complete symbolic listing is given on the following pages.

```
HARMONIC GUST AERODYNAMIC INFLUENCE COEFFICIENTS                    7/11/
C                    BY INCOMPRESSIBLE STRIP THEORY.                HM020002
C                                                                   HM020003
      DIMENSION  CGIR(100,4), FREQ(100), DELY(100), B(100),         HM020004
     1            X(100),    EJOX(100), EYOX(100)                  HM020005
                                                                    HM020006
      COMMON  NT1, NT2, NT3                                         HM020007
C                                                                   HM020008
    1 FORMAT  ( 18I4 )                                              HM020009
    2 FORMAT  ( 6E12.8 )                                            HM020010
    4 FORMAT  (1HO 46X, 18HHARMONIC GUST AICS  / 1HO 39X, I3, 9H STRIPS,HM020011
     1          I3, 20H REDUCED FREQUENCIES / 1HO 24X, 16HCOSINE LAMBDA =HM020012
     2          E15.8, 7H, BR =  E15.8, 6H, S =   E15.8       )      HM020013
    5 FORMAT  ( 1HO 23X, 1HI 7X, 7HDELY(I) 15X, 4HB(I)  16X, 4HX(I) /  HM020014
     1         (1H 21X, I3, E17.8, 2E20.8))                         HM020015
    6 FORMAT  (1HO 6X, 9H 1/K(R) = 5E17.8, / (1H 15X, 5E17.8))      HM020016
    7 FORMAT  (1H1 21X, 29HHARMONIC GUST AICS, 1/K(R) =   E15.8,    HM020017
     1          21H, NUMBER OF STRIPS =      I3  )                  HM020018
    9 FORMAT  (1HO 28X, 57HALL STRIP PARTITIONS 2 ROWS BY 1 COLUMN, COMPHM020019
     1LEX ELEMENTS  / 1HO 14X, 5HSTRIP 4X, 10HROW 1 REAL 9X, 10HROW 1 IMHM020020
     2AG  9X, 10HROW 2 REAL  9X, 10HROW 2 IMAG     )                HM020021
   10 FORMAT  (1H 15X, I13,  4E19.8 )                               HM020022
C                                                                   HM020023
C NT1 = INPUTTAPE                                                   HM020024
C NT2 = OUTPUTTAPE                                                  HM020025
C NT3 = PUNCHTAPE                                                   HM020026
C                                                                   HM020027
      NT1 = 2                                                       HM020028
      NT2 = 3                                                       HM020029
      NT3 = 12                                                      HM020030
C                                                                   HM020031
      TWOPI = 6.2831853                                             HM020032
      ITWO = 2                                                      HM020034
      NCARD=0                                                       HM020035
                                                                    HM020036
   14 CALL RDLN ( NT1, NT2, 1 )                                     HM020037
      READINPUTTAPE NT1, 1, NSTRIP, NFREQ, NPUNCH                   HM020038
      READINPUTTAPE NT1, 2, COSLAM, BR, S                           HM020039
```

```
      READINPUTTAPE NT1, 2, (DELY(I), I=1,NSTRIP)                                HM020040
      READINPUTTAPE NT1, 2,    (B(I), I=1,NSTRIP)                                HM020041
      READINPUTTAPE NT1, 2,    (X(I), I=1,NSTRIP)                                HM020042
      READINPUTTAPE NT1, 2, (FREQ(I), I=1,NFREQ)                                 HM020043
C                                                                                HM020044
      CON1 = TWOPI*COSLAM                                                        HM020045
      WRITEOUTPUTTAPE NT2, 4, NSTRIP, NFREQ, COSLAM, BR, S                       HM020046
      WRITEOUTPUTTAPE NT2, 5, ((I, DELY(I), B(I), X(I)), I=1,NSTRIP)             HM020047
      WRITEOUTPUTTAPE NT2, 6, (FREQ(I),I=1,NFREQ)                                HM020048
                                                                                 HM020049
   16 DO  21   JFREQ = 1,NFREQ                                                   HM020050
      WRITEOUTPUTTAPE NT2, 7, FREQ(JFREQ), NSTRIP                                HM020051
                                                                                 HM020052
      DO  19   ISTRIP = 1,NSTRIP                                                 HM020053
      CGIR(ISTRIP,3) = 0.                                                        HM020054
      CGIR(ISTRIP,4) = 0.                                                        HM020055
      BIOBR = B(ISTRIP)/BR                                                       HM020056
      IF (FREQ(JFREQ))  17,17,18                                                 HM020057
   17 CGIR(ISTRIP,1) = CON1*BIOBR*DELY(ISTRIP)/S                                 HM020058
      CGIR(ISTRIP,2) = 0.                                                        HM020059
      GOTO   19                                                                  HM020060
C                                                                                HM020061
   18 EKJI =1./FREQ(JFREQ)*BIOBR                                                 HM020062
      CALL BESSEL  ( EKJI,1,EJOX,EYOX,0)                                         HM020063
      DEN = (EJOX(2)+EYOX(1))**2+(EYOX(2)-EJOX(1))**2                            HM020064
      F=(EJOX(2)*(EJOX(2)+EYOX(1))+EYOX(2)*(EYOX(2)-EJOX(1)))/DEN                HM020065
      G=-(EYOX(2)*EYOX(1)+EJOX(2)*EJOX(1))/DEN                                   HM020066
      PHIKR = EJOX(1)*F+EJOX(2)*G                                                HM020067
      PHIKI = EJOX(1)*G-EJOX(2)*F+EJOX(2)                                        HM020068
      TEMP = EKJI*X(ISTRIP)/B(ISTRIP)                                            HM020069
      EPSR = COSF (TEMP)                                                         HM020070
      EPSI =-SINF (TEMP)                                                         HM020071
      CON2 = CON1*BIOBR*DELY(ISTRIP)/S                                           HM020072
      CGIR(ISTRIP,1)=CON2*(PHIKR*EPSR-PHIKI*EPSI)                                HM020073
      CGIR(ISTRIP,2)=CON2*(PHIKR*EPSI+PHIKI*EPSR)                                HM020074
   19 CONTINUE                                                                   HM020075
                                                                                 HM020076
      WRITEOUTPUTTAPE NT2, 9                                                     HM020077
```

```
HARMONIC GUST AERODYNAMIC INFLUENCE COEFFICIENTS                    7/11/
      WRITE OUTPUT TAPE NT2, 10, ( I,(CGIR(I,J),J=1,4),I=1,NSTRIP)    HM020078
      IF (NPUNCH) 21,20,21                                            HM020079
C                                                                     HM020080
   20 CALL AEROPS  (FREQ(JFREQ),NSTRIP,CGIR,NT2,NT3,NCARD)            HM020081
   21 CONTINUE                                                        HM020082
      GOTO  14                                                        HM020083
      END(1,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0)
```

STORAGE NOT USED BY PROGRAM

DEC	OCT	DEC	OCT
1496	02730	32558	77456

STORAGE LOCATIONS FOR VARIABLES APPEARING IN COMMON STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
NT1	32561	77461	NT2	32560	77460	NT3	32559	77457			

STORAGE LOCATIONS FOR VARIABLES APPEARING IN DIMENSION AND EQUIVALENCE STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
B	1295	02417	CGIR	895	01577	DELY	1395	02563	EJDX	1095	02107
EYDX	995	01743	FREQ	1495	02727	X	1195	02253			

STORAGE LOCATIONS FOR VARIABLES NOT APPEARING IN COMMON, DIMENSION, OR EQUIVALENCE STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
BIOBR	495	00757	BR	494	00756	CON1	493	00755	CON2	492	00754
COSLAM	491	00753	DEN	490	00752	EKJI	489	00751	EPS1	488	00750
EPSR	487	00747	F	486	00746	G	485	00745	I	484	00744
ITWO	483	00743	NCARD	482	00742	NFREQ	481	00741	NPUNCH	480	00740
NSTRIP	479	00737	PHIKI	478	00736	PHIKR	477	00735	S	476	00734
TEMP	475	00733	TWOPI	474	00732						

SYMBOLS AND LOCATIONS FOR SOURCE PROGRAM FORMAT STATEMENTS

	EFN	LOC		EFN	LOC		EFN	LOC		EFN	LOC
8)1	1	00722	8)2	2	00720	8)4	4	00716	8)5	5	00657
8)6	6	00637	8)7	7	00626	8)9	9	00604	8)A	10	00547

LOCATIONS FOR OTHER SYMBOLS NOT APPEARING IN SOURCE PROGRAM

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
1)	467	00723	2)	342	00526	3)	347	00533	4)	32767	77777
6)	350	00536	C)G1	471	00727	C)G2	472	00730	C)100	473	00731
D)20F	165	00245	D)30F	164	00244	D)40E	145	00221			

LOCATIONS OF NAMES IN TRANSFER VECTOR

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
AEROP5	9	00011	BESSEL	6	00006	COS	7	00007	RDLN	1	00001
SIN	8	00010	(FIL)	5	00005	(FPT)	0	00000	(RTN)	3	00003
(STH)	4	00004	(TSH)	2	00002						

ENTRY POINTS TO SUBROUTINES NOT OUTPUT FROM LIBRARY

AEROP5	BESSEL	COS	RDLN	SIN	(FIL)	(FPT)	(RTN)
(STH)	(TSH)						

EXTERNAL FORMULA NUMBERS WITH CORRESPONDING INTERNAL FORMULA NUMBERS AND OCTAL LOCATIONS

EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC
14	18	00031	16	59	00115	17	67	00260	18	70	00270
19	84	00440	20	94	00506	21	96	00522			

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,

(STHM)	(FIL)	(TSHM)	(RTN)	(IOS)	(WRS)	(RCH)	(WTC)	(WER)
(TES)	**(FPT)**	**COS**	**SIN**					

MACHINE TAPE	TOTAL WRITES	TOTAL READS	NOISE RECORDS WRITING	NOISE RECORDS READING	TOTAL REDUNDANCIES WRITING	TOTAL REDUNDANCIES READING	POSITIONIN ERROR
A 1	0	483	0	0	0	0	
B 2	**127**	**137**	**0**	**0**	**0**	**0**	
B 3	**26**	**32**	**0**	**0**	**0**	**0**	
A 4	**80**	**85**	**0**	**0**	**0**	**0**	
A 2	0	168	0	0	0	0	
A 3	118	1	0	0	0	0	
B 4	32	32	0	0	0	0	

EXECUTION 10.660

```
BESSEL                                                          7/09/

C                                                                       HM020086
C    COMPUTES BESSEL FUNCTIONS (1) OF THE FIRST KIND  ( JN(X) ) ,       HM020087
C                        AND/OR (2) OF THE SECOND KIND ( YN(X) ) .      HM020088
C                                                                       HM020089
C     X = ARGUMENT          N = ORDER   (0,1,2,3,4, OR 5 )              HM020090
C     FJ= J ANSWERS         T = +1 , COMPUTE ONLY Y,S                   HM020091
C     FY= Y ANSWERS           =  0 , COMPUTE BOTH Y AND J               HM020092
C                             = -1 , COMPUTE ONLY J,S                   HM020093
C                                                                       HM020094
C            USES SUBROUTINES  RW BJY0  AND RW BJY1                     HM020095
C                                                                       HM020096
      SUBROUTINE  BESSEL   ( X, N, FJ, FY, T )                          HM020097
                                                                        HM020098
      DIMENSION   FJ(1), FY(1)                                          HM020099
                                                                        HM020100
C                                                                       HM020101
C ALWAYS FIND ZERO ORDER VALUES.                                        HM020102
C                                                                       HM020103
      CALL  BJY0 (X, T, FJ, FY )                                        HM020104
                                                                        HM020105
      IF  ( N )    50,50,10                                             HM020106
                                                                        HM020107
   10 CALL  BJY1 (X, T, FJ(2), FY(2) )                                  HM020108
                                                                        HM020109
      IF  ( N-1 )  50,50,12                                             HM020110
                                                                        HM020111
   12 IF  ( T )    16,14,14                                             HM020112
                                                                        HM020113
   14 FY(3) =  2.*FY(2)/X - FY(1)                                       HM020114
                                                                        HM020115
   16 IF  ( T )    17,17,18                                             HM020116
                                                                        HM020117
   17 FJ(3) =  2.*FJ(2)/X - FJ(1)                                       HM020118
                                                                        HM020119
   18 IF  ( N-2 )  50,50,20                                             HM020120
                                                                        HM020121
   20 IF  ( T )    24,22,22                                             HM020122
```

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BESSEL                                                          7/09/

C                                                                       HM020086
C    COMPUTES BESSEL FUNCTIONS (1) OF THE FIRST KIND  ( JN(X) ) ,       HM020087
C                        AND/OR (2) OF THE SECOND KIND ( YN(X) ) .      HM020088
C                                                                       HM020089
C     X = ARGUMENT          N = ORDER   (0,1,2,3,4, OR 5 )              HM020090
C     FJ= J ANSWERS         T = +1 , COMPUTE ONLY Y,S                   HM020091
C     FY= Y ANSWERS           =  0 , COMPUTE BOTH Y AND J               HM020092
C                             = -1 , COMPUTE ONLY J,S                   HM020093
C                                                                       HM020094
C            USES SUBROUTINES  RW BJY0  AND RW BJY1                     HM020095
C                                                                       HM020096
      SUBROUTINE  BESSEL   ( X, N, FJ, FY, T )                          HM020097
                                                                        HM020098
      DIMENSION   FJ(1), FY(1)                                          HM020099
                                                                        HM020100
C                                                                       HM020101
C ALWAYS FIND ZERO ORDER VALUES.                                        HM020102
C                                                                       HM020103
      CALL  BJY0 (X, T, FJ, FY )                                        HM020104
                                                                        HM020105
      IF  ( N )    50,50,10                                             HM020106
                                                                        HM020107
   10 CALL  BJY1 (X, T, FJ(2), FY(2) )                                  HM020108
                                                                        HM020109
      IF  ( N-1 )  50,50,12                                             HM020110
                                                                        HM020111
   12 IF  ( T )    16,14,14                                             HM020112
                                                                        HM020113
   14 FY(3) =  2.*FY(2)/X - FY(1)                                       HM020114
                                                                        HM020115
   16 IF  ( T )    17,17,18                                             HM020116
                                                                        HM020117
   17 FJ(3) =  2.*FJ(2)/X - FJ(1)                                       HM020118
                                                                        HM020119
   18 IF  ( N-2 )  50,50,20                                             HM020120
                                                                        HM020121
   20 IF  ( T )    24,22,22                                             HM020122
```

STORAGE NOT USED BY PROGRAM

DEC	OCT	DEC	OCT
325	00505	32561	77461

STORAGE LOCATIONS FOR VARIABLES NOT APPEARING IN COMMON, DIMENSION, OR EQUIVALENCE STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
Y	324	00504	Z	323	00503						

LOCATIONS FOR OTHER SYMBOLS NOT APPEARING IN SOURCE PROGRAM

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
1)	318	00476	2)	291	00443	3)	295	00447	6)	305	00461
9)	310	00466									

LOCATIONS OF NAMES IN TRANSFER VECTOR

	DEC	OCT		DEC	OCT		DEC	OCT
BJY0	0	00000	BJY1	1	00001			

ENTRY POINTS TO SUBROUTINES NOT OUTPUT FROM LIBRARY

BJY0 BJY1

EXTERNAL FORMULA NUMBERS WITH CORRESPONDING INTERNAL FORMULA NUMBERS AND OCTAL LOCATIONS

EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC
10	7	00164	12	10	00176	14	11	00202	16	12	00207
17	13	00212	18	14	00217	20	15	00224	22	16	00230
24	17	00247	26	18	00252	28	19	00271	30	20	00276
32	23	00325	34	24	00334	36	25	00337	38	26	00346
40	27	00353	42	30	00416	44	31	00425	46	32	00430
50	33	00437									

```
                                00001          ENTRY  BJY0                                                    HMD20150
A     00000  0000 00 0 00000                   HTR                                                            HMD20161
      00001 -0634 00 4 00000   BJY0   SXD BJY0-1,4                                                           HMD20162
      00002  0500 00 4 00001          CLA 1,4                                                                 HMD20163
      00003  0621 00 0 00023          STA B3                 STORE ADDRESS OF ARGUMENT                        HMD20164
      00004  0500 00 4 00003          CLA 3,4                                                                 HMD20165
      00005  0621 00 0 00027          STA B4                 SET J STORAGE                                    HMD20166
      00006  0500 00 4 00004          CLA 4,4                                                                 HMD20167
      00007  0621 00 0 00030          STA B5                 SET Y STORAGE                                    HMD20168
      00010  0500 00 4 00002          CLA 2,4                                                                 HMD20169
      00011  0621 00 0 00012          STA B1                                                                  HMD20170
A     00012  0500 00 0 00000   B1     CLA                                                                    HMD20171
      00013  0601 00 0 00014          STO CALL+1             SET PARAMETER                                    HMD20172
      00014  0100 00 0 00023          TZE B3                 BOTH J AND Y                                     HMD20173
      00015 -0120 00 0 00021          TMI B2                 ONLY J                                           HMD20174
      00016  0500 00 0 00036          CLA B7                 ONLY Y                                           HMD20175
      00017  0621 00 0 00027          STA B4                                                                  HMD20176
      00020  0020 00 0 00023          TRA B3                                                                  HMD20177
      00021  0500 00 0 00036   B2     CLA B7                                                                  HMD20178
      00022  0621 00 0 00030          STA B5                                                                  HMD20179
A     00023  0500 00 0 00000   B3     CLA                                                                    HMD20180
      00024  0074 00 4 00053   CALL   TSX BF2F,4                                                             HMD20181
      00025  0 00000 0 00000          PZE                                                                     HMD20182
      00026  0020 00 0 00033          TRA B6                                                                  HMD20183
A     00027  0601 00 0 00000   B4     STO                                                                    HMD20184
A     00030 -0600 00 0 00000   B5     STQ                                                                    HMD20185
      00031 -0534 00 4 00000          LXD BJY0-1,4                                                            HMD20186
      00032  0020 00 4 00005          TRA 5,4                                                                 HMD20187
      00033  0560 00 0 00037   B6     LDQ B8                 ERROR RETURN                                     HMD20188
      00034  0500 00 0 00040          CLA B9                                                                  HMD20189
      00035  0020 00 0 00027          TRA B4                                                                  HMD20190
      00036  0 00000 0 00041   B7     PZE COMMON                                                              HMD20191
      00037 +377777777777      B8     OCT 377777777777                                                       HMD20192
      00040 +201400000000      B9     DEC 1.                                                                 HMD20193
      00041                    COMMON BSS 10                                                                  HMD20194
                                      BESSEL FUNCTIONS J ZERO AND/OR Y ZERO OF X                             HMD20195
      00053 -0634 00 1 00112   BF2F   SXD BF2F+0031,1                                                        HMD20196
      00054 -0634 00 2 00104          SXD BF2F+0025,2                                                         HMD20197
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00065 -0634 00 4 00135        SXD BF2F+0050,4                                  HMD20198
00066  0560 00 4 00001        LDQ 1,4                                          HMD20199
00067  0162 00 0 00061        TQP BF2F+0006                                    HMD20200
00070  0020 00 0 00064        TRA BF2F+0009                                    HMD20201
00071  0560 00 0 00216        LDQ BF2F+0099                                    HMD20202
00072  0040 00 0 00064        TLQ BF2F+0009                                    HMD20203
00073  0020 00 4 00002        TRA 2,4                                          HMD20204
00074  0601 00 0 00047        STO COMMON+006                                   HMD20205
00075  0760 00 0 00003        SSP                                              HMD20206
00076  0601 00 0 00050        STO COMMON+007                                   HMD20207
00077  0560 00 0 00216        LDQ BF2F+0099                                    HMD20208
00100  0040 00 0 00073        TLQ BF2F+0016                                    HMD20209
00101  0500 00 0 00226        CLA BF2F+0107                                    HMD20210
00102  0020 00 4 00003        TRA 3,4                                          HMD20211
00103 -0534 00 1 00135        LXD BF2F+0050,1                                  HMD20212
00104  0560 00 0 00150        LDQ BF2F+0061                                    HMD20213
00105  0040 00 0 00125        TLQ BF2F+0042                                    HMD20214
00106  0500 00 0 00047        CLA COMMON+006          FC2                      HMD20215
00107  0241 00 0 00150        FDP BF2F+0061                                    HMD20216
00110 -0600 00 0 00041        STQ COMMON+000                                   HMD20217
00111  0260 00 0 00041        FMP COMMON+000                                   HMD20218
00112  0601 00 0 00041        STO COMMON+000                                   HMD20219
00113  0074 00 4 00203        TSX BF2F+0088,4                                  HMD20220
00114  0 00000 0 00227        PZE BF2F+0108                                    HMD20221
00115  0560 00 1 00001        LDQ 1,1                                          HMD20222
00116  0162 00 0 00110        TQP BF2F+0029                                    HMD20223
00117  0020 00 0 00172        TRA BF2F+0079                                    HMD20224
00120  0601 00 0 00051        STO COMMON+008                                   HMD20225
00121  0074 00 4 00203        TSX BF2F+0088,4          FC3                     HMD20226
00122  0 00000 0 00236        PZE BF2F+0115                                    HMD20227
00123  0601 00 0 00052        STO COMMON+009                                   HMD20228
00124  0560 00 0 00047        LDQ COMMON+006                                   HMD20229
00125  0260 00 0 00217        FMP BF2F+0100                                    HMD20230
00126  0074 00 4 00347        TSX BF2F+0188,4                                  HMD20231
00127  0020 00 0 00176        TRA BF2F+0083                                    HMD20232
00130  0241 00 0 00254        FDP BF2F+0129                                    HMD20233
00131  0260 00 0 00051        FMP COMMON+008                                   HMD20234
00132  0300 00 0 00052        FAD COMMON+009                                   HMD20235
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00123  0765 00 0 00043        LRS 35                                          HM020235
00124  0020 00 0 00171        TRA BF2F+0078                                   HM020237
00125  0500 00 0 00050        CLA COMMON+007          FC4                     HM020238
00126  0074 00 4 00316        TSX BF2F+0163,4                                 HM020239
00127  0020 00 0 00176        TRA BF2F+0083                                   HM020240
00130  0601 00 0 00044        STO COMMON+003                                  HM020241
00131  0500 00 0 00150        CLA BF2F+0061                                   HM020242
00132  0241 00 0 00050        FDP COMMON+007                                  HM020243
00133 -0600 00 0 00041        STO COMMON+000                                  HM020244
00134  0074 00 4 00203        TSX BF2F+0088,4                                 HM020245
00135  0 00000 0 00245        PZE BF2F+0122                                   HM020246
00136  0601 00 0 00046        STO COMMON+005                                  HM020247
00137  0074 00 4 00203        TSX BF2F+0088,4                                 HM020248
00140  0 00000 0 00254        PZE BF2F+0129                                   HM020249
00141  0601 00 0 00052        STO COMMON+009                                  HM020250
00142  0500 00 0 00050        CLA COMMON+007                                  HM020251
00143  0302 00 0 00052        FSB COMMON+009                                  HM020252
00144  0601 00 0 00045        STO COMMON+004                                  HM020253
00145  0500 00 1 00001        CLA 1,1                                         HM020254
00146  0340 00 0 00104        CAS BF2F+0025                                   HM020255
00147  0020 00 0 00164        TRA BF2F+0073                                   HM020256
00150 +202600000000           DEC 3.                                          HM020257
00151  0500 00 0 00045        CLA COMMON+004          FC5                     HM020258
00152  0074 00 4 00255        TSX BF2F+0130,4                                 HM020259
00153  0241 00 0 00044        FDP COMMON+003                                  HM020260
00154  0260 00 0 00046        FMP COMMON+005                                  HM020261
00155  0560 00 0 00047        LDQ COMMON+006                                  HM020262
00156  0162 00 0 00160        TQP BF2F+0069                                   HM020263
00157  0760 00 0 00002        CHS                                             HM020264
00160  0601 00 0 00051        STO COMMON+008                                  HM020265
00161  0560 00 1 00001        LDQ 1,1                                         HM020266
00162  0162 00 0 00164        TQP BF2F+0073                                   HM020267
00163  0020 00 0 00172        TRA BF2F+0079                                   HM020268
00164  0500 00 0 00045        CLA COMMON+004          FC6                     HM020269
00165  0074 00 4 00256        TSX BF2F+0131,4                                 HM020270
00166  0241 00 0 00044        FDP COMMON+003                                  HM020271
00167  0260 00 0 00046        FMP COMMON+005                                  HM020272
00170  0765 00 0 00043        LRS 35                                          HM020273
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00171  0500 00 0 00051          CLA COMMON+008                                  HH020274
00172 -0534 00 1 00112          LXD BF2F+0031,1                                 HH020275
00173 -0534 00 4 00135          LXD BF2F+0050,4                                 HH020276
00174 -0534 00 2 00104          LXD BF2F+0025,2                                 HH020277
00175  0020 00 4 00003          TRA 3,4                                         HH020278
00176 -0534 00 1 00112          LXD BF2F+0031,1                                 HH020279
00177 -0534 00 2 00104          LXD BF2F+0025,2                                 HH020280
00200 -0534 00 4 00135          LXD BF2F+0050,4                                 HH020281
00201  0500 00 0 00047          CLA COMMON+006                                  HH020282
00202  0020 00 4 00002          TRA 2,4                                         HH020283
00203  0500 00 4 00001          CLA 1,4                                         HH020284
00204  0621 00 0 00212          STA BF2F+0095                                   HH020285
T 00205 -0754 00 0 00007        PXD 7                                           HH020286
00206  0534 00 2 00205          LXA BF2F+0090,2                                 HH020287
00207  0020 00 0 00212          TRA BF2F+0095                                   HH020288
00210  0560 00 0 00042          LDQ COMMON+001                                  HH020289
00211  0260 00 0 00041          FMP COMMON+000                                  HH020290
00212  0300 00 2 00000          FAD ,2                                          HH020291
00213  0601 00 0 00042          STO COMMON+001                                  HH020292
00214  2 00001 2 00210          TIX BF2F+0093,2,1                               HH020293
00215  0020 00 4 00002          TRA 2,4                                         HH020294
00216 +105447113564             DEC 1E-18                                       HH020295
00217 +200400000000             DEC .5                                          HH020296
00220 +164670315620             DEC +.0002100,-.0039444,+.0444479               HH020297
00221 -171402400064
00222 +174554074002
00223 -177503765545             DEC -.3163866,+1.2656208,-2.2499997,+1.         HH020298
00224 +201503777346
00225 -202437777765
00226 +201400000000
00227 -165404416744             DEC -.00024846,+.00427916,-.04261214            HH020299
00230 +171430340621
00231 -174635050211
00232 +177403045364             DEC +.25300117,-.74350384,+.60559366,+.36746691  HH020300
00233 -200574531044
00234 +200466040575
00235 +177570222373
00236 +164457452673             DEC +.00014476,-.00072805,+.00137237            HH020301
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00237 -166575552336
00240 +167547604304
00241 -163616754512          DEC -.00009512,-.00552740,-.00000077,+.79788456                  HH020302
00242 -171552174610
00243 -154635307772
00244 +200630410514
00245 -164434251725          DEC -.00013558,+.00029333,+.00054125                             HH020303
00246 +165463450260
00247 +166433612541
00250 -170530121603          DEC -.00262573,+.00003954,+.04166397,+.78539816                  HH020304
00251 +162513537003
00252 +174525237266
00253 +200622077324
00254 +201622077325          DEC 1.57079633                                                   HH020305
00255  0300 00 0 00314       FAD BF2F+0161       ADD PI/2 FOR COSINE                          HH020306
00256  0240 00 0 00314       FDH BF2F+0161       OBTAIN NO. OF QUADRANTS                      HH020307
00257 -0600 00 0 00041       STQ COMMON+000                                                   HH020308
00260  0502 00 0 00041       CLS COMMON+000                                                   HH020309
00261 -0634 00 4 00043       SXD COMMON+002,4                                                 HH020310
00262 -0534 00 4 00267       LXD BF2F+0140,4                                                  HH020311
00263 -0300 00 0 00315       UFA BF2F+0162       FIX FOR QUADRANT ADJUST                      HH020312
00264 -0773 00 0 00010       RQL 8                                                            HH020313
00265  0760 00 0 00010       RND                    OBTAIN NEAREST SEMICIRCLE                 HH020314
00266  0760 00 0 00001       LBT                    TEST QUADRANTS                            HH020315
00267  1 00004 4 00270       TXI BF2F+0141,4,4         FIRST AND FOURTH                       HH020316
00270  0300 00 0 00315       FAD BF2F+0162       FLOAT                                        HH020317
00271  0300 00 0 00041       FAD COMMON+000                                                   HH020318
00272  2 00004 4 00274       TIX BF2F+0145,4,4                                                HH020319
00273  0760 00 0 00002       CHS                    SECOND AND THIRD                          HH020320
00274  0601 00 0 00041       STO COMMON+000         FIRST QUADRANT EQUIVALENT                 HH020321
00275 -0300 00 0 00315       UFA BF2F+0162                                                    HH020322
00276  0260 00 0 00041       FMP COMMON+000         OBTAIN SQUARED ARGUMENT                   HH020323
00277  0601 00 0 00042       STO COMMON+001                                                   HH020324
00300  0560 00 0 00310       LDQ BF2F+0157                                                    HH020325
00301  0260 00 0 00042       FMP COMMON+001                                                   HH020326
00302  0300 00 4 00315       FAD BF2F+0162,4                                                  HH020327
00303  0765 00 0 00043       LRS 35                                                           HH020328
00304  2 00001 4 00301       TIX BF2F+0150,4,1                                                HH020329
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00305  0260 00 0 00041          FMP COMMON+000                                          HHD20330
00306 -0534 00 4 00043          LXD COMMON+002,4                                        HHD20331
00307  0020 00 4 00001          TRA 1,4                EXIT                             HHD20332
00310 +164476053726             OCT 164476053726,571462246361,175506321703             HHD20333
00311 -171462246361
00312 +175506321703
00313 -200512567414             OCT 600512567414,201622077324,234000000000             HHD20334
00314 +201622077324
00315 +234000000000
00316  0601 00 0 00041          STO COMMON+000          SAVE ARGUMENT SIGN              HHD20335
00317  0760 00 0 00003          SSP                    N                                HHD20336
00320  0100 00 0 00342          TZE BF2F+0183       TO EXIT IF ZERO                     HHD20337
00321  0601 00 0 00042          STO COMMON+001        SAVE N                            HHD20338
00322 -0320 00 0 00345          ANA BF2F+0186       PUTE TRIAL VALUE, X                 HHD20339
00323  0765 00 0 00001          LRS 1                  X                                HHD20340
00324  0400 00 0 00042          ADD COMMON+001         X                                HHD20341
00325  0765 00 0 00001          LRS 1                  X                                HHD20342
00326  0400 00 0 00346          ADD BF2F+0187                                           HHD20343
00327 -0634 00 4 00041          SXD COMMON+000,4       DD RETURN ADDRESS                HHD20344
00330  0534 00 4 00317          LXA BF2F+0164,4         S   INDEX FOR 3 ITERATIONS      HHD20345
00331  0601 00 0 00043          STO COMMON+002        SAVE X                            HHD20346
00332  0500 00 0 00042          CLA COMMON+001        COMPUTE SQUARE ROOT               HHD20347
00333  0240 00 0 00043          FDH COMMON+002        X N/X                             HHD20348
00334 -0600 00 0 00044          STQ COMMON+003        X                                 HHD20349
00335  0500 00 0 00044          CLA COMMON+003        X N/X                             HHD20350
00336  0300 00 0 00043          FAD COMMON+002        X + X                             HHD20351
00337  0402 00 0 00345          SUB BF2F+0186      IVIDE BY 2                           HHD20352
00340  2 00001 4 00331          TIX BF2F+0174,4,1     REPEAT LOOP                       HHD20353
00341 -0534 00 4 00041          LXD COMMON+000,4      OORE EXIT ADDRESS                 HHD20354
00342  0560 00 0 00041          LDQ COMMON+000        TEST SIGN OF ARGUMENT             HHD20355
00343  0162 00 4 00002          TQP 2,4               IF + , SKIP ONE                   HHD20356
00344  0020 00 4 00001          TRA 1,4               IF - , DO NOT SKIP ONE            HHD20357
00345 +001000000000             DEC 134217728,8657043456 0*2 EXP -127, 1/2 * EXP -64    HHD20358
00346 +100400000000
00347  0100 00 4 00001          TZE 1,4                ERROR RETURN                     HHD20359
00350 -0120 00 4 00001          TMI 1,4                *                                HHD20360
00351  0601 00 0 00041          STO COMMON+000                                          HHD20361
00352 -0320 00 0 00411          ANA BF2F+0222       MASK EXPONENT                       HHD20362
```

```
00353  0300 00 0 00041      FAD COMMON+000          NORMALIZE                  4M020363
00354  0765 00 0 00033      LRS 27                                             4M020364
00355  0767 00 0 00001      ALS 1                                              4M020365
00356  0402 00 0 00412      SUB BF2F+0223                                      4M020366
00357 -0501 00 0 00421      ORA BF2F+0230                                      4M020367
00360 -0600 00 0 00042      STQ COMMON+001                                     4M020368
00361  0300 00 0 00421      FAD BF2F+0230                                      4M020369
00362  0560 00 0 00042      LDQ COMMON+001                                     4M020370
00363  0601 00 0 00042      STD COMMON+001                                     4M020371
00364  0500 00 0 00413      CLA BF2F+0224                                      4M020372
00365  0763 00 0 00033      LLS 27                                             4M020373
00366  0300 00 0 00417      FAD BF2F+0228                                      4M020374
00367  0601 00 0 00041      STO COMMON+000                                     4M020375
00370  0302 00 0 00420      FSB BF2F+0229                                      4M020376
00371  0240 00 0 00041      FDH COMMON+000                                     4M020377
00372 -0600 00 0 00041      STQ COMMON+000                                     4M020378
00373  0260 00 0 00041      FMP COMMON+000                                     4M020379
00374  0601 00 0 00043      STD COMMON+002                                     4M020380
00375  0560 00 0 00416      LDQ BF2F+0227                                      4M020381
00376  0260 00 0 00043      FMP COMMON+002                                     4M020382
00377  0300 00 0 00415      FAD BF2F+0226                                      4M020383
00400  0765 00 0 00043      LRS 35                                             4M020384
00401  0260 00 0 00043      FMP COMMON+002                                     4M020385
00402  0300 00 0 00414      FAD BF2F+0225                                      4M020386
00403  0765 00 0 00043      LRS 35                                             4M020387
00404  0260 00 0 00041      FMP COMMON+000                                     4M020388
00405  0300 00 0 00042      FAD COMMON+001                                     4M020389
00406  0765 00 0 00043      LRS 35                                             4M020390
00407  0260 00 0 00422      FMP BF2F+0231                                      4M020391
00410  0020 00 4 00002      TRA 2,4                                            4M020392
00411 +377000000000         OCT 377000000000                                   4M020393
00412  0000 00 0 00401      HTR 257                                            4M020394
00413  0000 00 0 00200      HTR 128                                            4M020395
00414 +202561251001         DEC 2.8853912903                                   4M020396
00415 +200754213603         DEC .9614706323                                    4M020397
00416 +200462532521         DEC .5989786496                                    4M020398
00417 +200552023631         DEC .707106781187                                  4M020399
00420 +201562023631         DEC 1.41421356237                                  4M020400
```

```
00353  0300 00 0 00041      FAD COMMON+000          NORMALIZE                  4M020363
00354  0765 00 0 00033      LRS 27                                             4M020364
00355  0767 00 0 00001      ALS 1                                              4M020365
00356  0402 00 0 00412      SUB BF2F+0223                                      4M020366
00357 -0501 00 0 00421      ORA BF2F+0230                                      4M020367
00360 -0600 00 0 00042      STQ COMMON+001                                     4M020368
00361  0300 00 0 00421      FAD BF2F+0230                                      4M020369
00362  0560 00 0 00042      LDQ COMMON+001                                     4M020370
00363  0601 00 0 00042      STD COMMON+001                                     4M020371
00364  0500 00 0 00413      CLA BF2F+0224                                      4M020372
00365  0763 00 0 00033      LLS 27                                             4M020373
00366  0300 00 0 00417      FAD BF2F+0228                                      4M020374
00367  0601 00 0 00041      STO COMMON+000                                     4M020375
00370  0302 00 0 00420      FSB BF2F+0229                                      4M020376
00371  0240 00 0 00041      FDH COMMON+000                                     4M020377
00372 -0600 00 0 00041      STQ COMMON+000                                     4M020378
00373  0260 00 0 00041      FMP COMMON+000                                     4M020379
00374  0601 00 0 00043      STD COMMON+002                                     4M020380
00375  0560 00 0 00416      LDQ BF2F+0227                                      4M020381
00376  0260 00 0 00043      FMP COMMON+002                                     4M020382
00377  0300 00 0 00415      FAD BF2F+0226                                      4M020383
00400  0765 00 0 00043      LRS 35                                             4M020384
00401  0260 00 0 00043      FMP COMMON+002                                     4M020385
00402  0300 00 0 00414      FAD BF2F+0225                                      4M020386
00403  0765 00 0 00043      LRS 35                                             4M020387
00404  0260 00 0 00041      FMP COMMON+000                                     4M020388
00405  0300 00 0 00042      FAD COMMON+001                                     4M020389
00406  0765 00 0 00043      LRS 35                                             4M020390
00407  0260 00 0 00422      FMP BF2F+0231                                      4M020391
00410  0020 00 4 00002      TRA 2,4                                            4M020392
00411 +377000000000         OCT 377000000000                                   4M020393
00412  0000 00 0 00401      HTR 257                                            4M020394
00413  0000 00 0 00200      HTR 128                                            4M020395
00414 +202561251001         DEC 2.8853912903                                   4M020396
00415 +200754213603         DEC .9614706323                                    4M020397
00416 +200462532521         DEC .5989786496                                    4M020398
00417 +200552023631         DEC .707106781187                                  4M020399
00420 +201562023631         DEC 1.41421356237                                  4M020400
```

POST PROCESSOR ASSEMBLY DATA

423 IS THE FIRST LOCATION NOT USED BY THIS PROGRAM

REFERENCES TO DEFINED SYMBOLS

432	R	
12	B1	11
21	B2	15
23	**B3**	**3, 14, 20**
27	**B4**	**5, 17, 35**
30	**B5**	**7, 22**
33	B6	26
36	B7	16, 21
37	B8	33
40	**B9**	**34**
53	**BF26**	**24, 53, 54, 55, 57, 60, 61, 62, 67, 70, 71, 73, 74, 75, 77**
		103, 104, 106, 107, 111, 112, 115, 116, 117, 120, 124, 126, 127, 131, 134
		135, 137, 140, 146, 147, 152, 156, 162, 163, 165, 172, 173, 174, 176, 177
		200, 204, 206, 207, 214, 255, 256, 262, 263, 267, 270, 272, 275, 300, 302
		304, 320, 322, 326, 330, 337, 340, 352, 356, 357, 361, 364, 366, 370, 375
		377, 402, 407
1	**BJY0**	**1, 31**
24	**CALL**	**13**
41	COMMON	36, 64, 66, 76, 100, 101, 102, 110, 113, 114, 121, 122, 125, 130, 132
		133, 136, 141, 142, 143, 144, 151, 153, 154, 155, 160, 164, 166, 167, 171
		201, 210, 211, 213, 257, 260, 261, 271, 274, 276, 277, 301, 305, 306, 316
		321, 324, 327, 331, 332, 333, 334, 335, 336, 341, 342, 351, 353, 360, 362
		363, 367, 371, 372, 373, 374, 376, 401, 404, 405

NO ERROR IN ABOVE ASSEMBLY.

```
                    00001                ENTRY  BJY1                                                    HMD20405
                                              BESSEL FUNCTIONS J, (X) AND Y, (X)                        HMD20407
A   00000  0000 00 0 00000                HTR                                                           HMD20408
    00001 -0634 00 4 00000  BJY1         SXD BJY1-1,4                                                  HMD20409
    00002  0500 00 4 00001               CLA 1,4                                                       HMD20410
    00003  0621 00 0 00023               STA B3          STORE ADDRESS OF ARGUMENT                     HMD20411
    00004  0500 00 4 00003               CLA 3,4                                                       HMD20412
    00005  0621 00 0 00027               STA B4          SET J STORAGE                                 HMD20413
    00006  0500 00 4 00004               CLA 4,4                                                       HMD20414
    00007  0621 00 0 00030               STA B5          SET Y STORAGE                                 HMD20415
    00010  0500 00 4 00002               CLA 2,4                                                       HMD20416
    00011  0621 00 0 00012               STA B1                                                        HMD20417
A   00012  0500 00 0 00000  B1           CLA                                                           HMD20418
    00013  0601 00 0 00025               STO CALL+1      SET PARAMETER                                 HMD20419
    00014  0100 00 0 00023               TZE B3          BOTH J AND Y                                  HMD20420
    00015 -0120 00 0 00021               TMI B2          ONLY J                                        HMD20421
    00016  0500 00 0 00036               CLA B7          ONLY Y                                        HMD20422
    00017  0621 00 0 00027               STA B4                                                        HMD20423
    00020  0020 00 0 00023               TRA B3                                                        HMD20424
    00021  0500 00 0 00036  B2           CLA B7                                                        HMD20425
    00022  0621 00 0 00030               STA B5                                                        HMD20426
A   00023  0500 00 0 00000  B3           CLA                                                           HMD20427
    00024  0074 00 4 00053  CALL         TSX BF3F,4                                                    HMD20428
    00025  0 00000 0 00000               PZE                                                           HMD20429
    00026  0020 00 0 00033               TRA B6                                                        HMD20430
A   00027  0601 00 0 00000  B4           STO                                                           HMD20431
A   00030 -0600 00 0 00000  B5           STQ                                                           HMD20432
    00031 -0534 00 4 00000               LXD BJY1-1,4                                                  HMD20433
    00032  0020 00 4 00005               TRA 5,4                                                       HMD20434
    00033  0560 00 0 00037  B6           LDQ B8          ERROR RETURN                                  HMD20435
    00034  0500 00 0 00040               CLA B9                                                        HMD20436
    00035  0020 00 0 00027               TRA B4                                                        HMD20437
    00036  0 00000 0 00041  B7           PZE COMMON                                                    HMD20438
    00037 +377777777777    B8           OCT 377777777777                                              HMD20439
    00040  0 00000 0 00000  B9           PZE 0                                                         HMD20440
    00041                  COMMON       BSS 10                                                        HMD20441
                                              BESSEL FUNCTIONS J ONE AND/OR Y ONE OF X                  HMD20442
    00053 -0634 00 1 00114  BF3F         SXD BF3F+0033,1                                               HMD20443
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                00054 -0634 00 2 00104    SXD BF3F+0025,2                                  4MD20444
                00055 -0634 00 4 00140    SXD BF3F+0053,4                                  4MD20445
                00056  0560 00 4 00001    LDQ 1,4                                          4MD20446
                00057  0162 00 0 00061    TQP BF3F+0006                                    4MD20447
                00060  0020 00 0 00064    TRA BF3F+0009                                    4MD20448
                00061  0560 00 0 00222    LDQ BF3F+0103                                    4MD20449
                00062  0040 00 0 00064    TLQ BF3F+0009                                    4MD20450
                00063  0020 00 4 00002    TRA 2,4                                          4MD20451
                00064  0601 00 0 00047    STD COMMON+006                                   4MD20452
                00065  0760 00 0 00003    SSP                                              4MD20453
                00066  0601 00 0 00050    STD COMMON+007                                   4MD20454
                00067  0560 00 0 00222    LDQ BF3F+0103                                    4MD20455
                00070  0040 00 0 00073    TLQ BF3F+0016                                    4MD20456
T               00071 -0754 00 0 00000    PXD                                              4MD20457
                00072  0020 00 4 00003    TRA 3,4                                          4MD20458
                00073 -0534 00 1 00140    LXD BF3F+0053,1                                  4MD20459
                00074  0560 00 0 00153    LDQ BF3F+0064                                    4MD20460
                00075  0040 00 0 00130    TLQ BF3F+0045                                    4MD20461
                00076  0500 00 0 00047    CLA COMMON+006          FC2                      4MD20462
                00077  0241 00 0 00153    FDP BF3F+0064                                    4MD20463
                00100 -0600 00 0 00041    STQ COMMON+000                                   4MD20464
                00101  0260 00 0 00041    FMP COMMON+000                                   4MD20465
                00102  0601 00 0 00041    STO COMMON+000                                   4MD20466
                00103  0074 00 4 00207    TSX BF3F+0092,4                                  4MD20467
                00104  0 00000 0 00232    PZE BF3F+0111                                    4MD20468
                00105  0765 00 0 00043    LRS 35                                           4MD20469
                00106  0260 00 0 00047    FMP COMMON+006                                   4MD20470
                00107  0560 00 1 00001    LDQ 1,1                                          4MD20471
                00110  0162 00 0 00112    TQP BF3F+0031                                    4MD20472
                00111  0020 00 0 00176    TRA BF3F+0083                                    4MD20473
                00112  0601 00 0 00051    STO COMMON+008                                   4MD20474
                00113  0074 00 4 00207    TSX BF3F+0092,4         FC3                      4MD20475
                00114  0 00000 0 00241    PZE BF3F+0118                                    4MD20476
                00115  0241 00 0 00047    FDP COMMON+006                                   4MD20477
                00116 -0600 00 0 00052    STQ COMMON+009                                   4MD20478
                00117  0560 00 0 00047    LDQ COMMON+006                                   4MD20479
                00120  0260 00 0 00231    FMP BF3F+0110                                    4MD20480
                00121  0074 00 4 00352    TSX BF3F+0191,4                                  4MD20481
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00122  0020 00 0 00202          TRA BF3F+0087                                  HH020482
00123  0241 00 0 00257          FDP BF3F+0132                                  HH020483
00124  0260 00 0 00051          FMP COMMON+008                                 HH020484
00125  0300 00 0 00052          FAD COMMON+009                                 HH020485
00126  0765 00 0 00043          LRS 35                                         HH020486
00127  0020 00 0 00175          TRA BF3F+0082                                  HH020487
00130  0500 00 0 00050          CLA COMMON+007          FC4                    HH020488
00131  0074 00 4 00321          TSX BF3F+0166,4                                HH020489
00132  0020 00 0 00202          TRA BF3F+0087                                  HH020490
00133  0601 00 0 00044          STO COMMON+003                                 HH020491
00134  0500 00 0 00153          CLA BF3F+0064                                  HH020492
00135  0241 00 0 00050          FDP COMMON+007                                 HH020493
00136 -0600 00 0 00041          STQ COMMON+000                                 HH020494
00137  0074 00 4 00207          TSX BF3F+0092,4                                HH020495
00140  0 00000 0 00250          PZE BF3F+0125                                  HH020496
00141  0601 00 0 00046          STO COMMON+005                                 HH020497
00142  0074 00 4 00207          TSX BF3F+0092,4                                HH020498
00143  0 00000 0 00257          PZE BF3F+0132                                  HH020499
00144  0601 00 0 00052          STO COMMON+009                                 HH020500
00145  0500 00 0 00050          CLA COMMON+007                                 HH020501
00146  0302 00 0 00052          FSB COMMON+009                                 HH020502
00147  0601 00 0 00045          STO COMMON+004                                 HH020503
00150  0500 00 1 00001          CLA 1,1                                        HH020504
00151  0340 00 0 00104          CAS BF3F+0025                                  HH020505
00152  0020 00 0 00167          TRA BF3F+0076                                  HH020506
00153 +202600000000             DEC 3.                                         HH020507
00154  0500 00 0 00045          CLA COMMON+004          FC5                    HH020508
00155  0074 00 4 00261          TSX BF3F+0134,4                                HH020509
00156  0241 00 0 00044          FDP COMMON+003                                 HH020510
00157  0260 00 0 00046          FMP COMMON+005                                 HH020511
00160  0560 00 0 00047          LDQ COMMON+006                                 HH020512
00161  0162 00 0 00163          TQP BF3F+0072                                  HH020513
00162  0760 00 0 00002          CHS                                            HH020514
00163  0601 00 0 00051          STO COMMON+008                                 HH020515
00164  0560 00 1 00001          LDQ 1,1                                        HH020516
00165  0162 00 0 00167          TQP BF3F+0076                                  HH020517
00166  0020 00 0 00176          TRA BF3F+0083                                  HH020518
00167  0500 00 0 00045          CLA COMMON+004          FC6                    HH020519
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00170  0074 00 4 00260        TSX BF3F+0133,4                                  HM020520
00171  0241 00 0 00044        FDP COMMON+003                                   HM020521
00172  0260 00 0 00046        FMP COMMON+005                                   HM020522
00173  0760 00 0 00002        CHS                                              HM020523
00174  0765 00 0 00043        LRS 35                                           HM020524
00175  0500 00 0 00051        CLA COMMON+008                                   HM020525
00176 -0534 00 1 00114        LXD BF3F+0033,1                                  HM020526
00177 -0534 00 4 00140        LXD BF3F+0053,4                                  HM020527
00200 -0534 00 2 00104        LXD BF3F+0025,2                                  HM020528
00201  0020 00 4 00003        TRA 3,4                                          HM020529
00202 -0534 00 1 00114        LXD BF3F+0033,1                                  HM020530
00203 -0534 00 2 00104        LXD BF3F+0025,2                                  HM020531
00204 -0534 00 4 00140        LXD BF3F+0053,4                                  HM020532
00205  0500 00 0 00047        CLA COMMON+006                                   HM020533
00206  0020 00 4 00002        TRA 2,4                                          HM020534
00207  0500 00 4 00001        CLA 1,4                                          HM020535
00210  0621 00 0 00216        STA BF3F+0099                                    HM020536
T 00211 -0754 00 0 00007      PXD 7                                            HM020537
00212  0534 00 2 00211        LXA BF3F+0094,2                                  HM020538
00213  0020 00 0 00216        TRA BF3F+0099                                    HM020539
00214  0560 00 0 00042        LDQ COMMON+001                                   HM020540
00215  0260 00 0 00041        FMP COMMON+000                                   HM020541
00216  0300 00 2 00000        FAD ,2                                           HM020542
00217  0601 00 0 00042        STO COMMON+001                                   HM020543
00220  2 00001 2 00214        TIX BF3F+0097,2,1                                HM020544
00221  0020 00 4 00002        TRA 2,4                                          HM020545
00222 +105447113564           DEC 1E-18                                        HM020546
00223 +160564074577           DEC +.00001109,-.00031761,+.00443319,-.03954289  HM020547
00224 -165515023444
00225 +171442421130
00226 -174503736715
00227 +176657776111           DEC +.21093573,-.56249985                        HM020548
00230 -200437777753
00231 +200400000000           DEC .5                                           HM020549
00232 +170555254422           DEC +.0027873,-.0400976,+.3123951,-1.3164827     HM020550
00233 -174510365414
00234 +177477711001
00235 -201521012012
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00236 +202425423632          DEC +2.1682709,+.2212091,-.6366198                    HMD20551
00237 +176705022433
00240 -200505746037
00241 -164644076546          DEC -.00020033,+.00113653,-.00249511,+.00017105       HMD20552
00242 +167451736362
00243 -170507023776
00244 +164546557423
00245 +173417726752          DEC +.01659667,+.00000156,+.79788456                  HMD20553
00246 +155642604610
00247 +200630410514
00250 +165461647612          DEC +.00029166,-.00079824,-.00074348,+.00637879       HMD20554
00251 -166642403726
00252 -166605630311
00253 +171642024531
00254 -162731751515          DEC -.00005650,-.12499612,+.78539816                  HMD20555
00255 -175777767671
00256 +200622077324
00257 +201622077325          DEC 1.57079633                                        HMD20555
00260  0300 00 0 00317       FAD BF3F+0164       ADD PI/2 FOR COSINE               HMD20557
00261  0240 00 0 00317       FDH BF3F+0164       OBTAIN NO. OF QUADRANTS           HMD20558
00262 -0600 00 0 00041       STQ COMMON+000                                        HMD20559
00263  0502 00 0 00041       CLS COMMON+000                                        HMD20560
00264 -0634 00 4 00043       SXD COMMON+002,4                                      HMD20561
00265 -0534 00 4 00272       LXD BF3F+0143,4                                       HMD20562
00266 -0300 00 0 00320       UFA BF3F+0165       FIX FOR QUADRANT ADJUST           HMD20563
00267 -0773 00 0 00010       RQL 8                                                 HMD20564
00270  0760 00 0 00010       RND                    OBTAIN NEAREST SEMICIRCLE      HMD20565
00271  0760 00 0 00001       LBT                    TEST QUADRANTS                 HMD20566
00272  1 00004 4 00273       TXI BF3F+0144,4,4         FIRST AND FOURTH            HMD20567
00273  0300 00 0 00320       FAD BF3F+0165       FLOAT                             HMD20568
00274  0300 00 0 00041       FAD COMMON+000                                        HMD20569
00275  2 00004 4 00277       TIX BF3F+0148,4,4                                     HMD20570
00276  0760 00 0 00002       CHS                    SECOND AND THIRD               HMD20571
00277  0601 00 0 00041       STO COMMON+000         FIRST QUADRANT EQUIVALENT      HMD20572
00300 -0300 00 0 00320       UFA BF3F+0165                                         HMD20573
00301  0260 00 0 00041       FMP COMMON+000         OBTAIN SQUARED ARGUMENT        HMD20574
00302  0601 00 0 00042       STO COMMON+001                                        HMD20575
00303  0560 00 0 00313       LDQ BF3F+0160                                         HMD20576
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00304  0260 00 0 00042        FMP COMMON+001                                  HHD20577
00305  0300 00 4 00320        FAD BF3F+0165,4                                 HHD20578
00306  0765 00 0 00043        LRS 35                                          HHD20579
00307  2 00001 4 00304        TIX BF3F+0153,4,1                               HHD20580
00310  0260 00 0 00041        FMP COMMON+000                                  HHD20581
00311 -0534 00 4 00043        LXD COMMON+002,4                                HHD20582
00312  0020 00 4 00001        TRA 1,4                 EXIT                    HHD20583
00313 +164476053726           DCT 164476053726,571462246361,175506321703      HHD20584
00314 -171462246361
00315 +175506321703
00316 -200512567414           DCT 600512567414,201622077324,234000000000      HHD20585
00317 +201622077324
00320 +234000000000
00321  0601 00 0 00041        STO COMMON+000          SAVE ARGUMENT SIGN      HHD20586
00322  0760 00 0 00003        SSP                     N                       HHD20587
00323  0100 00 0 00345        TZE BF3F+0186         TO EXIT IF ZERO           HHD20588
00324  0601 00 0 00042        STO COMMON+001          SAVE N                  HHD20589
00325 -0320 00 0 00350        ANA BF3F+0189       PUTE TRIAL VALUE, X         HHD20590
00326  0765 00 0 00001        LRS 1                   X                       HHD20591
00327  0400 00 0 00042        ADD COMMON+001          X                       HHD20592
00330  0765 00 0 00001        LRS 1                   X                       HHD20593
00331  0400 00 0 00351        ADD BF3F+0190                                   HHD20594
00332 -0634 00 4 00041        SXD COMMON+000,4      00 RETURN ADDRESS         HHD20595
00333  0534 00 4 00322        LXA BF3F+0167,4         SET INDEX FOR 3 ITERATIONS HHD20596
00334  0601 00 0 00043        STO COMMON+002        SAVE X                    HHD20597
00335  0500 00 0 00042        CLA COMMON+001        COMPUTE SQUARE ROOT       HHD20598
00336  0240 00 0 00043        FDH COMMON+002        X N/X                     HHD20599
00337 -0600 00 0 00044        STQ COMMON+003        X                         HHD20600
00340  0500 00 0 00044        CLA COMMON+003        X N/X                     HHD20601
00341  0300 00 0 00043        FAD COMMON+002        X + X                     HHD20602
00342  0402 00 0 00350        SUB BF3F+0189     IVIDE BY 2                    HHD20603
00343  2 00001 4 00334        TIX BF3F+0177,4,1     REPEAT LOOP               HHD20604
00344 -0534 00 4 00041        LXD COMMON+000,4      OOORE EXIT ADDRESS        HHD20605
00345  0560 00 0 00041        LDQ COMMON+000        TEST SIGN OF ARGUMENT     HHD20606
00346  0162 00 4 00002        TQP 2,4               IF + , SKIP ONE           HHD20607
00347  0020 00 4 00001        TRA 1,4               IF - , DO NOT SKIP ONE    HHD20608
00350 +001000000000           DEC 134217728,8657043456 0*2 EXP -127, 1/2 * EXP -64 HHD20609
00351 +100400000000
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00352  0100 00 4 00001        TZE  1,4              ERROR RETURN                  HMD20510
00353 -0120 00 4 00001        TMI  1,4              *                             HMD20511
00354  0601 00 0 00041        STO  COMMON+000                                     HMD20512
00355 -0320 00 0 00414        ANA  BF3F+0225    MASK EXPONENT                     HMD20513
00356  0300 00 0 00041        FAD  COMMON+000       NORMALIZE                     HMD20514
00357  0765 00 0 00033        LRS  27                                             HMD20515
00360  0767 00 0 00001        ALS  1                                              HMD20516
00361  0402 00 0 00415        SUB  BF3F+0226                                      HMD20517
00362 -0501 00 0 00424        ORA  BF3F+0233                                      HMD20518
00363 -0600 00 0 00042        STQ  COMMON+001                                     HMD20519
00364  0300 00 0 00424        FAD  BF3F+0233                                      HMD20520
00365  0560 00 0 00042        LDQ  COMMON+001                                     HMD20521
00366  0601 00 0 00042        STO  COMMON+001                                     HMD20522
00367  0500 00 0 00416        CLA  BF3F+0227                                      HMD20523
00370  0763 00 0 00033        LLS  27                                             HMD20524
00371  0300 00 0 00422        FAD  BF3F+0231                                      HMD20525
00372  0601 00 0 00041        STO  COMMON+000                                     HMD20526
00373  0302 00 0 00423        FSB  BF3F+0232                                      HMD20527
00374  0240 00 0 00041        FDH  COMMON+000                                     HMD20528
00375 -0600 00 0 00041        STQ  COMMON+000                                     HMD20529
00376  0260 00 0 00041        FMP  COMMON+000                                     HMD20530
00377  0601 00 0 00043        STO  COMMON+002                                     HMD20531
00400  0560 00 0 00421        LDQ  BF3F+0230                                      HMD20532
00401  0260 00 0 00043        FMP  COMMON+002                                     HMD20533
00402  0300 00 0 00420        FAD  BF3F+0229                                      HMD20534
00403  0765 00 0 00043        LRS  35                                             HMD20535
00404  0260 00 0 00043        FMP  COMMON+002                                     HMD20536
00405  0300 00 0 00417        FAD  BF3F+0228                                      HMD20537
00406  0765 00 0 00043        LRS  35                                             HMD20538
00407  0260 00 0 00041        FMP  COMMON+000                                     HMD20539
00410  0300 00 0 00042        FAD  COMMON+001                                     HMD20540
00411  0765 00 0 00043        LRS  35                                             HMD20541
00412  0260 00 0 00425        FMP  BF3F+0234                                      HMD20542
00413  0020 00 4 00002        TRA  2,4                                            HMD20543
00414 +377000000000           OCT  377000000000                                   HMD20544
00415  0000 00 0 00401        HTR  257                                            HMD20545
00416  0000 00 0 00200        HTR  128                                            HMD20546
00417 +202561251001           DEC  2.8853912903                                   HMD20547
```

```
00420 +200754213603          DEC .9614706323                    H4020643
00421 +200462532521          DEC .5989786496                    H4020649
00422 +200552023631          DEC .707106781187                  H4020650
00423 +201852023631          DEC 1.41421356237                  H4020651
00424 +232000000000          OCT 232000000000                   H4020652
00426 +200542710277          DEC .69314718056                   H4020653
                       R     END                                H4020654
```

POST PROCESSOR ASSEMBLY DATA

426 IS THE FIRST LOCATION NOT USED BY THIS PROGRAM

REFERENCES TO DEFINED SYMBOLS

425	R														
12	B1	11													
21	B2	15													
23	B3	3,	14,	20											
27	B4	5,	17,	35											
30	B5	7,	22												
33	B6	26													
36	B7	16,	21												
37	B8	33													
40	B9	34													
53	BF3F	24,	53,	54,	55,	57,	60,	61,	62,	67,	70,	73,	74,	75,	77,	103
		104,	110,	111,	113,	114,	120,	121,	122,	123,	127,	131,	132,	134,	137,	140
		142,	143,	151,	152,	155,	161,	165,	166,	170,	176,	177,	200,	202,	203,	204
		210,	212,	213,	220,	260,	261,	265,	266,	272,	273,	275,	300,	303,	305,	307
		323,	325,	331,	333,	342,	343,	355,	361,	362,	364,	367,	371,	373,	400,	402
		405,	412													
1	BJY1	1,	31													
24	CALL	13														
41	COMMON	36,	64,	66,	76,	100,	101,	102,	106,	112,	115,	116,	117,	124,	125,	130
		133,	135,	136,	141,	144,	145,	146,	147,	154,	156,	157,	160,	163,	167,	171
		172,	175,	205,	214,	215,	217,	262,	263,	264,	274,	277,	301,	302,	304,	310
		311,	321,	324,	327,	332,	334,	335,	336,	337,	340,	341,	344,	345,	354,	356
		363,	365,	366,	372,	374,	375,	376,	377,	401,	404,	407,	410			

NO ERROR IN ABOVE ASSEMBLY.

```
      SUBROUTINE AEROP5 (VBRW,ISTRIP,CH,NTAPE3,NTAPE7,NSTART )          HM020655
      DIMENSION   CH(100,4), A(22)                                      HM020656
                                                                        HM020657
    1 FORMAT  ( 1E12.8, 60X, 4HHM02  1I4 )                              HM020658
    2 FORMAT  ( 1HO 40X, 24H PUNCHED CARDS NOS. HM02   1I4,             HM020659
     1          10H THRU HM02    1I4  )                               HM020660
    3 FORMAT  ( 2I4,  64X, 4HHM02   1I4 )                               HM020661
                                                                        HM020662
B     BCDZ=603044000260                                                 HM020663
      IORG=1                                                            HM020664
      IS=NSTART                                                         HM020665
      WRITE OUTPUT TAPE NTAPE7,  1, VBRW, IS                            HM020666
      IS=IS+1                                                           HM020667
      K=2*ISTRIP                                                        HM020668
      WRITE OUTPUT TAPE NTAPE7,  3,  K, ISTRIP, IS                      HM020669
      IS=IS+1                                                           HM020670
      DO  4  I=1,22                                                     HM020671
    4   A(I)=0.                                                         HM020672
      L=0                                                               HM020673
      M=0                                                               HM020674
      DO  12  I=1,ISTRIP                                                HM020675
        DO  11  J=1,2                                                   HM020676
          M=M+1                                                         HM020677
          IF  (M-23)   8,5,5                                            HM020678
    5     M=M-22                                                        HM020679
          CALL BINPU  (A,22,IORG,BCDZ,IS,NTAPE7)                        HM020680
          IORG=IORG+22                                                  HM020681
          IS=IS+1                                                       HM020682
          DO  6  N=1,22                                                 HM020683
    6       A(N)=0.                                                     HM020684
          IF  (M-23)  15,5,5                                            HM020685
   15 IF  (L)   8,8,7                                                   HM020686
    8     A(M)=CH(I,J)                                                  HM020687
          M=M+1                                                         HM020688
          IF (M-23)    10,9,9                                           HM020689
    9     L=1                                                           HM020690
          GOTO  5                                                       HM020691
    7 L=0                                                               HM020692
```

```
10      A(M)=CH(I,J+2)                                          HM020693
11      M=M+K-2                                                 HM020694
12    M=M+2                                                     HM020695
      M=M-K                                                     HM020696
      IF  ( M )    14,14,13                                     HM020697
13  CALL BINPU  (A,M,IORG,BCDZ,IS,NTAPE7)                       HM020698
      IS=IS+1                                                   HM020699
14  CALL BINPU  (A,0,0,BCDZ,IS,NTAPE7)                          HM020700
      WRITE OUTPUT TAPE NTAPE3, 2, NSTART, IS                   HM020701
      NSTART=IS+1                                               HM020702
      RETURN                                                    HM020703
      END(1,0,0,0,0,0,0,0,0,1,0,0,0,0,0)
```

STORAGE NOT USED BY PROGRAM

DEC	OCT	DEC	OCT
269	00415	32561	77461

STORAGE LOCATIONS FOR VARIABLES APPEARING IN DIMENSION AND EQUIVALENCE STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
A	268	00414									

STORAGE LOCATIONS FOR VARIABLES NOT APPEARING IN COMMON, DIMENSION, OR EQUIVALENCE STATEMENTS

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
BCDZ	246	00366	IORG	245	00365	IS	244	00364	K	243	00363
L	242	00362	M	241	00361						

SYMBOLS AND LOCATIONS FOR SOURCE PROGRAM FORMAT STATEMENTS

	EFN	LOC		EFN	LOC		EFN	LOC		EFN	LOC
811	1	00354	812	2	00347	813	3	00327			

LOCATIONS FOR OTHER SYMBOLS NOT APPEARING IN SOURCE PROGRAM

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
2)	199	00307	3)	204	00314	6)	206	00316	9)	237	00355
C)62	239	00357	C)100	240	00360						

LOCATIONS OF NAMES IN TRANSFER VECTOR

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
BINPU	2	00002	(FIL)	1	00001	(STH)	0	00000			

ENTRY POINTS TO SUBROUTINES NOT OUTPUT FROM LIBRARY

BINPU (FIL) (STH)

EXTERNAL FORMULA NUMBERS WITH CORRESPONDING INTERNAL FORMULA NUMBERS AND OCTAL LOCATIONS

EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC
4	18	00104	5	25	00133	6	31	00156	15	33	00166
8	34	00171	9	37	00205	7	39	00210	10	40	00212
11	41	00214	12	42	00225	13	45	00245	14	48	00261

```
                                                                    7/09/
  SUBROUTINE  RDLN  (NTAPE2, NTAPE3, I )                            HM020705
1 FORMAT(80H                                                        HM020706
 1                          )                                       HM020707
2 FORMAT(1H1)                                                       HM020708
3 FORMAT  ( 1HO )                                                   HM020709
                                                                    HM020710
  READ INPUT TAPE NTAPE2, 1                                         HM020711
  GOTO   (4,5),I                                                    HM020712
                                                                    HM020713
4 WRITE OUTPUT TAPE NTAPE3, 2                                       HM020714
  GOTO  6                                                           HM020715
                                                                    HM020716
5 WRITE OUTPUT TAPE NTAPE3, 3                                       HM020717
                                                                    HM020718
6 WRITE OUTPUT TAPE NTAPE3, 1                                       HM020719
                                                                    HM020720
  RETURN                                                            HM020721
  END(1,0,0,0,0,0,0,0,0,1,0,0,0,0,0)
```

STORAGE NOT USED BY PROGRAM

DEC	OCT	DEC	OCT
76	00114	32561	77461

SYMBOLS AND LOCATIONS FOR SOURCE PROGRAM FORMAT STATEMENTS

	EFN	LOC		EFN	LOC		EFN	LOC		EFN	LOC
$$1	1	00112	$)2	2	00073	$)3	3	00072			

LOCATIONS FOR OTHER SYMBOLS NOT APPEARING IN SOURCE PROGRAM

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
6)	52	00064	C)GO	75	00113	E)1	28	00034			

LOCATIONS OF NAMES IN TRANSFER VECTOR

	DEC	OCT		DEC	OCT		DEC	OCT		DEC	OCT
(F(U)	3	00003	(RTN)	1	00001	(STH)	2	00002	(TSH)	0	00000

ENTRY POINTS TO SUBROUTINES NOT OUTPUT FROM LIBRARY

(F(L)	(RTN)	(STH)	(TSH)

EXTERNAL FORMULA NUMBERS WITH CORRESPONDING INTERNAL FORMULA NUMBERS AND OCTAL LOCATIONS

BGN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC	EFN	IFN	LOC
4	8	00035	5	10	00044	6	11	00052			

```
                    ********************************************************************** HM020727
                    *                                                                      HM020728
                    * CALLING SEQUENCE                                                     HM020729
                    *       TSX     BINPU,4                                                HM020730
                    *       TSX     LOC (ARRAY TO BE PUNCHED)                              HM020731
                    *       TSX     LOC (NO. WORDS TO PUNCH)                               HM020732
                    *       TSX     LOC (CARD ORIGIN FOR 1ST CARD)                         HM020733
                    *      *TSX     LOC (SEQ NO. OF 1ST CARD)                              HM020734
                    *      *TSX     LOC (BCD ID FOR THIS DECK, 1ST AND 2ND CHARACTER BLANKS) HM020735
                    *       TSX     LOC (OUTPUT TAPE NUMBER)                               HM020736
                    *****CONTRARY TO BELOW, NO ITEMS MAY BE OMITTED IN THIS MODIFICATION.   HM020737
                    *                                                                      HM020738
                    * ITEMS MARKED (*) MAY BE DELETED. BCD ID WILL BE                      HM020739
                    *       UNCHANGED AND SEQ. NOS. WILL BE CONTINUOUS STARTING            HM020740
                    *       FROM  000. ALSO ORDER MAY BE SWITCHED.                         HM020741
                    *                                                                      HM020742
                    * THIS VERSION PUNCHES OFF-LINE ONLY.                                  HM020743
                    *                                                                      HM020744
                    ********************************************************************** HM020745
                    00006           ENTRY   BINPU                                          HM020746
                    *                                                                      HM020747

 TRANSFER VECTOR
00000  743146623460     (IOS)
00001  746651623460     (WRS)
00002  745123303460     (RCH)
00003  746663233460     (WTC)
00004  746625513460     (WER)
00005  746325623460     (TES)

00006  0634 00 1 00142  BINPU SXA     X1,1                                               HM020748
00007  0634 00 2 00143        SXA     X2,2                                               HM020749
00010 -0500 60 4 00006        CAL*    6,4                                                HM020750
00011  0622 00 0 00331        STD     140                                                HM020751
00012  0500 00 4 00001        CLA     1,4             LOC OF ARRAY                       HM020752
00013  0621 00 0 00062        STA     ARRAY                                              HM020753
00014 -0500 60 4 00002        CAL*    2,4             WORD COUNT                         HM020754
00015  0602 00 0 77776        SLW     END             END=0 IF TRANSFER CARD             HM020755
```

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                                                                                                    HMD20755
00016  0402 00 0 00325          SUB     D1                                                         HMD20756
00017  0622 00 0 00066          STD     LOCN                                                       HMD20757
00020  0634 00 4 00061          SXA     COUNT,0                                                    HMD20758
00021  0500 60 4 00003          CLA*    3,4             SET UP CONTROL WORD                        HMD20759
00022  0771 00 0 00022          ARS     18                                                         HMD20760
00023 -0120 00 0 00025          TMI     *+2                                                        HMD20761
00024 -0501 00 0 00266          ORA     REL             ADD RELATIVE BIT                           HMD20762
00025 -0501 00 0 00334          ORA     IMAGE           7-9, WORD COUNT=22                         HMD20763
00026  0602 00 0 77740          SLW     CIMAGE          CONTROL WORD ESTABLISHED.                  HMD20764
                        ********************************************************************************HMD20765
                        *       TEST FOR FOURTH AND-OR FIFTH ARGUMENTS.                          HMD20766
                        *       DETERMINE WHETHER ARGUMENT REFERS TO ID OR SEQ NUMBER            HMD20767
                        *       AND SET CELLS FROM CALLING SEQUENCE.                             HMD20768
                        ********************************************************************************HMD20769
                                                                                                    HMD20770
00027  0774 00 2 00002          AXT     2,2                                                        HMD20771
00030 -0625 00 0 00302          STL     BLSEQ           SET BLSEQ TO ITS NORMAL STATE              HMD20772
00031 -0500 00 4 00004  G4      CAL     4,4             TEST FOR 4TH, 5TH ARGS                     HMD20773
00032 -0320 00 0 00265          ANA     MSKPDT                                                     HMD20774
00033  0322 00 0 00307          ERA     MSKTSX                                                     HMD20775
00034 -0100 00 0 00054          TNZ     G2              NO MORE TSXES                              HMD20776
00035  0500 60 4 00004          CLA*    4,4                                                        HMD20777
00036 -0340 00 0 00262          LAS     BCI8                                                       HMD20778
00037  0020 00 0 00051          TRA     G3              BIG, THIS IS ID                            HMD20779
00040  0600 00 0 00302          STZ     BLSEQ           EQUAL, FLAG BLANK SEQ. NO.                 HMD20780
00041 -0100 00 0 00043          TNZ     *+2             IS SEQ NO NON-ZERO.                        HMD20781
T 00042 -0754 00 0 00000        PXD                     NO                                         HMD20782
00043 -0130 00 0 00000          XCL                     SMALL, THIS IS SEQ NO.                     HMD20783
00044  0634 00 4 00046          SXA     *-2,4                                                      HMD20784
00045  0074 00 4 00172          TSX     COSEQ,4         CONVERT SEQ NO TO BCD                      HMD20785
00046  0774 00 4 00000          AXT     **,4                                                       HMD20786
00047  0602 00 0 00267          SLW     SEQNO           SAVE                                       HMD20787
00050  1 77777 4 00053          TXI     G5,4,-1                                                    HMD20788
00051  0601 00 0 00305  G3       STO     BCDID                                                      HMD20789
00052  1 77777 4 00053          TXI     G5,4,-1         MOVE TO NEXT ARGUMENT                      HMD20790
00053  2 00001 2 00031  G5       TIX     G4,2,1          AT MOST 2 EXTRA ARGS.                      HMD20791
00054  0634 00 4 00144  G2       SXA     X4,4                                                       HMD20792
00055 -0520 00 0 77776          NZT     END             IS WORD COUNT ZERO                         HMD20793
00056  0020 00 0 00152          TRA     TRCD            MUST BE A TRANSFER CARD
```

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                                        *                                                                                  HMD20794
                                        ***********************************************************************************HMD20795
                                        *       BUILD THE CARD IMAGE.                                                      HMD20796
                                        ***********************************************************************************HMD20797
                                        *                                                                                  HMD20798
 00057  0774 00 2 00026  NEXT   AXT     22,2                                                                               HMD20799
T00060 -0754 00 0 00000          PXD                          CLEAR AC FOR CHECKSUM.                                       HMD20800
 00061  0774 00 4 00000  COUNT  AXT     **,4                                                                               HMD20801
 00062  0560 00 4 00000  ARRAY  LDQ     **,4                 MOVE ARRAY INTO CORE.                                        HMD20802
 00063 -0600 00 2 77770          STQ     CIMAGE+24,2                                                                     HMD20803
 00064  0361 00 2 77770          ACL     CIMAGE+24,2          ACCUMULATE CHECKSUM FOR BODY.                                HMD20804
 00065  1 00001 4 00066          TXI     *+1,4,1                                                                         HMD20805
 00066  3 00000 4 00160  LOCN   TXH     OUT,4,**             FINISH WHEN SPECIFIED                                        HMD20806
 00067  2 00001 2 00062          TIX     ARRAY,2,1            BY NO. WORDS DESIRED.(2,4)                                   HMD20807
 00070  0634 00 4 00061  IN     SXA     COUNT,4              SET COUNT FOR NEXT LOOP.                                     HMD20808
 00071  0361 00 0 77740          ACL     CIMAGE               ADD IN CONTROL WORD.                                         HMD20809
 00072  0602 00 0 77741          SLW     CIMAGE+1             PUT CHECKSUM IN IMAGE.                                       HMD20810
                                        *                                                                                  HMD20811
                                        ***********************************************************************************HMD20812
                                        *       EDIT THE IDENTIFICATION FIELD.                                             HMD20813
                                        ***********************************************************************************HMD20814
                                        *                                                                                  HMD20815
 00073 -0500 00 0 00267  EDIT   CAL     SEQNO                                                                              HMD20816
 00074  0560 00 0 00327          LDQ     L(1)                                                                            HMD20817
 00075 -0765 00 0 00022          LGR     18                                                                              HMD20818
 00076 -0500 00 0 00305          CAL     BCDID                                                                           HMD20819
 00077 -0763 00 0 00006          LGL     6                                                                               HMD20820
 00100 -0600 00 0 00326          STQ     IDLCD                SAVE FOR FINISHING.                                        HMD20821
 00101 -0130 00 0 00000          XCL                                                                                     HMD20822
 00102  0634 00 1 00120          SXA     SV1,1                                                                           HMD20823
 00103  0774 00 2 00004          AXT     4,2                                                                             HMD20824
 00104  0774 00 4 00002          AXT     2,4                                                                             HMD20825
 00105  0774 00 1 00003  ABC    AXT     3,1                                                                             HMD20826
T00106 -0754 00 0 00000          PXD                                                                                     HMD20827
 00107 -0114 01 0 00230          CAQ     TAB,,1                                                                          HMD20828
 00110 -2 00001 1 00113          TNX     *+3,1,1                                                                         HMD20829
 00111  0767 00 0 00014          ALS     12                                                                              HMD20830
 00112  0020 00 0 00107          TRA     *-3                                                                             HMD20831
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00113  0602 00 2 77734          SLW     LAST+4,2        COL BIN AT LAST TO LAST+3                HMD20832
00114  1 77777 2 00115          TXI     *+1,2,-1                                                 HMD20833
00115  2 00001 4 00105          TIX     ABC,4,1                                                  HMD20834
00116  0560 00 0 00326          LDQ     IDLCD           FINISH W/SAVED C(MQ).                    HMD20835
00117  3 00000 2 00104          TXH     ABC-1,2,0                                                HMD20836
00120  0774 00 1 00000  SV1     AXT     **,1                                                     HMD20837
                        *                                                                        HMD20838
                        ************************************************************************HMD20839
                        *       THE ENTIRE CARD IMAGE IS BUILT, WITH THE BODY                    HMD20840
                        *       AT CIMAGE THRU CIMAGE+23, AND ID AT LAST THRU LAST+3.            HMD20841
                        *       NOW  ***** WRITE THE CARD ON TAPE. ********                      HMD20842
                        ************************************************************************HMD20843
00121  0761 00 0 00000  WRITE   NOP                                                              HMD20844
00122 -0500 00 0 00331  WRITE1  CAL     14D                                                      HMD20845
00123  0074 00 4 00000          CALL    (IOS)           ESTABLISH I/O FOR TAPE 14.               HMD20846
00124  0522 60 0 00001          XEC*    $(WRS)                                                   HMD20847
00125 -0774 00 4 00213          AXC     PUNCMD,4                                                 HMD20848
00126  0522 60 0 00002          XEC*    $(RCH)                                                   HMD20849
00127  0754 00 4 00000          PXA     0,4             SET (WER) FOR RETRY.                     HMD20850
00130  0621 60 0 00003          STA*    $(WTC)                                                   HMD20851
00131  0074 00 4 00004  BPTES   TSX     $(WER),4                                                 HMD20852
00132 -0500 00 0 00267          CAL     SEQNO                                                    HMD20853
00133  0400 00 0 00327          ADD     L(1)            INCREMENT CARD COUNT.                    HMD20854
00134  0114 06 0 00215          CVR     TB1,,6                                                   HMD20855
00135  0602 00 0 00267          SLW     SEQNO                                                    HMD20856
00136  0520 00 0 77776          ZET     END             TEST IF LAST CARD.                       HMD20857
00137  0020 00 0 00146          TRA     SWTCH               NOT THE LAST CARD....                HMD20858
00140 -0500 00 0 00131          CAL     BPTES                                                    HMD20859
00141  0602 60 0 00005          SLW*    $(TES)                                                   HMD20860
00142  0774 00 1 00000  X1      AXT     **,1                ALL DONE. EXIT                       HMD20861
00143  0774 00 2 00000  X2      AXT     **,2                                                     HMD20862
00144  0774 00 4 00000  X4      AXT     **,4                                                     HMD20863
00145  0020 00 4 00005          TRA     5,4                                                      HMD20864
                        *                                                                        HMD20865
                        ************************************************************************HMD20866
00146 -0500 00 0 77740  SWTCH   CAL     CIMAGE              UPDATE THE CARD ORIGIN.              HMD20867
00147  0361 00 0 00333          ACL     A22                                                      HMD20868
00150  0602 00 0 77740          SLW     CIMAGE                                                   HMD20869
```

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                00151  0020 00 0 00057          TRA     NEXT                                                    HMD20870
                                                ********************************************************************HMD20871
                                                *                                                                HMD20872
                00152  0774 00 2 00027   TRCD   AXT     23,2            CLEAR REST OF                           HMD20873
                00153  0600 00 2 77770          STZ     CIMAGE+24,2     CARD IMAGE.                             HMD20874
                00154  2 00001 2 00153          TIX     *-1,2,1                                                 HMD20875
                00155  0500 00 0 00322          CLA     ZWC             STORE ZERO WORD COUNT                   HMD20876
                00156  0622 00 0 77740          STD     CIMAGE                                                  HMD20877
                00157  0020 00 0 00073          TRA     EDIT                                                    HMD20878
                                                *                                                               HMD20879
                                                ********************************************************************HMD20880
                                                *                                                               HMD20881
                00160  0600 00 0 77776   OUT    STZ     END             WORD COUNT EXHAUSTED                    HMD20882
                00161 -2 00001 2 00070          TNX     IN,2,1          RETURN IF CARD IS FULL                  HMD20883
                00162  0602 00 0 77777          SLW     COMMON          SAVE CHECKSUM.                          HMD20884
                00163 -0754 00 2 00000          PXD     0,2             CORRECT WORD COUNT                      HMD20885
                00164  0402 00 0 77740          SUB     CIMAGE                                                  HMD20886
                00165  0622 00 0 77740          STD     CIMAGE                                                  HMD20887
                00166 -0500 00 0 77777          CAL     COMMON          RETURN CHECKSUM.                        HMD20888
                00167 -3 00000 2 00070          TXL     IN,2,0                                                  HMD20889
                00170  0600 00 2 77770          STZ     CIMAGE+24,2     CLEAR REST OF CARD.                     HMD20890
                00171  1 77777 2 00167          TXI     *-2,2,-1                                                HMD20891
                                                *                                                               HMD20892
                                                ********************************************************************HMD20893
                                                * THIS ROUTINE CONVERTS A BINARY INTEGER TO BCD. (4 DIGITS DECR-MQ)HMD20894
                                                ********************************************************************HMD20895
                                                *                                                               HMD20896
T               00172 -0754 00 0 00000   COSEQ  PXD                                                             HMD20897
                00173 -0520 00 0 00302          NZT     BLSEQ           TEST IF BLANKS DESIRED.                 HMD20898
                00174  0020 00 0 00211          TRA     COSEQX                                                  HMD20899
                00175  0765 00 0 00022          LRS     18              RIGHT ADJUST BIN INTEGER                HMD20900
                00176  0221 00 0 00332          DVP     TEN                                                     HMD20901
                00177  0601 00 0 77777          STO     COMMON                                                  HMD20902
T               00200 -0754 00 0 00000          PXD                                                             HMD20903
                00201  0221 00 0 00332          DVP     TEN                                                     HMD20904
                00202  0767 00 0 00006          ALS     6                                                       HMD20905
                00203 -0602 00 0 77777          ORS     COMMON                                                  HMD20906
T               00204 -0754 00 0 00000          PXD                                                             HMD20907
```

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00205  0221 00 0 00332          DVP     TEN                                          HM020908
00206  0767 00 0 00014          ALS     12                                           HM020909
00207 -0501 00 0 77777          DRA     COMMON          RIGHT ADJUSTED SEQ NO.       HM020910
00210  0020 00 4 00001          TRA     1,4                                          HM020911
00211 -0500 00 0 00306  COSEQX  CAL     BLANK           BLANK OUT SEQ. NO.           HM020912
00212  0020 00 4 00001          TRA     1,4                                          HM020913
                                *                                                    HM020914
                                ********************************************************************HM020915
                                *                                                    HM020916
00213 -0 00030 0 77740  PUNCMD  IOCP    CIMAGE,0,24                                  HM020917
00214  0 00003 0 77730          IOCD    LAST,0,3                                     HM020918
                                *                                                    HM020919
                                * TABLE FOR BCD ADDITION OF 1 TO C(ACC)              HM020920
                                *                                                    HM020921
00215  0000 00 0 00215  TB1     HTR     TB1             0                            HM020922
00216  0100 00 0 00215  TB      TZE     TB1             1                            HM020923
00217  0200 00 0 00215          MPY     TB1             2                            HM020924
00220  0300 00 0 00215          FAD     TB1             3                            HM020925
00221  0400 00 0 00215          ADD     TB1             4                            HM020926
00222  0500 00 0 00215          CLA     TB1             5                            HM020927
00223  0600 00 0 00215          STZ     TB1             6                            HM020928
4 00224  0700 00 0 00215        CPY     TB1             7                            HM020929
TD 00225  1 00000 0 00215        TXI     TB1             8                           HM020930
00226  1 10000 0 00215          TXI     TB1,0,4096      9                            HM020931
00227  0000 00 0 00216          HTR     TB              0 WITH CARRY                 HM020932
                                * TABLES FOR BCD-COL. BIN. CONVERSION               HM020933
                                * HOLES ARE FILLED IN WITH CONSTANTS                HM020934
00230 +000000001000  TAB     OCT     1000,400,200,100,40,20,10,4,2,1              HM020935
00231 +000000000400
00232 +000000000200
00233 +000000000100
00234 +000000000040
00235 +000000000020
00236 +000000000010
00237 +000000000004
00240 +000000000002
00241 +000000000001
00242 -377777770000  MSK2CH OCT     777777770000,102,42                          HM020936
```

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      00243 +000000000102
      00244 +000000000042
      00245 +000000000000       ID123 OCT     0,0,0                                                    HMD20937
      00246 +000000000000
      00247 +000000000000
      00250 +000000004000             OCT     4000,4400,4200,4100,4040,4020,4010,4004,4002,4001        HMD20938
      00251 +000000004400
      00252 +000000004200
      00253 +000000004100
      00254 +000000004040
      00255 +000000004020
      00256 +000000004010
      00257 +000000004004
      00260 +000000004002
      00261 +000000004001
      00262  106060606060       BCI8  BCI     1,8                                                      HMD20939
      00263 +000000004102             OCT     4102,4042                                                HMD20940
      00264 +000000004042
      00265 -3 77777 7 00000    MSKPDT TXL     0,7,-1                                                   HMD20941
A     00266  0400 00 0 00000      REL  ADD                                                              HMD20942
      00267  606060606060       SEQNO BCI     1,                                                       HMD20943
      00270 +000000002000             OCT     2000,2400,2200,2100,2040,2020,2010,2004,2002,2001        HMD20944
      00271 +000000002400
      00272 +000000002200
      00273 +000000002100
      00274 +000000002040
      00275 +000000002020
      00276 +000000002010
      00277 +000000002004
      00300 +000000002002
      00301 +000000002001
      00302  0 00000 0 00000    BLSEQ                                                                  HMD20945
      00303 +000000002102             OCT     2102,2042                                                HMD20946
      00304 +000000002042
      00305  606060606060       BCDID BCI     1,                                                       HMD20947
      00306  606060606060       BLANK BCI     1,                                                       HMD20948
      00307  0074 00 0 00000    MSKTSX TSX     ,0                                                       HMD20949
      00310 +000000000000             OCT     0,1400,1200,1100,1040,1020,1010,1004,1002,1001           HMD20950
```

```
00311 +000000001400
00312 +000000001200
00313 +000000001100
00314 +000000001040
00315 +000000001020
00316 +000000001010
00317 +000000001004
00320 +000000001002
00321 +000000001001
00322 +000500000000          ZWC     OCT     000500000000        ZERO WORDS FOR TCD          H4D20951
00323 +000000001102                  OCT     1102,1042                                       H4D20952
00324 +000000001042
00325   0 00001 0 00000       D1              0,0,1                                           H4D20953
00326   0 00000 0 00000       IDLCD   PZE                                                     H4D20954
00327   0 00000 0 00001       L(1)    PZE     1                                               H4D20955
00330   0 00000 0 00005       5A      PZE     5                                               H4D20956
00331   0 00014 0 00020       14D     PZE 16,,12                                              H4D20957
00332 +000000000012           TEN     DEC     10                                              H4D20958
00333   0000 00 0 00026       A22     HTR     22                                              H4D20959
00334 +000526000000           IMAGE   OCT     000526000000        CONTROL WORD SKELETON       H4D20960
                    77777     COMMON  EQU     -1                                              H4D20961
                    77740     CIMAGE  EQU     -32                                             H4D20962
                    77730     LAST    EQU     -40                                             H4D20963
                    77776     END     SYN     COMMON-1                                        H4D20964
                              END                                                             H4D20965
```

POST PROCESSOR ASSEMBLY DATA

336 IS THE FIRST LOCATION NOT USED BY THIS PROGRAM

REFERENCES TO DEFINED SYMBOLS

330	5A										
336	D1	16									
54	G2	34									
51	G3	37									
31	G4	53									
53	G5	50,	52								
70	IN	161,	167								
216	TB	227									
142	X1	6									
143	X2	7									
144	X4	54									
391	14D	11,	122								
333	A22	147									
105	ABC	115,	117								
77776	END	15,	55,	136,	160,	335					
160	OUT	66									
266	REL	24									
120	SV1	102									
230	TAB	107									
215	TB1	134,	215,	216,	217,	220,	221,	222,	223,	224,	225, 226
332	TEN	176,	201,	205							
322	ZWC	155									
262	BCIB	36									
73	EDLT	157									
77730	LAST	113,	214,	335							
66	LOCN	17									
327	L(1)	74,	133								
57	NEXT	151									
152	TRCD	56									
62	ARRAY	13,	67								
305	BCDID	51,	76								
6	BINPU										
306	BLANK	211									
302	BLSEQ	30,	40,	173							

POST PROCESSOR ASSEMBLY DATA

```
      131  BPTES    140
      172  COSEQ     45
       61  COUNT     20,   70
      245  ID123
      326  IDLCD    100,  116
      334  IMAGE     25
      267  SEQNO     47,   73,  132,  135
      146  SWTCH    137
      121  WRITE
        0  (IOS)    123
        2  (RCH)    126
        5  (TES)    141
        4  (WER)    131
        1  (WRS)    124
        3  (WTC)    130
    77740  CIMAGE    26,   63,   64,   71,   72,  146,  150,  153,  156,  164,  165,  170,  213,  335
    77777  COMMON   162,  166,  177,  203,  207,  335
      211  COSEQX   174
      242  MSK2CH
      266  MSKPDT    32
      307  MSKTSX    33
      213  PUNCMD   125
      122  WRITE1
```

NO ERROR IN ABOVE ASSEMBLY.

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